DRAFT REPORT

FOCUSED SITE INVESTIGATION

of the

Former Merrill & Ring Property
Port Angeles, Washington

prepared for

Daishowa
America
Port Angeles
MILL

by

CH2M HILL

MARCH 1989

PREFACE

This report has been prepared by CH2M HILL under a contract with Daishowa America Company, Ltd.

CONCLUSIONS AND EXECUTIVE SUMMARY

A focused environmental site investigation was conducted at the former Merrill & Ring wood treating facility located in Port Angeles, Washington. The site investigation was undertaken in the late summer and autumn of 1988 and was focused on a 2-acre area of the former Merrill & Ring Lumber Company. The main objective of the study was to evaluate the magnitude and extent of the wood preservatives pentachlorophenol (PCP) and tetrachlorophenol (TCP) potentially released to soil, groundwater, and marine sediments by Merrill and Ring. The practice of applying PCP and TCP to wood was discontinued in the focused site investigation area over 15 years ago. The study was performed by CH2M HILL under contract to Daishowa America Company, Ltd., which recently purchased the site.

Project conclusions and results are summarized below.

CONCLUSIONS

PCP and TCP were detected in soil, groundwater, and marine sediments as follows:

- PCP and/or TCP were detected in soil samples collected from 6 of 12 locations at depths of 5 to 30 feet below the ground surface. Excluding results that are quantitatively suspect, concentrations ranged from 1.7 mg/kg (ppm, on an as received basis) to 24 mg/kg. With the exception of the highest value (24 mg/kg), the remaining values are within three to five times the method detection limit (1.0 mg/kg, on an as received basis.

- PCP and/or TCP were detected in groundwater samples collected from 9 of 19 monitoring wells (nine existing Hart Crowser wells included). However, only three wells (MW-6A, MW-6C, and MW-16A--see Figure S-1 for well locations) indicated the presence of these compounds consistently over time. Concentrations of PCP and TCP in these three wells ranged from 0.04 to 14.3 mg/l (ppm). Groundwater from each of these wells was sampled three times. The two followup sampling events show consistently lower values, with a high value of 2.1 mg/l at MW-6A. These subsequent values are believed to be more representative of the actual conditions because of difficulties in developing or redeveloping the wells.

- PCP was detected in marine sediments at two of five locations. Concentrations were 4.7 and

6.4 mg/kg on a dry weight basis. However, both of these values were qualified by the analytical laboratory as being quantitatively suspect. These values are relatively low, being within three to five times the method detection limit.

Based on analytical results and characterization of subsurface conditions at the former Merrill & Ring property, there is no technical precedent, nor are there human health or environmental criteria, that would indicate that remedial action is required. Although there is some limited PCP and TCP contamination in soil and groundwater, the analytical results are anomalous and many of the detected values are qualified by the laboratory as quantitatively or qualitatively suspect. Further action is not justified for the following reasons:

- The reported PCP and TCP concentrations in soil do not exceed any published criteria for soil quality. Using the EPA convention that laboratory results for soil may not be meaningful when concentrations are less than 5 to 10 times the practical quantitation limit, the concentrations detected during the focused site investigation are not significant with the exception of one value at boring 16C. As an additional comparison, the concentrations of PCP detected in soil samples collected at the site are comparable to those reported for residential street sweeping debris (Metro, December 1982).
- Groundwater at the site is not used for any beneficial purpose and, because of its brackish quality, it is not suitable as a future source of drinking water. Therefore, regulatory standards for drinking water are not applicable to groundwater at the site. Furthermore, PCP and TCP concentrations in groundwater samples collected from monitoring wells nearest the shoreline are below the federal and state criteria for marine surface waters.
- The planned expansion of the Daishowa facility includes the construction of a new paper mill. The mill will be constructed directly over the focused site investigation area. All identified zones of contamination will therefore be effectively "capped." This will prevent infiltration of precipitation and surface runoff through the unsaturated soils that may act as a potential source of groundwater contamination. Figure S-2

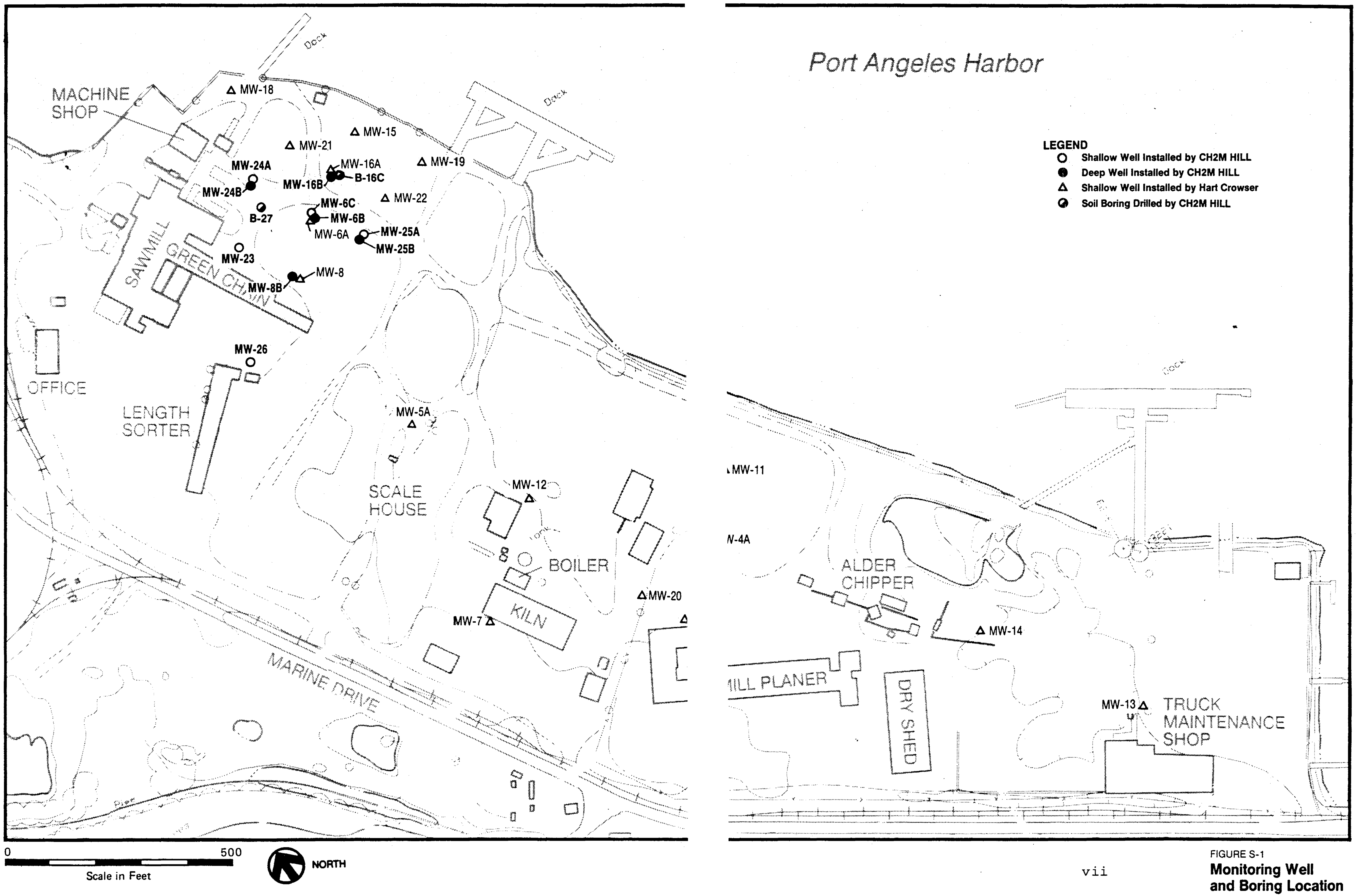


FIGURE S-1
Monitoring Well and Boring Location

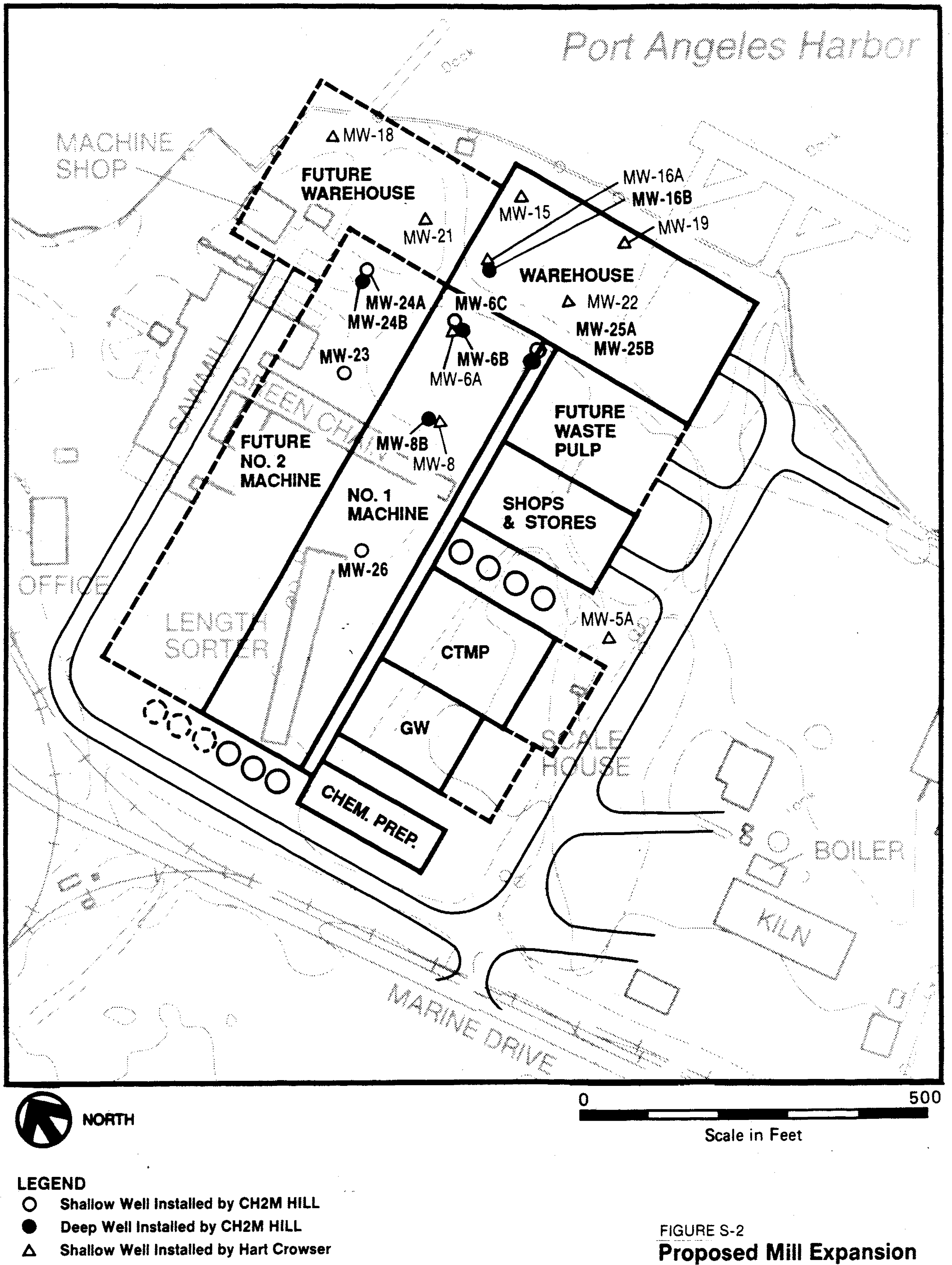


FIGURE S-2

Proposed Mill Expansion
Daishowa America Co., Ltd.

shows the layout of the proposed mill relative to the existing monitoring wells in the focused site investigation area.

- Data collected concerning the PCP and TCP in groundwater suggest that these chemicals may be degraded by chemical and microbiological means before reaching Port Angeles Harbor. The anaerobic conditions and periodic flooding of the Merrill & Ring site may further enhance microbial breakdown of PCP (Mikesell and Boyd, 1988, and reference cited therein). This fact appears to be supported by the low levels and absence of PCP and TCP in groundwater and soil samples collected from monitoring wells nearest the Port Angeles Harbor and from marine sediment samples collected downgradient and offshore of the study area.

- Based on groundwater analytical data, the presence of PCP and TCP in groundwater appears to be limited to shallow depths (i.e., 5 to 15 feet below the ground surface) in small areas near monitoring wells MW-6A, MW-6C, and MW-16A (see Figure S-1 for well locations). This is corroborated by the lack of PCP and TCP in soil and groundwater adjacent to and downgradient of these locations. PCP was not detected in any groundwater samples collected from deep monitoring wells (screened approximately 40 to 50 feet below ground surface). TCP was detected only one time in a deep monitoring well (MW-6B), at a concentration very near the method detection limit. This detection is anomalous as neither PCP or TCP were detected in a subsequent groundwater sample collected from MW-6B, or in the soils obtained in boring this well, except for one qualified TCP result.

BACKGROUND INFORMATION AND STUDY FINDINGS

In June 1988, Daishowa purchased and leased approximately 50 acres of land, formerly the site of the Merrill & Ring Lumber Company. During a property transfer assessment performed by Hart Crowser, it was determined that wood preservatives, including PCP and TCP, had contaminated soils and possibly groundwater in the northeast corner of the property (Hart Crowser, 1988). This portion of the former Merrill & Ring site was the location of an old planer mill and dip tank. The source of PCP is attributed to drippage and spillage associated with the application of PCP to wood. This area of the former Merrill & Ring site has not been used for wood preserving activities for approximately 15 years.

In response to the property transfer assessment, Daishowa retained CH2M HILL to determine the nature and extent of PCP contamination in the vicinity of the old planer mill and, if necessary, identify remedial actions that could effectively be implemented to protect human health and the environment.

Daishowa also requested that CH2M HILL conduct a review of the property transfer assessment report prepared by Hart Crowser and verify available site information and records. A limited number of soil and groundwater samples were also collected and analyzed to corroborate or refute the general findings of the property transfer assessment.

In response to Daishowa's requests, CH2M HILL conducted a focused site investigation, which included assessment of local hydrogeological conditions and chemical analyses of soil, groundwater, and marine sediment samples. Using nine groundwater monitoring wells installed by Hart Crowser, and installing ten new groundwater monitoring wells, CH2M HILL characterized site groundwater hydrogeology and analyzed soils and groundwater for the presence or absence of PCP and TCP. Figure S-1 presents the focused site investigation area and the location of all groundwater monitoring wells. The verification study sample locations are presented in the technical memorandum appended to this report.

SITE INVESTIGATION AND ANALYTICAL METHODS

Evaluation of site groundwater hydrology was undertaken by classifying subsurface materials, measuring groundwater elevations, performing noninvasive slug tests, and measuring tidal influence or groundwater elevation and movement.

Soil and marine sediment samples were characterized for physical characteristics including grain size, permeability, and--for marine sediments only--total organic carbon content.

Soil, sediment, and groundwater samples were analyzed in accordance with appropriate test methods described in the Code of Federal Regulations (40 CFR, Part 261, Appendix III--Chemical Analysis Test Methods). The procedures selected are described in Test Methods for Evaluating Solid Waste (SW 846, September 1986) and include:

- EPA recommended analytical Test Method 8040 for PCP and TCP
- EPA recommended analytical Test Method 8270 for semivolatile organic compounds
- 40 CFR 264 Appendix IX parameters

- EPA recommended analytical Test Method 7471 for mercury in soils

Method 8040 analyses were performed on 60 soil, 6 sediment, and 44 groundwater samples. Method 8270 analyses were conducted on 17 soil, 1 sediment, and 4 groundwater samples. Method 8270 analyses were used as a performance check on the Method 8040 analyses and as a means to test sampled media for the presence of other contaminants including phenolic breakdown products.

Mercury analyses were performed to determine if the wood preservative used, Permatox 180, included a fungicide that could have contaminated soils with mercury. Finally, Appendix IX analyses of four groundwater and one soil sample were performed as a standard of concern by Daishowa to ensure that it conducted a thorough examination of the most probable contaminated areas for other hazardous substances that may be of concern to the Washington State Department of Ecology (Ecology). Appendix IX parameters were chosen as the most extensive and practical set of analyses for potentially regulated contaminants. The soil sample was analyzed for the same set of parameters although the regulations in 40 CFR 264 are aimed at groundwater only. The Appendix IX analyses also serve as verification of previous dioxin test results performed by Hart Crowser.

Verification of the groundwater samples of the Hart Crowser property transfer assessment wells was undertaken during the sampling of groundwater in the focused site investigation. Verification of six soils and two additional marine sediments also was undertaken. A summary of the verification data acquisition efforts is provided in a technical memorandum included as an addendum to this report.

Laboratory results and the significance of the project findings are presented in detail in Sections 4 and 5 of this report. Raw data are presented in Appendixes D, E, and F.

SUBSURFACE SOILS

With the exception of monitoring well MW-16C (TCP at 6.2 mg/kg) all subsurface soil samples analyzed by Method 8040 indicate that PCP and TCP were present in very low concentrations (PCP at 2.22 to 2.81 mg/kg; TCP at 1.35 to 4.55 mg/kg). These reported values fall near the laboratory's method detection limit and the concentrations do not exceed published soils criteria for PCP. In general, the results of these soils analyses are similar to the average concentration of PCP detected in urban residential street sweeping dust (Metro, December 1982).

The Method 8270 analyses of subsurface soils compare favorably to the Method 8040 results, with no PCP or TCP (tentatively identified since 8270 does not target TCP specifically) at any concentration in any samples except those collected from MW-25B (PCP at 1.7 and 0.28 mg/kg; TCP at 0.19 and 0.71 mg/kg) and SB-16CD (PCP at 24 mg/kg; TCP at 27 mg/kg).

None of the PCP and the tentatively identified TCP values exceed EPA's health-based soil criterion of 500 mg/kg for PCP.

Other results from the Method 8270 analysis for semivolatile organic compounds indicated the presence of some polynuclear aromatic hydrocarbon (PAH) compounds, phenol, and 4-methylphenol in surface soils (2.5 feet or less). None of these compounds was detected in soils below the surface. These compounds also were reported at very low concentrations, all of which fall below apparent biological effects thresholds (AETs) proposed to evaluate marine sediments in the draft Puget Sound Marine Sediment Criteria Evaluation (Ecology, 1988). These samples are surface soils, so the comparison to marine sediment standards is for illustration only. There are no other health-based or regulating criteria with which to compare these results. The AETs, however, are considered stringent criteria.

Mercury analyses of soils (29 samples) indicated that no soil tested exceeded the range of mercury found naturally in soils.

Appendix IX analyses of soil did not identify any significant contamination. The Appendix IX results confirmed Hart Crowser's conclusion that dioxin contamination is unlikely at the Merrill & Ring site. No dioxins were detected in any of the Appendix IX analyses conducted during the focused site investigation.

GROUNDWATER

With the exception of monitoring wells MW-6A (PCP ranged from 0.51 mg/l to 3.07 mg/l) and MW-6C (PCP ranged from 0.16 mg/l to 14.3 mg/l), the groundwater sampled by Method 8040 analyses showed PCP values below or very near the practical quantitation limit (0.05 mg/l or ten times the laboratory's method detection limit of 0.005 mg/l). It is important to note that the highest value for both MW-6B and MW-6C were detected during the first round of sampling and analysis and dropped to a much lower level with subsequent sampling events. This is believed to be a result of the gradual reduction in turbidity of the groundwater collected from monitoring wells after well development or redevelopment. The close support laboratory reported the turbidity of the groundwater samples was due in large part to colloidal suspensions that could not be centrifuged out of the samples. Studies have shown that PCP can be adsorped on colloids (Choi and Aomine, 1974). If colloidal PCP were being measured as part of the groundwater level, the gradual settling of the suspension should be accompanied by a lowering of the diluted levels in the groundwater. This groundwater is brackish and is not a source of drinking water, so there are no applicable regulatory standards.

TCP detections and concentrations varied in groundwater samples collected from the same wells at different times. TCP was detected in groundwater samples collected from MW-19 and MW-25A in one of the two rounds of sampling and analyses. Both values are qualified as suspect by the laboratory. TCP was detected in samples collected from MW-16A in all three sampling events. These values, however, are all qualified by the laboratory. Concentrations were 0.105 mg/l for Round 1, 0.006 mg/l for Round 2, and 0.092 mg/l for Round 3. PCP was detected in groundwater samples collected from MW-16A during Round 1 (0.052 mg/l) and Round 3 (0.064 mg/l) only. PCP was not detected in the Round 2 sample.

The groundwater sample collected from deep well MW-6B during Round 1 contained TCP at 0.010 mg/l (only two times the method detection limit). MW-6B was analyzed a second time by Method 8040, twice by Method 8270, and for Appendix IX constituents; neither PCP nor TCP was detected in any of these tests. This discrepancy is believed to be the result of prolonged groundwater turbidity after well development. PCP was not detected in this well during either round of sampling. It is believed that the detected TCP may have been detected in the colloidal material. PCP or TCP was not identified in the deep monitoring zone near MW-6B.

Analysis of groundwater samples collected from shallow wells MW-6A and MW-6C verify the presence of PCP and TCP at the site. Detectable concentrations of both compounds were reported in samples collected from both wells during all three sampling events, although, again, samples collected during the first sampling event had substantially higher levels than those collected during latter sampling events. Furthermore, the 40 CFR Appendix IX analysis of MW-6C, which was conducted during the last sampling event, did not detect the presence of PCP or TCP. MW-6A showed irregular fluctuations in concentrations of PCP and TCP. It is believed that these fluctuations are a result of particulates in groundwater samples, and are not a true measure of soluble PCP and TCP in groundwater.

There are no drinking water criteria for TCP, and the groundwater sampled does not represent a drinking water source. For comparison, however, the second and third groundwater samples collected from MW-6C did not contain TCP at concentrations greater than the proposed maximum contaminant level goals (MCLGs) for PCP in drinking water (0.22 mg/l).

The State of Washington Water Quality Standards (WAC 173-201-047) has set the marine surface water toxic substance criteria for PCP at 0.0079 mg/l for chronic exposure and 0.013 mg/l for acute exposure. For the three wells closest to the harbor (approximately 60 to 80 feet from the shoreline), one well did not have PCP values that exceed either criterion, one well reported PCP value during the first sampling round that exceeded the chronic limit but was below both limits for the second round, and the third well exceeded both the chronic and acute limits during the first round but was below both for the second round of sampling. It is important to emphasize that these limits are for marine surface waters and do not apply to these groundwater monitoring well samples. The values that exceeded the marine criteria were both reported during the first round of sampling following well development. Tetrachlorophenol is not listed in the state regulations. It was detected in only one of the three wells nearest the harbor, at a level below the published marine chronic lowest observed effect value of 0.440 mg/l. Again, this comparison of groundwater to surface water criteria or published effects data is for illustrative purposes only to demonstrate that values of contaminants detected in groundwater at this site are at or below regulated levels in marine water. It is reasonable to assume that marine surface waters 60 to 80 feet away would not exceed current water quality standards.

PCP was detected in two of the four groundwater samples analyzed by Method 8270. The PCP concentration (6.9 mg/l) in a groundwater sample collected in the first round of sampling from MW-6C is the same magnitude (14.3 mg/l) as the Method 8040 analysis of a sample collected during the same sampling round. Analysis of a sample collected from MW-16A in the third round of sampling indicated a low level (below the EPA quantitation limit) of PCP. Isomers of TCP were among the tentatively identified compounds detected in samples collected from MW-6C and MW-16A. (TCP is not on the target list for this method.) The levels are of similar magnitude as the Method 8040 values for these samples.

The only other Method 8270 compounds identified in groundwater samples were two of the possible PCP breakdown products, 2,4-dichlorophenol and 2,4,5-trichlorophenol detected in groundwater from MW-6C, and napthalene (a PAH compound) detected in groundwater collected from both MW-6C and MW-16C. All these values from Method 8270 analyses except the TCP and PCP at MW-6C, are below the health-based drinking water criteria; these criteria, however, are not applicable to this site because the groundwater is not potable.

CONTENTS

Appendixes

TABLES

FIGURES

GLOSSARY

Advection:	The process by which solutes are transported by the bulk motion of flowing groundwater.
Aerobic:	Description of a biological reaction that requires the presence of air or oxygen.
Airlifting:	A means of removing water from a well using compressed air.
Alkalinity:	The capacity of a water to accept protons (i.e., hydrogen ions).
Alluvium:	Unconsolidated material (e.g., gravel, sand, silt, and clay) deposited by a river, stream, or other body of running water.
Anaerobic:	Description of a biological reaction that occurs in the absence of air or oxygen.
Anions:	An ion having a negative charge; anions in a liquid subjected to electric potential collect at the positive pole or anode.
Annular seal:	A sanitary seal consisting of a relatively impermeable material (e.g., bentonite and/or grout) that is placed in the annular space between a well casing and the borehole wall.
Anthropogenic:	Made or induced by man.
Aquifer:	A geologic formation, group of formations, or part of a formation that is capable of yielding significant quantities of water to a well or spring.
Brackish:	When used in reference to water, brackish indicates a salinity content less than seawater but more than water suitable for drinking.
Cations:	An ion having a positive charge; cations in a liquid subjected to electric potential collect at the negative pole or cathode.

Centralizer:	A device used to center a well screen and casing in a borehole during installation and stabilization of filter pack and seal materials.
Colloid:	Extremely small, insoluble particles (0.0001 to 1 micron in diameter) that will not settle out of a solution.
Detection limit:	The lowest concentration at which a chemical compound or element can be identified.
Detritus:	Loose particles of rock or organic debris separated from the parent material by mechanical means such as abrasion or disintegration.
Diurnal:	On a daily basis.
Eductor pipe:	A pipe through which water is discharged from a well during airlift pumping.
Filter pack:	A material generally consisting of clean, washed siliceous sand of uniform grain size distribution that is placed around a well screen to prevent smaller size formation material (e.g., fine sand, silt, and clay) from entering the well.
Gas chromatography:	The process in which a gaseous mixture is passed through a column packed with absorbent material to identify and quantify the chemical constituents (generally volatile organic compounds).
Head space:	(1) The space filled with air above the static water level in a well. (2) The space filled with air above a sample material in a sample container.
Heave:	When formation materials (i.e., sand, silt) are forced up into temporary drill casing or hollow-stem auger during drilling by hydrostatic pressure encountered below the water table.
Heterogeneous:	Nonuniform in structure and composition.

Hydraulic conductivity:	The rate at which water will move through a porous medium under a unit hydraulic gradient.
Hydraulic gradient:	The rate of change of hydraulic head per unit distance.
Hydraulic head:	Potential energy of a water mass due to elevation, pressure, or velocity.
Hydrographs:	A graph showing stage, flow, velocity, or other properties of water with respect to time.
Isomer:	(1) One or two or more molecules having the same number and kind of atoms and hence the same molecular weight, but differing in respect to the arrangement or configuration of the atoms. (2) Nuclides having the same atomic and mass numbers, but existing in different energy states.
Lithosphere:	The outer, rigid part of the earth's crust.
Microbial:	Refers to the activity and effects of microorganisms.
Monitoring well:	A well used to collect groundwater samples and hydrologic data such as groundwater elevations.
Partitioning coefficient:	The ratio of a chemical's concentration in the octanol phase to its concentration in the aqueous phase of a two-phase octanol/water system.
Peristaltic pump:	A type of suction pump.
Pleistocene:	An epoch of the Quarternary period, which occurred approximately 10,000 to 2 million years before present.
Practical quantitation limit:	The lowest concentration of a chemical compound or element at which acceptable precision and accuracy can be reliably maintained by an analytical laboratory.

Purge water:	Groundwater removed from a monitoring well before a groundwater sample is collected. Purging removes stagnant water from the well and allows collection of more representative groundwater sample.
Qualitative:	Refers to the identification of individual chemical compounds and elements in an environmental sample.
Quantitative:	Refers to the determination of a concentration or percentage of a known chemical compound or element in an environmental sample.
Recharge:	The addition of water to the groundwater system by natural or artificial processes.
Saline:	Any solution of sodium chloride and water, usually containing other salts.
Shelby tube:	A thin-walled steel tube used to collect relatively undisturbed soil samples.
Slug test:	A hydrologic test performed in a well to measure the hydraulic conductivity of the geologic materials surrounding the well screen.
Split-spoon:	A steel, cylindrical soil-sampling device, which splits in half to reveal the sample material. The split-spoon sampler is usually used with a drill rig and is driven through subsurface geologic strata to collect soil samples.
Static groundwater level:	The level of water in a well that is not being affected by artificial withdrawal (e.g., pumping) or recharge of groundwater.
Stratified:	Refers to beds or layers in sedimentary deposits formed during deposition.
Transducer:	A measurement device that converts an input signal to an output signal.

	Pressure transducers are commonly used to measure water levels in wells.
Turbidity:	The presence of nondissolved suspended solids in a solution.

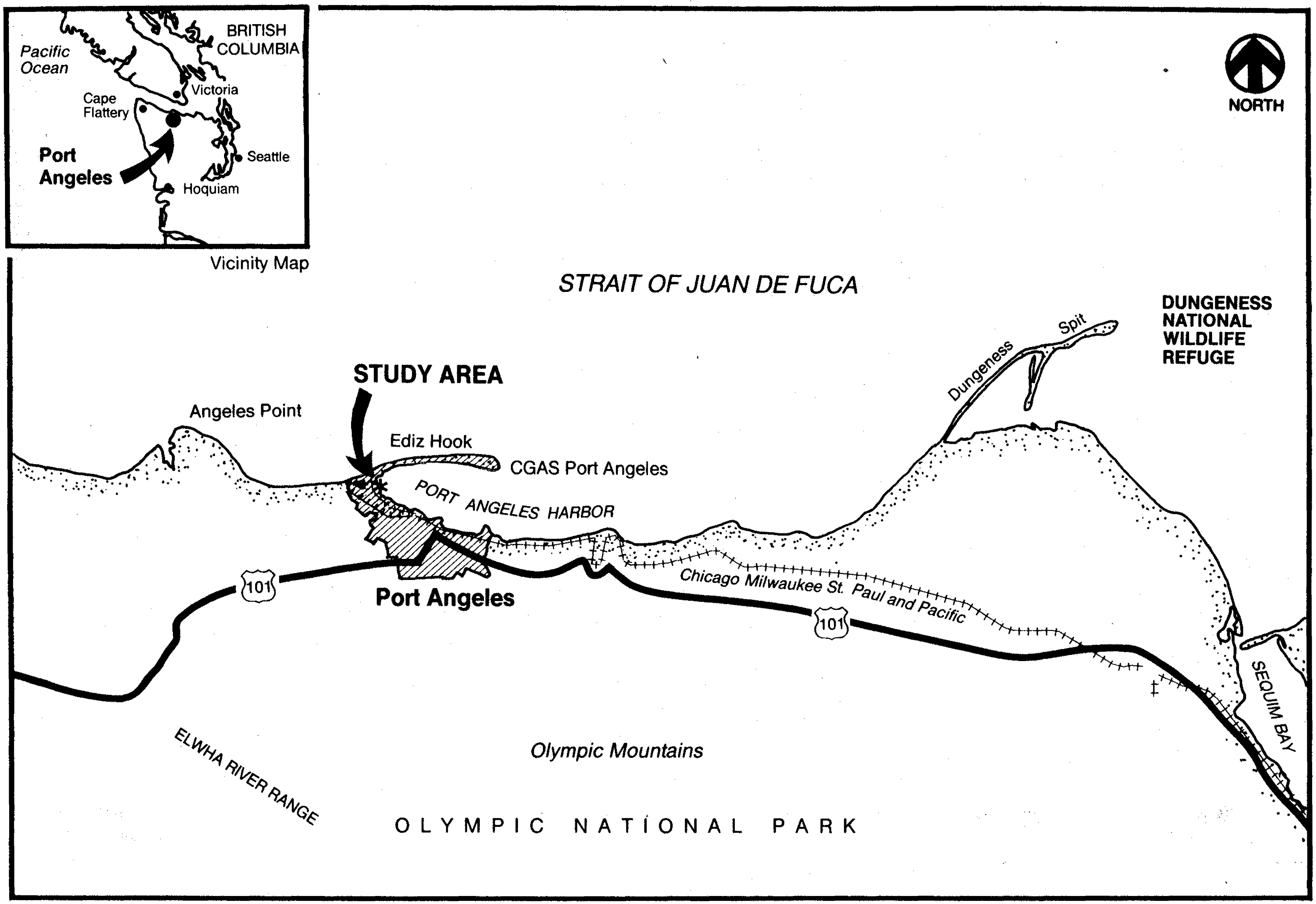
1 INTRODUCTION

In June 1988 Daishowa America Co., Ltd. (Daishowa), purchased outright and obtained the lease rights to approximately 50 acres of land along the Port Angeles Harbor shoreline. Formerly owned by the Merrill & Ring Lumber Company (M&R), the site is an artificially filled parcel situated along Ediz Hook and the shoreline of Port Angeles Harbor in Sections 4 and 5 of Township 30N, Range 6W of the Willamette Meridian. The property is bounded by Daishowa's Port Angeles Mill on the northwest, Marine Drive to the south and west, and the Port Angeles Marina on the southeast. All property is within the City of Port Angeles in Clallam County, Washington (see Figure 1-1). Approximately 20 acres of the parcel is owned by Daishowa while the remainder consists of leased land owned by the Port of Port Angeles. Daishowa intends to use this property for expansion of its Port Angeles paper mill operations.

Prior to the sale M&R (the seller) conducted an environmental assessment of the property to determine the potential of contamination caused by past practices. This property transfer environmental assessment (Hart Crowser, 1988) determined that wood preservatives including pentachlorophenol (PCP) had contaminated soils and possibly groundwater in the northeast corner of the property, at the site of the old planer mill. The source of PCP is attributed to drippage and spillage associated with application of the PCP to wood. The property transfer assessment did not define the extent and magnitude of PCP contamination. Neither did the assessment determine certain site-specific characteristics (geology, hydrogeology, etc.) that could be used to further characterize the extent of contamination and its potential consequences. In order to evaluate the nature, extent, and consequences of contamination in conjunction with site characteristics, a more detailed environmental investigation of the portion of the property near the old planer mill was necessary.

1.1 BACKGROUND INFORMATION

In May 1988, Hart Crowser (HC) performed a property transfer assessment (Hart Crowser, 1988) of the M&R Lumber Company Port Angeles property. The assessment included a paperwork and interview information-gathering effort and a subsurface boring and groundwater monitoring program. As a result of the findings of this assessment, Hart Crowser performed additional work, also in May 1988, that included further evaluation of potential contamination in the vicinity of the old and new planer mills. The areas of concern around the old planer mill, included an abandoned sawmill, the green chain



SOURCE: USGS, 1957

FIGURE 1-1
Location of Study Area

lumber conveyor, a spraybooth, and a dip tank where wood products were treated for sapstain control with Permatox 180, a product containing PCP. Today the old planer mill area is used to store logs. The new planer mill area was also further evaluated for potential soil contamination resulting from the use of PCP and a carbamate chemical called NP1. These wood treatment chemicals were applied to the lumber within a spray room equipped with a recirculating distribution system.

Hart Crowser concluded that contamination at the new planer mill was confined to the ground surface and posed no threat to groundwater. They also concluded that PCP-related contamination existed in soils and groundwater near the old planer mill. Upon disclosure of these results to Daishowa, Daishowa immediately notified the Washington State Department of Ecology (Ecology) requesting a review of the assessment results and guidance with regards to appropriate procedures that Daishowa must follow to ensure protection of human health and the environment. Ecology requested that Daishowa further investigate the site in order to substantiate Hart Crowser's findings. In response to this request, Daishowa contracted with CH2M HILL to determine the nature and extent of contamination, compare contamination to published guidance and regulations, and, if necessary, develop remedial action alternatives. Daishowa gave CH2M HILL two assignments in this effort.

1. Determine the nature and extent of PCP contamination in the vicinity of the old planer mill resulting from PCP spillage. If necessary, based upon comparison to requirements, identify remedial alternatives that could be used to control, manage, or otherwise correct the situation.

2. Conduct a review of the Hart Crowser preliminary evaluation in order to verify that available site information and records for the 50-acre parcel have been examined. Collect a limited number of soil and groundwater samples that would corroborate or deny Hart Crowser's findings.

1.2 SPECIAL PROJECT CONSIDERATIONS

The purpose of this focused site investigation is to determine the nature and extent of PCP contamination in the soils and the groundwater at the old planer mill. It is also the purpose of this study to identify potential remedial action alternatives to manage or otherwise correct the PCP contamination in this area if there is contamination that requires remedial action.

Because of mill construction activities scheduled to occur in the near future on site, CH2M HILL concentrated its first efforts in the planned construction area. This included the area in the vicinity of HC monitoring Wells MW-8, MW-6A, and MW-16A. Field efforts were then intensified throughout the area with fast analytical turnaround on results in order to define potential contamination. This intensified effort was undertaken to provide for worker safety and verify that proposed construction activities would not aggravate any environmental contamination present in that area. Potential site corrective measures would be identified during this investigation so that future mill construction could be initiated without undue risk to workers or unnecessary spread of any contamination.

1.3 ORGANIZATION OF THIS REPORT

This report summarizes activities performed by CH2M HILL in the investigation of the M&R property in the vicinity of the old planer mill. Section 2 describes in greater detail the focused site investigation area, its environment and use, and summarizes the pertinent conclusions of the Hart Crowser preliminary site assessment. Section 3 describes the site investigation methods, including the field methods and the analytical and QA/QC programs. Results from the site characterization and laboratory analyses are presented in Section 4. Section 5 presents the current regulatory criteria and guidance and compares the findings of this focused site investigation to those published levels. Finally, Section 6 summarizes major findings of this study and discusses remedial action alternatives for the focused site investigation area.

Results of the verification review of the Hart Crowser preliminary evaluation are presented in a technical memorandum attached as an addendum to this report.

2 SITE DESCRIPTION

2.1 LOCATION: FOCUSED SITE INVESTIGATION AREA

The former Merrill and Ring, Inc., property consists of approximately 50 acres of land located 1 mile northwest of Port Angeles along Marine Drive between the Port Angeles marina and the base of Ediz Hook (see Figure 1-1). It is bordered by Marine Drive on the south and Port Angeles Harbor on the north. Major historical structures present on the former M&R property included a sawmill, green chain, machine shop, lumber and log storage, length sorter, hog fuel boiler, dry kiln, lumber planing mill, sap stain control treatment operation, alder chipper and chip storage, dry shed, and truck maintenance shop. Many of these structures are no longer present.

The Focused Site Investigation area consists of approximately 2 acres and is located at the northeast corner of the M&R site. It is bounded by the green chain on the west, machine shop on the north, Port Angeles Harbor on the east, and a log storage yard on the south. The area includes approximately 600 feet of shoreline. The shoreline consists of a bulkhead constructed from treated timbers. There are three piers along this 600-foot shoreline, all constructed of treated timbers and approximately 200 feet in length. Figure 2-1 presents the layout of the Focused Site Investigation area.

The area west of the shoreline contains miscellaneous debris from log and lumber storage situated on filled material. The green chain is located approximately 500 feet from the shoreline. It runs north to south and is approximately 200 feet in length. Appendix B provides several photographs of the focused site investigation area.

2.2 ENVIRONMENTAL SETTING

2.2.1 CLIMATE

Port Angeles is characterized by a cool maritime climate. Temperatures are moderated by the Strait of Juan de Fuca, and precipitation varies greatly over the region because of the effects of the Olympic Mountains. Port Angeles is near the western edge of an area referred to as the "rain shadow" of the Olympic Mountains. The climate of the Port Angeles area is mostly a marine type with cool summers, mild and cloudy winters, moist air and a small daily variance in temperature. January is generally the coldest month and July the warmest. The mean daily winter temperature is 43°F with nighttime temperatures around 30°F. Afternoon average temperatures in the warmest summer months range from 65°F to 70°F.

The prevailing wind direction is from the west. Summer winds range up to 8 to 13 mph, while winter winds range up to 7 to 10 mph. On most summer afternoons a moderate to strong westerly breeze can be expected. Winds from the south and east occur more frequently during the winter.

The average annual precipitation, measured between 1931 and 1960, is 24.61 inches. The rainy season begins in October, reaching a peak in winter, then gradually decreasing in the spring. The dry season begins in late spring and reaches a peak in midsummer as marine air moves inland becoming warmer and drier. The rainy season averages 19.52 inches of precipitation while the dry season averages 5.09 inches. In lower elevations, snow rarely reaches an excess of 6 inches in depth. In the mountains, elevations above 5,000 feet, snow can be expected by the end of October, accumulating rapidly after mid-November (U.S. Department of Commerce, Annual Weather Summary for Port Angeles, Washington).

2.2.2 GEOLOGY AND TOPOGRAPHY

Geologic conditions in the Port Angeles area consist of Pleistocene glacial drift overlying folded mudstone, siltstone, and sandstone of the Twin River Formation (Tabor and Cady, 1978). The glacial sediments mantle the uplands in and around Port Angeles and are composed of stratified clay, silt, sand, and gravel. Alluvium consisting predominantly of sand and gravel is present in the numerous stream and river valleys that are incised into the glacial drift. The near-shore areas in the Port Angeles area are characterized by steep bluffs (150 to 200 feet) that have been formed by wave erosion; these expose underlying glacial drift materials. Beach deposits, generally consisting of silt, sand, and gravel, are present between the bluffs and shoreline and overlie the glacial drift that extends out under Port Angeles Harbor and the Strait of Juan de Fuca. Many of the near-shore areas in Port Angeles, including the Daishowa property, have been modified by the placement of fill materials.

Groundwater is present within the more permeable strata of the glacial drift and generally flows northward toward Port Angeles Harbor and the Strait of Juan de Fuca. Approaching the shoreline, groundwater levels are influenced by tidal fluctuations and groundwater becomes increasingly brackish because of seawater intrusion.

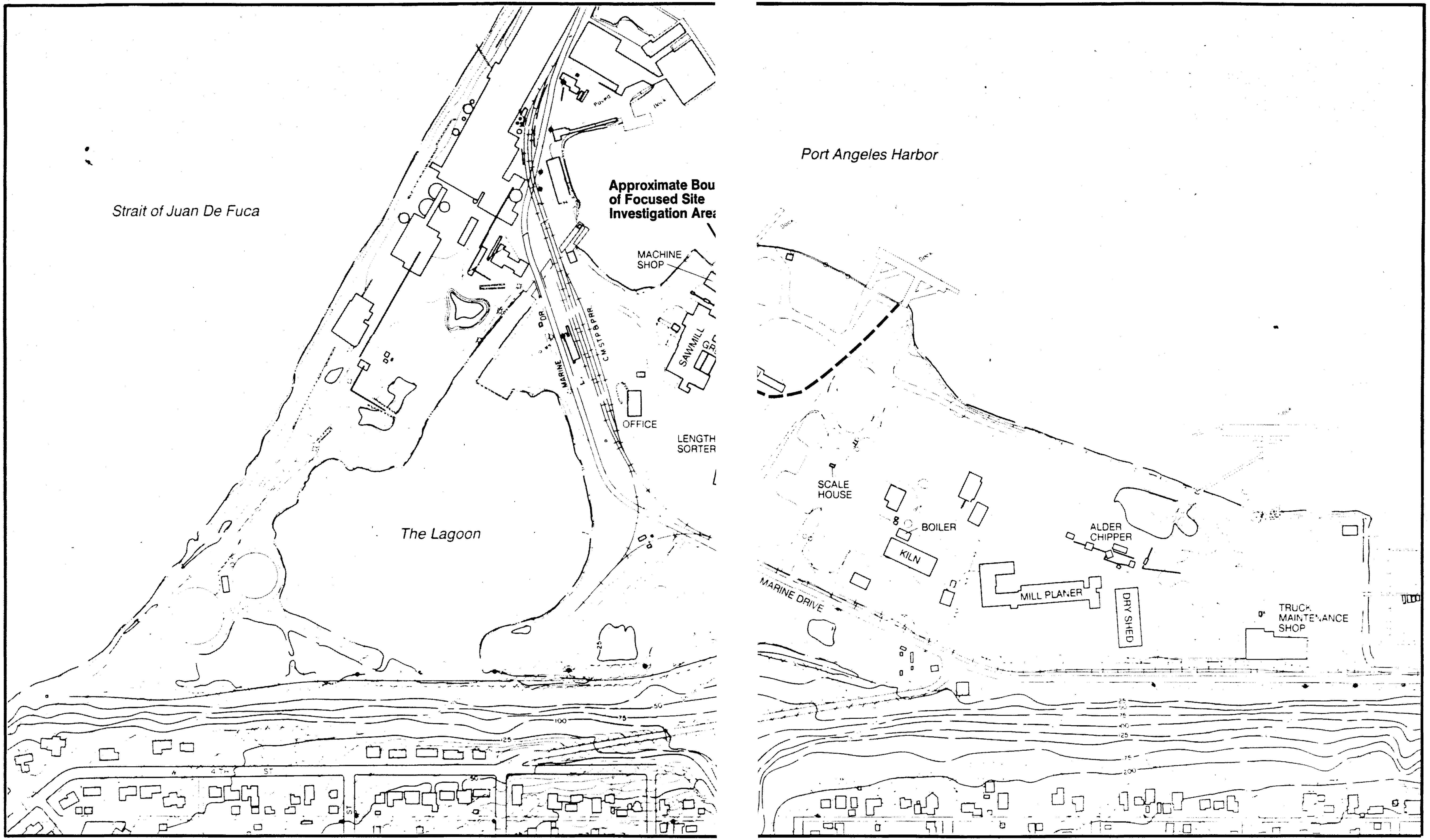


FIGURE 2-1
Focused Site Investigation Area

2.2.3 SURFACE WATER

The former M&R property is bounded by Port Angeles Harbor to the northeast which is a protected embayment of the Strait of Juan de Fuca. The strait of Juan de Fuca is the principal connection between the Pacific Ocean and the interior waters of British Columbia and Washington state including the Strait of Georgia and Puget Sound. Port Angeles Harbor is bordered on the south by the City of Port Angeles and on the north by Ediz Hook, a 3-mile-long spit that extends northeasterly from the Daishowa Mill into the Strait of Juan de Fuca.

Surface water runoff in the Port Angeles area is carried by numerous streams and rivers that flow northward from the Olympic Mountains and adjacent foothills to Port Angeles Harbor and the Strait of Juan de Fuca. Most of these streams and rivers are incised deeply into the uplands, forming steep-sided ravines. Tumwater Creek discharges into Port Angeles Harbor approximately 1 mile southeast of the Daishowa property; it is the closest stream to the site. Valley, Peabody, Whit, and Enurs Creeks discharge into Port Angeles harbor east of Tumwater Creek. The Elwah River discharges into the Strait of Juan de Fuca approximately 4 miles west of the Daishowa property.

A log storage pond (the lagoon), covering an area of 23 acres, is located about 300 feet west of the former M&R property (see Figure 2-1). This area is influenced by tides and, therefore, water levels fluctuate. The lagoon was previously used by industries located in the area to store logs. Currently the City of Port Angeles uses the lagoon to store boat ramps and floats during the winter months (Paul Hopkins and Dan Hansen, Daishowa, pers. comm.; December, 1988).

2.2.4 BIOTA AND ECONOMIC INFORMATION

Port Angeles Harbor has both commercial and natural resource values. Finfish including salmonids and marine fish can be found in Port Angeles Harbor near the Daishowa property. Salmon resources common to this area include chinook (king), coho, chum, and pink salmon. The Port Angeles area hosts one of the most concentrated salmon sport fisheries in Washington waters.

Marine fish common to Port Angeles Harbor include groundfish such as Pacific cod, rockfish, and rock sole. These fish are harvested commercially and are fished for recreation all year. Waters inland of Ediz Hook are classified by the Washington State Department of Fisheries (WDF) as a major resource/fishery area for groundfish (WDF, 1983).

Shellfish resources found in the Port Angeles Harbor include Dungeness crab, hardshell clams (in subtidal areas), and spot shrimp (WDF, 1983).

From a commercial standpoint, the harbor is important to the economic stability of the Port Angeles area. The major source of revenue for the port is raw and finished wood products such as timber and wood chips, which are loaded on vessels and shipped to other Pacific Rim nations. This industry brings to the Port of Port Angeles more than $3 million in revenue per year (William Oliver, Port of Port Angeles, pers. comm.; December, 1988). The harbor is also the home port for a lucrative sport and commercial fishing industry, which provides substantial revenues to the local Port Angeles economy.

2.3 HISTORICAL LAND USE

Existing records or Port sources indicate that the area referred to as the former M&R property is composed of two sections with separate mailing addresses: 1608 Marine Drive and 1313 Marine Drive. By 1972, M&R had leased or bought both sections. Prior to 1972 the two sections were developed separately and were occupied by different commercial entities.

Situated between 1608 Marine Drive and 1313 Marine Drive is another parcel of land (approximately 4 acres), which extends from Marine Drive to the harbor. The address of this parcel is 1417 Marine Drive (William Oliver, Port of Port Angeles, pers. comm.; August, 1988). The locations of all three properties are presented in Figure 2-2. The last parcel is owned by the Port of Port Angeles and is currently leased to Levaque Co., which produces cedar shingles. From 1959 until the present, this parcel has been leased by several shake companies.

A chronology of businesses operating on these parcels since 1912 as indicated in current records is included in Table 2-1. Land use information about this property preceding 1912 could not be found. In order to present the historical land use information of the former M&R site in as clear a manner as possible, the historical land use of each parcel is discussed separately in the following sections.

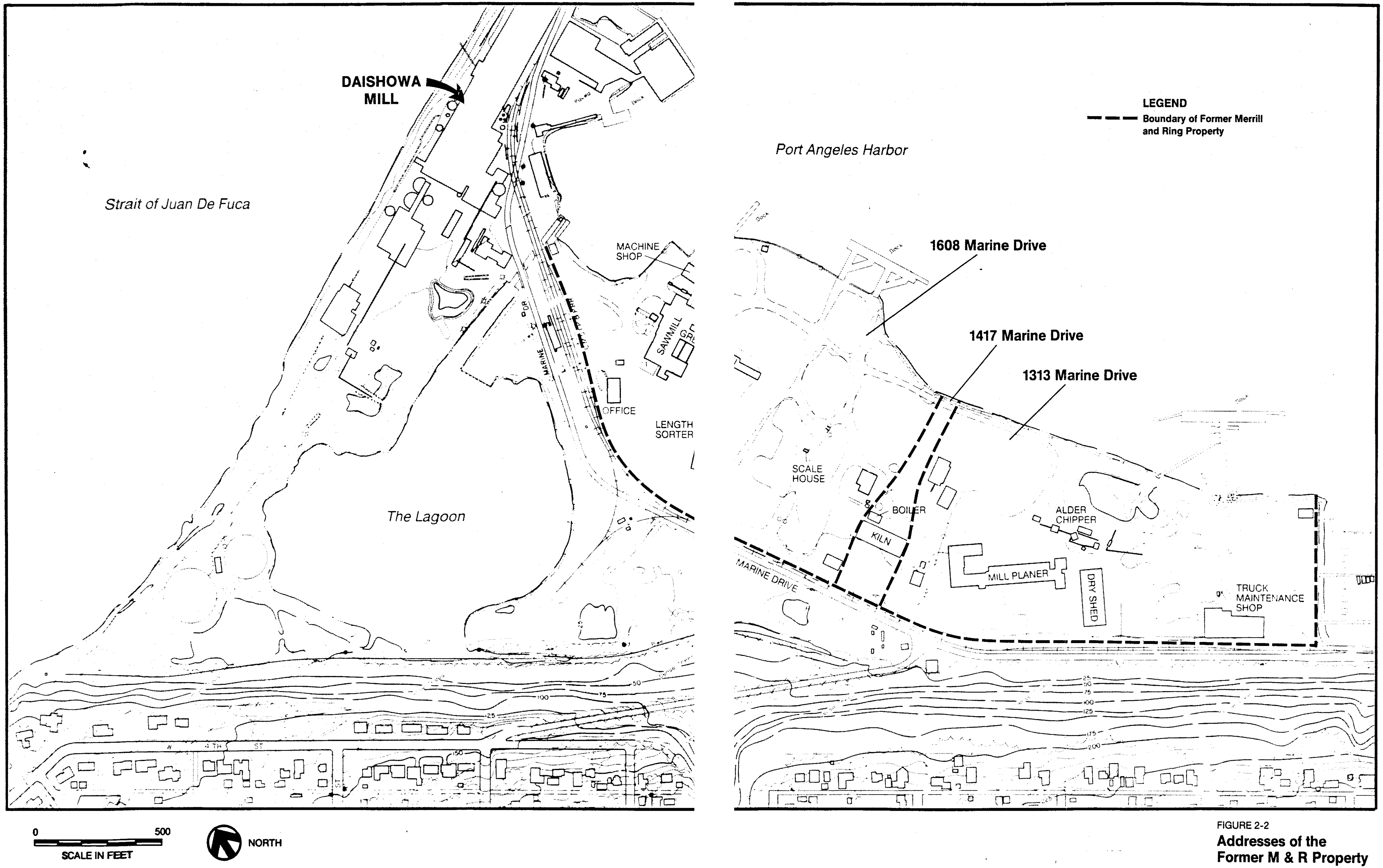


FIGURE 2-2
Addresses of the Former M & R Property

Table 2-1
BUSINESSES LOCATED ON THE FORMER M&R PROPERTY

Address	Name of Business	Approximate Years of Operation
1608 Marine Drive	Puget Sound Mill & Timber Co.	1912 - 1914
	Charles Nelson Mill	1914 - late 1920s
	Washington Cafeteria	1941 - 1948
	Western Lumber Co./ M&R Western Lumber Co.	1955 - 1988
	Hansen's Boat Yard	1959 - 1960
	Nelson Shipyard	1962 - 1967
	P. A. Hardwood	mid-1960s - 1977
	Daishowa America Co., Ltd.	1988 - present
1417 Marine Drive	Peninsula Shingle	1959 - 1964
	Angeles Shake & Shingle	1965 - 1972
	Levaque Co.	1973 - present
1313 Marine Drive	Fibreboard	1919 - 1972
	M&R Lumber Co.	1972 - 1988
	Daishowa America Co., Ltd.	1988 - present

1608 MARINE DRIVE

This parcel of land includes approximately 25 acres and is built on tideland that was filled over several years (William Oliver, Port of Port Angeles, pers. comm.; December, 1988). The first reported commercial development of this parcel occurred in 1912. The Puget Sound Mill & Lumber Company or Earles Mill was built on land that Michael Earles purchased from Charles Nelson, the first reported land owner. The owner operated a sawmill, a shingle mill, and a planing mill on the property in addition to providing log storage and drying kilns. The site also contained a power supply (boiler and engine room) and a shipping dock. In 1914, the mill was renamed the Charles Nelson Mill. It is assumed that the change in name was the result of land ownership reverting to Charles Nelson. The Charles Nelson Mill was in operation until the late 1920s. During the 1930s the site was not used, and it is believed the inactivity was caused by the Depression. By the mid 1940s, mill buildings were in disrepair and the site was condemned by the Port Angeles Fire Department. Shortly after the site was condemned, the P. G. Piedmont Co., a demolition firm, was hired to demolish the mill's dilapidated wood structures using a controlled fire. The fire was reportedly fueled by gasoline, crude oil, tar paper, and old tires (Port Angeles Library file, Chronicle, January 2, 1985, and an unnamed and undated Port Angeles area newspaper article from the mid 1940s).

Between late 1944 and early 1945, the Port of Port Angeles purchased the land from Charles Nelson (William Oliver, Port of Port Angeles, pers. comm.; August, 1988). Land use from the mid-1940s to 1955 is not well documented. It is believed that the land was vacant and at times was used for log storage (William Oliver, Port of Port Angeles, pers. comm.; December, 1988).

In 1955, the Western Lumber Co. opened a re-manufacturing mill on the site that milled rough-cut lumber. From the mid-1960s to the mid-1970s, P. A. Hardwood was also located on this site. P. A. Hardwood was an alder and hardwood sawmill cutting rough lumber from logs. P. A. Hardwood also operated a dry kiln. (Paul Hopkins, Daishowa, pers. comm.; December, 1988). In 1977 M&R acquired the lease for this parcel of land.

By 1962, Western Lumber changed its name to Merrill & Ring Western Lumber Company. This name remains today. M&R produced wood chips used for paper production and re-manufactured lumber. It was stated that one year's chip supply produced by M&R provided enough chips to meet the needs of the Crown Zellerbach paper mill for one month (Port Angeles Library File, anonymous newspaper article, March 7, 1962). By 1984, operations at M&R had been scaled down and only the chip mill was operating (Port Angeles Library File, Port Angeles Daily News, September 18, 1984). In February 1988, the Port of Port Angeles leased the land to Daishowa America Co., Ltd.

During the period from 1941 to 1967, other small businesses supporting mill operations were identified including a cafeteria and log-sort yard on this parcel. No additional information on their operation was obtained (Polk Guides 1940-1988).

1313 MARINE DRIVE

This parcel lies to the southeast of 1608 Marine Drive and is roughly 20 acres in size. This area was also formed by artificial filling to the harbor area (see Figure 2-2). Commercial development of this parcel began in 1919 when Fibreboard Paper Products Corporation (Fibreboard) opened a plant at this site. The plant produced boxboard, sulphite pulp, and wood chips. Feedstocks used to manufacture these products included aqueous ammonia, alum, resin, fuel oil, and sulphur (Testimony of Vern Basom, manager of Fibreboard, to Washington Pollution Control Commission; June; 1958). Fibreboard operated onsite until 1971 when the property was sold to M&R. In 1971 M&R removed many of the structures and built a new planer mill on the site. The old planer mill continued to treat wood until 1971, when a fire severely damaged the mill building. The new planer mill included a spray booth which treated finished lumber with Permatox 180 and later, NP-1. In 1988, M&R sold this parcel of land to Daishowa.

2.4 PREVIOUS ENVIRONMENTAL STUDIES

Hart Crowser performed an environmental property transfer assessment in 1988. Other environment-related information specific to this property is available and includes inspection reports conducted by the Washington Pollution Control Commission (WPCC), and its successor, the Washington Department of Ecology.

By the late 1940s, the WPCC observed that Port Angeles Harbor's water quality was degraded; WPCC attributed the pollution to sulphite waste liquor discharged by pulp mills operating in the Port Angeles area (WPCC, April 17, 1946). WPCC issued a wastewater discharge permit to Fibreboard in 1956 and reissued it in 1961. The only known reference to wastes produced specifically by M&R was located in WPCC files. These files refer to M&R wood waste that was disposed as solid waste or used as hog fuel (WPCC Inspection Report, 1964).

By 1972, sanitary sewage from the M&R office building on the site was connected to the municipal sewage system. Sanitary lines in the new planer mill area were connected later. Before the connection with the city sewer system, all sewage was treated in septic tanks (Ecology Archives, 1972).

In 1974, M&R applied for a National Pollutant Discharge Elimination System (NPDES) permit for four outfalls. The location of each outfall is presented in Figure 2-3. Discharges 001, 003, and 004 were noncontact cooling water and discharge 002 was surface water drainage from the site. Some city storm runoff is also collected and discharged from these outfalls. The NPDES permit (NOWA-0037942) was issued in 1975 and renewed in 1985 without any history of violations (Ecology, NPDES Files).

In a February 8, 1983 Ecology inspection report, it was stated that the spray booth in the new planer mill was a totally enclosed system with overspray and drippings recycled into a containment tank. Sludge from the bottom of the tank was disposed of as solid waste.

Until 1988 and the sale of the M&R property, no other records were found that documented site activities or environmental characteristics. The property transfer environmental assessment of the M&R property conducted by Hart Crowser in May, 1988 was performed to evaluate the potential for contamination from past site activities. Results of the preliminary investigation indicated that groundwater and soils in the vicinity of the old planer mill were contaminated with PCP. Figure 2-4 shows the approximate location of contamination as postulated by Hart Crowser.

As part of the same property transfer assessment, 17 groundwater monitoring wells were installed throughout the site. Eight of these wells are located in the area of suspected PCP contamination (Figure 2-4 and Figure 2-5). The remaining nine wells were located throughout the rest of the parcel. Each well was screened approximately 5 to 15 feet below ground surface. Reference point elevations for water level measurements were not established for each monitoring well; therefore, hydraulic gradient and groundwater flow direction at the site were not estimated.

Groundwater samples were obtained from existing wells at the site of suspected groundwater contamination. These were analyzed for PCP and TCP using a modified Method 8150 technique. [It should be noted that Method 8150 is not the EPA recommended test method in the Code of Federal Regulations (40 CFR Part 261) to analyze for PCP.] Analyses of groundwater in three wells (MW-6A, MW-16A, and MW-22) indicated detectable levels of PCP. The highest PCP concentration (5.7 mg/l) was reported at MW-6A. This value, however, was reported from a groundwater sample containing a significant amount of suspended sediments (Prel. Assessment, page 43, Hart Crowser; June, 1988). The PCP concentration at MW-16A was 0.59 mg/l; at MW-22, PCP was measured at the reported laboratory detection limit of 0.01 mg/l.

Soil samples were obtained from the ground surface and from various depths in the boreholes drilled at the site. PCP soil contamination in subsurface soils was reported at a number of borehole locations (B-15, B-16, B-17, B-18, B-21). The highest concentration (34 mg/kg) was reported at B-16 in soils found approximately 10 to 11.5 feet below the ground surface. Other PCP concentrations in subsurface soils ranged from <0.05 mg/kg to 11.0 mg/kg; TCP concentrations were reported from <0.05 mg/kg to 4.5 mg/kg.

PCP reported in surface soils ranged from <0.05 mg/kg to 0.67 mg/kg. TCP ranged from .09 mg/kg to 0.62 mg/kg. Soils in the vicinity of the former planer mill were analyzed for dioxins. The results indicated that there was no significant evidence of soil contamination from dioxins (Triangle Labs., Proj. No. 12456R submitted to Hart Crowser, 1988).

The property transfer environmental assessment reported inconsistent levels of PCP in soil and groundwater at five

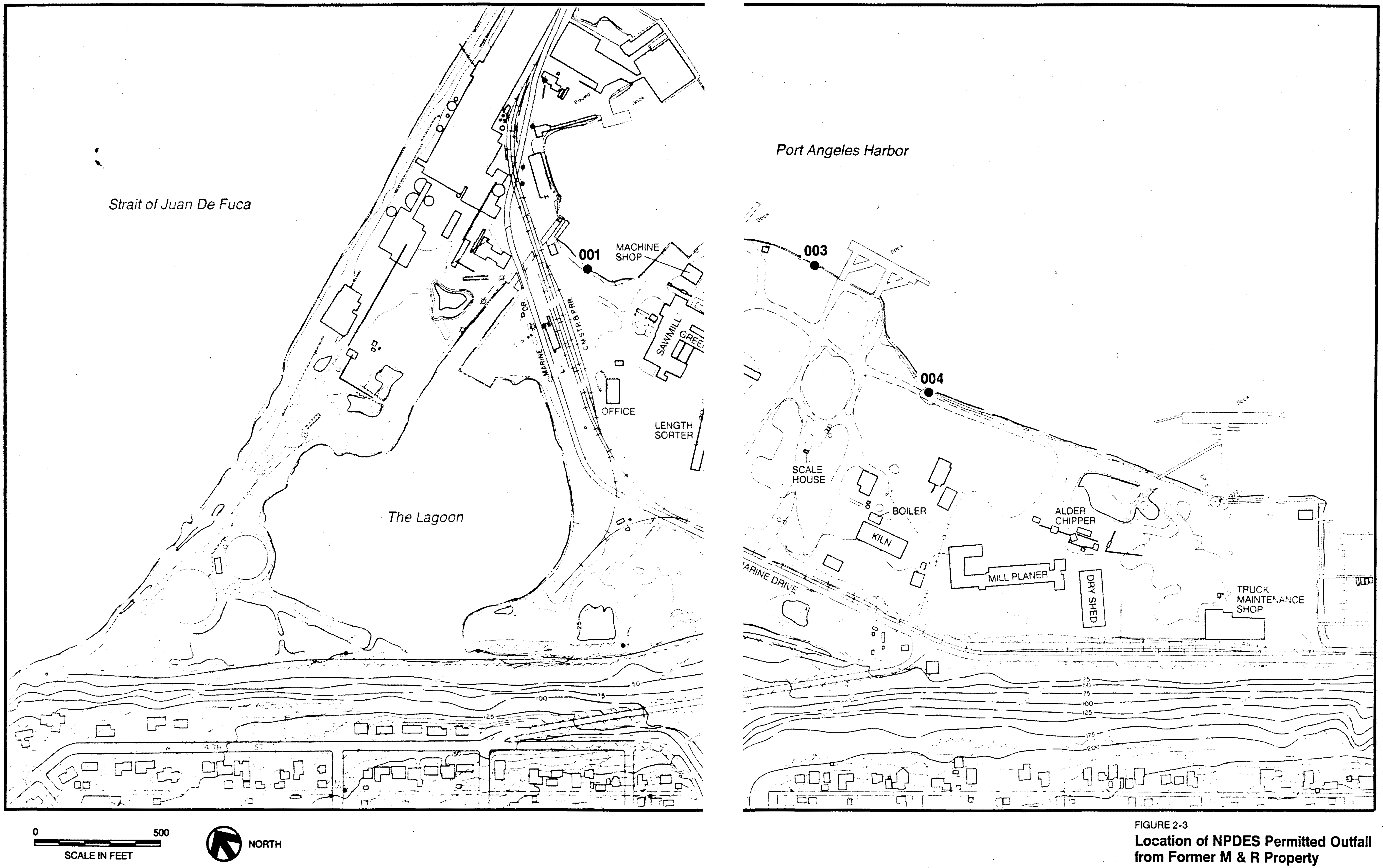


FIGURE 2-3
Location of NPDES Permitted Outfall from Former M & R Property

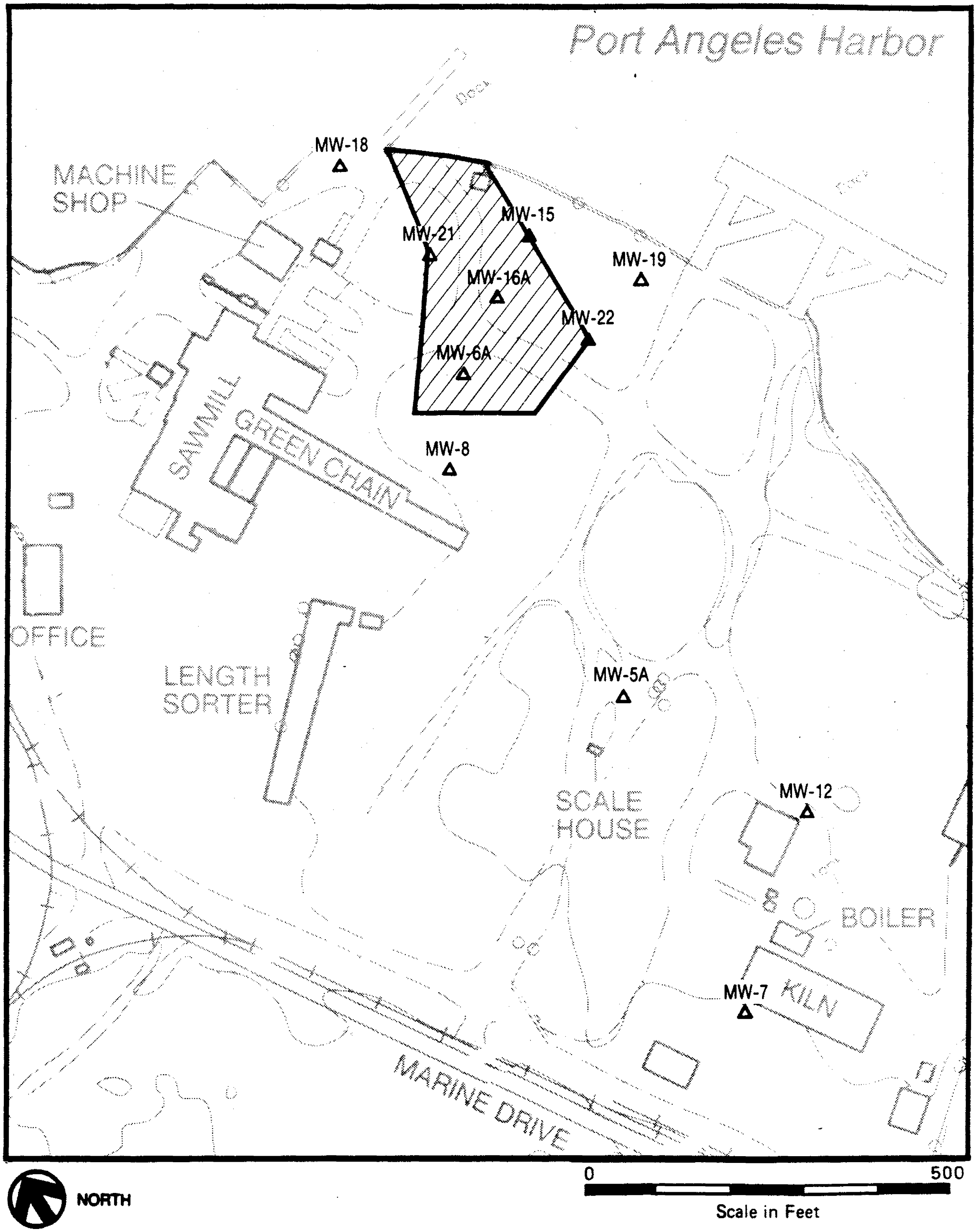


FIGURE 2-4

Approximated PCP Contamination Area as Proposed by Hart Crowser, June 1988

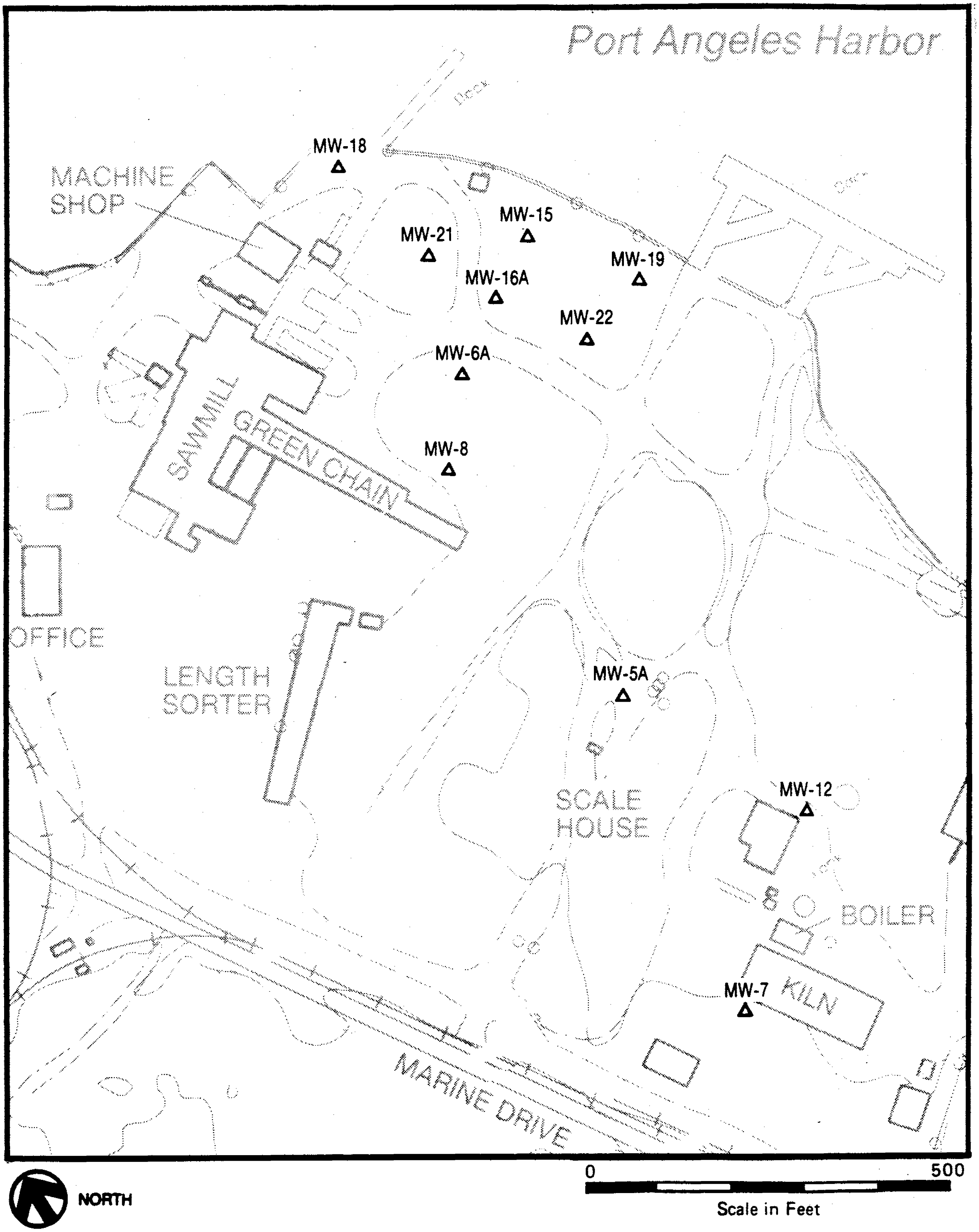


FIGURE 2-5
Hart Crowser Wells in Focused Site Investigation

locations. PCP was detected in soil samples from Boreholes B-15, B-17, B-18, and B-21, while it was not detected in groundwater at the same locations or adjacent to them. At B-22, PCP was detected in groundwater but was not detected in the soil. The assessment did not explain or interpret these inconsistencies.

A limited investigation of the marine environment (four sediments samples and four water samples) was conducted along the shoreline between the piers north of the suspected PCP contamination area. PCP in marine sediment samples ranged from 0.08 mg/kg to 0.3 mg/kg for sample numbers OSS-2 and OSS-1, respectively. The results for OSS-1 were questioned by Hart Crowser because a duplicate analysis reported an inconsistent result. No PCP contamination was detected in marine water samples collected from Port Angeles Harbor.

In summary, the findings of the Hart Crowser site investigation indicated that soil and groundwater near the old planer building was contaminated with PCP. The area of contamination was tentatively identified as approximately 150 to 250 feet wide extending from the old planer mill toward, but not as far as, Port Angeles Harbor (see Figure 2-4).

PCP contamination was also detected in surface soil samples collected west of the new planer mill. However, the contamination near the new planer mill was reported to be "isolated to a small area that is located between the new planer building and the adjacent asphalt road. Based on the available information the contamination appears to be surficial and does not appear to be migratory in the groundwater." (Prel. Env. Assessment, page 45; Hart Crowser; June, 1988.)

3 SITE INVESTIGATION METHODS

Section 3 provides information about the field and analytical procedures employed during the focused site investigation.

3.1 FIELD METHODOLOGY

Investigation field work was conducted at the former M&R site from August 1988 through November 1988. Detailed descriptions of the field methods used during the focused site investigation are presented in the Sampling and Analysis Plan (SAP) (CH2M HILL, August 1988). The SAP is provided as Appendix A.

3.1.1 REDEVELOPMENT AND SAMPLING OF EXISTING WELLS

Redevelopment of the monitoring wells previously installed at the site by Hart Crowser was necessary because the groundwater produced by the wells contained excessive amounts of formation sand and silt. On August 3, 1988, CH2M HILL personnel visited the site and determined that existing wells contained approximately 6 inches of fine grain sediment and organic material at the bottom of the well screens. The wells also produced additional entrained solid material as water was removed with a bailer.

On August 16, 1988, CH2M HILL began to redevelop the existing wells. Redevelopment was conducted by airlifting and surging the wells to remove fine-grained sediment from the filter pack and formation surrounding the well screens.

The air compressor used during airlifting was outfitted with an in-line water and oil filter to prevent contaminants from being introduced into the wells by the airlifting process. Air was delivered from the compressor to the wells via new, flexible polyethylene pipe.

Airlifting was used to redevelop the HC monitoring wells. Initially redevelopment was conducted using a 1-inch-diameter air line inserted into the sump at the bottom of the well. Compressed air was directed to the bottom of the well through the air line, thereby lifting water up the well casing to the ground surface where it was collected. This method was found to be ineffective as the quantity of fine grain material pulled into the well did not decrease with time. The airlift technique was then modified so that compressed air was directed through a 1/2-inch-diameter air line into the bottom of a 1-inch-diameter eductor pipe extending to the bottom of the well. This second method limited water with entrained air to the inside of the eductor pipe and minimized agitation inside the well screen. This second airlift method was only partially successful in that less fine grain material was pulled into the well with time.

The first method continued to be used at all wells during the early stage of development to remove existing sediment from the bottom of the screen and sump. Development was then completed using the second method. Figure 3-1 illustrates the first and second airlift methods discussed above (Methods 1 and 2, respectively). Photographs showing the two methods are presented in Appendix B.

Before redevelopment of each well, the downhole tubing was decontaminated by washing with trisodium phosphate (TSP) and water followed by a distilled water rinse. The compressor was started and air was then slowly introduced through the air line tubing to the well. The rate of air being supplied to the well was slowly increased until the water production rate was maximized.

After continuously airlifting each well for approximately 1 hour, the well was agitated by surging, which consisted of repeatedly turning the air supply to the well on and off. During surging, water in the well was repeatedly lifted and dropped. This loosened the fine-grained sediment in the sand pack surrounding the well allowing it to move into the well and be discharged. Table 3-1 summarizes the volume of water removed from each well during redevelopment procedures.

Table 3-1
VOLUME OF WATER REMOVED DURING WELL REDEVELOPMENT

Monitoring Well No.	Redevelopment Volume (gallons)
MW-5	55
MW-6A	25
MW-8A	275
MW-15	55
MW-16A	55
MW-18	165
MW-19	55
MW-21	55
MW-22	30

Water and sediment generated by redeveloping the existing wells was placed into plastic-lined, DOT-approved, Type 17C, 55-gallon steel drums. The liquid portion of each drum was

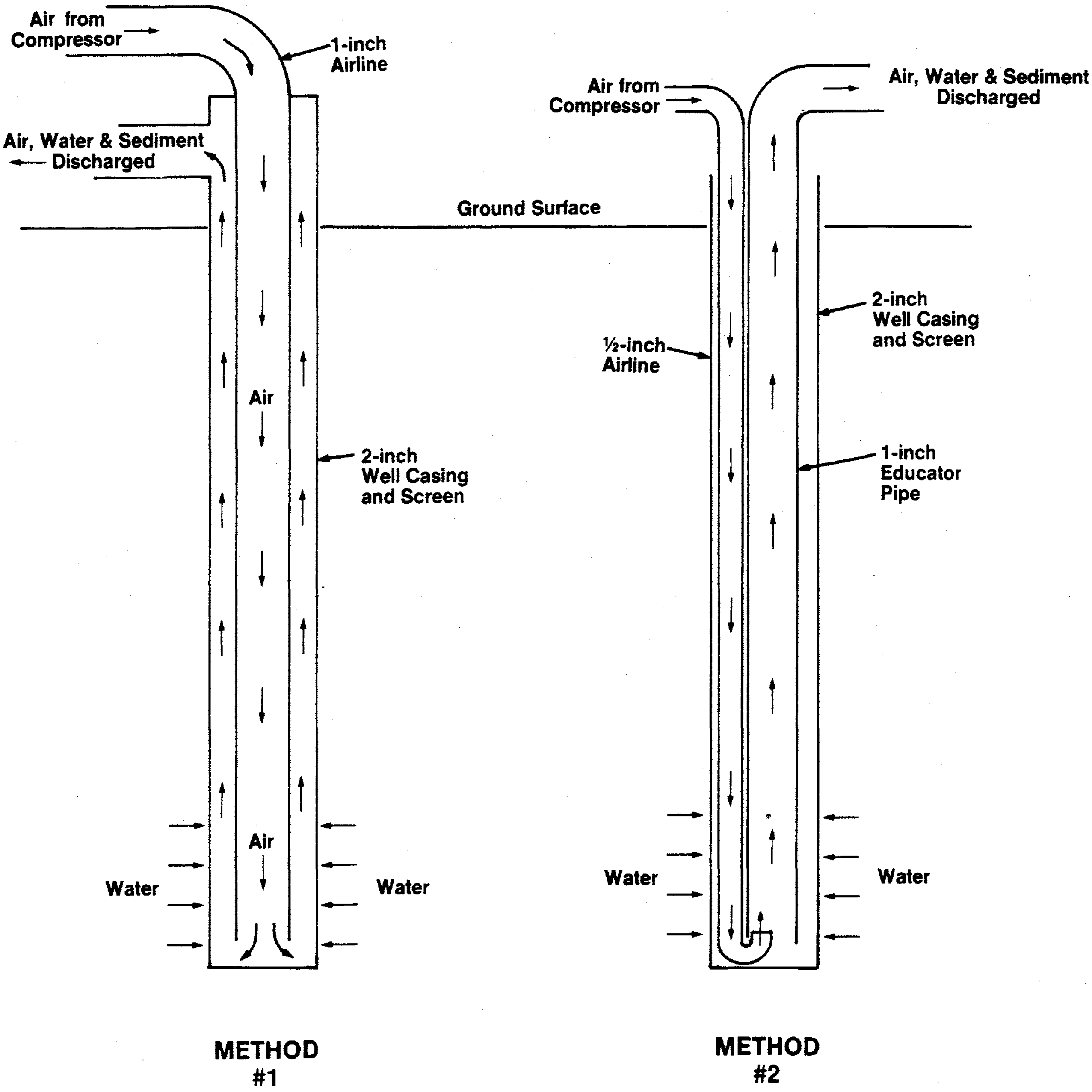


FIGURE 3-1
Airlift Methods Well Development

pumped into a 5,000-gallon holding tank. The sediment and plastic drum liners were composited and placed into several drums for disposal by Daishowa. Sediment and water were tested for PCP and TCP content before disposal.

The redevelopment of existing wells was generally unsuccessful in reducing the quantity of formation sand and silt produced by the wells. Although production of sand decreased during airlift pumping, sand production increased to its original levels when the well was surged. At most locations the production of formation sand and silt did not decrease over time. Typical wells (e.g., MW-6A and MW-8) produced 1/2 to 1 inch of sediment in a 5-gallon bucket as the bucket was filled. The production of sand and silt is attributed to the large slot size (0.020 inch) of the well screens and the coarse sand used as a filter pack.

3.1.2 DRILLING AND MONITORING WELL INSTALLATION

Drilling and well installation were performed by Pacific Testing Laboratories, Inc., under subcontract to CH2M HILL. A total of 10 additional groundwater monitoring wells were installed and two soil borings drilled at the site by CH2M HILL and Pacific Testing Laboratories. From August 29, 1988, through September 22, 1988, nine wells were installed and the two soil borings were drilled. On October 6 and October 7, 1988, a tenth well was drilled and installed. Figure 3-2 presents the location of the 10 monitoring wells and 2 soil borings drilled by CH2M HILL and the 17 monitoring wells installed by HC.

Drilling was conducted using 6-inch inside-diameter (ID) hollow-stem auger advanced by a truck-mounted drill rig. Soil samples were obtained during drilling with split-spoon and Shelby tube samplers. The monitoring wells were drilled and screened at two general depth intervals. Five deep wells were drilled to a total depth of 53 feet with well screens positioned from approximately 40 to 50 feet below ground surface. Five shallow wells were drilled to an approximate total depth of 18 feet with well screens positioned spanning 5 to 15 feet below ground surface. The geologic and well construction logs for the 10 monitoring wells installed by CH2M HILL are included in Appendix C. Table 3-2 summarizes well construction details for these 10 wells and nine wells installed by HC in the focused site investigation area.

To prevent cross contamination of soil and water samples obtained during this investigation, the drill rig and downhole equipment were thoroughly steam-cleaned prior to drilling at each soil boring or monitoring well location. Potentially contaminated soils generated during drilling were placed into lined DOT-approved, Type 17C, 55-gallon

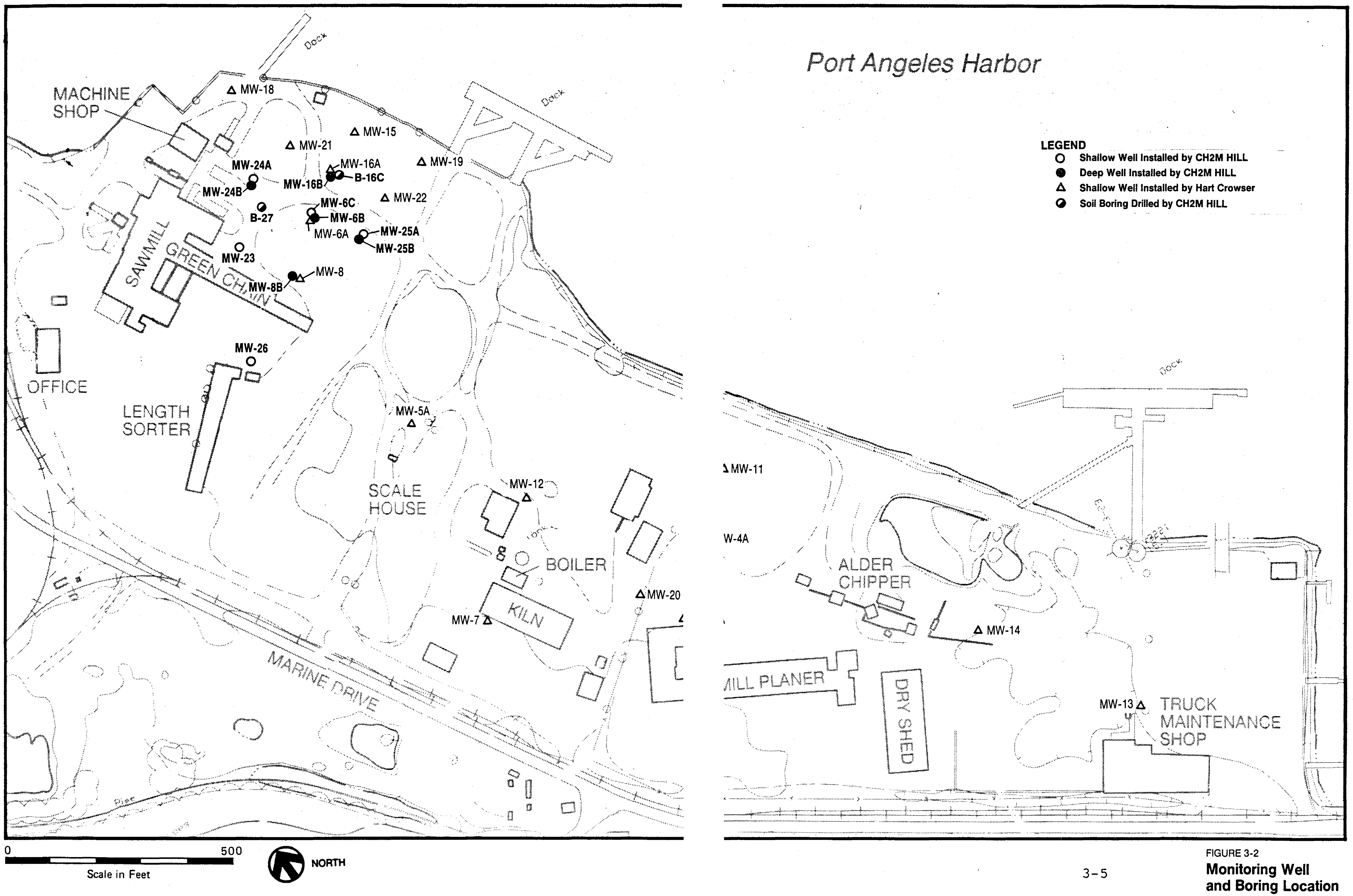


FIGURE 3-2
Monitoring Well and Boring Location

Table 3-2
WELL CONSTRUCTION SUMMARY

Well Designation	Firm	Date Drilled	Total Depth	Filter Pack Interval (ft bgs)[a]	Screen Interval (ft bgs)[a]	Elevation at Top of PVC Casing (feet)[b]	Comments
MW-5A	Hart Crowser	5/11/88	14.0	3.5-14.0	4.0-14.0	9.14	
MW-6A	Hart Crowser	5/13/88	14.0	3.0-14.0	4.0-14.0	8.63	
MW-8	Hart Crowser	5/16/88	14.0	3.0-14.0	4.0-14.0	9.76	
MW-15	Hart Crowser	6/9/88	16.5	4.0-16.5	5.0-15.0	7.85	
MW-16A	Hart Crowser	6/12/88	16.5	4.0-16.5	6.0-16.0	8.11	
MW-18	Hart Crowser	6/10/88	20.0	6.0-20.0	9.0-19.0	9.53	
MW-19	Hart Crowser	6/11/88	17.5	5.0-17.5	7.0-17.0	9.73	
MW-21	Hart Crowser	6/11/88	16.5	4.0-16.5	6.0-16.0	9.18	
MW-22	Hart Crowser	6/12/88	15.0	2.5-15.0	3.0-13.0	10.43	
MW-6B	CH2M HILL	8/30/88	55.5	36.8-53.0	40.0-50.0	8.77	
MW-6C	CH2M HILL	10/6/88	17.5	3.0-17.5	4.5-14.5	8.78	
MW-8B	CH2M HILL	9/12/88	53.0	37.0-52.5	39.5-49.5	9.17	
MW-16B	CH2M HILL	9/8/88	53.0	37.0-53.0	40.0-50.0	8.51	
MW-23	CH2M HILL	8/29/88	17.5	3.0-17.0	4.0-14.0	8.24	
MW-24A	CH2M HILL	9/1/88	20.0	3.5-18.0	5.0-15.0	9.33	
MW-24B	CH2M HILL	9/6/88	53.0	37.0-53.0	40.0-50.0	9.67	Cloth measuring tape, weight, and duct tape in filter pack.
MW-25A	CH2M HILL	9/15/88	17.0	3.0-17.0	4.0-14.0	9.01	
MW-25B	CH2M HILL	9/14/88	53.0	37.0-53.0	40.0-50.0	8.55	Cloth measuring tape, weight, and duct tape in filter pack.
MW-26	CH2M HILL	9/19/88	17.5	3.0-17.5	4.5-14.5	8.06	

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[a] ft bgs = feet below ground surface.

[b] Elevations referenced to Wilsey and Ham datum.

steel drums. The drums were labeled and sealed until they were tested for PCP and TCP. No soils or water contained in drums were qualified as dangerous wastes based on the analysis.

Geologic conditions at the site presented some difficulties to drilling and well installation. "Heaving" sand migrated into the bottom of the hollow-stem auger during drilling in the uppermost 20 feet at the site. Maximum heaving was 2 feet during drilling of MW-6C. To offset heaving conditions, water was added to the inside of the hollow-stem augers. The hydrostatic pressure of the additional water inside the auger was successful in preventing major problems in drilling or completing the wells.

Monitoring well materials were installed through the inside of the 6-inch ID hollow-stem auger after drilling the borehole to the termination depth. Each well consists of a PVC sump, screen, and casing. A stainless steel centralizer was placed below the well screen to center the screen and casing assembly in the borehole. Well materials were steam-cleaned before installation.

Well casing for all monitoring wells installed by CH2M HILL consists of Schedule 40 PVC pipe with flush joint threads. Well screen for all CH2M HILL wells is 10 feet long and consists of Schedule 40 PVC with 0.010-inch factory-milled slots. A 3-foot-long Schedule 40 PVC sump was installed below each screen.

Filter pack material was installed adjacent to each well screen as the augers were withdrawn from the borehole. The filter pack extends to approximately 3 feet above the top of the screen. Filter pack material consists of Monterey No. 16 sand for wells MW-23, MW-24A, MW-24B, MW-16B, MW-6B, and MW-26. The filter pack material for wells MW-25A, MW-25B, MW-8B, and MW-6C is Colorado Silica Sand, Grade 20-40. These two sand types are very similar in grain size gradation. The filter pack material was poured slowly into the well and allowed to settle around the screen. The depth to the top of the filter pack was measured regularly, during installation, with a weighted tape.

An annular seal was installed above the filter pack in each borehole. For shallow wells, the seal is approximately 2 feet thick and consists of 50 pounds of 1/2-inch-diameter bentonite pellets. For deep wells, the bentonite seal is approximately 5 feet thick and consists of 50 pounds of granular bentonite mixed with 17 gallons of water. The remainder of the borehole annulus in each deep well is filled with a cement slurry containing 3 to 5 percent powdered bentonite by dry weight.

The uppermost 2 feet of each borehole annulus was filled with concrete. An 8-inch-diameter steel protective casing was installed to a depth of 2 feet within the concrete seal. The steel protective casing extends approximately 2 feet above the ground surface and is equipped with a steel lid secured with a combination padlock. The top of the 2-inch-diameter casing is covered with a vented PVC slip cap. A 3-foot-square concrete pad was constructed around each well. The steel casings were marked with the well identification number using welding bead. Three-inch-diameter steel guard posts were installed around each well to a depth of approximately 2 feet. The guard posts were secured in place with concrete. The guard posts and protective casing were spray-painted fluorescent orange for optimum visibility. At least three steel guard posts were installed at each well. Four steel guard posts were installed at most wells.

Well development was conducted following completion of each well, allowing a minimum of 24 hours for the bentonite and cement seals to stabilize. Well development was accomplished by airlifting and surging in a similar manner to that used for redevelopment of the Hart Crowser wells as described in Section 3.1.1. Airlift Method No. 1 was used to initially remove sediment from the wells. Method No. 2 was used during the final stages of well development (see Figure 3-1). At least 55 gallons of water was removed from each monitoring well installed by CH2M HILL.

3.1.3 GROUNDWATER SAMPLING

Two rounds of groundwater samples were obtained from nine existing HC wells and from the 10 new wells constructed in the focused site investigation area. The first samples were obtained from the HC wells between August 25 and 26, 1988, prior to drilling new wells at the site. The first samples from newly constructed wells were obtained periodically during the project as the wells were completed and developed. The second round of groundwater samples was obtained from all 19 monitoring wells between October 3 and 5, 1988, excluding MW-6C, which was not drilled and constructed until October 6, 1988. Groundwater samples were obtained from MW-6C on October 13 and November 1, 1988. A third groundwater sample was obtained from MW-6C on November 21, 1988, to verify the presence of PCP found in the two previous samples.

Before sampling each well, the head space in the well was checked for volatile organic compounds with an HNu photoionization detector. This check was conducted immediately after opening the security casing and removing the PVC well cap. The depth to groundwater was then measured with an electric water level probe (Slope Indicator Model No. 51453) and recorded in the project logbook.

Presample purging of the wells was conducted with a peristaltic pump (Geotech Model No. Geopump 2) at a flow rate of approximately 0.2 gallons per minute. Purge water was withdrawn from each monitoring well using new Teflon® tubing below the static water level and Tygon tubing above the water level. The Teflon® tubing was dedicated to each well for use during subsequent sampling rounds. The Tygon tubing was not dedicated to each well, but was decontaminated between each use with a TSP-and-water wash followed by a distilled-water rinse.

A minimum of three wetted casing volumes was removed from each well before sampling. For shallow wells, 10 gallons were removed before sampling. For deep wells, 25 gallons were removed before sampling. All purge water was contained at the well head in DOT-approved, Type 17C, 55-gallon drums and then transferred to the 5,000-gallon-capacity tank.

Temperature, specific conductance, and pH of the purge water were measured periodically during purging to verify stabilization of these parameters prior to sample collection. Samples were collected directly from the peristaltic pump discharge in a disposable plastic container. All field parameters were measured immediately and the results recorded in the project logbook.

The field probes were rinsed with distilled water before each use. The pH meter was field-calibrated daily using standard calibration solutions in accordance with the manufacturer's specifications.

Stainless steel bailers with Teflon® check valves were used to collect groundwater samples after purging was completed. Dedicated lengths of monofilament fishing line were used to raise and lower the bailer and were discarded after use at each well. The bailers were decontaminated prior to use at other wells.

Water samples were transferred from the bailer directly into the sample bottle or vial. A final field sample was obtained after collection of all laboratory samples. The field parameters pH, conductivity, and temperature were then measured and recorded.

Equipment blanks were collected during the site investigation to confirm that the groundwater samples were not contaminated by sampling equipment or procedures. To obtain equipment blanks, a bailer was first decontaminated. Distilled water was then poured through the bailer and collected in sample containers.

3.1.4 SOIL SAMPLING

Soil samples were obtained from each boring for geological characterization. The samples were obtained at 2.5-foot intervals over the entire depth of the boring using a precleaned, 2-inch-ID, split-spoon sampler, or Shelby tube.

At most borings, two samples were obtained for grain size analyses (ASTM 422-63). These samples were transferred from the split-spoon sample into prelabeled Ziplock® plastic bags. At MW-6C and MW-6B, only one sample was collected for grain size analyses.

Shelby tube samples were obtained from the screen intervals of seven monitoring wells for laboratory permeability testing. Shelby tube samples were capped in the field and were kept in a vertical position until molten paraffin wax was used to seal the top of the sample tubes. Shelby tube samples were obtained at MW-6B, MW-24B, MW-24A, MW-16B, MW-8B, MW-25B, and MW-25A.

Selected soil samples were collected during drilling with split-spoon samplers for chemical analyses including PCP, TCP, semivolatile organic chemicals, and 40 CFR 264 Appendix IX parameters. Soil samples were collected for chemical analysis above the water table at 2.5-foot intervals in all boreholes. In shallow wells (generally 18 feet deep), samples were also obtained from immediately below the water table and at the bottom of the boring. For deep wells (generally 53 feet deep), samples were also obtained from immediately below the water table, at the bottom of the boring, and from an interval midway between the water table and the bottom of the boring.

After visually logging the soil material, it was transferred into a precleaned stainless steel mixing bowl. The soil was then thoroughly homogenized using a precleaned stainless steel spoon and placed directly into laboratory-prepared glass sample containers. Laboratory-prepared sample containers were provided by I-Chem Research, Inc.

Equipment blanks were collected during the site investigation to confirm that soil samples were not contaminated by sampling equipment or procedures. To obtain an equipment blank, a split-spoon sampler was first decontaminated. Distilled water was then poured through the sampler and discharged into a precleaned stainless steel mixing bowl. The collected water was then poured into sample containers.

3.1.5 GROUNDWATER LEVEL MEASUREMENTS AND SLUG TESTS

Four rounds of groundwater level measurements were obtained during the field investigation. Because groundwater levels fluctuate up to several feet in some wells in response to tidal influence, each round was completed within approximately 1-1/2 hours so that the measurements would be as contemporaneous as possible. Each round of groundwater level measurements included 25 monitoring wells on the former Merrill and Ring property, including those outside of the focused site investigation area.

Groundwater levels were measured in 15 Hart Crowser wells on August 3, 1988 to determine groundwater flow directions as part of the planning activities for the focused site investigation. An additional round of measurements was obtained on August 30, 1988. Two rounds of groundwater level measurements were obtained on September 24, 1988, after nine additional wells had been installed by CH2M HILL in the focused site investigation area. One of the two rounds occurred at high tide; the other occurred at low tide. Groundwater levels corresponding to high and low tide were measured to evaluate the change in groundwater flow directions near the shoreline at tidal extremes.

All groundwater-level measurements were obtained with an electronic well probe (Slope Indicator Model No. 51453). The probe was rinsed with distilled water after each use to prevent the possibility of cross-contamination of monitoring wells. The probe was thoroughly decontaminated periodically during the field investigation with a TSP wash and distilled-water rinse.

Depth to groundwater was measured from a marked reference point at the top of each PVC well casing. Vertical survey control was provided for the reference points by Northwest Territory Surveyors, under subcontract to Rust Engineering.

Continuous groundwater level measurements were obtained at the site from September 14, 1988 through September 28, 1988. Continuous water level measurements were obtained in five locations simultaneously, using 5- and 10-psi pressure transducers and a data logger (Terrasciences Model No. 8D). Two separate arrays of monitoring wells were established to monitor the hydraulic response of deep and shallow wells to tidal action.

The first array was established to evaluate the influence of tidal action on groundwater levels in shallow wells at the site. Transducers were placed in MW-15, MW-16A, MW-18, MW-21, and a stilling well located in Port Angeles Harbor. This array was monitored at 10-minute intervals for 5 days.

The second array was established to evaluate the influence of tidal action on groundwater levels in selected shallow and deep wells, including the relationship between a deep and shallow well pair. Transducers were placed in MW-16B, MW-21, MS-24A, MW-24B, and the stilling well in the harbor. This array was monitored at 15-minute intervals for 4 days.

The pressure transducers were steam cleaned prior to installation in wells at the site. After installing the transducers in the wells, the data logger was calibrated to record groundwater levels in feet relative to a common datum (Wilsey and Ham datum).

The data logger and transducers were also used to record data from noninvasive aquifer slug tests conducted at the site September 27 and 28, 1988. Slug tests were conducted in new wells MW-6B, MW-8B, MW-16B, MW-23, MW-24A, MW-24B, MW-25A, MW-25B, MW-26, and HC wells MW-6A, MW-8A, MW-15, and MW-16A.

Slug tests were conducted by inserting a rod or "slug" of known volume into the well being tested, thereby displacing and raising the water level in the well. After the water level equilibrated, the rod was removed, lowering the water level. A pressure transducer placed in the well below the inserted rod measured the rise and subsequent equilibration of the static water level in the well versus time. Time versus water level data were recorded by the data logger.

The rod used in the slug test procedure consisted of a weighted and sealed 1-inch-diameter polyethylene pipe. The pipe was cleaned prior to use at each well with a TSP-and-water wash followed by a distilled-water rinse.

3.1.6 MARINE SEDIMENT INVESTIGATION

CH2M HILL collected and analyzed a total of four marine sediment samples, one background sample, and one field duplicate in accordance with the Sampling and Analysis Plan (Appendix A). Table 3-3 identifies each sample by number, location, and physical description. Figure 3-3 identifies the sample location. Samples were analyzed for PCP and TCP using a modified EPA Method 8040, grain size (Method ASTM 422-63), total organic carbon (TOC) (Method No. EPA3-73), and percent moisture (Method No. ASTM D 2216). One sediment sample, DS-MS05, was also analyzed using EPA Method 8270 for semi-volatile organic chemicals as a performance check on the Method 8040 analysis.

Samples were collected between the hours of 0800 and 0940 on September 22, 1988. During this time the tide was flooding from -0.6 foot below mean lower low water to 7.1 feet above mean lower low water. At the time samples were collected, the water level was approximately 2.8 feet above mean lower low water.

Table 3-3
MARINE SEDIMENT SAMPLES COLLECTED AT M&R ON SEPTEMBER 22, 1988

Station	Odor	Bottom Description	Color	Composition	Field Sample No.	Sample Description	Analyses	Time Sample Collected	Depth of Water (feet)	Depth of Sample (inches)
DS-MS-01	Hydrogen sulfide	Approximately 2.5 feet of bark/chips on bottom	Grey brown with some black	Soft silty sand	DSA-MS1	Wood chips and bark in sample. Three grabs required to obtain adequate sample.	8040, Grain size, TOC, percent moisture	0915	16	6
DS-MS-02	Hydrogen sulfide	No logs, piles of wood chips and bark	Grey black	Soft silty sand	DSA-MS2	Wood chips and bark in sample. Two grabs required to obtain adequate sample.	8040, Grain size, TOC, percent moisture	0855	16	6
DS-MS-03	Strong hydrogen sulfide	Over 1 foot of wood chips	Brown	Soft silty sand	DSA-MS3	Wood chips in sample. Oil sheen observed. Two grabs required to obtain adequate sample.	8040, Grain size, TOC, percent moisture	0836	16.5	6
DS-MS-04	Strong hydrogen sulfide	Bark and timber	Black with some brown streaks	Soft silty sand	DSA-MS4	Bark intermingled with sediment. Oil sheen observed. Two grabs required to obtain adequate sample.	8040, Grain size, TOC, percent moisture	0815	20	6

Table 3-3
(continued)

Station	Odor	Bottom Description	Color	Composition	Field Sample No.	Sample Description	Analyses	Time Sample Collected	Depth of Water (feet)	Depth of Sample (inches)
DS-MS-05	None detected	Numerous timbers, few wood chips	Black grey	Well consolidated sandy silt	DSA-MS5	Few wood chips in sample. Three grabs required to obtain adequate sample. Performance audit and field duplicate collected at this site.	8040, Grain size, TOC, percent moisture	0940	18	6
DS-MS-05	None detected	Numerous timbers, few wood chips	Black grey	Well consolidated sandy silt	DSA-MS53	Few wood chips in sample. Three grabs required to obtain adequate sample. Performance audit and field duplicate collected at this site.	8270, Grain size, TOC, percent moisture	0940	18	6

Sediment sampling was performed by Global Diving and Salvage, Inc., under subcontract to CH2M HILL. A diver using a clam gun and working from a 24-foot Boston Whaler was used. See Appendix B for photographic documentation of sampling methods. The diver was tethered to the boat by the oxygen line and cable and was able to verbally communicate with field personnel on the Boston Whaler.

Sediment sample stations were positioned by aligning a transect connecting the piers and a third point onshore. The diver confirmed the location prior to submerging and sample collection. Once the diver reached the bottom, he described the bottom conditions and cleared away debris and wood chips that covered the sediments. The diver inserted the clam gun into the sediments until maximum penetration, approximately 6 inches to 1 foot, was obtained. The clam gun was then carefully removed and the bottom sealed to prevent the sample from leaking out of the sampler.

The diver surfaced and handed the sampler over to CH2M HILL personnel on the boat to process. This involved carefully draining the water overlaying the sample and then extruding the sample into a stainless steel bowl. This process was repeated until adequate sample material was obtained. The physical appearance of the sample was observed and recorded along with time, location, depth of water, depth of sample penetration, and description of bottom conditions. The sample was then homogenized using a precleaned stainless steel spoon and bowl. The sample material was transferred into laboratory-prepared (I-Chem Research, Inc.) containers.

Wood chips and wood debris were observed at all stations, although few wood chips were observed at the southernmost station, DS-MS-05. The amount of wood chips overlaying the bottom sediments increased from the southern dock to the northern dock. At Station DS-MS-01, approximately 2.5 feet of wood chips and bark were observed overlaying the surface of the sediments (see Table 3-3).

Six-inch cores were collected at each station. A hydrogen sulfide odor was emitted from all samples. At Stations DS-MS-03 and DS-MS-04 the hydrogen sulfide odor was strong. An oil sheen was observed in samples collected from Stations DS-MS-03 and DS-MS-04.

3.1.7 VERIFICATION SOIL SAMPLING

During the course of this study, in order to verify HC findings throughout the former M&R site, CH2M HILL collected a total of seven samples (two marine sediments and five soils). Discussion of the verification study is provided in a technical memorandum provided as an addendum to this

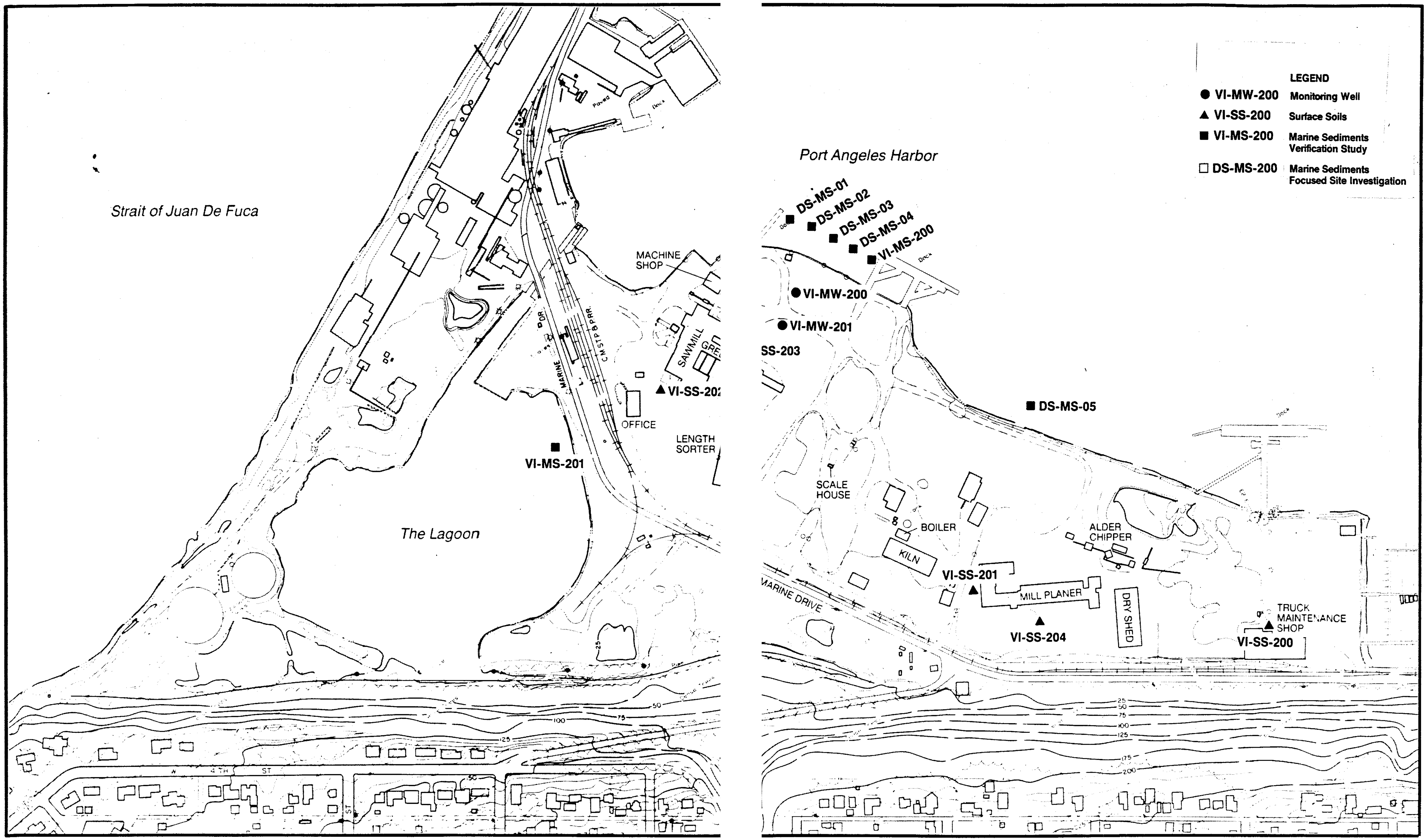


FIGURE 3-3

Marine Sediments Station Locations and Verification Study Sample Locations

report. All verification analytical results, however, are included both in the memorandum and in this report.

3.1.8 HANDLING AND DISPOSAL OF DRILL CUTTINGS AND WATER

Drill cuttings were containerized, as they were generated, in DOT-approved, plastic-lined, Type 17C, 55-gallon steel drums. Drums were sealed after being filled. The drums were labeled in the field with the date, boring number, and drum contents (soil or water). The drums were then transported with a forklift and flatbed truck from the boring location to a temporary onsite storage location.

Temporary onsite drum storage was located on an asphalt pad at the west end of the site. This location was specifically prepared for drum storage by building an 8-inch-high berm around the area with logs and covering the area and the berm with 40-millimeter-thick polyethylene sheeting. The outsides of the drums were steam-cleaned in the decontamination area to remove any contaminated cuttings that had spilled or splashed onto them. The drums were then placed on wooden pallets before moving them into the temporary storage location. Polyethylene sheeting was also placed over the top of the drums and secured. As additional drums were added to the area, the polyethylene liner and berm were extended to accommodate them. Appendix B includes photographs identifying the onsite temporary drum storage area.

The results of analytical tests on soil samples obtained from the borings were used to determine whether the drummed soils were contaminated. All drummed soils showing undetectable levels of TCP and PCP, or TCP and PCP present at concentrations less than the EPA PCP criterion for soil (EPA, Revised Draft RFI Guidance, Section 8, December 1984), were returned to the focused site investigation area and spread on the ground surface. Drummed soils obtained from borings with detectable levels of TCP and PCP (MS-24A and MW-24B) were also returned to the study area because analytical results did not exceed PCP soil criteria as established by EPA (EPA, Revised Draft RFI Guidance, Section 8, December 1984). Finally, all disposable plastic sheeting and clothing used during the project were drummed and sealed and turned over to Daishowa for disposal.

Well development water, including that generated during redevelopment of the Hart Crowser wells, and presample purge water generated during groundwater sampling activities was containerized at the wellhead in DOT-approved, Type 17-C, 55-gallon drums. Before September 7, 1988, the drummed water was moved and stored with the drummed soil cuttings as described earlier. On September 7, 1988, a 5,000-gallon holding tank was delivered to the site by Northwest Enviroservices. All drummed waters were then pumped into the tank. After September 7, all water generated by well development and purging was drummed at the wellhead, then transported and pumped into the holding tank. Approximately 4,000 gallons of water were containerized in the holding tank by the completion of this study.

On October 8, 1988, water in the holding tank was mixed and a sample was collected and analyzed for PCP and TCP using testing Method 8040. Neither compound was detected. The holding tank was subsequently moved to Daishowa's wastewater treatment plant. With the approval of Ecology, the water in the holding tank was then disposed of by slowly bleeding it into the wastewater treatment plant. Daishowa's treatment plant utilizes activated sludge for secondary treatment.

3.2 ANALYTICAL PROGRAM

The following sections describe the analytical methods selected for the focused site investigation at the former M&R property. A discussion explaining the rationale for specific analytical methods and a summary of all soil and water sample analyses is also provided. Physical soil characteristics (grain size and laboratory permeability tests) were discussed in Section 3.1.4.

3.2.1 CHEMICAL ANALYSIS TEST METHODS

Analytical procedures selected to test the presence or absence of PCP, TCP, or other chemicals were based on the appropriate test methods described in the Code of Federal Regulations (40 CFR, Part 261, Subpart D, Appendix III--Chemical Analysis Test Methods). Table 1 of Appendix III, the Analysis Methods for Organic Chemicals, specifies that Analytical Methods 8040 and 8250 are the appropriate procedures for PCP. Method 8270 is also an EPA recommended procedure for semivolatile organic compounds, including PCP, because it provides better chromatographic separation than Method 8250. These procedures are described in Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846) (November, 1986). Other methods selected for this study include a scan of chemicals in selected soils and groundwater (40 CFR 264, Appendix IX parameters), mercury in soils (EPA Method number 7471), and physical parameters such as common ions and permeability procedures.

3.2.1.1 CH2M HILL Corvallis Laboratory Method 8040--PCP and TCP

Analytical Method Number 8040 is used to determine the concentration of phenolic compounds including PCP and TCP. Extraction of the target constituents is analyzed on a two-channel capillary gas chromatograph using a flame ionization detector (FID). CH2M HILL's Corvallis laboratory characterized site soils and groundwater using a modified 8040 analytical method that focused on PCP and TCP only. PCP as discussed in this report and analyzed by Method 8040 is 2,3,4,5,6-Pentachlorophenol. TCP as discussed in this report is the sum of the three isomers of tetrachlorophenol including 2,3,4,5-TCP, 2,3,4,6-TCP, and 2,3,5,6-TCP unless otherwise specified. This modification permitted a rapid matrix characterization to assess the potential for contamination and, consequently, to permit more accurate siting of monitoring wells. A detailed summary of the modified or close support laboratory (CSL) method is provided in the Quality Assurance Project Plan (QAPP). The QAPP is included as Appendix A.

Table 3-4 identifies the sample location, frequency, and matrix of all method 8040 samples collected for the focused site investigation.

3.2.1.2 Method 8270--Semivolatile Organic Chemicals

Approximately 30 percent of the soil samples that were analyzed for PCP and TCP by Method 8040 were split and sent to California Analytical Laboratory, Sacramento, California, for confirming analysis by Method 8270. Approximately 10 percent of the groundwater and marine sediment samples were also sent for Method 8270 analysis. Method 8270 is an EPA-approved gas chromatographic/mass spectraphotometric (GC/MS) procedure for the analysis of extractable semivolatile organic compounds from the hazardous substance list (HSL) including PCP and some of its breakdown products. The complete compound list is given in Table 3-5. Method 8270 is a more sensitive but less specific (more compound-inclusive) analysis procedure than Method 8040 and serves as a verification of the results obtained by the PCP and TCP screen. Sending the samples to an independent, laboratory provides a performance audit to ensure that laboratory-specific bias is not introduced into the data.

The samples chosen for analysis are listed in Table 3-4 and the rationale for choosing these samples is included in the SAP and QAPP (Appendix A).

3.2.1.3 Appendix IX Parameters

Four water samples and one soil sample were analyzed for the compounds identified in Appendix IX of 40 CFR 264. Although the Appendix IX list is intended for application to groundwater monitoring programs at RCRA facilities, it was selected for soil and groundwater analyses for the FSI only because it is a comprehensive list of contaminants potentially present at industrial sites. The soil sample included analysis for the presence of dioxins. This sample verified the favorable

Table 3-4
Summary of Soil and Groundwater Analyses

Location	Sample ID No.	Date Sampled	Matrix	Soil Depth	8040	8270	Mercury	Common Ions	Appendix IX
MW5A	DSA-MW5 (8320-5)	8/28/88	Groundwater	N/A	●			●	
	DSA-MW5 (8527-2)	10/6/88	Groundwater	N/A	●			●	
MW6A	DSA-MW6 (8318-4)	8/24/88	Groundwater	N/A	●			●	
	DSA-MW6A (8527-11)	10/6/88	Groundwater	N/A	●			●	
	DSA-MW6A (8552-1)	10/13/88	Groundwater	N/A	●				
MW6B	DSA-MW6B-SS2.5 (8334-6)	8/30/88	Soil	2.5 to 4.0 ft.	●		●		
	DSA-MW6B-SS5.0 (8334-7)	8/30/88	Soil	5.0 to 6.5 ft.	●	●	●		
	DSA-MW6B-SS7.5 (8334-8)	8/30/88	Soil	7.5 to 9.0 ft.	●		●		
	DSA-MW6B-SS30.0 (8334-10)	8/30/88	Soil	30.0 to31.5 ft.	●		●		
	DSA-MW6B-SS50.0 (8334-11)	8/30/88	Soil	50.0 to 51.5 ft.	●		●		
	DSA-MW6B (8350-1)	9/21/88	Groundwater	N/A	●	●		●	
	DSA-MW6B (8552-2)	10/13/88	Groundwater	N/A	●	●		●	●
MW6C	DSA-MW6C-SS2.5 (8527-6)	10/6/88	Soil	2.5 to 4.0 ft.	●				
	DSA-MW6C-SS5.0 (8527-7)	10/6/88	Soil	5.0 to 6.5 ft.	●				
	DSA-MW6C-SS7.5 (8527-8)	10/6/88	Soil	7.5 to 9.0 ft.	●				
	DSA-MW6C-SS17.5 (8527-9)	10/6/88	Soil	17.5 to 19.0 ft.	●				

Table 3-4

Summary of Soil and Groundwater Analyses (continued)

Location	Sample ID No.	Date Sampled	Matrix	Soil Depth	8040	8270	Mercury	Common Ions	Appendix IX
MW6C	DSA-MW6C (8552-4)	10/13/88	Groundwater	N/A	●	●		●	●
	DSA-MW6C (8633-2)	11/1/88	Groundwater	N/A	●				
	DSA-MW6C (8680-1)	11/21/88	Groundwater	N/A	●				
MW8	DSA-MW8 (8288-1)	8/17/88	Groundwater	N/A	●			●	
	DSA-MW8 (8320-4)	8/26/88	Groundwater	N/A	●				
	DSA-MW8A (8512-1)	10/3/88	Groundwater	N/A	●			●	
MW8B	DSA-MW8B-SS2.5 (8401-2)	9/12/88	Soil	2.5 to 4.0 ft.	●		●		
	DSA-MW8B-SS2.5D (8401-3)	9/12/88	Soil	2.5 to 4.0 ft.	●	●	●		
	DSA-MW8B-SS5.0 (8401-6)	9/12/88	Soil	5.0 to 6.5 ft.	●	●	●		
	DSA-MW8B-SS7.5 (8401-7)	9/12/88	Soil	7.5 to 9.0 ft.	●				
	DSA-MW8B-SS30.0 (8401-8)	9/12/88	Soil	30.0 to 31.5 ft.	●				
	DSA-MW8B-SS50.0 (8401-10)	9/12/88	Soil	50.0 to 51.5 ft.	●		●		
	DSA-MW8B (8482-3)	9/26/88	Groundwater	N/A	●			●	
	DSA-MW8B (8512-2)	10/3/88	Groundwater	N/A	●			●	
MW15	DSA-MW15 (8318-3)	8/24/88	Groundwater	N/A	●			●	
	DSA-MW15 (8521-2)	10/4/88	Groundwater	N/A	●			●	

Table 3-4
Summary of Soil and Groundwater Analyses (continued)

Location	Sample ID No.	Date Sampled	Matrix	Soil Depth	8040	8270	Mercury	Common Ions	Appendix IX
MW16A	DSA-MW16 (8320-1)	8/28/88	Groundwater	N/A	●			●	
	DSA-MW16A (8512-5)	10/14/88	Groundwater	N/A	●			●	
	DSA-MW16A (8552-6)	10/14/88	Groundwater	N/A	●	●			
MW16B	DSA-MW16B-SS2.5 (8380-3)	9/8/88	Soil	2.5 to 4.0 ft.	●	●	●		
	DSA-MW16B-SS5.0 (8380-4)	9/8/88	Soil	5.0 to 6.5 ft.	●	●	●		
	DSA-MW16B-SS7.5 (8380-5)	9/8/88	Soil	7.5 to 9.0 ft.	●				
	DSA-MW16B-SS30.0 (8380-6)	9/8/88	Soil	30.0 to 31.5 ft.	●				
	DSA-MW16B-SS50.0 (8380-7)	9/8/88	Soil	50.0 to 51.5 ft.	●		●		
	DSA-MW16B-SS50.0D (8380-8)	9/8/88	Soil	50.0 to 51.5 ft.	●				
	DSA-MW16B (8458-1)	9/23/88	Groundwater	N/A	●			●	●
	DSA-MW16BD (8458-2)	9/23/88	Groundwater	N/A	●				
	DSA-MW16B (8512-6)	10/4/88	Groundwater	N/A	●			●	
Boring 16C	DSA-SB-16C-11 (8667-1)	11/16/88	Soil	9.0 to 14.0 ft.	●	●			
	DSA-SB-16C-11D (8667-11)	11/16/88	Soil	9.0 to 14.0 ft.	●				

Table 3-4

Summary of Soil and Groundwater Analyses (continued)

Location	Sample ID No.	Date Sampled	Matrix	Soil Depth	8040	8270	Mercury	Common Ions	Appendix IX
MW18	DSA-MW18 (8318-2)	8/24/88	Groundwater	N/A	●			●	
	DSA-MW18 (8521-3)	10/4/88	Groundwater	N/A	●			●	
MW19	DSA-MW19 (8320-2)	8/26/88	Groundwater	N/A	●			●	
	DSA-MW19 (8521-1)	10/15/88	Groundwater	N/A	●			●	
MW21	DSA-MW21 (8318-1)	8/24/88	Groundwater	N/A	●			●	
	DSA-MW21 (8521-5)	10/5/88	Groundwater	N/A	●			●	
MW22	DSA-MW22 (8320-3)	8/28/88	Groundwater	N/A	●			●	
	DSA-MW22 (8521-4)	10/5/88	Groundwater	N/A	●			●	
MW23	DSA-MW23-SS2.5 (8334-1)	8/29/88	Soil	2.5 to 4.0 ft.	●		●		
	DSA-MW23-SS5.0 (8334-2)	8/29/88	Soil	5.0 to 6.5 ft.	●		●		
	DSA-MW23-SS7.5 (8334-3)	8/29/88	Soil	7.5 to 9.0 ft.	●		●		
	DSA-MW23-SS10.0 (8334-4)	8/29/88	Soil	10.0 to 11.5 ft.	●	●	●		
	DSA-MW23.SS17.5 (8334-5)	8/29/88	Soil	17.5 to 19.0 ft.	●		●		
	DSA-MW23 (8345-1)	9/1/88	Groundwater	N/A	●			●	
	DSA-MW23 (8527-1)	10/6/88	Groundwater	N/A	●			●	

Table 3-4
Summary of Soil and Groundwater Analyses (continued)

Location	Sample ID No.	Date Sampled	Matrix	Soil Depth	8040	8270	Mercury	Common Ions	Appendix IX
MW24A	DSA-MW24.SS2.5 (8345-2)	9/1/88	Soil	2.5 to 4.0 ft.	●	●	●		
	DSA-MW24-SS5.0 (8345-3)	9/1/88	Soil	5.0 to 6.5 ft.	●		●		
	DSA-MW24-SS7.5 (8345-4)	9/1/88	Soil	7.5 to 9.0 ft.	●	●	●		
	DSA-MW24-SS20 (8345-5)	9/1/88	Soil	20.0 to 21.5 ft.	●	●	●		
	DSA-MW24A (8401-12)	9/13/88	Groundwater	N/A	●			●	●
	DSA-MW24A (8512-3)	10/3/88	Groundwater	N/A	●			●	
MW24B	DSA-MW24B-SS2.5 (8356-1)	9/6/88	Soil	2.5 to 4.0 ft.	●		●		
	DSA-MW24B-7.5 (8356-2)	9/6/88	Soil	7.5 to 9.0 ft.	●		●		
	DSA-MW24B-SS12.5 (8356-3)	9/6/88	Soil	12.5 to 14.0 ft.	●				
	DSA-MW24B-SS35.0 (8356-4)	9/6/88	Soil	35.0 to 36.5 ft.	●				
	DSA-MW24B-SS50.0 (8356-5)	9/6/88	Soil	50.0 to 51.5 ft.	●		●		
	DSA-MW24B-SS50.0D (8356-6)	9/6/88	Soil	50.0 to 51.5 ft.	●				
	DSA-MW24B (8401-11)	9/13/88	Groundwater	N/A	●			●	
	DSA-MW24BD (8512-4)	9/13/88	Groundwater	N/A	●			●	

Table 3-4

Summary of Soil and Groundwater Analyses (continued)

Location	Sample ID No.	Date Sampled	Matrix	Soil Depth	8040	8270	Mercury	Common Ions	Appendix IX
MW25A	DSA-MW24A-SS2.5 (8419-1)	9/15/88	Soil	2.5 to 4.0 ft.	●	●			
	DSA-MW25A-SS5.0 (8419-2)	9/15/88	Soil	5.0 to 6.5 ft.	●	●			
	DSA-MW25A-SS7.5 (8419-3)	9/15/88	Soil	7.5 to 9.0 ft.	●				
	DSA-MW25A-SS17.0 (8419-4)	9/15/88	Soil	17.0 to 18.5 ft.	●				
	DSA-MW25-SS17.0D (8419-5)	9/15/88	Soil	17.0 to 18.5 ft.	●				
	DSA-MW25A (8482-1)	9/26/88	Groundwater	N/A	●				
	DSA-MW25A (8512-7)	10/4/88	Groundwater	N/A	●			●	
	DSA-MW25AD (8512-9)	10/4/88	Groundwater	N/A	●				
MW25B	DSA-MW25B-SS0.0 (8410-3)	9/14/88	Soil	0.0 to 1.5 ft.	●	●	●		
	DSA-MW25B-SS2.5 (8410-6)	9/14/88	Soil	2.5 to 4.0 ft.	●	●	●		
	DSA-MW25B-SS5.0 (8410-4)	9/14/88	Soil	5.0 to 6.5 ft.	●				
	DSA-MW25B-SS5.0D (8410-5)	9/14/88	Soil	5.0 to 6.5 ft.	●				
	DSA-MW25B-SS30.0 (8410-7)	9/14/88	Soil	30.0 to 31.5 ft.	●		●		
	DSA-MW25B-SS50.0 (8401-8)	9/14/88	Soil	50.0 to 51.5 ft.	●				
	DSA-MW25B (8482-2)	9/26/88	Groundwater	N/A	●			●	
	DSA-MW25B (8512-8)	10/4/88	Groundwater	N/A	●			●	

Table 3-4
Summary of Soil and Groundwater Analyses (continued)

Location	Sample ID No.	Date Sampled	Matrix	Soil Depth	8040	8270	Mercury	Common Ions	Appendix IX
MW26	DSA-MW26-SS2.5 (8429-1)	9/19/88	Soil	2.5 to 4.0 ft.	●	●			
	DSA-MW26-SS2.5D (8429-2)	9/19/88	Soil	2.5 to 4.0 ft.	●				
	DSA-MW26-SS5.0 (8429-3)	9/19/88	Soil	5.0 to 6.5 ft.	●	●			
	DSA-MW26-SS7.5 (8429-4)	9/19/88	Soil	7.5 to 9.0 ft.	●				
	DSA-MW26-SS17.0 (8429-6)	9/19/88	Soil	17.0 to 18.5 ft.	●	●			
	DSA-MW26 (8482-4)	9/26/88	Groundwater	N/A	●			●	
	DSA-MW26 (8527-3)	10/5/88	Groundwater	N/A	●			●	
Boring 27	DSA-MWB27-SS2.5 (8432-1)	9/20/88	Soil	2.5 to 4.0 ft.	●		●		
	DSA-MWB27-SS2.5D (8432-2)	9/20/88	Soil	2.5 to 4.0 ft.	●		●		
	DSA-MWB27-SS5.0 (8432-3)	9/20/88	Soil	5.0 to 6.5 ft.	●				
	DSA-MWB27B-SS7.5 (8432-4)	9/20/88	Soil	7.5 to 9.0 ft.	●				
	DSA-MWB27-SS20.0 (8432-5)	9/20/88	Soil	20.0 to 21.5 ft.	●				
	DSA-MWB27-SS40.0 (8432-6)	9/20/88	Soil	40.0 to 41.5 ft.	●				
Boring 28	DSA-B28-S1.5	9/20/88	Soil	1.5					●

Summary of Soil and Groundwater Analyses (continued)

Marine Sediment Samples

Location	Sample ID No.	Date Sampled	Matrix	Soil Depth	8040	8270	Mercury	Common Ions	Appendix IX	TOC	% Moisture	Grain Size
DS-MS-01	DSA-MS1 (8454-6)	9/22/88	Marine Sediment	0-6"	●					●	●	●
DS-MS-02	DSA-MS2 (8454-5)	9/22/88	Marine Sediment	0-6"	●					●	●	●
DS-MS-03	DSA-MS3 (8454-4)	9/22/88	Marine Sediment	0-6"	●					●	●	●
DS-MS-04	DSA-MS4 (8454-1)	9/22/88	Marine Sediment	0-6"	●					●	●	●
DS-MS-05	DSA-MS5 (8454-2)	9/22/88	Marine Sediment	0-6"	●					●	●	●
DS-MS-05	DSA-MS53 (Marine Sediment)	9/22/88	Marine Sediment	0-6"		●						

Verification Study Samples

Location	Sample ID No.	Date Sampled	Matrix	Soil Depth	8040	TOC	% Moisture	Grain Size	TPH[a]	TOX[b]
VI-MS-200	VI-MS-200 (8454-8)	9/22/88	Marine Sediment	0-6"	●	●	●	●		
VI-MS-201	VI-MS-201 (8453-3)	9/22/88	Lagoon Sediment	0-4"	●	●	●	●		
VI-SS-200	VI-SS-200 (8453-8)	9/22/88	Truck Maintenance Area	0-3"	●		●		●	●
VI-SS-201	VI-SS-201 (8453-10)	9/22/88	New Planer Mill	0-3"	●		●			
VI-SS-202	VI-SS-202 (8453-6)	9/22/88	Sawmill	0-3"	●		●			
VI-SS-203	VI-SS-203 (8453-5)	9/22/88	Green Chain	0-3"	●		●			
VI-SS-204	VI-SS-204 (8453-9)	9/22/88	New Planer Mill	0-3"	●		●			
VI-SS-205D	VI-SS-205 (8453-7)	9/22/88	Green Chain	0-3"	●		●			

[a] TPH - Total Petroleum Hydrocarbons (See Verification Study)

[b] TOX - Total Organic Halides (See Verification Study)

Table 3-5
METHOD 8270 SEMIVOLATILE ORGANIC COMPOUNDS (HAZARD SUBSTANCE LIST)

Parameter	Water Quantitation Limit (µg/l)	Soil and Sediment Quantitation Limit (µg/l)
2,4-Dinitrophenol	50	1,600
4-Dinitrophenol	50	1,600
Dibenzofuran	10	330
2,4-Dinitrotoluene	10	330
2,6-Dinitrotoluene	10	330
Diethyl phthalate	10	330
4-Chlorophenyl phenyl ether	10	330
Fluorene	10	330
4-Nitroaniline	50	1,600
4,6-Dinitro-2-methylphenol	50	1,600
4-Bromophenyl phenyl ether	10	330
Hexachlorobenzene	10	330
Pentachlorophenol	50	1,600
Phenanthrene	10	330
Anthracene	10	330
Di-n-butyl phthalate	10	330
3,3'-Dichlorobenzene	30	660
Benzo(a)anthracene	10	330
bis(2-ethylhexyl)phthalate	10	330
Chrysene	20	660
Di-n-octyl phthalate	10	330
Benzo(b)fluoranthene	10	330
Benzo(k)fluoranthene	10	330
Benzo(a)pyrene	10	330
Indeno(1,2,3-cd)pyrene	10	330
Dibenz(a,h) anthracene	10	330
Benzo(g,h,i)perylene	10	330
N-Nitrosodimethylamine	10	330
Phenol	10	330
bis(2-Chloroethyl) ether	10	330
2-Chlorophenol	10	330
1,3-Dichlorobenzene	10	330
1,4-Dichlorobenzene	10	330
Benzyl alcohol	10	330
1,2-Dichlorobenzene	10	330
2-Methylphenol	10	330
bis(2-Chloroisopropyl) ether	10	330
4-Methylphenol	10	330
N-Nitrosodipropylamine	10	330
Hexachloroethane	10	330
Nitrobenzene	10	330
Isophorone	10	330
2-Nitrophenol	10	330
2,4-Dimethylphenol	10	330
Benzoic acid	50	1,600

Table 3-5
(continued)

Parameter	Water Quantitation Limit (µg/l)	Soil and Sediment Quantitation Limit (µg/l)
bis(2-Chloroethoxyl) methane	10	330
2,4-Dichlorophenol	10	330
1,2,4-Trichlorobenzene	10	330
Naphthalene	10	330
4-Chloroaniline	10	330
Hexachlorobutadiene	10	330
4-Chloro-3-methylphenol (para-chloro-meta-cresol)	10	330
2-Methylnaphthalene	10	330
Hexachlorocyclopentadiene	10	330
2,4,6-Trichlorophenol	10	330
2,4,5-Trichlorophenol	50	1,600
2-Chloronaphthalene	10	330
2-Nitroaniline	50	1,600
Dimethyl phthalate	10	330
Acenaphthylene	10	330
3-Nitroaniline	50	1,600
Acenaphthene	10	330

results presented by Hart Crowser, indicating that no dioxin is present in the vicinity of the old planer mill. The Appendix IX list contains 232 hazardous chemicals for which there are reliable analytical methods available including organic chemicals (volatile, semivolatile, pesticides, and herbicide compounds), metals and two anions (cyanide and sulfide). The complete list of compounds is presented in the QAPP (Appendix A). This is the most extensive and practical set of analyses for potentially regulated contaminants. Analyses of the nine organophosphate pesticides were not included in this study because there is no information about this site that suggests these compounds were ever used. All analyses were performed using methods specified in EPA's laboratory manual, Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW-846, September 1986).

The selection of Appendix IX analysis establishes a standard of concern by Daishowa; the company is interested in thoroughly investigating the potential presence of any contamination that may be associated with this property. Finally, the comprehensive analysis provided by Appendix IX can also serve as a useful benchmark for characterizing site conditions and verifying the Method 8040 and Method 8270 results.

3.2.1.4 Mercury

The information available on sapstain control chemicals such as Permatox 180 indicated there were several formulations on the market and at least one contained mercury (John Cult, American Wood Preserver's Institute, pers. comm., July, 1988). Soil samples in the target area were analyzed to determine if there was any mercury contamination present at the site. Analysis was performed at CH2M HILL's Corvallis laboratory using SW-846 Method 7471, a manual cold vapor atomic absorption procedure. Samples analyzed for mercury are indicated on Table 3-4.

3.2.1.5 Common Ions

Groundwater samples collected during the focused site investigation were analyzed for a suite of natural groundwater quality parameters. Natural groundwater quality data were obtained to:

- Evaluate the vertical and horizontal extent of saline water intrusion
- Assess the potential presence of anthropogenic inorganic constituents that may represent a hazard or be useful as indicators of other contaminants

- Determine the potential chemical behavior of the contaminants of interest (i.e., PCP) in response to the type and concentrations of natural groundwater constituents

Natural groundwater chemistry parameters included the common ions chloride, sulfate, nitrogen (as nitrate), calcium, potassium, magnesium, and sodium; pH, conductivity; alkalinity; and total dissolved solids. Groundwater samples were analyzed for common ions, alkalinity, and total dissolved solids only during the first round of sampling. Conductivity and pH were measured each time a groundwater sample was analyzed for organic contaminants.

3.2.2 LABORATORY AND FIELD QA/QC

Quality assurance (QA) and quality control (QC) programs were implemented to provide data of known quality. Data quality is assessed by representativeness, compatibility, accuracy, precision, and completeness.

The analyses of groundwater and soil samples for Appendix IX parameters and Method 8270 semivolatile organic compounds were carried out by the latest EPA Contract Laboratory Program (CLP) protocols for Superfund sites. These protocols are based on EPA's SW846 methods and are described in the EPA invitation for bid documents (IFBs WA 85 H646/680, WA 85 J838/833, WA 87 K025/027 and WA 87 J001/003). Guidelines for independent review and validation of Contract Laboratory Program (CLP) data are given in EPA Sample Management Office Technical Directive Document No. HQ-8410-01, Contract No. 68-01-6699. Final data reviews followed the above-noted guidelines. Analysis of PCP and TCP by Method 8040 was carried out under an equivalent level of effort. Specific QC details are provided in the QAPP (Appendix A).

4 RESULTS

Results of the focused site investigation are presented in the following sections commencing with the physical site characterization including geologic and hydrologic characteristics. The analytical QA/QC and results of all chemical tests are also summarized.

4.1 SITE CHARACTERIZATION

The physical characteristics of the focused site investigation area were evaluated for potential contaminant transport pathways. Site geology, groundwater hydrology and chemistry, and the nature of offshore marine sediments were also evaluated.

4.1.1 SUBSURFACE CONDITIONS

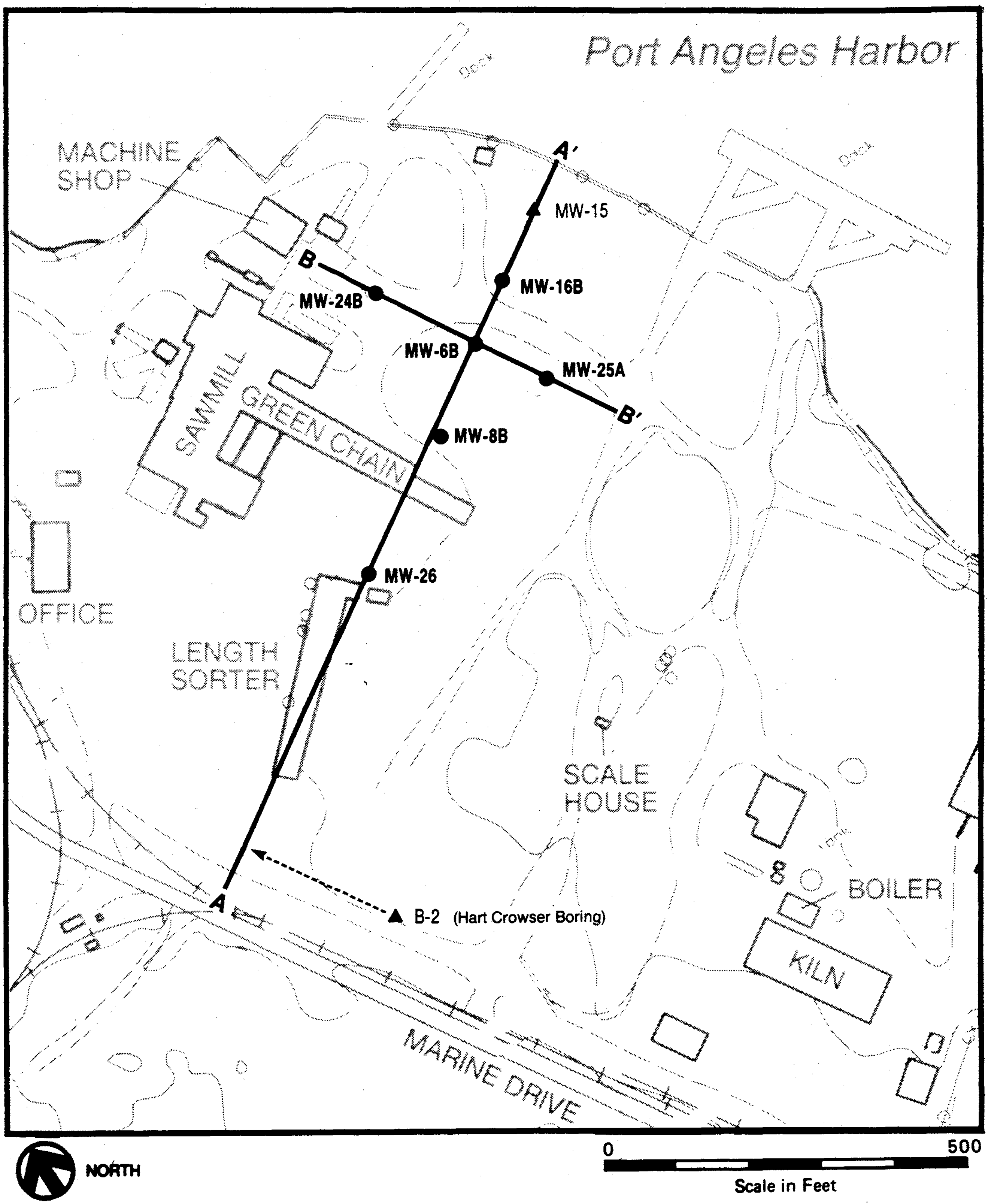
4.1.1.1 Site Geology

The geologic information presented in this section was obtained during the focused site investigation conducted from August through October 1988. A total of 10 groundwater monitoring wells and two soil borings were installed at the site. The geologic logs for the monitoring wells and borings, and well construction details, are included in Appendix C. Geologic information presented by Hart Crowser (May 1988) was also used in evaluating site geology.

Subsurface conditions within the focused site investigation area consist of artificial fill material overlying native sediments deposited in beach and shallow marine environments. Fill material is on the order of 10 to 20 feet deep in most areas. Unconsolidated fine sand and silt appears to underlie the entire site below this depth.

Figure 4-1 shows the location of two geologic cross sections prepared to illustrate the subsurface conditions. Figures 4-2 and 4-3 show geologic cross-sections oriented perpendicular and parallel to the shoreline at the site.

Figures 4-2 (A-A' cross section) and 4-3 (B-B' cross section) show the vertical extent of fill material as interpreted from soil samples collected during drilling. The fill material ranges from approximately 10 to 20 feet deep and is variable in composition. The fill materials consist mainly of poorly sorted sand and gravel with variable amounts of silt and clay. The fill material also contains rip rap, wood chips and sawdust, log and root debris, and concrete and brick fragments. In places, the fill also contains shell fragments, suggesting the presence of dredge spoils.

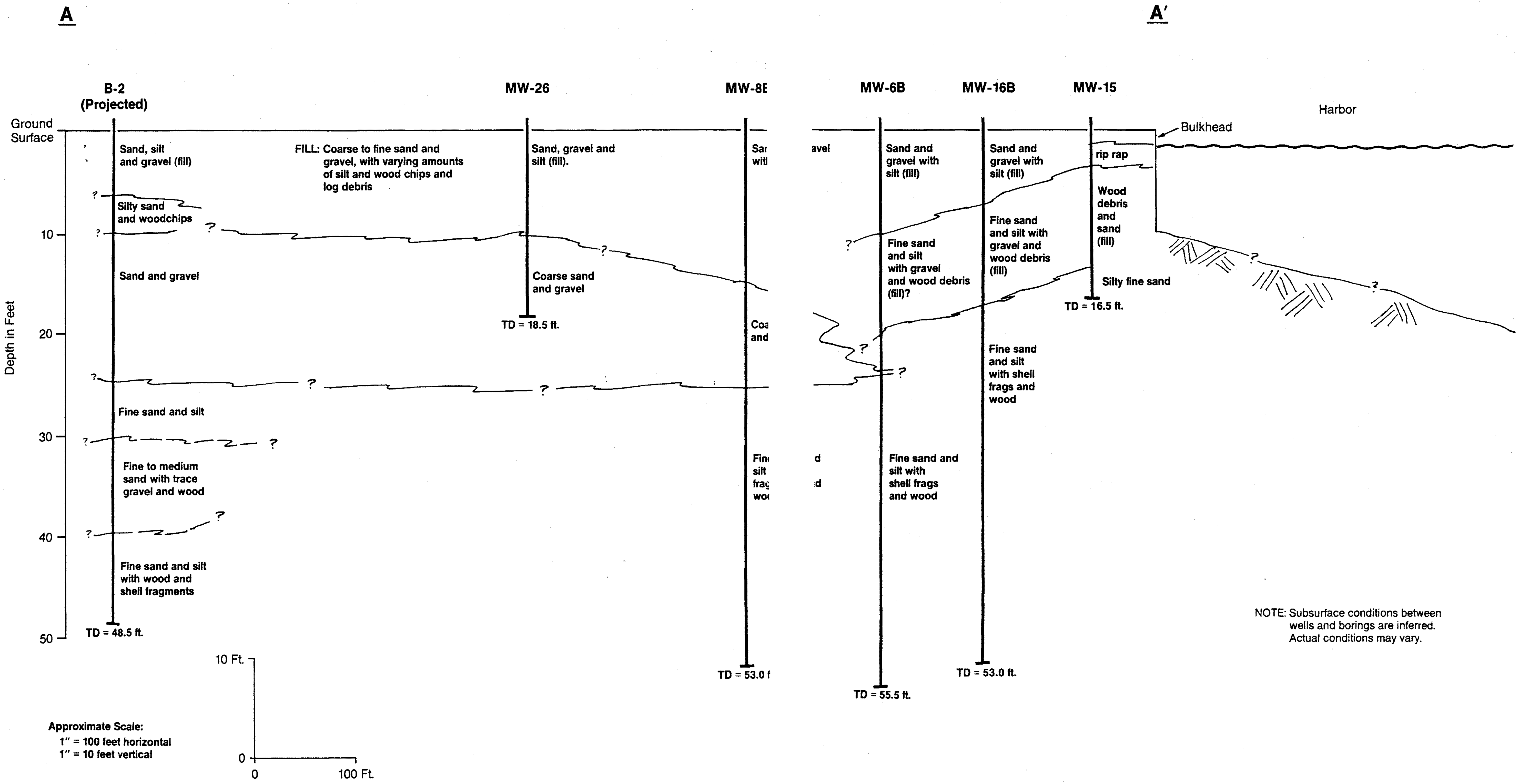


LEGEND

● **CH2M HILL Monitoring Well**

▲ **Hart Crowser Monitoring Well or Boring**

FIGURE 4-1
Location of Generalized Geologic Cross-Sections



NOTE: Subsurface conditions between wells and borings are inferred. Actual conditions may vary.

FIGURE 4-2
Generalized Geologic Cross Section A-A′

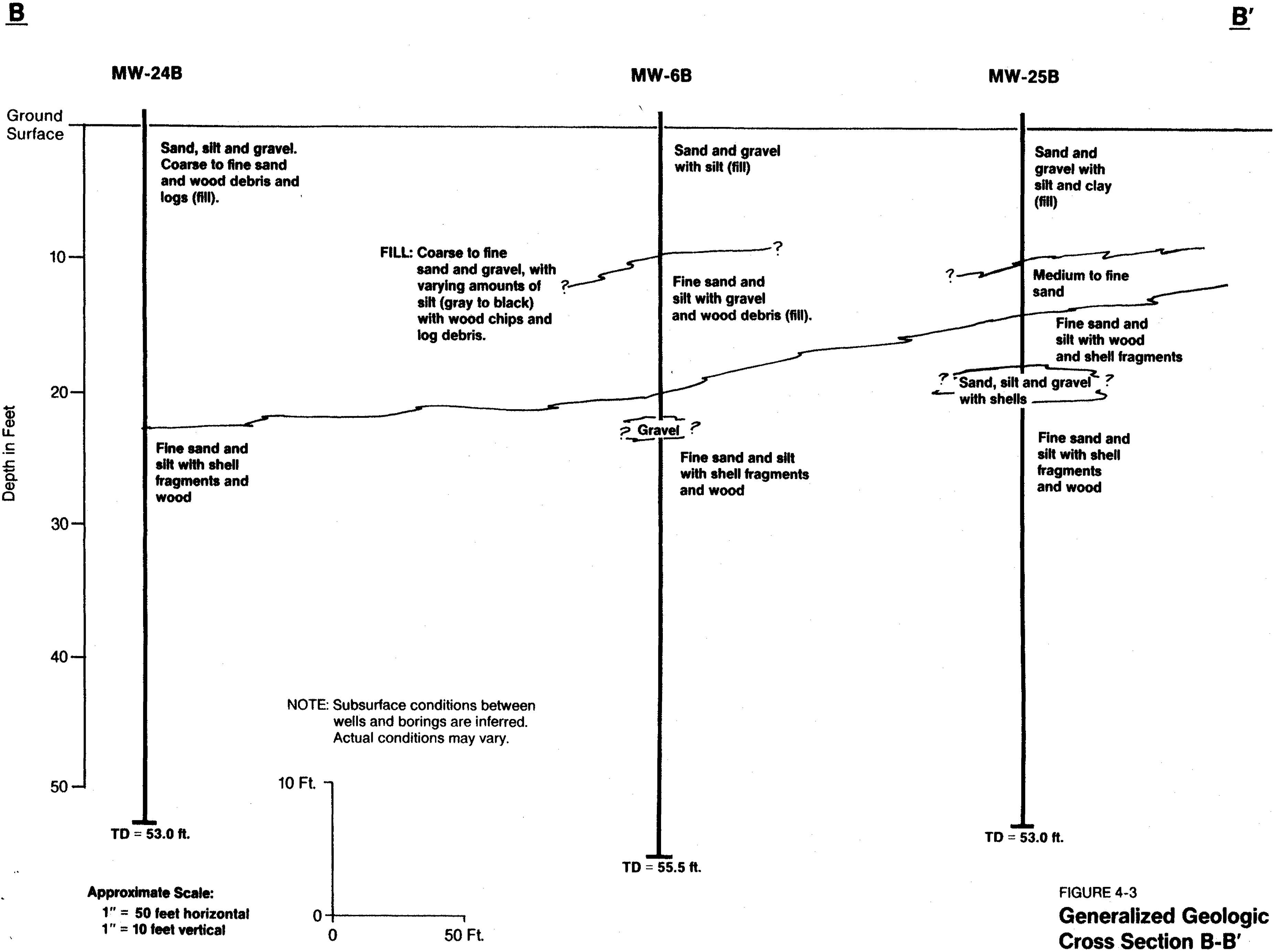


FIGURE 4-3
Generalized Geologic Cross Section B-B′

Grain-size analysis conducted on selected samples of the fill material indicate the soils are in the SP or SM group using the United Soil Classification System (USCS). The SP and SM groups are described as poorly graded sands and gravelly sands with little or no fine-grained material, to silty sands or sand-silt mixtures. The fill materials are generally coarser grained and contain more gravel than the native soils at the site.

Several feet of relatively clean sand and gravel directly underly the above-referenced fill in many areas, especially in the southwest portion of the site away from the harbor. The sand and gravel appear to be native in most areas. A mixture of unconsolidated fine sand and silt underlies the fill and native sand and gravel (where present). In most areas, the fine sand and silt are present in nearly equal proportions. The fine sand and silt is gray in color, unconsolidated, soft, and contains organic detritus and abundant shell fragments. The unconsolidated fine sand and silt appears to underly the entire site from a depth of approximately 20 feet to at least 50 feet, the limits of the boreholes drilled by CH2M HILL. Deep boreholes drilled by Hart Crowser (June 1988) indicate the presence of interbedded very dense sand and hard silt below a depth of approximately 60 feet.

The results of grain size distribution analyses for 14 subsurface soil samples are presented in Table 4-1 and are graphically illustrated in Figures 4-4 through 4-6. Based on the grain size analyses, the samples range from gravelly fine to coarse sand with little silt or clay, to varying mixtures of fine sand and silt. Samples recovered from depths greater than 20 feet display a consistent grain size distribution curve characteristic of silty fine sand and silt (SM and ML using the USCS).

4.1.1.2 Groundwater Hydrology

The groundwater hydrology of the former M&R site was evaluated during the focused site investigation. Although 17 monitoring wells were installed early in 1988 by Hart Crowser, no evaluation of the groundwater hydrology at the site was included as part of this previous investigation.

Ten monitoring wells were installed by CH2M HILL during the focused site investigation to collect groundwater samples and evaluate groundwater hydrology. Five of the wells (MW-6C, MW-2S, MW-24A, MW-25A, and MW-26) were screened adjacent to the water table from approximately 5 to 15 feet below the ground surface. The other five monitoring wells (MW-6B, MW-8B, MW-16B, MW-24B, and MW-25B) were screened from approximately 40 to 50 feet below the ground surface. The hydrogeologic conditions at these two depth intervals are different,

Table 4-1
SOIL GRAIN SIZE DISTRIBUTION

		U.S. Standard Sieve Size and Percent Passing							
Well No.	Sample Interval (feet bgs[a])	1 inch	No. 4 (0.187")	No. 10 (0.0787")	No. 20 (0.0331")	No. 40 (0.0165")	No. 60 (0.0098")	No. 100 (0.0059")	No. 200 (0.0029")
MW-8B	15.0-16.5	100.0	70.4	44.5	20.0	11.1	5.1	1.4	0.5
MW-8B	42.5-44.0	100.0	100.0	100.0	100.0	99.7	99.5	95.7	46.3
MW-16B	15.0-16.5	100.0	100.0	99.7	99.0	98.2	94.9	84.5	21.7
MW-16B	42.5-44.0	100.0	100.0	100.0	99.9	99.7	99.2	83.5	39.5
MW-23	10.0-11.5	100.0	63.5	50.5	38.5	23.9	8.3	2.9	1.3
MW-23	17.5-19.0	90.5	56.9	35.0	14.8	8.7	4.5	1.3	0.4
MW-24A	10.0-11.5	100.0	72.4	64.6	58.3	45.9	25.0	12.9	6.1
MW-24A	15.0-16.5	100.0	99.3	97.3	94.9	92.9	87.6	70.3	18.5
MW-24B	27.5-29.0	100.0	100.0	99.5	98.9	97.4	90.3	77.7	24.0
MW-24B	45.0-46.5	100.0	100.0	99.8	99.6	99.2	98.6	96.2	50.0
MW-25A	12.5-14.0	100.0	87.6	81.9	75.1	64.7	45.7	32.0	12.4
MW-25A	15.0-16.5	100.0	100.0	98.6	96.0	93.9	90.8	79.9	32.1
MW-26	10.0-11.5	94.7	81.3	69.1	56.0	32.6	5.1	0.9	0.4
MW-26	17.0-18.5	100.0	73.8	56.2	44.6	34.3	19.2	11.0	5.1

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[a] bgs = below ground surface.

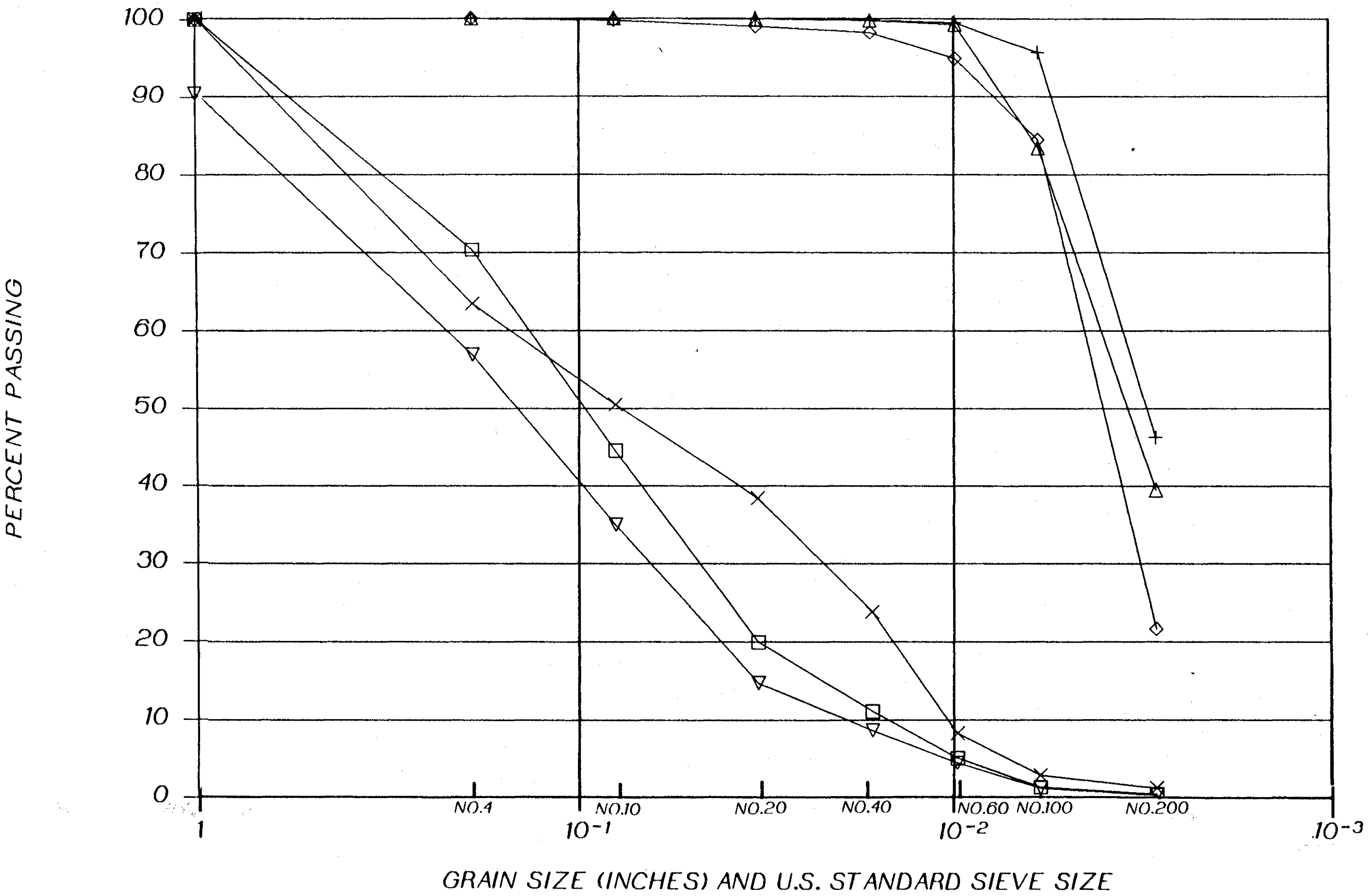


FIGURE 4-4
Grain Size Distribution for Soil

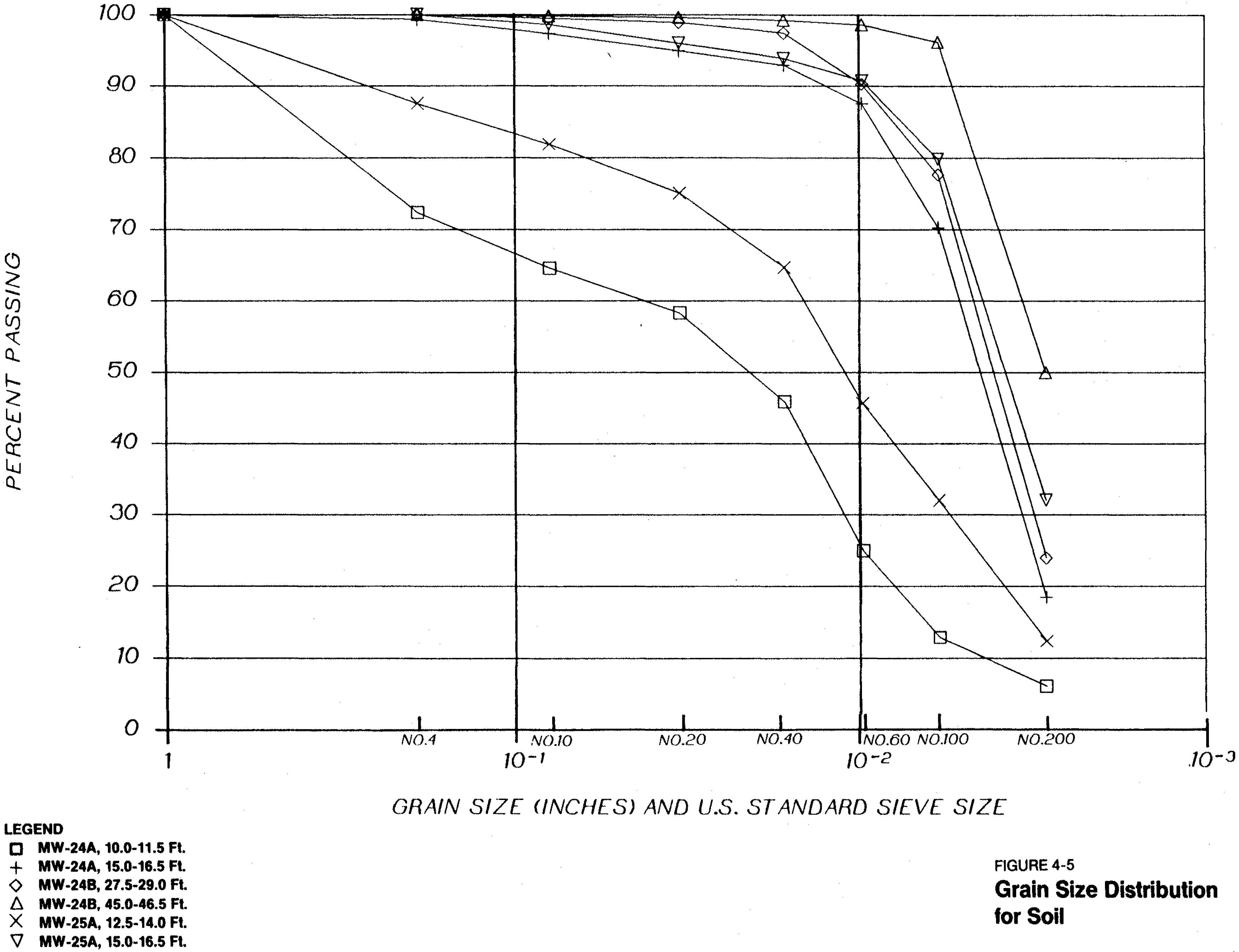
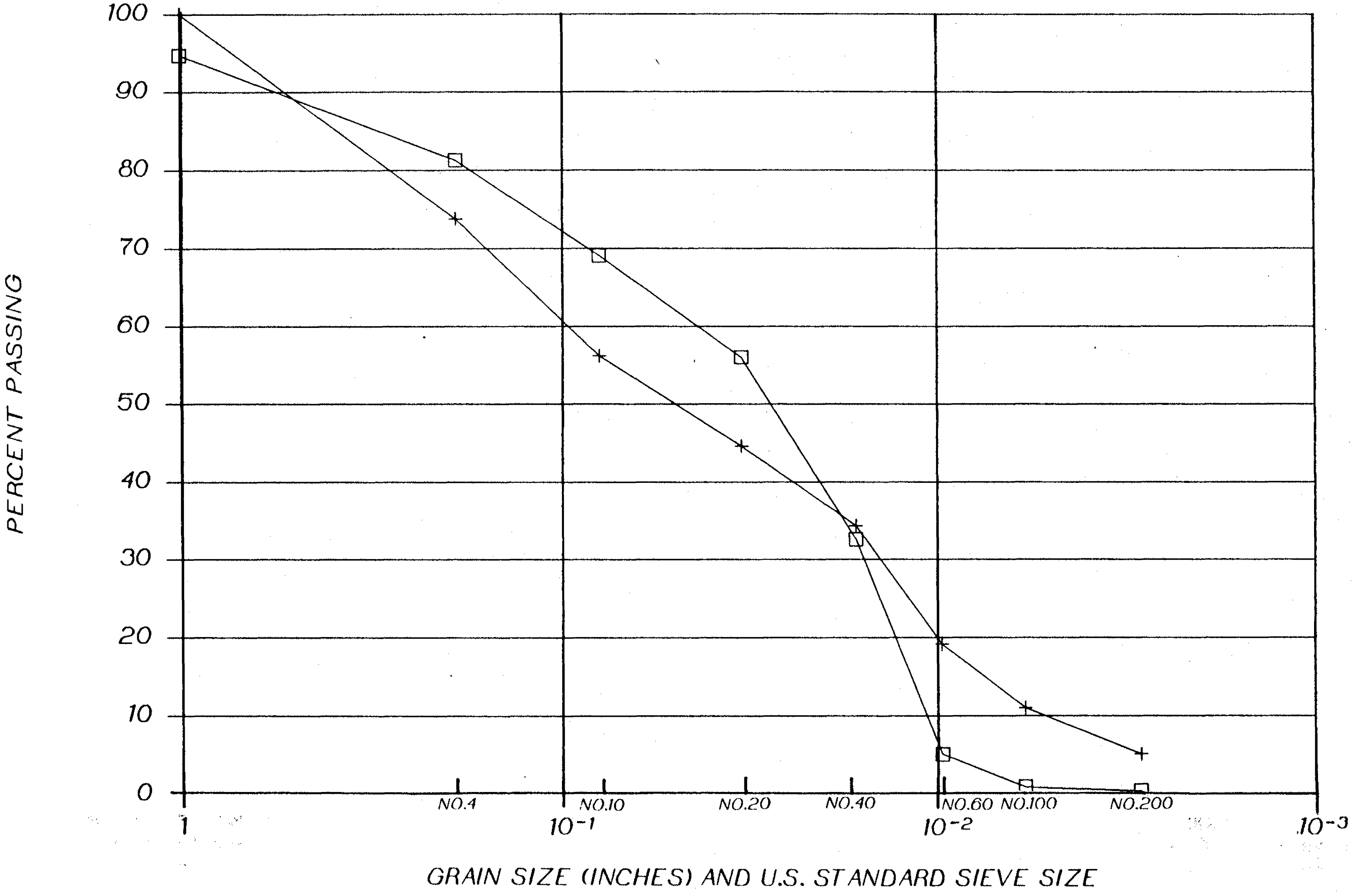


FIGURE 4-5

Grain Size Distribution for Soil



LEGEND
☐ MW-26, 10.0-11.5 Ft.
+ MW-26, 17.0-18.5 Ft.

FIGURE 4-6
Grain Size Distribution for Soil

and for the purposes of discussion, they are referred to as the shallow and deep monitoring zones.

As described in Section 4.1.1.1, the shallow monitoring zone is characterized by both fill and native materials that consist primarily of gravelly sand with a minimal quantity of accessory silt and clay. The deep monitoring zone is characterized by silt and fine sand present in approximately equal proportions. No low-permeability confining unit of any appreciable thickness or lateral extent is known to separate the two zones. Based on boring logs and geologic cross sections presented by HC (June, 1988), interbedded hard silt and very dense silty sand are present at approximately 60 feet below the ground surface in the focused site investigation area.

Hydrologic information collected by CH2M HILL during the focused site investigation included:

- Static groundwater elevations for evaluation of groundwater flow directions and hydraulic gradients
- Slug test and laboratory permeability data for estimation of hydraulic conductivity
- Groundwater and tide elevations versus time for evaluation of tidal effects on groundwater movement

Groundwater Flow Directions and Gradients. The water table is within 4 to 5 feet of the ground surface in most areas of the former M&R site. Approaching Port Angeles Harbor, the groundwater levels fluctuate up to several feet in response to tidal influence.

Static groundwater levels were measured in all available monitoring wells on four occasions during the field investigation. As referenced in Section 3.1.5, groundwater levels were measured on August 3, August 30, and twice (at high and low tide) on September 24, 1988. During each measurement, groundwater levels were obtained within a period of approximately 1-1/2 hours so that they would be as contemporaneous as possible. Table 4-2 presents groundwater level elevations as measured on the above referenced dates.

Potentiometric contour maps representing groundwater elevations and flow directions on September 24, 1988 are presented in Figures 4-7, 4-8, 4-9, and 4-10. Figures 4-7 and 4-8 illustrate the potentiometric surface as determined from groundwater elevation data collected during high and low tide in the shallow monitoring wells, respectively. Figures 4-9 and 4-10 illustrate the potentiometric surface

Table 4-2
GROUNDWATER ELEVATION DATA

		Groundwater Elevation[a]			
Well No.	Reference Point Elevation[b]	03 Aug. 88	30 Aug. 88[c]	Low Tide 24 Sept. 88[d]	High Tide 24 Sept. 88[e]
MW-3A	10.02	4.04	3.96	4.02	4.02
MW-4A	12.37	3.70	3.57	3.63	3.64
MW-5A	9.14	2.76	2.65	2.64	2.64
MW-6A	8.63	2.14	2.03	2.03	2.04
MW-6B	8.77	N/A	N/A	1.55	1.73
MW-6C[f]	8.78	N/A	N/A	N/A	N/A
MW-7	7.88	3.75	3.72	3.74	3.75
MW-8	9.76	2.43	2.30	2.20	2.30
MW-8B	9.17	N/A	N/A	2.11	2.21
MW-11	12.26	1.20	1.30	1.38	1.16
MW-12	10.92	N/A	2.97	2.98	2.98
MW-13	9.97	0.12	3.03	3.06	3.06
MW-14[g]	N/A	N/A	N/A	N/A	N/A
MW-15	7.85	-0.98	-0.05	-2.75	1.04
MW-16A	8.11	1.88	1.79	1.78	1.78
MW-16B	8.51	N/A	N/A	0.78	1.22
MW-18	9.53	-1.58	-1.38	-3.28	1.69
MW-19	9.73	-1.08	-0.96	-3.15	1.51
MW-20	10.14	3.23	3.89	3.95	3.95
MW-21	9.18	0.93	1.03	0.69	1.14
MW-22	10.43	1.80	1.76	1.75	1.66
MW-23	8.24	N/A	N/A	2.20	2.22
MW-24A	9.33	N/A	N/A	1.64	1.66
MW-24B	9.67	N/A	N/A	1.19	1.46
MW-25A	9.01	N/A	N/A	1.98	1.98
MW-25B	8.55	N/A	N/A	1.76	1.98
MW-26	8.06	N/A	N/A	2.45	2.43

---

[a] All elevations referenced to Wilsey and Ham datum.

[b] Top of PVC well casing used as reference point for all groundwater level measurements.

[c] Measurements taken between 9:56 a.m. and 11:13 a.m. High tide at 7:56 a.m.; low tide at 1:09 p.m.

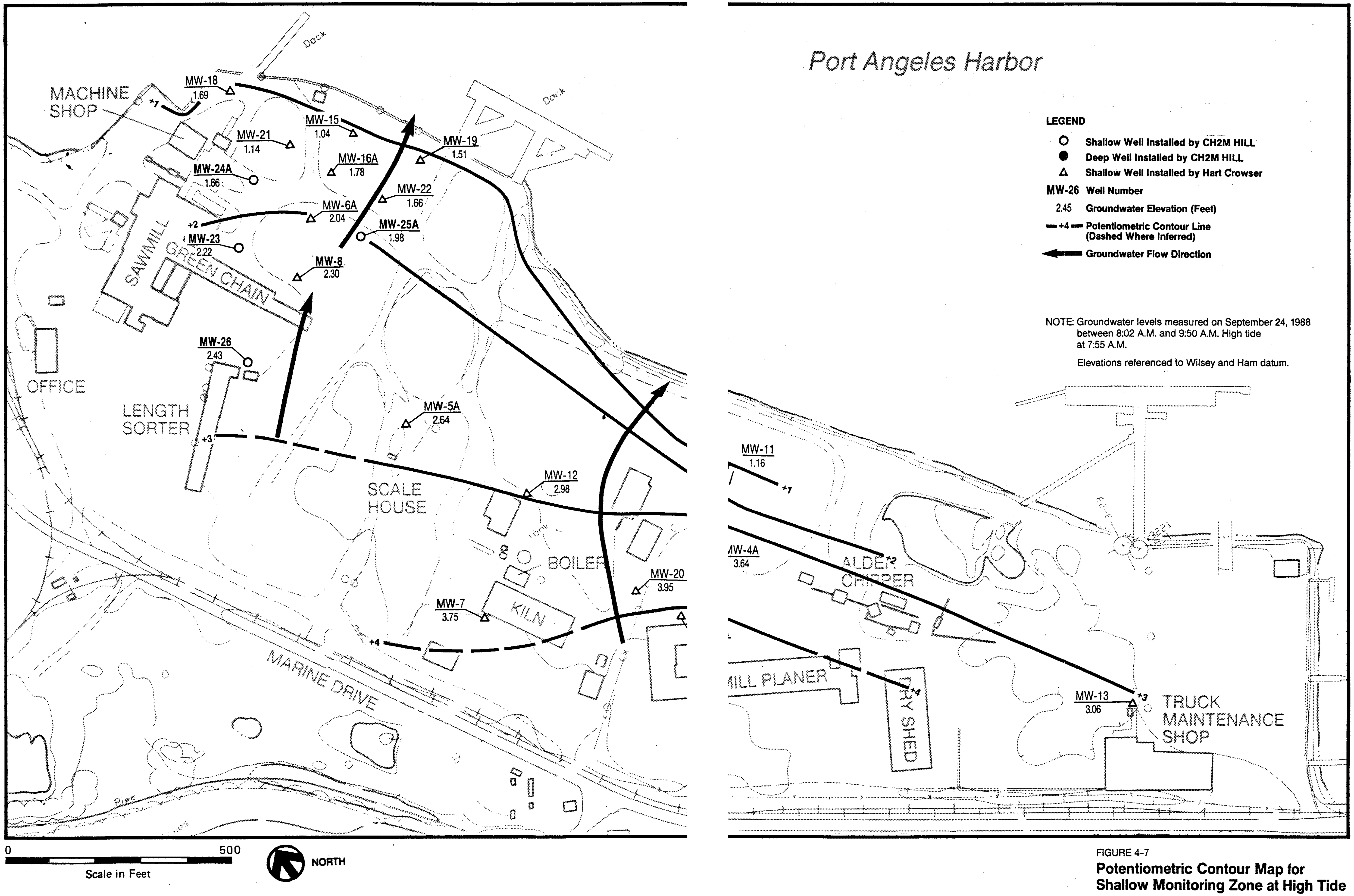
[d] Measurements taken between 8:02 a.m. and 9:50 a.m. Low tide at 7:55 a.m.

[e] Measurements taken between 1:25 p.m. and 2:55 p.m. High tide at 2:59 p.m.

[f] MW-6C installed in October 1988. Groundwater elevations not available.

[g] MW-14 buried under wood chip pile. Reference point and groundwater elevations not available.

[h] N/A = Not applicable; well not installed or not accessible.

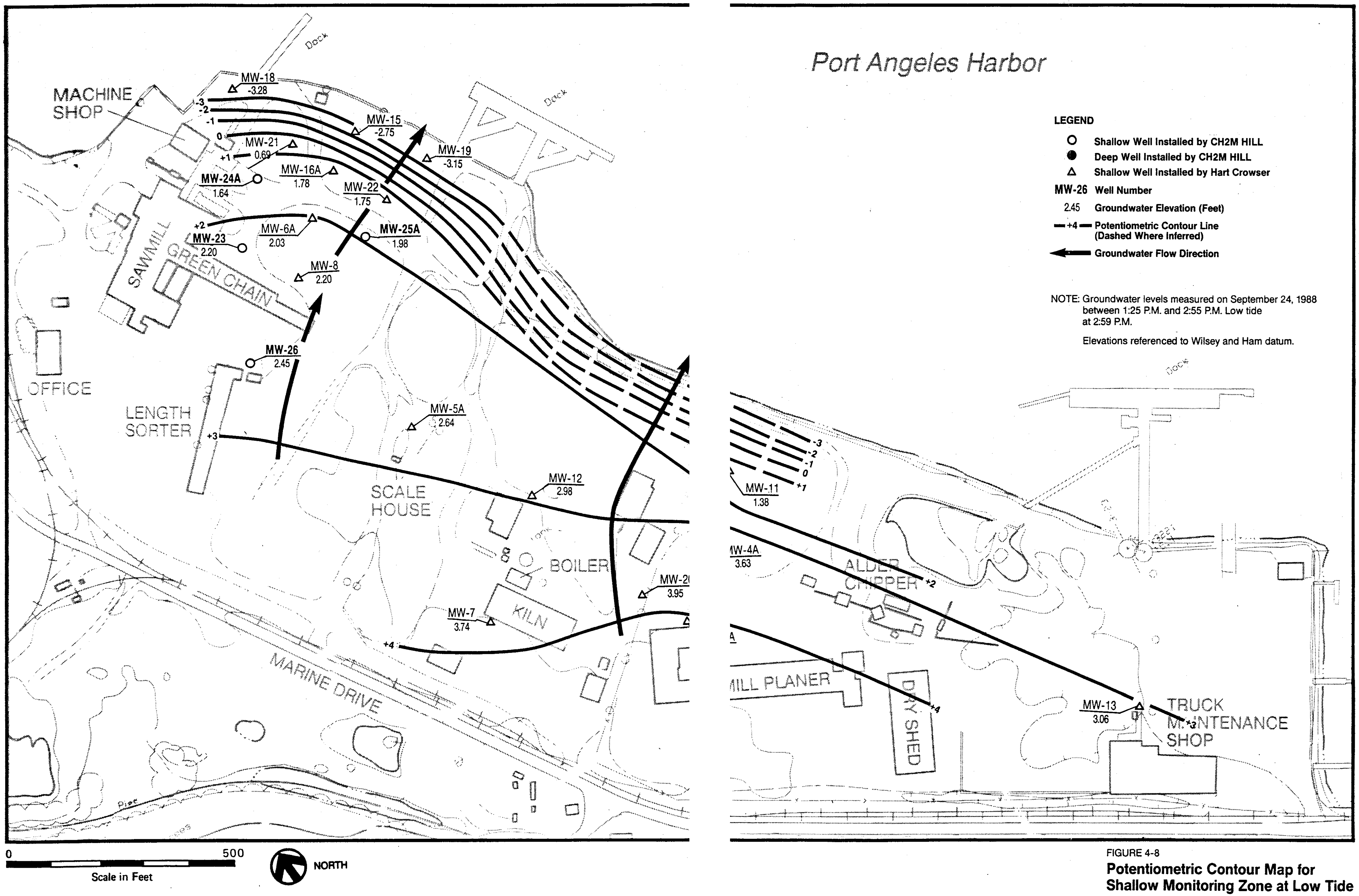


NOTE: Groundwater levels measured on September 24, 1988 between 8:02 A.M. and 9:50 A.M. High tide at 7:55 A.M.

Elevations referenced to Wilsey and Ham datum.

FIGURE 4-7

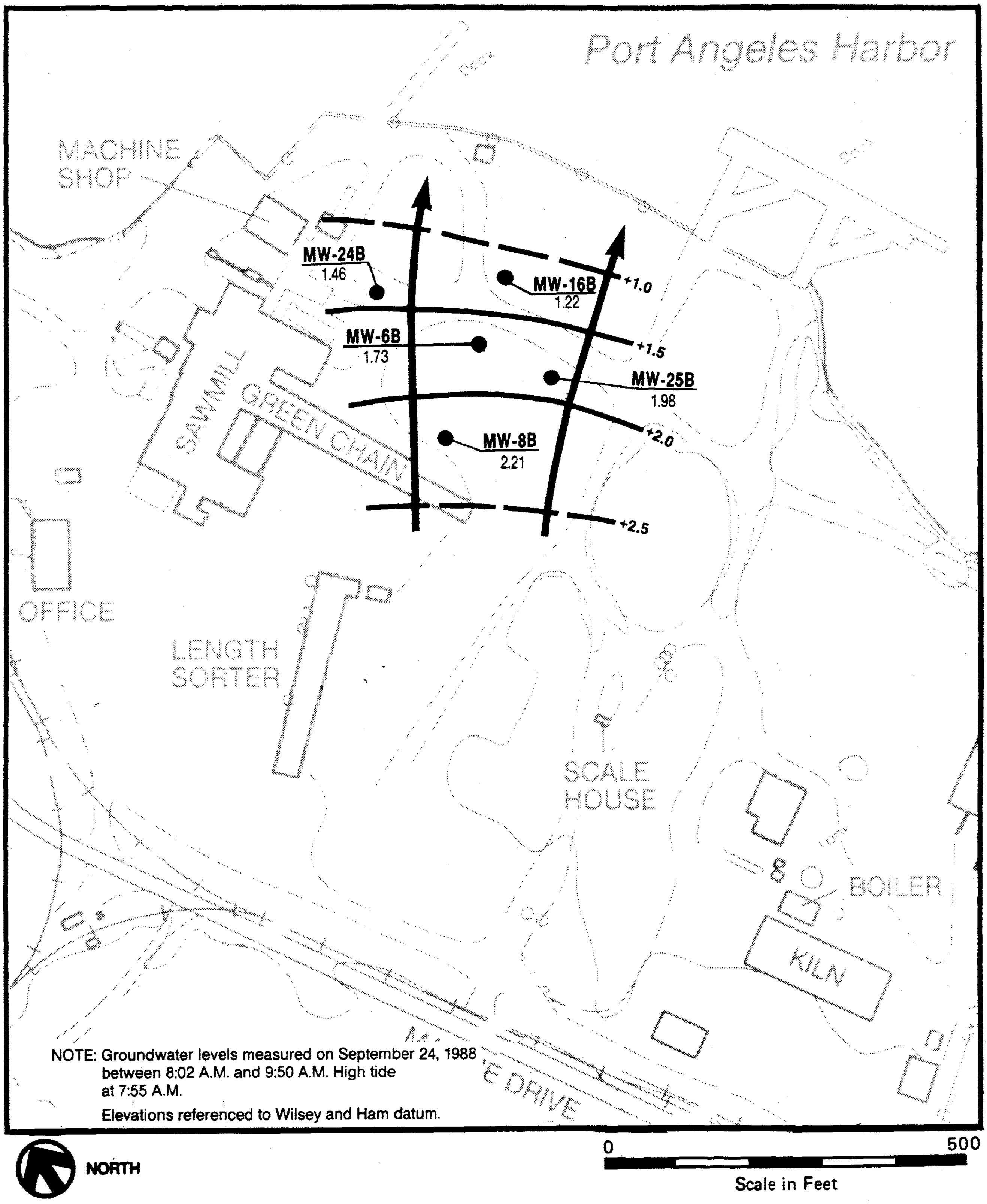
Potentiometric Contour Map for Shallow Monitoring Zone at High Tide



NOTE: Groundwater levels measured on September 24, 1988 between 1:25 P.M. and 2:55 P.M. Low tide at 2:59 P.M.

Elevations referenced to Wilsey and Ham datum.

FIGURE 4-8
Potentiometric Contour Map for Shallow Monitoring Zone at Low Tide



NOTE: Groundwater levels measured on September 24, 1988 between 8:02 A.M. and 9:50 A.M. High tide at 7:55 A.M.

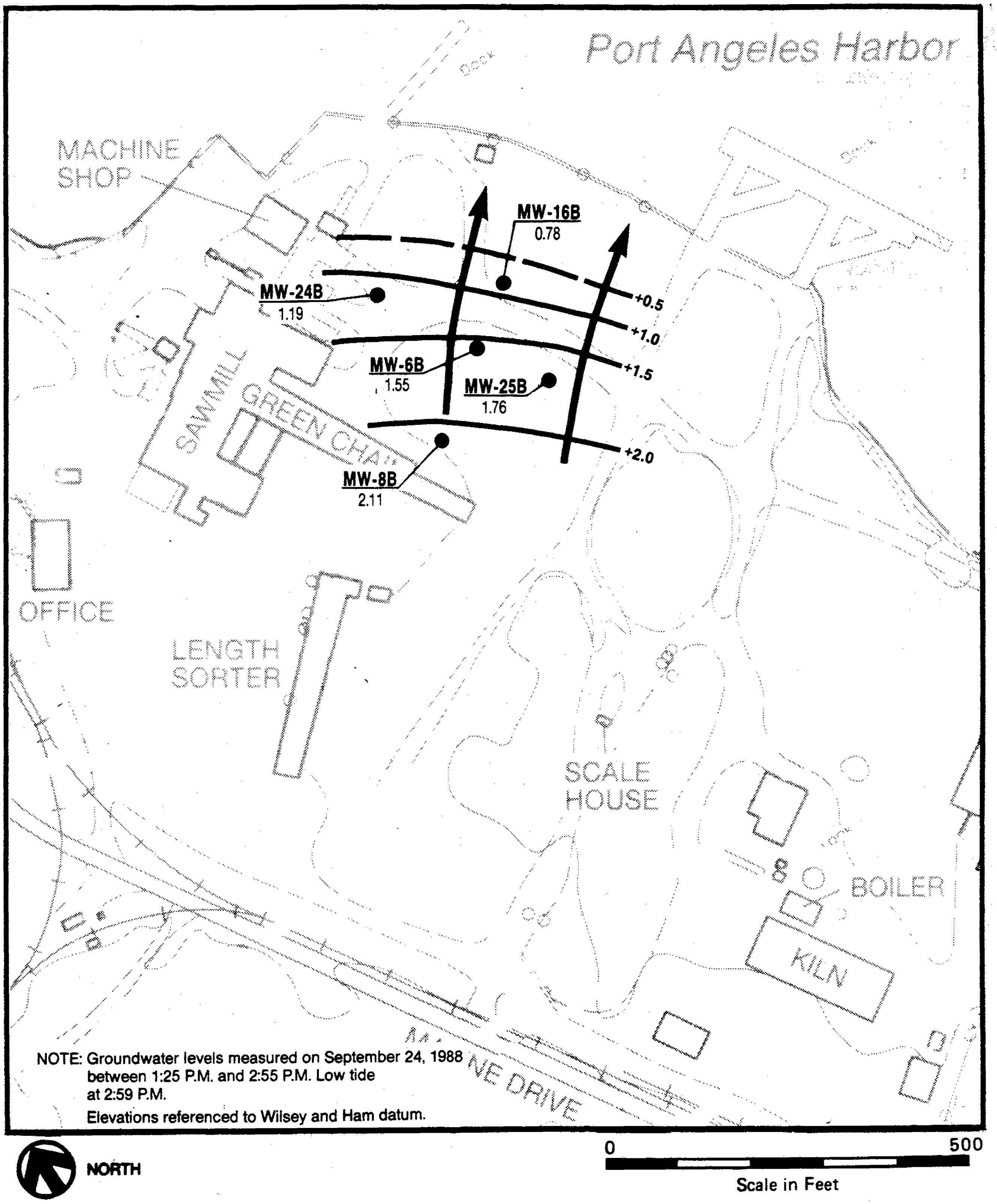
Elevations referenced to Wilsey and Ham datum.

LEGEND

●	**Deep Well Installed by CH2M HILL**
MW-26	**Well Number**
2.45	**Groundwater Elevation (Feet)**
— +4 —	**Potentiometric Contour Line (Dashed Where Inferred)**
←	**Groundwater Flow Direction**

FIGURE 4-9

Potentiometric Contour Map for Deep Monitoring Zone at High Tide



NOTE: Groundwater levels measured on September 24, 1988 between 1:25 P.M. and 2:55 P.M. Low tide at 2:59 P.M.
Elevations referenced to Wilsey and Ham datum.

LEGEND

●	**Deep Well Installed by CH2M HILL**
MW-26	**Well Number**
2.45	**Groundwater Elevation (Feet)**
—+4—	**Potentiometric Contour Line (Dashed Where Inferred)**
◄—	**Groundwater Flow Direction**

FIGURE 4-10

Potentiometric Contour Map for Deep Monitoring Zone at Low Tide

as determined from groundwater elevation data collected during high and low tide in the deep monitoring wells, respectively.

The above referenced figures indicate that groundwater flow is northeast toward Port Angeles Harbor during both high and low tides in both the shallow and deep monitoring zones. Tidal fluctuations have a significant effect on groundwater levels in the shallow monitoring zone within about 150 feet of the harbor. Groundwater levels changed as much as 4.97 feet (monitoring well MW-18) in approximately six hours in response to the 7.2-foot tidal fluctuation for the same period.

As can be seen by comparing Figures 4-7 and 4-8, the horizontal hydraulic gradient in the shallow monitoring zone is greater at low tide than at high tide. Figures 4-9 and 4-10 indicate that the hydraulic gradient in the deep monitoring zone is less affected by tidal action. However, the response of the deep zone within about 175 feet of the harbor is not known because there are no wells deeper than approximately 15 feet in this area.

Based on groundwater level elevations measured on September 24, 1988, horizontal hydraulic gradients in the shallow monitoring zone range from approximately 0.002 (unitless) in the southwest portion of the site during both high and low tide, to approximately 0.05 near the harbor during low tide. Horizontal gradients in the deep monitoring zone are on the order of 0.004 to 0.008 during both high and low tide.

Vertical hydraulic gradients are presented in Table 4-3. These data are based on groundwater elevations measured in adjacent shallow and deep monitoring wells at high and low tide on September 24, 1988. Where measurable gradients exist, the vertical component of groundwater flow potential is in the upward direction. The vertical gradient was found to be greatest at monitoring well pair MW-16/MW-16B, ranging from 0.02 to 0.03 during high and low tides, respectively. Vertical gradients at other monitoring well pairs were generally found to be in the order of 0.01 to 0.001.

Tidal Influence. Groundwater and tide elevations were monitored over a period of several days to evaluate the response of groundwater levels to tidal fluctuation. As discussed in Section 3.1.5, two arrays of wells were monitored during the investigation. Each array included four monitoring wells and a stilling well located in Port Angeles Harbor.

Hydrographs are presented in Figure 4-11 for shallow monitoring wells MW-6, MW-15, MW-16, MW-18, and the tide. The hydrographs represent water level conditions during an 80-hour period between September 14 and 18, 1988. The wells are located approximately 35 feet (MW-18) to 285 feet (MW-6A) from the harbor. As depicted in Figure 4-11, MW-15 and MW-18 are strongly affected by tidal fluctuation because of their proximity to the shoreline. No significant groundwater level changes are apparent at monitoring wells MW-6A or MW-16, suggesting that tidal fluctuations only affect the shallow zone of saturation within about 150 feet of the harbor. For the period monitored, the hydrographs indicate that there were brief diurnal periods of reversal in the groundwater flow direction near the shore. This occurred when the elevation of the water table at monitoring wells MW-15 and MW-18 was higher than at monitoring wells MW-6A and MW-16A.

Table 4-3
VERTICAL HYDRAULIC GRADIENTS

Well Pair No.	Screen Separation (feet)[b]	Vertical Hydraulic Gradient[a] High Tide[c]	Low Tide[d]
6A/6B	36	8.6×10^{-3}	1.3×10^{-2}
8/8B	36	2.5×10^{-3}	2.5×10^{-3}
16A/16B	34	1.6×10^{-2}	2.9×10^{-2}
24A/24B	35	5.7×10^{-3}	1.3×10^{-2}
25A/25B	36	0.00	6.1×10^{-3}

---

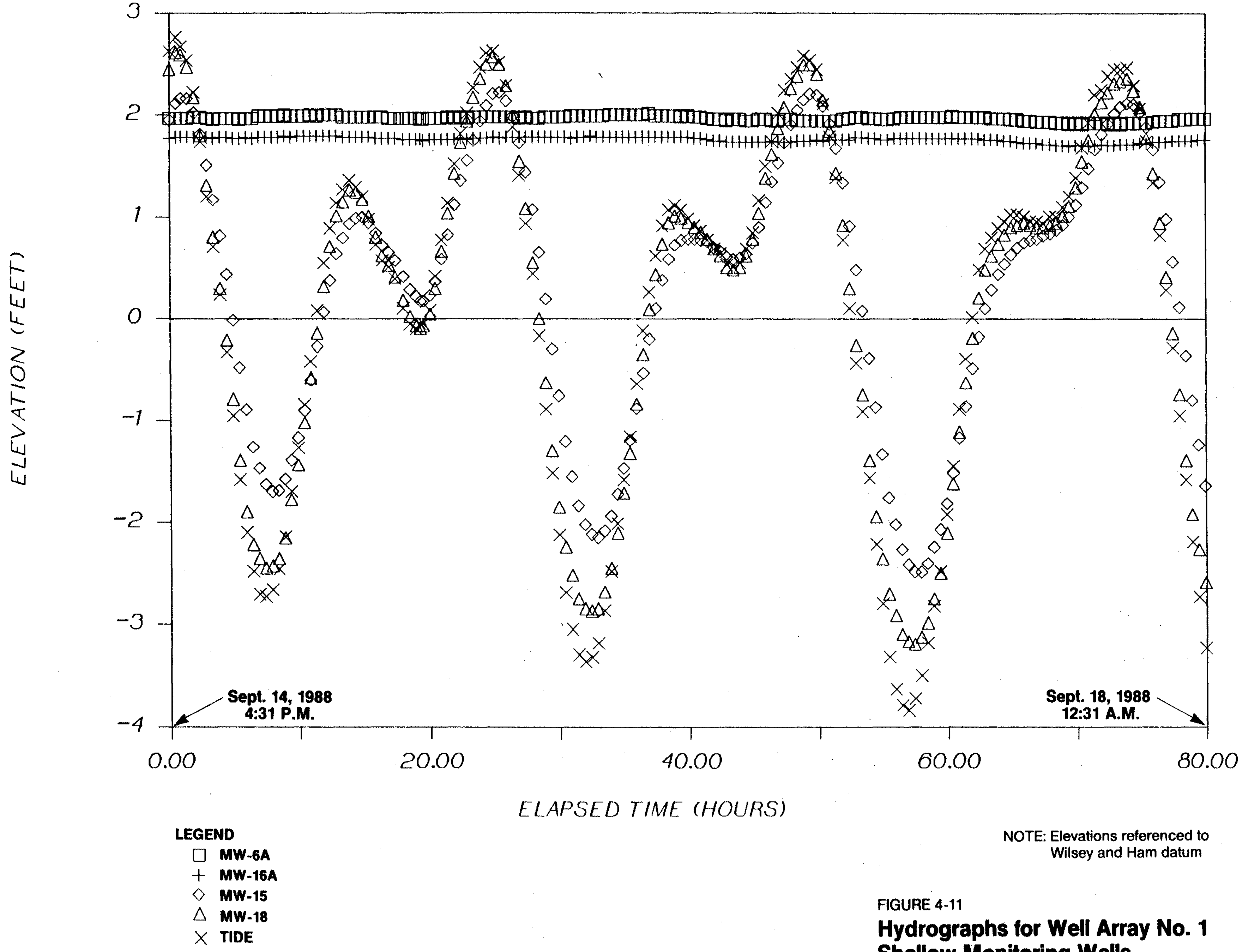
[a] Vertical component of groundwater flow potential is upward for all measurable gradients.

[b] Separation measured from middle of screens.

[c] Gradients based on groundwater levels measured on September 24, 1988 between 8:02 a.m. and 9:50 a.m.. High tide at 7:55 a.m.

[d] Gradients based on groundwater levels measured on September 24, 1988 between 1:25 p.m. and 2:55 p.m. Low tide at 2:59 p.m.

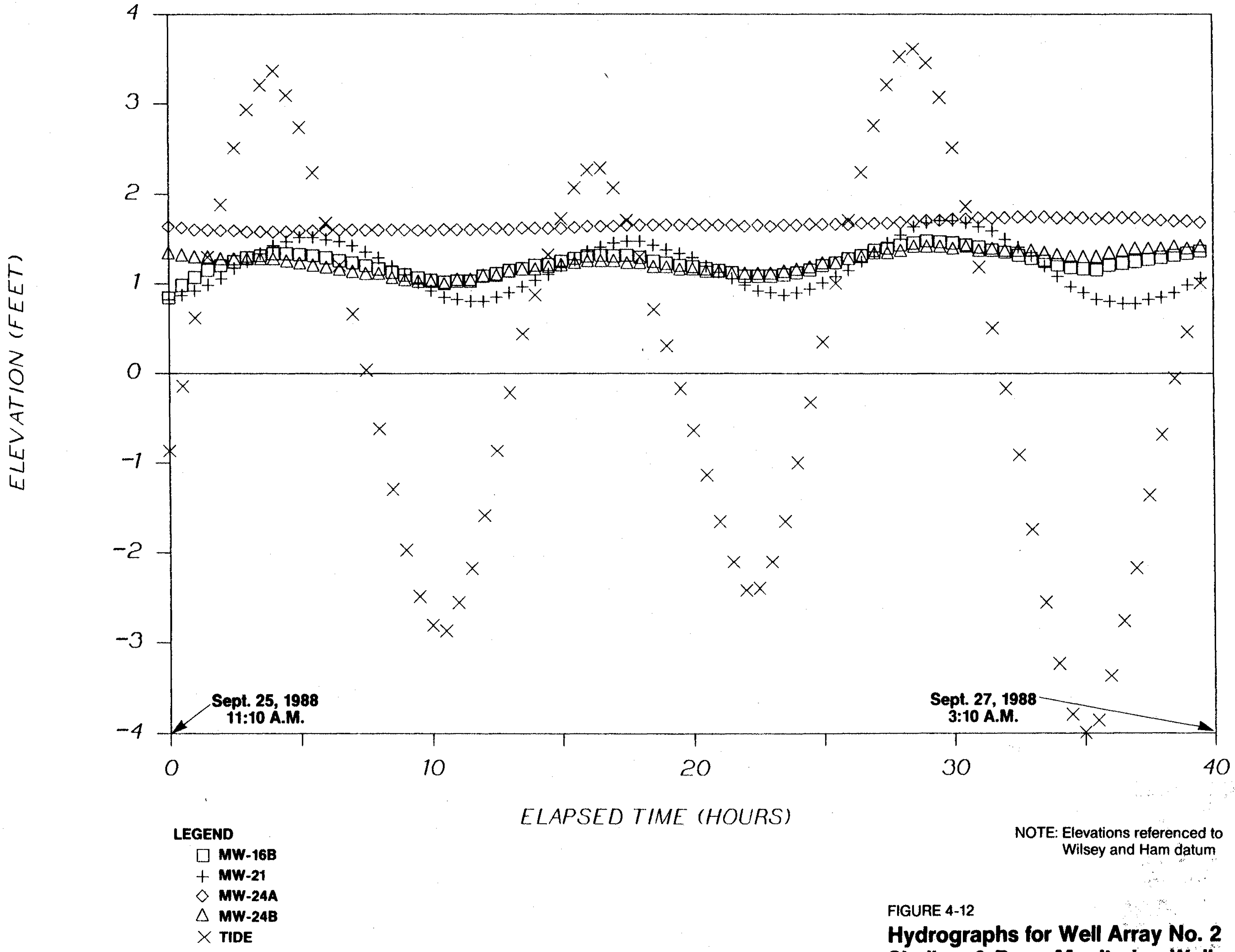
Hydrographs are presented on Figure 4-12 for shallow monitoring well MW-21, deep monitoring well MW-16B, paired (deep and shallow) monitoring wells MW-24A/MW-24B, and the tide. The hydrographs represent conditions during a 40-hour period between September 25 and 27, 1988. The wells are located approximately 140 (MW-21) to 175 feet (MW-24A/MW-24B) from the harbor. The hydrographs indicate that shallow monitoring



NOTE: Elevations referenced to Wilsey and Ham datum

FIGURE 4-11

Hydrographs for Well Array No. 1 Shallow Monitoring Wells



Sept. 25, 1988
11:10 A.M.

Sept. 27, 1988
3:10 A.M.

NOTE: Elevations referenced to
Wilsey and Ham datum

FIGURE 4-12

Hydrographs for Well Array No. 2
Shallow & Deep Monitoring Wells

well MW-21 is influenced by the tide. No significant change in groundwater elevation was noted at monitoring well MW-24A during the monitoring period. Deep monitoring wells MW-16B and MW-24B are both influenced by tidal fluctuation even though the adjacent shallow wells were not apparently affected (the hydrograph for monitoring well MW-16A is shown on Figure 4-11).

Hydraulic Conductivity. As described in Section 3.1.5, slug tests were conducted in five Hart Crowser wells and eight CH2M HILL wells to estimate the hydraulic conductivity of the water-bearing materials. Eight shallow and five deep wells were tested. The wells tested and the calculated hydraulic conductivity values are presented in Table 4-4.

Slug tests provide a rapid way to approximate hydraulic conductivity. However, because the test duration is short and the radial area around the well being tested is relatively small, the results provide only a rough estimate of hydraulic conductivity.

The slug test data were analyzed using a method described by Bouwer and Rice (1976). The procedure is applicable to partially penetrating wells in unconfined aquifers. Negligible drawdown and no flow above the water table is assumed.

Using the analytical method described by Bouwer and Rice (1976), hydraulic conductivity is calculated by:

$$K = \frac{r_c \ln (R_e/r_w)}{2tL_e} \ln \frac{Y_o}{Y_t}$$

where: K = hydraulic conductivity
R_e = effective radial distance over which the head difference is dissipated
r_c = well screen radius
r_w = radial distance from center of the well to the borehole wall
L_e = length of screen
y_o = water level at time zero
y_t = water level at time t
t = time since y_o

Bouwer and Rice (1976) present an empirical formula to calculate R_e that requires an estimate of the aquifer thickness. However, R_e is relatively insensitive to large errors in the aquifer thickness approximation. Based on hydrogeologic data presented by Hart Crowser (June 1988), an aquifer thickness of 60 feet was assumed.

As described in Section 4.1.1.1, gravelly sand is predominate in the saturated zone screened by the shallow monitoring wells. Finer grained material consisting predominantly

Table 4-4
SLUG TEST RESULTS

Shallow Monitoring Wells

Well No.	Screen Interval (ft bgs[b])	Hydraulic Conductivity[a] (ft/day)
MW-6A	4-14	1.0×10^{-1}
MW-8	4-14	1.5×10^{-1}
MW-15	5-15	2.1×10^{-1}
MW-16A	6-16	1.6×10^{-1}
MW-22	3-13	1.8×10^{-1}
MW-24A	5-15	1.8×10^{-2}
MW-25A	4-14	1.4×10^{-1}
MW-26	4.5-14.5	1.1×10^{0}
	MEAN =	2.6×10^{-1}

Deep Wells

Well No.	Screen Interval (ft bgs[b])	Hydraulic Conductivity[a] (ft/day)
MW-6B	40-50	3.6×10^{-3}
MW-8B	39.5-49.5	4.3×10^{-3}
MW-16B	40-50	4.0×10^{-3}
MW-24B	40-50	7.6×10^{-3}
MW-25B	40-50	3.7×10^{-3}
	MEAN =	4.6×10^{-3}

---

[a] Hydraulic conducvity values presented are the mean of initial and recovery tests.

[b] bgs = below ground surface.

of silt and fine sand are prevalent in the deep monitoring zone. The range in calculated hydraulic conductivity values for the eight shallow monitoring wells tested is 0.018 to 1.1 feet/day, with a mean value of 0.26 feet/day. This range in hydraulic conductivity is relatively small considering several of the shallow wells are screened in fill materials that probably vary in their physical characteristics. The range in calculated hydraulic conductivity values for the five deep monitoring wells is 0.036 to 0.076 feet/day, with a mean value of 0.046 feet/day.

Seven undisturbed soil samples were recovered from the screen intervals of monitoring wells for laboratory permeability testing. Five of the samples tested were recovered from the screen intervals of deep monitoring wells. Only two samples were recovered from shallow wells. The coarse granular material prevalent at the shallower depths made recovery of undisturbed samples difficult. Each sample was tested using U.S. Army Corps of Engineers Method No. EM 110-2-19-06. Due to the orientation of the samples relative to the hydraulic head applied during testing, the laboratory analysis measures permeability in the vertical direction.

Table 4-5 presents the results of laboratory permeability testing. Permeability values range from 0.0074 to 0.12 feet/day for the samples collected from the deep zone and 0.048 and 3.1 feet/day for the two samples collected from the shallow zone. When compared to slug test results for some of the same wells (see Table 4-4), the laboratory values are generally about one order of magnitude higher.

Table 4-5
LABORATORY PERMEABILITY TEST RESULTS

Well No.	Sample Depth (ft bgs[a])	Laboratory Permeability[b] (ft/day)	Material Description
MW-6B	51.5-54.0	1.4×10^{-2}	Fine sand and silt
MW-8B	47.5-49.0	1.2×10^{-2}	Fine sand and silt
MW-16B	40.0-41.5	1.2×10^{-1}	Fine sand and silt
MW-24A	17.5-20.0	4.8×10^{-2}	Silty fine sand
MW-24B	40.0-41.5	2.1×10^{-2}	Fine sand and silt
MW-25A	10.0-12.5	3.1×10^{0}	Silty fine sand with gravel
MW-25B	47.5-50.0	7.4×10^{-3}	Fine sand and silt

---

[a] bgs = below ground surface

[b] Permeability Test Method EM 110-2-19-06 (U.S. Army Corps of Engineers).

Lower hydraulic conductivity values calculated from slug test data may be due to formation damage along the monitoring well borehole caused by drilling. In contrast, higher permeability values obtained from laboratory permeability analyses may have been caused by piping in the testing apparatus during analysis. The variation in results can also be attributed to the heterogeneity of the aquifer and the small volume of material tested at, or from, each well. Regardless, this degree of variability is low considering that the methods used are suitable only for providing estimates of hydraulic conductivity.

Groundwater Flow Velocities. Horizontal groundwater flow velocities in the focused site investigation area can be estimated from a modified version of Darcy's Law given values for hydraulic conductivity, horizontal gradient, and effective porosity. Flow velocity can be estimated from the equation:

$$V = \frac{KI}{n_e}$$

where:

V = average interstitial horizontal groundwater flow velocity

K = horizontal hydraulic conductivity

I = horizontal hydraulic gradient

n_e = effective porosity

Depending on tidal stage and location within the focused site investigation area, the horizontal groundwater flow velocity in the shallow monitoring zone is estimated to be in the range of 3 to 83 feet/year assuming:

K = 0.26 to 1.6 feet/day (mean of slug test and laboratory permeability results for shallow wells, respectively)

I = 0.01 to 0.05

n_e = 0.35 (reasonable values per Freeze and Cherry [1979] and Todd [1976])

4.1.1.3 Groundwater Chemistry

Groundwater samples were obtained from CH2M HILL wells and selected Hart Crowser monitoring wells and analyzed for common ion chemistry and water quality parameters. Table 4-6 summarizes the wells sampled, analyses conducted, and results.

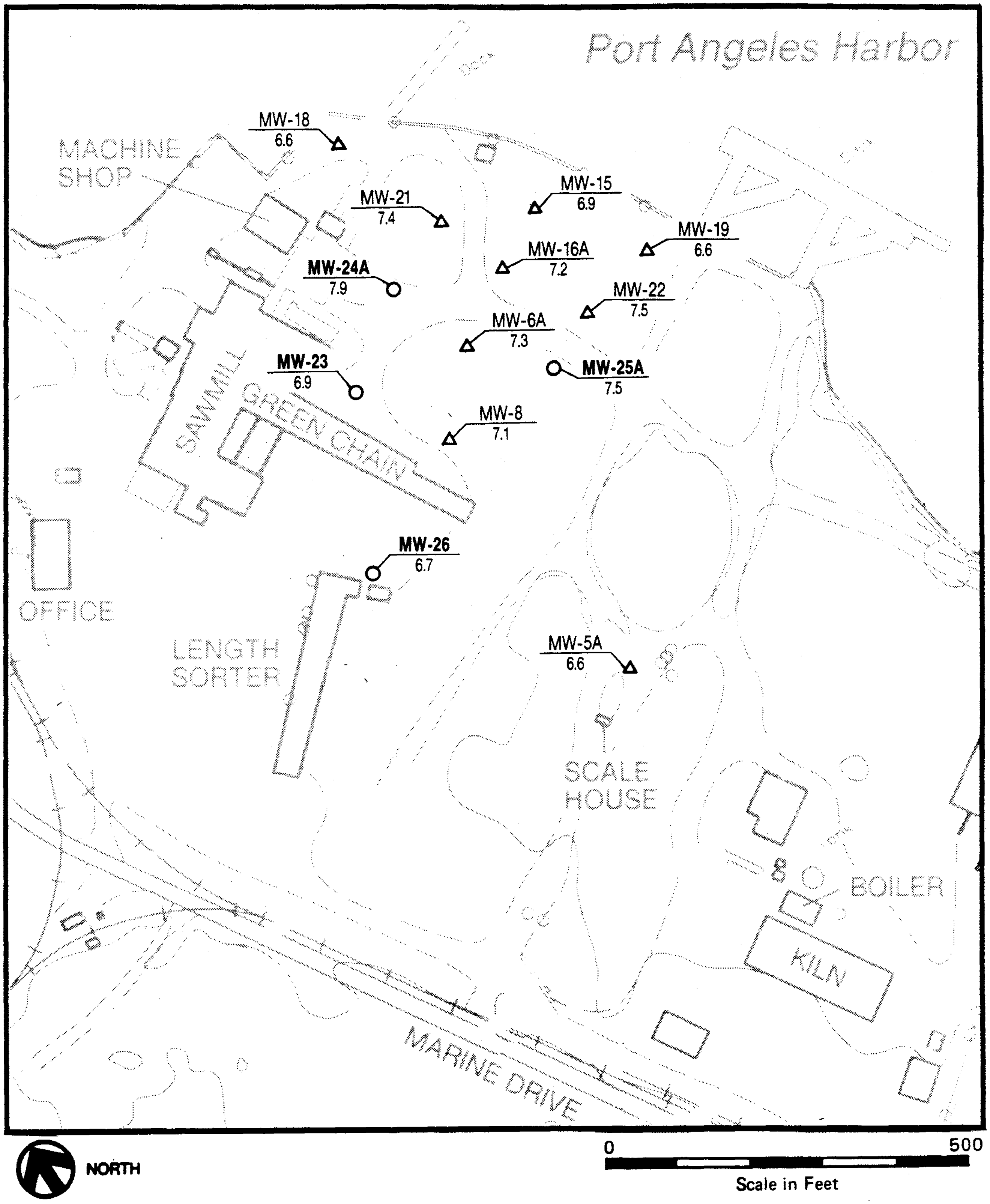
Figures 4-13 and 4-14 show the average laboratory pH values for water samples collected from shallow and deep wells,

Table 4-6
SUMMARY OF NATURAL WATER QUALITY DATA

Well No.	Sample Date	pH	Conductivity (μmhos/cm)	Alkalinity AS $CaCO_3$ mg/L	Chloride (mg/L)	Sulfate (mg/L)	Nitrate (mg/L)	Total Dissolved Solids (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)
MW-5	8/88	6.5	960	352	51.4	<1.0	<0.5	512	41.5	17.5	12.3	104
	10/88	6.6	825	256	62.2	<1.0	<0.5	534	18.5	9.8	12.7	101
MW-6A	8/88	7.2	2,380	900	173	21.5	<2.5	1,290	181	380	75.0	175
	10/88	7.4	1,175	913	81.3	13.1	<0.5	1,550	168	41.6	82.3	120
MW-6B	9/88	8.0	41,000	2,200	10,100	6.7	<0.5	19,500	252	736	171	5,300
	10/88	7.6	32,000	2,210	11,400	34.9	<5	20,400	246	620	171	6,060
MW-6C	10/88	7.7	2,000	924	99.7	9.9	<0.5	1,470	136	46.1	92.9	189
	10/88											
MW-8	8/88	7.0	1,400	431	110	10.6	<0.5	704	9.2	18.0	17.6	185
	10/88	7.2	1,250	433	111	10.8	<0.5	921	16.2	15.0	16.4	237
MW-8B	9/88	7.7	16,500	706	5,450	390	3.3	9,860	198	299	109	3,020
	10/88	7.8	15,500	759	6,160	454	<0.5	11,300	202	337	114	3,130
MW-15	8/88	7.0	28,500	1,280	7,850	430	<50	15,100	177	520	165	4,400
	10/88	6.9	24,000	1,290	6,370	329	3.6	12,500	126	337	158	4,160
MW-16A	8/88	7.2	2,460	943	180	<5.0	<2.5	1,320	98.0	57.0	74.0	238
	10/88	7.1	2,000	906	192	5.2	<0.5	1,320	71.0	50.5	82.3	258
MW-16B	9/88	7.3	35,800	2,050	10,300	15.7	8.0	19,500	350	249	800	5,940
	10/88	7.1	30,000	2,030	11,100	<1.0	84.7	19,700	260	438	239	6,310
MW-18	8/88	6.6	48,500	396	14,100	1,570	<50	25,300	282	800	25.6	7,220
	10/88	6.6	53,000	252	15,100	2,370	<50	29,100	276	425	318	1,010
MW-19	8/88	6.6	57,300	411	14,600	1,950	<100	27,600	320	930	280	8,950
	10/88	6.5	52,500	352	15,700	1,970	<50	28,900	348	1,010	338	1,020
MW-21	8/88	7.4	1,920	882	96.0	4.4	<0.5	1,140	122	57.0	26.7	141
	10/88	7.4	1,770	881	1,200	<1.0	<0.5	1,200	135	48.8	29.0	174
MW-22	8/88	7.3	1,990	766	123	41.3	<0.5	1,080	122	51.0	23.2	119
	10/88	7.7	1,780	793	114	24.7	<0.5	1,120	115	23.5	35.3	176
MW-23	9/88	6.9	1,120	461	97.0	5.2	<0.5	662	68.0	46.0	17.4	101
	10/88	6.9	1,250	501	98.8	3.6	<0.5	736	70.0	43.4	13.7	84.3

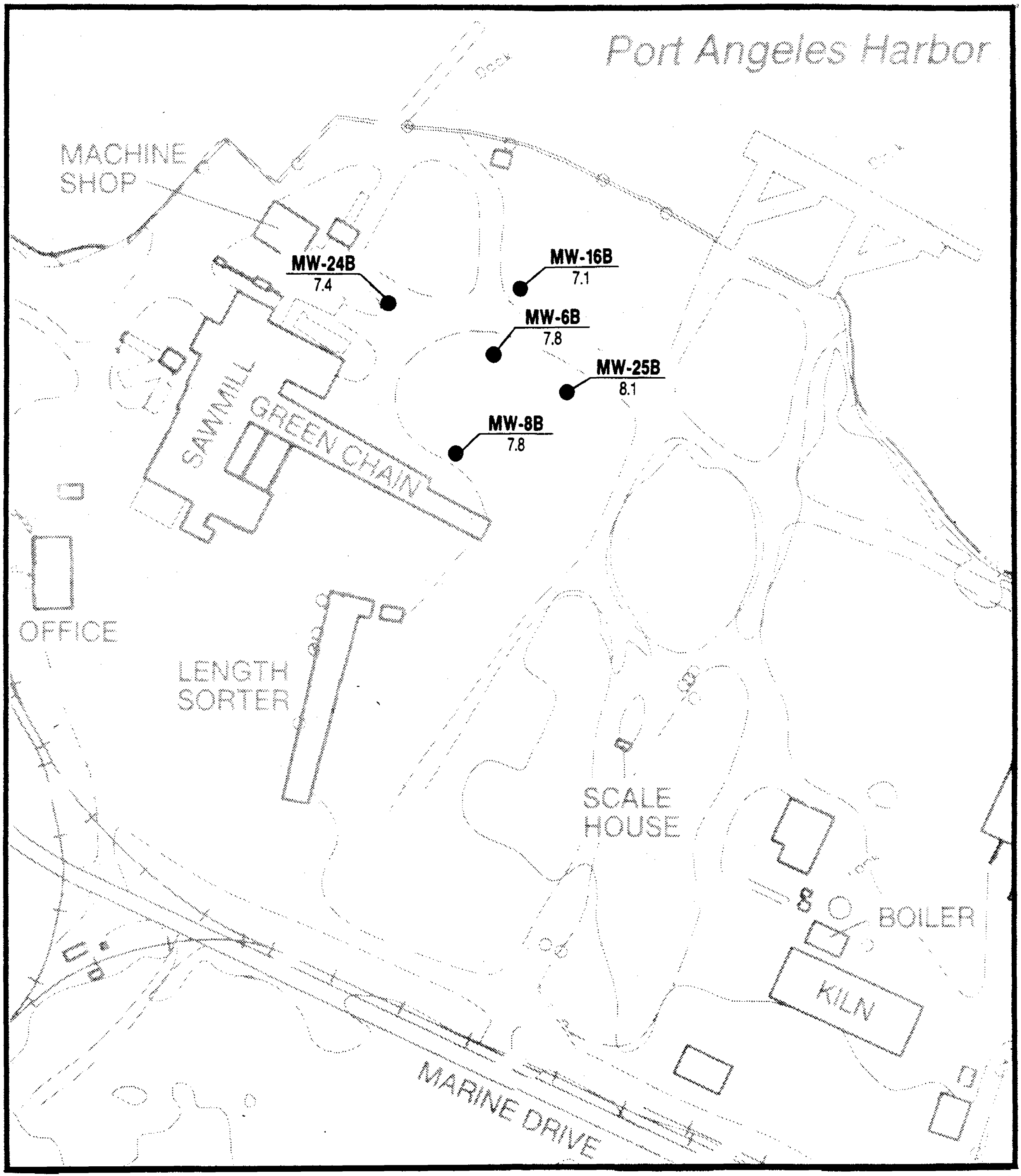
Table 4-6
(continued)

Well No.	Sample Date	pH	Conductivity (μmhos/cm)	Alkalinity AS $CaCO_3$ mg/L	Chloride (mg/L)	Sulfate (mg/L)	Nitrate (mg/L)	Total Dissolved Solids (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)
MW-24B	9/88	7.4	43,700	1,820	10,600	15.6	12.5	20,700	248	760	199	6,080
	10/88	7.4	32,000	1,980	12,100	<100	<50	20,500	230	600	207	6,880
MW-24A	9/88	7.8	2,250	890	77.5	8.5	<0.5	1,175	55.0	66.5	31.9	272
	10/88	7.8	1,075	926	66.4	15.5	<0.5	1,120	50.5	51.3	26.9	252
MW-25A	9/88	6.7	1,300	542	92	51	<0.5	890	103	339	19.0	162
	10/88	7.7	1,430	545	97.4	44.2	<0.5	1,030	80.0	321	23.1	199
MW-25B	9/88	8.0	18,900	1,160	7,260	25	2.7	11,500	150	262	109	387
	10/88	8.1	17,000	1,130	6,850	104	3.9	12,100	119	279	126	4,180
MW-26	9/88	6.6	890	292	71	2	<0.5	576	15.2	17.6	13.5	109
	10/88	6.7	890	313	66.0	3.4	<0.5	928	19.0	10.8	12.3	104



LEGEND
○ Shallow Well Installed by CH2M HILL
△ Shallow Well Installed by Hart Crowser

FIGURE 4-13
Average Laboratory pH Values for the Shallow Monitoring Zone



LEGEND

● **Deep Well Installed by CH2M HILL**

FIGURE 4-14

Average Laboratory pH Values for the Deep Monitoring Zone

respectively. All pH values fall within the expected range for natural waters. In the shallow monitoring zone (Figure 4-13), pH values range from 6.6 to 7.9. Values are relatively low inland, higher in the middle of the focused site investigation area, then decrease in wells nearest the harbor. The low pH (e.g., 6.6) of wells nearest the harbor is not characteristic of seawater.

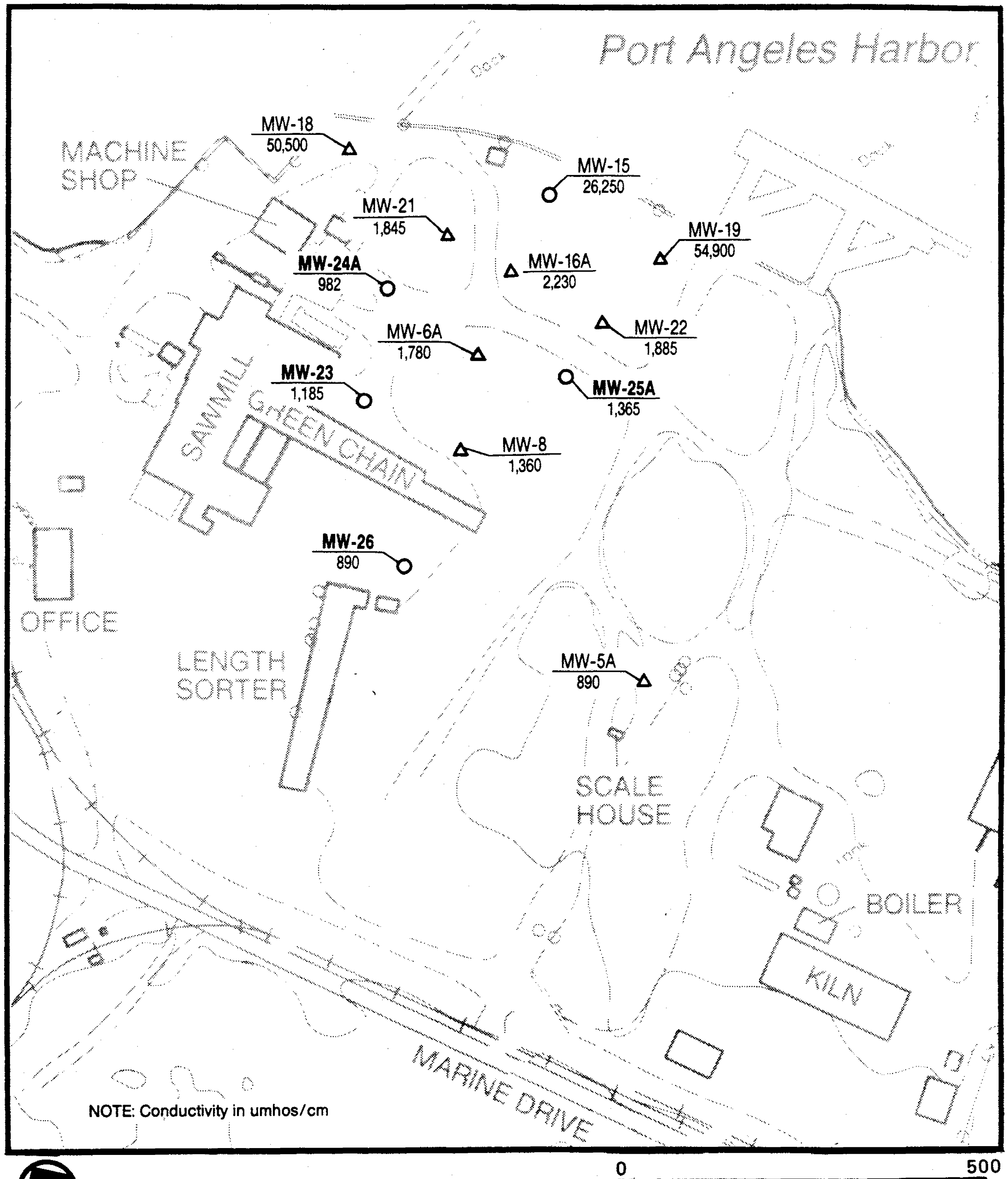
In the deep monitoring wells (Figure 4-14) the pH values range from 7.1 to 8.1. Groundwater from MW-25B indicates the highest pH value. The pH values of deep monitoring wells are nearer the expected value for seawater (7.9-8.2) than groundwater samples collected from the shallow monitoring wells.

Figures 4-15 and 4-16 show the average laboratory specific conductivity values for shallow and deep wells, respectively. In the shallow monitoring zone (Figure 4-15), conductivity is highest near the harbor. The increase in conductivity indicates that brackish or salt water from the harbor is mixing with the fresh groundwater approaching the shoreline. In the deep monitoring zone (Figure 4-16), conductivity values are high (e.g., 16,000 to 37,850 umhos/cm) and generally increase toward the harbor. If the conductivity values for shallow and deep monitoring well pairs are compared, conductivity of groundwater in the deep wells is consistently more than an order of magnitude higher. This marked change in conductivity with depth indicates intrusion of saline water beneath the site.

Figures 4-17 and 4-18 graphically illustrate on trilinear diagrams the relative concentrations of cations and anions in groundwater samples from selected wells. Figure 4-17 demonstrates the difference in chemistry between shallow wells located inland and shallow wells located near the harbor. Inland wells are characterized by water with sodium as the predominant cation and carbonate as the predominant anion. Wells nearer the harbor are characterized by sodium as the predominant cation and chloride as the predominant anion.

Comparison of the absolute values of ions in the different wells (Table 4-6) indicates that the inland groundwater is relatively fresh whereas groundwater near the harbor is relatively brackish.

Figure 4-18 illustrates the natural groundwater chemistry for groundwater samples collected from selected deep wells at the site. Typical seawater is also plotted on the trilinear diagram for comparison. Sodium and chloride are the dominant ions in groundwater collected from deep monitoring wells. The relative concentration of ions for deep wells and for shallow wells near the harbor is very similar to seawater except for elevated alkalinity values and below



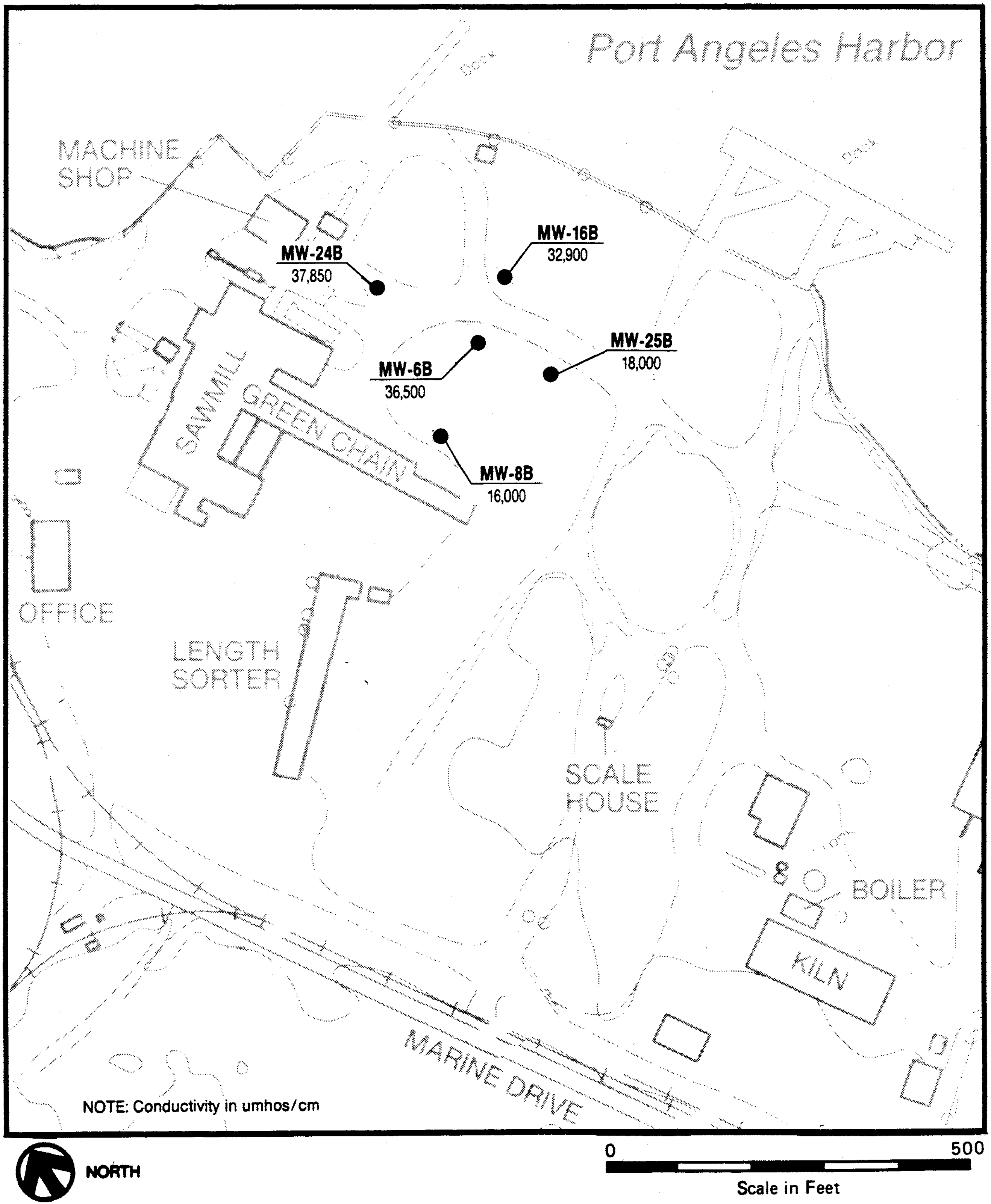
LEGEND

○ Shallow Well Installed by CH2M HILL

△ Shallow Well Installed by Hart Crowser

FIGURE 4-15

Average Laboratory Specific Conductivity Values for the Shallow Monitoring Zone

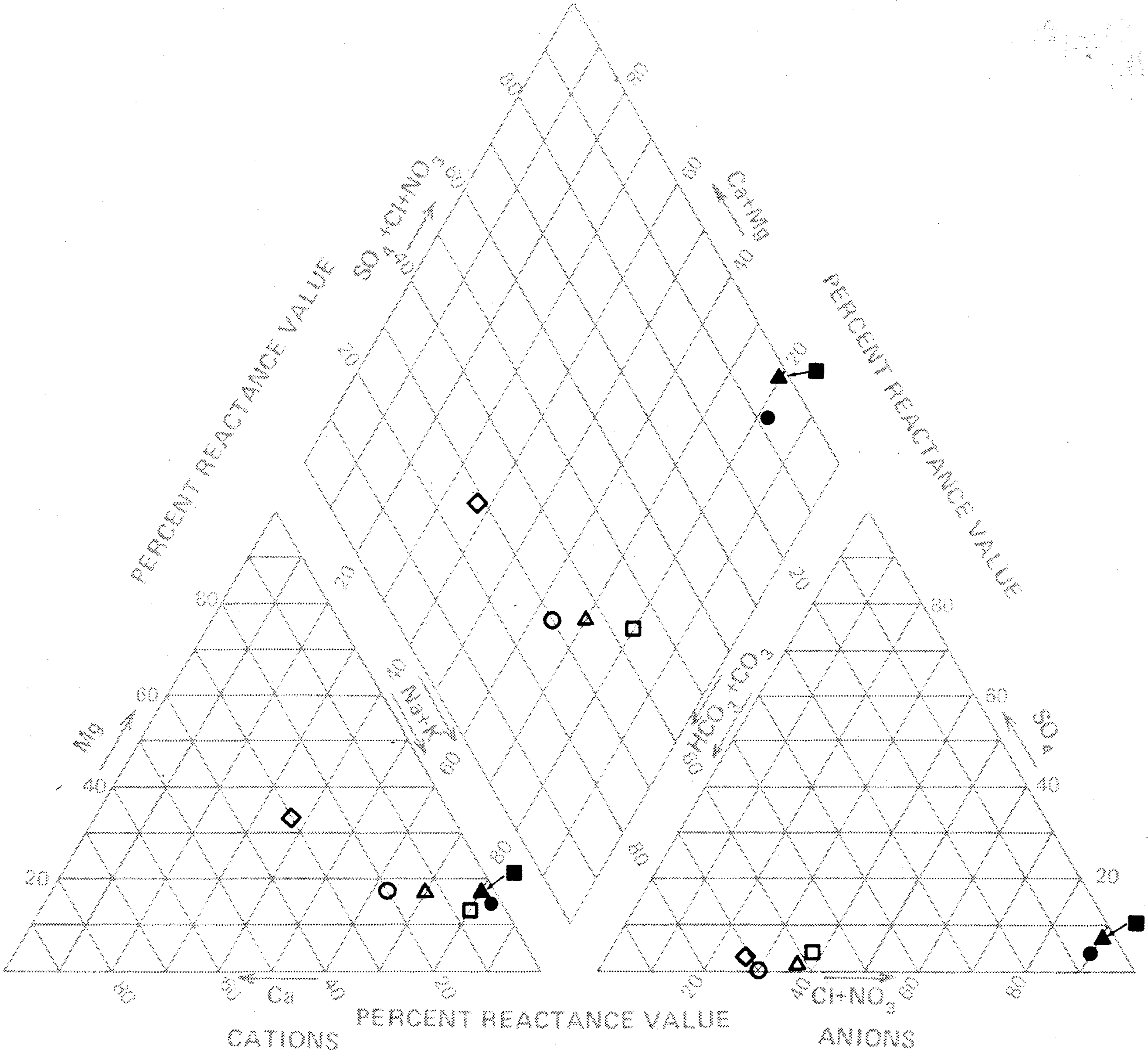


LEGEND

● Deep Well Installed by CH2M HILL

FIGURE 4-16

Average Laboratory Specific Conductivity Values for the Deep Monitoring Zone



Shallow Inland Wells
- △ MW-26
- ○ MW-5
- ◇ MW-23
- □ MW-8

Shallow Near-Shore Wells
- ▲ MW-18
- ● MW-15
- ■ MW-19

NOTE: MW-18 and MW-19 plot in same location

FIGURE 4-17

Comparison of Natural Groundwater Chemistry — Shallow Monitoring Wells

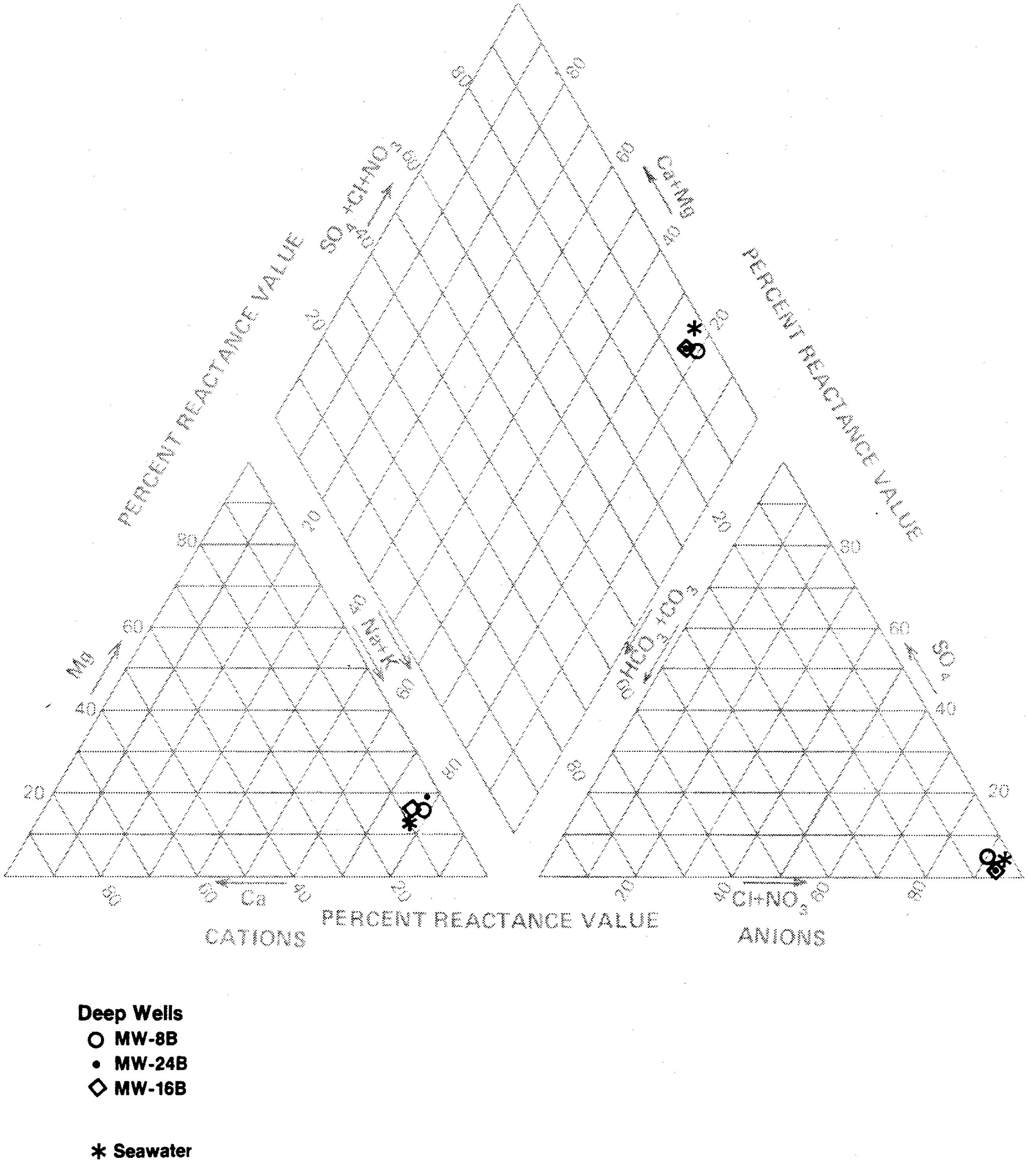


FIGURE 4-18

Natural Groundwater Chemistry — Deep Monitoring Wells

normal sulfate values among the deep well samples, and low magnesium values among deep and nearshore samples.

4.1.2 MARINE SEDIMENT AND VERIFICATION STUDY SOIL SAMPLES

Table 4-7 summarizes the physical characteristics of marine sediment samples collected during the focused site investigation. Moisture content of the five samples and one field duplicate ranged from 62.4 percent to 85.0 percent. The total organic carbon content ranged from 0.78 to 2.6 percent on wet weight basis.

The relative grain size distribution of these samples generally range from silty fine sand to sandy silt (SM to ML designation per the Unified Soil Classification System). Grain size distribution curves for both marine sediments and verification soils (Section 4.1.3) are illustrated in Figures 4-19 and 4-20.

A discussion of the verification study is provided in a technical memorandum as an addendum to this report. The technical memorandum includes a complete discussion of all sampling procedures performed during the course of verifying the HC Preliminary Environmental Assessment.

Table 4-7
MARINE SEDIMENT ANALYTICAL DATA COLLECTED
ON SEPTEMBER 22, 1988

Parameter	DS-MS-01	DS-MS-02	DS-MS-03	DS-MS-04	DS-MS-05	DS-MS-05[c]
% Moisture	85.0	81.0	78.8	82.7	62.4	62.4
TOC[a]	1.6	0.78	1.7	1.8	2.6	1.7
Grain size[b]						
<0.75"	0	5	0	21.8	0	0
0.374"	4.1	15.1	1.4	3.1	0	2.2
0.187"	3.0	10.7	8.4	4.7	0.5	0.2
0.0787"	2.5	9.5	6.9	2.9	0.2	1.1
0.0331"	1.4	6.3	2.8	1.6	0.2	0.8
0.0165"	2.8	3.2	2.7	6.0	0.5	1.0
0.0098"	7.7	8.1	4.2	13.6	2.3	1.0
0.0059"	11.1	6.8	5.7	9.8	16.8	3.0
0.0029"	21.6	10.8	11.1	11.3	43.6	38.8
Pan	45.9	24.5	26.9	25.1	35.9	57.9

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[a] Wet weight basis (percent).

[b] Percent retained on screen (100 percent organic material at screens ≥0.75 in; high organic content observed for all screen sizes).

[c] Field duplicate.

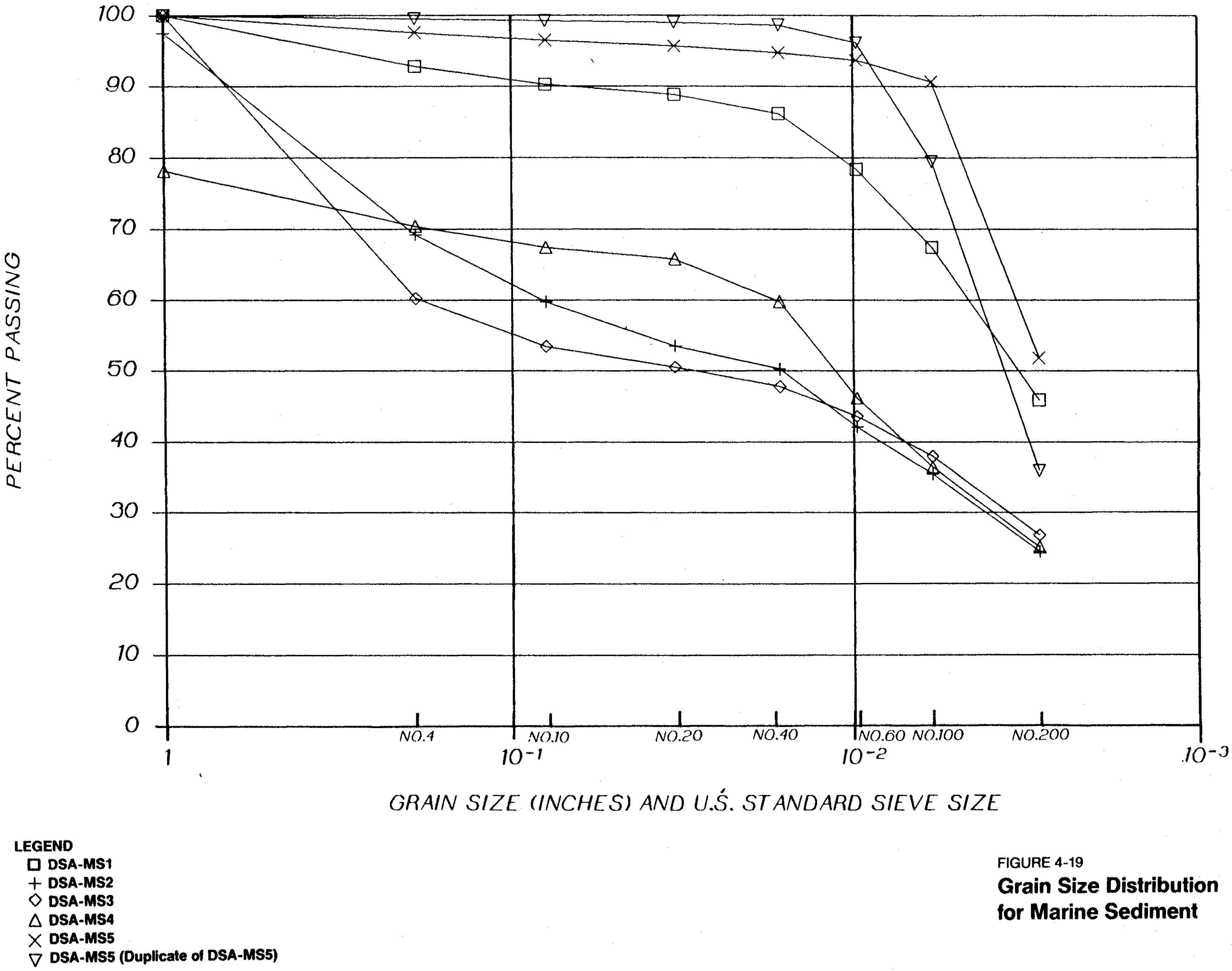
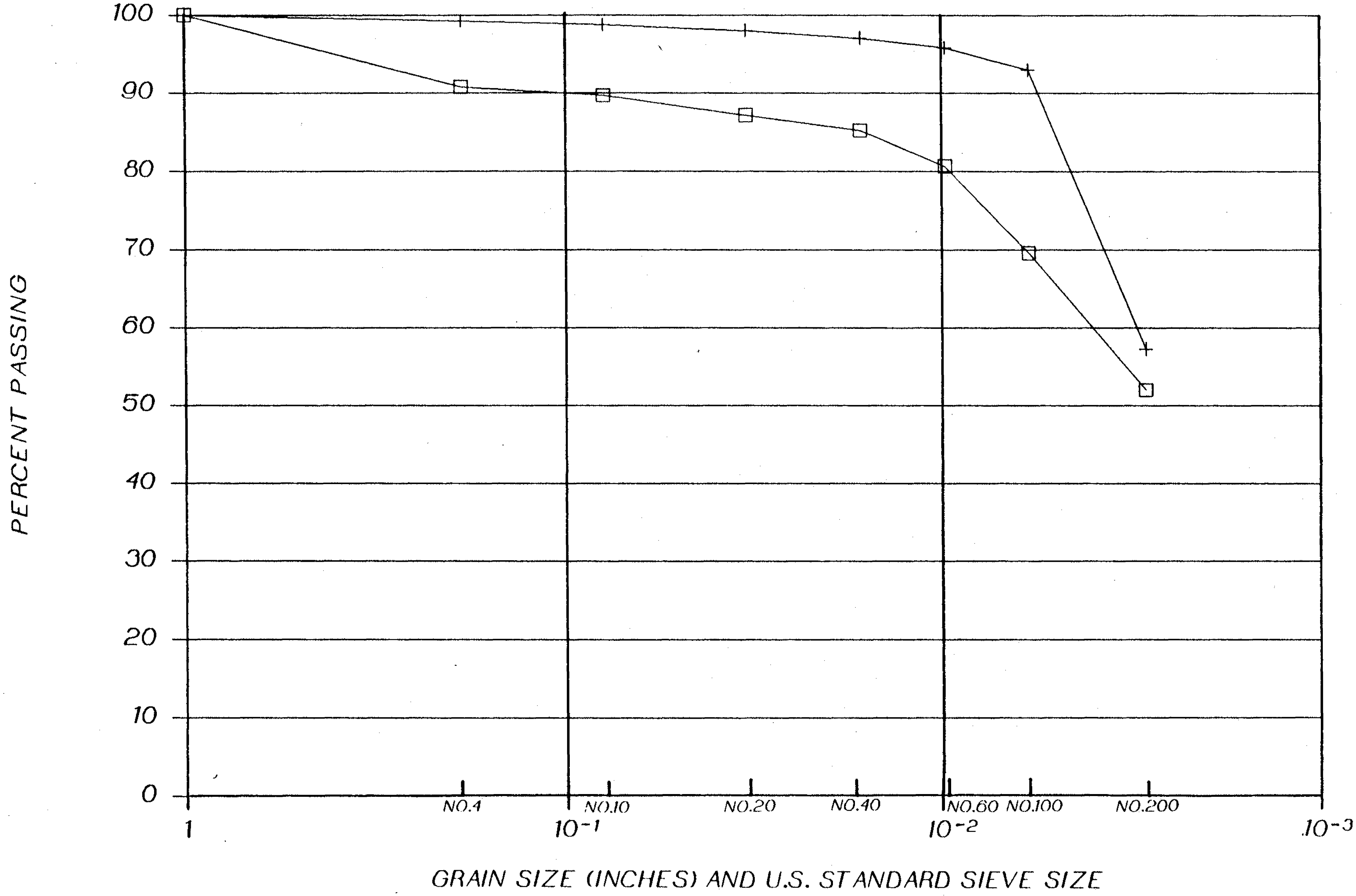


FIGURE 4-19

Grain Size Distribution for Marine Sediment



LEGEND
□ **MS-200**
\+ **MS-201**

FIGURE 4-20
Grain Size Distribution for Marine Sediment

4.2 LABORATORY RESULTS

4.2.1 QUALITY ASSURANCE AND QUALITY CONTROL

CH2M HILL carried out an extensive quality assurance program that included final data validation reviews for conformance to EPA Contract Laboratory Program (CLP) protocols and project specific parameters.

The completeness of all data with regard to the EPA criteria and control limits was found to be above 95 percent. Completeness is defined as the percent of data found valid in 2accordance with EPA CLP control limits and criteria; these limits and criteria are noted for each section below. In general practice, 95 percent completeness represents very high quality data.

Sample chain-of-custody, sample preservation, and sample holding times were documented as described in the CLP protocols. Holding times were noted to be within guidelines. Sample preparation, analytical methodology, usage of standards as established by laboratory records, and instrument output were carried out in accordance with CLP methods and the methods previously defined in the quality assurance plan.

The analytical results were reviewed after analysis with regard to acceptability standards defined in the CLP protocols. The protocols define the level of effort for QC (the frequency with which the quality control procedures are to be carried out). Method blanks, accuracy, and precision measurements (defined below) were carried out at 10 percent frequency in general, as specified in the protocols. Instrument calibrations and tuning were also carried out at the level of frequency defined in the protocols, with an equivalent level of effort for other parameters.

The quality control data were also evaluated quantitatively. For the CLP parameters, EPA has established control limits for the evaluation of the data. These EPA limits are based on past data bases. Quality control data that are not within these limits were noted, and the impact on the results was evaluated. For non-CLP parameters, the quality control data were used for qualification of data with regard to precision and accuracy, as further discussed below.

Several compounds did not meet initial and/or continuing calibration criteria. None of these compounds were detected in the samples analyzed after these calibrations so only the quantitation limit is affected.

4.2.1.1 Accuracy, Precision, and Blank Measurements

Accuracy is a measure of the deviation between the true value and the observed test value. The accuracy of chemical test results is measured by establishing the average recovery. The recovery is determined by splitting a series of samples into two portions, spiking (adding a known quantity of the constituent of interest) one of the portions, and submitting both portions for laboratory analysis as independent samples. In general, two types of recoveries are measured: matrix spike recoveries and surrogate spike recoveries. For a matrix spike, known amounts of standard compounds identical to the compounds present in the sample of interest are added to the sample. For a surrogate spike, the standards are chemically similar but not identical to the compounds in the fraction being analyzed. The purpose of the surrogate spike is to provide quality control on every sample by constantly monitoring for unusual matrix effects and gross sample processing errors. Surrogate spikes are generally done for organic compounds analyses.

Perfect accuracy would be defined by 100 percent recovery. EPA control limits for CLP data for each parameter are noted in the tables in this section. Data that are outside these control limits have been flagged as noted in the footnotes. For non-CLP parameters, the accuracy measurement serves as a quantitative qualifier, as defined above. For the CLP parameters, data were found to be within the listed control limits for above 95 percent of measurements, indicating data of high quality.

Precision is a measure of the spread of the data when more than one measurement is taken on the same sample. For duplicate measurements, precision can be expressed as the relative percent difference (RPD). The EPA CLP control limits are noted, along with any data points outside the limits. For the CLP parameters, the data were again found to be within the listed control limits for above 95 percent of measurements.

A laboratory method blank is defined as an appropriate volume of "organic-free" water that has been processed exactly as a sample (same glassware, reagents, and solvents). A blank measurement helps distinguish observed test results that are caused by contamination or instrument error from those that are intrinsic to the sample. As part of this quality assurance program, the conclusions presented in this report were reviewed. All statements calling for corrective action in interpreting the data on the basis of measured quantities were noted, and these quantities were checked to ensure that they were not affected by any laboratory contaminants.

4.2.1.2 Close Support Laboratory Method 8040 QA/QC Results

All of the sample and QA data in this section are the results of work performed by staff at CH2M HILL's Corvallis, Oregon, laboratory. The laboratory's proximity and rapid analyses allowed it to serve as the close support laboratory (CSL) on this project rather than as an onsite field laboratory subject to problems inherent with field conditions.

The CSL performed modified EPA methods for the analysis of phenols: SW 846 Method 8040 for soil samples and Method 604 for water samples. (Method 604 is equivalent to Method 8040 for an aqueous matrix.) These methods were modified for detection and quantification of targeted chlorophenols, specifically tetrachlorophenols (sum of 2,3,4,5 and 2,3,5,6 isomers) and pentachlorophenol. Modifications to the methods are described in the CSL methods included in the QAPP (Appendix A).

An important sample preparation feature of these analyses, regardless of sample type, was acidification prior to extraction. Acidification converts pentachlorophenate, the anionic form of pentachlorophenol that was used at the site, to pentachlorophenol. Hence the analyses also measured both pentachlorophenate and pentachlorophenol as pentachlorophenol.

Performance criteria for Daishowa samples were established at the beginning of the project and are detailed in the QAPP (Appendix A). The project-specific quality assurance and performance criteria for Method 8040 are shown in Table 4-8. For comparative purposes, EPA Contract Lab Program criteria are also shown in Table 4-8, where applicable.

Other QA performance criteria include instrument calibration response factor variance (±15 percent of initial calibration) and quality control sample analysis (within 95 percent confidence limits).

The QA analyses were performed at the frequencies specified in the QAPP. The QA data were calculated daily to determine if the analytical system was "in control".

Accuracy. All spiking was performed with tetrachlorophenols and pentachlorophenol and 2-fluorophenol as a surrogate. Frequency of accuracy analysis was 1 in 20 or 1 per batch, whichever was more frequent. The percent recoveries of the matrix spikes, matrix spike duplicates, and surrogate spikes are shown on Table 4-9 and surrogate recoveries on Figure 4-21. Recovery data are also in Figures 4-22 and 4-23 for PCP and TCP respectively.

Table 4-8
PROJECT-SPECIFIC QUALITY ASSURANCE AND PERFORMANCE CRITERIA

	Project-Specific CSL Criteria		EPA CLP Criteria	
	Water	Soil	Water	Soil
Detection Limits*	0.005 mg/l	1.0 mg/kg	0.05 mg/l	1.6 mg/kg
Precision, % RPD				
Tetrachlorophenols	±40	±40	NS	NS
Pentachlorophenol	±40	±40	±50	±47
Accuracy, % Recovery				
Tetrachlorophenols	40-160	40-160	NS	NS
Pentachlorophenol	40-160	40-160	9-103	17-109
2-Fluorophenol (surrogate)	60-140	60-140	21-100	25-121
Retention Time, Min	±0.05	±0.05	±0.06	±0.06
Holding Time	24 hrs	48 hrs	7 days	7 days

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*CSL detection limits for Pentachlorophenol based on instrument detection limits

NS: Not specified.

At times the recovery of tetrachlorophenol and pentachlorophenol was adversely affected by high organic background, which masked the spike compounds. Conversely, the 2-fluorophenol displayed little effect from the organic background.

Frequency of precision analysis was 1 in 20 or 1 per batch, whichever is more frequent. Matrix spike/matrix duplicate data were used to calculate precision. The %RPD values are shown in Table 4-9.

Low concentrations of the analytes in the sample and spiked sample can cause duplicate analyses to exceed the target range for RPD. Near the instrument detection limit the measurements become inherently less repeatable (see the discussion in Section 5). Often, precision criteria are modified to allow duplicates of plus or minus the detection limit, where the results are less than 10 times the detection limit. No data were rejected if they met these alternative criteria.

Holding times were met for all of the Daishowa samples. Soil samples were analyzed within 24 hours and water samples were analyzed within 48 hours.

Table 4-9
MATRIX SPIKES, MATRIX SPIKE DUPLICATES, SURROGATE SPIKES
METHOD 8040

	Tetrachlorophenols					Pentachlorophenol					2-Fluor-Phenol (Surrogate)
Sample ID	Initial Value	% Recovery	Dupe Value	% Recovery	% RPD	Initial Value	% Recovery	Dupe Value	% Recovery	% RPD	% Recovery
H_2O Spike	0.367	94.3	0.334	85.8	9	0.152	77.1	0.174	88.4	-13	101
8318-4	2.32		2.03		13	2.52		2.66		-5	56
8318-4 S.	1.33	-180	1.29	-190	3	2.01	-328	2.27	-197.5	-12	67
8320-1	0.105		0.108		-3	0.052		0.049		6	58
8320-1 S.	0.076	-7.5	0.08	20.6	-5	0.007	-21.8	0.032	16.1	-128	87
8334-11	<0.005		<0.005		0	<0.005		<0.005		0	84
8344-11 S.	29.7	79.2	28	80	6	13.4	70.4	12.5	70.7	7	90
8345-5	<0.005		<0.005		0	3.74		2.13		55	75
8345-5 S.	23		22.4	80.4	3	8.5		8.76	40.8	-3	78
8350-1	0.007		0.008		-13	<0.005		<0.005		0	90
8356-6	<1		<1		0	<1		<1		0	110
8356-6 S.	21.9	65.2	18.5	62.7	17	9.71	56.9	7.81	52.2	22	141
8380-3	<1				ERR	<1				ERR	71
8380-3 S.	24.6	70.8	21.3	67.8	14	11.7	66.2	11.4	71.4	3	102
8401-10	<1		<1		0	<1		<1		0	57
8401-10 S.	11	45.8	13	56.3	-17	9.81	80.6	11.8	110.7	-18	77
8401-12	<0.005		<0.005		0	<0.005		<0.005		0	107
8410-8	<1		<1		0	<1		<1		0	73
8410-8 S.	7.65	22.4	8.13	32.6	-6	4.9	28.3	5.32	42.1	-8	85
8410-2	<0.005		<0.005		0	<0.005		<0.005		0	92
8419-5	<1		<1		0	<1		<1		0	95
8419-5 S.	27	78	15.4	65.2	55	12.8	73.3	6.88	57.4	60	100
8429-6	<1		<1		0	<1		<1		0	112
8426-6 S.	9.22	40.4	25.7	93.3	-94	4.09	35.3	13.1	93.7	-105	106
H_2O Spike	31.5	81.1			ERR	17	86.1			ERR	94
8432-1	<1		<1		0	<1		<1		0	104
8432-1 S.	17.9	58.7	24.5	92.4	-31	10.1	65.2	14.1	104.8	-33	99
8432-5	<1		<1		0	<1		<1		0	86
8432-5 S.	15.8	83.5	16.5	84.1	-4	8.5	88.8	8.33	83.9	2	110
H_2O Spike	0.324	83.3			ERR	0.148	75.1			ERR	91
8453-5	<1		<1		0	<1		<1		0	87
8453-5 S.	22	59.8	25.5	80.4	-15	11.4	59.5	14.1	85.6	-21	77
8453-10	<1		<1		0	<1		<1		0	70
8453-10 S.	19.2	46	29	52.1	-41	7.37	34.9	18.4	65.5	-86	82
8453-1	<0.005		<0.005		0	<0.005		<0.005		0	70
8453-1 S.	0.185	47.6	0.172	44.2	7	0.039	19.8	0.036	18.2	8	80
8482-1	0.045		0.046		-2	<0.005		<0.005		0	102
8482-1 S.	0.359	92.2	0.309	79.3	15	0.108	54.6	0.08	40.5	30	73
8512-5	0.006		0.006		0	<0.005		<0.005		0	93
8512-5 S.	0.32	82.1	0.326	83.7	-2	0.177	89.9	0.169	85.7	5	74
8527-3	<0.005		<0.005		0	<0.005		<0.005		0	79
8527-3 S.	0.271	69.5	0.29	74.4	-7	0.152	77	0.086	43.8	55	94
8527-9	<1		<1		0	<1		<1		0	40
8527-9 S.	3.89	15.1			ERR	0.202	1.6			ERR	84
H_2O Spike	0.239	61.5	0.276	71	-14	0.107	54.1	0.116	58.9	-8	90
8552-6	0.092		0.055		50	0.064		0.038		51	

NOTE: ERR signifies that duplicates were not analyzed.
RPD is the relative percent difference between the two values.

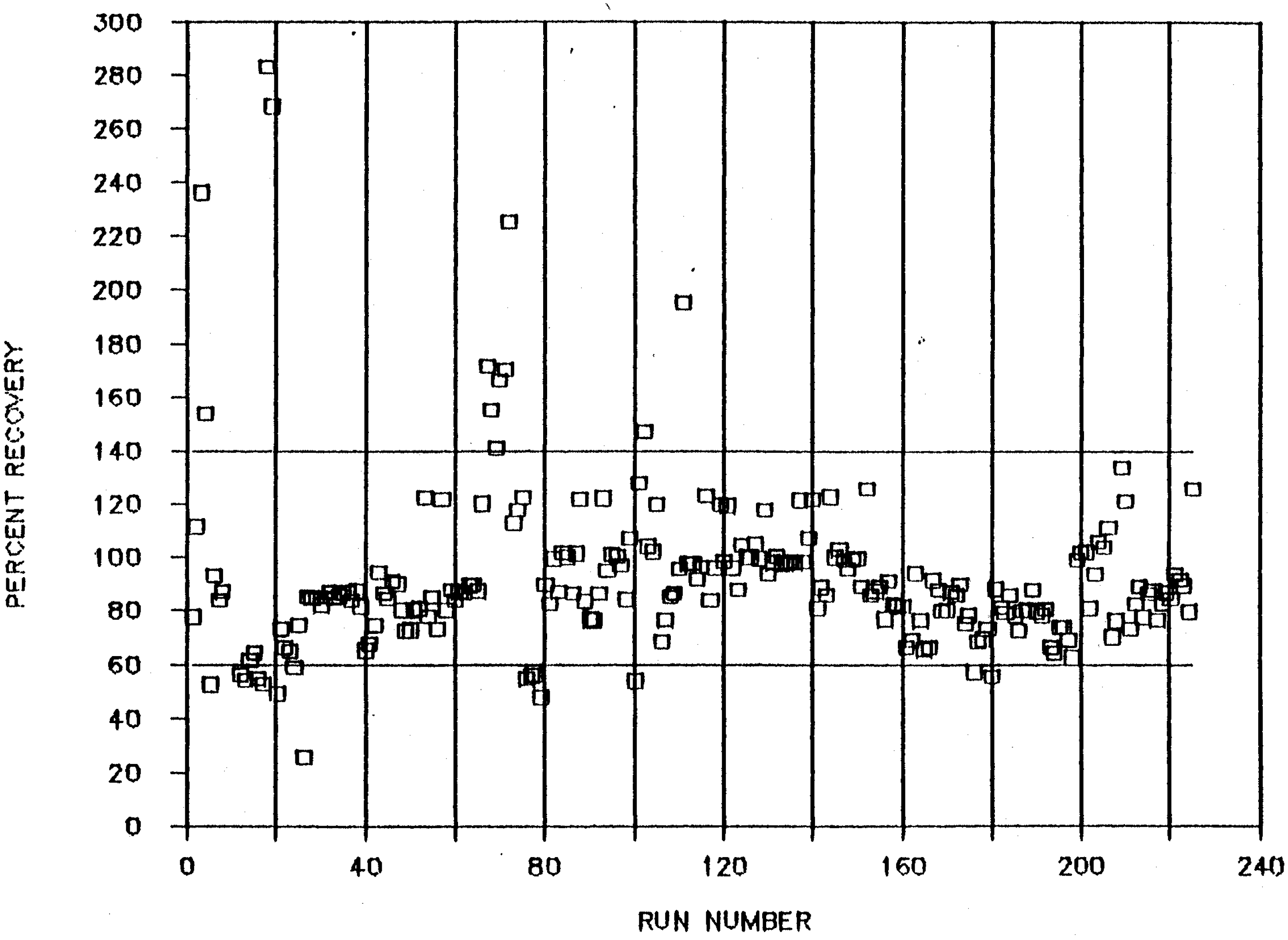

FIGURE 4-21
Close Support Laboratory Method (8040)
Surrogate Recoveries 2-Fluorophenol

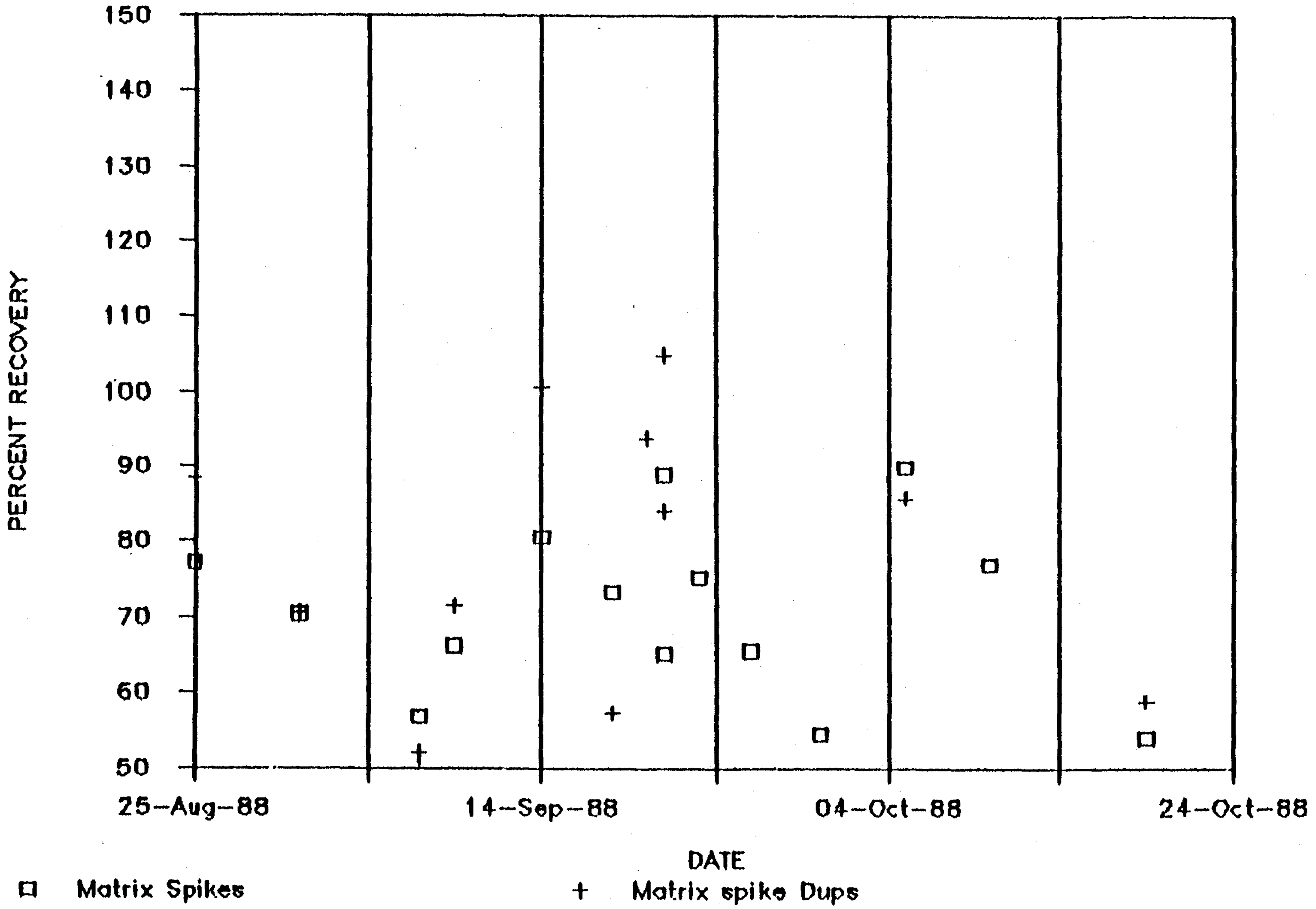

FIGURE 4-22
Close Support Laboratory Method (8040)
Matrix Spike Recoveries Pentachlorophenol

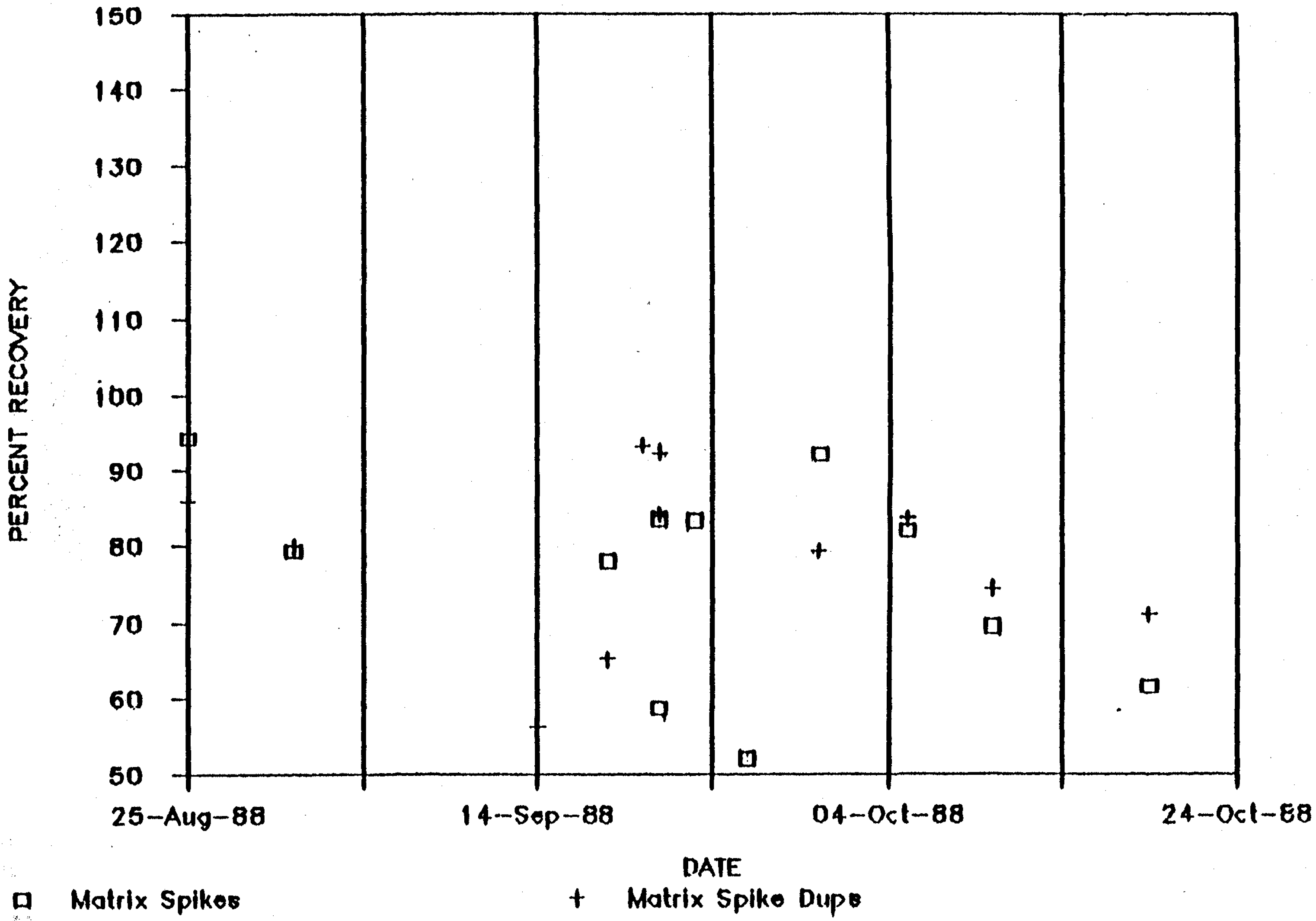

FIGURE 4-23
Close Support Laboratory Method (8040)
Matrix Spike Recoveries Tetrachlorophenols

Blanks were used to determine the existence and magnitude of contamination, if any, introduced by laboratory and field procedures. Field and laboratory blanks were both used in this investigation. Blank data are compared to detection limit criteria.

Distilled water was used as a water blank and sodium sulfate was used as a soil blank by the lab. These blanks were treated identically as samples in sample preparation and analysis procedures. Frequency of blank analysis was 1 in 20 or 1 per batch, whichever was more frequent. Throughout the Daishowa project, there were no detectable compounds found in any lab blanks.

Equipment blanks were also analyzed. All equipment blanks showed no contamination except for DSA-MW6C-EB-11/8/88 which had 0.030 mg/l PCP and DSA-16C-EB with 0.009 mg/l TCP and 0.016 mg/l PCP. For sample MW-6C, the sample value was greater than five times the blank contamination and is valid according to EPA data validation guidelines. In sample MW-16C, no PCP was found above the detection limit and the TCP value was greater than five times the blank contamination level so no action was taken.

Detection limits for the analytes were set at 1.0 mg/kg for soil samples and 0.005 mg/l for water. These were based on method and instrumental performance and did not take into account the potential matrix effects. This should be considered when interpreting the data. Considering the effects of water matrix on the instrumental detection limit, it is apparent that the practical quantification limit for analysis of Daishowa water samples is 0.03 mg/l. The practical quantification limit for Daishowa soil samples is 1.0 mg/kg as originally specified.

Daily mid-range calibration checks were performed prior to the analysis of each day's samples or with each lot of 20, whichever was more frequent. The initial linear range can be seen on Table 4-10. If the daily response factors varied by more than ±15 percent from the initial calibration, a fresh standard was prepared and recalibration performed.

A retention time marker, 2,4,6-tribromophenol, was used in all samples to monitor the instrument performance. Figure 4-24 shows that retention times stayed within the ±0.05 minutes, except for three outliers in the first week of work.

Water pollution quality control samples (WP 281) (obtained from from EPA-EMSL repository) were run to monitor the extraction procedure and quality of lab standards. With the exception of phenol and 2,4-dimethylphenol, all compounds were within the 95 percent confidence intervals. This can be seen on Table 4-11.

Table 4-10
DAISHOWA
INITIAL CALIBRATION DATA
Date: 8/22/88

Compound	Estd 1 Area 50 ppm	Estd 2 Area 5 ppm	Estd 3 Area 0.5 ppm	Linearity
2-Fluorophenol	14026000	1200000	282320	0.999491
Phenol	2967300	252950	52750	0.999568
2-Chlorophenol	2062800	182670	38268	0.999664
2-Nitrophenol	1906000	171750	33853	0.999738
2,4-Dimethylphenol	3207000	278760	57623	0.999625
2,4-Dichlorophenol	1880800	163800	34989	0.999609
4-Chloro3-Methylphenol	13632000	1163900	250490	0.999552
2,4,6-Trichlorophenol	4732000	419920	88349	0.999666
2,4-Dinitrophenol	4395900	346270	40857	0.999622
4-Nitrophenol	12031000	1130200	240330	0.999790
Tetrachlorophenols	16309000	1524300	327330	0.999792
2-Me-4,6-Dinitrophenol	9760800	888300	154260	0.999815
Pentachlorophenol	7105900	598790	127970	0.999520

Table 4-11
WATER POLLUTION QUALITY CONTROL SAMPLES
EPA STANDARD WP281

Parameter	True Value	$\bar{X}$	95 Percent Confidence Interval	8/25/88 Value	8/25/88 Dupe Value	8/25/88 % RPD	9/23/88 Value
Phenol	0.100	0.0431	0.0269 - 0.0593	0.065	0.067	-3	0.065
2,4-dimethylphenol	0.0833	0.0507	0.0217 - 0.0797	0.119	0.116	3	0.069
2-chlorophenol	0.110	0.0905	0.0509 - 0.130	0.107	0.108	1	0.098
4-chloro-3-methylphenol	0.175	0.150	0.0992 - 0.201	0.174	0.169	3	0.167
2,4-dichlorophenol	0.070	0.0572	0.0354 - 0.0790	0.070	0.069	1	0.064
2,4,6-trichlorophenol	0.125	0.107	0.0744 - 0.140	0.125	0.125	3	0.124
Pentachlorophenol	0.090	0.0768	0.0404 - 0.113	0.105	0.093	12	0.081
2-nitrophenol	0.175	0.141	0.0938 - 0.188	0.172	0.168	2	0.158
4-nitrophenol	0.120	0.060	0.0276 - 0.0924	0.085	0.084	1	0.074
2,4-dinitrophenol	0.275	0.218	0.0820 - 0.354	0.297	0.276	7	0.221

Note: Concentrations in mg/l.

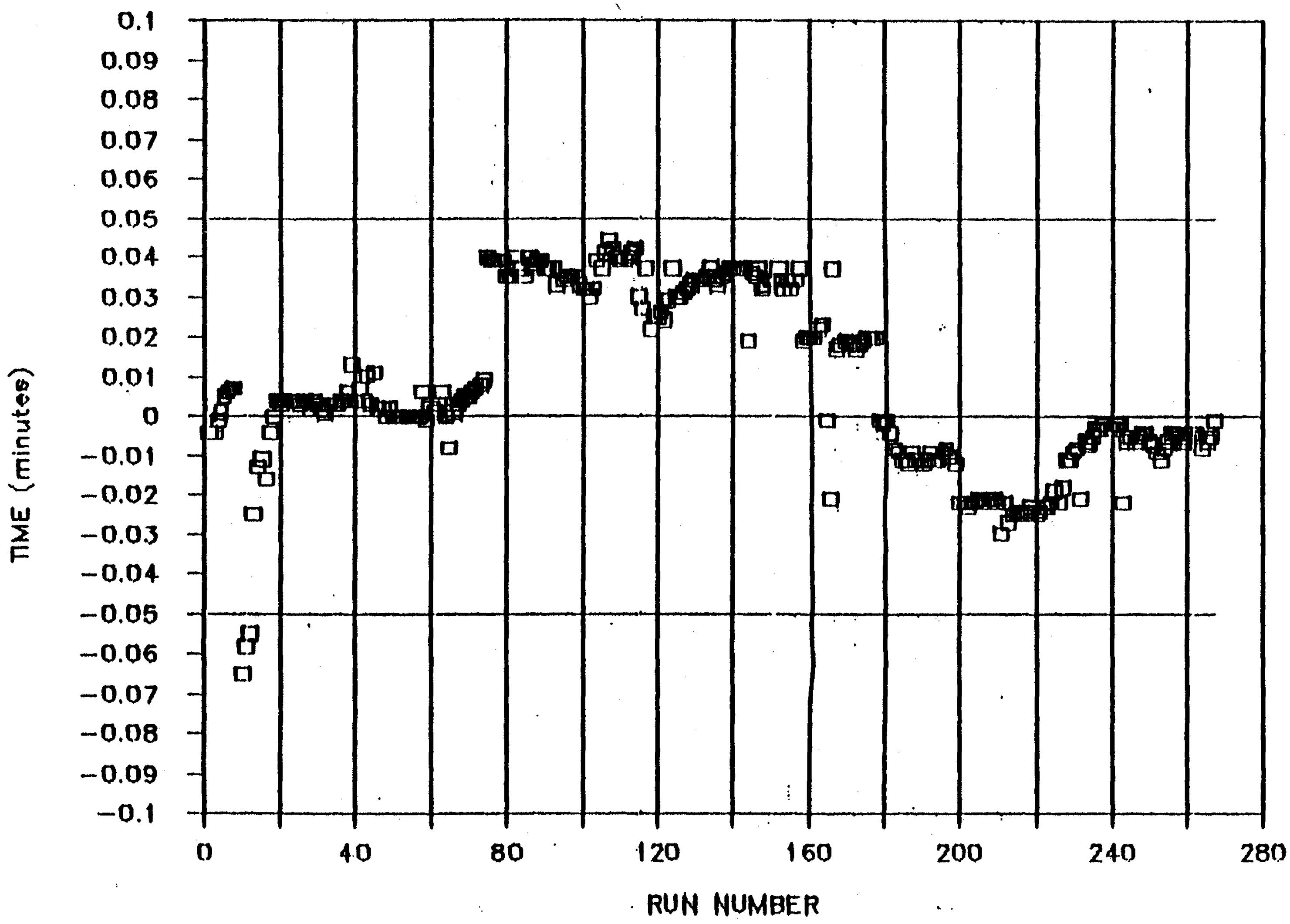

FIGURE 4-24
Close Support Laboratory Method (8040)
Retention Time Marker Variation

4.2.2. Chemical Data Quality Assurance--Method 8270 and Appendix IX Parameters

Groundwater and soil samples were analyzed for semivolatile organic compounds by Method 8270 for Appendix IX parameters. The specific parameters are presented in the QAPP (Appendix A).

Analyses were carried out by Enseco's California Analytical Laboratory and Rocky Mountain Analytical Laboratory using the EPA Contract Laboratory Program (CLP) protocols. The semivolatile organic compounds analyzed for were the compounds listed in the target compound list (TCL) used by the EPA CLP for Superfund sites. The TCL includes the priority pollutants plus other compounds from the Hazardous Substances List (HSL). The presence and nature of other existing organic contaminants were also established as defined by the EPA CLP protocols. The Appendix IX parameters were analyzed by standard EPA methods (volatile compounds 624 and 8240, semivolatile compounds 625 and 8270, pesticides/PCBs 608 and 8080, metals 200.7, 206.2, 239.2, 245.1, 270.2, 279.2, 6010, 7060, 7421, 7471, 7740, and 7841; cyanide 335.3 and 9010, and sulfide 376.2 and EPA/OSW) with an equivalent level of quality assurance effort with regard to the CLP protocols. Only the Method 8270 QA tables appear in this section. Appendix IX data is provided in Appendix J.

The quality control measurements that aided in the quantitative assessment of the Method 8270 data are summarized in Tables 4-12 through 4-17 presented in this section. These include accuracy, precision, and blank measurements; the meaning and usage of these measures are explained in Section 4.2.1. Other quality control parameters have been documented in accordance with EPA CLP protocols and are on file at CH2M HILL and the subcontracted laboratory (California Analytical); this constitutes over a thousand pages of documentation. Quality assurance review notes are also filed with these data. This documentation provides data of known quality from the most extensive state-of-the-art quality control procedures designed in this area of study.

Accuracy, Precision, and Blank Measurements. Matrix spike and matrix spike duplicate results for groundwater samples are presented in Table 4-12. Table 4-13 has matrix spike results for soil samples. Surrogate spike recovery values for the samples are presented in Table 4-14 for groundwater and Table 4-15 for soils.

For duplicate measurements, precision can be expressed as the relative percent difference (RPD). Acceptable precision limits are based on past data bases. Precision measurements for samples are presented in Table 4-12 for groundwater and Table 4-13 for soil samples. The EPA CLP control limits are

Table 4-12
GROUNDWATER MATRIX SPIKE AND MATRIX SPIKE DUPLICATE RECOVERY
METHOD 8270

Fraction	Compound	Conc. Spike Added (µg/l)		Sample Result	MS (µg/l)	Conc. Percent Rec	Conc. MSD (µg/l)	Percent Rec	RPD	EPA QC Limits	
		Spike	Duplicate							RPD	Recovery
VOA Sample Name	1,1-Dichloroethene									14	61-145
	Trichloroethene									14	71-120
	Chlorobenzene									13	75-130
	Toluene									13	76-125
	Benzene									11	76-127
B/N Sample Name	1,2,4-Trichlorobenzene	100	100	0	76	76	81	81	6	28	39-98
	Acenaphthene	100	100	0	86	86	89	89	3	31	46-118
DSA-6B (9/7/88)	2,4-Dinitrotoluene	100	100	0	92	92	92	92	0	38	24-96
	Pyrene	100	100	0	86	86	97	97	12	31	26-127
	N-nitrosodi-N-propylamine	100	100	0	76	76	75	75	1	38	41-116
	1,4-Dichlorobenzene	100	100	0	74	74	76	76	3	28	36-97
Acid Sample Name	Pentachlorophenol	200	200	0	230	115[a]	250	125[a]	8	50	9-103
	Phenol	200	200	0	110	55	110	55	0	42	12-89
DSA-6B (9/7/88)	2-Chlorophenol	200	200	0	220	110	230	115	4.4	40	27-123
	4-Chloro-3-methylphenol	200	200	0	200	100[a]	210	105[a]	5	42	23-97
	4-Nitrophenol	200	200	0	86	43	90	45	5	50	10-80
Pesticide Sample Name	Lindane									15	56-123
	Heptachlor									20	40-131
	Aldrin									22	40-120
	Dieldrin									18	52-126
	Endrin									21	56-121
	4,4'-DDT									27	38-127

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[a] Value is outside EPA QC limits.

RPD: VOAs NR
B/N 0 of 6 outside QC limits
Acid 0 of 5 outside QC limits
Pest NR

Recovery: VOAs NR
B/N 0 of 12 outside QC limits
Acid 4 of 10 outside QC limits
Pest NR

Abbreviations:			
VOAs	Volatile organics	Rec	Recovery
B/N	Bases/neutrals	MSD	Matrix spike duplicate
Pest	Pesticides	RPD	Relative percent deviation
MS	Matrix spike	QC	Quality control
NR	Not required		

Table 4-13
SOIL MATRIX SPIKE AND MATRIX SPIKE DUPLICATE RECOVERY
METHOD 8270

Fraction	Compound	Conc. Spike Added (µg/kg)		Sample Result	MS (µg/kg)	Conc. Percent Rec	Conc. MSD (µg/kg)	Percent Rec	RPD	EPA QC Limits	
		Spike	Duplicate							RPD	Recovery
VOA Sample Name	1,1-Dichloroethene									22	59-172
	Trichloroethene									24	62-137
	Chlorobenzene									21	60-133
	Toluene									21	59-139
	Benzene									21	66-142
B/N Sample Name	1,2,4-Trichlorobenzene	1,960	1,960	0	1,410	72	1,530	78	8	23	38-107
	Acenaphthene	1,960	1,960	0	1,530	78	1,530	78	0	19	31-137
DSA-MW23	2,4-Dinitrotoluene	1,960	1,960	0	1,530	78	1,530	78	0	47	28-89
	Pyrene	1,960	1,960	0	1,760	90	1,880	98	7	36	35-142
	N-nitrosodi-N-propylamine	1,960	1,960	0	1,290	66	1,290	66	0	38	41-126
	1,4-Dichlorobenzene	1,960	1,960	0	1,410	72	1,530	78	8	27	28-104
Acid Sample Name	Pentachlorophenol	3,920	3,920	0	2,350	60	2,120	54	10	47	17-109
	Phenol	3,920	3,920	0	2,700	69	2,820	72	4	35	26-90
DSA-MW23	2-Chlorophenol	3,920	3,920	0	3,760	96	4,000	102	6.2	50	25-102
	4-Chloro-3-methylphenol	3,920	3,920	0	3,060	78	3,180	81	4	33	26-103
	4-Nitrophenol	3,920	3,920	0	3,060	78	2,940	75	4	50	11-114
Pesticide Sample Name	Lindane									50	46-127
	Heptachlor									31	35-130
	Aldrin									43	34-132
	Dieldrin									38	31-134
	Endrin									45	42-139
	4,4'-DDT									50	23-134

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[a] Value is outside EPA QC limits.

RPD:			Recovery:	
	VOAs	NR	VOAs	NR
	B/N	0 of 6 outside QC limits	B/N	0 of 12 outside QC limits
	Acid	0 of 5 outside QC limits	Acid	0 of 10 outside QC limits
	Pest	NR	Pest	NR

Abbreviations:				
	VOAs	Volatile organics	Rec	Recovery
	B/N	Bases/neutrals	MSD	Matrix spike duplicate
	Pest	Pesticides	RPD	Relative percent deviation
	MS	Matrix spike	QC	Quality control
	NR	Not required		

Table 4-14
GROUNDWATER SURROGATE PERCENT RECOVERY SUMMARY
METHOD 8270

	Volatile Organics			Semivolatile Organics						Pesticide	Herbicide
Sample Name	Toluene-d8 (88-110)	Bromofluorobenzene (86-115)	1,2-Dichloroethane-d4 (76-114)	Nitrobenzene-d5 (35-114)	2-Fluorobiphenyl (43-116)	Terphenyl-d14 (33-141)	Phenol-d5 (10-94)	2-Fluorophenol (21-100)	2,4,6-Tribromophenol (10-123)	Dibutylchlorendate[a] (24-154)	2,4-D[c]
DSA-MW6B (9/7/88)	NR	NR	NR	104	69	91	55	67	100	NR	NR
DSA-MW6B MS	NR	NR	NR	103	66	80	56	65	102	NR	NR
DSA-MW6B MSD	NR	NR	NR	106	69	92	56	66	106	NR	NR
DSA-MW6C	NR	NR	NR	55	45	70	44	55	74	NR	NR
DSA-MW6B (10/19/88)	NR	NR	NR	64	54	85	62	62	78	NR	NR
DSA-MW16A	NR	NR	NR	66	54	101	22	25	68	NR	NR
Blank 1	NR	NR	NR	98	65	81	42	63	90	NR	NR
Blank 2	NR	NR	NR	72	50	77	48	63	76	NR	NR

---

[a] Advisory limits only.

[b] Values are outside of contract-required QC limits.

[c] No established EPA contract-required QC limits.

[d] Surrogates diluted out.

Notes: Numbers in parentheses indicate EPA contract-required QC limits.

Volatiles: NR
Semivolatiles: 0 of 48 outside QC limits
Pesticides: NR

Abbreviations:
MS = matrix spike.
MSD = matrix spike duplicate.
NR = not required.

Table 4-15
SOIL SURROGATE PERCENT RECOVERY SUMMARY
METHOD 8270

	Volatile Organics			Semivolatile Organics						Pesticide
Sample Name	Toluene-d8 (88-110)	Bromo-fluoro-benzene (86-115)	1,2-Dichloro-ethane-d4 (76-114)	Nitro-benzene-d5 (35-114)	2-Fluoro-biphenyl (43-116)	Terphenyl-d14 (33-141)	Phenol-d5 (10-94)	2-Fluoro-phenol (21-100)	2,4,6-Tribromo-phenol (10-123)	Dibutyl-chlorendate[a] (24-154)
DSA-MS53 Marine Sed	NR	NR	NR	63	60	69	65	57	80	NR
DSA-MW6B	NR	NR	NR	78	55	76	71	77	61	NR
DSA-MW8B-SS2.5	NR	NR	NR	98	70	84	92	85	89	NR
DSA-MW8B-SS5.0	NR	NR	NR	91	68	85	87	83	98	NR
DSA-MW-16B-SS2.5	NR	NR	NR	81	54	74	74	75	72	NR
DSA-MW-16B-SS5.0	NR	NR	NR	81	56	84	71	72	72	NR
DSA-MW23	NR	NR	NR	84	56	87	72	70	58	NR
DSA-MW23 MS	NR	NR	NR	86	59	81	79	78	82	NR
DSA-MW23 MSD	NR	NR	NR	94	64	90	90	91	87	NR
DSA-MW24-SS2.5	NR	NR	NR	78	57	81	74	57	79	NR
DSA-MW24-SS7.5	NR	NR	NR	87	58	86	78	75	74	NR
DSA-MW24-SS20.0	NR	NR	NR	78	55	78	77	77	68	NR
DSA-MW25A-SS2.5	NR	NR	NR	94	56	62	64	57	80	NR
DSA-MW25A-SS5.0	NR	NR	NR	104	58	71	68	61	86	NR
DSA-MW-25B-SS-0.0	NR	NR	NR	89	67	94	89	80	83	NR
DSA-MW-25B-SS2.5	NR	NR	NR	94	65	86	87	84	95	NR
DSA-MW26-SS2.5	NR	NR	NR	82	60	76	84	81	73	NR
DSA-MW26-SS5.0	NR	NR	NR	85	57	73	81	78	71	NR
DSA-MW26-SS17.0	NR	NR	NR	95	57	77	87	86	64	NR
DSA-SB-16CD-11	NR	NR	NR	59	61	86	79	62	78	NR
Blank 1	NR	NR	NR	105	70	96	97	93	89	NR
Blank 2	NR	NR	NR	81	55	82	73	76	58	NR
Blank 3	NR	NR	NR	81	57	85	72	78	63	NR
Blank 4	NR	NR	NR	91	61	76	70	62	67	NR
Blank 5	NR	NR	NR	81	55	82	76	73	58	NR
Blank 6	NR	NR	NR	88	60	83	88	84	56	NR
Blank 7	NR	NR	NR	81	63	82	91	82	79	NR

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[a] Advisory limits only.

[b] Values are outside of contract-required QC limits.

[c] No established EPA contract-required QC limits.

[d] Surrogates diluted out.

Notes: Numbers in parentheses indicate EPA contract-required QC limits.

Volatiles:	NR
Semivolatiles:	0 of 162 outside QC limits
Pesticides:	NR

Abbreviations:

MS = matrix spike.
MSD = matrix spike duplicate.
NR = not required.

Table 4-16
GROUNDWATER METHOD BLANK SUMMARY
METHOD 8270

Method Blank Name	Date of Analysis	Fraction	Matrix	Level	Inst. ID	CAS Number	Compound (HSL, TIC, or unknown)	Concentration (µg/l)	CRDL
Blank 1	10/14/88	SVOA	Water	Low	F19	117-81-7	Bis(2ethyhexyl)phthalate	9	10
Blank 2	11/10/88	SVOA	Water	Low	F16	117-81-7	Bis(2ethylhexyl)phthalate	9	20
							Unknown	72	
							Unknown	32	

CRDL = contract required detection limit.
HSL = hazardous substance list.
TIC = tentatively identified compound.

Table 4-17
SOIL METHOD BLANK SUMMARY
METHOD 8270

Method Blank Name	Date of Analysis	Fraction	Matrix	Level	Inst. ID	CAS Number	Compound (HSL, TIC, or unknown)	Concentration (µg/kg)	CRDL
Blank 1	10/14/88	SVOA	Soil	Low	F19	84-74-2	Di-n-butylphthalate	30	330
						117-81-7	Bis(2-ethylhexyl)phthalate	140	330
						110-02-1	Thiophene	96	
						625-23-0	2-Hexanol, 2methyl	2,000	
						1187-58-2	Propanamide, n-methyl	130	
						620-05-3	Benzene (iodomethyl)	750	
Blank 2	10/13/88	SVOA	Soil	Low	F19	117-81-7	Bis(2thylhexyl)phthalate	290	330
						110-02-1	Thiophene	220	
						4337-65-9	Hexanediotic acid	1,100	
Blank 3	10/13/88	SVOA	Soil	Low	F19	84-74-2	Bi-n-butyl-phthalate	55	330
						117-81-7	Bis(2-ethylhexyl)phthalate	140	330
						110-02-1	Thiophene	168	
						625-23-0	2-Hexanol, 2-methyl	3,800	
						3970-62-5	3-Pentanol, 2,2-dimethyl	280	
						16487-65-3	Benzene, 3-pentenyl	55	
						1984-04-9	Naphthalene, 1-isocyano-	2,100	
Blank 4	10/22/88	SVOA	Soil	Low	F19	84-74-2	Di-n-butylphthalate	98	330
						117-81-7	Bis(2-ethylhexyl)phthalate	110	330
							Unknown	360	
							Unknown	300	
							Unknown	8,250	
							Unknown	260	
						5074-71-5	(DFTPP) Phosphine, bis (pentaflurophenyl)phenyl	730	
						545783-80-8	D4-Di-N-octyl phthalate	2,000	
Blank 5	10/13/88	SVOA	Soil	Low	F19	117-81-7	Bis(2-ethylhexyl)phthalate	290	330
						110-02-1	Thiophene	200	
						625-23-0	2-Hexanol	3,900	
						3970-62-5	3-Pentanol	300	
						620-05-3	Phenoxy methyl benzene	590	
						23403-41-0	L threonine	1,700	
Blank 6	10/22/88	SVOA	Soil	Low	F19	117-81-7	Bis(2-ethylhexyl)phthalate	150	330
							Substituted benzene	790	
							Unknown	500	
							Unknown	330	
							Unknown	11,000	
							Unknown	290	
Blank 7	12/6/88	SVOA	Soil	Low	F21	117-81-7	Bis(2-ethylhexyl)phthalate	51	330
						00-00-0	Unknown	660	

CRDL = contract required detection limit.
HSL = hazardous substance list.
TIC = tentatively identified compound.

noted, along with any data points outside the limits. For the CLP parameters, the data were again found to be within the listed control limits for above 95 percent of measurements.

The laboratory contaminants found in method blank measurements for samples are summarized in Table 4-16 for groundwater and Table 4-17 for soils. All blanks meet CLP criteria in that laboratory contaminants were found to be below EPA-specified quantitation levels. The data set has been qualified with regard to organic compounds observed in blanks by adjusting the detection limits for those compounds and flagging the data "UJ."

4.2.2.3 Chemical Data Quality Assurance--Mercury

Samples received for mercury analysis were analyzed according to SW846 Method 7471 for soil analysis. A sample size of 1 gram was used for soil. The digestion procedure was according to SW846 manual cold vapor technique and then the samples were analyzed on a Model MAS-50B mercury analyzer system.

Thirty-four samples were received for mercury analysis; three duplicates and three spikes were performed. Table 4-18 presents the QA/QC results of all mercury analysis.

Table 4-18
MERCURY PRECISION AND ACCURACY
Concentrations in mg/kg

PRECISION

Determination No.	Sample Value	Duplicate Value	Percent RPD
1	0.04	0.04	±0.0
2	0.06	0.05	-18.2
3	0.008	0.009	+11.8

ACCURACY

Determination No.	Sample Size (g)	Sample Value	Spike Added	Spike Sample Value	Percent Recovery
1	1.09	0.008	0.100	0.113	96
2	1.00	0.008	0.100	0.113	105
3	1.03	0.008	0.100	0.113	102

Both precision and accuracy for these determinations were within QA requirements: RPD of ±20 percent and percent recovery of 80-120.

4.3 SOIL RESULTS

4.3.1 METHOD 8040-PCP/TCP

Close Support Laboratory (CSL) Method 8040 was used to analyze 60 soil samples collected during monitoring well installation for the presence of PCP and TCP. Six marine sediment samples were also analyzed by Method 8040 for PCP/TCP.

All samples were analyzed by the modified Method 8040 described in Section 3.2.1.1 and in the SAP and QAPP (Appendix A). Neither PCP nor TCP were detected in any background soil sample (MW-26). Results for the Method 8040 analysis for all samples (soils and groundwater) are presented in Table 4-19. Table 4-19 also presents the PCP results from the Method 8270 semivolatile organic compounds analysis in order to compare the PCP results of the two analytical methods.

In addition to the 60 soil samples discussed above, six additional surface soils and two additional marine sediments were collected from adjacent to the former M&R property and offshore locations (see Figure 3-3). Finally, as part of the verification of the Preliminary Environmental Assessment (HC, 1988), samples were analyzed for PCP and TCP. A summary of the verification data gathering efforts, selected analyses, and sampling rationale are presented in the Technical Memorandum, "Verification Study of the Former M&R Property." The memorandum is provided as an addendum to this report.

4.3.1.1 SUBSURFACE SOIL SAMPLES

PCP was detected in only two of the 60 soil boring samples analyzed by Method 8040. Both of the two 8040 results were collected from MW-24B (2.81^J mg/kg dry weight at 7.5 feet and 2.22^N mg/kg dry weight at 35 feet, respectively). Both results were flagged by the laboratory, one as quantitatively (J) suspect and the remaining sample as qualitatively (N) suspect. According to the CSL designation, quantitatively suspect means the compound is likely to be present but the exact concentration is unknown. It is believed by the laboratory, however, that the flagged value represents the upper limit of possible compound concentration, and that the actual concentration will not exceed the reported value. The qualitatively suspected value means that the exact compound's identity is not clearly identifiable (i.e., something was detected, but the identification is questioned).

TCP was detected in seven of the 60 soil boring samples. The seven samples were collected from four borings (MW-6B, MW-16C, MW-24A, and MW-24B). Five of the seven Method 8040

Table 4-19

Soil and Groundwater Results for TCP/PCP and Mercury by Methods 8040 and 8270

					TCP		PCP					
					Method 8040		Method 8040		Method 8270	Mercury		
Location	**Sample ID No.**	**Date Sampled**	**Matrix**	**Soil Depth**	**As Received**	**Dry Wt.**	**As Received**	**Dry Wt.**	**As Received**	**As Received**	**Dry Wt.**	**Concentration Units**
MW5A	DSA-MW5 (8320-5)	8/28/88	Groundwater	N/A	0.005 U		0.005 U					mg/l
	DSA-MW5 (8527-2)	10/6/88	Groundwater	N/A	0.005 U		0.005 U					mg/l
MW6A	DSA-MW6 (8318-4)	8/24/88	Groundwater	N/A	2.84		3.07					mg/l
	DSA-MW6A (8527-11)	10/6/88	Groundwater	N/A	0.28 N		0.51 J					mg/l
	DSA-MW6A (8552-1)	10/13/88	Groundwater	N/A	1.35 J		2.13					mg/l
MW6B	DSA-MW6B-SS2.5 (8334-6)	8/30/88	Soil	2.5 to 4.0 ft.	1.0 U		1.0 U			0.245	0.259	mg/kg
	DSA-MW6B-SS5.0 (8334-7)	8/30/88	Soil	5.0 to 6.5 ft.	1.0 U		1.0 U		1.6 U	0.235	0.286	mg/kg
	DSA-MW6B-SS7.5 (8334-8)	8/30/88	Soil	7.5 to 9.0 ft.	1.0 U		1.0 U			0.055	0.070	mg/kg
	DSA-MW6B-SS30.0 (8334-10)	8/30/88	Soil	30.0 to31.5 ft.	1.4 N		1.0 U			0.03 U	0.039 U	mg/kg
	DSA-MW6B-SS50.0 (8334-11)	8/30/88	Soil	50.0 to 51.5 ft.	1.0 U		1.0 U			0.03 U	0.043 U	mg/kg
	DSA-MW6B (8350-1)	9/21/88	Groundwater	N/A	0.010		0.005 U		0.050 U			mg/l
	DSA-MW6B (8552-2)	10/13/88	Groundwater	N/A	0.005 U		0.005 U		0.010 U			mg/l
MW6C	DSA-MW6C-SS2.5 (8527-6)	10/6/88	Soil	2.5 to 4.0 ft.	1.0 U	1.1 U	1.0 U	1.1 U				mg/kg
	DSA-MW6C-SS5.0 (8527-7)	10/6/88	Soil	5.0 to 6.5 ft.	1.0 U	1.3 U	1.0 U	1.3 U				mg/kg
	DSA-MW6C-SS7.5 (8527-8)	10/6/88	Soil	7.5 to 9.0 ft.	1.0 U	1.2 U	1.0 U	1.2 U				mg/kg
	DSA-MW6C-SS17.5 (8527-9)	10/6/88	Soil	17.5 to 19.0 ft.	1.0 U	1.2 U	1.0 U	1.2 U				mg/kg

J = Quantitatively suspect
U = Undetected above this concentration

N = Qualitatively suspect
R = Unable to calculate due to interference

Table 4-19

Soil and Groundwater Results TCP, PCP and Mercury by Methods 8040 and 8270 (continued)

					TCP		PCP					
					Method 8040		Method 8040		Method 8270	Mercury		
Location	Sample ID No.	Date Sampled	Matrix	Soil Depth	As Received	Dry Wt.	As Received	Dry Wt.	As Received	As Received	Dry Wt.	Concentration Units
MW6C	DSA-MW6C (8552-4)	10/13/88	Groundwater	N/A	10.2 J		14.3		6.9			mg/l
	DSA-MW6C (8633-2)	11/1/88	Groundwater	N/A	0.23		0.27					mg/l
	DSA-MW6C (8680-1)	11/21/88	Groundwater	N/A	0.04		0.16					mg/l
MW8	DSA-MW8 (8288-1)	8/17/88	Groundwater	N/A	0.005 U		0.005 U					mg/l
	DSA-MW8 (8320-4)	8/26/88	Groundwater	N/A	0.005 U		0.005					mg/l
	DSA-MW8A (8512-1)	10/3/88	Groundwater	N/A	0.005 U		0.005 U					mg/l
MW8B	DSA-MW8B-SS2.5 (8401-2)	9/12/88	Soil	2.5 to 4.0 ft.	1.0 U	1.07 U	1.0 U	1.07 U		0.05 U	0.05 U	mg/kg
	DSA-MW8B-SS2.5D (8401-3)	9/12/88	Soil	2.5 to 4.0 ft.	1.0 U	1.06 U	1.0 U	1.06 U	1.6 U	0.05 U	0.05 U	mg/kg
	DSA-MW8B-SS5.0 (8401-6)	9/12/88	Soil	5.0 to 6.5 ft.	1.0 U	1.24 U	1.0 U	1.24 U	1.6 U	0.05 U	0.06 U	mg/kg
	DSA-MW8B-SS7.5 (8401-7)	9/12/88	Soil	7.5 to 9.0 ft.	1.0 U	1.13 U	1.0 U	1.13 U				mg/kg
	DSA-MW8B-SS30.0 (8401-8)	9/12/88	Soil	30.0 to 31.5 ft.	1.0 U	1.31 U	1.0 U	1.31 U				mg/kg
	DSA-MW8B-SS50.0 (8401-10)	9/12/88	Soil	50.0 to 51.5 ft.	1.0 U	1.43 U	1.0 U	1.43 U		0.05 U	0.07 U	mg/kg
	DSA-MW8B (8482-3)	9/26/88	Groundwater	N/A	0.005 U		0.005 U					mg/l
	DSA-MW8B (8512-2)	10/3/88	Groundwater	N/A	0.005 U		0.005 U					mg/l
MW15	DSA-MW15 (8318-3)	8/24/88	Groundwater	N/A	0.005 U		0.009					mg/l
	DSA-MW15 (8521-2)	10/4/88	Groundwater	N/A	0.005 U		0.005 U					mg/l

J = Quantitatively suspect
U = Undetected above this concentration
N = Qualitatively suspect
R = Unable to calculate due to interference

Table 4-19

Soil and Groundwater Results TCP, PCP and Mercury by Methods 8040 and 8270 (continued)

					TCP		PCP			Mercury		
					Method 8040		Method 8040		Method 8270			
Location	**Sample ID No.**	**Date Sampled**	**Matrix**	**Soil Depth**	**As Received**	**Dry Wt.**	**As Received**	**Dry Wt.**	**As Received**	**As Received**	**Dry Wt.**	**Units**
MW16A	DSA-MW16 (8320-1)	8/28/88	Groundwater	N/A	0.105N		0.052					mg/l
	DSA-MW16A (8512-5)	10/14/88	Groundwater	N/A	0.006N		0.005 U					mg/l
	DSA-MW16A (8552-6)	10/14/88	Groundwater	N/A	0.092 J		0.064		0.017 J			mg/l
MW16B	DSA-MW16B-SS2.5 (8380-3)	9/8/88	Soil	2.5 to 4.0 ft.	1.0 U	1.03 U	1.0 U	1.03 U	1.6 U	0.05 U	0.05 U	mg/kg
	DSA-MW16B-SS5.0 (8380-4)	9/8/88	Soil	5.0 to 6.5 ft.	1.0 U	1.11 U	1.0 U	1.11 U	1.6 U	0.05 U	0.06 U	mg/kg
	DSA-MW16B-SS7.5 (8380-5)	9/8/88	Soil	7.5 to 9.0 ft.	1.0 U	1.22 U	1.0 U	1.22 U				mg/kg
	DSA-MW16B-SS30.0 (8380-6)	9/8/88	Soil	30.0 to 31.5 ft.	1.0 U	1.30 U	1.0 U	1.30 U				mg/kg
	DSA-MW16B-SS50.0 (8380-7)	9/8/88	Soil	50.0 to 51.5 ft.	1.0 U	1.42 U	1.0 U	1.42 U		0.05 U	0.07 U	mg/kg
	DSA-MW16B-SS50.0D (8380-8)	9/8/88	Soil	50.0 to 51.5 ft.	1.0 U	1.39 U	1.0 U	1.39 U				mg/kg
	DSA-MW16B (8458-1)	9/23/88	Groundwater	N/A	0.005 U		0.005 U					mg/l
	DSA-MW16BD (8458-2)	9/23/88	Groundwater	N/A	0.005 U		0.005 U					mg/l
	DSA-MW16B (8512-6)	10/4/88	Groundwater	N/A	0.005 U		0.005 U					mg/l
Boring 16C	DSA-SB-16C-11 (8667-1)	11/16/88	Soil	9.0 to 14.0 ft.	4.7	6.2	1.0 U	1.3 U				mg/kg
	DSA-SB-16C-11D (8667-1D)	11/16/88	Soil	9.0 to 14.0 ft.	4.6	6.1	1.0 U	1.3 U	24			mg/kg

J = Quantitatively suspect
U = Undetected above this concentration
N = Qualitatively suspect
R = Unable to calculate due to interference

Table 4-19

Soil and Groundwater Results TCP, PCP and Mercury by Methods 8040 and 8270 (continued)

					TCP		PCP					
					Method 8040		Method 8040		Method 8270	Mercury		
Location	Sample ID No.	Date Sampled	Matrix	Soil Depth	As Received	Dry Wt.	As Received	Dry Wt.	As Received	As Received	Dry Wt.	Units
MW16A	DSA-MW16 (8320-1)	8/28/88	Groundwater	N/A	0.105N		0.052					mg/l
	DSA-MW16A (8512-5)	10/14/88	Groundwater	N/A	0.006N		0.005 U					mg/l
	DSA-MW16A (8552-6)	10/14/88	Groundwater	N/A	0.092 J		0.064		0.017 J			mg/l
MW16B	DSA-MW16B-SS2.5 (8380-3)	9/8/88	Soil	2.5 to 4.0 ft.	1.0 U	1.03 U	1.0 U	1.03 U	1.6 U	0.05 U	0.05 U	mg/kg
	DSA-MW16B-SS5.0 (8380-4)	9/8/88	Soil	5.0 to 6.5 ft.	1.0 U	1.11 U	1.0 U	1.11 U	1.6 U	0.05 U	0.06 U	mg/kg
	DSA-MW16B-SS7.5 (8380-5)	9/8/88	Soil	7.5 to 9.0 ft.	1.0 U	1.22 U	1.0 U	1.22 U				mg/kg
	DSA-MW16B-SS30.0 (8380-6)	9/8/88	Soil	30.0 to 31.5 ft.	1.0 U	1.30 U	1.0 U	1.30 U				mg/kg
	DSA-MW16B-SS50.0 (8380-7)	9/8/88	Soil	50.0 to 51.5 ft.	1.0 U	1.42 U	1.0 U	1.42 U		0.05 U	0.07 U	mg/kg
	DSA-MW16B-SS50.0D (8380-8)	9/8/88	Soil	50.0 to 51.5 ft.	1.0 U	1.39 U	1.0 U	1.39 U				mg/kg
	DSA-MW16B (8458-1)	9/23/88	Groundwater	N/A	0.005 U		0.005 U					mg/l
	DSA-MW16BD (8458-2)	9/23/88	Groundwater	N/A	0.005 U		0.005 U					mg/l
	DSA-MW16B (8512-6)	10/4/88	Groundwater	N/A	0.005 U		0.005 U					mg/l
Boring 16C	DSA-SB-16C-11 (8667-1)	11/16/88	Soil	9.0 to 14.0 ft.	4.7	6.2	1.0 U	1.3 U				mg/kg
	DSA-SB-16C-11D (8667-1D)	11/16/88	Soil	9.0 to 14.0 ft.	4.6	6.1	1.0 U	1.3 U				mg/kg

J = Quantitatively suspect
U = Undetected above this concentration
N = Qualitatively suspect
R = Unable to calculate due to interference

Table 4-19

Soil and Groundwater Results TCP, PCP and Mercury by Methods 8040 and 8270 (continued)

					TCP		PCP					
					Method 8040		Method 8040		Method 8270	Mercury		
Location	Sample ID No.	Date Sampled	Matrix	Soil Depth	As Received	Dry Wt.	As Received	Dry Wt.	As Received	As Received	Dry Wt.	Units
MW18	DSA-MW18 (8318-2)	8/24/88	Groundwater	N/A	0.005 U		0.006					mg/l
	DSA-MW18 (8521-3)	10/4/88	Groundwater	N/A	0.005 U		0.005 U					mg/l
MW19	DSA-MW19 (8320-2)	8/26/88	Groundwater	N/A	0.005 U		0.015					mg/l
	DSA-MW19 (8521-1)	10/15/88	Groundwater	N/A	0.345 J		R					mg/l
MW21	DSA-MW21 (8318-1)	8/24/88	Groundwater	N/A	0.005 U		0.021					mg/l
	DSA-MW21 (8521-5)	10/5/88	Groundwater	N/A	0.005 U		0.005 U					mg/l
MW22	DSA-MW22 (8320-3)	8/28/88	Groundwater	N/A	0.005 U		0.025					mg/l
	DSA-MW22 (8521-4)	10/5/88	Groundwater	N/A	0.005 U		0.005 U					mg/l
MW23	DSA-MW23-SS2.5 (8334-1)	8/29/88	Soil	2.5 to 4.0 ft.	1.0 U		1.0 U			0.064	0.069	mg/kg
	DSA-MW23-SS5.0 (8334-2)	8/29/88	Soil	5.0 to 6.5 ft.	1.0 U		1.0 U			0.03 U	0.031 U	mg/kg
	DSA-MW23-SS7.5 (8334-3)	8/29/88	Soil	7.5 to 9.0 ft.	1.0 U		1.0 U			0.056	0.071	mg/kg
	DSA-MW23-SS10.0 (8334-4)	8/29/88	Soil	10.0 to 11.5 ft.	1.0 U		1.0 U		1.6 U	0.03 U	0.034 U	mg/kg
	DSA-MW23.SS17.5 (8334-5)	8/29/88	Soil	17.5 to 19.0 ft.	1.0 U		1.0 U			0.03 U	0.035 U	mg/kg
	DSA-MW23 (8345-1)	9/1/88	Groundwater	N/A	0.005 U		0.005 U					mg/l
	DSA-MW23 (8527-1)	10/6/88	Groundwater	N/A	0.005 U		0.005 U					mg/l

J = Quantitatively suspect
U = Undetected above this concentration

N = Qualitatively suspect
R = Unable to calculate due to interference

Table 4-19

Soil and Groundwater Results TCP, PCP and Mercury by Methods 8040 and 8270 (continued)

					TCP		PCP					
					Method 8040		Method 8040		Method 8270	Mercury		
Location	Sample ID No.	Date Sampled	Matrix	Soil Depth	As Received	Dry Wt.	As Received	Dry Wt.	As Received	As Received	Dry Wt.	Units
MW24A	DSA-MW24.SS2.5 (8345-2)	9/1/88	Soil	2.5 to 4.0 ft.	1.0 U	1.1 U	1.0 U	1.1 U	3.2 U	0.064	0.071	mg/kg
	DSA-MW24-SS5.0 (8345-3)	9/1/88	Soil	5.0 to 6.5 ft.	3.72 N	4.55 N	1.0 U	1.2 U		0.05 U	0.06 U	mg/kg
	DSA-MW24-SS7.5 (8345-4)	9/1/88	Soil	7.5 to 9.0 ft.	3.44 N	3.83 N	1.0 U	1.1 U	1.6 U	0.043	0.048	mg/kg
	DSA-MW24-SS20 (8345-5)	9/1/88	Soil	20.0 to 21.5 ft.	1.0 U	1.3 U	1.0 U	1.3 U	1.6 U	0.05 U	0.07 U	mg/kg
	DSA-MW24A (8401-12)	9/13/88	Groundwater	N/A	0.005 U		0.005 U					mg/l
	DSA-MW24A (8512-3)	10/3/88	Groundwater	N/A	0.005 U		0.005 U					mg/l
MW24B	DSA-MW24B-SS2.5 (8356-1)	9/6/88	Soil	2.5 to 4.0 ft.	2.28 N	2.66 N	1.0 U	1.17 U		0.13	0.15	mg/kg
	DSA-MW24B-7.5 (8356-2)	9/6/88	Soil	7.5 to 9.0 ft.	1.16 N	1.35 N	2.41 J	2.81 J		0.05 U	0.06 U	mg/kg
	DSA-MW24B-SS12.5 (8356-3)	9/6/88	Soil	12.5 to 14.0 ft.	1.0 U	1.35 U	1.0 U	1.35 U				mg/kg
	DSA-MW24B-SS35.0 (8356-4)	9/6/88	Soil	35.0 to 36.5 ft.	1.0 U	1.33 U	1.67 N	2.22 N				mg/kg
	DSA-MW24B-SS50.0 (8356-5)	9/6/88	Soil	50.0 to 51.5 ft.	1.0 U	1.41 U	1.0 U	1.41 U		0.05 U	0.07 U	mg/kg
	DSA-MW24B-SS50.0D (8356-6)	9/6/88	Soil	50.0 to 51.5 ft.	1.0 U	1.39 U	1.0 U	1.39 U				mg/kg
	DSA-MW24B (8401-11)	9/13/88	Groundwater	N/A	0.005 U		0.005 U					mg/l
	DSA-MW24BD (8512-4)	9/13/88	Groundwater	N/A	0.005 U		0.005 U					mg/l

J = Quantitatively suspect
U = Undetected above this concentration

N = Qualitatively suspect
R = Unable to calculate due to interference

Table 4-19

Soil and Groundwater Results TCP, PCP and Mercury by Methods 8040 and 8270 (continued)

					TCP		PCP					
					Method 8040		Method 8040		Method 8270	Mercury		
Location	Sample ID No.	Date Sampled	Matrix	Soil Depth	As Received	Dry Wt.	As Received	Dry Wt.	As Received	As Received	Dry Wt.	Units
MW25A	DSA-MW24A-SS2.5 (8419-1)	9/15/88	Soil	2.5 to 4.0 ft.	1.0 U	1.05 U	1.0 U	1.05 U	1.6 U			mg/kg
	DSA-MW25A-SS5.0 (8419-2)	9/15/88	Soil	5.0 to 6.5 ft.	1.0 U	1.10 U	1.0 U	1.10 U	1.6 U			mg/kg
	DSA-MW25A-SS7.5 (8419-3)	9/15/88	Soil	7.5 to 9.0 ft.	1.0 U	1.16 U	1.0 U	1.16 U				mg/kg
	DSA-MW25A-SS17.0 (8419-4)	9/15/88	Soil	17.0 to 18.5 ft.	1.0 U	1.26 U	1.0 U	1.26 U				mg/kg
	DSA-MW25-SS17.0D (8419-5)	9/15/88	Soil	17.0 to 18.5 ft.	1.0 U	1.26 U	1.0 U	1.26 U				mg/kg
	DSA-MW25A (8482-1)	9/26/88	Groundwater	N/A	0.045 N		0.005 U					mg/l
	DSA-MW25A (8512-7)	10/4/88	Groundwater	N/A	0.005 U		0.005 U					mg/l
	DSA-MW25AD (8512-9)	10/4/88	Groundwater	N/A	0.005 U		0.005 U					mg/l
MW25B	DSA-MW25B-SS0.0 (8410-3)	9/14/88	Soil	0.0 to 1.5 ft.	1.0 U	1.08 U	1.0 U	1.08 U	1.7	0.17	0.18	mg/kg
	DSA-MW25B-SS2.5 (8410-6)	9/14/88	Soil	2.5 to 4.0 ft.	1.0 U	1.10 U	1.0 U	1.10 U	0.28 J	0.05 U	0.06 U	mg/kg
	DSA-MW25B-SS5.0 (8410-4)	9/14/88	Soil	5.0 to 6.5 ft.	1.0 U	1.10 U	1.0 U	1.10 U				mg/kg
	DSA-MW25B-SS5.0D (8410-5)	9/14/88	Soil	5.0 to 6.5 ft.	1.0 U	1.11 U	1.0 U	1.11 U				mg/kg
	DSA-MW25B-SS30.0 (8410-7)	9/14/88	Soil	30.0 to 31.5 ft.	1.0 U	1.34 U	1.0 U	1.34 U		0.05 U	0.07 U	mg/kg
	DSA-MW25B-SS50.0 (8401-8)	9/14/88	Soil	50.0 to 51.5 ft.	1.0 U	1.48 U	1.0 U	1.48 U				mg/kg
	DSA-MW25B (8482-2)	9/26/88	Groundwater	N/A	0.005 U		0.005 U					mg/l
	DSA-MW25B (8512-8)	10/4/88	Groundwater	N/A	0.005 U		0.005 U					mg/l

J = Quantitatively suspect
U = Undetected above this concentration
N = Qualitatively suspect
R = Unable to calculate due to interference

Table 4-19

Soil and Groundwater Results TCP, PCP and Mercury by Methods 8040 and 8270 (continued)

					TCP		PCP					
					Method 8040		Method 8040		Method 8270	Mercury		
Location	Sample ID No.	Date Sampled	Matrix	Soil Depth	As Received	Dry Wt.	As Received	Dry Wt.	As Received	As Received	Dry Wt.	Units
DS-MS-01	DSA-MS1 (8454-6)	9/22/88	Marine Sediment	0-6"	1.0 U	6.7 U	1.0 U	6.7 U				mg/kg
DS-MS-02	DSA-MS2 (8454-5)	9/22/88	Marine Sediment	0-6"	1.0 U	5.3 U	1.0 U	5.3 U				mg/kg
DS-MS-03	DSA-MS3 (8454-4)	9/22/88	Marine Sediment	0-6"	1.0 U	4.7 U	1.0 J	4.7 J				mg/kg
DS-MS-04	DSA-MS4 (8454-1)	9/22/88	Marine Sediment	0-6"	1.0 U	5.8 U	1.0 U	5.8 U				mg/kg
DS-MS-05	DSA-MS5 (8454-2)	9/22/88	Marine Sediment	0-6"	1.0 U	2.7 U	2.4 J	6.4 J				mg/kg
DS-MS-05	DSA-MS53 (Marine Sediment)	9/22/88	Marine Sediment	0-6"					1.6 U			mg/kg

J = Quantitatively suspect
U = Undetected above this concentration

N = Qualitatively suspect
R = Unable to calculate due to interference

detected values were flagged by the laboratory as being qualitatively suspect (i.e., precise compound identification is unknown). These five are MW-6B (30 feet), MW-24A (5 feet and 7.5 feet), and MW-24B (2.5 feet and 7.5 feet). The last two TCP results, 6.2 mg/kg dry weight and 6.1 mg/kg (MW-16C at 9 feet and MW-16C field duplicate at 9 feet), are considered qualitatively and quantitatively acceptable. The significance of these results is discussed in Section 5.3.2.

4.3.1.2 MARINE SEDIMENT SAMPLES

Marine sediment results for all PCP and TCP analysis are presented in Table 4-19. PCP was detected in two out of a total of five and one duplicate samples by Method 8040. Both detected results DS-MS-3 (4.7 mg/kg dry weight) and DS-MS-5 (6.4 mg/kg) were flagged by the laboratory as quantitatively suspect, meaning that PCP was detected in both samples, buth the quantity is uncertain. As with the monitoring well soils, the probability that the actual concentration exceeds the flagged value is considered to be highly unlikely.

Tetrachlorophenol (TCP) was not reported in any marine sediment sample by Method 8040.

4.3.1.3 VERIFICATION SOILS SAMPLES

Table 4-19 presents the TCP results of soil and marine sediment samples collected for the verification study (see addendum). Pentachlorophenol (PCP) was not detected in any of the eight verification samples, six soil and two marine sediments. TCP was detected in one soil sample (VI-SS-200) at 2.2 mg/kg dry weight). This result is considered qualitatively and quantitatively acceptable and is discussed in Section 5.3.

4.3.1.4 Summary of Method 8040 PCP/TCP Soil Results

Table 4-20 presents a summary of all PCP/TCP detected values for soil and sediments by analytical Method 8040. Of the 12 reported detections, only three (monitoring 16-C and 16-C duplicate and verification sample V1-SS-200) are considered qualitatively and quantitatively acceptable by the analytical laboratory.

Table 4-20
METHOD 8040 SOIL AND SEDIMENT SAMPLE RESULTS SUMMARY

Detected Compound	Location	Results	Comments
PCP	MW-24B, 7.5 ft	2.81J	Quantitatively Suspect
PCP	MW-24B, 35.0 ft	2.22N	Qualitatively Suspect
TCP	MW-6B, 30.0 ft	1.40N	Qualitatively Suspect
TCP	MW-24A, 5.0 ft	4.55N	Qualitatively Suspect
TCP	MW-24A, 7.5 ft	3.83N	Qualitatively Suspect
TCP	MW-24B, 2.5 ft	2.66N	Qualitatively Suspect
TCP	MW-24B, 7.5 ft	1.35N	Qualitatively Suspect
TCP	MW-16C, 9.0 ft	6.2	
TCP	MW-16C, 9.0 ft	6.1	
PCP	Station DS-MS-3	4.7J	Quantitatively Suspect
PCP	Station DS-MS-5	6.4J	Quantitatively Suspect
TCP	V1-SS-200	2.2	

4.3.2 METHOD 8270 SEMIVOLATILE ORGANIC COMPOUNDS

Table 4-21 presents a summary of the Method 8270 soils analyses. Method 8270 analyzes for the presence of 65 semivolatile organic compounds from the hazardous substance list. Method 8270 analysis is described in Section 3.2.1.2 and in the SAP and QAPP (Appendix A). The complete hazardous substance list and quantification limit for each compound is presented in Table 3-5 and in the QAPP (Appendix A).

4.3.2.1 SUBSURFACE SOIL SAMPLES

Sixteen soil samples collected during monitoring well installation were analyzed by Method 8270. Only ten of the semivolatile target compounds (out of a total of 65) were detected in soils for a total of 40 reported detects in monitoring well soils (see Table 4-21).

As shown in Table 4-21, 22 of the 40 results are qualified by the laboratory because of probable laboratory contamination. The accuracy of these sample results is suspect because of contamination in the laboratory method blanks. Consequently, the sample quantitation limits have been elevated for these samples and flagged "UJ." The sample results listed in Table 4-21 were not detected above these adjusted levels.

Sixteen of the remaining eighteen reported results are qualified as estimates (flagged by the laboratory as "J") because they are below the quantitation limit but above the instrument detection limit. These results are qualitatively

Table 4-21
DETECTED HAZARDOUS SUBSTANCE LIST COMPOUNDS[a]
(μg/kg)

Soil Sample Number	Phenol Result[b]	4-Methylphenol Result[b]	Benzoic Acid Result[b]	2,4,5-Trichlorophenol Result[b]	Fluorene Result[b]	Pentachlorophenol Result[b]
DSA-MS53Marine	330 U	330 U	96 J	1,600 U	66 J	1,600 U
DSA-MW6B-SS5.0	660 U	660 U	3,200 U	3,200 U	660 U	3,200 U
DSA-MW8B-SS2.5	330 U	330 U	1,600 U	1,600 U	330 U	1,600 U
DSA-MW8B-SS5.0	330 U	330 U	1,600 U	1,600 U	330 U	1,600 U
DSA-MW16B-SS2.5	330 U	120 J	1,600 U	1,600 U	330 U	1,600 U
DSA-MW16B-SS5.0	330 U	330 U	1,600 U	1,600 U	330 U	1,600 U
DSA-MW23-SS10.0	330 U	330 U	1,600 U	1,600 U	330 U	1,600 U
DSA-MW24-SS2.5	900	660 U	3,200 U	3,200 U	110 J	3,200 U
DSA-MW24-SS7.5	330 U	330 U	1,600 U	1,600 U	330 U	1,600 U
DSA-MW24-SS20.0	330 U	330 U	1,600 U	1,600 U	330 U	1,600 U
DSA-MW25A-SS2.5	330 U	330 U	1,600 U	1,600 U	330 U	1,600 U
DSA-MW25A-SS5.0	330 U	330 U	1,600 U	1,600 U	330 U	1,600 U
DSA-MW25B-SS0.0	330 U	330 U	1,600 U	1,600 U	330 U	1,700
DSA-MW25B-SS2.5	330 U	330 U	1,600 U	1,600 U	330 U	280 J
DSA-MW26-SS2.5	330 U	330 U	1,600 U	1,600 U	330 U	1,600 U
DSA-MW26-SS5.0	330 U	330 U	40 J	1,600 U	330 U	1,600 U
DSA-MW26-SS17.0	330 U	330 U	1,600 U	1,600 U	330 U	1,600 U
DSA-SB16CD-11	1,300 U	1,300 U	6,400 U	2,300 J	1,300 U	24,000
Blank 1[c]	330 U	330 U	1,600 U	1,600 U	330 U	1,600 U
Blank 2[d]	330 U	330 U	1,600 U	1,600 U	330 U	1,600 U
Blank 3[e]	330 U	330 U	1,600 U	1,600 U	330 U	1,600 U
Blank 4[f]	330 U	330 U	1,600 U	1,600 U	330 U	1,600 U
Blank 5[g]	330 U	330 U	1,600 U	1,600 U	330 U	1,600 U
Blank 6[h]	330 U	330 U	1,600 U	1,600 U	330 U	1,600 U
Blank 7[i]	330 U	330 U	1,600 U	1,600 U	330 U	1,600 U

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[a] The other analytes requested were analyzed for but not detected by the laboratory.

[b] U: Parameter analyzed for but not detected above this concentration.
J: Indicates an estimated value. Result is less than the specified detection limit but greater than zero.
UJ: The parameter was analyzed for, but not detected above this limit. Because of contamination and/or analytical deficiencies, adjustment of the sample quantitation limit was necessary.

[c] Semivolatile method blank associated with samples DSA-MW8B-SS2.5, DSA-MW8B-SS5.0, DSA-MW25A-SS2.5, DSA-MW25A-SS5.0, DSA-MW25B-SS2.0, DSA-MW25B-SS5.0.

[d] Semivolatile method blank associated with samples DSA-MW23-SS10.0, DSA-MW6B-SS5.0.

[e] Semivolatile method blank associated with samples DSA-MW16B-SS2.5, DSA-MW16B-SS5.0.

[f] Semivolatile method blank associated with sample DSA-MS53Marine.

[g] Semivolatile method blank associated with samples DSA-MW24-SS2.5, DSA-MW24-SS5.0, DSA-MW24-SS17.0.

[h] Semivolatile method blank associated with samples DSA-MW26-SS2.5, DSA-MW26-SS5.0, DSA-MW26-SS17.0.

[i] Semivolatile method blank associated with samples DSA-SB16CD-11.

Table 4-21
(continued)

Soil Sample Number	Phenanthrene Result[b]	Di-n-butylphthalate Result[b]	Fluoranthene Result[b]	Pyrene Result[b]	bis(2-Ethylhexyl) phthalate Result[b]
DSA-MS53Marine	560	330 UJ	580	570	330 UJ
DSA-MW6B-SS5.0	660 U	98 J	660 U	660 U	660 UJ
DSA-MW8B-SS2.5	330 U	330 UJ	330 U	330 U	330 UJ
DSA-MW8B-SS5.0	330 U	330 UJ	330 U	330 U	330 UJ
DSA-MW16B-SS2.5	330 U	330 UJ	330 U	330 U	330 UJ
DSA-MW16B-SS5.0	330 U	330 UJ	330 U	330 U	330 UJ
DSA-MW23-SS10.0	330 U	84 J	330 U	330 U	650 UJ
DSA-MW24-SS2.5	470 J	210 J	180 J	140 J	330 UJ
DSA-MW24-SS7.5	330 U	260 J	330 U	330 U	330 UJ
DSA-MW24-SS20.0	330 U	150 J	330 U	330 U	330 UJ
DSA-MW25A-SS2.5	330 U	330 UJ	330 U	300 U	330 UJ
DSA-MW25A-SS5.0	330 U	330 U	330 U	330 U	330 UJ
DSA-MW25B-SS0.0	330 U	330 UJ	330 U	330 U	330 UJ
DSA-MW25B-SS2.5	40 J	330 U	43 J	54 J	330 UJ
DSA-MW26-SS2.5	330 U	330 U	330 U	330 U	330 UJ
DSA-MW26-SS5.0	330 U	330 U	330 U	330 U	442 UJ
DSA-MW26-SS17.0	330 U	51 J	330 U	330 U	330 UJ
DSA-SB16CD-11	1,300 U	1,300 U	1,300 U	1,300 U	1,300 UJ
Blank 1[c]	330 U	30 J	330 U	330 U	140 J
Blank 2[d]	330 U	330 U	330 U	330 U	290 J
Blank 3[e]	330 U	55 J	330 U	330 U	140 J
Blank 4[f]	330 U	98 J	330 U	330 U	110 J
Blank 5[g]	330 U	330 U	330 U	330 U	290 J
Blank 6[h]	330 U	330 U	330 U	330 U	150 J
Blank 7[i]	330 U	330 U	330 U	330 U	51 J

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[a] The other analytes requested were analyzed for but not detected by the laboratory.

[b] U: Parameter analyzed for but not detected above this concentration.
J: Indicates an estimated value. Result is less than the specified detection limit but greater than zero.
UJ: The parameter was analyzed for, but not detected above this limit. Because of contamination and/or analytical deficiencies, adjustment of the sample quantitation limit was necessary.

[c] Semivolatile method blank associated with samples DSA-MW8B-SS2.5, DSA-MW8B-SS5.0, DSA-MW25A-SS2.5, DSA-MW25A-SS5.0, DSA-MW25B-SS2.0, DSA-MW25B-SS5.0.

[d] Semivolatile method blank associated with samples DSA-MW23-SS10.0, DSA-MW6B-SS5.0.

[e] Semivolatile method blank associated with samples DSA-MW16B-SS2.5, DSA-MW16B-SS5.0.

[f] Semivolatile method blank associated with sample DSA-MS53Marine.

[g] Semivolatile method blank associated with samples DSA-MW24-SS2.5, DSA-MW24-SS5.0, DSA-MW24-SS17.0.

[h] Semivolatile method blank associated with samples DSA-MW26-SS2.5, DSA-MW26-SS5.0, DSA-MW26-SS17.0.

[i] Semivolatile method blank associated with samples DSA-SB16CD-11.

Table 4-21
(continued)

Soil Sample Number	Naphthalene Result[b]	Acenaphthene Result[b]	Dibenzofuran Result[b]	Anthracene Result[b]	Benzo(a)anthracene Result[b]
DSA-MS53Marine	42 J	40 J	38 J	140 J	210 J
DSA-MW6B-SS5.0	660 U	660 U	660 U	660 U	660 U
DSA-MW8B-SS2.5	330 U	330 U	330 U	330 U	330 U
DSA-MW8B-SS5.0	330 U	330 U	330 U	330 U	330 U
DSA-MW16B-SS2.5	330 U	330 U	330 U	330 U	330 U
DSA-MW16B-SS5.0	330 U	330 U	330 U	330 U	330 U
DSA-MW23-SS10.0	330 U	330 U	330 U	330 U	330 U
DSA-MW24-SS2.5	330 U	330 U	330 U	330 U	330 U
DSA-MW24-SS7.5	330 U	330 U	330 U	330 U	330 U
DSA-MW24-SS20.0	330 U	330 U	330 U	330 U	330 U
DSA-MW25A-SS2.5	330 U	330 U	330 U	330 U	330 U
DSA-MW25A-SS5.0	330 U	330 U	330 U	330 U	330 U
DSA-MW25B-SS0.0	330 U	330 U	330 U	330 U	330 U
DSA-MW25B-SS2.5	330 U	330 U	330 U	330 U	330 U
DSA-MW26-SS2.5	330 U	330 U	330 U	330 U	330 U
DSA-MW26-SS5.0	330 U	330 U	330 U	330 U	330 U
DSA-MW26-SS17.0	330 U	330 U	330 U	330 U	330 U
DSA-SB16CD-11	1,300 U	1,300 U	1,300 U	1,300 U	1,300 U
Blank 1[c]	330 U	330 U	330 U	330 U	330 U
Blank 2[d]	330 U	330 U	330 U	330 U	330 U
Blank 3[e]	330 U	330 U	330 U	330 U	330 U
Blank 4[f]	330 U	330 U	330 U	330 U	330 U
Blank 5[g]	330 U	330 U	330 U	330 U	330 U
Blank 6[h]	330 U	330 U	330 U	330 U	330 U
Blank 7[i]	330 U	330 U	330 U	330 U	330 U

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[a] The other analytes requested were analyzed for but not detected by the laboratory.

[b] U: Parameter analyzed for but not detected above this concentration.
J: Indicates an estimated value. Result is less than the specified detection limit but greater than zero.
UJ: The parameter was analyzed for, but not detected above this limit. Because of contamination and/or analytical deficiencies, adjustment of the sample quantitation limit was necessary.

[c] Semivolatile method blank associated with samples DSA-MW8B-SS2.5, DSA-MW8B-SS5.0, DSA-MW25A-SS2.5, DSA-MW25A-SS5.0, DSA-MW25B-SS2.0, DSA-MW25B-SS5.0.

[d] Semivolatile method blank associated with samples DSA-MW23-SS10.0, DSA-MW6B-SS5.0.

[e] Semivolatile method blank associated with samples DSA-MW16B-SS2.5, DSA-MW16B-SS5.0.

[f] Semivolatile method blank associated with sample DSA-MS53Marine.

[g] Semivolatile method blank associated with samples DSA-MW24-SS2.5, DSA-MW24-SS5.0, DSA-MW24-SS17.0.

[h] Semivolatile method blank associated with samples DSA-MW26-SS2.5, DSA-MW26-SS5.0, DSA-MW26-SS17.0.

[i] Semivolatile method blank associated with samples DSA-SB16CD-11.

Table 4-21
(continued)

Soil Sample Number	Chrysene Result[b]	Benzo(b)-fluoranthene Result[b]	Benzo(k)-fluoranthene Result[b]	Benzo(a)-pyrene Result[b]	Indeno(1,2,3-cd)-pyrene Result[b]	Benzo(g,h,i)-perylene Result[b]
DSA-MS53Marine	320 J	180 J	150 J	150 J	63 J	71 J
DSA-MW6B-SS5.0	660 U	660 U	660 UJ	660 U	660 U	660 UJ
DSA-MW8B-SS2.5	330 U	330 U	330 U	330 U	330 UJ	330 U
DSA-MW8B-SS5.0	330 U	330 U	330 U	330 U	330 UJ	330 U
DSA-MW16B-SS2.5	330 U	330 U	330 UJ	330 U	330 U	330 UJ
DSA-MW16B-SS5.0	330 U	330 U	330 UJ	330 U	330 U	330 UJ
DSA-MW23-SS10.0	330 U	330 U	330 UJ	330 U	330 U	330 UJ
DSA-MW24-SS2.5	330 U	330 U	330 UJ	330 U	330 U	330 UJ
DSA-MW24-SS7.5	330 U	330 U	330 UJ	330 U	330 U	330 UJ
DSA-MW24-SS20.0	330 U	330 U	330 UJ	330 U	330 U	330 UJ
DSA-MW25A-SS2.5	330 U	330 U	330 U	330 U	330 U	330 U
DSA-MW25A-SS5.0	330 U	330 U	330 U	330 U	330 U	330 U
DSA-MW25B-SS0.0	330 U	330 U	330 U	330 U	330 U	330 U
DSA-MW25B-SS2.5	330 U	330 U	330 U	330 U	330 U	330 U
DSA-MW26-SS2.5	330 U	330 U	330 U	330 U	330 U	330 UJ
DSA-MW26-SS5.0	330 U	330 U	330 U	330 U	330 U	330 UJ
DSA-MW26-SS17.0	330 U	330 U	330 U	330 U	330 U	330 UJ
DSA-SB16CD-11	1,300 U	1,300 U	1,300 U	1,300 U	1,300 U	1,300 U
Blank 1[c]	330 U	330 U	330 U	330 U	330 U	330 U
Blank 2[d]	330 U	330 U	330 U	330 U	330 U	330 U
Blank 3[e]	330 U	330 U	330 U	330 U	330 U	330 U
Blank 4[f]	330 U	330 U	330 U	330 U	330 U	330 U
Blank 5[g]	330 U	330 U	330 U	330 U	330 U	330 U
Blank 6[h]	330 U	330 U	330 U	330 U	330 U	330 U
Blank 7[i]	330 U	330 U	330 U	330 U	330 U	330 U

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[a] The other analytes requested were analyzed for but not detected by the laboratory.

[b] U: Parameter analyzed for but not detected above this concentration.
J: Indicates an estimated value. Result is less than the specified detection limit but greater than zero.
UJ: The parameter was analyzed for, but not detected above this limit. Because of contamination and/or analytical deficiencies, adjustment of the sample quantitation limit was necessary.

[c] Semivolatile method blank associated with samples DSA-MW8B-SS2.5, DSA-MW8B-SS5.0, DSA-MW25A-SS2.5, DSA-MW25A-SS5.0, DSA-MW25B-SS2.0, DSA-MW25B-SS5.0.

[d] Semivolatile method blank associated with samples DSA-MW23-SS10.0, DSA-MW6B-SS5.0.

[e] Semivolatile method blank associated with samples DSA-MW16B-SS2.5, DSA-MW16B-SS5.0.

[f] Semivolatile method blank associated with sample DSA-MS53Marine.

[g] Semivolatile method blank associated with samples DSA-MW24-SS2.5, DSA-MW24-SS5.0, DSA-MW24-SS17.0.

[h] Semivolatile method blank associated with samples DSA-MW26-SS2.5, DSA-MW26-SS5.0, DSA-MW26-SS17.0.

[i] Semivolatile method blank associated with samples DSA-SB16CD-11.

acceptable but quantitatively unreliable because of uncertainties in the analytical precision near the limit of detection. Despite the quantitative uncertainties, if one examines the magnitude of these results as shown in Table 4-21, it can be safely concluded that these detected values will not exceed the quantitation limit even when accounting for normal variability.

The last two results (0.90 mg/kg phenol at MW-24A and 1.7 mg/kg PCP at MW-25B) are considered qualitatively and quantitatively acceptable. The significance of these results is discussed in Section 5.3.2.

The only other indication of PCP and TCP in subsurface soils are PCP at 2.5 feet (0.28 mg/kg) and TCP at the surface (0.9 mg/kg) and at 2.5 feet (0.71 mg/kg) below the surface in MW-25B. All of these detected concentrations, however, have been qualified by the laboratory. Further, TCP is not a target compound of Method 8270. The TCP reported here is tentatively identified.

One additional soil boring sample was collected to verify the results found at MW16A. A composite sample from this boring was analyzed by Method 8270. Three of the semivolatile target compounds were detected in this sample (Table 4-21).

One compound is qualified by the laboratory because of probable laboratory contamination. The accuracy of this sample result is suspect because of contamination in the laboratory method blank. The sample quantitation limit has been elevated and the result flagged "UJ." The compound was not detected at a level above this adjusted level.

The second result was qualified as an estimate (flagged "J" by the laboratory) because it was below the quantitation limit but above the instrument detection limit. This result is qualitatively acceptable but quantitatively unreliable because of uncertainties in the analytical precision near the limit of detection.

The last result (24 mg/kg PCP) is qualitatively and quantitatively acceptable. The significance of this result is discussed in Section 5.3.2.

4.3.2.2 MARINE SEDIMENT SAMPLES

Five marine sediment samples and one field duplicate sample were collected in the course of this study. One sample, Station DSA-MS53, was analyzed for Method 8270 semivolatile organic compounds as a performance check of the 8040 Method and as a screen for additional organic compounds. The results of this analysis are presented in Table 4-21.

Eighteen of the 65 semivolatile compounds were detected in the marine sample. These are presented in Table 4-21.

Two of the 18 detected compounds are qualified because of probable laboratory contamination. The accuracy of these sample results is suspect because of contamination in the method blanks. The sample quantitation limits have been elevated for these compounds; the results should not be considered detected above the flagged levels. Thirteen of the remaining detected compounds are qualified (flagged with the letter "J") as estimates because they are below the quantitation limit but are above the instrument detection limit. These compounds are qualitatively acceptable but quantitatively unreliable because of uncertainties in the analytical precision near the detection limit.

The remaining three detected compounds, (phenanthrene 0.56 mg/kg, fluoranthrene, 0.58 mg/kg, and pyrene 0.57 mg/kg in DS-MS53) are above the quantitation limit and are considered qualitatively and quantitatively acceptable. The significance of these results are discussed in Section 5.3.2.

4.3.2.3 VERIFICATION SOILS

No verification samples were analyzed for semivolatile analysis using Method 8270.

4.4 APPENDIX IX PARAMETERS

Only one soil sample (Boring 28, Sample No. DSA B28) was analyzed for Appendix IX parameters. Boring 28 was collected in the vicinity of the old planer mill where a fire occurred in 1971.

A summary of the Appendix IX analysis is as follows:

- No volatile chemicals (out of a total of 52 compounds analyzed) were detected.
- No semivolatile chemicals (out of a total 112 compounds analyzed) were detected.
- No organochlorine pesticides or polychlorinated biphenyl (PCBs) compounds analyzed(out of 30 total) were detected.
- No organochlorine herbicides were detected (out of three total).
- Reactive sulfide was detected at 0.7 mg/kg.
- No cyanide was detected.

The following metals (total) were detected:

Arsenic	3.4 mg/kg
Barium	12.0 mg/kg
Beryllium	0.2 mg/kg
Chromium	16.0 mg/kg
Cobalt	6.0 mg/kg
Lead	5.1 mg/kg
Nickel	16.0 mg/kg
Vanadium	34.0 mg/kg
Zinc	36.0 mg/kg

These metal concentrations are within the range naturally occuring in soil (see Section 5.3.4).

4.5 MERCURY ANALYSIS (METHOD 7470 and 7471)

Table 4-19 presents all detected mercury results in subsurface soils. Twenty-nine soil boring samples were tested for mercury. Of these 29, nine soils were identified by the CSL as having detectable concentrations of mercury (three samples from MW-6B, two samples from MW-23, two samples from MW-24A, one sample from MW-24B, and one sample from MW-25B.) These concentrations are within the range naturally occuring in soil (see Section 5.3.3).

4.6 GROUNDWATER RESULTS

4.6.1 METHOD 8040--PCP/TCP

The Close Support Laboratory (CSL) used Method 8040 to analyze 44 groundwater samples collected during two to three sampling events between August and October 1988. Table 4-19 presents all Method 8040 groundwater results. Method 8270 semivolatile performance check results for PCP are also listed in Table 4-19 for comparison. Pentachlorophenol (PCP) was detected in 14 groundwater samples using the 8040 method. PCP was not detected in background wells MW-5 and MW-26. One detected groundwater result, 0.51 mg/l (MW-6A, Round Two), was flagged by the CSL as quantitatively suspect. The remaining 13 samples are considered qualitatively and quantitatively acceptable. The 13 reported results are as follows:

MW-6A:	Sampling Round One (3.07 mg/l); and Three (2.13 mg/l)
MW-6C:	Round One (14.3 mg/l), Two (0.27 mg/l) and Three (0.16 mg/l)
MW-8A:	Round One (0.005 mg/l)

MW-15: Round One (0.009 mg/l)

MW-16A: Round One (0.052 mg/l) and Three (0.064 mg/l)

MW-18: Round One (0.006 mg/l)

MW-19: Round One (0.015 mg/l)

MW-21: Round One (0.021 mg/l)

MW-22: Round One (0.025 mg/l)

Tetrachlorophenol (TCP) was detected in 12 out of 44 groundwater samples. These results are presented in Table 4-19. Four of the detected values were flagged by the laboratory as quantitatively suspect: MW-6A, Round Three; MW6C, Round One; MW-16A, Round Three; and MW-19, Round 2. Four of the remaining eight detected values: MW-6A, Round Two; MW-16A, Round One and Round Two; and MW-25A, Round One were flagged by the laboratory as qualitatively suspect "N" (i.e., the compound identification is not reliable). Four detected values remain and are considered quantitatively and qualitatively acceptable (MW-6A, Round One (2.8 mg/l); MW6B Round One, (0.10 mg/l) and MW6C, Round Two (10.2 mg/l) and Three (0.04 mg/l).

4.6.2 METHOD 8270 SEMIVOLATILE ORGANIC COMPOUNDS

Table 4-22 presents the Method 8270 groundwater results. A total of six of the 65 semivolatile compounds were detected in one or more of the four total groundwater samples analyzed by Method 8270. Three monitoring wells (MW-6B, MW-6C, and MW16A) were where these organic compounds, 11 total, results occurred.

Four of the 11 results are qualified as estimates due to probable laboratory method blank contamination. The accuracy of these sample results is suspect due to this contamination. Consequently, sample quantitation limits have been elevated for these samples and flagged "UJ"; sample results were not detected above these elevated levels.

Five of the remaining seven results are qualified as estimates because they are below the quantitation limit (flagged as "J" in Table 4-22) but are above the instrument detection limit. They are qualitatively acceptable but quantitatively unreliable due to uncertainties in the analytical precision near the limit of detection.

The last two results [naphthalene (0.77 mg/l) and PCP (6.9 mg/l) both from MW-6C] are above the quantitation limit

Table 4-22
DETECTED HAZARDOUS SUBSTANCE LIST COMPOUNDS[a]
(μg/l)

Water Sample Number	2,4-Dichloro-phenol Result[b]	Naphthalene Result[b]	2,4,5-Trichloro-phenol Result[b]	Pentachloro-phenol Result[b]	Di-n-butyl-phthalate Result[b]	Bis(2-ethylhexyl)-phthalate Result[b]
DSA-MW6B(9/7/88)	10 U	10 U	10 U	50 U	10 U	44 UJ
DSA-MW6B(10/19/88)	20 U	20 U	20 U	100 U	20 U	20 UJ
DSA-MW6C	11 J	77	80 J	6,900	2 J	20 UJ
DSA-MW16A	20 U	2 J	20 U	17 J	20 U	20 UJ
Blank 1[c]	10 U	10 U	10 U	50 U	10 U	9 J
Blank 2[d]	20 U	20 U	20 U	100 U	20 U	9 J

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[a] The other analytes requested were analyzed for but not detected by the laboratory.

[b] U: Parameter analyzed for but not detected above this concentration.
J: Indicates an estimated value. Result is less than the specified detection limit but greater than zero.
UJ: The parameter was analyzed for, but not detected above this limit. Because of contamination and/or analytical deficiencies, adjustment of the sample quantitation limit was necessary.

[c] Semivolatile method blank associated with sample DSA-MW6B(9/7/88).

[d] Semivolatile method blank associated with samples DSA-MW6B(10/19/88), DSA-MW6C, DSA-MW16A.

and are considered qualitatively and quantitatively acceptable. These results are discussed in Section 5.4.3.

4.6.3 Appendix IX Parameters

Four groundwater samples from MW6B, MW6C, MW16B, and MW24A were analyzed for Appendix IX parameters.

A summary of the Appendix IX analyses is as follows:

- All 4 samples and two trip blanks were analyzed for 52 volatile organic compounds. The only detected compound was benzene at 0.0087 mg/l in MW6C. The trip blanks were analyzed only for volatile organics because there is a small possibility of cross contamination of samples packed together during shipping.
- The 4 groundwater samples were analyzed for 112 semivolatile compounds. Only 2,3,4,6-TCP was detected (at 14.0 mg/l) in MW6C.
- No organochlorine pesticides or polychlorinated biphenyls (PCB's) were detected (of the 30 analyzed) in any of the samples.
- No organochlorine herbicides (of the 3 analyzed) were detected in any sample.
- No cyanide was detected in any sample. Sulfide was detected only in the sample from MW6B at 0.05 mg/l.
- Table 4-23 shows the results of the total metal analyses.

Table 4-23
APPENDIX IX METALS DETECTED IN GROUNDWATER
(Concentration in mg/l)

Metal	MW6B	MW6C	MW16B	MW24A
Arsenic	0.04	ND	0.014	ND
Barium	0.12	0.19	0.19	0.016
Chromium	ND	0.02	ND	ND
Copper	ND	0.013	ND	0.008
Lead	ND	0.003	0.022	0.003
Vanadium	ND	0.02	ND	0.01
Zinc	ND	0.05	ND	0.02

ND = Not detected.

5 SIGNIFICANCE OF FINDINGS

Section 5 includes a summary of the current regulatory status of PCP and TCP. Current and proposed regulations and guidelines for pentachlorophenol (PCP) and tetrachlorophenol (TCP) are included in this section pertaining to hazardous waste, surface water, drinking water, and soil. Using these regulations and guidelines, the qualitatively and quantitatively validated results identified in Section 4 are compared and evaluated. A discussion of this evaluation is then presented for soils, marine sediments, and groundwater.

5.1 CURRENT REGULATORY CRITERIA AND GUIDELINES

The following discussion presents the current published criteria and guidelines for PCP and TCP.

5.1.1 RCRA REGULATIONS FOR PCP/TCP

PCP was used at the old planer mill site as a wood preservative; it was not manufactured onsite. This is an important distinction, since Federal RCRA hazardous waste regulations and Washington State Dangerous Waste regulations list PCP wastes derived from the production or manufacturing use of PCP (F021) and discarded unused formulations containing tri-, tetra-, or pentachlorophenol (F027) (40 CFR 261 and WAC 173-303). The use of PCP at the old planer mill is not included in either of these categories and therefore is not a RCRA listed hazardous waste. When the PCP hazardous waste listing regulations were being developed, the preamble in the Federal Register specifically stated that the listing does not include residues from wood preservation: ..."the term 'manufacturing use' does not include residues from the use of chlorophenoxy pesticide formulations, e.g. in wood preservation" (48 FR 14515). The preamble also noted the types of wastes not covered by the regulations including "sludges from wood preserving using pentachlorophenol" (48 FR 14523). Since the promulgation of these regulations, EPA has been investigating whether wastes from wood preservation processes using PCP should be listed as hazardous wastes. EPA has proposed (53 FR 53282, December 30, 1988) listing surface-applied wood preservative formulations containing PCP as hazardous wastes under a new category F033. The proposed health-based water concentration limit for PCP is 1 mg/l; 2,3,4,6-TCP is proposed as 1 mg/kg and 2,4,6-trichlorophenol is proposed as 0.0018 mg/kg.

5.1.2 WATER QUALITY STANDARDS

PCP in surface waters is regulated by the State of Washington Water Quality Standards (WAC 173-201-047). The

Washington State Water Quality Standards for PCP are the same as the federal water quality criteria [EPA, Water Quality Criteria (Gold Book), as revised by Federal Register, December 3, 1986]. The state and federal water quality criteria are presented in Table 5-1. It is important to note that these criteria apply to surface waters, not groundwater.

Tetrachlorophenol is not listed in WAC 173-201-047. There are no published federal water quality criteria for TCP. There is a federal marine chronic lowest observed effect level of 440 µg/l for 2,3,4,6-tetrachlorophenol (EPA, Revised Draft RFI Guidance, Volume 1, Section 8, December 1987). The Revised Draft RFI Guidance states that there are insufficient data to develop marine chronic water quality criteria for TCP.

5.1.3 DRINKING WATER STANDARDS

There are currently no drinking water standards for PCP or TCP. A draft proposed maximum contaminant level goal (MCLG) for PCP is in internal EPA review (U.S. EPA, February 1, 1988, Safe Drinking Water Update). These proposed concentrations are presented in Table 5-1. There are no proposed drinking water standards for TCP.

5.1.4 RCRA FACILITY INVESTIGATION (RFI) CRITERIA

EPA has developed PCP criteria for human ingestion of water and fish, and health-based criteria for systemic toxicants. The health-based criteria are the only criteria that apply to PCP in soil. These values are presented in Table 5-1. These criteria are federal guidelines and are not codified in regulations. No published EPA criteria exist for tetrachlorophenol for human ingestion of water and fish. However, the health-based criteria for systemic toxicants for 2,3,4,6-TCP are the same values as for PCP (EPA, Revised Draft RFI Guidance, Volume 1, Section 8, December 1987).

5.1.5 WASHINGTON STATE PCP CLEANUP CRITERIA

Ecology does not currently have any published cleanup standards for soil or water contaminated with PCP. However, Ecology had previously prepared a draft cleanup goal for soil contaminated with PCP at a specific site. These draft cleanup goals were presented in correspondence from Ecology to McFarland Cascade (November 12, 1987), a wood preserving plant. The proposed levels were not finalized. Ecology based its draft cleanup goal for soil contaminated with PCP on a 1.0 ppb of 2,3,7,8-TCDD toxicity equivalence factor (TEF): "With respect to pentachlorophenol (PCP), the soil cleanup level is set at PCP levels that correspond to 1.0 ppb of 2,3,7,8-TCDD equivalents. This is 10 ppm and is

Table 5-1

Published Criteria and Guidelines on Pentachlorophenol

CRITERIA SOURCE	MEDIA		
	SOIL	WATER	
		Drinking	Marine
Proposed Federal SDWA MCLG[1]	NA	220 μg/l	NA
Federal CWA[2] Water Quality Criteria for Aquatic Life	NA	9 μg/l[3]/5.7 μg/l[3]	13.0 μg/l/7.9 μg/l[8]
Federal CWA Limits for Human Ingestion of Water and Fish[4]	NA	1010 μg/l[5]	NA
Federal Health-Based Criteria for Systemic Toxicants[4]	500 mg/kg[6]	1000 μg/l[7]	NA
WAC 173-201-047 Surface Water Toxic Substances Criteria	NA	9 μg/l[3]/5.7 μg/l[3]	13.0 μg/l/7.9 μg/l[8]

NA = Not applicable

[1] Draft proposed MCLG currently in internal EPA review (US EPA SDWA Fact Sheet 2/88)

[2] EPA, Water Quality Criteria (Gold Book), as revised by Federal Register, December 3, 1986

[3] Acute/chronic values shown are for pH of 7 using $e^{[1.005 (pH) - 4.830]}$ and $e^{[1.005 (pH) - 5.290]}$ as prescribed in 51 FR 43666 and WAC 173-201-047; pH values measured in the field ranged from 6.2 to 8.5

[4] EPA, Revised Draft RFI Guidance, Volume 1, Section 8, December 1987

[5] EPA Revised Draft RFI Guidance implies that entire limit based on water ingestion

[6] Based on 17kg child over a 5 year exposure period ingesting 1.0 gram/day of soil (EPA Revised Draft RFI Guidance, Volume 1, Section 8, December 1987)

[7] Based on 70kg adult over 70 year lifetime exposure at 2 liters/day (EPA Revised Draft RFI Guidance, Volume 1, Section 8, December 1987)

[8] 13.0 μg/l is the acute criteria, 7.9 μg/l is the chronic criteria

10 percent of the dangerous waste level (WAC 173-303-102 and WAC 173-303-9907)." (Ecology, November 1987)

The 1.0 ppb 2,3,7,8-TCDD TEF is not a written criterion or a codified regulation. Since Ecology developed this draft criterion, EPA has re-examined the hazard identification and dose-response assessment for the potential human carcinogenicity of 2,3,7,8-TCDD. A draft report (EPA/600/6-88/007Aa) has been prepared that concludes the following as stated in 53 FR 24141:

> "The draft report concludes that (1) the 1985 assessment that associates a 0.006 pg/kg/day (picogram/kilogram/day) dose with a plausible upper bound increased cancer risk of one in a million should be reconsidered, and (2) a change to a 0.1 pg/kg/day dose as a plausible upper bound associated with an increased lifetime risk of one in a million is consistent with the available data and theories, and represents a reasonable science policy position for the Agency."

The information proposed by EPA suggests a lower health risk associated with 2,3,7,8-TCDD. The above conclusion represents a 17-fold increase in dosage (0.006 x 17 = 0.1). Using the increased dosage, Ecology's cleanup level would proportionately increase to 17.0 ppb 2,3,7,8-TCDD TEF (if this cleanup level were going to be used). Consequently, pentachlorophenol cleanup levels would increase to approximately 170 ppm.

The only other known cleanup policy established by Ecology is not contaminant-specific. Ecology developed this cleanup policy, titled Final Cleanup Policy-Technical, with an effective date of July 10, 1984. The standard/background cleanup levels established in this policy are as follows:

1. Soil
   a. 10X the appropriate drinking water or water quality standard, or
   b. If no standard exists, 10X water quality background
   c. If water quality background is not detectable, soil background
2. Groundwater and Surface Water
   a. Appropriate drinking water or ambient water quality standard

   b. If no standard exists, background

Ecology's Final Cleanup Policy also provides protection levels that may be used after the Preliminary Technical Assessment shows that Standard/Background Levels are not achievable or appropriate for the site. These protection levels are as follows:

1. Soil Protection Level--Threat to Water

   a. 100X the appropriate water quality standard, or

   b. 100X water quality background, or

   c. 10X soil background, or

   d. Defined based on site-specific contaminant and soil characteristics, leaching tests, biologic tests, etc. If sufficient data are available, predictive models may be used to define the protection levels.

5.1.6 OTHER PCP CRITERIA

The RCRA Extraction Procedure (EP) Toxicity Test for hazardous waste does not include criteria for PCP or TCP (WAC 173-303-090). EPA has proposed another extraction method known as the toxicity characteristic leaching procedure (TCLP) which does include criteria for PCP and TCP; however, the TCLP regulations are only in draft form (51 FR 21685 supplemented by 53 FR 18024). These proposed limits are based upon analytical procedures in which solubilized chemical constituents released from a soil or waste in a water extract are compared against designation limits based on risk factors at a municipal solid waste landfill. For the TCLP procedure, 1 gram of soil is extracted with 20 grams of fluid, then the fluid is filtered off and analyzed. To be considered a toxic waste, the extract must have a PCP or 2,3,4,6-TCP level of 3.6 mg/l or higher. The TCLP regulations are due to be published as final regulations in 1989 (RCRA Hotline, M. Stevens, personal communication, 11/29/88).

For illustrative purposes, a worst case can be assumed (all PCP and TCP present in the soil would leach out) in order to assess whether TCLP levels for PCP and TCP would be exceeded. For example, one gram of soil with a PCP concentration of 20 mg/kg would, when totally solubilized in 200 milliliters of water, results in a worst case concentration of 1.0 mg/l in the extract.

Ecology is currently in the process of developing Sediment Quality Standards (WAC 173-204), which will be based on chronic marine biological test data for Puget Sound marine organisms. PCP is an organic chemical proposed to be included in the sediment standards when they are complete (estimated completion date is late 1989) (B. Betts, Ecology, personal communication, 12/88).

The most recent apparent biological effects threshold (AET) for Puget Sound organisms includes 0.36 mg/kg-amphipod toxicity, 0.69 mg/kg-benthic toxicity, and >0.14 mg/kg for oyster larvae toxicity and microtox testing (the latter represents the highest level tested to date in which there are no reported effects) (B. Barrick, PTI Environmental Services, personal communication 12/88). These reported AETs are not sediment criteria but represent measured effects data only.

5.2 ANALYSIS OF SAMPLES CONTAINING LOW LEVELS OF CONTAMINATION

As can be seen in Sections 4.3 (Soil Results) and 4.4 (Groundwater Results), most compounds detected in this study were at low concentrations at or very near the testing laboratory's method detection limit for both Method 8040 (PCP and TCP) and Method 8270 (Semivolatile Organic Compounds).

When samples containing low levels of contamination are analyzed, seemingly contradictory results are often obtained. One analysis of a sample may yield one estimated concentration while another analysis of the same or similar sample may yield a different concentration estimate. Yet a third analysis may indicate that the contaminant is undetectable.

All measurements have some variability. For a complex measuring system such as a gas chromatograph, used in this study, and with multiple sample extraction and cleanup processing steps, there is inherent variability in determining a true concentration for a soil or water sample.

In order for a laboratory result to confirm the presence of contamination in a sample, it is generally accepted that the value of the reported concentration should be significantly greater than any value reported in background samples or the laboratory method blank. Further, EPA believes that establishing a practical quantitation limit (PQL) of an analytical method detection limit is important in order to establish the lowest concentration at which acceptable precision and accuracy can be reliably maintained by laboratories practicing acceptable standard procedures. EPA, therefore, has reported it believes that setting PQLs in a range between 5 and 10 times the method detection limit is a fair expectation (50 FR 16306).

For some compounds such as phthalate esters, which are commonly found in laboratory method blanks, EPA has raised the

PQLs to even higher levels. Because phthalate esters are commonplace in the environment, their presence in any sample is not unusual. Phthalates are used as plasticizers and as a common intermediate and primary ingredient in finished plastic products (e.g., plastic bags, litter, protective laboratory gloves). Furthermore, recent evidence suggests that these compounds may occur naturally in the environment (Versar, Inc., 1974). The EPA guidance document "Laboratory Data Validation, Functional Guidelines for Evaluating Organic Analysis" states that if certain compounds including phthalate esters are found in a matrix at concentrations less than ten times the method blank, the compounds are not to be reported (EPA, 1988).

Any concentration estimate less than the instrument detection limit is regarded as being an uncontaminated sample. This estimate would then be classified as a nondetect. In our study, the Method 8040 results indicate this by designating a nondetect as a given value, i.e., ≤1.0 ppm. Method 8270 flags the concentration with the letter "U." The U means that the parameter was analyzed but was not detected above the specified concentration.

A sample for which the true concentration is the same as the method detection limit will have almost no chance of being mistaken for a noncontaminated sample, using the PQL as the criterion for reporting contamination. This is the minimum concentration in a sample that would almost certainly be classified as a positive detect when analyzed. Finally, the nature of the media undergoing analysis is also an important consideration when establishing PQLs.

For example, EPA has used the level of 10 times the method detection limit as the PQL for water samples for Method 8040. This limit has been established as the level of concern for compounds that are generally found at low or nondetectable concentrations (SW-846, 9/86).

The PQL for Method 8040 soils, however, is much greater: 670 times the method detection limit for low-level contamination (SW-846 page 8040-2 9/86). This is due to the complexities of the soil matrix as compared to water.

Thus the PQLs reflect not only the uncertainties inherent in the measurement process but also the additional uncertainties that derive from the more complex media being analyzed (e.g., heterogeneity of soils, soil particle size and characteristics, other chemicals).

Using the information from this discussion, all detected results from the focused site investigation are compared and discussed in the following sections.

5.3 SOILS AND MARINE SEDIMENT ANALYTICAL RESULTS

Using the regulations and guidelines discussed earlier, the validated soil and sediment results are evaluated in the following sections.

5.3.1 METHOD 8040--PCP AND TCP RESULTS

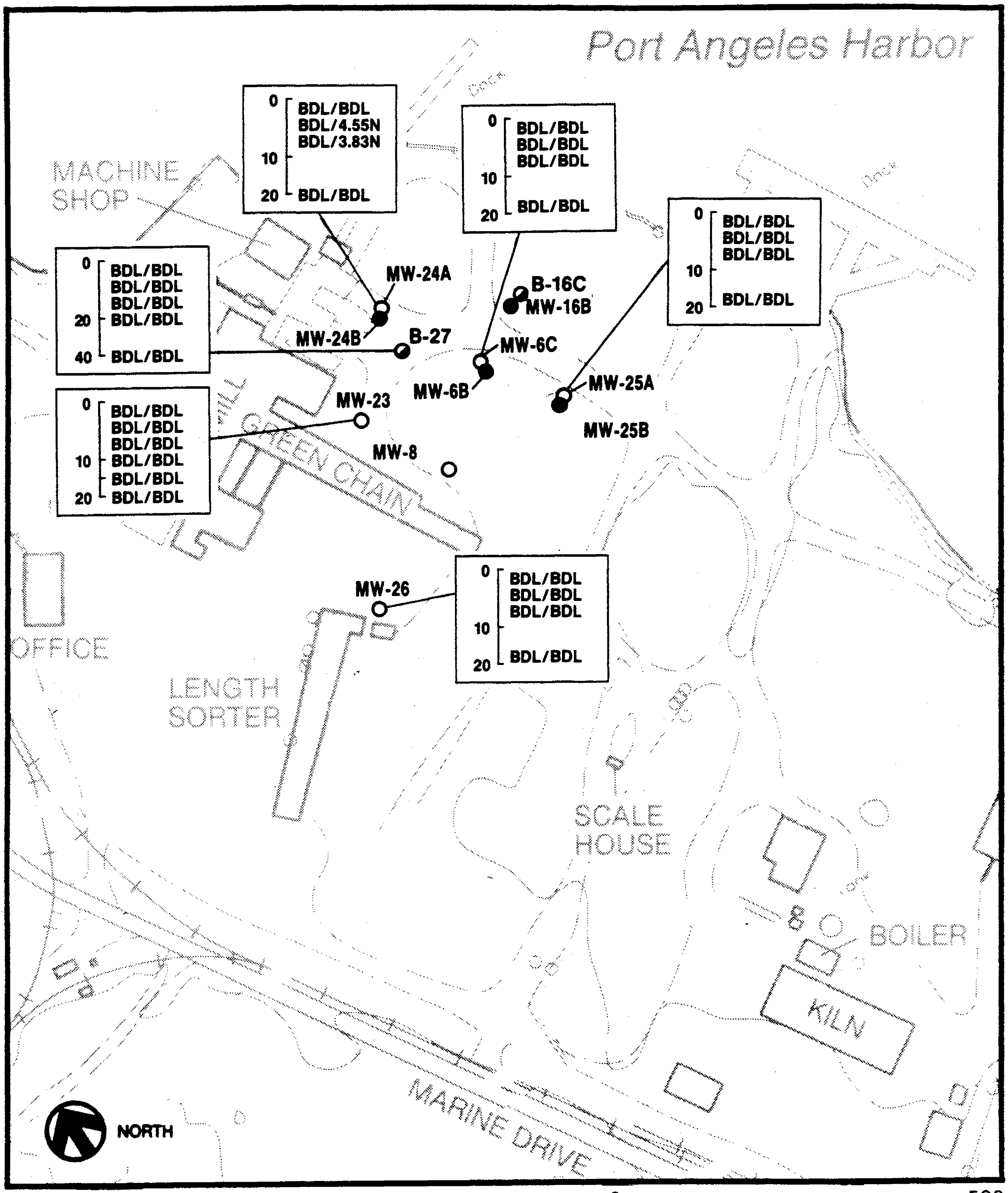
Table 4-20 presents a summary of all the PCP and TCP results detected by Method 8040 in soils and sediments collected during this study. All Method 8040 soil and sediment results are reported on a dry-weight basis.

5.3.1.1 Subsurface Soil Samples

Figure 5-1 illustrates the Method 8040 results for soil samples collected from boreholes drilled to install shallow monitoring wells. Figure 5-2 presents the results for soil samples collected from the boreholes drilled to install deep wells.

PCP was detected in only two (MW-24B, 7.5 ft and 35.0 ft) of the 60 soil samples analyzed by Method 8040. Using the convention presented in Section 5.2 that the PQL is 5 to 10 times the laboratory detection limit as a guideline, it appears that the concentration of PCP in soils collected from MW-24B is not significant. Both of the results (2.8 mg/kg and 2.22 mg/kg, respectively) in soil samples collected from MW-24B are less than three times the laboratory detection limit (DL) of 1.0 mg/kg for Method 8040. Both of these values were also qualified by the laboratory as suspect values. The 7.5-foot sample is quantitatively suspect (i.e., PCP is present but the exact amount reported is not reliable). The 35.0-foot sample is qualitatively suspect (i.e., the detected compound is only tentatively identified as PCP). Neither PCP concentration reported in samples collected from MW-24B would exceed the federal health-based criterion of 500 mg/kg for systemic toxicants (EPA, Revised Draft RFI Guidance, 1987). These PCP concentrations in soils are relatively low. For comparison, the average PCP concentration measured in urban Bellevue, Washington, residential street dust samples was 1.8 mg/kg with a reported standard deviation of ±2.3 mg/kg (Metro, Toxicants in Urban Runoff, 12/82).

Finally, PCP soil concentrations in samples collected from boreholes drilled by Hart Crowser were compiled and plotted (Figure 5-3). PCP ranged from a low of below detection at monitoring wells MW-8 and MW-22 to a high of 34.0 mg/kg from subsurface soils sampled at MW-16A. During the course of their study, Hart Crowser used two analytical methods, neither of which is recommended by EPA for the analysis of PCP. The first was a modified Method 8150, and the second was a

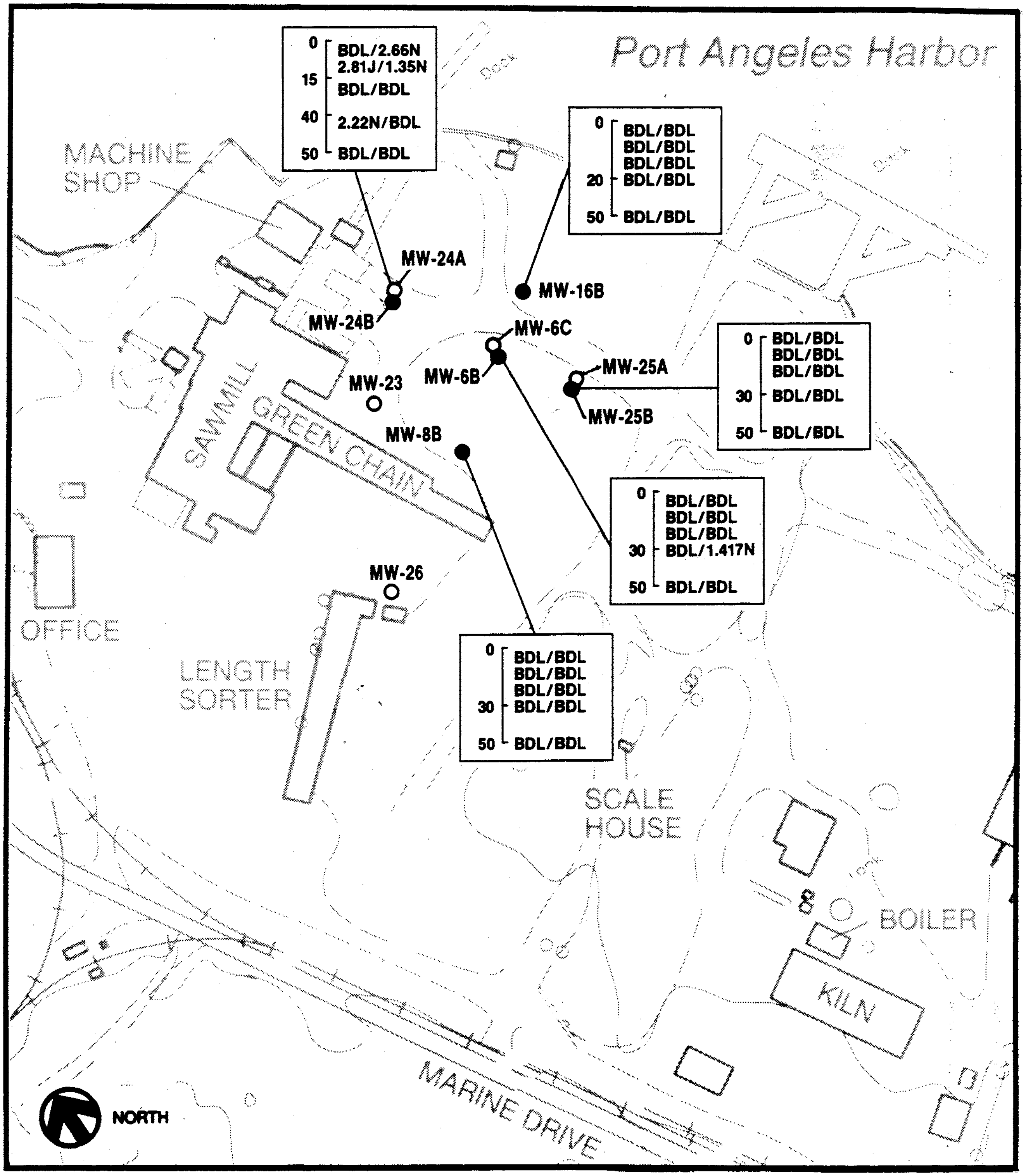


0 500
Scale in Feet

LEGEND

○	Shallow Wells Installed by CH2M HILL
●	Deep Wells Installed by CH2M HILL
◐	Borings Installed by CH2M HILL
0 10 20	Vertical Bar Represents Depth Below Ground Surface in Feet. Analytical Results (PCP/TCP) are Referenced to Approximate Depth.
BDL	Below Detection Limit
N	Qualitatively Suspected Compound

FIGURE 5-1
CH2M HILL Wells Pentachlorophenol and Tetrachlorophenol Analytical Results for Soil (mg/kg) Shallow Wells — CH2M HILL Results

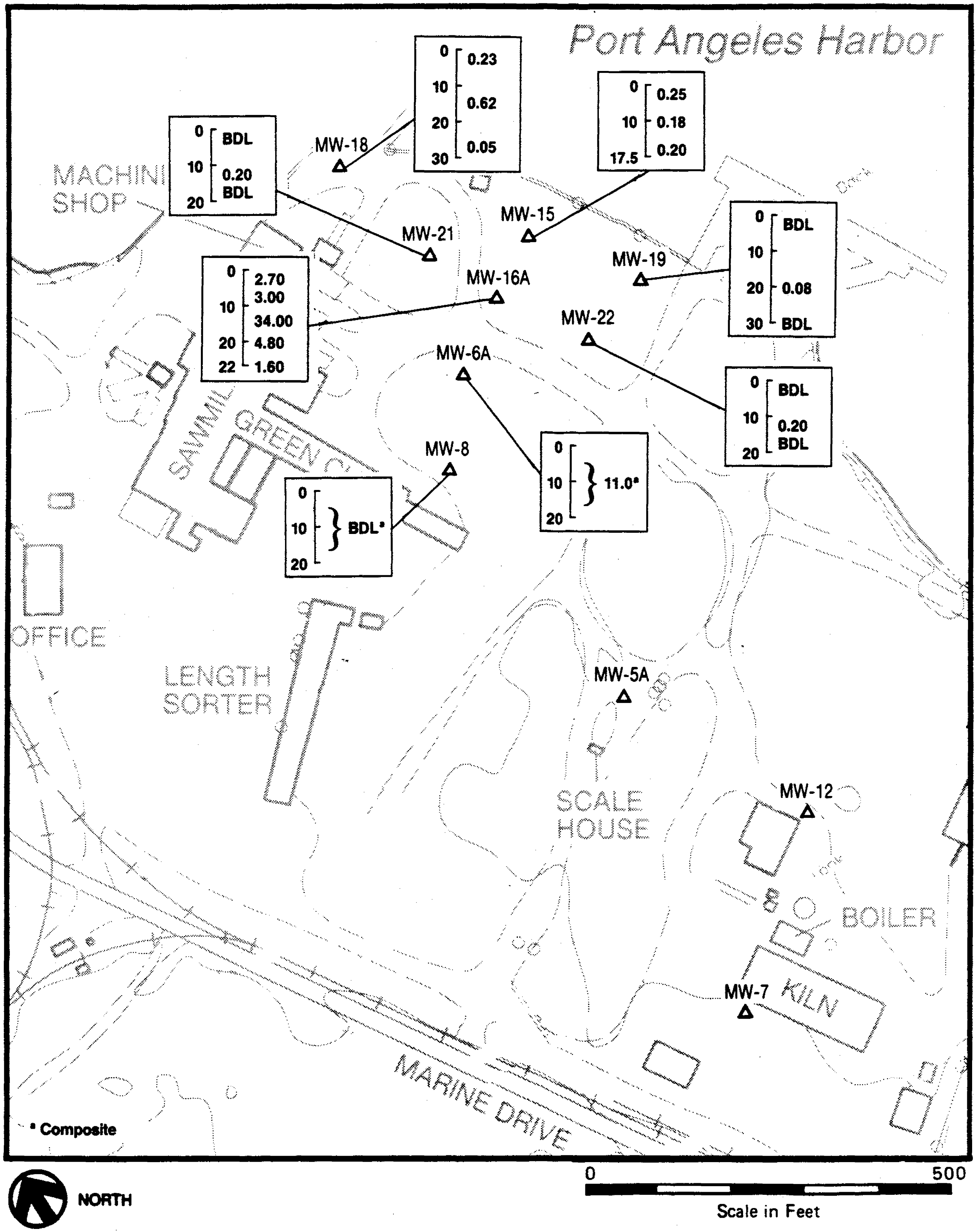


LEGEND

○	Shallow Wells Installed by CH2M HILL
●	Deep Wells Installed by CH2M HILL
0 10 20	Vertical Bar Represents Depth Below Ground Surface in Feet. Analytical Results (PCP/TCP) are Referenced to Approximate Depth.
BDL	Below Detection Limit
N	Qualitatively Suspected Compound
J	Quantitatively Suspected Results

FIGURE 5-2

CH2M HILL Wells Pentachlorophenol and Tetrachlorophenol Analytical Results for Soil (mg/kg) Deep Wells — CH2M HILL Results



LEGEND

△	Shallow Wells Installed by Hart Crowser
0 10 20	Vertical Bar Represents Depth Below Ground Surface in Feet. Analytical Results (PCP) are Referenced to Approximate Depth.
BDL	Below Detection Limit
a	Composite Sample

FIGURE 5-3

Hart Crowser Wells Pentachlorophenol Analytical Results for Soil (mg/kg) Hart Crowser Results

field gas chromatography method using an electron capture detector. Standard laboratory quality control/quality assurance procedures are not available for either method. Both methods, while providing useful qualitative data, should not be relied on for quantitative accuracy. The purpose of the Hart Crowser evaluation was to perform a property transfer audit and not a detailed site inspection for PCP contamination.

In general, the concentrations of PCP reported by Hart Crowser fall within the same order of magnitude as results detected during this investigation. Based on both studies, it appears that PCP is randomly dispersed in soils throughout the focused study area. None of the reported concentrations, however, exceed EPA's health-based criterion for soils (500 mg/kg).

Table 4-20 presents all reported TCP results detected in this study for soils and sediments. Figures 5-1 and 5-2 illustrate these results for shallow and deep monitoring wells, respectively.

Method 8040 identified TCP at 6.2 mg/kg in a composite soil sample (9 to 14 feet) collected from MW-16C. The field duplicate result of this sample (MW-16CD) was comparable (6.1 mg/kg). Both values are less than five times the detection limit and therefore are not significant. TCP was reported in the equipment blank (0.009 mg/l), suggesting the possibility of contamination by field procedures.

Method 8040 identified TCP in two soil samples from MW-24A (4.55 mg/kg at 5.0 feet and 3.83 mg/kg at 7.5 feet). These values, however, were flagged by the laboratory as being qualitatively suspect (i.e., tentatively identified compounds). The concentrations reported fall within 3 to 4 times the detection limit and are below significant levels.

Two additional monitoring wells, MW-6B and MW-24B, yielded three soil samples in which TCP was detected; MW-6B (1.4 mg/kg at 30 feet); MW-24B (2.66 mg/kg at 2.5 feet); and MW-24B (1.35 mg/kg at 7.5 feet). All three results are also flagged by the laboratory for qualitative reasons, are less than three times the detection limit, and therefore are not significant. No TCP value detected exceeds the health-based criterion of 500 mg/kg for systemic toxicants (2,3,4,6-TCP).

It is not surprising to report the presence of PCP and TCP in soils at the site, particularly when one considers that historical land use included activities such as lumber sapstain control with PCP and TCP. One would anticipate the presence of wood waste and debris throughout the focused site investigation area that could have originated from the green chain wood treatment area. The entire M&R property is composed of artificial fill material, a significant component of which is wood waste, as can be seen in geologic logs (Appendix C) and site photographs (Appendix B). Furthermore, the practice of log sorting and storage on the site is accomplished by heavy equipment which conceivably can disperse wood debris widely throughout the entire property.

Other considerations concerning the occurrence of PCP (and TCP) in soils may include natural background sources. Detectable levels of PCP have been reported in untreated Ponderosa pine and Douglas fir wood samples using either a GC method similar to Method 8040 or a GC/MS method similar to Method 8270 (Arsenault, 1976).

Compounds that are similar to PCP and TCP in chemical structure and molecular weight will respond in a like manner when analyzed using GC methods. It is possible to mistake these compounds for PCP (Arsenault, 1976) resulting in false detections when no PCP is present, or higher reported concentrations when these other compounds are quantified with any PCP that is truly present. This shortcoming is inherent in the GC technique, although it is an EPA-approved method for phenols. Many of these problems are avoided using the GC/MS method for analysis. However, laboratory turnaround time is longer.

5.3.1.2 Marine Sediment Samples

Table 4-20 summarizes the PCP detected in marine sediments by Method 8040. TCP was not reported in any marine sediment using this analytical method. PCP was detected at two stations: DS-MS-03 (4.7 mg/kg) and DS-MS-05 (6.4 mg/kg). (See Figure 3-3 for the locations of these stations.) Both of these results are flagged by the laboratory as being quantitatively suspect. In fact, DS-MS-03 is at the adjusted method detection limit, and DS-MS-05 is less than three times the method detection limit (after moisture content is taken into account) of 2.7 mg/kg dry weight.

It is important to note that the method detection limit (1.0 mg/kg) used in the Method 8040 analysis is based on the wet weight (as received) basis, and all sediments received are analyzed according to that detection limit. When the laboratory adjusts the results to a dry weight basis, there will be an increase in both the apparent concentration level of the sample and the method detection limit (e.g., DS-MS-03, 1.0 mg/kg; DS-MS-05, 2.4 mg/kg). However, dry weight concentrations are preferred for reporting soil or sediment results since the result is the most uniform; it eliminates moisture content as a variable.

No reported value exceeds the federal health-based criterion for PCP in soils as a systemic toxicant (500 mg/kg). The most recent reported apparent biological effects for PCP in Puget Sound sediments range from >0.14 mg/kg to 0.69 mg/kg dry weight, depending on the organism listed (B. Barrich, PTI, personal communication, 12/88). The reported AET levels are based on a recommended analytical method with detection limits that are lower than can be achieved by the EPA Method 8040 used for this study.

Since the two reported results are near or at the method detection limit, it is not possible to further evaluate these results relative to the AETs discussed above. It is important to note, however, that these AETs are not regulatory standards but measures of biological responses.

5.3.1.3 Verification Study Soil Samples

PCP was not detected in any soil sample collected for the verification study (see the technical memorandum provided as an addendum to this report for a discussion on verification study samples). TCP was reported in sample number VI-SS-200 at 2.2 mg/kg, collected in the vicinity of the truck maintenance shop (see Figure 3-3). The presence of TCP in this soil sample is not believed to be from direct chemical application as there is no record of wood treatment occurring in this area. It is reasonable to assume that the TCP found in soil near the maintenance shop may have originated as TCP, or TCP-contaminated soil, that was either washed or dropped from a truck brought to the site for maintenance. The detected value (2.2 mg/kg) is less than three times the method detection limit and it is well below the 500 mg/kg health-based criterion established by EPA.

5.3.2 SOIL RESULTS--METHOD 8270, SEMIVOLATILE ORGANIC COMPOUNDS

Table 4-21 presents all Method 8270 results for subsurface soils and sediments. All Method 8270 results are presented on a wet-weight basis. The PCP results for Method 8270 also are in Table 4-19 to facilitate comparison to Method 8040 results.

5.3.2.1 Subsurface Soil Results

PCP was detected at 1.7 mg/kg in a soil sample collected from a depth of 0.0 to 2.5 feet at MW-25B. This same sample was below the detection limit using Method 8040. The Method 8270 concentration is only slightly greater than the EPA practical quantitative level (PQL) of 1.6 mg/kg. The reported values are comparable to the levels of PCP detected in residential street sweeping debris (Metro, Toxicant Program, 12/82) as discussed in Section 5.3.1.1.

PCP was also detected in the composite sample SB-16CD-11 at 24 mg/kg. A separate composite sample analyzed in duplicate by Method 8040 had no detected PCP. It is possible that in compositing the samples one portion may have contained treated wood fragments that are found throughout the fill material.

TCP was tentatively identified in MW-25B at the surface (0.71 mg/kg) and at 2.5 feet below ground surface (0.19 mg/kg), and in soil boring SB-16CD-11 (27 mg/kg). TCP was only "tentatively" identified because Method 8270 does not include TCP as a target compound. Therefore, there is no detection limit or PQL that can be used for comparison. However, the detected levels are substantially less than the federal health-based criterion of 500 mg/kg for 2,3,4,6-TCP.

The 2,4,5-trichlorophenol was detected in soil boring SB-16CD-11 at an estimated concentration of 2.3 mg/kg, which is below the PQL. This isomer is not a constituent of concern in PCP formulations, and is not one that EPA has listed in the proposed regulations due to health effects (53 FR 53295).

All phthalate esters detected in soil samples were also detected in the laboratory blanks. Using EPA's guidelines, none of these phthalate esters would be reported because they are not greater than ten times the level found in the associated blanks.

Several PAH compounds (fluorene, 0.11 mg/kg; phenanthrene, 0.04 mg/kg and 0.47 mg/kg; flouranthene, 0.043 mg/kg and 0.18 mg/kg; and pyrene, 0.054 mg/kg and 0.14 mg/kg) were detected in soil samples collected from MW-24A and MW-25B. All PAH concentrations were below the PQL. All detected values occurred in samples collected from 2.5 ft or less below the ground surface. In addition, all of the detected PAH values are less than the lowest AET documented (Tetra Tech, 8/86).

4-Methylphenol was detected in one soil sample collected from MW-16B (0.12 mg/kg at 2.5 ft) at one-third the PQL. Phenol was detected in one MW-24A sample (0.9 mg/kg at 2.5 ft). The phenol is less than 1.5 times the PQL. No other compounds from the Method 8270 parameter list were detected in any soil sample.

There are no criteria, guidelines, or regulations for 4-methylphenol. The range of AETs for this compound is 0.067 to 1.2 mg/kg. Phenol has a health-based criterion of 700 mg/kg and an AET range from 0.042 to 1.2 mg/kg. While the detected value occurs within the reported AET range, the value is three orders of magnitude below the health-based criteria.

The occurrence of all of these semivolatile organic compounds on or near the surface is not surprising. The fact that these compounds were not reported from any lower depths suggests their presence does not extend to subsurface soils. It is likely the compounds originate from onsite structures or possibly from creosote-treated wood that may have been used as fill material. (Creosote was not used at this site as a wood preservative.)

Another possible explanation for the occurrence of PAH compounds such as these, with small-ringed structures, is that they may be by-products of past fires or fill material that was burned. The proximity of these sample locations to the building that burned in 1971 supports this possibility. The site has a history of controlled burning for demolition (see Section 2.3).

The presence of phenol may also be from natural sources including the timber stored on the property. Phenols have been reported to occur naturally in leaves and other woody materials at concentrations similar to that reported in MW-24A (Arsenault, 1976).

5.3.2.2 Marine Sediment Samples

The Method 8270 analysis of sediment sample DS-MS-53 did not detect the presence of PCP. Method 8270 did not detect any compounds that would be tentatively identified as TCP.

Phthalate esters were detected in sediment sample DS-MS-53 (Di-n-butylphthalate at 0.16 mg/kg; and bis(2-ethylhexyl)-phthalate at 0.18 mg/kg). Using EPA's guidelines, these levels of phthalate esters would not be reportable because they are not greater than ten times the contamination reported in the laboratory method blank (0.098 mg/kg and 0.11 mg/kg for di-n-butyl-phthalate and bis(2-ethylhexyl) phthalate, respectively).

Fifteen PAHs were detected in sample DS-MS-53 by Method 8270. These compounds are listed with their respective concentrations in Table 4-21. All of the PAH compounds are consistent with those found in creosote mixtures used to treat wood products. The concentrations for 12 of the compounds fall between the laboratory method detection limit and the PQL. For all of the PAHs for which there are AETs, none of the detected values from sample DS-MS-53 exceed the lowest apparent effects threshold. It is likely that the source of these compounds is creosoted bulkheads, piers, and other treated marine timber surrounding the sample area (see Appendix B for photographs of these structures).

Finally, benzoic acid was the only other semivolatile organic compound from the Method 8270 target list detected in sample DS-MS-53 at 0.096 mg/kg. The concentration is far below the PQL and AET.

5.3.2.3 Verification Study Soil Samples

No Method 8270 analyses were performed on soil samples collected for the verification study.

5.3.3 SOIL RESULTS, MERCURY ANALYSIS

Twenty-nine subsurface soil samples were analyzed for the presence of mercury. Mercury was detected in nine of the samples at concentrations greater than the detection limit (0.03 to 0.05 mg/kg), with a concentration range of 0.048 mg/kg to 0.286 mg/kg. Mercury occurs naturally in soil with a common range of 0.01 mg/kg to 0.3 mg/kg (Lindsay, 1979). All the results are within this naturally occurring range. There are no criteria for mercury in soils (USEPA, RCRA Hotline, K. Mitchell personal communication, 12/88). In fact, the proposed TCLP trigger concentration for mercury hazardous waste designation is 0.2 mg/l (51 FR 21685, 6/13/86). (The TCLP measures the concentration of a compound or element that can be leached from a soil or other solid using a slightly acidic solution.) Considering the 20:1 dilution factor used in the TCLP (see Section 5.1.6), none of the soil samples analyzed for mercury would exceed the TCLP trigger level.

5.3.4 SUBSURFACE SOILS, APPENDIX IX RESULTS

Only metals (total) and sulfide were found in the soil sample collected near the old planer mill and fire location and analyzed for 40 CFR 264 Appendix IX constituents. Table 5-2 presents values for the detected metal results compared with available regulatory standards [EP-Toxicity, TCLP, and health-based criteria for carcinogens (arsenic only) and systemic toxicants]. Table 5-2 also presents the normal range of the detected metals and the average elemental values found in soils and in the lithosphere (Lindsay, 1979). As can be seen in Table 5-2, no detected metal value exceeds natural soil conditions, would exceed EP toxicity trigger levels when dilution factors are considered, or poses health risks, based on EPA's criteria.

5.4 DISCUSSION OF GROUNDWATER RESULTS

Using the regulations and guidelines discussed in Section 5.1, the validated groundwater results are evaluated.

Table 5-2
METALS DETECTED BY 40 CFR APPENDIX IX SOIL ANALYSIS AND PUBLISHED CRITERIA AND GUIDELINES
(concentrations in mg/kg)

Analyte	Reported Level	Naturally Occurring Range in Soils[b]	Average Natural Range[b]	EP Toxicity Levels[c]	TCLP Levels[d]	Health-Based Criteria[e] Carcinogens	Health-Based Criteria[e] Systemic Toxicants
Arsenic	3.4	1-500	5	5.0	5.0	0.022	NL
Barium	12.0	100-3,000	430	100	100	NL	900
Beryllium	0.2	0.1-40	6	NL	NL	NL	900
Chromium	16.0	1-1,000	100	5.0	5.0	NL	f
Cobalt	6.0	1-40	8	NL	NL	NL	NL
Copper	26.0	2-100	30	NL	NL	NL	g
Lead	5.1	2-200	10	5.0	5.0	NL	NL
Nickel	16.0	5-500	40	NL	NL	NL	300
Vanadium	34.0	20-500	100	NL	NL	NL	h
Zinc	36.0	10-300	50	NL	NL	NL	i

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[a] From Appendix IX analysis of MW-B28.

[b] Lindsay, <u>Chemical Equilibrium in Soils</u>, Table 1.1, pages 7 and 8.

[c] 40 <u>CFR</u> Part 261.24.

[d] 51 FR 21685.

[e] EPA, Revised Draft RFI Guidance, Vol. 1, Section 8, December 1987.

[f] Chromium (III) criterion is 20,000 mg/kg and Chromium (VI) criterion is 90 mg/kg. Value is for total chromium present and oxidation states are not known.

[g] Copper cyanide is the only copper entry in the regulations with a value of 1,000 mg/kg. This analysis was for total copper present so no information on possible compounds is available. Cyanide was analyzed for and not detected in the sample.

[h] Vanadium pentoxide at 300 mg/kg is the only vandium compound listed. Analysis was for total vandium and no information on the possible compounds are available.

[i] Two zinc compounds are listed: zinc cyanide at 5 mg/kg and zinc phosphide at 900 mg/kg. No information on compounds present is available since the analysis was for total zinc.

NL = Not listed.

5.4.1 METHOD 8040 RESULTS--PCP

Table 5-3 summarizes the Method 8040 results for groundwater. No PCP was reported in background wells (MW-26 and MW-5A), nor was PCP detected in any deep well (Figures 5-4 and 5-5). (Figures 5-4 through 5-6 illustrate all Method 8040 results by sampling event and by monitoring well.)

PCP was found in 14 out of 44 groundwater samples analyzed by Method 8040. These 14 samples were collected from nine shallow monitoring wells. The nine monitoring wells and the concentrations of PCP in groundwater samples are presented in Table 5-3.

Table 5-3
METHOD 8040 PCP GROUNDWATER RESULTS SUMMARY

Monitoring Well	Company	Concentration (mg/l) Round 1	Round 2	Additional Analysis
6A	HC	3.07	0.51J	2.13
6C	CH2M HILL	14.3[a]	0.27[a]	0.16
8	HC	0.005[b]	BDL	Not sampled
15	HC	0.009	BDL	Not sampled
16A	HC	0.052	BDL	0.064
18	HC	0.006	BDL	Not sampled
19	HC	0.015	BDL	Not sampled
21	HC	0.021	BDL	Not sampled
22	HC	0.025	BDL	Not sampled

---

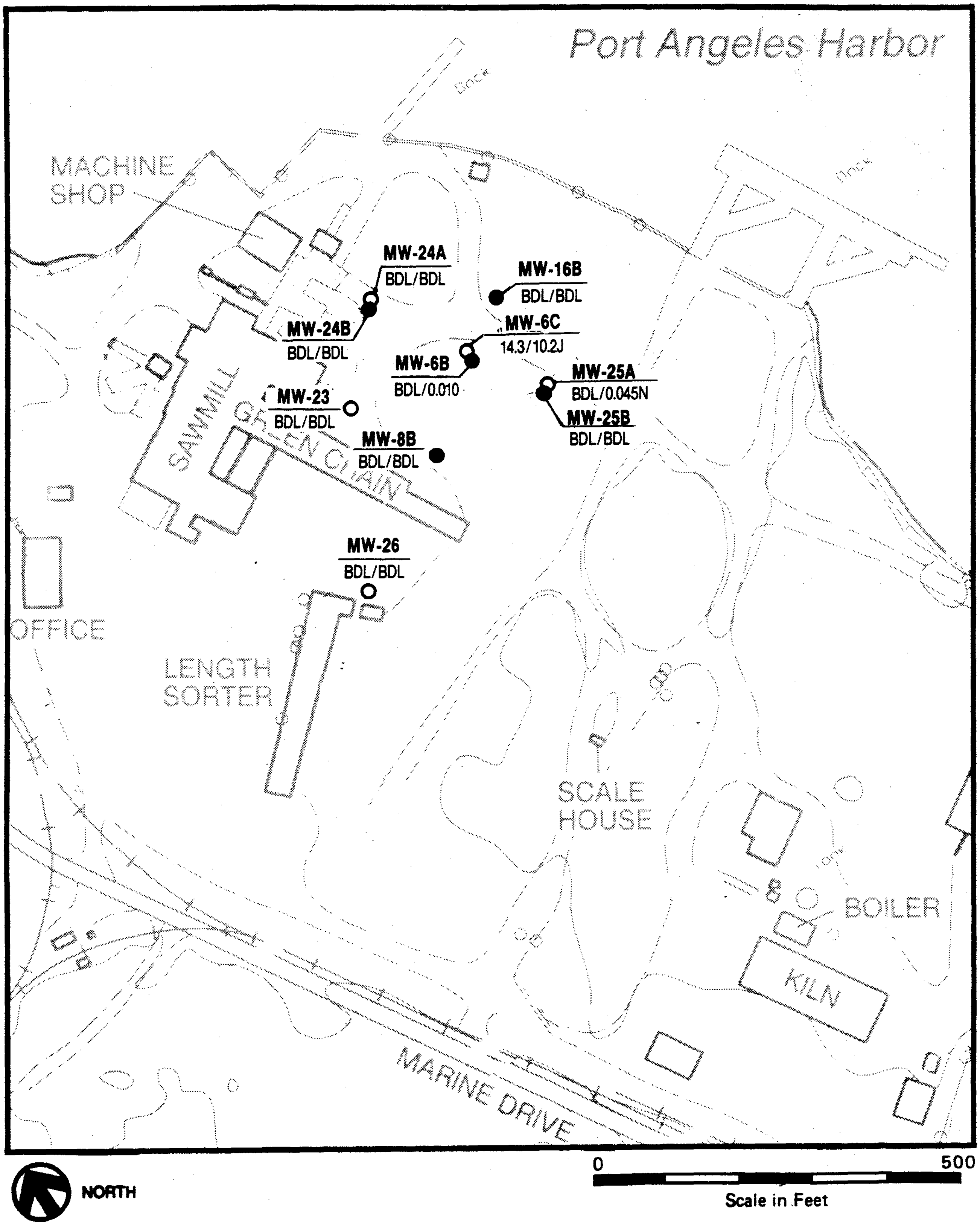
[a] MW-6C sampled later than specified dates for Rounds 1 and 2 because it was installed last.

[b] 0.005 is the Method 8040 detection limit.

BDL = below detection limit.

J = quantitatively suspected value.

With the exception of monitoring wells MW-6A, MW-6C, and MW-16A, the detected levels of PCP are at low levels, slightly above the method detection limit (MDL) of 0.005 mg/l, but well below a PQL set at ten times the MDL. During Round 1, MW-8 and MW-18 contained PCP at the MDL, PCP in MW-15 was twice the MDL, PCP in MW-19 was three times the MDL, PCP in MW-21 was less than five times the MDL, and PCP in MW-22 was five times the MDL. PCP in MW-16A only slightly exceeds the PQL. The PCP concentration in MW-16A



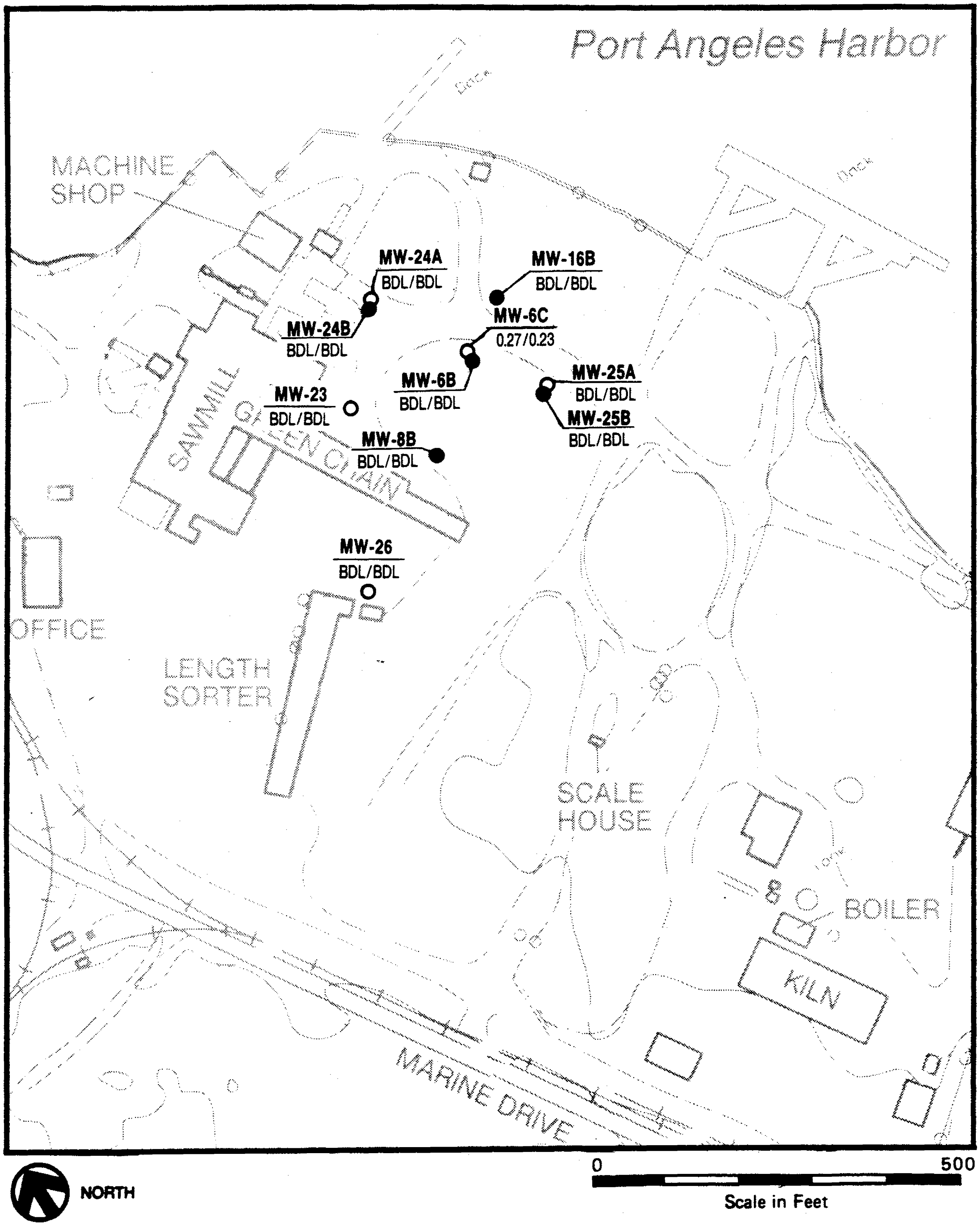
LEGEND

●	**Deep Wells Installed by CH2M HILL**
○	**Shallow Wells Installed by CH2M HILL**
N	**Qualitatively Suspect**
J	**Quanitatively Suspect**
R	**Unable to Calculate Due to Interference**
BDL	**Below Detection Limit**

Analytical Results — PCP/TCP

FIGURE 5-4

Pentachlorophenol and Tetrachlorophenol Analytical Results for Groundwater (mg/l) Round 1 — CH2M HILL Wells

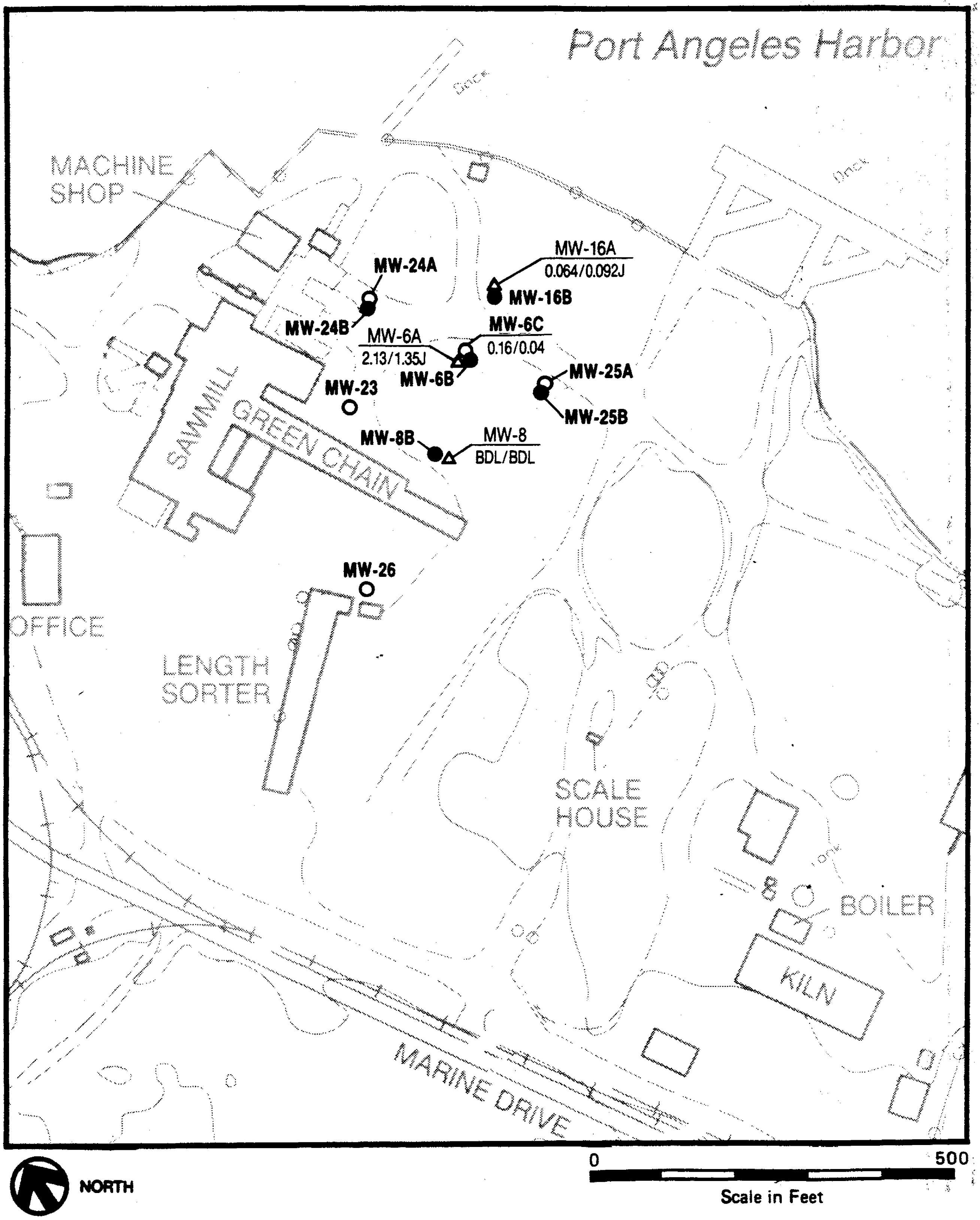


LEGEND

- ● Deep Wells Installed by CH2M HILL
- O Shallow Wells Installed by CH2M HILL
- N Qualitatively Suspect
- J Quanitatively Suspect
- R Unable to Calculate Due to Interference
- BDL Below Detection Limit
- Analytical Results — PCP/TCP

FIGURE 5-5

Pentachlorophenol and Tetrachlorophenol Analytical Results for Groundwater (mg/l) Round 2 — CH2M HILL Wells



LEGEND

- ● Deep Wells Installed by CH2M HILL
- O Shallow Wells Installed by CH2M HILL
- Δ Shallow Well Installed by Hart Crowser

Analytical Results — PCP/TCP

J Quantitatively Suspected Result

BDL Below Detection Limit

FIGURE 5-6

Pentachlorophenol and Tetrachlorophenol Analytical Results for Groundwater (mg/l) Additional 8040 Analysis

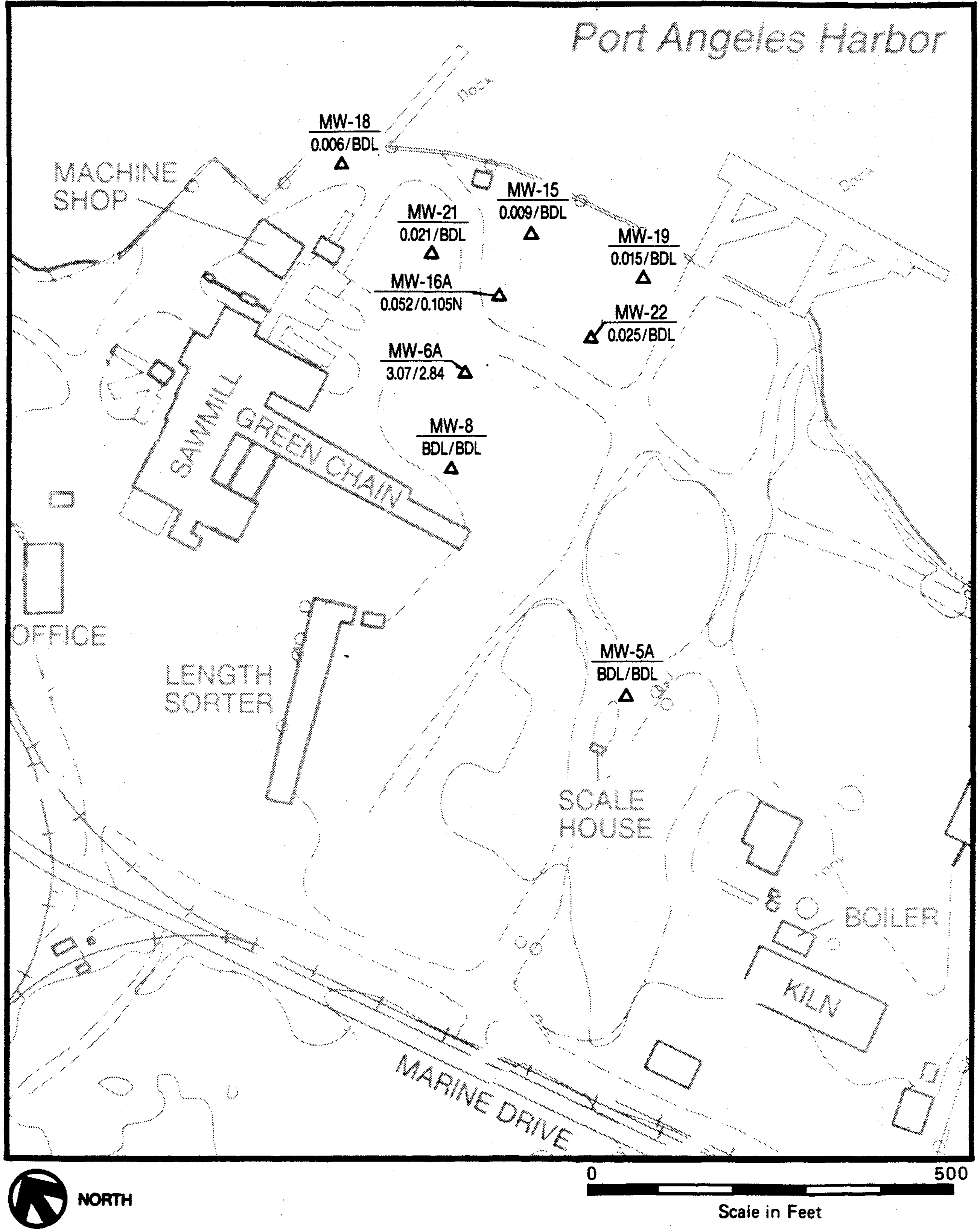
(0.052 mg/l) was several orders of magnitude less than the concentration of PCP found in MW-6A and MW-6C.

It is interesting to note that these very low-level detections in samples collected from Hart Crowser monitoring wells MW-8, MW-15, MW-16A, MW-18, MW-19, MW-21, and MW-22 all occurred in Round 1 of sampling. During Round 2, no detectable PCP was reported in any of these seven wells. This may be a result of the field sampling methods, particularly the redevelopment methods reported in Section 3.1.1. Except for MW-6C, all the PCP detections reported during Round 1 are in samples from Hart Crowser wells that required the special well development techniques.

The monitoring wells constructed by Hart Crowser may not have been designed optimally for the subsurface conditions present at the site. The presence of fine sand and silt in the subsurface required the use of a finer filter pack and smaller screen openings. Colloidal material, which was also present, could not be filtered out of the groundwater, but the suspended particulates could be screened and removed. Of the nine monitoring wells in which detectable concentrations of PCP were reported, eight of the wells were constructed with a screen-opening size of 0.020 inch, which is twice that of the wells constructed by CH2M HILL. Further, the diameter of the filter pack material used to surround the well screen in the eight preliminary assessment (Hart Crowser) wells may also be too large for the subsurface materials that exist at the site. Consequently, the presence of particulates, including wood splinters, was observed in these wells by CH2M HILL staff.

The presence of particulates in groundwater was particularly evident to CH2M HILL during well redevelopment in August 1988. CH2M HILL had to use two methods to attempt to develop these wells. Ultimately, however, these wells continued to yield formation material (see Section 3.1.1). Hence, it is not clear whether PCP detected in the groundwater samples was in solution or whether it adhered to wood or soil particles included in the sample.

Figures 5-7, 5-8, and 5-9 present the Method 8040 analytical results for groundwater samples collected from nine Hart Crowser wells. As can be seen by comparing the occurrence of PCP in groundwater samples collected from the Hart Crowser property transfer assessment wells with those constructed later by CH2M HILL, more PCP (and TCP) detections are associated with the property transfer monitoring wells. It should also be noted that the results reported in Figure 5-9 were analyzed by a modified Method 8150 (chlorinated herbicides), not the recommended procedure for PCP.

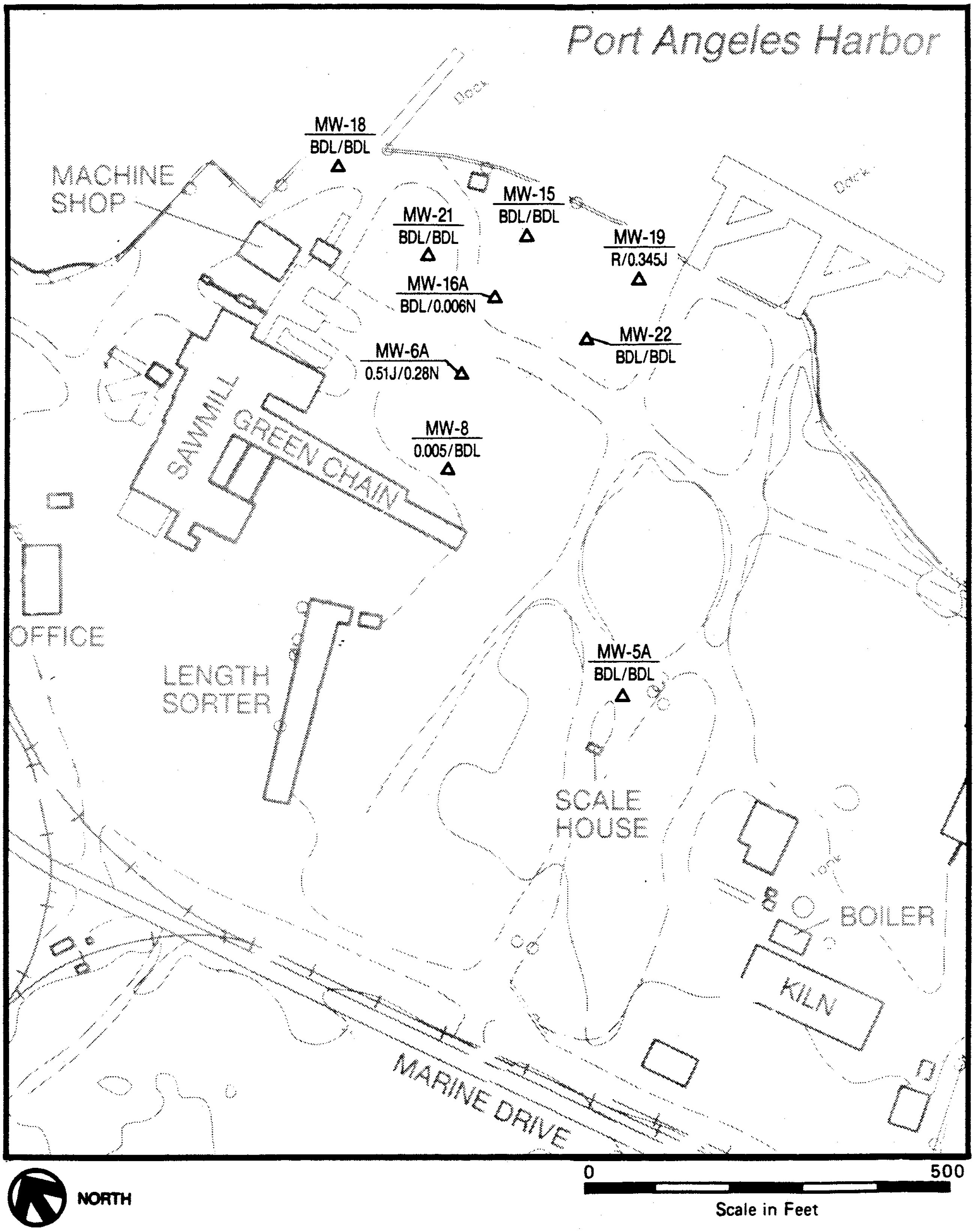


LEGEND

△ Shallow Well Installed by CH2M HILL
Analytical Results — PCP/TCP

FIGURE 5-7

Hart Crowser Wells
Pentachlorophenol and Tetrachlorophenol
Analytical Results for Groundwater (mg/l)
Round 1 — CH2M HILL Results



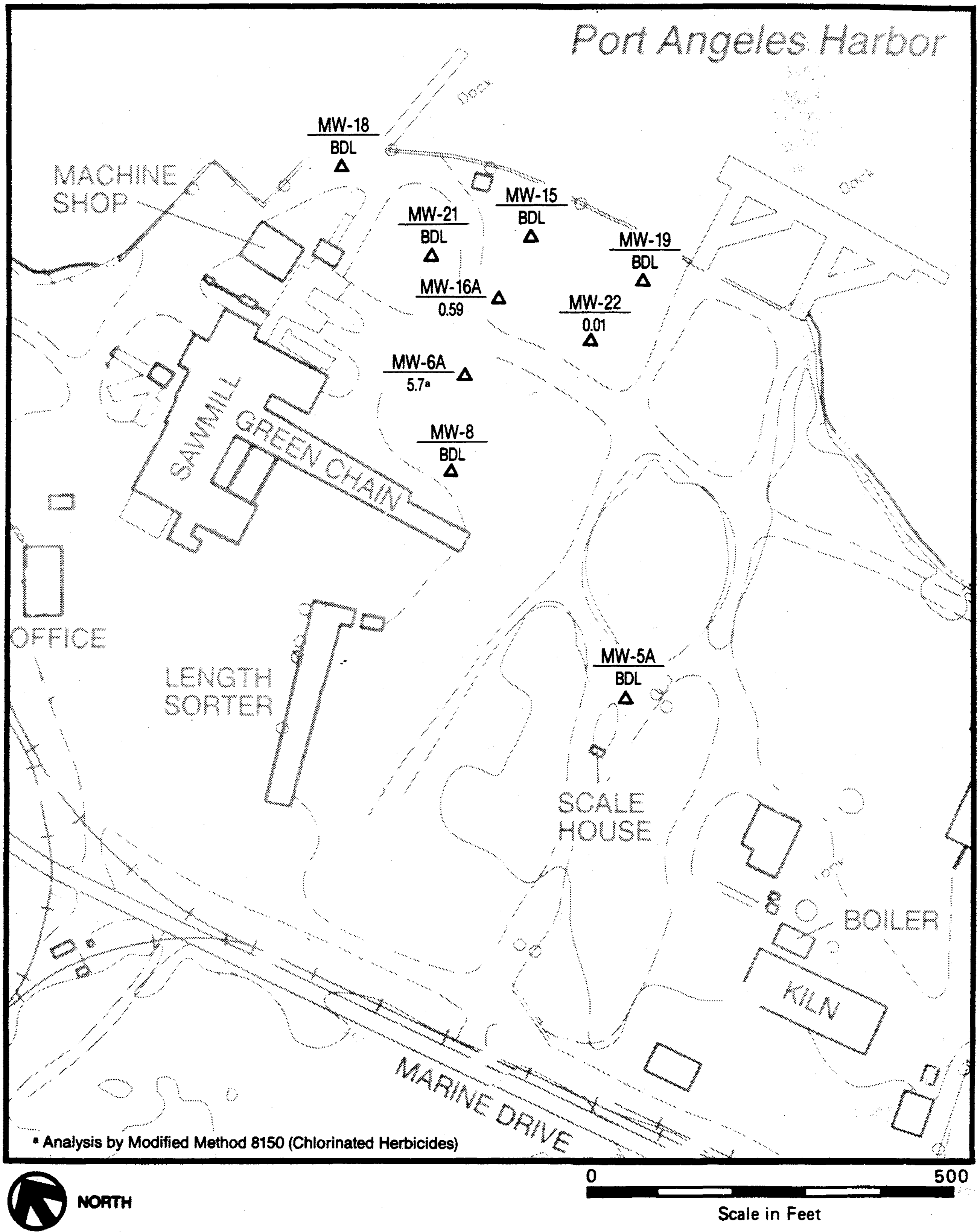
LEGEND

△ Shallow Well Installed by Hart Crowser
N Qualitatively Suspect
J Quanitatively Suspect
R Unable to Calculate Due to Interference
BDL Below Detection Limit

Analytical Results — PCP/TCP

FIGURE 5-8

Hart Crowser Wells Pentachlorophenol and Tetrachlorophenol analytical Results for Groundwater (mg/l) Round 2 — CH2M HILL Results



a Analysis by Modified Method 8150 (Chlorinated Herbicides)

LEGEND

△ Shallow Well Installed by Hart Crowser

FIGURE 5-9

Hart Crowser Wells Pentachlorophenol Analytical Results for Groundwater (mg/l) Hart Crowser Results

In comparison to the Hart Crowser property transfer assessment wells, only one of 11 monitoring wells (MW-6C) constructed by CH2M HILL yielded groundwater with detectable levels of PCP (14.3 mg/l). Interestingly, only 0.27 mg/l PCP was detected in monitoring well MW-6C during Round 2, a substantial decrease from the Round 1 result. It was decided to sample MW-6C a third time because of the discrepancy in the first two values. The third sample collected from MW-6C tested at 0.16 mg/l PCP (see Figure 5-6). The last value compared favorably to the Round 2 result and is believed to be more representative of PCP levels in groundwater from this well.

It is possible that the high value obtained from the first round was due to suspended particulates, particularly the colloidal material that can not be screened out. If groundwater turbidity in the monitoring well had not stabilized following development, an anomolous value could have resulted. It is believed, however, that PCP is present in shallow subsurface soils and localized groundwater in the vicinity of monitoring wells MW-6A and MW-6C. Deep well MW-6B does not show PCP in groundwater. Similarly, PCP has not been detected in monitoring wells MW-24A, MW-24B, and MW-16B, located downgradient of MW-6C. MW-25A and MW-25B located to the south are also free of detectable PCP, as are MW-23, MW-24A, and MW-24B located to the north. If a major source of PCP were present near these wells, its presence almost certainly would be detected.

It is believed that, as with MW-6A and MW-6C, there is a potential for limited PCP contamination in the immediate vicinity of MW-16A. It is difficult, however, to ascertain whether these detected values represent soluble PCP in groundwater or PCP adhering to particulates in the groundwater samples. The partitioning coefficient of PCP is high, indicating a high preference for adsorption to particles and, in particular, organic material. Pentachlorophenol behaves similarly to many other organic compounds in its tendency to adsorb onto the surface of soil, particulate material, and suspended solids from aqueous solution. The degree of adsorption is strongly influenced by three factors: the nature and quantity of organic matter associated with the solid phase; the pH of the water; the specific surface area of the solids.

The strong tendency of PCP to adhere to soil, particulate material, and suspended solids that contain (non-PCP) organic matter is reflected in the octanol-water partitioning coefficient, $\log P_{ow} = 5.01$ (Verschueren, K., *Handbook of Environmental Data on Organic Chemicals*, Van Nostrand Reinhold Company, New York, 1983). This coefficient is derived from laboratory data on the relative concentrations of PCP in octanol (the prototypical soil-organic phase) and water (representing soil or sediment pore water), and is treated as an indication of the degree of partitioning between pore water and the organic-rich solid phase under environmental conditions. A value for log P_{ow} of 5.01 indicates that PCP would be about 100,000 times more concentrated in pure octanol than in an equal quantity of pure water in contact with the octanol. Allowing for the fact that the sediments analyzed averaged approximately 1.6 percent organic carbon (wet weight), the degree of partitioning between soil and water would be lower than that for octanol and water. Nevertheless, there would be a tendency for PCP to be strongly adsorbed onto the soil. PCP adsorption coefficients from laboratory studies (Banerji et al., 1986) indicate significant retardation of any PCP contamination is expected during groundwater flow through a source of PCP.

Increasing pH of the pore water increases the solubility of PCP in water and decreases its solubility in octanol. At typical groundwater pH values for the study area (6.8 to 8.1) the soil affinity of PCP would be lower than would be predicted from octanol-water partitioning, after adjustments for the reduced organic content of soil and sediments.

While the extent to which the PCP is partitioned between soil and water cannot be quantitatively predicted from the octanol-water partitioning coefficient, the high-specific surface area of soils (surface area per volume of bulk soil) suggests that some degree of PCP adsorption should occur. One consequence of this adsorption is that the PCP would migrate at a slower rate than the groundwater flow velocity. Another consequence is that groundwater samples that are reported to contain PCP, but which also contained suspended solids (including colloidal-sized particles) could be the result of solids-associated PCP, rather than soluble PCP that might migrate with the groundwater. The noticeable reduction in the detected level of PCP from the first sampling event to the later sampling events indicates that the levels from the first round may be due in part to colloids that could not be centrifuged out of the solution.

Groundwater at the site does not fall under marine surface water or drinking water classifications, but the federal and state criteria provide useful comparisons. The federal MCLG for PCP in drinking water is 0.22 mg/l. MW-6A and MW-6C exceeded this value during all sampling except during the third sample collected from MW-6C. The PCP concentration in all other groundwater samples falls below this level.[1]

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[1] The proposed regulation of wood treatment solutions would set a health-based water limit at 1 mg/l for PCP. This level would have been exceeded only at MW-6A, Round 1 and 3, and MW-6C, Round 1 only. All other values are below this level.

Federal and state marine surface water criteria are 0.013 mg/l (acute) and 0.0079 mg/l (chronic). MW-18 is nearest the harbor and does not exceed either the chronic or acute limits. The other two monitoring wells near the harbor are MW-15 and MW-19. MW-19 exceeds both the chronic and acute criteria (the result, 0.015 mg/l, exceeds the chronic criterion and is marginally over the acute criterion). MW-15, with a detected level of 0.009 mg/l, exceeds the chronic but not the acute standards. It should be noted that even though these two concentrations are above the criteria for marine surface water, they are below the PQL for PCP in water. The second round of sampling for all three wells did not show any detectable PCP, and thus they do not exceed any marine chronic or acute criteria.

It should be restated that surface water criteria are not applicable to groundwater, and that the comparison of groundwater PCP levels to surface water criteria is for illustration only. The values detected in these groundwater samples are on the order of the detected PCP contamination in urban (Bellevue, Washington) residential storm runoff for which concentrations have been measured in the range of 0.003 mg/l to 0.115 mg/l (Metro Toxicant Program, 1982).

In summary, it appears that limited amounts of PCP may be localized in soils and possibly in groundwater in the vicinity of MW-6A, MW-6C, and MW-16A. There are no groundwater criteria or standards for PCP. Because this water is not potable, drinking water criteria (or proposed criteria as in the case of PCP) do not apply to this site.

Groundwater movement in the central portion of the focused site investigation area does not appear to be conducive to rapid migration of contaminants by advection. An upper bound estimate for horizontal groundwater flow velocity between monitoring wells MW-6A and MW-16A is 10 to 15 feet per year. This estimate is based on horizontal hydraulic gradients illustrated in Figures 4-7 and 4-8, and hydraulic parameters presented in Section 4.1.1.2. In addition, downward vertical migration of contaminants is inhibited by vertical groundwater flow potentials that are upward and the relative low hydraulic conductivity of the silt and fine sand present below a depth of about 20 feet.

Based on the groundwater velocity presented above and other hydrologic information presented in Section 4.1.1.2, any potentially contaminated groundwater near MW-6C being transported by advection is likely migrating to the northeast at a very slow rate. This scenario is supported by the analytical data. With the exception of monitoring wells MW-6A and MW-6C, MW-16A is the only shallow monitoring well in which PCP has been detected more than once (0.052 and 0.064 mg/l during Rounds 1 and 2, respectively). Neither

TCP nor PCP has been detected in monitoring wells MW-24A and MW-25A, indicating that the contamination is not distributed laterally relative to groundwater flow past MW-6A. Furthermore, neither TCP nor PCP has been detected in deep zone monitoring wells, except for monitoring well MW-6B during Round 1 (TCP at 0.010 mg/l), indicating that the vertical extent of any contamination is limited.

This slow movement of potentially contaminated groundwater would also serve to facilitate biological degradation of PCP and TCP before the groundwater is discharged to Port Angeles Harbor. It has been shown (Kauffman, 1978 and Arsenault, 1976) that PCP will degrade to numerous mono-, tri-, and dichlorinated phenols, and ultimately to carbon dioxide and water. These chlorinated compounds represent a lesser health risk than PCP (U.S. EPA, RFI Guidance, December 1987). The breakdown of PCP can occur by chemical, microbiological, and photochemical means. Interestingly, Kauffman reported that PCP degrades more rapidly in flooded or anaerobic soil than in aerobic, moist soil. The soils found in the focused site investigation area are perennially flooded and would appear to provide enhanced degradation conditions.

The EPA Office of Research and Development (Ada, Oklahoma) has published a report on the treatability of soils contaminated with PCP (McGinnis et al., 1988). The report draws from literature data and laboratory experiments with soil from eight wood processing plants. The general conclusions are:

- In studies going back to 1950, the rate of decomposition of PCP in soils was faster under flooded or near saturation conditions.
- In soils from wood processing plants that had used PCP, added PCP had a half life of 2 to 3 months.
- "The general conclusions from this study are that PAH's and PCP are readily degraded in soil systems ... PCP was transformed much more quickly in soils with long term exposure to PCP."

5.4.2 METHOD 8040 RESULTS--TCP

Table 5-4 summarizes the Method 8040 TCP results reported in groundwater. Figures 5-4 through 5-6 summarize all groundwater analytical results for the CH2M HILL wells. Figures 5-6 through 5-9 present the results for the Hart Crowser property transfer assessment wells.

TCP was found in 12 of 44 groundwater samples analyzed by Method 8040. The detected values were found in samples collected from the six monitoring wells presented in Table 5-4.

Table 5-4
METHOD 8040 TCP GROUNDWATER RESULTS SUMMARY

Monitoring Well	Company	Concentration (mg/l) Round 1	Round 2	Additional Analysis
6A	HC	2.84	0.28N	1.35J
6B	CH2M HILL	0.010	BDL	Not sampled
6C	CH2M HILL	10.2J[a]	0.23[a]	0.04
16A	HC	0.105N	0.006N	0.092J
19	HC	BDL	0.345J	Not sampled
25A	CH2M HILL	0.045N	BDL	Not sampled

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[a] MW-6C sampled later than specified dates for Rounds 1 and 2 because it was installed later.

BDL = below detection limit.

N = Qualitatively suspected compound.

J = Quantitatively suspected value.

As with PCP levels, TCP was reported in samples collected from the MW-6 series wells. In MW-6A and MW-6C, high levels of TCP were detected in the first round of sampling at 2.84 mg/l and 10.2 mg/l respectively. The 10.2 mg/l concentration was qualified by the laboratory as being quantitatively suspect. During the second round of sampling, TCP was detected in samples from MW-6A and MW-6C at 0.28 mg/l and 0.23 mg/l, respectively. The significant drop in TCP detected may again be associated with well development and the optimum length of time required for groundwater turbidity to stabilize before sampling should ideally occur. In MW-6B, TCP was detected at 0.010 mg/l (less than three times the method detection limit) in Round 1 and was not detected in Round 2. TCP was not reported in samples from any other deep well. Monitoring well MW-16A detected TCP at 0.105 mg/l in Round 1 and at 0.006 in Round 2. Both values were flagged by the laboratory as being qualitatively suspect. The additional sampling of MW-16A yielded a detected value that is just above the detection limit of 0.005 mg/l. TCP was detected in the Round 1 sample collected from MW-25A. This value was flagged by the analytical laboratory as qualitatively suspect. TCP was not detected in Round 2. MW-19 had no TCP detected in the first round and 0.345 mg/kg for the second round. The laboratory flagged this value as quantitatively suspect.

Based on the results discussed above, only shallow monitoring wells MW-6C and MW-6A appear to show reliable levels of

TCP. As with the PCP, the TCP contamination appears localized and may be associated with suspended particulates or colloidal matter in groundwater samples. The presence of a large source or area of TCP contamination is not supported by the data.

There are no water quality criteria available for groundwater contaminated with TCP.

5.4.3 METHOD 8270 GROUNDWATER ANALYSIS

Results of the Method 8270 (semivolatile organic chemicals) analysis of groundwater are presented in Table 4-21. Four groundwater samples were collected from three monitoring wells (MW-6B, MW-6C, MW-16A) and analyzed using Method 8270. PCP was reported in wells MW-6C (6.9 mg/l) and MW-16A (0.017 mg/l). The concentration detected in MW-16A was qualified by the laboratory as an estimate only. This compound was detected between the MDL and the PQL. The value reported in MW-16A is less than one-fifth of the PQL. The Method 8270 PCP value for MW-6C (6.9 mg/l) compares favorably with the CSL 8040 result for the same sample (14.3 mg/l), indicating good agreement between the methods and laboratories.

Method 8270 does not include TCP as one of the 65 target compounds, but it was tentatively identified in two of the four groundwater samples. The sample collected from MW-6C contained two TCP isomers with a combined level of approximately 3.5 mg/l; the sample from MW-16A had one isomer at a level of 0.02 mg/l.

Other semivolatile compounds detected by Method 8270 included phthalate esters, which were found in all four samples and two method blanks. Because phthalate esters are ubiquitous, the Data Validation Guidelines (EPA, 1988) state that phthalate esters and other common contaminants should be present at levels greater than ten times blank contamination levels before they are considered to be present in the sample. None of the samples exceeded this 10-fold criterion, indicating that phthalate contamination is not a concern at the site.

Two possible PCP breakdown products were detected in groundwater samples collected from MW-6C. 2,4-dichlorophenol (at 0.011 mg/l) and 2,4,5-trichlorophenol (at 0.080 mg/l) were both detected below the EPA quantitation limit and are considered to be estimated quantities. Naphthalene was detected in MW-16A at an estimated level of 0.002 mg/l and in MW-6C at 0.077 mg/l.

Although groundwater around all of the study's wells are neither marine surface waters nor a source of drinking water, it is useful to compare the federal and state criteria to the levels detected in these four samples. The level of PCP found in MW-6C is above the federal MCLG of 0.22 mg/l. This represents only one sample result (Round 1), and it is not known if subsequent analyses by Method 8270 would decrease in value as was observed in the Method 8040 PCP analysis for this monitoring well. Appendix IX analysis of this groundwater did not detect the presence of PCP during the third groundwater sample collected five weeks later.

The 0.017 mg/l concentration in groundwater collected from MW-16A is considerably below the drinking water standard (0.22 mg/l) and marginally exceeds the marine life acute and chronic criteria (0.013 mg/l and 0.0079 mg/l, respectively).

Two isomers of TCP were found among the nontarget compounds detected at MW-6C. A regulatory criterion exists only for 2,3,5,6-TCP in drinking water (0.44 mg/l). The estimated level in MW-6C was 3.44 mg/l. As referenced earlier, however, the groundwater beneath the focused site investigation is not suitable for use as drinking water.

There are no regulatory criteria for 2,3,4,5-TCP, but the two detected values (0.18 mg/kg at MW-6C and 0.0196 mg/kg at MW-16A) are below the drinking water criteria for both PCP and 2,3,5,6-TCP. The 2,4,5-trichlorophenol at MW-6C and naphthalene at MW-6C and MW-16A are two orders-of-magnitude below the regulatory limits. The 2,4-dichlorophenol detected at MW-6C, at an estimated concentration of 0.011 mg/l, is near the MDL and is well below the criterion of 0.1 mg/l.

5.4.4 APPENDIX IX GROUNDWATER ANALYSIS

Only benzene, sulfide, and TCP were reported from four Appendix IX groundwater samples collected from MW-6B and MW-6C. None of the dioxin or dibenzofuran compounds were detected in any of the groundwater samples. There are no known criteria for 2,3,4,6-TCP in groundwater. The presence of TCP reported by Appendix IX analyses supports evidence based on other analytical methods that there is localized contamination in the vicinity of MW-6A and MW-6C. Benzene was reported at 0.0087 mg/l at MW-6C, which is above the health-based criterion for benzene (0.0011 mg/l) in drinking water. The acute and chronic marine concentration limits for aquatic life are both greater than the 0.0087 mg/l reported value. Sulfide was detected at 0.05 mg/l at MW-6B.

Table 5-5 presents the criteria and guidelines for metals detected in groundwater by Appendix IX analyses. As can be seen from Table 5-5, none of the detected values are above the concentrations found generally in Puget Sound and are at or below the guidelines.

Table 5-5
METALS DETECTED BY 40 CFR APPENDIX IX GROUNDWATER ANALYSES AND PUBLISHED CRITERIA AND GUIDELINES
(concentration in mg/l)

						Health-Based Criteria[b]		Federal Clean Water Act		
Metal	MW-6B[a]	MW-6C[a]	MW-16B[a]	MW-24A[a]	Proposed MCL[b]	Carcinogens	Systemic Toxins	Criteria for Marine Aquatic Life (Acute/Chronic)[b]	Limits for Human Consumption of Water and Fish[c]	Concentrations Found in Puget Sound[d] (Minimum-Maximum)
Arsenic	0.04	ND	0.014	NA	0.05	0.0000022	NCL	NCL	0.0000022	0.001-3.815
Barium	0.12	0.19	0.190	0.016	1.0	NCL	2.0	NCL	1.0	NL
Chromium[e]	ND	ND	ND	ND	0.05 NCL	NCL NCL	0.2 40	1.1/0.05 10.3/NCL	0.05 170	0.001-0.320
Copper	ND	ND	ND	0.008	NCL	NCL	f	0.0029/0.0029	NCL	0.001-1.240
Lead	ND	0.003	0.022	0.003	0.05	NCL	NCL	0.14/0.0056	0.050	ND-1.750
Vanadium	ND	ND	ND	0.01	NCL	NCL	g	NCL	NCL	NL
Zinc	ND	ND	ND	0.02	NCL	NCL	h	0.095/0.086	NCL	ND-11.800

ND = not detected.
NCL = no criteria listed.
NA = not analyzed.
NL = not listed.

[a] Values are from Appendix IX analyses for total recoverable metals.

[b] EPA, Revised Draft RFI Guidance, Volume 1, Section 8, December 1987.

[c] Based on a 70-kg adult over 70 years lifetime exposure at 2 liters/day (b).

[d] EPA, Pollutant of Concern Matrix, 1986. Ranges are for receiving water in non-reference areas (e.g., urban bays and the central basin).

[e] Upper value is for chromium (VI), the lower value is for chromium (III). The analysis gives only total chromium so no information on the oxidation state is available.

[f] The only listed value for copper is copper cyanide at 2.0 mg/l. No information on what copper compounds are present in sample is available.

[g] Vanadium pentoxide is the only listed vanadium compound. No information on what vanadium compounds are present is available for these samples.

[h] Zinc cyanide, 2.0 mg/l; zinc phosphide, 0.01 mg/l. No information on what zinc compounds are present is available for these samples.

6 CONCLUSIONS

A focused environmental site investigation was conducted at the former Merrill & Ring wood treating facility located in Port Angeles, Washington. The site investigation was undertaken in the late summer and autumn of 1988 and was focused on a 2-acre area of the former Merrill & Ring Lumber Company. The main objective of the study was to evaluate the magnitude and extent of the wood preservatives pentachlorophenol (PCP) and tetrachlorophenol (TCP) potentially released to soil, groundwater, and marine sediments by Merrill & Ring. The practice of applying PCP and TCP to wood was discontinued in the focused site investigation area over 15 years ago. The study was performed by CH2M HILL under contract to Daishowa America Company, Ltd., which recently purchased the site.

The subsurface investigation verified the general distribution and type of subsurface materials identified by Hart Crowser in their property transfer assessment. Fill materials were found to be heterogeneous and characterized by significant quantities of wood and other organic debris in many locations. Much of this wood may have been treated prior to burial and is partially responsible for the presence of PCP and TCP in soil (soil containing treated wood fragments) and groundwater.

Analysis of subsurface soils by both Method 8040 and Method 8270 show that in the samples where PCP or TCP were detected it was at very low levels (PCP at 0.28 to 2.81 mg/kg; TCP at 0.19 to 1.35 mg/kg) except at MW16C (TCP at 6.2 mg/kg by Method 8040 and 27 mg/kg by Method 8270; PCP not detected by Method 8040 and 24 mg/kg by Method 8270). None of the samples exceed EPA's health-based PCP criterion of 500 mg/kg.

Other results from the Method 8270 analysis for semivolatile organic compounds indicated the presence of some polynuclear aromatic hydrocarbon (PAH) compounds, phenol, and 4-methylphenol in surface soils (2.5 feet or less). None of these compounds were detected in soils below the surface. These compounds also were reported at very low concentrations, all of which fall below apparent biological effects thresholds (AETs) proposed to evaluate marine sediments in the draft Puget Sound Marine Sediment Criteria Evaluation (Ecology, 1988). These samples are surface soils, so the comparison to marine sediment standards is for illustration only. There are no other health-based or regulating criteria with which to compare these results. The AETs, however, are considered stringent criteria.

Mercury analyses of soils (29 samples) indicated that no soil tested exceeded the range of mercury found naturally in soils.

Appendix IX analyses of soil did not identify any significant contamination. The Appendix IX results confirmed Hart Crowser's conclusion that dioxin contamination is unlikely at the Merrill & Ring site. No dioxins were detected in any of the Appendix IX analyses conducted during the focused site investigation.

Groundwater flow is toward Port Angeles Harbor. Therefore, groundwater at the site does not appear to recharge any aquifer or discharge to any surface water used as a source of drinking water. Groundwater at the site is not used for any beneficial purpose and, because of its brackish quality, it is not suitable as a future source of drinking water.

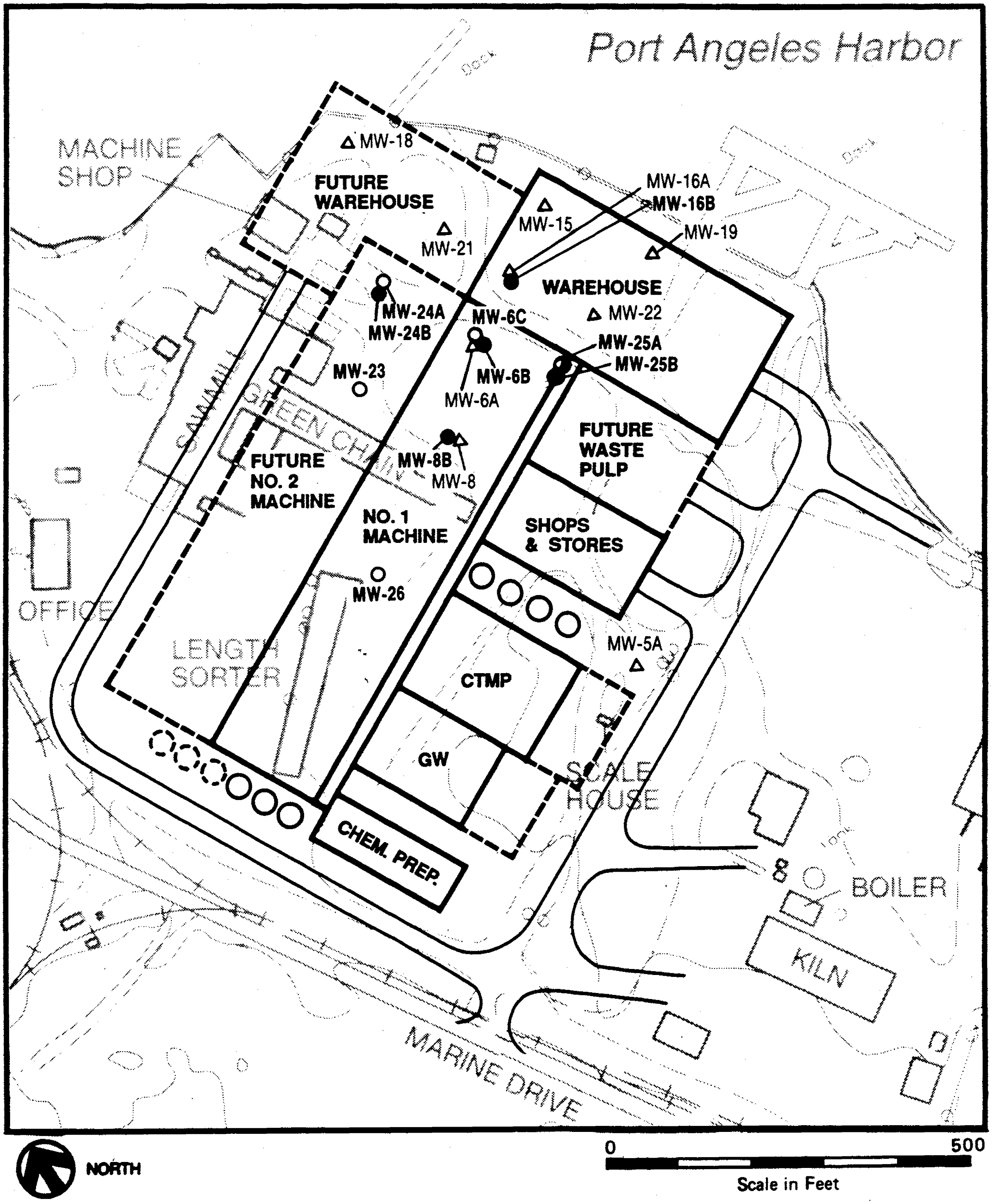
Because groundwater at the site moves almost entirely in a horizontal direction to the northeast, any groundwater contamination migrating by means of advection ultimately will be discharged to Port Angeles Harbor. The small vertical component of the groundwater flow potential was found to be upward. This means that the downward migration of contaminants into deeper groundwater effectively is prevented.

The influence of the tide on groundwater movement in the shallow zone of saturation appears to be limited to within about 150 feet of the harbor. This means that groundwater gradients and flow directions, and contaminant migration in most of the focused site investigation areas are relatively constant and are not affected by tidal fluctuations.

Groundwater gradients and hydraulic conductivity are such that horizontal flow rates are estimated to be relatively slow (i.e., in the range of 3 to 83 feet per year). Likewise, the spread of groundwater contamination by advection would be slow.

Based on analytic results and on characterization of subsurface conditions and groundwater at the former Merrill & Ring property, there is no technical precedent or human health or environmental criteria that would indicate that remedial action is required at this site. Although there is some limited PCP and TCP contamination in soil that can be detected in localized groundwater, these circumstances do not require further remedial action because:

- No reported soil value exceeds any published criteria for PCP or TCP in soils
- The planned expansion of Daishowa's paper production facility includes the construction of a new



LEGEND

○ Shallow Well Installed by CH2M HILL

● Deep Well Installed by CH2M HILL

△ Shallow Well Installed by Hart Crowser

FIGURE 6-1

Proposed Mill Expansion
Daishowa America Co., Ltd.

paper mill. The mill will be positioned directly over the focused site investigation area. All identified zones of contamination will therefore be effectively "capped," preventing infiltration and inflow of surface runoff. Figure 6-1 shows the layout of the proposed mill relative to the existing monitoring wells.

- The slow movement of groundwater facilitates degradation of PCP and TCP by chemical and microbiological means before it is discharged into Port Angeles Harbor. The anaerobic conditions and periodic flooding of the site further enhance microbial breakdown of PCP (Mikesell and Boyd, 1988). This fact appears to be supported by the low levels and absence of PCP and TCP in groundwater and soil samples collected from monitoring wells nearest the Port Angeles Harbor and for marine sediments downgradient and offshore of the study area.

- Based on groundwater analytical data, the extent of PCP and TCP in groundwater appears to be limited to shallow depths (i.e., 5 to 15 feet below ground surface) in small areas near MW-6A, MW-6C, and MW-16A. This is corroborated by the lack of PCP and TCP in soil and groundwater adjacent and downgradient of these locations. Further, PCP or TCP do not appear to be present in groundwater in the deep monitoring zone (approximately 40 to 50 feet below ground surface).

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ATTACHMENT

VERIFICATION STUDY AT M&R SITE

TECHNICAL MEMORANDUM

TO: Daishowa America Company, Ltd.

FROM: CH2M HILL

DATE: February 17, 1989

RE: Verification Study at M&R Site

PROJECT: SEA26655.V1

CONTENTS

TABLES

FIGURES

TECHNICAL MEMORANDUM

February 17, 1989
SEA26655.V1

1.0 INTRODUCTION

An environmental verification study was conducted for the former Merrill and Ring (M&R) property in Port Angeles, Washington. The study consisted of reviewing historical information and interviewing persons knowledgeable about past uses of the site to evaluate the potential for existing environmental problems. A limited number of soil, groundwater, and sediment samples were also collected and analyzed.

Based on recent studies completed by Hart Crowser (1988) and CH2M HILL (1988), areas of minor soil and groundwater contamination have been identified and evaluated in certain areas of the site. These include soil contaminated with hydrocarbons near the truck maintenance facility, and soil and groundwater near the former green-chain area that contains low concentrations of pentachlorophenol (PCP) and tetrachlorophenol (TCP). The personal interviews, research, and sampling and analyses conducted for the verification study indicate that there are no other areas of potential concern. With the exception of motor fuels, and other petroleum products used for the repair and maintenance of vehicles and machinery, there is no evidence that chemicals other than those used to treat wood products were ever used or stored at the former M&R property. Furthermore, there is no indication that chemical processes other than wood preservation were conducted at the site, or that chemicals or wastes were routinely or deliberately disposed of on the property.

1.1 OBJECTIVE OF THE VERIFICATION STUDY

In June 1988, Daishowa America Co., Ltd. (Daishowa), acquired land adjacent to Port Angeles Harbor through purchase and lease arrangements with M&R and the Port of Port Angeles, respectively. As part of the property transaction, M&R retained Hart Crowser to conduct an environmental assessment of the property to evaluate the potential for environmental contamination caused by past land use practices. The Hart Crowser assessment was completed in May and June of 1988.

During the environmental assessment conducted by Hart Crowser, chemicals used for wood preservation, including PCP, were found to be present in soil and groundwater samples collected from certain areas of the property. As a result of Hart Crowser's findings, Daishowa retained CH2M HILL to conduct a verification study of the initial environmental assessment. The two objectives of the verification study were to: (1) review the environmental assessment conducted by Hart Crowser and pursue and review other available sources of information to determine if information and records for the site had been fully examined, and (2) collect a limited number of groundwater, soil, and marine sediment samples at selected locations throughout the property to corroborate the findings of the Hart Crowser study.

1.2 SITE DESCRIPTION

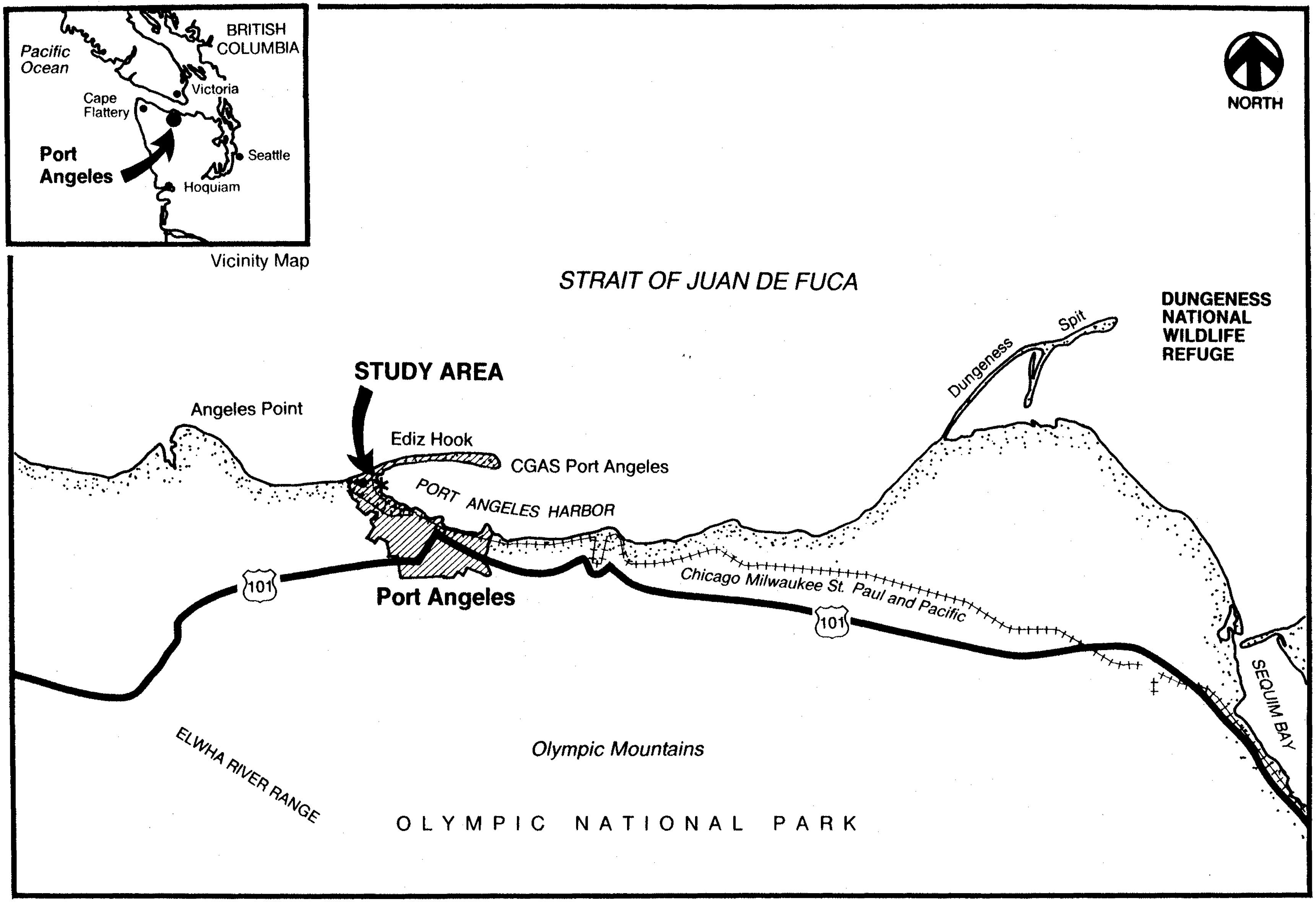
The site formerly occupied by the Merrill & Ring Lumber Company is approximately 50 acres in size and located at the base of Ediz Hook, adjacent to the shoreline of Port Angeles Harbor in Sections 4 and 5 of Township 30N, Range 6W of the Willamette Meridian (Figure 1). The property is bounded by Daishowa's Port Angeles paper mill on the northwest, Marine Drive to the south and west, and the Port Angeles Marina on the southeast (Figure 2). The entire parcel is located within the city limits of Port Angeles.

The property formerly owned by M&R is composed of two sections with separate mailing addresses. These addresses are 1608 Marine Drive and 1313 Marine Drive. The property locations are shown on Figure 2. By 1972, M&R had leased or bought both parcels. Prior to 1972, the two parcels were developed separately and were occupied by different commercial businesses.

Situated between 1608 Marine Drive and 1313 Marine Drive is another parcel of land (approximately 4 acres) that extends from Marine Drive to Port Angeles Harbor. The address of this parcel is 1417 Marine Drive. It is owned by the Port of Port Angeles and is currently leased to the Levaque Company, a cedar shake and shingle manufacturer.

2.0 METHODS

To obtain a better understanding of the site and its history, an investigation of past land use activities was conducted. In addition, groundwater and soil samples were collected from selected areas that were sampled by Hart Crowser during the initial environmental assessment. Additional soil and marine sediment samples were also collected in areas not previously sampled, but identified as areas of potential concern based on a review of historical information.



SOURCE: USGS, 1957

FIGURE 1
Location of Study Area

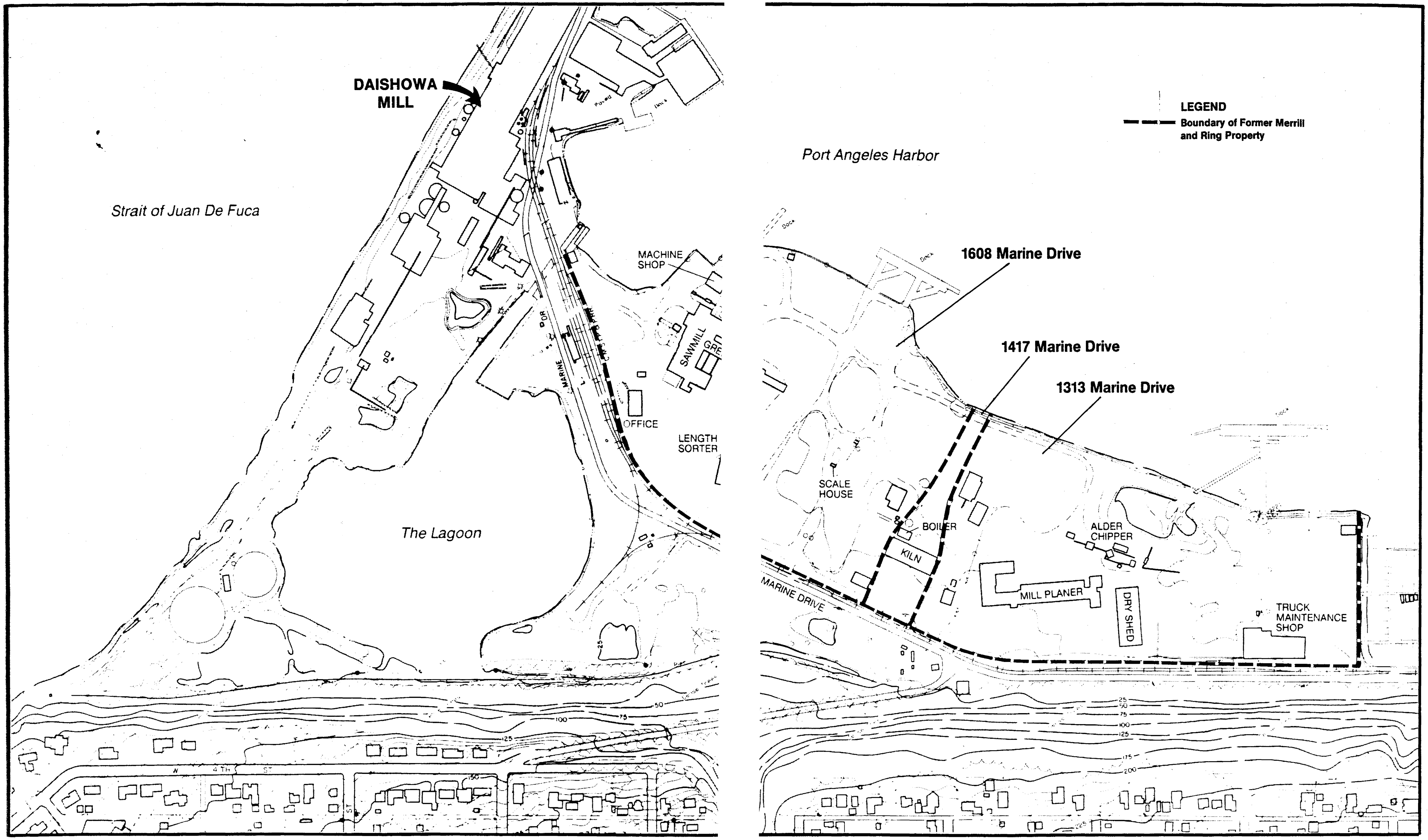


FIGURE 2
Site Map

2.1 DATA SOURCES

In order to obtain historical data regarding the site, its historical land uses, and any areas potentially affected by contamination, CH2M HILL gathered and reviewed available information and conducted personal interviews. Information was collected from a variety of state and local government agencies. Current or former employees of Daishowa and M&R who are familiar with historical site activities were interviewed. The following were pursued as sources of information:

- U.S. Environmental Protection Agency (EPA)--Region X
- U.S. Coast Guard
- Washington State Department of Ecology (Ecology)--Southwest Regional Office and Records Management Division
- State of Washington Department of Social and Health Services (DSHS)
- Clallam County Planning Department
- City of Port Angeles Planning Department
- Port of Port Angeles
- Port Angeles Fire Department
- Past employees of M&R and current employees of Daishowa who had knowledge of site operations
- Newspaper archives at the Port Angeles Public Library

2.2 SAMPLE COLLECTION AND ANALYSIS

As part of the verification study, CH2M HILL collected 5 surface soil samples, 2 marine sediment samples, 1 field duplicate marine sediment, and 18 groundwater samples from 9 monitoring wells installed by Hart Crowser (monitoring wells MW-5, MW-6A, MW-8, MW-15, MW-16A, MW-18, MW-19, MW-21, and MW-22). All soil, sediment, and groundwater samples were analyzed for phenolic compounds, including PCP and TCP, using EPA Method 8040.

In order to provide supplemental information, several other types of analyses were conducted on selected samples. The marine sediment samples were analyzed for total organic carbon (TOC) as a general indication of potential anthropogenic sources of contamination that might be present in marine sediments. One soil sample collected from near the maintenance shop was also analyzed for total petroleum hydrocarbons (TPH) and total organic halogens (TOX) as petroleum products and chlorinated solvents are commonly used in the repair and maintenance of vehicles and machinery.

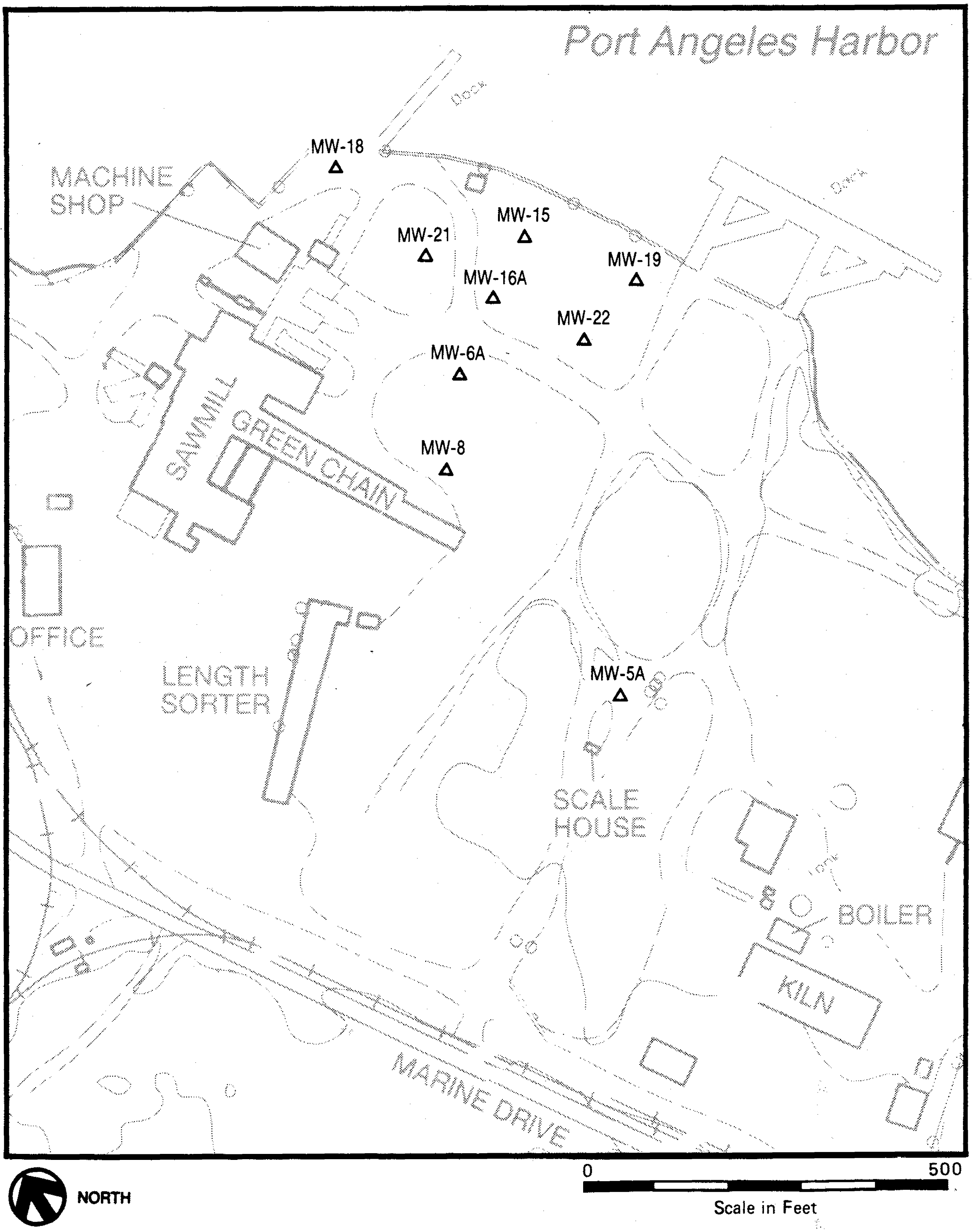
The location and analyses conducted for each sample are presented in Table 1. Sample locations are shown on Figures 3 and 4.

Most of the samples collected were taken at, or near, the same locations as samples collected by Hart Crowser. This fulfilled one of the primary objectives of the verification study, i.e., to verify the results reported by Hart Crowser. However, one sediment sample (sample VI-MS-201) and two soil samples (samples VI-SS-202 and VI-SS-204) were also collected from areas not sampled by Hart Crowser. These are areas where it seemed plausible that contamination may have occurred as a result of past practices at the site. Sediment sample VI-MS-201 was collected from the lagoon at the outfall of a drainage pipe for an adjacent car wash. Soil sample VI-SS-202 was collected from the west side of the old saw mill based on a statement from a former M&R employee who indicated that Permatox 180 was used to treat wood at this location (Paul Hopkins, pers. comm., September 1988). Soil sample VI-SS-204 was collected from near the new planer mill to determine if PCP or TCP might be present in surface soils near this facility.

In addition to the samples described above, other soil, marine sediment, and groundwater samples were collected concurrently with the verification study samples as part of the Focused Site Investigation conducted by CH2M HILL. The Focused Site Investigation report (CH2M HILL, 1988) summarizes the results of sampling conducted within the Focused Site Investigation Area. The Focused Site Investigation Area is located at the north end of the former M&R site, between the former green chain and Port Angeles Harbor.

Table 1
VERIFICATION SAMPLE LOCATIONS

Sample Identification No.	Matrix	Date Sampled	Location Description	Depth of Sample	Analyses
V1-MS-200	Marine sediment	9/22/88	End of southern pier, inside log boom, 10 feet northwest of corner of pier head, closest to the shoreline	6 in.	8040 TOC Grain size % moisture
V1-MS-201	Marine sediment	9/22/88	Eastern shore of lagoon, along drainage ditch from car wash facility	3 in.	8040 TOC Grain size % moisture
V1-SS-200	Soil	9/22/88	East side of maintenance shop, south side of driveway to maintenance shop	3 in.	8040 TPH (method 418.1) TOX
V1-SS-201	Soil	9/22/88	West side of planer mill, 100 feet from southwest corner	3 in.	8040
V1-SS-202	Soil	9/22/88	Northwest corner of sawmill	3 in.	8040
V1-SS-203	Soil	9/22/88	East of green chain at northern end of green chain	3 in.	8040
V1-SS-204	Soil	9/22/88	Two hundred feet west corner of planer mill and 220 feet from Marine Drive	3 ft	8040
V1-SS-205	Soil	9/22/88	Field duplicate, collected at V1-SS-203	3 ft	8040
V1-SS-206	Water	9/22/88	Equipment blank	N/A	8040
DSA-MW5	Groundwater	8/22/88	Monitoring well No. 5	N/A	8040
	Groundwater	10/6/88	Monitoring well No. 5	N/A	8040
DSA-MW6	Groundwater	8/24/88	Monitoring well No. 6A	N/A	8040
DSA-MW6A	Groundwater	10/6/88	Monitoring well No. 6A	N/A	8040
DSA-MW8	Groundwater	8/17/88	Monitoring well No. 8	N/A	8040
DSA-MW8A	Groundwater	10/3/88	Monitoring well No. 8	N/A	8040
DSA-MW15	Groundwater	8/24/88	Monitoring well No. 15	N/A	8040
DSA-MW15	Groundwater	10/4/88	Monitoring well No. 15	N/A	8040



LEGEND

△ Hart Crowser Well Used For Verification Sampling

FIGURE 3

Monitoring Wells Sampled During The Verification Study

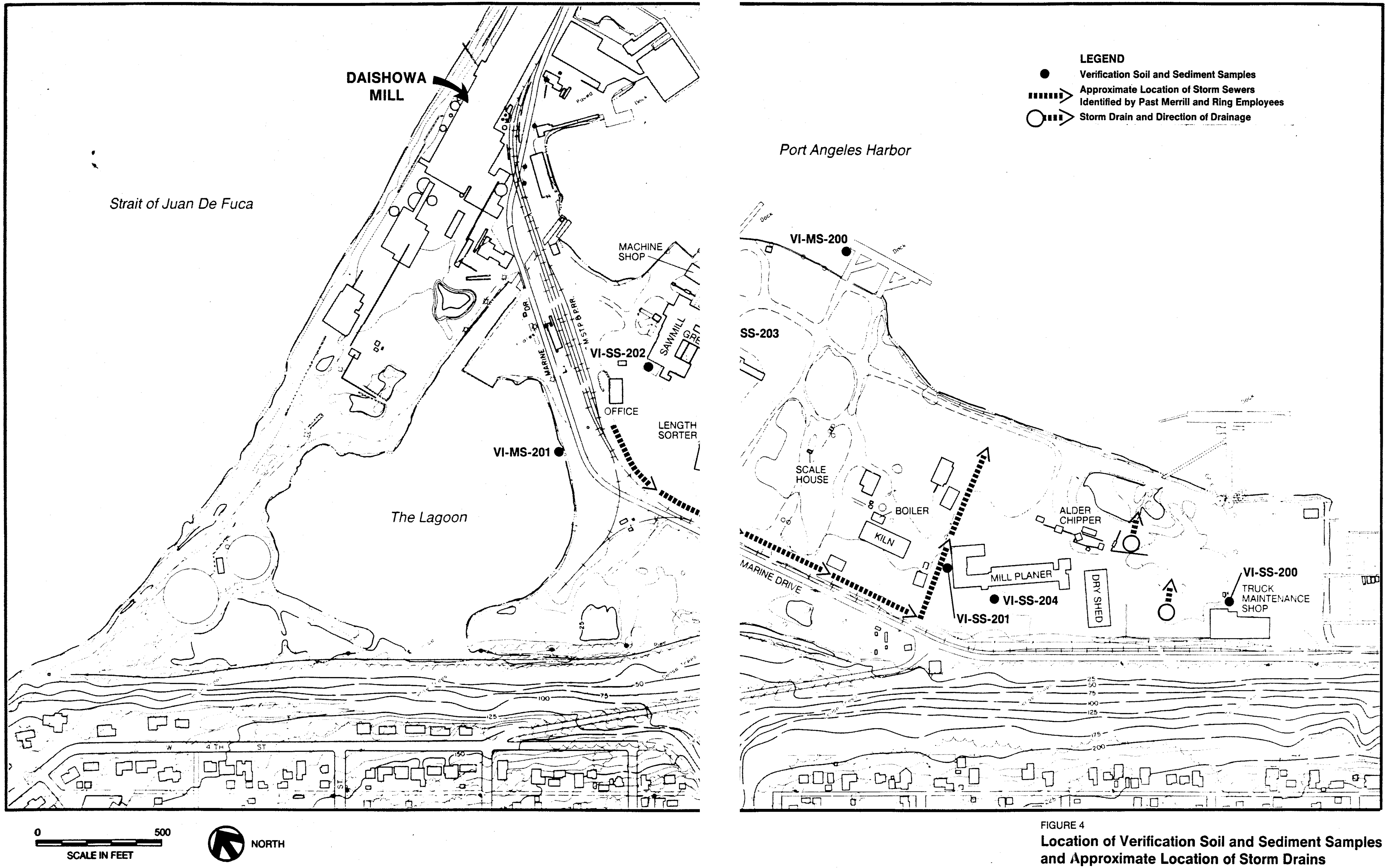


FIGURE 4

Location of Verification Soil and Sediment Samples and Approximate Location of Storm Drains

Although the samples collected as part of the Focused Site Investigation were not specifically collected to replicate or verify work conducted by Hart Crowser, the results are significant to this study. For example, 34 soil samples were collected from within the Focused Site Investigation Area from depths of up to approximately 50 feet and analyzed for mercury. Mercury was selected for analysis because available information on sapstain control chemicals indicate that at least one formulation historically used in the wood products industry contained mercury (John Cult, American Wood Preserver's Institute, pers. comm., July 1988).

All groundwater samples referenced in this Technical Memorandum were collected from monitoring wells located within the Focused Site Investigation Area. All soil, sediment, and groundwater samples were collected and analyzed in accordance with the protocol outlined in the Focused Site Investigation Sampling and Analysis Plan (CH2M HILL, 1988).

3.0 RESULTS

The results of the records search and review, interviews, and laboratory analyses are presented below.

3.1 RECORDS SEARCH AND INTERVIEWS

The data collected during the records search and personal interviews are discussed below by each source of information.

3.1.1 U.S. Environmental Protection Agency, Region X

CH2M HILL requested available files or information pertaining to the former M&R site from EPA Region X on September 2, 1988. EPA's Freedom of Information Officer reported that EPA did not have any records regarding operations or environmental problems at the former M&R site (M. Neilson, U.S. EPA, pers. comm., September 1988).

3.1.2 U.S. Coast Guard

CH2M HILL requested information on any oil or chemical spills that may have occurred in Port Angeles Harbor adjacent to the former M&R site. From 1973 to October 1987, approximately 322,000 barrels of oil were spilled into Port Angeles

Harbor (U.S. Coast Guard, computer printout, September 1988). Two separate spills released a total of 13 gallons of creosote into Port Angeles Harbor. These spills occurred on March 28, 1980, and March 20, 1984. The precise location of the spills is not stated in the computer printout provided by the U.S. Coast Guard. The sources of the spills were also not identified, but Ecology records indicate that they were not associated with the M&R facility.

3.1.3 Washington State Department of Ecology

In August 1988, CH2M HILL requested any available Ecology records pertaining to the M&R site. In addition, CH2M HILL reviewed Ecology archive records and current files on October 4 and 13, 1988.

Available archived records (from the mid-1940s to the present) were reviewed. These records included inspection reports prepared by the Washington Pollution Control Commission (WPCC) and Ecology. Based on these reports, it appears that site inspections were not conducted regularly. A former Ecology employee reported that the frequency of inspections through the years was based on awareness of environmental problems, size of the regulated industry, and the budget of the regulatory agency (F. Monahan, pers. comm., September 1988). When agency funds were reduced or limited, inspections were curtailed, particularly at facilities without a record of major problems and located long distances from the regulatory agency's office. Since there were no significant problems at M&R, Ecology appears to have investigated the facility infrequently.

The first record of a wastewater discharge permit issued to the M&R facility (1608 Marine Drive) by WPCC was in 1964. However, according to a 1974 discharge report, no specific wastewater abatement practices were in use (Ecology, 1974). In 1975, M&R applied for, and was issued, a National Pollutant Discharge Elimination (NPDES) permit to discharge surface runoff and noncontact cooling water to Port Angeles Harbor from four outfalls. There are no records in Ecology files indicating permit violations or fines. The permit required that M&R monitor the effluent weekly for total oil and grease and quarterly for total flow and temperature. The permit (No. WA-0037942) was renewed in 1985.

In 1972, a sanitary sewer from the M&R office building was connected to the city sewer system (Ecology, Inspection Report, 1972). Sanitary wastewater from M&R process areas were not tied to the city's system until later. Prior to connecting the onsite sewage systems to the city, all sewage waste went to septic tanks.

At 1313 Marine Drive, a company called Fibreboard operated between 1919 and 1972, producing paper packaging materials and wallboard from virgin pulp and waste paper stock. Raw products used in the production process were wood, ammonia, sulphur, waste paper, resin, alum, and fuel oil. Based on Ecology records, the major documented source of pollution at the Fibreboard section of the M&R site appears to have been pulp mill effluent discharged to the Port Angeles Harbor. Fibreboard was issued its first wastewater discharge permit in 1956. The permit was renewed in 1961.

Sludge beds with a high fiber content were observed near the wastewater discharged at Fibreboard according to the WPCC (1969). These beds were removed by M&R in 1973 (Ecology, 1978). The WPCC was also concerned with air pollution from the main boiler stack at Fibreboard. It was reported that vegetation on the hillside west of the plant tended to turn brown during the summer; this was attributed to sulfur dioxide in the exhaust system (WPCC, 1968).

Other areas of concern according to Ecology included log storage and wood debris piles located close to the harbor (Ecology 1977, Ecology 1973, Ecology 1975). Some leakage of oil from storage containers was also documented (Ecology 1975).

The first Ecology record of wood preservative being used at the site was found in an inspection report dated February 8, 1983. The report described a spray booth located in the new planer mill where Permatox 180 was used. No problems were identified in the inspection report.

3.1.4 State of Washington Department of Social and Health Services (DSHS)

CH2M HILL requested information from DSHS regarding community or municipal drinking water wells located in the vicinity of the M&R site. DSHS has no record of community or municipal wells located in Sections 4 or 5 of Township 30N, Range 6W (S. Tung, pers. comm., September 1988).

3.1.5 City of Port Angeles Planning Department

The City of Port Angeles Planning Department reported that they had no information on operations or ownership of the M&R site (City of Port Angeles Planning Department, pers. comm., September 1988).

3.1.6 Port of Port Angeles

William Oliver (pers. comm., August 1988), the Marine Terminals Manager for the Port of Port Angeles, reported that the Port purchased a portion of the site (1608 Marine Drive) from the Charles Nelson Corporation in December 1944 and January 1945. The property was first leased to M&R for a mill site in 1958. From 1963 to 1969, the lease agreement was amended to include newly filled harbor land. In 1977 the site occupied by P. A. Hardwood was included in the lease agreement with M&R. Mr. Oliver reported that in 1967 M&R constructed a dock on the land leased from the Port.

In the late 1960s or early 1970s, M&R acquired the Fibreboard mill site. Mr. Oliver reported that the origin of the fill material used by the Port, M&R, and Fibreboard to create the filled land is not known.

3.1.7 Port Angeles Fire Department

Hazardous material and fire prevention specialists for the Port Angeles Fire Department reported that, since 1980 when the department began maintaining files on hazardous waste releases, there is no record of spills at the M&R site (Ed Bonollo, Hazardous Materials Specialist, and Jeff Abram, Fire Prevention Specialist, pers. comm., September 1988).

3.1.8 Interviews with Current and Former Employees of M&R and Daishowa

Former employees of M&R report that Permatox 180, diluted at 55:1 with water, was used in a dip tank at the green chain, in an old spray booth (removed in the mid-1980s) located southwest of the green chain, and in a spray booth in the new planer mill. Small amounts of dilute Permatox 180 may have spilled or dripped from the wood as it moved along the green chain. Since there is no concrete or asphalt surface underneath the green chain, liquid dripping from the moving logs presumably infiltrated into the soil below. (Paul

Hopkins, Bill Lester, John Strean, Daishowa, pers. comm., September 1988; Dale Woodside, pers. comm., August 1988).

In 1971 the old planer mill was destroyed by fire. An unknown number of barrels containing undiluted Permatox 180 were in the building and burned during the fire. The building had a concrete floor, but some of the Permatox 180 may have drained to surrounding soils during fire suppression (P. Hopkins, B. Lester, and J. Strean, Daishowa, pers. comm., September 1988).

According to employees who worked for M&R, Permatox 180 was used to treat wood at the old planer mill for at least 15 years (P. Hopkins, B. Lester, and J. Strean, Daishowa, pers. comm., September 1988). In addition to Permatox 180, fungicides, fuel oil, and sulphur were used at the Fibreboard site. The names or types of fungicides used are not known (D. Woodside, pers. comm., August 1988).

Permatox 180 was also applied with a sprayer to wood at the southwest side of the sawmill. To the knowledge of M&R's past employees, Permatox 180 did not drain from the area during the spray process as the material was applied on a concrete slab. All preservative residues in dip tanks and spray booths were either used in process or disposed of at the Port Angeles solid waste landfill; they were not disposed of on the site.

It was also reported that lumber was sealed with a wax-based paint at a location west of the new planer mill. This paint was green in color and may have caused green stains on the soil near the area of application. M&R removed the stained soils in June 1988 (P. Hopkins, B. Lester, and J. Strean, Daishowa, pers. comm., September 1988).

Former M&R employees report that the City of Port Angeles stormwater drains located onsite follow the railroad tracks in a southeast direction, then traverse the M&R property and discharge to the harbor at the approximate midsection of the property (Figure 4). It was reported that there are two drains west and north of the truck maintenance shop that are plugged. In the past, a black oozing material was observed in the drains (P. Hopkins, B. Lester, and J. Strean, Daishowa, pers. comm., September 1988, and D. Woodside, pers. comm., August 1988). The source of this material is not known.

3.1.9 Newspaper Archives, Paper Mill File, Port Angeles Public Library

Newspaper articles in the "Paper Mill File" at the Port Angeles Public Library were reviewed on August 3, 1988. The file contained newspaper articles from the mid 1940s to the early 1980s. These articles provided historical land use and economic information for industries located at the site.

3.2 ANALYTICAL RESULTS

Table 2 presents analytical data for soil, marine sediment, and groundwater samples. Sample locations are shown on Figures 3 and 4.

PCP and/or TCP were detected in groundwater samples collected from six of the nine Hart Crowser wells that were sampled. PCP and TCP concentrations in groundwater ranged up to 3.07 and 2.84 mg/l, respectively (the highest concentrations were for samples collected from well MW-6A).

With the exception of TCP at 2.2 mg/kg in the soil sample collected from near the maintenance shop, PCP or TCP was not detected in any soil sample collected for the verification study. The same soil sample collected from near the maintenance shop was also analyzed for TPH and TOX. TPH was detected at 3,400 mg/kg. No organic halogens were detected. Mercury was detected in nine soil samples collected in the Focused Site Investigation Area. Where detected, mercury concentrations ranged from 0.048 to 0.286 mg/kg. These concentrations are within the published background range for mercury (0.01 to 0.3 mg/kg) in soil (Lindsay, 1979).

No PCP or TCP was detected in either sediment sample collected. TOC was detected in both sediment samples at 15,000 and 17,000 mg/kg.

A complete summary of the Method 8040 data and the Quality Assurance/Quality Control (QA/QC) data is presented in Section 4.0 of the Focused Site Investigation Report (CH2M HILL, 1988). A complete summary of the analytical results associated with the Focused Site Investigation Area is presented in the same report.

Table 2
Summary of Verification Study Results for TCP and PCP

				Hart Crowser Data		Verification Study Method 8040							
						Round 1		Round 2					
Location	**Corresponding HC Sample No.**	**Verification Sample No.**	**Matrix**	**TCP**	**PCP**	**TCP**	**PCP**	**TCP**	**PCP**	**TOC**	**TPH**	**TOX**	**Units**
MW5	MW-5A	DSA-MW5	Groundwater	0.01 U	0.01 U	0.005 U	0.005 U	0.005 U	0.005 U				mg/l
		DSA-MW5	Groundwater					0.005 U	0.005 U				
MW6A	MW6A	DSA-MW6	Groundwater	Data Not Reported	5.7	2.84	3.07	0.28 N	0.51 J				mg/l
		DSA-MW6A	Groundwater										
MW8	MW-8	DSA-MW8	Groundwater	0.001 U	0.001 U	0.005 U	0.005 U	0.005 U	0.005 U				mg/l
		DSA-MW8A	Groundwater										
MW15	MW-15	DSA-MW15	Groundwater	0.01 U	0.01 U	0.005 U	0.005 U	0.005 U	0.005 U				mg/l
		DSA-MW15	Groundwater										
MW16A	MW-16	DSA-MW16	Groundwater	0.01 U	0.59	0.105 N	0.052	0.006 N	0.005 U				mg/l
		DSA-MW16A	Groundwater										
MW18	MW-18	DSA-MW18	Groundwater	0.01 U	0.01 U	0.005 U	0.006	0.005 U	0.005 U				mg/l
		DSA-MW18	Groundwater										
MW19	MW-19	DSA-MW19	Groundwater	0.01 U	0.01 U	0.005 U	0.015	0.345 U	R				mg/l
		DSA-MW19	Groundwater										

J = Quantitatively suspect
U = Undetected above this concentration
N = Qualitatively suspect
R = Unable to calculate due to interference

TOC = Total Organic Carbon
TPH = Total Petroleum Hydrocarbon
TOX = Total Organic Halogens

Table 2 (continued)

Summary of Verification Study Results for TCP and PCP

				Hart Crowser Data		Verification Study Method 8040							
						Round 1		Round 2					
Location	**Corresponding HC Sample No.**	**Verification Sample No.**	**Matrix**	**TCP**	**PCP**	**TCP**	**PCP**	**TCP**	**PCP**	**TOC**	**TPH**	**TOX**	**Units**
MW21	MW-21	DSA-MW21	Groundwater	0.01 U	0.01 U	0.005 U	0.21	0.005 U	0.005 U				mg/l dry wt.
		DSA-MW21	Groundwater										
MW22	MW-22	DSA-MW22	Groundwater	0.01 U	0.01	0.005 U	0.025	0.005 U	0.005 U				mg/l dry wt.
		DSA-MW22	Groundwater										
Marine Sediment	OSS-1	VI-MS-200	Sediment	0.09	0.30	3.9 U	3.9 U			17,000			mg/kg dry wt.
Lagoon	Area Not Sampled	VI-MS-201	Sediment	NA	NA	1.4 U	1.4 U			15,000			mg/kg dry wt.
Maintenance Shop	SS-3	VI-SS-200	Soil	0.10	0.09	2.2	1.8 U				3,400	<0.020	mg/kg dry wt.
New Planer Mill	SS-1	VI-SS-201	Soil	0.44	0.64	2.5 U	2.5 U						mg/kg dry wt.
Saw Mill	Area Not Sampled	VI-SS-202	Soil	NA	NA	1.2 U	1.2 U						mg/kg dry wt.
Green Chain	SS-6	VI-SS-203	Soil	0.05 U	0.05 U	1.9 U	1.9 U						mg/kg dry wt.
New Planer Mill	Area Not Sampled	VI-SS-204	Soil	NA	NA	1.5 U	1.5 U						mg/kg dry wt.

J = Quantitatively suspect
U = Undetected above this concentration
N = Qualitatively suspect
R = Unable to calculate due to interference

TOC = Total Organic Carbon
TPH = Total Petroleum Hydrocarbon
TOX = Total Organic Halogens

4.0 DISCUSSION

Included in this section is a discussion of the verification study data with emphasis on historical land use and use of PCP at the site. The analytical data collected during the verification study is also compared to the results reported by Hart Crowser in the initial environmental assessment report.

4.1 HISTORICAL LAND USE OF THE M&R SITE

In order to present the historical land use information for the M&R site in as clear a manner as possible, the historical land use of each of the three parcels is discussed separately (i.e., by address) in the following sections. A chronology of businesses operating on these parcels since 1912 is included in Table 3.

Table 3
BUSINESSES LOCATED ON THE M&R SITE

Address	Name of Business	Approximate Years of Operation
1608 Marine Drive	Puget Sound Mill & Timber Co.	1912 to 1914
	Charles Nelson Mill	1914 to late 1920s
	Washington Cafeteria	1941 to 1948
	Western Lumber Co./ M&R Western Lumber Co.	1955 to 1988
	Hansen's Boat Yard	1959 to 1960
	Nelson Shipyard	1962 to 1967
	P. A. Hardwood	mid-1960s to 1977
	Daishowa America Co. Ltd.	1988 to present
1417 Marine Drive	Peninsula Shingle	1959 to 1964
	Angeles Shake & Shingle	1965 to 1972
	Levaque Co.	1973 to present
1313 Marine Drive	Fibreboard	1919 to 1972
	M&R Lumber Co.	1972 to 1988
	Daishowa America Co. Ltd.	1988 to present

1608 Marine Drive

The parcel of land identified as 1608 Marine Drive is approximately 25 acres and consists of tideland that was filled over a period of several years (William Oliver, Port of Port Angeles, pers. comm., August 1988). The first reported commercial development of this parcel occurred in 1912. The Puget Sound Mill & Lumber Company (also known as Earles Mill) was built on land that Michael Earles purchased from Charles Nelson, the first reported land owner. The Puget Sound Mill & Lumber Company operated a saw mill, a shingle mill, and a planing mill on the property in addition to storing logs and operating drying kilns. The site also contained a power supply facility (boiler and engine room) and a shipping dock (Hart Crowser, 1988).

In 1914, the mill was renamed the Charles Nelson Mill. It is assumed that the change in name was the result of land ownership reverting back to Charles Nelson, the original property owner. The Charles Nelson Mill was in operation until the late 1920s. During the 1930s, the site was not used, presumably because of the Great Depression.

By the mid-1940s, mill buildings were in disrepair and the site was condemned by the Port Angeles Fire Department. Shortly after, the demolition firm P. G. Piedmont Co. was hired to demolish the mill's dilapidated wood structures using a controlled fire. The fire was reportedly fueled by gasoline, crude oil, tar paper, and old tires (Port Angeles Library File, *Chronicle*, January 2, 1985, and an unknown Port Angeles area newspaper article from the mid-1940s).

Between late 1944 and early 1945, the Port of Port Angeles purchased the land from Charles Nelson (William Oliver, Port of Port Angeles, pers. comm., August 1988). Land use from the mid-1940s to 1955 is not well documented. It is believed that the land was vacant and at times was used for log storage. Hart Crowser (1988) reports that Port Angeles Forest Products used the site during the 1940s. Records reviewed by CH2M HILL did not document this business.

In 1955, the Western Lumber Co. opened a remanufacturing mill on the site that cut rough-cut lumber. From the mid-1960s to the mid-1970s, P. A. Hardwood was also located on this site. P. A. Hardwood operated an alder and hardwood sawmill with a dry kiln and cut rough lumber from logs (Paul

Hopkins, Daishowa, pers. comm., December 1988). In 1977 M&R acquired the lease for this parcel of land.

By 1962, the Western Lumber Co. changed its name to Merrill & Ring Western Lumber Company; this name remains today. M&R produced wood chips used for paper production and remanufactured lumber. By 1984, operations at M&R had been scaled down and only the chip mill was operating (Port Angeles Library File, Port Angeles Daily News, September 18, 1984). In February 1988, the Port of Port Angeles leased the land to Daishowa America Co., Ltd.

During the period from 1941 to 1967, several small businesses were located on the site. These included a cafeteria and log sorting yard (Polk Guides 1940 to 1988). No additional information on the operation of these businesses was available.

1313 Marine Drive

The parcel of land at 1313 Marine Drive is approximately 20 acres in size. Commercial development of this parcel began in 1919 when Fibreboard opened a plant. The plant produced boxboard, sulphite pulp, and wood chips. Feedstocks used to manufacture these products included aqueous ammonia, alum, resin, fuel oil, and sulphur (Testimony of Vern Basom, manager of Fibreboard, to Washington Pollution Control Commission, June 1958).

Fibreboard operated at the site until 1971 when the property was sold to M&R. In 1971, M&R purchased the property, removed many of the structures, and built a new planer mill on the site. The new planer mill included a spray booth, which was used for treating finished lumber with Permatox 180 (P. Hopkins, B. Lester, J. Strean, Daishowa, pers. comm., September 1988 and D. Woodside, pers. comm., August 1988). M&R sold this parcel of land to Daishowa in 1988.

4.2 COMPARISON OF ANALYTICAL DATA TO HART CROWSER RESULTS

The TCP and PCP data collected during the verification study were compared to the corresponding TCP and PCP data presented in the Hart Crowser (1988) report. Table 2 presents analytical data for samples collected by both Hart Crowser and CH2M HILL. Because different analytical methods were used during the Hart Crowser and CH2M HILL studies, the two data sets are not directly comparable, particularly on a quantitative basis. The modified EPA Method 8150 data provided by the laboratory that analyzed the samples for Hart Crowser did not include any QA/QC data to demonstrate quantitative accuracy. The quantitative reliability of data is generally established with calibration factors, accuracy measurements (spikes), precision measurements (replicates), and blank measurements. These data were not presented. Furthermore, the methods used by the laboratories that performed the analyses for Hart Crowser were not the EPA recommended procedures for analysis of PCP and TCP. The data do, however, provide some qualitative information that is useful for comparison of the verification study results.

Other factors to consider when comparing the data include the following: First, marine sediments for the verification study were not collected at the same locations as those collected by Hart Crowser. This was because Hart Crowser collected the samples from the intertidal zone during a minus tide. During the sampling conducted for the verification study, minus tides were not occurring. Therefore, samples were collected by a diver working from a boat. Sample locations were not as close to shore as those collected by Hart Crowser. Second, surface soil samples collected during the verification study may not be representative of the same material sampled by Hart Crowser, even though samples were collected in the same area. For example, after Hart Crowser collected their soil samples, M&R removed some of the soils exhibiting hydrocarbon stains (Hart Crowser, 1988 and P. Hopkins, B. Lester, J. Strean, pers. comm., September 1988).

As referenced earlier, nine groundwater monitoring wells installed by Hart Crowser were sampled for verification purposes. TCP was not detected in any sample collected and analyzed by Hart Crowser. TCP was detected in verification study samples collected by CH2M HILL from wells MW-6A and MW-16A at concentrations of up to 2.84 mg/l. PCP was detected by Hart Crowser in wells MW-6A, MW-16A, and MW-22 at concentrations of 5.7, 0.59, and 0.01 mg/l, respectively. PCP was detected during the verification study in all three of these wells at concentrations of up to 3.07 mg/l. The PCP concentrations in the verification study samples collected from MW-6A and MW-16A were lower than those detected by Hart Crowser. The PCP concentration detected in the verification study sample collected from MW-22 was slightly higher than that detected by Hart Crowser. In addition, PCP was detected in the verification study samples collected from wells MW-18, MW-19, and MW-21 at concentrations of up to 0.21 mg/l. PCP was not detected in samples collected by Hart Crowser from these three wells. Possible explanations for the differences between the results reported by Hart Crowser and CH2M HILL are addressed in the Focused Site Investigation Report (CH2M HILL, 1988).

Only one marine sediment sample was collected from Port Angeles Harbor during the verification study. This sample was collected from near the large dock located at the 1608 Marine Drive property. Neither PCP nor TCP were detected above the detection level of 3.9 mg/kg. Hart Crowser reported both PCP and TCP at concentrations of 0.30 and 0.09 mg/kg, respectively, in a marine sediment sample collected from a nearby location. It is not possible to compare these results directly because of the difference in the method detection levels used during the two studies. A sediment sample was collected from the lagoon west of the former M&R property during the verification study. Neither PCP nor TCP was detected.

Five surface soil samples were collected from the former M&R property during the verification study. With the exception of TCP at 2.2 mg/kg in the sample collected from near the maintenance shop, no PCP or TCP was detected. Three of these five samples were collected from the same approximate locations as samples collected by Hart Crowser. Both PCP and TCP were detected by Hart Crowser in two of these three samples. PCP and TCP were detected at 0.09 and 0.10 mg/kg, respectively, in a sample collected from near the maintenance shop. PCP and TCP were detected at 0.64 and 0.44 mg/kg, respectively, in a sample collected from near the new planer mill.

In summary, the verification study conducted by CH2M HILL did not reveal any areas of soil or sediment contamination that were not previously identified by Hart Crowser.

4.3 ANALYTICAL CRITERIA AND QA/QC

Section 5.0 of the Focused Site Investigation Report (CH2M HILL, 1988) presents a complete description of the comparison of laboratory data to accepted analytical criteria. A detailed explanation of the QA/QC data collected for the verification study is included in Section 4.0 of the same report. In general, the QA/QC data for the verification study were within acceptable ranges.

4.4 USE OF PCP AT THE SITE

It is not known when PCP was first used at the site although it was mentioned in an Ecology inspection report written in February 1983 (Ecology Inspection Report, February 8, 1983). During this inspection, the spray booth located in the new planer mill was inspected. It was reported that the spray booth was fully enclosed and that all overspray and drippings were directed into a containment tank. Prior to this inspection report, there was no mention in the Ecology files of PCP being used at the site. This implies that if PCP was used prior to 1984, there were no major problems associated with its storage, use, or disposal.

Past employees of M&R were asked when PCP was first used at the site. All stated that PCP or Permatox 180 was used for at least 15 to 20 years (P. Hopkins, B. Lester, J. Strean, Daishowa, pers. comm.). They also reported that Permatox 180 was expensive and, therefore, care was taken not to spill or waste any of the product.

Research into the commercial use of PCP indicates that it was first used in the 1940s (Hunt and Garrat, 1953). This information, when considered in conjunction with historical site information, indicates that the earliest PCP use at the site was most likely the mid-1950s when the Western Lumber Company began operations there.

5.0 CONCLUSIONS

Review of available information for the former M&R site indicates that there is one area in which information and data are minimal and further investigation may be warranted. The exact location of storm drains on the property is not known. Preliminary data obtained in this study indicate that the potential for significant contamination at the site is low. However, storm drains and drainage ditches may be a source of contamination and/or a pathway for transporting contamination to and from the site. An accurate plan of the storm drains and ditches on the site needs to be developed. An investigation to characterize the storm drains may include one or more of the following:

- Identify the location of any seeps entering Port Angeles Harbor.
- Identify the location of storm drains that parallel railroad tracks and traverse the former M&R property.
- Identify the location and source of storm drains northwest of the truck maintenance shop and collect samples from these drains for chemical analysis.
- Collect water and soil (sludge) samples from randomly selected seeps and drains to characterize material conveyed and accumulating in the drains.

Chemical analyses should focus on PCP, TCP, and TPH.

6.0 RECOMMENDATIONS

Based on the personal interviews, research, sampling, and analyses conducted for this verification study, it is believed that chemical contamination at the former M&R property is known (hydrocarbons at the truck maintenance area and PCP/TCP near the former green chain), it is low-level contamination, and the contamination is limited to the areas where the chemicals were used. Specific recommendations for the site are included in Section 6.0 of the Focused Site Investigation report (CH2M HILL, 1988).

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