RI/FS and IRAM DEVELOPMENT WORK PLAN
PHASE 1

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

July 15, 2002

1964 Oblique photo, courtesy Port of Astoria

Prepared by:

EnviroLogic Resources, Inc.
8948 SW Barbur Boulevard #56
Portland, Oregon 97219
(503)768-5121
www.h2ogeo.com

July 15, 2002
10077.002

Oregon Department of Environmental Quality
Northwest Region
2020 SW Fourth Avenue
Suite 400
Portland, Oregon 97201-4987

VIA Hand Delivery

Attention: Anna Coates

Subject: RI/FS and IRAM Development Work Plan
Astoria Area-Wide Petroleum Site
Astoria, Oregon
DEQ ECSI File #2277

Dear Ms. Coates:

Enclosed are three bound and one unbound copies of the above-referenced work plan. This work plan is being submitted to you on behalf of the Astoria Area-Wide PRP group as required in DEQ Order No. ECSR-NWR-01-11. Included with these copies is a CD that contains the entire document as well as supporting documentation.

Comments provided to the PRP Group in your letter of June 11, 2002, have been addressed in the work plan. In our telephone conference of June 19, we discussed some clarifications of DEQ's comments and I believe the work plan reflects the understanding reached. If upon your review there are issues that need further clarification, these can be addressed most efficiently through an addendum to the work plan. Our intent is to begin field work in the middle of August 2002.

Please call me at (503)768-5121 if you have any questions or comments.

Sincerely,
EnviroLogic Resources, Inc.

<<ORIGINAL SIGNED>>

Thomas J. Calabrese, R.G.
Principal/Hydrogeologist

cc: Distribution list attached

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Astoria Area-Wide Petroleum Site
Astoria, Oregon

July 15, 2002

Prepared for:

Astoria Area-Wide PRP Group

Prepared by:

***EnviroLogic Resources, Inc*.**
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Astoria Area-Wide Petroleum Site
Astoria, Oregon

July 15, 2002

This report has been prepared by *EnviroLogic Resources, Inc.*, of Portland, Oregon.

EnviroLogic Resources, Inc. Project No. 10077.002

By

Melanie N. Hance
Associate Project Geologist

Lynn D. Green
Senior Project Geochemist

Thomas J. Calabrese, RG
Principal/Hydrogeologist
Project Manager

REGISTERED PROFESSIONAL
OREGON
Thomas J. Calabrese
G1784
GEOLOGIST

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RI/FS and IRAM DEVELOPMENT WORK PLAN
PHASE 1

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

1.0 INTRODUCTION

The Oregon Department of Environmental Quality (DEQ) issued a unilateral order requiring the investigation and potential cleanup of properties in an area near the Port of Astoria in Astoria, Oregon. The Order (DEQ Unilateral Order No. ECSR-NWR-01-11) was issued to several of the current and former facility operators, property owners, and leaseholders that have engaged in industrial and commercial activities. ChevronTexaco Products Company (ChevronTexaco), Delphia Oil Company (Delphia), McCall Oil and Chemical Company (McCall), Ed Niemi Oil Company (Niemi Oil), Flying Dutchman and Harris Enterprises (Harris/Van West), Port of Astoria (the Port), Qwest Communications International (Qwest), and Shell Oil Company (Shell), collectively potentially responsible parties (PRPs), are identified in the Order and have agreed to comply with its requirements. The area of interest is termed the Astoria Area-Wide Petroleum Site (Astoria Area-Wide) and the Regional Study Area (RSA) within which investigations will be focused is shown on Figure 1.

A proposal to conduct a Remedial Investigation/Feasibility Study (RI/FS) and Interim Remedial Action Measures (IRAM) at the Astoria Area-Wide site was submitted by the PRPs to the DEQ on January 21, 2002 (*EnviroLogic Resources*, 2002). The proposal addressed the requirements of the Order and provided DEQ with a summary of planned activities and investigations to be conducted at the Astoria Area-Wide site prior to the formalization of the Astoria Area Wide RI/FS and IRAM Development Work Plan (Work Plan, this document). Comments received from the DEQ on the proposal and the Draft Work Plan have been incorporated into the scope of work described in this Work Plan.

This Work Plan provides details regarding investigations to be conducted during the Phase 1 RI at the Astoria Area-Wide site. The purpose of this document is to provide the DEQ with sufficient detail to understand the scope and magnitude of known releases of petroleum constituents to the environment, present the proposed scope of work for further evaluating these releases, explain procedures for data collection, and describe how data and information will be reported. The RI/FS will be implemented in accordance with the Oregon Administrative Rules (OAR 340-122) under the Order. In addition, elements of U.S. Environmental Protection Agency (EPA) "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (EPA, 1988) will be used in the preparation of the RI/FS documents and in performance of the investigations and evaluations.

EnviroLogic Resources, Inc., will be managing the RI/FS and IRAM development, defining quality assurance procedures, and preparing documentation for submittal to DEQ on behalf of the PRP Group in response to this Order. Each PRP has retained an environmental consultant to conduct the investigations on their property and to represent them in joint PRP activities.

The Work Plan is organized into the following sections:

Section 1.0 Introduction. This section provides a description of the properties and the development history and outlines the regulatory framework surrounding the RI/FS process. The objectives for the RI/FS and IRAM development work are presented followed by a discussion of the environmental investigations conducted previously at the properties that comprise the Astoria Area-Wide site.

Section 2.0 Site Environmental Conditions. This section summarizes the Initial Evaluation requested in the Order and describes the current understanding of the site geology and hydrogeology, nature and extent of chemicals of interest, and potential migration pathways for the facility. Data gaps that are the focus of the RI for Phase 1 are discussed to provide rationale for the proposed scope of work.

Section 3.0 Remedial Investigation. The scope of work for the Phase 1 RI activities is presented in this section. Included are proposed field activities and data collection efforts for soil and ground-water investigations, quality assurance/quality control procedures, and data evaluation and management protocols.

Section 4.0 IRAM Development. The process to be used to evaluate interim remedial action measures (IRAM) to remedy releases of hazardous substances to the environment is presented in this section. In addition, the IRAM process was applied to the known diesel and suspected gasoline seep to the Columbia River at Slip 2 of the Port.

Section 5.0 Endangerment Assessment (EA). This section presents the conceptual work plan for conducting an EA based on the results of the RI. Included are proposed methods for conducting human health evaluations, including identification of constituents of concern for the facility, an exposure assessment, a toxicity assessment, and risk characterization, and the steps for conducting environmental evaluations for each phase.

Section 6.0 Feasibility Study. This section presents the work plan for developing and evaluating appropriate remedial actions for areas of the facility addressed during the Phase 1 RI. Included are the evaluations to be used to conduct each phase of the FS.

Section 7.0 Reporting. The timing, frequency, and nature of reports to be produced during the RI/FS are described in this section.

Section 8.0 RI/FS Schedule. This section presents the schedule for RI/FS activities, including field programs, laboratory analysis, and reporting. The schedule extends through the end of the project as described in the Order.

Section 9.0 Project Management. This section identifies key personnel and the organization for the RI/FS project team.

Section 10.0 Community Relations Plan. The public involvement process is described in this section

Section 11.0 References. This section lists references identified throughout this work plan.

The Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), the Health and Safety Plan (HASP), and other supporting documentation are included as appendices to this work plan, Appendices A, B, and C, respectively. Table 1 presents a listing of the abbreviations used throughout the Work Plan. The entire document has been stored on a CD located at the back of the document.

1.1 BACKGROUND

The Astoria Area-Wide site comprises properties located at and near the Port in Astoria, Oregon (Figure 1). The Regional Study Area (RSA) includes the Astoria Area-Wide site and the surrounding areas. The RSA is located in Section 7, Township 8 North, Range 9 West, and Section 12, Township 8 North, Range 10 West, Willamette Base and Meridian. The Astoria Area-Wide site includes that property bounded by the Burlington Northern Railroad tracks to the southeast, Portway to the northeast, the Columbia River to the northwest, and Hamburg Street (including the former McCall bulk plant); and the property bounded by the Burlington Northern Railroad tracks to the northwest, Hamburg Street to the southwest, Marine Drive to the southeast, and Portway to the northeast.

A topographic high to the east forms a prominent hill overlooking the RSA. West Marine Drive (US Highways 26, 30, and 101) is located on a topographic bench approximately 15 feet above the level of the Port facilities. The Columbia River flows to the west on the north side of the RSA. Young's Bay lies to the south.

The area around the Port has been used for petroleum storage and distribution since the 1920s. Aboveground storage tanks (AST), underground storage tanks (UST), and pipelines are present on several of the facilities subject to this investigation. Historically, the area was home to at least four bulk petroleum storage facilities and five vehicle fueling or service stations between West Marine Drive and the Columbia River in the RSA. Pipelines from at least two of the bulk fuel storage facilities extend onto piers at the Port. The area is currently zoned for industrial and commercial uses and is expected to remain so. Figure 2 shows the RSA and the locations of each of the properties subject to the Order. Remedial actions have been conducted at several facilities in the RSA.

1.2 SITE HISTORY

Past development activities at the Astoria Area-Wide site provide clues to the locations of potential sources of release of hazardous substances. The discussion of the site history presented below is based on a review of aerial photographs from years 1939 to 2001. Sanborn Fire Insurance maps for the years 1948, 1959, 1965, 1967, and 1969 were acquired and reviewed by *EnviroLogic Resources*. These documents are included in the CD at the back of this Work Plan. Historical photographs available at the Port of Astoria were also reviewed. Sanborn maps for 1908, 1921, 1924, 1934, 1940 and 1954 were reviewed at the Astoria Public Library by Maul, Foster & Alongi, Inc.

Much of the land and many of the structures present at the Astoria Area-Wide site through the 1990s were constructed during the 1920s. The lower elevations of the RSA were initially under water as part of the Columbia River as shown by a photograph taken in 1915. The 1908 Sanborn map indicated that the current Val's Texaco site was occupied by a "bunk house" and a boardwalk that extended to the northwest toward a wharf. Tidal flats were located east of the Val's Texaco property at that time. In time, the area comprising the currently-developed area was constructed with fill, primarily from dredge spoils (silt, sand), and rip rap, and the piers were constructed. Pier 3 was constructed last and had been completed by 1922. All three piers were improved with buildings or warehouses. Railroads were constructed on Industry Street and in the area south of the piers. There were small docks entering Slip 2 that housed fueling stations from pipelines from the bulk oil storage facilities located near the Port. At the base of Pier 2 were a water tower and a small building.

PNG Environmental, Inc., reported of a pre-1930 historical photograph that shows Astoria Independent Oil Company located on or adjacent to the former Mobil/Niemi Oil Bulk Plant site. The Mobil Oil Bulk Plant at 490 Industry Street was built circa 1925 by one or more of Mobil's predecessors, including General Petroleum Corp. and Pilot Oil. A 1927 utility map shows that the Mobil Oil bulk plant included two fuel ASTs (420,000-gallon and 26,000-gallon), acid and alkali ASTs, ancillary equipment (pump house, piping), warehouse, garage, steam boiler and cesspool. The 1927 utility map also shows an Associated Oil Co. facility located on the northeastern portion of the current Niemi Oil Cardlock facility (former Burns-Johanson Bulk Plant property) and Shell on the current Oregon State Police Astoria Patrol Office site.

By 1939, four ASTs had been installed at the McCall property (1 large, 3 smaller) along with the pump house building. Additional ASTs had also been installed at the Mobil/Niemi Oil Bulk Plant property with some smaller buildings. A concrete fire wall surrounded the Mobil/Niemi Oil AST. West of the Mobil/Niemi Oil property, a building was constructed that appeared to have been the location of a boiler. This building was thought to be the former Astoria Oil Services building according to documentation from DEQ. The actual location of Astoria Oil Services was at the north end of Pier 3. East of the Mobil/Niemi Oil property, were three buildings – a former furniture manufacturing building and two steel works buildings. East of the steel works building is the former Shell Oil site. This site had five ASTs surrounded by berms and a few buildings by 1939. Between the Shell Oil property and Portway were the Bergeson buildings that are still present today.

The block between Industry Street and West Marine Drive was vegetated. At the Delphia property between 1934 and 1939 a metal warehouse with a wood floor was constructed on the north side of the bulk oil site and two 25-foot-high steel ASTs, an oil pump, and a filling station were constructed on the west side of the site. One to two residences and a grocery store appeared on the Val's Texaco portion of the Delphia site on the Sanborn maps between 1921 and 1954.

A building was constructed north of the McCall property at the base of Pier 3 as shown on the 1944 photograph. By 1945, the Port office and shop buildings were constructed and there was no longer a building next to the water tower. The base of Slip 2 appeared to have fill removed. The river edge was not far from the Port buildings and there was a dock connecting Piers 3 and 2. A building was being constructed on the Qwest property during 1948.

The 1948 Sanborn map shows the furniture warehouse building was run by the Uptegrove Lumber Company. The building was a veneer plant by this time, which included veneer dryers, a saw mill, a peeler, and fuel storage. The docks into Slip 2 used for fueling for small boats were present in 1948. Two small buildings at the base of Slip 2 were described as a paint shop and wash rack, and two small buildings south of these stored a fueling/maintenance cart.

Between 1948 and 1953, two more tanks were added to the Shell site for a total of seven ASTs. A couple of the buildings were removed to accommodate the new tanks. Also during this time, a new office, warehouse, garage building (same dimensions as current structure), additional ASTs and new loading rack were added to the Mobil/Niemi Oil property. By 1957, a total of seven ASTs were in place at the Mobil/Niemi Oil property, ranging in size between 2,000 to 420,000 gallons. The building at the Qwest property had been completed by 1953. The two former steel works buildings on Port property were joined by an addition. Residential-type development occurred at the ChevronTexaco property and the Harris/Van

West site. In the late 1940s or early 1950s, a machine shop was constructed on the east side of the Delphia property. The building was used as a machine shop until the early 1980s.

A third AST was added to the Delphia property between 1957 and 1958. More residential-type development occurred near the ChevronTexaco property. A junkyard/ storage area covered the area now occupied by the Niemi Oil cardlock and the north half of the Harris/Van West property.

By 1959, there was no longer an oil filling service on the small dock into Slip 2 as shown on the 1959 Sanborn map. Also shown on this map was the addition of a small office building next to the two small buildings at the base of Slip 2. The Port office building was leased by the US Navy. North of the Port office building, between the Port office and the water tower, was a small building used as a welding and machine shop. The 1959 Sanborn map shows the building north of McCall was the Contractor's Warehouse. There was a small building north of this at the base of Pier 3 used for welding. Additions to the furniture and steel works buildings occurred between 1958 and 1963. All these buildings appear to be under one roof by 1963. Also by 1963, the junkyard area was fenced off and a residential-type building was constructed on the south side of the area.

The former furniture manufacturing building was occupied by Port Plywood Company by 1965. Operations included wood storage, veneer manufacturing and storage, a machine shop, and fuel storage. The 1966 aerial photograph shows the junkyard covering only the Niemi Oil Cardlock property, which at that time was owned by Burns-Johanson Company through 1978, when the property was sold to Niemi Oil Company. Service stations had been developed at the Harris/Van West property and the Delphia property by this time. Logs for processing and export were stored at the base of Pier 3. The amount of wood stored varies between years/ photos. The largest amount of wood storage occurred in 1989.

By the late 1960s, several small buildings at the Port had been removed and Slip 2 had been reconfigured with fill added at the south end of the slip. Also, one larger building was built at the ChevronTexaco property with a fence surrounding the property.

One more AST was added to the Delphia site between 1970 and 1973, bringing the total number of ASTs to four. The western portion of the bulk plant property was paved with asphalt in the 1970s. Between 1973 and 1974, the furniture manufacturing building was removed. The property was left vacant with a few storage containers as shown on the 1974 aerial photo. The Shell facility closed in 1972 and all ASTs and associated above-ground piping and loading equipment were reportedly removed from the site between 1973 and 1974. Two ASTs were removed by Mobil Oil from the Mobil/Niemi Oil Bulk Plant facility in 1974. Additions to the area between 1973 and 1974 included the Burns-Johanson Bulk Plant on the Niemi Oil Cardlock preperty and a building on Pier 2. In 1976, Mobil sold bulk plant facilities to Niemi. By 1978, the storage containers on the former furniture manufacturing building property, and the largest ASTs at the Niemi Oil bulk plant property were removed. The former steel works building was removed by 1983. In the early 1980s, the Delphia Oil bulk facility office and warehouse operations were moved from the original oil warehouse into the machine shop building on the east side of the property.

The 1989 aerial photograph shows much of the north part of the Astoria Area-Wide site being used for wood/log storage. This includes all of Pier 3, excluding the area covered by the warehouse building, most of Slip 1, the base of Slip 2 around the Port shop, and in the area of the former furniture and steelworks buildings. Development continued at Piers 1 and 2 as new buildings were added. A portion of the southwest side of the Pier 2 was burned in a fire that occurred sometime between 1983 and 1989. New development also occurred on the property south of the McCall bulk plant by 1989 while the ChevronTexaco property appears vacant. The present Oregon State Police building was constructed at the former Shell site in the late 1980s.

In 1993, the original oil products warehouse on the Delphia property was removed and the area was graveled. By 1994, the structure at the Harris/Van West service station was removed. Two of the residential buildings remain between the Harris/Van West and ChevronTexaco sites; one is a longer apartment-type building. In the early 1990s, a 12,000-gallon paper machine oil (lube oil) AST surrounded by a concrete secondary containment wall was installed inside the warehouse at the Delphia property. A tank farm (east tank farm) was installed in the early 1990s directly west of the Delphia Oil Bulk Facility office/warehouse building. The east tank farm includes an 8,000-gallon hydraulic lube oil AST, a 4,500-gallon diesel lube oil AST, a 4,000-gallon paper machine oil (lube oil) AST, and an empty 500-gallon AST within a secondary containment structure including a concrete slab and walls. According to Mr. Delphia, the eastern portion of the Delphia Bulk Oil facility was paved with asphalt in the early 1990s.

Young's Bay Texaco was built on the ChevronTexaco property by 1995. The retaining wall between the Niemi Oil Cardlock facility and the Harris/Van West property is visible in the 1995 aerial photo, as well as the boom in Slip 2 near the diesel release that occurred in the early 1990s. In 1996, six USTs that were originally installed by Texaco were removed from the Val's Texaco service station area on the Delphia property. Prior to the removal of the USTs, new above-ground tanks were installed in a vault located in the northeast corner of the Val's Texaco site. One diesel UST remains in service at the site. A new building was constructed on the Harris/Van West property by 1998.

The building on Pier 3 was torn down by 2001 but the foundation of the building is still present. Some small buildings were constructed at the base of Pier 3, and a third Port shop building was added on the west side of the previous shop building. The boom installed by McCall in Slip 2 is visible in the 2001 photo. Development continues in the area. During 2002, the ASTs at the McCall bulk plant were removed for a new development and AST foundations and walls at the Niemi bulk plant were demolished. In April 2002, the historic water tower overlooking the Astoria Area-Wide site was torn down. Columbia River water was used to fill this water tower when it operated for fire protection.

The site development history includes installation and demolition of features that can be considered potential sources of the release of chemicals to the environment. Some of these features have been addressed through environmental investigations conducted in the past. Others have not been evaluated. Table 2 presents a listing of the features at each facility that have been identified as potential sources. Often, the installation or demolition dates are not known, but dates inferred from the site history discussion are presented to provide a time period that a particular potential source may have been in existence. Releases that may have occurred from these potential sources are largely unknown. Chemicals of interest related to these potential sources are based on the type of feature and are principally petroleum hydrocarbons. The table also indicates those potential sources that have been subject to investigative efforts in the past. These investigations are described more fully in Section 1.5.

1.3 REGULATORY FRAMEWORK

The environmental investigations conducted in the past at the properties that comprise the Astoria Area-Wide site have been done under several regulatory programs. Matters relating to USTs have been investigated and, in some cases, remedied under rules promulgated in OAR 340-122-0205 through 340-122-0360, and their predecessors. These cleanup rules are applicable specifically to leaking petroleum UST systems. ASTs and releases from pipelines have been investigated under OAR 340-122-0010 through 340-122-0140, and their predecessors. These hazardous substance remedial action rules apply to releases of hazardous substances from sources other than USTs but may be considered relevant and appropriate for addressing UST issues. In addition, permits for discharge of storm water have been issued pursuant to ORS 468B.050.

The Order issued by the DEQ requires that a RI and FS be performed at the Astoria Area-Wide site in accordance with Oregon Revised Statutes (ORS) 465.200 et seq., and rules promulgated as a result of the statute. The scope of investigation and analysis for the RI/FS is contained in the hazardous substances remedial action portion of the rules. However, portions of the UST rules may be applied to aspects of the RI/FS if deemed applicable or relevant and appropriate. Specifically, OAR 340-122-0244 (Risk-Based Concentrations) may be used to evaluate risk associated with the release of petroleum hydrocarbons to the environment.

1.4 OBJECTIVES

The overall goal of the RI/FS is to collect data sufficient to characterize the nature and extent of contamination at the Astoria Area-Wide site and to determine appropriate exposure scenarios for an EA so that remedial action alternatives that are protective of human health and the environment can be identified and evaluated. Specific objectives of the RI/FS, as described in the Order, include:

- Identify the hazardous substances released to the environment and develop a list of chemicals of interest (COIs);
- Define the nature and extent of hazardous substances in affected media on and offsite;
- Evaluate the direction and rate of migration of hazardous substances in affected media;
- Generate or use data of sufficient quality for site characterization, risk assessment, and the selection of remedial alternatives;
- Identify migration pathways and receptors;
- Evaluate the risk posed to human health and the environment;
- Identify hot spots of contamination;
- Implement IRAMs, where appropriate, based on imminent threats; and
- Develop a remedial alternative or alternatives to remedy potential threats to human health or the environment, as appropriate.

These objectives will be met through the RI/FS process. Site-specific objectives include:

- Develop and implement an IRAM to mitigate discharges of petroleum hydrocarbons to the Columbia River;
- Develop and implement an IRAM to mitigate volatile organic compound (VOC) vapor intrusion into buildings at levels exceeding DEQ risk-based concentrations, as appropriate;
- Document the storm water conveyance systems and characterize surface-water quality;
- Locate underground utilities and evaluate their potential to act as potential conduits for the migration of contaminants;
- Determine how tidal and seasonal influences are likely to effect interim or final remedial options for the facilities; and
- Complete a beneficial land and water use survey.

Each PRP will be compiling information about their facilities to meet these objectives. The information developed will be presented in a comprehensive evaluation of these issues for the Astoria Area-Wide site.

1.5 SUMMARY OF PREVIOUS INVESTIGATIONS

Several investigations and remedial actions have been conducted already at facilities at the Astoria Area-Wide site. These previous site investigations have included UST decommissioning; characterization of soil and ground water at UST, AST, and pipeline release sites; ground-water monitoring; and soil and ground-water treatment activities. Table 1 presents a chronology of these environmental activities organized by PRP. Data collected during these activities have been compiled, to the extent practical, and organized into a data management system for the Astoria Area-Wide RI/FS. The data have been evaluated on an area-wide basis and are presented in Section 2.0.

Evidence of a release of petroleum hydrocarbons was detected at the former Chevron service station on the ChevronTexaco property in June 1990. Impacted soil was identified associated with the pump islands and the USTs. The site was decommissioned in 1992, with USTs, piping, dispensers, and buildings removed. Over the next four years a program of investigation, UST decommissioning, soil treatment, and ground-water monitoring was conducted. Following four quarters of compliance monitoring, DEQ issued No Further Action status for the site.

By 1995, the Youngs Bay Texaco had been constructed on the ChevronTexaco property. In 1997, an overfill of the AST caused a release of gasoline to the adjacent Qwest property. Air sparging and soil vapor extraction systems were installed and operated until August 1997. Investigations in 1997 identified impacted soil and ground water under the adjacent Qwest building.

At Val's Texaco on the Delphia property, 25 gallons of gasoline were spilled near the pump island in 1991. The spill was caused by an attempted theft and occurred after the station had closed for the night. Sorbent material was used to contain the spill. There was no indication that the spill reached a storm or sanitary sewer drain. Five gasoline USTs and one used oil UST were removed from Val's Texaco in October of 1996. The former product lines for these USTs were removed from the pump island dispensers, cut off near the USTs, and capped when new ASTs were installed in 1993 (prior to the UST decommissioning) (PNE, 1994b). Eleven confirmation soil samples were obtained from the UST excavation pit and analyzed for TPH-HCID. Petroleum hydrocarbons were not detected at or above the laboratory reporting limit in any of the samples. Ground water was not encountered in the tank pit. Environmental investigations have not been conducted to date at the bulk plant portion of the Delphia property.

The McCall bulk plant had been a heavy oil, marine terminal since the 1920s. During the 1940s until the 1960s, tank bottoms were placed in open pits in the field behind the bulk plant. During the 1980s, environmental issues at the McCall bulk plant focused on tank bottom wastes. In 1984, 52,000 gallons of these wastes were removed. In 1985, most of the remaining tank bottom wastes were removed and the residual waste was consolidated into one pit. In 1987, EPA conducted a Preliminary Assessment of the bulk plant. Based on the removal of the waste, the non-drinking water-use of the aquifer, and the containment of surface runoff at the site, EPA recommended No Further Action under Superfund. In 1996, a subsurface investigation identified the minor residual tank bottom waste and elevated TPH and metals concentrations in shallow soil in limited areas near the tanks as the only areas of concern. During the demolition of the tanks and site structures in April 2002, impacted pavement and soil was identified in the area of the former pump building and an previously-unknown UST was located.

In May 1993, the pipeline leading from the bulk plant to the piers failed a tightness test and subsurface investigations ensued. Free phase hydrocarbons were detected migrating to the Columbia River at Slip 2 and a recovery system was installed. The system is not currently operating.

The former Burns-Johanson Bulk Plant/Niemi Oil Cardlock facility was the subject of a subsurface investigation conducted during 1997 and 1998. Some sampling of soils was conducted by DEQ at the Mobil/Niemi bulk plant property in 1996. Work conducted as part of this RI/FS will continue the investigations at these site.

Astoria Oil Services operated at the north end of Pier 3 at the Port. An investigation and soil excavation was completed in 1986 at this site. Three USTs were removed in 1993, one near the maintenance shop and two near the West Mooring Basin. Impacted soil was treated on site. Sediments undergo regular evaluation as part of the Port's dredging program. Sediments are generally dredged on an annual basis. Dredged material is deposited in-water at approved locations. Storm-water sampling occurs at the Port of Astoria under the 1200Z NPDES permit. Data from he November 2001 sampling event from two of the outfalls are the only data available at this time. An updated Storm Water Pollution Control Plan (SWPCP) was submitted to the DEQ in June 2002.

Qwest decommissioned a 10,000-gallon UST and conducted a soil investigation at their maintenance garage during 1997. The decommissioning was conducted in place, since the tank was located partially under the Qwest Astoria building. An investigation was performed and consisted of the collection of soil and ground-water samples during the advancement of 32 soil borings.

No environmental investigations have been conducted to date at the former Shell facility.

In 1990, losses of product were discovered at the Harris/Van West facility. Free phase petroleum hydrocarbons were later detected in the sewer line that runs past the Red Lion near the site. A free product recovery and ground-water treatment system was installed and four USTs were removed. A ground-water monitoring program was initiated that same year. Formal decommissioning of the USTs and treatment of excavated soil were conducted in 1993.

2.0 SITE ENVIRONMENTAL CONDITIONS

An initial evaluation of site environmental conditions at the Astoria Area-Wide site was conducted to gain an understanding of the hydrogeologic framework and conduits through which chemicals of interest (COIs) may migrate. The nature and extent of COIs in site media from historic releases were analyzed from information and data developed during the previous investigations.

2.1 REGIONAL HYDROGEOLOGIC SETTING

Source material for alluvial sediments in the RSA is derived from the surrounding mountains. Dredged material comes from river sediments that have been transported from the surrounding mountains as well as from upland areas of the Columbia River upstream. Hydraulic characteristics observed in the water-bearing materials beneath the RSA are, in part, defined by the nature of the source material and nature of their deposition.

Dredged materials and alluvial sediments underlie most of the RSA adjacent to the Columbia River. To the southeast, marine sedimentary rocks form the bedrock to an alluvial layer. The depth of this alluvial material has not been determined. Ground water flows northwest after infiltration to the alluvial material, except where diverted by storm-water management features and other utility lines. The depth to water is variable across the RSA, ranging from 7 feet in depth below ground surface near the Columbia River, to 19 feet in depth near West Marine Drive.

2.1.1 Topographic Setting

The City of Astoria is located at the western margin of the Oregon Coast Range, at the mouth of the Columbia River. The Coast Range is a north-south trending range with a maximum elevation of about 5,000 feet above mean sea level (msl), extending from the latitude of Coos

Bay northward into Washington State. Generally, mountain passes through the range reach about 1,000 feet elevation. The Coast Range in Oregon is bounded on the east by the Willamette Valley and on the west by the Pacific Ocean.

Astoria is situated on a peninsula that protrudes westward into the bay at the mouth of the Columbia River. North of Astoria is the main channel of the Columbia River. South of Astoria is Young's Bay. Across Young's Bay and to the west are fine-grained bay sediments and young, active dunal sands (Sweet, 1977; Schlicker and others, 1972; and Niem and Niem, 1985). Much of these low-lying areas are at, or just above sea level. Because of the low elevation, many areas associated with the bay sediments are marshy or just above the water table.

2.1.2 Regional Geology

The Coast Range is composed primarily of Tertiary volcanic and sedimentary rocks, with a few intrusive dikes, sills, and plugs. The basement rocks are the Siletz River Volcanics, which are oceanic basalts that originated as seamounts on the ocean floor. As the western edge of the North American Plate moved westward, converging with the northeastward movement of the oceanic seafloor, the seamounts rising to substantial height above the floor were too large to subduct at the plate boundary subduction zone. These basalts became accreted to the North American Plate, effectively moving the plate margin westward (Orr and Orr, 1999; and Wells and others, 1983).

In late Paleocene or early Eocene time, the accreted Siletz terrane began subsiding, while areas to the east were uplifted. The uplift resulted in the erosion and incursion of large volumes of sediment into the subsiding coastal area. The southern Coast Range had the earliest and greatest amount of subsidence, leading to the deposition of the Roseburg, Lookingglass, and Flournoy Formations in that area. The northern Coast Range subsided about late Eocene time, with development of a marine environment with brackish embayments and development of the classic continental shelf and slope profiles. The subsidence of the northern Coast Range led to the burial of the Siletz volcanics by the Yamhill Formation (representing continental shelf muds and silts (Wells and others, 1983), equivalent to the Hamlet formation of Niem and Niem (1985) and Rickreall and Buell limestones (interpreted as aprons of shell banks marginal to low volcanic islands and seamounts). These formations were in turn overlain by the Tillamook Volcanics (subaerial basalt flows) and the 5,000-feet thick Nestucca Formation, representing deep water deposition of muds and silts with considerable contribution of sediments and volcanic ash from the Clarno and then the Cascade volcanic arc to the east. The Cowlitz Formation was deposited in shallow brackish waters at approximately the same time. Overlying the Cowlitz Formation is the Keasey Formation (Niem and Van Atta, 1973), composed of fine volcanic ash deposited in a deep-water setting (Niem and Niem, 1985; Orr and Orr, 1999).

Around the beginning of the Oligocene, shallow-water conditions developed in the northern Coast Range, with shifting deltas and brackish backwater bays. Into this environment was deposited the tuffaceous glauconitic sandstones and tuffaceous siltstones and claystones of the Pittsburg Bluff and Scappoose Formations. The Scappoose Formation contained significant amounts of muscovite, quartz, and potash feldspar, indicating sediment contribution from the Idaho Batholith. In the middle to late Oligocene, the southern and central Coast Range experienced an uplift, which was accompanied with emplacement of several prominent intrusions, which as erosional remnants now occupy the highest elevations within the range. However the northern portion of the Coast Range remained a shallow seaway. The Miocene age Astoria Formation, the predominant rock unit of the Astoria peninsula, is composed of fossiliferous sandstones and siltstones. The fossil assemblage of corals, mollusks, crabs, turtles, seals and even hoofed mammals is suggestive of a shallow to very shallow marine environment (Niem and Niem, 1985; Orr and Orr, 1999; Wells and others, 1983; Niem and Van Atta, 1973).

The middle Miocene to the present is characterized by general uplift and retreat of the marine shoreline from the area now characterized as the northern Coast Range. However, in the middle Miocene, voluminous flows of the Columbia River Basalt Group flowed into western

Oregon through the ancestral and present day Columbia River Valleys. The flows continued to flow westward through lows in the Coast Range and along the channel of the Columbia River, until they reached the ocean margins. In many places within the range the basalt flows have been shown to be invasive into the soft sediments they buried, creating dike-like and sill-like intrusive-appearing bodies. All three formations of the Columbia River Basalt Group (Grande Ronde Basalt, Wanapum Basalt, and Saddle Mountains Basalt) entered the northern Oregon Coast Range. The basalt flows are typically found at higher elevations, including as the capping unit on the Astoria peninsula. Also present at one location (near the top of the Astoria peninsula) is the Troutdale Formation (Niem and Niem, 1985; Niem and Van Atta, 1973), deposited as the ancestral deposits of the Columbia River. The Troutdale Formation was probably emplaced 12 million to 2 million years before present (Tolan, 1982).

The Pleistocene was characterized by dramatic changes of sea level in response to climatic changes (ice ages) as well as influx of catastrophic floods. As the ice ages waxed four times, marine terraces were cut into the headlands and shoreline areas, with deposition of marine beach sands and gravels on the wave-cut terraces. The older terraces are at higher elevations, with succeeding terraces cut at successively lower elevations. Fluvial-cut terrace deposits are described as alluvial silt, arkosic and basaltic sand, and semi-consolidated cross-bedded to medium-bedded, poorly sorted basaltic gravel (Niem and Niem, 1985; Orr and Orr, 1999; and Niem and Van Atta, 1973). Geologic workers have sometimes included elevated tidal flat marshes with these deposits. Colluvium deposits of the marine terrace deposits are frequently semi-lithified and are a relatively extensive, mappable, geologic unit (Priest, G.R., 2002).

Alluvial/bay muds and tidal flats are present along portions of the Columbia River mouth, as well as along other areas of the northern Oregon Coast. Active dunes and shore sands are present along the Columbia River Spit and surrounding shoreline areas (Sweet, 1977; Rankin, 1983; Reckendorf and others, 2001).

2.1.3 Regional Hydrogeology

The Columbia River is the predominant river of the Pacific Northwest, draining very large areas consisting of the Columbia Plateau, Deschutes Basin, Willamette Valley, Owyhee Region, Snake River Basin, and surrounding highlands around those basins. Between 1997 and the present, Columbia River mean daily streamflows measured near Quincy, Oregon, varied between 117,000 and 400,000 cubic feet per second (USGS, 2002). Other, smaller rivers and creeks flow out of the Northern Coast Range directly to the ocean or to the Columbia River and its estuary.

In the Columbia River's lower reach and within the estuaries at the mouths of the smaller rivers and creeks, water levels rise and fall in response to tidal forces. The stream gage at Quincy in the Columbia River shows that between early January 2002 and mid-February 2002, Columbia River gage levels varied from 0 to 8.1 feet. The tidal influence of the Columbia River extends eastward past Portland to Bonneville Dam in the center of the Cascade Range. The tidal influence results in daily flow reversals of the river and, to a limited extent, sediment transport processes. Despite the flow reversals, predominant flow pattern and transport pattern is westerly, toward the Columbia River mouth at the ocean margin.

At sea level elevations, snowfall is rare. At higher elevations snowfall accumulation becomes significant. The following briefly summarizes Astoria weather data. January is the coldest month, with an average high temperature of 48^{o}F and average low temperature of 37 ^{o}F. The hottest month is August, with an average high temperature of 69 ^{o}F and an average low temperature of 53 ^{o}F. Winter precipitation averages 10-inches per month, but decreases to 1.15-inch average during July, the driest month. Windspeeds average 8- to 10-miles per hour each month of the year. Winter wind directions are typically easterly, but become northwesterly during the summer months. In the Spring and Fall, wind directions predominantly are southwesterly or southeasterly (Weather Underground, 2002).

Ground-water use is limited in the Coast Range to domestic wells because of low permeability of bedrock units (Frank, 1970). Ground water in some of the bedrock units bears relatively high concentrations of sodium and chloride due to contributions from connate salt from the original marine depositional environment. Ground-water use is also generally limited in the mud flats, marine beach deposits, and sand dune areas, because of water quality issues and possible seawater intrusion into wells. However at least one water purveyor has developed the fresh ground-water lens above salt-bearing ground water with a horizontal well collection system (Pacific City). F. J. Frank (1970) reported that moderate amounts of ground water could be pumped from the dune and littoral (i.e., beach) sand aquifer from properly constructed wells.

2.2 LOCAL HYDROGEOLOGY

Much of the RSA has been filled with dredged spoils based on historical photographic information and information gleaned from previous subsurface investigations conducted at various locations at the Astoria Area-Wide site. The Columbia River flowed over much of the northern portion of the RSA, as shown in photographs taken in 1915 and 1920 (provided on the CD). Since 1915, dredged spoils were used to fill much of this area, creating additional land base. Piers 1, 2, and 3 were constructed to service Slips 1 and 2. The Port maintains these slips by dredging annually. The dredged spoils are deposited in the river on the outgoing tide from November to the end of February under a flow-lane permit. When dredging is conducted at other times, the dredged material is stored in-water at the base of Slip 2 until it can be disposed.

Boring logs recorded during previous investigations indicate that the soil types are highly variable across the site. The deposition of the fill materials was not conducted in a single event, and may have involved different source materials from different source locations. Additionally, dredge spoils are often pumped into fill areas or end-dumped from trucks, making lithologic and stratigraphic correlations of the subsurface environment difficult. The variability in the soil types is demonstrated on a cross section of the conceptual hydrogeologic model shown on Figure 3. This model was developed using logs of borings and wells located near the Port office buildings, the Niemi Oil Cardlock site, and the Harris/Van West site. The soil types logged at the site consist of various percentages of gravel, sand, silt, silty clay, and other fill material. While some borings encounter similar geologic materials as nearby borings, correlations across the Astoria Area-Wide site cannot be drawn with certainty based on the current data. Most of the borings drilled at the site do not appear to have encountered the native geologic units deposited by the Columbia River. Table 4 presents information concerning each of the soil boring or well locations cataloged at the Astoria Area-Wide site. The locations of soil borings identified at the site are shown on Figure 4 and monitoring-well locations are shown on Figure 5.

The depth to ground water is variable across the site, ranging from 7 feet in depth near the Columbia River, to 19 feet in depth near West Marine Drive. Variation in the ground water elevation generally reflects the topography, as the properties along West Marine Drive are approximately 15 feet higher in elevation than those along Industry Street and near the Columbia River. A retaining wall is present along the north sides of several of the sites along West Marine Drive. Ground-water elevations are shown on the conceptual site model (Figure 3). Since ground water is shallow and the entire site consists primarily of fill material, the ground-water system at the site is primarily influenced by tidal effects of Young's Bay and the Columbia River, as well as recharge from the higher topographic areas of the Astoria peninsula. It has been reported that the elevation of the ground-water system can vary by as much as 10 feet in response to tidal changes (JCR Consultants, Inc., 1986).

Ground water generally flows in a northwest direction except where diverted by storm-water management features and other utility lines. However, currently there is not enough ground-water elevation data across the Astoria Area-Wide site to produce a potentiometric surface map. Based on descriptions of grain-size and sediment texture characteristics, SEACOR estimated the hydraulic conductivity in the vicinity of the Harris/Van West site to range from 200 to 300 gallons per day per square foot (gal/day/ft^2) (SEACOR, 1992). It is not possible to assign a specific hydraulic conductivity to the entire site due to the variety of soils present, lack of lithologic data across the site, and lack of hydraulic testing information.

An inventory of borings and wells was developed using the GRID database provided by the Oregon Water Resources Department (WRD). Based on information obtained from this database search and from Port personnel, no water-supply wells appear to exist on or near the site. Boring and monitoring-well logs from previous investigations and reports were also reviewed. Twenty-one (21) monitoring wells have been reportedly drilled at the site. The WRD database was also searched for possible water rights related to properties on site. There are no places of use or points of diversion or appropriation located on or near the Astoria Area-Wide site.

2.3 STORM WATER AND SURFACE WATER SYSTEM

The goal of this surface water, storm water, and subsurface utilities review is to determine if underground utility corridors and storm water drainage features potentially provide preferential ground water and contaminant flow paths, influencing the pattern of ground-water flow and contaminant distribution across the site. Additionally, storm-water flow is a contaminant transport mechanism; therefore, an understanding of both historic and current storm-water management strategies is necessary to gain an understanding of potential contaminant transport pathways. Public utility diagrams provided by the City of Astoria Public Works Department and the Port were reviewed as part of this work plan preparation.

2.3.1 Surface Water Features

Southeast of the Astoria Area-Wide site is a hillside rising to approximately 275 feet, to the crest of the Astoria peninsula (Figure 1). The bedrock in this area consists of the low-permeability Astoria Formation. Precipitation falling on the Astoria peninsula tends to be shed (i.e., drain) as surface water or interflow, rather than penetrating into the bedrock unit.

The hillside has been developed as a predominantly residential neighborhood. Surface drainage on the slope and infiltrating interflow naturally flow toward the northwest, toward the Astoria Area-Wide project area. Development of the area with streets, sewer services, and other infrastructure has resulted in disruption of the natural storm water flow pattern. The effectiveness of the infrastructural controls on limiting the down-slope flow of surface water and interflow of the natural storm-water patterns are as yet poorly understood. However, interflow and a certain amount of surface drainage undoubtedly contribute to a recharge area at the southeast side of the Astoria Area-Wide site.

No natural drainages are noted crossing the unconsolidated deposits underlying the Astoria Area-Wide site. However, topographic analysis of the hillside to the southeast indicates the development of reentrants that probably direct recharge to the unconsolidated sediments to distinct locations at the base of the hillside. Water shed off the hillside percolates into the unconsolidated sediments at the base of the hillside based on the significantly higher permeability of the unconsolidated sediments, the absence of surface drainages between the base of the hillside and the Columbia River, and the high precipitation rate in this area.

2.3.2 Storm Water and Sanitary Sewer Utilities

A city storm sewer currently runs along the northwest side of West Marine Drive, as shown on Figure 6. Public utility diagrams provided by the City of Astoria and Port indicate the sewer connects to storm water catch basins present on both sides of West Marine Drive and flows toward the northeast. The first two catch basins for this storm sewer are located approximately 500-feet southwest of the intersection of Portway with West Marine Drive.

Public utility diagrams indicate that a city sanitary sewer-line runs along the southeast side of Industry Street. A second city sanitary sewer constructed in 1966 is shown on utility drawings to follow approximately the same alignment, with the exception of a branch-line leading from the current McCall property at the southwestern end of the line. It is not clear if the 1966 line is still in active use. Both lines (the existing City line and the 1966 line) run down the center of Hamburg Street, then turn northeast, running along the south side of Industry Street, intersecting with a northwest-trending sewer-line generally following Portway (Figure 6). Several catch basins were noted along both Industry Street and Portway, and it is understood that this is a combined sanitary/storm water sewer (CSO).

A secondary sanitary sewer trunk intersects the Industry Street main sewer-line from the south, connecting in the approximate middle of the block between Portway and Hamburg Street. Another secondary line is aligned between the industrial and commercial properties fronting West Marine Drive and Industry Streets, connecting with the sewer main following Portway. Again, catch basins are indicated in the same vicinity as this line, suggesting this line may be a CSO.

The Port has a sewer trunk following each of the three piers, as well as servicing the Port office area located in the north-central portion of the Astoria Area-Wide site. These sewer trunks flow generally southeast, eventually intersecting with the sewer main traversing Portway. An abandoned "sanitary sewer" and "sewer pump" are indicated just west of the Port Maintenance Shop (Figure 6).

A 6-inch diameter "tile" (possibly vitrified [terra cotta] construction) sewer line is present in the northern portion of the Astoria area-wide subject area. This drainage feature drains northern areas of the Astoria Area-Wide area, including a "drain" located on the former Shell site, a "drain tile" located on the former steel works and plywood manufacturing area, several catch basins located in the northeast portion of the Astoria Area-Wide area, a 6-inch "tile" sewer trunk-line located at the south end of Pier 2, and a "10" Water Pipe" that ran under the Port office building connecting to a manhole just south of the Port office building.

As many as ten storm-water outfalls are understood to be present at the Astoria Area-Wide site discharging storm water to the Columbia River (Figure 6). The Port submitted a Storm Water Pollution Control Plan (SWPCP) to the DEQ in June 2002. This plan presents a description of the facility covered by the Port's 1200-Z NPDES Permit and the program used to monitor storm-water quality. A Spill Prevention, Control, and Countermeasures Plan is included in the SWPCP. Sample collection for permit compliance will occur at Outfall #1 and Outfall #6.

As part of implementing the Work Plan, additional data will be acquired from appropriate sources regarding construction details of these utilities (i.e., elevation of inverts, depth to utility lines, backfill material, process used in sealing inactive areas, size or construction of the utility, flow direction, etc). Other unidentified sewer and storm features may be present as well. As part of the RI/FS, a detailed utility/geophysical survey will be conducted (Section 3.0) to better identify present and abandoned utilities.

2.3.3 Other Subsurface Utilities

Information obtained to date has not indicated natural gas services in this area. However, since natural gas service is used at the Astoria Area-Wide site, Northwest Natural will be contacted regarding gas utility locations, construction, and depths. Additionally, since a detailed utility survey of the Astoria Area-Wide subject area is planned as part of the Work Plan, natural gas services will be identified as part of that scope of work.

An elevated water tank was present east of the Port office. Private water services and City water lines were not identified in the maps received to date. As part of implementing the Work Plan, these features will be identified by interviews with City staff and during the geophysical survey of the Astoria Area-Wide site. Data will be acquired from appropriate sources (Port of Astoria, City of Astoria, public utility companies) as to construction details of these water distribution utilities (i.e., depth to water lines, backfill material, process used in sealing inactive (abandoned) areas, size or construction of the utility, etc.)

Private underground electrical and communication services were not identified in the maps received to date. As part of the Work Plan these features will be identified, if present, and described (depths, construction, backfill, abandoned/inactive status, etc.), both by interviews with the local electrical power provider, and during the utility locating survey of the Astoria Area-Wide site.

Several bulk fuel facilities are or have historically been located within the Astoria Area-Wide site. Figure 6 shows known petroleum pipeline distributions. Three bulk fuel facilities included extensive subsurface petroleum distribution lines; specifically McCall (former Standard Oil) on the western portion of the RSA, the former Mobil/Niemi Oil site in the approximate center of the study area, and the former Shell site on the eastern portion of the RSA. All three sites had petroleum-distribution lines generally trending from the respective sites to the north central portion of the Astoria Area-Wide site, then extending to Slip 2 and Pier 2. These features will be described more fully (depths, construction, backfill, etc.), from information collected during the utility survey of the Astoria Area-Wide site.

2.4 NATURE AND EXTENT OF COIs IN THE ENVIRONMENT

Site characterization investigations and related remedial actions have been performed on several of the individual PRP sites, and in near-shore sediments by the EPA. Petroleum hydrocarbons and related chemical constituents have been detected in soil and ground water at the Astoria Area-Wide site and data suggest that metals may be present above background concentrations as well. Much of the available data from these previous investigations have been entered into a single Astoria Area-Wide data management system to streamline data analysis. Analytical results were entered into the database directly from available laboratory analytical reports. A listing of analytical data for soil, ground water, storm water, and sediments in the data management system is presented in Appendix D and an MS-Access 2000 file is contained in the CD. Chemicals detected to date and their maximum concentrations detected at the Astoria Area-Wide site are listed in Table 5.

The distributions of key COIs at the site are discussed in the following sections. The discussion encompasses historical data that may represent contamination that has been removed or otherwise addressed and should be considered preliminary, to be refined as a result of the RI. For example, the petroleum hydrocarbon impacted soils at the former Harris/Van West service station site have been removed.

2.4.1 Extent of COIs in Soil

Petroleum hydrocarbons and related constituents comprise nearly all of the detections of COIs at the Astoria Area-Wide site. Figure 7 shows the historical extent of total petroleum hydrocarbons (TPH) in soil on the basis of data collected from previous investigations. TPH has been detected at each of the sites subject to the Order with the exception of the Delphia and Shell sites, and the former Mobil/Niemi property. The following discussion describes the distribution of various fractions and constituents of TPH.

Gasoline-range TPH have been detected in several areas historically as shown on Figure 8. The largest area of historical detections encompasses the former Harris/Van West service station site, Niemi Oil Cardlock property, and the northern portion of the Qwest Property. A second area is located on the Young's Bay Chevron Texaco property, possibly extending to another area of gasoline-range TPH detections on the Qwest property. A third area is located near the former Mobil/Niemi Oil bulk plant and the Port office building.

The historical extent of TPH-diesel in soil is shown on Figure 9. The largest area of impact appears to be the area between the former Niemi Oil bulk plant and the Port office building, and extending to the river at Slip 2. This encompasses the area of the diesel release from the McCall pipeline that was discovered in 1993. Other areas with diesel-range petroleum detections include north of the former McCall bulk plant, Young's Bay Chevron Texaco, and Niemi Cardlock and former Harris/Van West service station area, where diesel-impacted soils have been removed. However, review of the gas chromatograms for samples collected within the Niemi Cardlock and Harris/Van West service station area indicate that most of the reported TPH diesel is carryover from gasoline.

Oil-range petroleum hydrocarbons have been previously detected north of the former McCall bulk plant, in the vicinity of the Niemi Cardlock-Van West Service Station, and west and northwest of the Port Office Building.

Benzene in soil has been historically detected between the former Mobil/Niemi bulk plant and the Port office buildings, coincident with sampling conducted along the McCall pipeline. The Young's Bay Chevron Texaco, the Harris/Van West service station, and at the north end of the Qwest building are also locations where benzene has been detected in soil. Figure 10 shows the extent of benzene in soil on the basis of historical data.

Only two, relatively small areas where polynuclear aromatic hydrocarbons (PAHs) have been detected have been identified to date in soil. One of the locations is the former McCall bulk plant; the other is in the Niemi Oil Cardlock and former Harris/Van West service station area.

Lead was historically detected at one location, near the former McCall bulk plant. Several areas of arsenic detections were noted, near the former McCall bulk plant and along the petroleum distribution pipelines on the northern portion of the Astoria Area-Wide site. Natural background concentrations of metals and concentrations considered background for dredged materials have not been evaluated to date in the area.

Occurrences of COIs in soil appear to correlate well with known or potential sources of petroleum hydrocarbons. Explanations for the presence of gasoline-range TPH and benzene in areas where specific sources have yet to be identified will be developed as part of the RI.

2.4.2 Extent of COIs in Ground Water

Occurrences of petroleum hydrocarbons in ground water have been observed as free and dissolved phases. Figure 11 shows the area where free product has been reported in monitoring wells. Most of the occurrences of free product are in the area near the river at Slip 2. The nature of the free product has not been fully defined and it appears that some gasoline exists along with the principally diesel free phase. This inference is made on the basis of the distribution of benzene in soil and ground water. Additionally, two monitoring wells situated between the Niemi Oil Cardlock and the Harris/Van West properties were both reported to contain free product prior to its removal by Harris/Van West.

Benzene occurs in ground water in an area coincident with and near the diesel release from the McCall pipeline. In addition, benzene has been detected in ground water near the Niemi Cardlock and Harris/Van West service station, and north of the Young's Bay Chevron Texaco, as shown on Figure 12. PAHs have been previously detected northwest of the Port Office Building; north of the Former McCall bulk plant; at the former Harris/Van West service station; and the Niemi Oil Cardlock.

2.4.3 Extent of COIs in Sediment

The Port has conducted dredging operations at Slips 1 and 2 annually since at least 1981. According to the Sampling and Analysis Plan for the Port of Astoria Slips 1 and 2 dated July 30, 1999 (revised September 1, 1999), the Port received a permit allowing dredging and flowlane disposal in 1981 (CREST, 1999). In 1987 the Port received a second permit allowing in-water dredged material disposal in the Columbia River flowlane. The material removed consists of Columbia River sand and silt accumulated over the previous year. Sediments in Slips 1 and 2 are estimated to accumulate at a rate of 4 to 6 feet per year (DEQ, 1996). The Port estimates that a total of 100,000 cubic yards of sediments are dredged from the two slips annually. The dredging occurs to –40 feet mean lower low water (MLLW) in order to maintain 40 feet of depth. Since the slips have been dredged annually over the past years, it is likely that sediments containing COIs would previously have been dredged from the slips.

As part of the annual dredging operations, the Port has collected sediment samples from the dredged sediment from Slips 1 and 2. The data acquired from samples analyzed from the dredged sediments represents the sediment previously removed, not the existing sediment.

Findings from sediment chemical tests conducted in 1987 did not find any COC concentrations above screening levels. Most of the samples containing detected constituents were taken from composite samples. Sampling was conducted using a 2 ½" diameter gravity corer deployed by a Port-owned barge-mounted crane. The gravity corer was maneuvered into place and lowered just over the water surface. The corer was then allowed to free fall the remaining distance so that the corer's barrel could penetrate into the sediments to its maximum possible depth (CREST, 1999). The samples were analyzed for all the parameters listed in Table 8-1, "Screening Level, Bioaccumulation Triggers, and Maximum Levels" of the Dredged Material Evaluation Framework (DMEF). In the data available, the only known constituent detected in the sediments from Slip 2 was 1,2,4-trichlorobenzene. Constituents detected in the sediments from Slip 1 include 4,4'-DDE, ammonia as nitrogen, PAHs, and metals (cadmium, chromium, copper, lead, mercury, nickel, and zinc). The results of sediment sampling are presented in Appendix D. The detected constituents have met the regulatory requirements for disposal under the Port's flow-lane disposal permit. Dredged materials must pass the Army Corps of Engineers' DMEF chemical and physical testing in order to be disposed of in the designated disposal site.

The Port's dredging and flowlane disposal is conducted with a hydraulic 12-inch pipeline dredge. The discharge of dredged sediments into the flow lane can occur only on the outgoing tide between November 1 and February 28. To assure downstream movement of sediments, discharge occurs one hour after ebb tides begin. If dredging is required during the remainder of the year, the Port stockpiles dredged material behind sediment curtains at the south end of Slip 2. Sediment in Slip 2 near the location of the hydrocarbon seep is the primary area of concern for the sediment characterization.

2.5 CONCEPTUAL SITE EXPOSURE MODEL

A conceptual site model (CSM) identifies all potential or suspected sources of contamination, potentially contaminated media, potential pathways of exposure, and potential receptors. The conceptual human health site exposure model is discussed in Section 2.5.1 and ecological receptors are discussed in Section 2.5.2.

2.5.1 Conceptual Human Health Site Exposure Model

An exposure pathway is the course a chemical takes from a source to an exposed population. Exposure pathways include four elements: (1) the source of contamination, (2) the means by which a chemical will be released, retained or travel in a given media (e.g. air, water, soil), (3) a point of potential contact with a receptor and (4) the means by which contact will occur (e.g. inhalation, ingestion). If any of these elements is missing, the pathway is considered incomplete.

Site investigations conducted to date on the Astoria Area-Wide site have identified soil and ground water as the impacted media of concern. The source of these impacts appears to have been related to the historical storage and distribution of petroleum products and possibly as a result of other historical uses of the property. Figure 13 presents the preliminary understanding of the conceptual site exposure model.

Based on the media of concern, potential receptors were identified. On-site workers and future trenchworkers were identified as potential receptors. Additionally, the localized potential for residential receptors was identified since there is a multi-family dwelling occupying a small portion of the Astoria Area-Wide site. The Astoria Area-Wide site is industrialized and zoned for commercial and industrial uses. Residential exposures will be addressed on a site-by-site basis.

The following potential pathways of exposure were identified during the preparation of this Work Plan:

- Ingestion of contaminated water sources by trenchworker;

- Inhalation of air contaminated by way of volatilization and vapor intrusion into buildings;
- Ingestion of and dermal contact with contaminated surface soil;
- Ingestion of and dermal contact with contaminated subsurface soil (trenchworker);
- Dermal contact with contaminated ground water (trenchworker); and
- Inhalation of volatilized constituents from ground water (trenchworker).

The on-site worker and residential scenarios are also considered to be protective of occasional visitors, retail customers and trespassers, whose exposure duration and frequency to on-site contaminants will be relatively limited. The beneficial land use investigation to be conducted as part of the RI will provide more information on reasonably likely future land uses. Presently, no known ground-water drinking water supply wells are present on the subject site, and the City of Astoria public water supply is used in the area. Therefore, ground-water ingestion by residents and on-site workers are not complete pathways. The reasonably likely future beneficial uses of water will be more completely described as part of the RI.

2.5.2 Conceptual Ecological Site Exposure Model

A preliminary conceptual ecological site model showing the potential sources of contamination, contaminant release and transport mechanisms, exposure media, and exposure routes to particular types of receptors is presented in Figure 14. Terrestrial receptors may be exposed to contaminated surface soils. However, no sensitive populations are understood to be present at the Astoria Area-Wide site. Aquatic receptors may be exposed to COIs through surface water or sediments. This model will be modified and refined as more data are acquired.

2.6 DATA GAPS

This section identifies data gaps that should be addressed during the forthcoming RI. During the preparation of this Work Plan, a conceptual hydrogeologic model was drawn, the estimated distributions of key COIs were mapped, and possible human and ecological receptors were identified on the basis of data that has been developed historically at facilities that are part of the Astoria Area-Wide site.

Stratigraphic data are available for shallow soils over portions of the Astoria Area-Wide site. Between these areas data gaps exist that prohibit drawing correlations, both horizontally and vertically. While drawing correlations within fill material from dredged sources may be problematic regardless of the amount of lithologic data collected, a more comprehensive understanding of the variability of soil types will be important in evaluating transport and migration of COIs. The elevation and nature of the contact between dredged and native materials may be important as well. Physical properties of soils, such as moisture content, bulk density, organic matter content, vertical hydraulic conductivity, and grain-size distribution have not been measured at the Astoria Area-Wide site and have an effect on the migration of COIs in soils.

The hydrogeologic properties of the ground-water system are understood in only a limited manner at this time. Water-level information has been recorded sporadically and without intent to extrapolate conditions beyond individual properties. A systematic water-level monitoring program that will allow for evaluation of seasonal and tidal effects will be needed to determine ground-water flow direction(s) and rate of movement. Aquifer testing has been conducted at one property. The potential for significant variability of soil types across the Astoria Area-Wide site suggests that aquifer testing should be performed at additional locations. An appropriate aquifer-testing program may be proposed as an addendum to this Work Plan once the distribution of soil types and COIs are evaluated from data collected during the Phase 1 RI.

The potential for storm-water flow to transport contaminants to other portions of the site and sediments should be determined. Up to ten storm-water outfalls exist near the Astoria Area-Wide site. The locations of these outfalls need to be evaluated with respect to potential sources.

Several areas of the site appear to have relatively complete characterization information locally. The relationship among the various known sources in the RSA and the distribution of COIs as a result of mixing in environmental media is less well understood. The potential source areas related to the historical and present operations and/or releases need to be evaluated. The characterization and delineation of COIs in surface soil, subsurface soil, and sediments needs to be completed with a more regional hydrogeologic understanding as the backdrop. This characterization should include TPH, TPH constituents, petroleum volatile organic compounds (VOCs), PAHs, and metals in soil and ground water, to the extent that TPH is present at a particular location. Once these constituents are analyzed, more specific follow-up analyses may be appropriate. The chemistry of free product that may be encountered needs to be evaluated (i.e., does the product contain 5 percent gasoline or 50 percent gasoline?). By combining this information with the knowledge of historical and present operations conducted at the Astoria Area-Wide site, the origin of the key COIs detected may be more clearly understood. Also, the fate of contaminant species that migrate in the presumed transport direction toward the Columbia River may need to be assessed.

The most recent data collected from the Astoria Area-Wide site is five years old. The estimated distribution of COIs presented earlier is based on these data and may not represent conditions as they are today. In addition, some data is of suspect quality, or analytical laboratory reports are absent. Confirming the accuracy and representativeness of the historical data is important to understand changes that may be taking place in the subsurface through such processes as biological degradation, attenuation, and adsorption. The measurement of certain parameters in ground water needs to be conducted while ground-water samples are collected for laboratory analysis. Field parameters such as pH, temperature, specific conductance, oxidation-reduction potential (ORP), and dissolved oxygen (DO) need to be measured.

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3.0 REMEDIAL INVESTIGATION

The basic objective of the RI at the Astoria Area-Wide site is to collect data sufficient to characterize the nature and extent of COIs from releases that may have occurred during former site operations to use in conducting risk assessments and in evaluating remedial alternatives during the FS process. This objective will be addressed for each PRP and the Astoria Area-Wide site as a whole. The RI will be conducted in a phased approach with each PRP performing a source/soil characterization for its property under quality assurance protocols presented in this Work Plan.

Phase 1 consists of a background investigation; soil, ground water, surface water, and sediment quality characterization; determination of ground-water flow directions and gradients; and a screening-level risk assessment, as described in Attachment A, Section III of the Order.

Background information was collected for each facility to help develop the scope of the Phase 1 RI field investigations. Historical aerial photographs and the results of local, state, and federal environmental database searches were researched and are presented on the CD in this Work Plan. Utility maps and historical site plans from the Port and City of Astoria, and Sanborn maps were used to develop the basemap for the project. A geophysical survey will be conducted on specific properties within the Astoria Area-Wide site to augment and refine utility information as described in Section 3.1.

Beneficial land and water use evaluations will be completed in accordance with DEQ guidance as part of the Phase 1 RI. The results of these evaluations will be submitted as technical memoranda. The reporting process is discussed in Section 7.0.

A soil-boring program has been developed to characterize potential source areas and identify suitable locations for the placement of monitoring wells in the shallow water-bearing zone at the Astoria Area-Wide site. Both soil and ground-water samples will be collected from the borings to evaluate the presence of hazardous substances associated with spills and past practices. The source/soil characterization program for each PRP is described in Section 3.2. Representative soil samples (approximately 12 total) will be analyzed for geoenvironmental properties, as appropriate.

A monitoring-well network will be installed in the shallow water-bearing zone to evaluate the extent of hazardous substances in ground water, and ground-water flow directions and gradients. The monitoring-well network will be developed in a subsequent phase of the RI based on the results of the temporary boring program. Where practical, previously installed wells will be redeveloped and included as part of the network. Seasonal ground-water fluctuations and tidal influences will be characterized by placing pressure transducers/data logger(s) in selected wells and by manually measuring water levels monthly in the monitoring-well network for one year. Ground water in the monitoring-well network will be sampled for chemical analysis on a quarterly basis for one year. The ground-water characterization program is described in Section 3.3.

Soil and ground-water data collected during the Phase 1 RI will be evaluated using DEQ guidance for Risk-Based Decision Making for Petroleum-Contaminated Sites. Other risk assessment techniques will be implemented as described in Section 5.0, as appropriate.

Surface water sampling locations will be established on the basis of the comprehensive storm-water conveyance system evaluation and samples collected to evaluate the quality of surface water discharging to the river and/or recharging the shallow water-bearing zone. The storm/surface water characterization program is described in Section 3.4.

Sediments are dredged from the slips at the Port on an annual basis. Stockpiling of sediments occurs when dredging is necessary but disposal cannot be completed within the permitted time frames.

Sampling locations and key site features will be surveyed as described in Section 3.6. Investigation-derived waste handling is discussed in Section 3.7.

Quality assurance procedures, mentioned in Section 3.8, are discussed in detail in the Field Sampling Plan (Appendix A) and the Quality Assurance Project Plan (Appendix B). The Technical Specifications for Drilling Operations are presented in Appendix E. The Health and Safety Plan for protection of site workers is presented in Appendix C.

Data developed as part of the RI will be stored in a data management system that has been prepared for the Astoria Area-Wide site. Evaluation of the data is discussed in Section 3.9.

This work plan provides the scope of work for Phase 1 of the RI/FS. Phase 2 of the RI /FS is intended to address data gaps in the characterization work, completion of risk assessments, and implementation of IRAMs. Phase 3 will involve completing the FS. If Astoria Area-Wide PRP Group and DEQ determine that additional work is needed to characterize the nature and extent of COI at the facility, this RI/FS work plan may be supplemented by additional project-specific planning material or may be amended or revised, as appropriate.

3.1 GEOPHYSICAL EXPLORATIONS

The subsurface conditions at the Astoria Area-Wide site are complicated by several factors, including:

- Shallow and tidally influenced ground-water system;
- Historical and current placement of public and private subsurface utilities and distribution systems;
- Presence of private storm water control measures (sumps, ditches, drywells, etc.);
- Possible presence and confirmed presence of other subsurface structures (tanks, leach-fields, septic systems, etc.); and

- Likely complex depositional history of dredged materials.

The subsurface consists largely of fill material imported to the site. Filling of the Astoria Area-Wide subject area commenced in the early 1900s. Continued development of the Astoria Area-Wide area consists of several fill events. A better definition of the subsurface conditions is required to more completely understand observed distributions of COIs. As part of the RI/FS investigation, a geophysical subsurface mapping survey for specific properties within the Astoria Area-Wide site will be conducted.

The objective for this proposed geophysical subsurface mapping survey is to map the location of underground utilities and subsurface anomalies, including:

- Confirm and/or identify locations of underground petroleum pipelines; and
- Identify locations of subsurface utilities (both abandoned and in-use) that may obstruct or endanger subsurface investigations, facilitate the mobilization of potential subsurface petroleum impacts, or may have been used for historical waste disposal practices (storm water or sanitary systems).

Geophysical instruments that will be used to conduct the survey may include electromagnetic (EM), magnetometer, and ground-penetrating radar (GPR).

EM conductivity (also known as terrain conductivity) measures the conductivity of subsurface materials. These materials include soil, ground water, rock, buried metal objects, and dissolved chemicals. Both ferrous and nonferrous features can be identified. Electromagnetic conductivity surveys are rapid and generally very accurate. Underground petroleum tanks can be located, contaminated ground water can be mapped, and clay units can be identified. The method has been very successfully used to map the margins of landfills, and may therefore be useful to map variations in sediments/fill materials. Because conductivity can be measured as a function of the porosity and permeability of soils and rock formations along with charges emitted by the contaminants therein, EM surveys can be used to produce data used to accurately map contaminant conductivity in soil and ground water.

Magnetometer surveys generally measure horizontal variations in the local magnetic field. The variations may be caused by naturally occurring geologic features and buried ferrous metal objects such as underground storage tanks, drums, pipes, and debris-filled trenches. Magnetic surveys can only detect ferrous metal objects. Interference caused by observed surface metal objects limits the accuracy of the survey. The anomalies produced by fences, power lines, cars, and buildings can easily mask an anomaly caused by an underground target.

GPR uses high frequency radio waves directed into the ground to acquire information about the subsurface. The energy radiated into the ground is reflected back to the antenna by features having significantly different electrical properties to that of the surrounding material. The greater the contrast, the stronger the reflection observed. Typical reflectors include water table, bedrock, bedding, fractures, voids, contaminant plumes, and man-made objects such as USTs and utilities. GPR can be a valuable tool to accurately locate both metallic and non-metallic USTs and utilities and buried drums and hazardous material, even below reinforced concrete floors and slabs. GPR can delineate trenches and excavations and, under some conditions, it can be used to locate contaminant plumes. GPR will be used principally to refine identification and interpretation of anomalies identified by the other geophysical methods.

The results of the geophysical investigation will be graphically presented in site plans, with specific information for each of the following:

- Magnetic and electromagnetic contour maps;
- Interpretation of results and mapping of objects of possible concern; and
- Interpretation of subsurface utilities.

Methods and results will be described as part of a technical memorandum documenting the geophysical survey. Benchmarks and landmarks will be indicated with respect to the survey.

3.2 SOURCE/SOIL CHARACTERIZATION PROGRAM

A soil boring program has been developed to characterize potential source areas and identify suitable locations for the placement of monitoring wells in the shallow water-bearing zone at the Astoria Area-Wide site. Both soil and ground-water samples will be collected from borings to evaluate the presence of hazardous substances associated with spills and past practices. Soil and ground water sampling and analytical procedures are presented in the project Field Sampling Plan (Appendix A) and the Quality Assurance Project Plan (Appendix B).

A summary of the proposed boring locations, rationale for placement, and the proposed analytical program for each boring is presented on Table 4. Soil samples will be collected for laboratory analysis from the unsaturated zone or from within the zone of water-table fluctuation. Laboratory analyses will focus on petroleum products and their constituents. Analyses for TPH NWTPH-HCID may be used to screen for samples for more detailed testing. Depending on the nature of the potential source, the detailed testing may include analyses for gasoline, diesel, oil, VOCs, PAHs, metals, or polychlorinated biphenyls (PCBs). Representative soil samples (approximately 12 total) will be analyzed for geoenvironmental properties for use in developing exposure models.

Soil samples collected from the unsaturated zone will be examined for lithology as well as for visual evidence of petroleum hydrocarbon impacts. Soil samples may be field screened with a photo-ionization detector (PID) or a flame ionization detector (FID). Lithologic logs will note the depth of visual impacts and the PID or FID readings, if collected. Where field screening occurs, the sample with the highest elevated reading will be retained for analytical laboratory testing. In the event that no samples from a given borehole exhibit elevated readings or visual indications of contamination, the sample collected from immediately above the water table will be analyzed.

A discussion of the proposed program at each PRP facility is presented below. The proposed boring locations are presented on Figures 15 through 20. The proposed plan for each facility was developed by the following team of consultants:

PRP	**CONSULTANT**
ChevronTexaco	PNG Environmental, Inc.
Delphia Oil	Maul, Foster & Alongi, Inc.
Harris/Van West	Kleinfelder, Inc.
McCall Oil	Anchor Environmental, LLC
Niemi Oil	GeoEngineers, Inc.
Port of Astoria	*EnviroLogic Resources, Inc.*
Qwest	Tetra Tech EM, Inc.
Shell Oil	Hart Crowser, Inc.

3.2.1 Chevron Texaco Products Company

ChevronTexaco operated a service station (the current Young's Bay Texaco) and a bulk plant (the McCall Bulk Plant) in the Astoria Area-Wide study area.

Young's Bay Texaco

A Chevron service station operated at the site from the late-1960s until 1990. The station was decommissioned in 1990 with the five USTs, product dispensers, product and vent lines, hoists and building removed. In 1990 and 1991, subsurface investigations identified soil and ground-water impacts in the area of the pump islands. DEQ was notified and the site was assigned DEQ LUST File 04-91-0250. Five monitoring wells were installed. In 1992, the USTs were removed, 200 cubic yards of soil were removed from the UST area and 30 cubic yards of soil were removed from the south pump island area. The soil was disposed off-site. In addition, 450 cubic yards of soil was removed from the north pump island area. This soil was treated on site under DEQ authorization. Following remediation, the treated soil was used as on-site fill material. Ground water was monitored until 1994. In 1994, DEQ issued No Further Action (NFA) status for the site and the monitoring wells were abandoned.

At the time of the NFA status from DEQ in 1994, the impact to soil and ground water at the site was minimal. All the USTs and associated piping and dispensers had been removed from the site. Eleven borings and fourteen test pits were installed to explore the site. Impacted soil in the gasoline UST cavity area and the pump island area was excavated and removed or treated on-site.

The present Young's Bay Texaco service station was constructed on the site of the former Chevron station in 1995. The station does not have USTs. ASTs have been installed in a below ground vault at the rear of the property. The base of the below ground vault is at the ground level of the adjacent Qwest property (formerly US West).

On May 5, 1997, an overfill of the AST occurred, spilling approximately 1,700 gallons of gasoline into the containment vault. Due to the alignment of the vent pipes and some confusion with the inventory records, the overspill was not identified. On June 5, 1997, the fire department located the overspill in the vault during an investigation of gasoline vapors in the adjacent Qwest building. (DEQ Release #97-1497). Over the month, approximately 164 gallons had seeped out of the containment vault into the soil and sanitary sewer line between the Young's Bay Texaco and Qwest properties. The remaining gasoline was removed from the vault and the sewer was vented to remove vapors.

The space between the vault and the Qwest building is limited. A sanitary sewer is located under this space, parallel to property boundary. In June 1997, a trench was installed in the release area and SPH was identified on ground water. Ground water and free product were removed from trench, with approximately 132 gallons product recovered. DEQ installed three hand auger borings in the trench area. Analysis of soil samples at the ground-water interface indicated that most of the impacted soil was located between the sewer and the vault.

A sparging system was installed and operated from early-July until mid-August 1997. At that time the system was shut down and the compressor was connected to a vent line in the trench to remove soil vapors. Two hand-auger monitoring wells were installed between the sewer and the Qwest building in August 1997. Water samples collected from these wells did not detect BTEX concentrations. Soil borings in the Qwest building identified soil and ground-water impact in the area adjacent to the release.

The purpose of the remedial investigation at the Young's Bay Texaco site is to:

- Verify the results of the previous investigations.
- Collect data to close data gaps required for closure of the site.
- Assess the subsurface impact from the 1997 release.

The scope of the investigation will include advancing five Geoprobe borings at the Young's Bay Texaco site as shown on Figure 15, collecting soil and ground-water samples from the borings, and analyzing selected samples. One soil probe will be advanced in the area of the former pump island excavation. Selected soil and ground-water samples will analyzed for TPH-Gx, TPH-Dx, RBDM VOCs, lead, and PAHs. One soil probe will be advanced in the area of the former waste oil UST. Selected soil and ground-water samples will analyzed for TPH-Gx, TPH-Dx, RBDM VOCs, lead, and PAHs. Two soil probes will be advanced in the area of the former fuel USTs. Selected soil and ground-water samples will analyzed for TPH-Gx, RBDM VOCs, and lead. One soil probe will be advanced in the area of the 1997 gasoline release. Selected soil and ground-water samples will analyzed for TPH-Gx, RBDM VOCs, and lead.

McCall Bulk Plant

ChevronTexaco owned the improvements and operated the marine bulk terminal from 1927 until 1980. The land is owned by the Port of Astoria. ChevronTexaco sold the improvements to McCall Oil in 1980. The bulk plant site is currently being decommissioned for future redevelopment as commercial/industrial property by the Port.

An investigation of the site was conducted in 1996. The investigation included 15 soil borings at the site. Twenty soil samples and six ground-water samples were analyzed. The investigation identified two areas of concern. Residual bunker C tank bottom material was identified in a shallow pit in the yard behind the large tank and elevated concentrations of heavy range petroleum hydrocarbons and metals were identified in shallow soils in the tank farm. No ground water areas of concern were identified.

During recent site decommissioning activities two additional areas of concern were identified. Stained soils and pavement were identified in the former pump building area and a UST was located in the area of the former boiler building.

The purpose of the remedial investigation at the marine bulk plant site is to define the extent of soil impact and to characterize the impacted soil for disposal. The site is scheduled for redevelopment in Summer 2002. The remedial investigation will assist in the development of an IRAM work plan for the remediation of site. The scope of the investigation includes:

- Decommissioning the recently located UST according to DEQ regulations.
- Define the lateral extent of the soil impact.
- Define the vertical extent of soil impact by advancing five Geoprobe soil borings, collecting soil and ground-water samples, and analyzing selected soil and ground-water samples.

Two soil probes will be advanced in the area of the residual bunker C waste, as shown on Figure 16. Samples will be analyzed for TPH-Dx, PAHs, and metals. Two soil probes will be advanced in tank farm area. Samples will be analyzed for TPH-Dx, PAHs, and metals. One soil probe will be advanced in area of stained soils associated with the former pumps. Samples will be analyzed for TPH-Dx, PAHs, and metals. In addition, soil samples will be collected from the excavation during the removal of the UST. Samples will be analyzed for TPH-Dx, PAHs, VOCs, and metals

3.2.2 Delphia Oil Company

The Delphia Property consists of three tax lots (i.e., tax lots 897CC-1600, 897CC-1700, and 897CC-3500). The property includes the Delphia Oil Bulk Facility site located at 65 Portway Street and the Val's Texaco site at 452 West Marine Drive (Figure 2).

The Delphia Oil Bulk Facility receives petroleum products from large tankers that fill the aboveground storage tanks (ASTs) through aboveground product lines. Aboveground product lines distribute product from the ASTs to small tanker trucks. The bulk facility consists of the following:

- A west tank farm with a tank cluster of one gasoline and three diesel ASTs (20,000-gallons each) with a secondary containment wall adjacent to a loading rack.
- An east tank farm with an 8,000-gallon hydraulic lube oil AST, a 4,500-gallon lube oil AST, a 4,000-gallon paper machine oil (lube oil) AST, and an empty 500-gallon AST within a secondary containment structure including a concrete slab and walls.
- An office/warehouse structure that houses a 12,000-gallon lube oil AST surrounded by a concrete berm and drums and small containers petroleum products (primarily lube oil and grease).
- An empty 3,500-gallon "spill" underground storage tank (UST).
- A 500-gallon heating oil AST located south of the office.
- A 550-gallon mixed oil AST (drained from 55-gallon drums prior to shipping off-site for reconditioning).
- An empty drum storage area for drums awaiting pick-up.

- 55-gallon drums of naphtha solvents and kerosene stored on wood pallets outside the facility.
- A storm water conveyance system equipped with an oil/water separator.
- A small shed that is used to store containers of antifreeze and oil.

Mr. Delphia indicated that the bulk facility experienced losses from one of the original ASTs in the west tank farm in the 1960s. Apparently there were “worm holes” in the bottom of the tank. According to Mr. Delphia, Texaco lined the inside of the four ASTs prior to 1979 when Mr. Delphia purchased the property.

The Val’s Texaco site consists of the following:

- A service station building.
- Separate gasoline and diesel fuel dispenser islands.
- A cluster of two 5,000-gallon and one 10,000-gallon ASTs housed in a sub-grade concrete-floored vault.
- One 1,000-gallon diesel UST (installed in 1989).
- A 500-gallon used oil AST located inside the building.
- A 275-gallon heating oil AST located along the outer north wall of the building.
- A hydraulic lift and associated below-grade hydraulic fluid tank are located one service bay.
- A floor drain and oil-water separator located in the other service bay

Delphia Property Soil Sampling Overview

At the Delphia property, the private utility locator will attempt to identify any remaining inactive product lines associated with the former USTs and current product lines and subsurface utilities. GPR and EM technologies will not be used at the Delphia property prior to the completion of the phase 1 source area investigation, but may be used after phase 1 is completed, if determined to be necessary.

At each boring location, discrete soil samples will be collected from the unsaturated zone at depths of 2 feet below ground surface, 5 feet below ground surface, and at 5-foot increments to the maximum depth of the boring. Sampling depths may be adjusted in the field based on visual observations. If ground water is to be sampled, a soil sample will be collected just above the water table. Selected soil samples will be screened for TPH using hydrocarbon identification (HCID). If TPH is detected, appropriate follow-up analyses will be conducted (if deemed necessary) to quantify gasoline by NWTPH-Gx or diesel and oil by NWTPH-Dx. If the soil sample has been noted to have a high organic content (located at depth of former mud flat horizon), the laboratory will perform a silica gel cleanup prior to analyzing the sample for diesel and oil. A minimum of one-third (33 percent) of the samples with detections of gasoline will be analyzed for BTEX and total lead. A minimum of one-third (33 percent) of the samples with detections of diesel and oil will be analyzed for PAHs.

Delphia Property Ground-Water Sampling Overview

Reconnaissance ground-water samples will be collected from selected boring locations in the shallow ground-water zone between approximately 6 feet (estimated depth to ground water at the Delphia Oil Bulk Facility) and 20 feet below ground surface (estimated depth to ground water at the Val's Texaco site). Initially, five ground-water samples will be analyzed for BTEX and PAHs. The rest of the ground-water samples will be held, pending results of the initial analyses. If BTEX is detected, a minimum of one-third (33 percent) of thesamples will be analyzed for dissolved lead.

Specific features to be investigated at the Delphia property are discussed in the following sections. The proposed boring locations are shown on Figure 17. The proposed analytical program for each boring is presented on Table 4.

West Tank Farm

Four hand-auger borings will be advanced inside the secondary containment area to a maximum depth of 10 feet below ground surface. Soil samples will be collected to assess potential impacts resulting from spills or leaks over time. Selected soil samples will be screened for TPH and analyzed for appropriate follow up parameters, as necessary (see description above).

One Geoprobe™ boring will be completed to the north of the secondary containment wall. This location was chosen to assess if there have been releases from the surge UST (formerly used to store stove oil), from the western portion of the loading rack, from the pump area, and from the truck unloading area. Selected soil samples will be screened for TPH and analyzed for appropriate follow up parameters, as necessary (see description above). A ground-water sample will be collected and analyzed for BTEX and PAHs. If BTEX is detected, the ground-water sample will also be analyzed for total and dissolved lead.

Loading Rack

One Geoprobe™ boring will be advanced east of the loading rack. Selected soil samples will be screened for TPH and analyzed for appropriate follow up parameters, as necessary (see description above). A ground-water sample will be collected and held pending receipt of the other analytical results.

Empty Drum Storage Area

One Geoprobe™ boring will be advanced in the empty drum storage area. Selected soil samples will be screened for TPH and analyzed for appropriate follow up parameters, as necessary (see description above). A ground-water sample will be collected and held pending receipt of the other analytical results.

Former Loading Rack and Product Lines

One Geoprobe™ boring will be installed north of and down-gradient of the former oil warehouse loading rack along the northern property boundary. Selected soil samples will be screened for TPH and analyzed for appropriate follow up parameters, as necessary (see description above). A ground-water sample will be collected and held pending receipt of the other analytical results.

A second Geoprobe™ boring will be installed near the former aboveground product lines associated with the west tank farm and former oil warehouse loading rack. The boring will be advanced to a depth of 5 feet below ground surface unless field observations indicate that deeper sampling is necessary. The soil sample collected at 5 feet below ground surface will be screened for TPH and analyzed for appropriate follow-up parameters, as necessary.

Storm water Drainage System and East Tank Farm

Two Geoprobe™ borings will be advanced near the storm water drainage system to assess potential impacts of petroleum releases from that system. Soil and ground-water samples will be collected from each boring. One boring will be located to the north of the catch basin. A second boring will be located along the subsurface drainage line (from the loading rack to the catch basin). This second boring serves a dual purpose of assessing the soil near the east tank farm containment area. Selected soil samples will be screened for TPH and analyzed for appropriate follow up parameters, as necessary (see description above). A ground-water sample will be collected and held pending receipt of the other analytical results.

Property Boundaries

Two Geoprobe™ borings will be advanced along the northern property boundary to collect ground-water samples. One boring will be located at the northwestern corner of the Property and a second boring will be located north of the petroleum products warehouse. Ground-water samples will be analyzed for BTEX and PAHs. If BTEX is detected, the ground-water samples will also be analyzed for total and dissolved lead.

Former Product Lines

One Geoprobe™ boring will be advanced in the vicinity of the former UST product lines. A soil sample collected from 5 feet below ground surface will be screened for TPH and analyzed for appropriate follow-up parameters, as necessary (see description above). Deeper soil samples and a ground-water sample will be held for possible analyses pending the results of the sample collected at 5 feet-below ground surface.

Diesel UST, Product Line, and Dispenser

One Geoprobe™ boring will be advanced north (downgradient) of the diesel UST to collect soil and ground-water samples. The soil sample collected at 10-feet below ground surface will be screened for TPH and will be analyzed for appropriate follow-up parameters, as necessary (see description above). Deeper soil samples will be held for possible analyses pending the results of the sample collected at 10 feet-below ground surface. The ground-water sample will be analyzed for BTEX and PAHs. If BTEX is detected, the ground-water samples will also be analyzed for total and dissolved lead.

Two Geoprobe™ borings will be advanced to a depth of 15 feet below ground surface to the north of the diesel fuel dispenser and along the active product line (approximately mid-way between the UST and the dispenser) to collect soil samples. The 5-foot below ground surface soil samples will be screened for TPH and will be analyzed for appropriate follow-up parameters, as necessary (see description above). Deeper soil samples will be held for possible analyses pending the results of the samples collected at 5 feet-below ground surface.

Catch Basin

One Geoprobe™ boring will be advanced to a depth of 10 feet below ground surface north of the catch basin. Soil samples will be collected to evaluate the potential impacts from storm water drainage. The soil sample collected from 5-foot-below ground surface will be screened for TPH and analyzed for appropriate follow-up parameters, as necessary (see description above). The deeper soil sample will be held for possible analyses pending the results of the sample collected at 5 feet-below ground surface.

Former USTs

One Geoprobe™ boring will be installed north of the former UST excavation to collect a ground-water sample. The ground-water sample will be analyzed for BTEX and PAHs. If BTEX is detected, the ground-water sample will also be analyzed for total and dissolved lead.

3.2.3 Harris/Van West

The Harris/Van West site is located at 460 West Marine Drive. The site has been built on approximately 15 feet of fill material raising its elevation to that of West Marine Drive. The adjacent properties north, northeast, and northwest of the site are located approximately 10 feet above msl. Current site features include a T&M Fast Lube facility and an asphalt parking lot. Historically, the site operated as a service station from the mid-1960's to 1991.

Tank Liners, Inc. Site Investigation

In November 1989, Larry Vandermay retained Tank Liners, Inc., to perform a site investigation to evaluate options in upgrading the USTs and to evaluate the soils in order to obtain financing to upgrade the gasoline station to a convenience store. During the site investigation, a release of gasoline was detected in the soils in the immediate vicinity of the UST nest and pump island. The vertical and horizontal extent of impacts were not evaluated and impacts to ground water were not assessed. Gasoline was detected in seven of the ten samples collected in borings C1 through C4 at concentrations that ranged from 46 to 600 milligrams per kilogram (mg/kg).

Soil samples were collected from borings C1 and C4 at the south and north ends, respectively, of the UST nest at depths of 5, 10, and 15 feet below the ground surface. Soil samples were collected from borings C2 and C3 at the west end of each pump island at depths of 7.5 and 15 feet below ground surface. Petroleum hydrocarbons were detected in C1 from the 10- and 15-foot samples at concentrations of 46 and 53 mg/kg, respectively. Petroleum hydrocarbons were detected in C4 from the 15-foot sample at a concentration of 600 mg/kg. Petroleum hydrocarbons were detected in C2 from the 7.5- and 15-foot samples at 100 and 140 mg/kg, respectively. Petroleum hydrocarbons were detected in C3 from the 7.5- and 15-foot samples at 75 and 67 mg/kg, respectively.

The release was not reported to any regulatory agency; however, tank and line pressure testing was scheduled for December 1989 to evaluate the potential for an ongoing leak.

Tank and Line Pressure Testing and Repair

In December 1989, Van West Oil Company entered into a purchase agreement in which the purchaser/lessee, Harris Enterprises, Inc., agreed to purchase certain assets, including the

UST system, and to lease certain assets, including the site. As part of the purchase agreement between Van West Oil Company and Harris Enterprises, Inc., Petroleum Services Unlimited, Inc., (PSU) was retained in December 1989 to perform line pressure testing. The supreme line tested tight; however, testing was inconclusive for the regular and unleaded lines due to faulty check valves on the submersible pumps.

Harris Enterprises, Inc., began the term of their ten-year lease on March 1, 1990. In August and September 1990, after several months of operation, an exceedance in the inventory control records for the regular leaded tank was noted. As a result, Harris Enterprises, Inc., (operating as Harris Oil Company) retained PSU to replace the regular fuel pressure line. During the work, conducted between October 15th and 18th, 1990, impacted soil was observed at the location of the failed regular line. Two soil samples, H1-EX-1 and H1-SS-2, were collected and gasoline was detected at concentrations of 77 and 115 mg/kg, respectively. The release was reported to the DEQ on October 16, 1990. DEQ assigned File No. 09-90-392 to the project. Following replacement of the line, inventory control records for the regular leaded tank confirmed the system was within federal standards for acceptable variance.

Release to the Sanitary Sewer and Emergency Response

On December 2, 1990, a tenant in Apartment #3 on the west adjacent property reported petroleum vapors emanating from her shower drain. On December 3, 1990, Riedel Environmental Services, Inc., (RES) responded at the request of the City of Astoria to investigate the release and determine its source. Through a combination of hand-augured borings and test pits located between the site and Industry Street to the north, RES determined that gasoline was migrating through the soil from the site into a combined sanitary sewer/storm water line. Gasoline apparently entered the line through holes created by form stakes driven in for a retaining wall, which ran parallel and directly above the line.

Samples of free product were collected from the sewer line at manhole A and below the retaining wall at test pit T6. Soil samples were collected from test pit T1 on the Niemi Oil site and from test pit T6. The samples were submitted to the DEQ Laboratory and analyzed for total petroleum hydrocarbons (TPH). The free product samples and soil sample collected from test pit T6 were characterized by DEQ as undegraded gasoline with similar chromatographic patterns. The soil sample collected from test pit T1 on the Niemi Oil Cardlock site was characterized as weathered gasoline and degraded diesel. Soils in test pit T3, excavated directly adjacent to the sewer line, did not contain coarse-grained backfill material around typically found around sewer lines. As a result, DEQ later indicated in a telephone conversation with Rittenhouse-Zeman and Associates (RZA) that because utility backfill material was not present, there was no immediate concern that the utility trench had facilitated off-site migration of contaminants, other than what had traveled within the sewer line itself.

Rittenhouse-Zeman and Associates Site Characterization

On December 7th through 9th and 21st, 1990, Harris Oil Company retained RZA to perform site characterization activities. The activities included: uncovering and inspecting all product lines; advancing six soil borings (MW-1 through MW-3, RW-2, B-6 and B-7); installing three monitoring wells (MW-1 through MW-3) and one recovery well (RW-2); excavating one recovery well (RW-1); and collecting twenty-six soil and six water samples. Soil samples were collected from the borings at depths ranging from 5 to 37 feet bgs. Free product was observed in monitoring well MW-3 and in recovery wells RW-1 and RW-2. Depth to ground water in the wells ranged from 17 to 20 feet bgs.

The product lines were uncovered and physically inspected for signs of a significant or catastrophic release to explain the presence of free product in the sanitary sewer system. According to RZA, no free product was found adjacent to any of the product lines and impacts to the soil were limited to a 1 square foot area identified next to an elbow fitting in the super unleaded line. The sample (HA-12690-1) collected from this location contained concentrations of petroleum hydrocarbons at 2,300 mg/kg as evaluated by EPA Method TPH-418.1.

Soil samples were submitted to Pacific Environmental Laboratory, Inc., (PEL) and RZA and selectively analyzed for gasoline; diesel; and benzene, toluene, ethylbenzene, and xylenes (BTEX). Ground-water/product samples collected from RW-1 were submitted to Friedman & Bruya, Inc., for fingerprint characterization. Ground-water samples were also submitted to RZA and W.F.R. Lab, Inc., and selectively analyzed for BTEX and fecal coliform. Concentrations detected in soil ranged from 100 to 23,000 mg/kg gasoline; 0.16 to 5.6 mg/kg benzene; 0.2 to 30.8 mg/kg toluene; 0.11 to 52.2 mg/kg ethylbenzene; and 0.23 to 278 mg/kg xylenes. Diesel was detected in one soil sample at a concentration of 3,300 mg/kg. Concentrations detected in ground-water ranged from 94 to 540 milligrams per liter (mg/l) gasoline; 1.1 to 35,600 micrograms per liter (µg/l) benzene; 38.1 to 29,000 µg/l toluene; 4.48 to 33,300 µg/l ethylbenzene; and 7.74 to 92,500 µg/l xylenes. Naphthalene was detected in one ground-water sample at a concentration of 0.22 µg/l.

On December 10, 1990, PSU performed a third tank and line pressure test at the site. All tanks and lines passed except for the unleaded line in which the test was inconclusive as the crash valve on the unleaded tank was cracked.

Ground Water Treatment

Between December 5 and 18, 1990, RZA installed a temporary ground-water recovery and product collection system in RW-1 located directly north of the retaining wall on the Niemi Oil Cardlock site. By the time the 20-Day Release Report was issued on December 28, 1990, approximately 50 to 60 gallons of free product had been recovered and approximately 8,000 gallons of ground water had been treated and discharged. During the first week of January 1991, a permanent air stripping system was installed by H2Oil Company. The system included a total fluids pump installed in RW-2, an oil/water separator, a batch tank, and an 18-inch diameter by 20-foot tall air stripping tower. Prior to activating the air stripping system on February 2, 1991, approximately 2.5 feet of product were measured in RW-2. Product was also identified in RW-1 and MW-3 . The ground-water treatment system was modified shortly after startup as the NPDES permitted discharge limits were exceeded on several occasions. The modifications included the removal of the oil/water separator and batch tank and the installation of a dual phase submersible pumping system. The system operated until March 1994 when operation was permanently discontinued due to the RZA's assessment that impacted ground water from off-site sources was being pulled on to the site.

SECOR's Subsurface Investigation

On December 2 through 4, 1991, SECOR advanced three hand-auger borings (HA1 – HA3), drilled five soil borings (B8/MW4, B9, B10, B11, and B12), excavated seven test pits (TP1 – TP7), and collected and analyzed forty-eight soil and eight ground-water samples. Soil samples were collected at depths ranging from 3 to 41 feet bgs. Soil samples were submitted to PEL and selectively analyzed for hydrocarbon identification, gasoline, and total petroleum hydrocarbons (TPH). Ground-water samples were submitted to PEL and selectively analyzed for TPH, BTEX, and polynuclear aromatic hydrocarbons (PAHs). Gasoline was detected in soil samples collected from HA1, TP1, TP2, TP3, B8/MW4, B10, and B12; and diesel/bunker was detected in soil samples collected from HA1, TP1, TP2, TP3, B8/MW4, B9, B10, B11, and B12. Gasoline, BTEX, and PAHs were detected in ground-water samples collected from MW2, MW3, and RW2; gasoline and BTEX were detected in MW4. Analytes were not detected in MW1.

Premium, Unleaded, and Regular Fuel UST Decommissioning

During the week of February 11, 1991, under the observation of RZA, PSU removed four USTs and all product lines. The tanks included one 6,000-gallon premium fuel UST, two 4,000-gallon regular fuel USTs, and one 8,000-gallon unleaded fuel UST. Of the four tanks only one (the regular fuel UST, designated T-1) contained holes. No closure samples were collected, and the excavation sidewalls were sloped and the pit left open.

Corrective Action Plan (CAP) by SECOR

On October 8, 1992, SECOR issued a CAP recommending excavation and off-site soil aeration of petroleum contaminated soil (PCS) followed by quarterly ground-water monitoring. The excavation, transport, and off-site treatment of soil were performed by

Pacific Northern Environmental (PNE) and documented in their October 20, 1993, Soil Matrix Cleanup Report.

Approximately 7,500 cubic yards of PCS were transported to property owned by the Port of Tillamook. Approximately 2,400 cubic yards of clean overburden were transported to property owned by the Port of Astoria for temporary staging. Upon completion of excavation and sampling activities, the excavation, which measured approximately 100 feet long by 70 feet wide by 35 feet deep, was backfilled with the clean overburden and approximately 870 cubic yards of imported material.

Twelve confirmation soil samples were collected from the excavation floor and sidewalls. Six of the twelve soil samples contained gasoline at concentrations ranging from 3.8 to 97 mg/kg. Only one soil sample exceeded the 80 mg/kg cleanup goal established in the CAP. Twenty-eight confirmation soil samples were collected from the treatment cell located on the Port of Tillamook's property. Only six of the twenty-eight samples contained gasoline with concentrations ranging from 2.7 to 13 mg/kg.

During excavation activities, a waste oil UST was encountered which was decommissioned at that time. A release from the tank, was observed and resulted in the excavation and off-site thermal treatment of approximately 400 cubic yards of PCS. Nine soil confirmation samples were collected and analyzed for TPH. TPH was detected in eight of the nine samples at concentrations ranging from 43 to 403 mg/kg. The DEQ cleanup goal was 500 mg/kg. Following additional excavation, five additional soil confirmation samples were collected and analyzed for hydrocarbon identification by TPH-HCID. Gasoline and diesel/heavy oil were not detected in excess of 20 and 50 mg/kg, respectively. The bottom sample was analyzed for barium, mercury, and PCBs. No concentrations of these constituents were detected in excess of the laboratory reporting limits.

Ground-Water Monitoring

Ten ground-water sampling events were conducted between December 1990 and September 1995 from one or more of the four monitoring wells and two recovery wells located on the subject property. Ground-water treatment activities appear to have been effective in removing free product from the water table and in reducing benzene concentrations in recovery well RW2 from 35,600 μg/l in December 1990 to 210 μg/l in January 1994. At this time, only one well is known to exist at the subject site. On December 8, 1997, Wayne Coppel installed a fifth monitoring well, designated MW-1, downgradient of the former UST excavation off the northwest corner of the former gas station building.

Request for Closure and Prospective Purchaser Agreement

On February 29, 1996, a request for closure was submitted to the DEQ by Wayne M. Coppel on behalf of Larry Vandermay (Flying Dutchman Enterprises, Inc.). The request was denied, based upon DEQ's assertion that the off-site extent of impacts to ground water had not been defined. Subsequently, a Prospective Purchaser Agreement (Agreement) was entered into between DEQ and Thomas and Min Tussing on August 28, 1997, as part of the sale of the property from Flying Dutchman Enterprises, Inc., to the Tussings. The Agreement stated, among other things, that "To date all impacted soil has been excavated and removed from the Property" and that "The Tussings shall install and eventually decommission two ground-water monitoring wells at and/or near the Property…".

Source/Soil Characterization

The facility-specific source characterization will include the following tasks:

1. Installation of ten push probes (SB-400(F) through SB-409(F)) by hydraulic percussion hammer. The push probes will be located around the perimeter of the former excavation and on the Niemi Oil Cardlock property located northwest of the site in conjunction with planned characterization activities at this site. The proposed push probe locations are shown on Figure 18. Soil samples will be described continuously from the surface to the

extent explored, and collected at a depth of 2.5 feet bgs and at 2.5-foot intervals, thereafter.

2. Field screening of collected soil samples for organic vapors will be performed using a PID. Organic vapor measurements will be recorded on soil boring logs. Up to 20 soil samples (two samples per boring) will be selected for laboratory analysis.

3. Grab ground-water samples will be collected from all ten push probes. The proposed grab ground-water sample locations are shown on Figure 18. The depth of water is estimated at 25 feet bgs on the upper level of the Flying Dutchman/Harris site and from 5 to 8 feet bgs on the lower level of the Flying Dutchman/Harris site and Niemi Oil Cardlock property.

4. Existing monitoring well MW1 will be developed to remove sediment-laden water and to increase the hydraulic radius of the well. Prior to purging and sampling a water level measurement will be made in MW1.

5. Laboratory Analysis

The soil and ground-water samples will be submitted under chain-of-custody to the laboratory. The samples will be analyzed as indicated in Table 4. The samples will be analyzed on a regular turnaround schedule, usually requiring 10 days for completion.

3.2.4 McCall Oil

The scope of work consists of a set of tasks designed to investigate the residual contamination resulting from the diesel pipeline release discovered in 1993.

Eleven soil borings will be advanced to an estimated depth of 12 feet to determine if diesel is still present in the site soils and continues to be a source of ground-water contamination.

Sampling locations are shown in Figure 19. The rationale for each of the boring locations is shown in Table 4. In general, the borings are located near 1993 soil borings and test pits where moderate to high concentrations of diesel were detected in soil.

Soil samples will be field screened with a photo-ionization detector (PID) or a flame ionization detector (FID). The sample with the highest elevated reading will be retained for offsite lab testing for total petroleum hydrocarbons by EPA methods NWTPH-Gx and NWTPH-Dx. In the event that no samples from a given borehole exhibit elevated readings or visual indications of contamination, the sample collected from immediately above the water table will be analyzed.

Following this protocol twelve primary soil samples will be selected and submitted to the lab for testing. Contingency soil samples will also be retained from each four feet depth interval. These contingency samples will be held at the lab for possible later testing, depending upon the initial results from testing the primary soil samples. If nothing anomalous is noted in the preliminary lab results from testing the primary samples, the contingency samples will be discarded without further testing.

3.2.5 Niemi Oil Company

Niemi Oil Company operated two facilities in the Study Area, a commercial cardlock fuel dispensing station located at 455 Industry Street, and a bulk petroleum storage facility located at 490 Industry Street (Figure 1). Niemi began operating these facilities in in 1978 and 1976, respectively, following previous ownership and operation by one or more oil companies as described below.

Niemi Oil Cardlock – 455 Industry Street

The Niemi Oil cardlock facility and associated bulk storage tanks were originally constructed by Burns-Johanson Oil Company in the early 1970s. Niemi Oil acquired the property and equipment from Burns-Johanson in 1978. A DEQ memorandum also indicates that

Associated Petroleum and Phillips Petroleum either owned or operated at this property since 1927 and 1967, respectively (Reiter, 1998).

The site is relatively flat and is situated at the base of a slope separating the site from the properties on Marine Drive, and is located approximately 600 feet southeast of the Columbia River. Four current or former service stations are located on Marine Drive, upgradient of the site. The cardlock site is approximately 0.45 acres in size and comprised of four separate tax lots. Current and historical petroleum storage and dispensing facilities at the cardlock site have generally been confined to the site's two middle tax lots. However, a map provided by the Port dated 1927 shows the presence of a former Associated Oil Company (Associated Oil) facility located on the northeastern tax lot. One AST and two fueling racks were shown on the 1927 map. No other information concerning the Associated Oil facility has been identified.

The current cardlock operation utilizes three USTs: two 10,000-gallon diesel USTs and one 20,000-gallon gasoline UST. Two 550-gallon gasoline USTs were removed by 3 Kings Environmental from east of the overhead loading rack in 1999. Three ASTs are also present at the site: two 1,000-gallon ASTs (one contains gasoline and the other is empty) and one 6,000-gallon gasoline AST. Petroleum products stored at the site (historically and/or currently) include unleaded gasoline (low to high octane), diesel and stove oil.

At present, the cardlock facility includes: two separate overhead loading racks for the filling of tanker trucks and one dispenser island for vehicular fueling. Another diesel dispenser island was removed from the site in 1998. The approximate locations of current and historical fuel storage and dispensing facilities are shown in Figure 18. Documentation regarding the diesel dispenser removal and 1999 removal of the two 550-gallon gasoline USTs, from the site was not found.

A release of gasoline was identified in December 1990 at the former Harris/Van West service station at 460 West Marine Drive, located adjacent to and immediately upgradient of the Niemi site. Separate phase gasoline (free product) from a leaking UST was released into the subsurface soils and also entered the sanitary sewer located between the properties. Free product from this release was encountered behind a concrete retaining wall separating the Harris/Van West and Niemi Cardlock properties, as well as in subsurface explorations completed on the cardlock site immediately downgradient from the Harris/Van West station.

In response to the December 1990 gasoline release, three soil borings (P1-P3) and six test pits (T1-T6) were completed by Riedel Environmental Services (on behalf of the City of Astoria) in the southeastern portion of the cardlock site near the concrete retaining wall. Quantitative analyses were not conducted on soil samples collected from these explorations, however visual evidence of petroleum-impacted soil was documented in boring P3 and test pits (T1, T4 and T6). Also in December 1990, a recovery well (RW-1) was installed in the southeastern corner of the Niemi cardlock site by Rittenhouse Zeman & Associates (RZA) to remove free product migrating from the Harris/Van West release. Reportedly, 50 to 60 gallons of free floating product and 8,000 gallons of ground water were removed from RW-1 between December 1990 and 1991. Qualitative analysis of free product sampled from inside RW-1 indicated the presence of gasoline and diesel.

In 1996, DEQ conducted a limited investigation of subsurface conditions throughout the Area Wide study area. One hand-augured boring (DEQ-5[A]) was completed near the southwestern corner of the Niemi cardlock site. Elevated levels of gasoline-range hydrocarbons were detected in a 6.5-foot-deep soil sample collected from DEQ-5(A).

In January 16, 1997, PNG Environmental Inc. (PNG) completed six soil borings (SB-1 through SB-6) to evaluate subsurface conditions (soil and ground water) around the cardlock's fuel storage and dispensing facilities. Borings were completed to depths of 8 and 12 feet and generally encountered brown to gray fine sand fill. Ground water was encountered in the soil borings at approximately 5.5 feet bgs and is expected to flow toward the Columbia River in a northwesterly direction beneath the site. Elevated levels of gasoline- and/or diesel-range hydrocarbons were detected in soil samples collected from borings SB-3, SB-5 and SB-6 between 0 to 8 feet below ground surface. In borings SB-5 and SB-6, the laboratory noted that detected diesel range hydrocarbons are partially attributed to overlap from the gasoline range. Relatively low levels of BETX and PAHs were detected in soil samples collected from SB-3, SB-4, SB-5 and/or SB-6 at these depths. Ground-water samples were collected from 5 boreholes (SB-1, and SB-3 through SB-6) near the water table. Elevated levels of gasoline- and diesel-range hydrocarbons were detected SB-2, SB-3, SB-4 and SB-5. Benzene was detected in these borehole water samples at concentrations ranging between 22.8 µg/l and 358 µg/l. The locations of SB-1 through SB-6 are shown in Figure 18.

In January 1998, PNG collected a ground-water sample from RW-1 for chemical analysis. Approximately one casing volume (280 gallons) of water was removed from RW-1 prior to sampling. Elevated levels of gasoline-, diesel, and oil-range hydrocarbons were detected in the water sample. However, the laboratory noted that detected hydrocarbons predominately resembled weathered gasoline. Ethylbenzene, xylenes, naphthalene and 2-methylnaphthalene were detected in RW-1 at concentrations ranging between 48 µg/l and 2,100 µg/l.

Recovery well RW-1 currently remains at the site and consists of a 48-inch-diameter corrugated metal casing that extends to an approximate depth of 12 feet below ground surface. The northwestern third of the site's surface in the vicinity of the overhead loading rack and dispenser island is covered with either asphalt or concrete pavement. The remainder of the site is unpaved.

To further define the nature and extent of petroleum impacts from both off-site and on-site sources previously encountered at the site, a soil and ground-water sampling program using GeoProbe or equivalent drilling method will be conducted. A total of 13 soil borings are planned at various locations within the site's property boundary (Figure 18). As part of the off-site characterization conducted by Harris/Van West, 3 of the 13 soil borings (located on the southern property boundary) will be completed by Kleinfelder. The locations of some borings may be moved while in the field in response to findings from the planned utility survey, as well as unforeseen obstacles (e.g., overhead and underground utilities). Proposed boring locations were selected based on the following criteria: (a) characterize soil conditions immediately adjacent to the site's current and historical fuel storage and ancillary equipment; (b) collect current soil and ground-water quality data within areas of previously detected petroleum impacts (i.e., adjacent to Harris/Van West and the Cardlock's dispenser island); (c) characterize soil and ground-water conditions in assumed downgradient areas of current and historical source areas; and (d) to assist the PRP Group, as appropriate, in establishing a monitoring-well network in the shallow water-bearing zone beneath the site. Depending on the results of field screening, up to 3 additional borings (in locations yet to be determined) may be required to better delineate the lateral extent of petroleum impacts to soil, if encountered.

The borings will be advanced to a maximum depth of 15 feet bgs and at least one soil sample from each boring will be analyzed for COIs. Ground-water samples will be collected from 9 of the 13 borings for analysis of COIs. Samples will be collected, handled and stored in accordance with procedures outlined in Appendix A, and copies of analytical data and hydrogeologic information will be stored in the Astoria Area-Wide database at *EnviroLogic Resources*.

Current and historical storm-water management practices employed at the site will be investigated. No catch basins have been identified on the Cardlock site. Two catch basins are present along Industry Street immediately adjacent to site's northern property boundary. Niemi Oil will participate as appropriate with the PRP Group in the development of a comprehensive storm-water system analysis. If necessary, Niemi Oil will develop and implement storm-water controls at the site.

Former Mobil Oil and Niemi Oil bulk Plant – 490 Industry Street

Mobil Oil Company or its predecessors (including, among others, General Petroleum Corp. and Pilot Oil Company) built the bulk plant in 1925 on property leased from the Port of Astoria. Mobil Oil maintained and operated the bulk facility until 1976. Service Oil Company and Niemi Oil Company obtained oil products from this facility under distributor agreements with Mobil. In 1976, Mobil terminated its lease and sold the storage tanks and equipment to Niemi Oil Company. Mobil supplied the various fuel and petroleum products by barge and tanker to the bulk facility, maintained and operated the tanks and equipment and allowed Niemi Oil and Service Oil to fill its tankers for fuel distribution from the fuel racks along the western side of the tank farm.

In 1976, Niemi purchased the Mobil equipment and commenced leasing the Mobil Bulk site from the Port of Astoria, operating under several lease agreements until the late 1990s. None of the oil storage tanks remain at the property and there have been no oil storage activities at this site for at least the last two years. A portion of the site containing the former Niemi Oil Company office and storage structures is currently leased by the Port to Cowlitz Clean Sweep, a subsidiary of Pacific Northern Environmental.

Petroleum products stored and distributed at the bulk plant site throughout its operational history included three grades of gasoline in several large above-ground bulk oil storage tanks. A total of 12 ASTs were once located on the northeastern half of the site, ranging in size between 750 to 420,000 gallons. Associated ancillary equipment included above and below ground product piping, product pumps and motors, two overhead loading racks and one ground-level dispenser island. A building was constructed in the southern portion of the site. This building included 1,900 square feet of office and storage space (second story), 1,900 square feet of warehouse, 700 square feet of elevated loading/unloading dock, and 2,250 square feet of vehicular parking/maintenance garage. In addition, historical research indicates the presence of one 550-gallon drywell, a former cesspool and former steam boiler. The approximate locations of the bulk plant facilities are shown in Figure 19. At this time, the locations of feed and discharge product piping to several ASTs, as well as the drywell are unknown.

In 1996, DEQ conducted a limited investigation of subsurface conditions throughout the Area Wide study area. One hand-augured boring (DEQ-3[A]) was completed in the northeastern portion of the former bulk plant site, near three 210,000 gallon ASTs. Petroleum hydrocarbons were not detected in soil samples collected from DEQ-3(A). Two additional hand-augured borings (DEQ-1[A] and DEQ-2[A]) were completed approximately 50 to 100 feet northeast of the bulk plant. Petroleum hydrocarbons were not detected in

DEQ-1(A), while elevated levels of gasoline- and diesel-range hydrocarbons were detected in DEQ-2(A). A former wood veneering operation occupied the property northeast of the bulk plant.

It is currently believed that the site's ASTs and aboveground ancillary equipment were removed piecemeal sometime during the 1970s and 1990s. At the time of a March 27, 2002 site visit, GeoEngineers observed the following site features associated with the former bulk plant: (a) the bulk plant office and storage building; (b) remnants of the concrete fire wall; (c) concrete AST foundations; (d) concrete drive slab beneath the former overhead loading rack; and (e) concrete foundation of former dispenser island along Beltline Street. The southern half of the site containing the building was fenced and occupied by Cowlitz Clean Sweep to store vacuum trucks and excavation equipment. This southern half of the site's surface between the building and the former ASTs was covered by either asphalt or concrete pavement. The remainder of the site's surface was covered by gravel.

To investigate subsurface conditions at the former bulk plant site, a soil and ground-water sampling program using GeoProbe or equivalent drilling method will be conducted. A total of 15 soil borings are planned at various locations within the site's property boundary (Figure 19). The locations of some borings may be moved while in the field in response to findings from the planned geophysical survey, as well as unforeseen obstacles (e.g., overhead and underground utilities). Also, some of the soil borings may be completed as test pits using a backhoe to better assess any subsurface anomalies identified by the geophysical survey. Proposed boring locations were selected based on the following reasons: (a) characterize soil conditions in the immediate vicinity of the site's historical ASTs and ancillary equipment; (b) characterize soil conditions in the immediate vicinity of the bulk plant building (i.e., loading dock, vehicular garage and cesspool/boiler); (c) characterize soil and ground-water conditions in assumed downgradient areas of these historical potential source areas; and (d) to assist the PRP Group, as appropriate, in establishing a monitoring-well network in the shallow water-bearing zone beneath the site. Depending on the results of field screening, up to 4 additional borings (in locations yet to be determined) maybe be required to better delineate the lateral extent of petroleum impacts to soil, if encountered.

The borings and/or test pits will be advanced to a maximum depth of 15 feet bgs and at least one soil sample from each exploration will be analyzed for COIs. Ground-water samples will be collected from 7 of the 16 borings for analysis of COIs. Samples will be collected, handled and stored in accordance with procedures outlined in Appendix A, and copies of analytical data and hydrogeologic information will be stored in the Astoria Area-Wide database at *EnviroLogic Resources*.

Niemi Oil will identify the locations of any abandoned USTs and/or ancillary equipment remaining at the site from historical research and utilization of geophysics. If encountered and deemed a source of ongoing contamination, Niemi Oil will oversee the removal of the bulk plant remnants in accordance with OAR 340-122-0205 through 340-122-0360.

Current and historical storm-water management practices employed at the site will be investigated. One on-site catch basin is present near the office/storage building and one located just beyond the northern property boundary along Portway. Niemi Oil will participate as appropriate with PRP Group in the development of a comprehensive storm-water system analysis. If necessary, Niemi Oil will develop and implement storm-water controls at the site.

3.2.6 Port of Astoria

The Port has leased properties to various tenants through the years. The types of operations conducted at some of these properties suggest that there is the potential for releases to have occurred. Of principal concern are potential releases related to the former furniture manufacturing and plywood operation, the former steelworks building, and the operations of Astoria Oil Services (Figure 2). In addition, the Port decommissioned an UST at the maintenance shop. The following discussion describes the areas of environmental interest and the proposed soil/source characterization program.

Former Furniture Manufacturing and Steelworks Buildings

Two warehouse buildings formerly occupied the large open area between the Niemi Oil bulk plant and the Oregon State Police property. One of these buildings housed a furniture manufacturing facility and subsequently, a plywood operation. The other was a steelworks operation. Eventually the former steelworks building was adjoined to the former furniture manufacturing building and used for veneer wood storage. The former furniture manufacturing building consisted of a finishing department, warehouse, cabinet shop, mill, painting shed, glue room, and a boiler house. The former steelworks building consisted of a black smith and boiler shop, machine shop, a boiler house, and a transformer bank.

Twelve Geoprobe™ borings will be advanced in the area of the former furniture and steel works buildings. The proposed boring locations are shown on Figure 19. All boring locations are approximate and may be moved depending on the locations of subsurface utilities, overhead power lines, and the results of a geophysical survey that will be performed prior to drilling. Two soil samples will be collected from each boring. Ground-water samples will be collected from the borings and analyzed for TPH constituents and COIs related to the potential source being investigated to assess impacts to shallow ground water.

Seven of the 12 borings will be sited on the former furniture site, of which two borings will be sited near an area historically indicated as fuel storage, two borings sited near an area historically identified as a maintenance shop, one near the former mill, one near an area identified as a boiler room, and one boring sited an area historically identified as a "glue room". Soil and ground-water samples obtained from borings sited on the former furniture and veneer lumber property will be analyzed for petroleum hydrocarbons, formaldehyde, phenolics, metals, and VOCs.

Five of the 12 borings will be sited on the former steel works site. Samples from this site will be analyzed for petroleum hydrocarbons and metals. Additionally, PCBs will be analyzed from samples obtained near the former transformer bank.

Astoria Oil Services

The Astoria Oil Services property has also had other historical business operations conducted on this property over the past 90 years, including ship refurbishing and seafood processing (JCR Consultants, Inc., 1986a). Astoria Oil Services moved onto the end of Pier 3, as shown on Figure 20, in August 1983. The site was used to construct oil and gas production modules (compressors, drilling control equipment, power control units, etc.) for use at exploration and production fields. The primary activities at the site were construction of these modules, including steel fabrication, unit assembly, and pipe installation. Associated activities included sand blasting and painting of these modules.

The type of hazardous waste generated at the site typically included waste paint and waste solvents used in the fabrication of the oil and gas modules, specifically, heavy metals (including chromium and lead associated with the painting operations), and solvents (including methylene chloride, acetone, 2-butanone, o-xylene, and dimethylbenzene). Primary areas of concern relative to possible environmental impacts are: 1) the waste management area where drums of waste paint and solvents were stored and, 2) the bolt washing area where the solvent methylene chloride was used in an area adjacent to and south of the site maintenance shop. The waste in the drums were solidified and transported off-site in two shipments on January 31 and February 1, 1982.

A previous soil investigation conducted at Astoria Oil Services indicated that one area sampled contained soil impacts of VOCs (acetone, ethylbenzene, and total xylenes). This impacted soil from this former waste management area was excavated and disposed of in 1986. Analytical results from the excavated area indicated detectable concentrations of methylene chloride and acetone. The consultant reported that these compounds could be attributed to unavoidable laboratory contamination. The compound trichloroethene (TCE) was reported at trace levels in soils samples. Subsequent testing was performed which confirmed the presence of this constituent in soil samples. The consultant reported that the soil samples were stored in close proximity to other samples (not associated with the site) that contained high concentrations of TCE and that cross-contamination during laboratory storage may have occurred. The laboratory noted this fact in the analytical results (JCR Consultants, Inc., 1986c). An interoffice memo dated December 3, 1986, by the DEQ states, "since all detected contaminants are 3 orders of magnitude less than the accepted detection limit, Astoria Oil Services has demonstrated that closure has been completed in accordance with their closure plan."

Given the questionable quality control in the above-mentioned analytical results, this area should be re-sampled to confirm whether or not TCE or other VOCs are present. Four Geoprobe™ borings are proposed to be sited in this area, sampling for VOCs and petroleum hydrocarbons (Figure 19).

Toward the middle of Pier 3 is a former transformer vault currently used for miscellaneous storage. A single hand auger boring filled to a depth of 5 feet below ground surface will be sited in this area and samples will be collected and analyzed for both PCBs and petroleum hydrocarbons.

Former UST Near Port Maintenance Shop

A 1,000-gallon UST was decommissioned in 1993 on the north side of the Port maintenance shop (Figure 19). The tank had been previously used for diesel and gasoline storage. The Port found petroleum-contaminated soil (PCS) and apparently perched water overlying clayey layers in the tank excavation at the time of decommissioning. A boring was advanced to a depth of 9 feet just north of the tank excavation. This sample was found to be free of significant petroleum contamination using TPH-HCID and the release was cleaned up by overexcavation of the tank excavation. Petroleum contamination did not extend under the nearby building. The PCS were removed until clean sidewalls and bottom soils were exposed in the excavation. Gasoline was not detected above reporting limits for either sample collected from the floor of the PCS/UST excavation (method H-HCID). Diesel oil was detected, however, and subsequently quantified by method TPH-D. Results from this quantification indicated that moderate levels of diesel-range petroleum hydrocarbons impacts to soil still existed in the UST/PCS excavation, although at levels below the DEQ Level II matrix cleanup levels (Neil Shaw, 1993).

Two Geoprobe™ borings will be sited near the former UST location (Figure 19). Samples collected from these borings will be analyzed for petroleum hydrocarbons, petroleum VOCs, and PAHs as confirmation of previous decommissioning and remedial activities.

The analytical results of samples collected from the above sited borings will be used to assist in planning any additional characterization and delineation investigations, as warranted. The complete soil characterization of the Astoria Area-Wide site will then be used in preparation of detailed ground-water investigation work plan.

3.2.7 QWEST Corporation

Qwest has leased the property since before the 1960s. In about 1962, a 10,000-gallon underground storage tank (UST) (UST Facility ID# 6293) was installed on the property for the storage of gasoline. In 1973, the UST was moved to its present location on the property; however, the previous location of the tank is unknown. In May 1987, the UST was glass armor-lined and in 1997, the tank was decommissioned. The decommissioning was conducted in place, since the tank partially underlies the Qwest Astoria SOC. At the time of the tank decommissioning, an investigation was performed to determine potential impacts to the property from the previous use and storage of petroleum. The investigation was conducted by First Strike Environmental (FSE) of Roseburg, Oregon and consisted of the collection of soil and ground-water samples during the advancement of 32 soil borings. The site investigation conducted during the decommissioning indicated that the property contained some petroleum contamination in soil and ground water. Based on a review of reports concerning the resulting cleanup associated with the tank decommissioning, a No Further Action letter was issued to Qwest by ODEQ on April 22, 1998 (ODEQ 1998).

Geoprobe™ borings will be advanced around the perimeter of the Qwest property, inside the Qwest garage and at the edge of the over-excavation previously conducted to remove contaminated soil in the vicinity of the former pump island.

The borings will be advanced in the locations shown on Figure 15 and 18. The rationale for placement of the borings is as follows:

- SB-800(Q) through SB-807(Q), drilled at locations spaced 50-feet apart, will determine the presence or absence of soil and ground-water contamination at the northern edge of the site, as well as determine the potential for ground-water contaminant migration offsite.

- SB-808(Q) through SB-814(Q), drilled at locations spaced 25-feet apart along the southern boundary of the property, will determine the potential for soil and ground-water contamination migrating on site from the Young's Bay Chevron/Texaco property. These borings will most likely be completed by Chevron/Texaco.

- SB-815(Q) and SB-816(Q), drilled at locations spaced 50-feet apart, will determine the presence or absence of soil and ground-water contamination at the southern edge of the property.

- SB-817(Q) through SB-822(Q) will be advanced to determine the presence or absence of soil and ground-water contamination at the western and eastern edges of the property. These borings will most likely be completed by Van West/Harris.

- SB-823(Q) through SB-828(Q), drilled approximately 20 feet from Boring "B" inside the Qwest garage. Previous investigations found soil and ground-water contamination at Boring "B". The additional samples will investigate the extent of soil and ground-water contamination that was previously detected at Boring "B". These borings will most likely be completed by Chevron/Texaco.

- SB-829(Q) through SB-833(Q) will be advanced to determine the presence or absence of soil and ground-water contamination at the perimeter of the excavation to remove contaminated soil in the vicinity of the former pump island.

The borings will be advanced using a Geoprobe™ drilling rig. Soil samples will be collected and field screened using visual, olfactory, and PID observations. Soil samples suspected of containing contamination of petroleum hydrocarbons will be submitted to a laboratory for analysis for total petroleum hydrocarbons (TPH) in the gasoline and diesel/lube oil range; TPH will be analyzed by the Northwest Total Petroleum Hydrocarbon Methods (DEQ, December 1996). After encountering the water table, a ground-water sample will be collected and submitted to a laboratory for analysis of TPH in the gasoline and diesel/lube oil range; TPH will be analyzed by the Northwest Total Petroleum Hydrocarbon Methods.

Temporary well points will be installed in several of the perimeter Geoprobe™ borings in order to determine the direction of the hydraulic gradient and measure the thickness of any floating product present. The locations of the well points will be based on the field conditions encountered.

3.2.8 Shell Oil Company

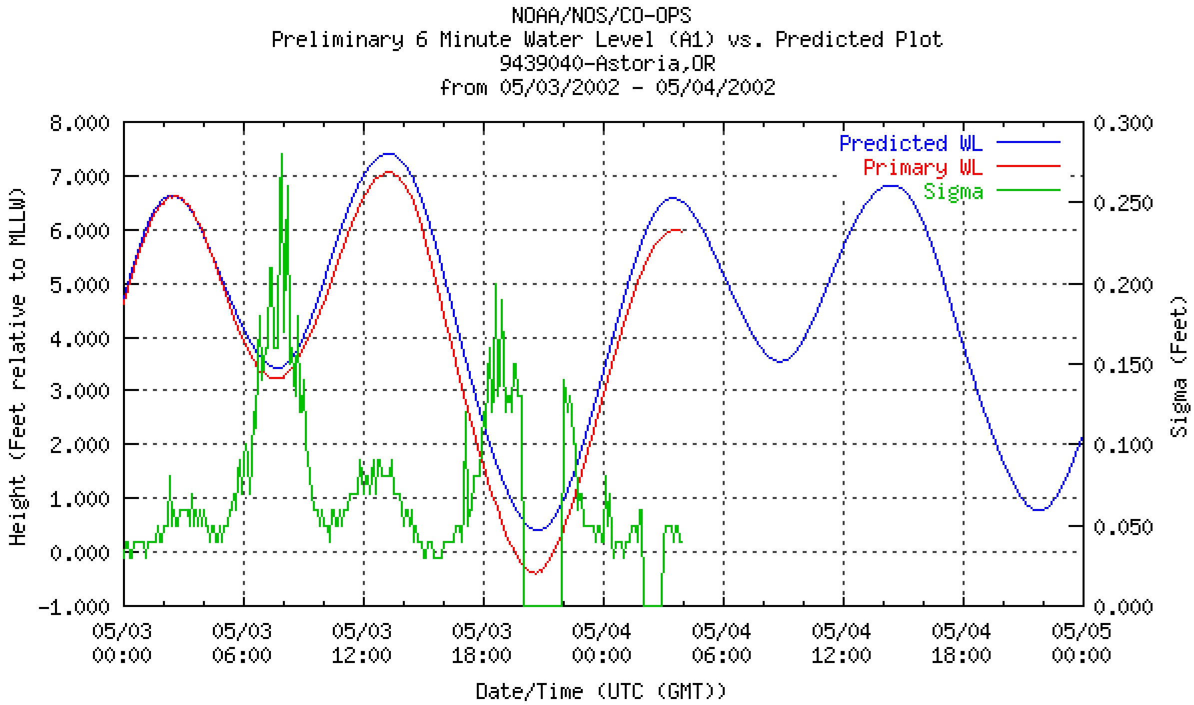
Shell operated a bulk petroleum products facility at 3 Portway Astoria, Oregon, from approximately 1925 to 1972 that consisted of seven ASTs and ancillary piping/loading facilities at the Portway site; and a pipeline network that extended from the site to loading and filling stations at Port facilities on the Columbia River. By 1974, all above ground tanks and other above-ground on-site bulk handling facilities were decommissioned and removed from the Portway site. The site has been redeveloped and is currently occupied by the Oregon State Police Astoria Patrol Office.

The former ASTs and other relevant former site features are shown on Figure 17. Specific information relating to the pipeline abandonment is not available. However, Shell's in-place abandonment procedures for pipelines at the time typically included draining product from the lines, running a cleaning "pig" through the lines to remove residual product and sludge, and capping the end of the lines.

Shell's Phase 1 RI site investigation activities will include completing 12 push-probe explorations in areas that were previously occupied by ASTs and loading facilities and at other accessible locations to provide a range of coverage over the site (Figure 17). The GeoProbe™ explorations will be completed using procedures described in Appendix E. Continuous soil samples will be collected from each exploration and each exploration will be completed to a depth sufficient to obtain a ground-water sample using procedures described in the Field Sampling Plan (Appendix A). A proposed test pit (TP-900(S)), will be completed near the northern site boundary to locate, access, and inspect the on-site terminus of the pipelines (Figure 17). Shell plans to locate and trace the length and termini of the off-site pipelines and verify that the pipelines do not contain product. If product is present in the pipelines, the product will be removed, and the lines flushed. The condition of the pipelines will be visually inspected for potential line breaks or other indications of leaks using an in-pipeline video camera. Areas of interest (pipe junctions, valves, and other areas identified during the pipeline inspection) will be identified during this phase of the investigation and test pits or probes will be completed in these areas during a subsequent phase of the investigation.

3.3 GROUND-WATER CHARACTERIZATION PROGRAM

Ground-water impacts from COIs have been detected at several of the facilities in the Astoria Area-Wide site. Ground-water occurs at a shallow depth, as shallow as 5 feet near the Columbia River. The elevation of the ground-water table is influenced by the daily tidal cycle. The tide is a semidiurnal mixed type tide with a range of about 7 feet in May 2002 in Astoria.



The magnitude of the tidal effect in the shallow water-bearing zone beneath the RSA is dependent on the hydraulic conductivity of the sediments and dredged fill that comprise the aquifer system. Anisotropy within the aquifer system may cause effects to be more pronounced in one area of the site versus another. Establishing a baseline of water level elevations at monitoring and observation wells is important in understanding these tidal influences and in their effect on fate and transport of COIs.

3.3.1 Water-Level Monitoring Program

To evaluate tidal influence in the shallow water-bearing zones, water levels will be monitored hourly for one year in three selected wells using a data logger and pressure transducers (or combined unit). The wells to be selected for this purpose will be identified in an addendum to this Work Plan once the monitoring-well network for the RI is defined. Water-level measurements in monitoring wells not equipped with a data logger will be measured on a monthly basis for one year after installation.

Water levels will be correlated with tide levels from a local tide gage before, midway, and at the completion of a ground-water quality sampling event. The midway reading would allow determination of rising, falling, or peaking/transitional trend in cycle. Water-level data from the wells selected to monitor tidal influence will be available for correlation of water levels for sampling events that extend over more than one day. The tidal influence will likely vary with lunar cycle, modified by weather conditions and, perhaps, water management policies/actions at locations up-river.

Initial water-level measurements will be obtained from all newly-installed monitoring wells after a minimum of twenty-four hours has elapsed following development. Depth to water will be recorded to the nearest 0.01-feet and all water-level information will be recorded on a water-level measurement form (Appendix A).

This water-level information will be evaluated by transferring the transducer data into a spreadsheet program for manipulation and correction of transducer drift, if necessary, and ultimately stored in the data management system for the Astoria Area-Wide site. Plots of water-level elevation over time (hydrographs) will be generated to evaluate tidal responses at each selected monitoring location.

3.3.2 Redevelopment of Existing Monitoring Wells

Monitoring wells remain from previous site investigations in the area of the pipeline diesel spill and the Harris/Van West service station. These monitoring wells will be inspected and redeveloped during the initial stages of the RI/FS. Each well will be sounded to evaluate the amount of sediment build-up, if any, and an initial water-level measurement will be made. The procedures to be used for redevelopment are the same as will be used for new well development and are described in Appendix E. Fluids and sediment produced by redevelopment will be handled as described in Section 3.7.

If air-lift techniques are required, air will be introduced into the well with an eductor pipe to prevent air from entering the well screen or filter pack. If ground-water quality sampling is to be conducted within seven days of air-lift redevelopment, pumping or bailing of sufficient duration should be performed so that oxygenated water in the vicinity of the well bore is removed. The procedure should be documented by dissolved oxygen measurements.

3.3.3 Ground-Water Monitoring Well Installation

Ground-water quality samples will be collected from temporary wells drilled during the source/soil characterization program. The distribution of COIs and the hydrogeologic conditions observed during drilling these borings will be used to prepare an appropriate plan for establishing the monitoring-well network for the Astoria Area-Wide site. An addendum to this Work Plan describing the proposed monitoring-well network will be prepared for submittal to DEQ.

The monitoring wells will be installed in accordance with WRD rules and DEQ guidance. An *EnviroLogic Resources* field representative under the supervision of an Oregon registered geologist will supervise and document each monitoring well installation. An as-built drawing of the well completion will be recorded on the boring log form (Appendix A). Appropriate sampling intervals and techniques depend on the materials penetrated and the drilling methods employed and will largely be based on knowledge of the site and subsurface conditions known to date. Appendix A details the techniques to be used on subsurface sampling from boreholes.

Wells installed in the shallow water-bearing zone will be screened over a ten feet interval across the water table, to a level above or approximately equaling the expected seasonal high water level. The bottom of the screened interval should not be placed below the saltwaterfreshwater interface. The seasonal high ground-water level will be determined after review of initial hydrographs developed from data collected to evaluate tidal influence. Modifications to the planned screened interval may be made once these data are reviewed.

3.3.4 Ground-Water Quality Monitoring Plan

A ground-water quality monitoring program will be implemented quarterly at the Astoria Area-Wide site. Following measurement of water levels, but before initiating the pre-sampling purge, each well will be checked for the presence of light nonaqueous phase liquids (LNAPL or free product) using oil-finding paste or a water-oil interface probe. If a separate phase is found, apparent thickness will be documented in the field notes/sampling form. A sample of the LNAPL phase for characterization by analytical method NWTPH-HCID will be collected on the initial sampling event, but a ground-water sample will not be collected from that monitoring well.

Ground-water samples will be collected and analyzed for all COIs from all existing and new monitoring wells during the initial ground-water sampling event. Sampling methods, containers, preservatives, and holding times for each analytical method are provided in the Field Sampling Plan (Appendix A). Additional sampling events will occur on a quarterly basis; however the sampling schedule and analyte list for some monitoring wells may be modified, with DEQ concurrence, based on results of the initial sampling event and to meet the objectives of the RI.

Ground-water quality sampling from wells in the monitoring-well network will be conducted by one *EnviroLogic Resources* sampling crew to minimize introduction of potential variables that could affect comparability of the data among the wells. Analytical work on ground-water samples from the monitoring-well network will be conducted by a single laboratory.

3.3.5 Characterization of the Aquifer System

Aquifer parameters that control ground-water movement and fate and transport of COIs will be evaluated during the RI/FS. Slug tests will be conducted at representative monitoring wells to develop an understanding of the range of hydraulic conductivity within the aquifer system. At least five monitoring wells will be included in the slug testing program. Slug tests will be conducted using an inert solid cylinder. The cylinder will be introduced to the well "instantaneously" and the change in water level will be recorded using data loggers and a pressure transducer. Once equilibrium is reached, the slug will be removed from the well and water levels recorded again. Comparisons of slug-in and slug-out data will be made to evaluate hydraulic conductivity. These data will be used to make estimations of the rate of movement of ground water and COIs. As an additional evaluation of aquifer properties, comparisons of the tidal change with changes in water level in monitoring wells will be evaluated (Millham and Howes, 1995).

More comprehensive aquifer testing and modeling of the ground-water system may be conducted if needed to support risk assessments and evaluate remedial alternatives. An addendum to this Work Plan detailing the procedures to be used for aquifer testing and modeling will be prepared and submitted to DEQ for review and approval.

3.4 STORM AND SURFACE WATER CHARACTERIZATION PROGRAM

The Columbia River is the primary surface water feature at the Astoria Area-Wide site. Up to 10 storm water outfalls are understood to be present in the RSA, discharging storm water to the Columbia River (Figure 6).

Storm water discharges from up to three selected outfalls will be sampled on a quarterly basis, in accordance with the Order. The Port discharges storm water under an industrial general permit 1200-Z. The intent of the storm water characterization for the RI/FS is to supplement the information developed by the Port as part of its permit requirements, where possible. Currently, biannual sampling events at Outfall #1 and Outfall #6 are conducted under this permit. Those sampling events will continue as described in the permit. Two additional sampling events will be conducted each year as part of the Astoria Area-Wide RI/FS. Outfall # 2 may be included in the sampling program after analysis of storm water catchment areas for each outfall is completed during the Phase 1 RI. These additional events will be conducted as described below.

Storm water samples will be collected in a manner consistent with the Field Sampling Plan (Appendix A), and analyzed for the following constituents using analytical methods specified for storm water samples in the permit.

- Total copper, using EPA Method 6010B;
- Total lead, using EPA Method 7421;
- Total zinc, using EPA Method 6010B;
- pH, using EPA Method 150.1;
- Total suspended solids, using EPA Method 160.2; and
- Oil and grease, using EPA Method 1664.

In addition, petroleum VOCs and PAHs will be analyzed using methods established for ground-water samples to evaluate contributions to storm water discharges from petroleum-related potential sources. As data are collected under the storm water sampling program, the sampling locations may be changed to focus characterization or to develop a broader evaluation of the quality of storm-water discharges.

A determination of flow rate will be made at each outfall for all sampling events. Sample data shall also include pH, temperature, electrical conductance, and visual observations for the presence of oil and grease sheen and floating solids. Storm-water sampling locations will be at up to three outfalls, taken prior to the confluence of the storm water flow with the receiving water. However, additional storm water sampling points may be necessary to identify sources of constituent impacts, if applicable. Additional analytical requirements may be added to satisfy RI objectives.

Storm water outfalls are observed on a monthly basis when discharging under the permit for visual indications of pollutant impacts (floating solids, sheen [oil and grease], discoloration, turbidity, etc.) and for non-storm discharges during periods that have been absent of storm events (typically August-September).

Monitoring data will be submitted to the DEQ in a technical memorandum at the completion of the first year of sampling. The Port will continue to report the results of its storm water sampling activities prior to July 15th of each year to the DEQ Stormwater Section as required in the permit.

3.5 SEDIMENT CHARACTERIZATION PROGRAM

Sediments are dredged from Slips 1 and 2 on an annual basis under a flow-lane discharge permit. The permit allows for discharging of dredged spoils from November through February each year. When dredging needs to be conducted outside these times, sediments are stockpiled at the base of Slip 2.

Sediment samples will be collected from two boring locations at the base of Slip 2 as shown on Figure 20. These sampling locations are in an area near where diesel is discharging to the Columbia River at Slip 2. The samples will be taken on the sediment shelf during low tide, as the shallow sediments will be exposed during this time. The sampling process is explained in detail in the Field Sampling Plan (Appendix A).

COIs in sediments include petroleum hydrocarbon related constituents. Sediment samples will be analyzed for petroleum hydrocarbons (NWTPH-HCID), petroleum VOCs, PAHs, and metals.

The Port will continue their dredging program in the present and future. Therefore, sediments will continue to be removed from the slip, which may include small concentrations of COIs within the sediments. Prior to dredging, the Port conducts its own analytical program to meet the requirements for discharging dredged spoils.

3.6 TOPOGRAPHIC SURVEY

As part of this RI/FS process, a data management system has been developed. Within the database is stored detailed information concerning previous investigation results (e.g., analytical data by media, depth, date of collection, etc.; sampling location; water level; well construction; etc.). The database provides the ability to query existing data, generate various data reports, and easily enter new data as it is made available. In order to make effective use of all the available features of this database, both planar and elevation surveys of sampling locations, monitoring well locations, and important site features will be required. Additionally, in order to determine hydraulic characteristics of the site (e.g., surface drainage; utility corridor interaction with ground-water flow), a site topographic survey will be required.

A vertical and horizontal survey will be conducted by a licensed land surveyor to determine and map the locations and elevations of each existing and newly installed monitoring well and well point. Soil boring locations or other facility features also may be surveyed, if determined necessary. The survey information will include northing and easting coordinates, existing surface elevations, and elevations for water level measurement reference points (generally the top of the well casing).

The survey will be referenced to a USGS benchmark, and previous surveys conducted at the facility. The National Geodetic Vertical Datum of 1929 will be used for vertical elevation control and the Oregon State Plane Coordinate System for horizontal control. The results of the survey will be translated to the data management system, spreadsheets, and maps used during the RI/FS.

3.6.1 Geodetic Surveys of Boring and Monitoring Wells

Surveys of temporary boring locations will be completed as part of the source/soil characterization program. Typical acceptable surveying methods are differential global positioning system (DGPS), or more conventional plane surveying techniques with conventional surveying methods (total station, level, prism and laser, professional land surveyor, etc.). The accuracy of the survey should be to within 0.1-feet for horizontal plane data and 0.1-feet for elevation (topographic) data. If DGPS is used, several data may need to be utilized to guarantee the accuracy of the data as DGPS accuracy is related to the distance of the receiver from the base station (discussion below).

In order for GPS receivers to achieve the type of accuracy required for planer spatial surveying within a local subject area, a GPS receiver is placed in a precisely surveyed position (datum) and used as a reference for other receivers. In particular, the reference receiver is used to estimate the relative instantaneous bias errors in the clocks of all the GPS satellites in view. These estimates are then used to correct the signals that are read by nearby receivers. This approach is called DGPS and can locate points with an error of +/- a few centimeters.

The effect of this method is to compensate not only for the Selective Availability (SA) noise that was added to the time signal from each satellite, but also for most other errors. Whatever errors the reference receiver produces that originate from tropospheric and ionospheric transmission delays, earth tides, relativistic effects and satellite ephemeredes will apply almost identically to any other nearby receiver. Therefore, such errors are “aliased” into the estimated satellite clock bias errors, and hence are canceled when the satellite clock estimates are applied to nearby receivers.

All existing and future monitoring wells will be surveyed to determine their position in space. The accuracy of the survey will be to within 0.1-feet for horizontal plane data and 0.01-feet for elevation (topographic) data. DGPS may be used as long as the accuracy of elevation data can be substantiated, otherwise conventional planar surveying techniques will need to be utilized.

3.6.2 Site Topographic Survey

A topographic survey depicts the "lay of the land" of the Astoria Area-Wide site. Elevations will be taken at numerous points (typically on a grid) using either DGPS or conventional surveying techniques. Should DGPS be used, several datum points throughout the AAW subject site may be needed to assure the accuracy of the data. The topographic survey will have contour intervals of 1-foot and will be referenced to USGS datum. The topographic survey will be used to evaluate the position of hydraulic features relative to ground surface and will help in determining of volumes of media of concern for remedial alternatives evaluation.

3.7 HANDLING OF INVESTIGATION-DERIVED WASTES

Investigation-derived wastes (IDW), such as water and soil cuttings generated during drilling activities, water purged from the wells during development sampling and aquifer testing, waste decontamination liquids, and solid residuals (e.g., Tyvek, gloves, etc.) will be collected and stored in a temporary staging area at the site until proper disposal methods are determined. Decontamination fluids containing decontamination solvents will be stored separately. These IDW will be disposed of appropriately, in a manner consistent with the analytical results and in accordance with local, state, and federal regulations (40CFR 262.11). The PRPs will be responsible to ensure that waste generate from their specific site being investigated is not listed (as defined in Subpart D of 40 CFR 261). Analytical testing of soil and ground water is discussed in Section 3.2. Additionally, wastes will need to be tested for characteristic ignitability (40 CFR 261.21), characteristic corrosivity (40 CFR 231.22), and characteristic reactivity (40 CFR 261.23). Toxicity characteristic leaching procedure may be required (characteristic toxicity, 40 CFR 261.24) if the waste(s) contains elevated levels of volatile organic constituents and/or RCRA regulated metals. At this time, it is assumed that waste may be impacted with petroleum hydrocarbon related constituents; however characterization of all waste will be necessary to properly treat or dispose generated waste.

3.7.1 Soil Cuttings, Cores, and Decontamination Water from Temporary Borings

Soil cuttings and cores derived from the drilling of temporary borings and/or installation of monitoring wells will be placed in drums, sealed, and labeled as to the a) nature of the contents, b) date contents sealed, and c) responsible party. Additionally, as all drilling and sampling equipment will be cleaned before going into the field and between sample locations to prevent contaminating samples (Appendix A), all decontamination waste will be similarly drummed, sealed, and labeled.

3.7.2 Test Pit/Trench Spoils

As test trenches may be used to characterize and/or delineate soil impacts, spoils derived from these installations will be placed on Visqueen. If the waste is to remain onsite overnight or for longer (but temporary) durations, the soil should also be covered with Visqueen. Additionally, the soil stockpile should be bermed on the edges. Decontamination waste from cleaning the excavation equipment will be drummed, sealed, and labeled.

3.7.3 Purge and Decontamination Water from Reconnaissance Ground Water and Monitoring Well Sampling

Purge water from both reconnaissance ground water and monitoring well sampling will be drummed, sealed, and labeled. Additionally, all decontamination waster associated with heavy equipment used for drilling (e.g., hollow-stem auger, GeoProbe^{TM}) will be similarly drummed.

3.7.4 IDW Disposal - Soil

Upon receipt of analytical data, the consultant for each PRP will evaluate the disposal requirements for the drummed and stockpiled soil IDW, and determine if additional analytical testing is required. Soil waste determined to be impacted with contaminants at levels regulated under RCRA rules as characteristic (hazardous waste) must be disposed or treated in a manner consistent with RCRA regulations. F-Listed Waste will be disposed of at the Waste Management, Inc., facility at Arlington, Oregon. Other wastes must be disposed at a Subtitle D landfill or approved treatment facility, in a manner consistent with the facility's permit, profiling, and disposal processes. If the IDW is not impacted, the PRP will be responsible for its proper disposal, consistent with Oregon Solid Waste disposal requirements.

3.7.5 IDW Disposal – Water/Fluid

Upon receipt of analytical data, the consultant for each PRP will evaluate the disposal requirements or the drummed fluid IDW. Water waste determined to be impacted with contaminants at levels regulated under RCRA rules as characteristic (hazardous waste) must be disposed or treated in a manner constituent with RCRA regulation.

Other non-RCRA hazardous materials determined to be impacted with petroleum hydrocarbon or indicated not to be contaminated will be stockpiled in drums or temporary storage tanks to be located in a designated area on-site. Pursuant to ORS 465.315, subparagraphs 3 and 4, a permit for the discharge of treated water will not be needed. Bulk water samples will be collected and evaluated based on the requirements of subsection (1)(a) of ORS 465.315, with the specific discharge limits that must be met with regard to this discharge indicated in the table below. *EnviroLogic Resources* will be in charge of this collective storage facility, and responsible for testing and physical discharge. Additionally, *EnviroLogic Resources* will ensure for the security and control of access to this storage facility. Bulk water found to exceed discharge requirements will either be treated on-site (i.e., oil/water separation, purge, carbon filtration, etc.) until the analytical results are at or below the discharge limits present below, or pumped from the bulk storage tanks and transported to a disposal facility for off-site treatment (i.e., Oil Re-refining and Harbor Oil). The bulk water discharge (as applicable) will be maintained at a rate consistent with a 10:1 dilution with the receiving stream.

Discharge Limits for Bulk Water Discharge

Constituent	Discharge Limit (mg/L)
Total Petroleum Hydrocarbon	1.0
Benzene	0.025
BTEX (sum of benzene, toluene, ethylbenzene, total xylenes detections)	0.25
pH	6 to 9 (pH units)

3.8 QUALITY ASSURANCE/QUALITY CONTROL

The RI data will be used to determine appropriate exposure scenarios for the EA and to support development of appropriate remedial alternatives for the FS. Therefore, the RI data must be collected in a manner that both provides for, and documents, an acceptable level of precision and accuracy. A quality assurance/quality control (QA/QC) program designed to provide the necessary level of precision and accuracy, as well as completeness, representativeness, and comparability is outlined in detail in Appendix B. The QA/QC program includes, among other things, identification of data quality objectives, specific QA/QC procedures for sample collection and handling, analytical protocols for the analytical laboratories, the use of QC samples, and data validation procedures.

3.9 DATA EVALUATION AND MANAGEMENT

Data collected during the RI will be used to address the objectives of the investigation. These data will be incorporated into the existing data management system and will be used to further develop a conceptual hydrogeologic model, including aspects of physical characteristics, the nature and extent of COIs, and COI fate and transport. Data from the RI will be used as the basis for the EA and FS. These evaluations are discussed briefly in the following paragraphs.

Scaled Base Map

A scaled base map of the facility has been prepared by combining various city, Port of Astoria, and PRP site specific maps. This map currently is used for presentation and interpretation of data, such as location of important past and present facility features, location of former borings and monitoring wells and other investigation activities, and plotting of contaminant distributions. New borings and monitoring wells will be plotted on this map along with the distribution of COIs and ground-water elevation contours.

Facility Physical Characteristics

Physical characteristics of the facility and vicinity, including topography, geology, and hydrogeology will be further evaluated. Data from boring logs and soil boring samples were used to develop a conceptual hydrogeologic model. Future borings will be used to further define the local hydrogeology and fill in the information gaps.

Nature and Extent of COIs

Historical constituent concentration data was incorporated into a database. Queries were performed in this database, and the results were used to evaluate the nature and extent of contamination in soil and ground water at the facility. The data from previous investigations helped form a basis for the proposed new boring locations. Results from analyses of historical facility operations, nature and extent of COIs, and physical site characteristics was used to refine the conceptual site model. This model was used in evaluating current and future fate and transport characteristics.

Analytical and field data results from these new borings will be added to the current database. Electronic deliverables will be provided by the laboratory and inserted into the database. The queries will then be used to produce tables for plotting, analyzing, and reporting data. Relevant RI data and other information will be presented on concentration contours maps, on cross sections, and in tabular format, where appropriate. Spatial and temporal trends in ground-water and storm-water constituent levels also will be evaluated.

Endangerment Assessment

Data collected during each phase of the RI will be used to perform an EA, including human health and ecological evaluations. These evaluations are discussed in Section 5.0.

Feasibility Study

Data collected during the RI will be used to evaluate remedial alternatives and IRAMs. Volumes and hydrogeochemistry of affected media will be evaluated to for input to the IRAM and FS processes.

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4.0 IRAM DEVELOPMENT

Site-specific objectives for the Astoria Area-Wide site were identified in the RI/FS and IRAM Development Proposal (*EnviroLogic Resources*, 2002). These site-specific objectives include the following:

- Develop and implement an IRAM to mitigate discharges of petroleum hydrocarbons to the Columbia River;

- Develop and implement an IRAM to mitigate volatile organic compound (VOC) vapor intrusion into buildings at levels exceeding DEQ risk-based concentrations, as appropriate.

This section describes the general process to develop and screen alternative interim remedial action measures (IRAM), as well as the process to document the rationale for selection of preferred IRAMs to address these site-specific objectives. This IRAM development process is designed to be used to evaluate potential IRAMs to meet other remedial objectives identified during the implementation of the RI/FS process.

4.1 IRAM DEVELOPMENT PROCESS

In general, the screening of technologies, assembly of IRAM alternatives, and detailed analysis of the IRAM alternatives will be consistent with the approach identified in OAR 340-122-0085 and OAR 340-122-0090, as well as DEQ "Final Guidance for Conduction Feasibility Studies" dated July 1, 1998. Information obtained during previous investigations and the RI will be used in the development of and subsequent evaluation of IRAM alternatives. The criteria used for screening of potential technologies and the detailed analysis of IRAM alternatives for the site are described below.

Technologies that could potentially be used to achieve the site-specific objectives, will be identified and screened with consideration of each technology's effectiveness, ease of implementation, and cost. Based on the screening, technologies best suited for detailed analysis will be carried forward for assembly into IRAM alternatives for a more detailed evaluation. If data gaps are identified during the identification and screening of technologies that are critical to the screening and assembly of alternatives, as well as detailed analysis, then these additional data needs will be incorporated into the scope of the RI. Upon obtaining the necessary data, the IRAM development and selection process will resume.

The detailed evaluation will include analysis of the assembled IRAM alternatives against criteria consisting of: protectiveness, a balancing of five remedy selection factors, as well as treatment of hot spots of contamination to the extent feasible. The remedy balancing factors include effectiveness, long-term reliability, implementability, implementation risk, and reasonableness of cost.

- **Effectiveness** – considers the magnitude of risk from untreated contamination or treatment residuals; adequacy of institutional and engineering controls; extent to which beneficial uses are restored or protected; and time until remedial action objectives are achieved.

- **Long-term Reliability** – evaluates the reliability of the treatment technology; the reliability of engineering and institutional controls necessary to manage risk; and uncertainties in long-term management (operation, maintenance and monitoring).

- **Implementability** – focuses on practical, technical and legal difficulties and unknowns associated with the remedy; the ability to monitor effectiveness; federal, state and local requirements; and the availability of necessary services, materials, equipment and specialists.

- **Implementation Risk** – looks at potential impacts on the community; potential impacts on workers; potential impacts on the environment; and the time required to complete the remedial action.

- **Reasonableness of Cost –** determines capital, operation and maintenance, and periodic review cost of the remedial action; and the degree to which costs are proportionate to benefits to human health and the environment. Such benefits are created through risk reduction or risk management and restoration or protection of beneficial uses of water

In addition, the evaluation of IRAM alternatives will consider the likely compatibility of an alternative with the final overall remedy for the site. Based on this detailed evaluation, an IRAM alternative will be recommended for implementation as the IRAM.

4.2 IRAM FOR MITIGATION OF PETROLEUM DISCHARGES TO RIVER

This section discusses the development and evaluation of IRAMs to address the site-specific objective to mitigate discharges of petroleum hydrocarbons to the Columbia River. In particular, this IRAM evaluation is focused on the area of the site where seeps of free phase petroleum hydrocarbons have historically been observed along the Columbia River.

The results of a preliminary screening of potentially applicable IRAM technologies are presented in this section. The preliminary screening was completed based upon the current understanding of the site conditions. Following collection of additional data during the RI activities, this preliminary screening will be updated and the IRAM development process completed to identify the preferred technologies to satisfy the IRAM objective of mitigating hydrocarbon discharges to the Columbia River.

4.2.1 Remedial Action Objectives

RAOs are media-specific goals for protecting human health and the environment. RAOs provide basis for developing and evaluating remedial actions since any remedy selected, must achieve these site specific RAOs. The interim RAOs identified for this IRAM to address petroleum hydrocarbons at the Astoria Area-Wide site are the following:

- Prevent migration of ground water containing free product, which could adversely affect beneficial uses of water; and
- Remove free product that may represent "hot spots" by reducing volume, mobility or concentrations to the extent feasible.

4.2.2 Identification and Screening of Potential Remedial Technologies:

To fully identify, evaluate, and select an IRAM to satisfy the RAOs for the site, a better understanding of the nature and extent of contamination and site subsurface conditions is necessary. Additional data must be collected as part of the RI activities to allow completion of the IRAM evaluation. However, pending receipt of the additional data from the investigation activities, general response actions and associated technologies to implement general response actions have been preliminarily identified and screened.

Technologies associated with a list of general response actions were identified and screened for applicability based on currently available information regarding soil conditions and the nature and extent of free product. General response actions are broad categories of remedial measures that address the remedial action objectives. General response actions identified to address the RAOs for the Astoria Area-Wide site include:

- No Action;
- Containment; and
- Removal/Extraction/Recovery.

The area and volume of free product, while generally understood, is not sufficiently defined at this time to effectively screen technologies. Additional investigation will be implemented to determine critical subsurface parameters and site characteristics. The need for additional data will be discussed in the following technology sections.

Based on the current understanding of the vertical and lateral extent of contamination, chemistry of contaminants, site geological and hydrogeological characteristics, as well as site infrastructure that may influence migration of free product and/or effective implementation of an action, technologies that appeared offer the most potential either alone or in combination with other technologies to satisfy the objectives for the IRAM include the following:

- Free Product Recovery;
- Free Product Collection Via Booms;
- Steam Cleaning and Soil/Sediment Excavation;
- Vapor Extraction;
- In-situ Physical Barrier/Treatment (ART Technology which includes in-well air sparging, air stripping and oxidation); and
- Cutoff Walls.

Several of these technologies are most effective when combined with other technologies. As appropriate, technologies will be combined to form functional IRAM alternatives. Performance monitoring is considered to be part of each IRAM alternative that will be assembled, except No Action.

A No Action alternative will be considered as a baseline for comparison. This alternative consists of performing no interim response activities to address free product at the site.

At this time, a comprehensive detailed analysis of IRAM alternatives can not be performed since important data related to free product volume, lateral and vertical extent, free product character (e.g., viscosity, specific gravity, chemical composition, etc.), and other necessary information is not available. However, based on the limited available information, several interim remedial response action technologies are considered to have the greatest potential.

Final IRAM alternatives will be assembled and evaluated following collection of additional data during the RI. However, based upon current information it appears likely that all IRAM alternatives will include the following components:

Free Product Recovery

Free product in the subsurface represents a significant source of contamination. To satisfy the IRAM objectives for the site, free product recovery to the extent practicable is considered likely from the subsurface at the site. Based upon currently available information, it is expected that free product will continue to seep into the river, and impact ground-water quality if no response action is implemented. Tidal and seasonal fluctuations in the water levels will result in frequent smearing of product in the vadose zone within the region influenced by ground-water elevation changes. Free product will also continue to represent a source of contamination to surface soil/sediment at the bank of the river in the area of observed seeps.

To effectively extract free product from the subsurface, total fluids vs. only free product recovery have been evaluated. Free product recovery via floating pumps or stationary and manually positioned pumps have been evaluated. Due to the daily and significant tidal related ground-water elevation changes, stationary and manually positioned free product recovery pumps are not considered applicable at this site. Therefore, floating free product recovery pumps will be retained for further evaluation following collection of additional data.

Free product recovery may be performed from a trench located along the migration pathway currently allowing discharge of product to the river. This would be achieved by excavating a trench in the area that would optimize free product recovery and prevention of seepage to the Colombia River. The trench may be excavated to five or more feet below normal low water levels. The trench would be designed to drain to a specific section and pumps would be located to recover free product and possibly impacted ground water. Free product recovery may also occur via extraction wells strategically located at the facility. The most effective and cost efficient approach/option will be determined following collection of additional RI characterization data.

For total fluid recovery, submersible pumps will be considered further. Pumps types and capacity will be specified when the selected remedy is approved and designed. Extraction and/or treatment well design will be detailed when the subsurface hydrogeological conditions and product characteristics are better understood. The locations and numbers of extraction trenches or wells will be estimated following the collection of the necessary additional information during the RI.

Free product recovery is a relatively straightforward technology. Many recovery pump options, both floating and submersible, are readily available. Pumps may be placed in wells or trenches. In order to further evaluate the feasibility of product recovery, the following information is necessary:

- Location and dimensions of the free product area, and the thickness of free product throughout the site;
- Daily and seasonal ground water level fluctuations;
- Free product elevation and thickness changes in response to daily and seasonal ground water fluctuations;
- Subsurface hydraulic conductivity and ground water velocity and direction at the site along with changes associated with ground water levels fluctuation;
- Physical and chemical product characteristics; and
- Soil engineering parameters including permeability, shear strength, cohesion, clay content, atterberg limits, and grain size distribution.

Free Product Collection Via Booms

Until additional site characterization data is collected, the effectiveness of technologies to recover and contain free product prior to discharging into the Columbia River is uncertain. Even if technologies are implemented to recover and/or contain free product, it is possible that all free product seepage into the Colombia River will not cease immediately after the implementation of free product recovery and/or containment measures. Free product may continue to seep into the river for sometime thereafter. The length of this period depends on the effectiveness of the free product recovery efforts. Therefore, temporary free product collection and removal measures may be implemented at the riverbank where seeps have occurred. Measures could consist of placing booms around the seepage area to absorb or collect seeping free product and minimize dispersal of constituents into the river. A maintenance program consisting of periodic visits to the seeps areas, replacement of booms and extraction of collected free product via vacuum trucks or other means, when necessary, would be implemented. Additional information including volume of daily seeping free product estimates will be necessary to select the most effective approach.

To enhance the effectiveness of floating absorbent booms, a wave attenuation method such as the addition of timbers to the existing piles and additional piles will be considered. This structure would prevent debris from damaging the booms and would reduce the wave action to limit hydrocarbons washing over the booms. In addition, improvements that include surface leveling of the riverbank in selected areas to prevent hydrocarbons from passing under the boom will be evaluated.

Installation of a concrete or a synthetic liner floor at the edge of the riverbank to enhance free product collection was also considered. However, a final option cannot be selected at this time since additional data regarding seepage volume and extent are needed. Also, the option needs to be considered in conjunction with other components of the final remedy. It appears that most of the free product seepage occurs along a sewer line. Thus, if a trench is installed that intersects the sewer line backfill, the free product seepage to the river may become minimal and structures for wave attenuation and the concrete apron may not be necessary.

Steam Cleaning Of Bank And Localized Surface Soil/Sediment Excavation

As a result of free product seepage into the Columbia River, dark surface stains are apparent in an area that extends approximately 200 feet along the river at the south end of Slip 2. Large aggregates, riprap and boulders are present in this area and are coated with a film of stains and free product. In addition, surface soil/sediment in this general area appeared to have been impacted. Observations during the RI are needed to determine if these stained materials represent a source of free product release to the river. If the RI activities indicate that the IRAM needs to address these materials along the bank of the Columbia River, then technologies will be evaluated to address these potential sources. These measures may include steam jetting and surfactant laden water spraying of the riprap and boulders to remove the free product film. Following the completion of this task, selected areas that exhibit signs of extensive free product contamination could be marked for surface soil/sediment removal. For accurate and effective evaluation additional data including vertical and lateral extent of impacted surface soil/sediment at the Columbia River bank adjacent to the site and degree of free product film coating the gravel and the riprap of this area is needed.

Other remedial technologies have been identified for evaluation based on their potential applicability to the Astoria Area-Wide site. The determination of feasibility of an IRAM alternative will be based on the evaluation criteria discussed previously. The final determination of the relative feasibility for each of these technologies will be determined through a comprehensive evaluation to be performed following the collection of additional data during the RI. These technologies include:

Vapor Extraction

Vapor extraction may be an effective technology to assist with the removal of limited free product volumes with suitable characteristics. This technology consists of extracting vapor from the subsurface, which will result in stripping volatile petroleum hydrocarbons from the free product in the subsurface. The volatile hydrocarbon laden vapor will be extracted to the surface to be treated or emitted to the atmosphere depending on the concentrations of the constituents in the vapor stream. In addition, this measure will result in increased oxygen concentrations in the subsurface, which will enhance in-situ biodegradation of petroleum compounds. Existing biological organisms in the subsurface will use the hydrocarbon constituents as a source of energy, which will result in additional reduction in the hydrocarbon concentrations.

ART Barrier Near The River

Accelerated Remediation Technologies, LLC (*ART*) has developed an innovative, proprietary remediation technology that is based on well-proven and established concepts. The *ART* technology combines in-situ air stripping, air sparging, soil vapor extraction and enhanced bioremediation/oxidation in an innovative wellhead system. The system is designed to accommodate a four-inch well and can be very cost-effective when compared with other, stand-alone remediation technologies. The air-sparging component results in lifting the water table. This lifting of the water in the well causes a net reduction in head at the well location, which results in water flowing toward the well. This "lifting" of the water table (i.e., mounding) can also inhibit migration or provide containment of free product. Vacuum pressure (the vapor extraction component) is applied atop of the well point to extract vapor from the subsurface. The negative pressure from vacuum extraction results in water suction that creates additional water lifting (mounding) and a net lower gradient. This further enlarges the radius of influence.

A submersible pump is placed at the bottom of the well to re-circulate water from the bottom of the well and the formation to the top for downward spray through a spray nozzle. The water cascades down the interior of the well similar to what occurs in an air-stripping tower. Enhanced stripping via air sparging near the bottom of the well will occur simultaneously. In essence, the well will act as a subsurface air-stripping tower. In addition to the air stripping effected by the pumping/cascading, a portion of the pumped, stripped, highly oxygenated water will flow down the well annulus out and over the "mounded" water back in to the aquifer. This sets up a circulation or flushing zone surrounding the well that will further enhance cleanup.

To capture and remove the largest volume of free product, the free product recovery technologies would have to be placed in the area that contains an appreciable thickness of free product. An area downgradient of the recovery system may need to be addressed since the recovery system may not provide collection in all areas up to the riverbank. Additionally, it is possible that the product recovery system will not intercept and capture all free product.

Some volume of free product may continue to travel downgradient toward the Colombia River. Therefore, *ART* technology implementation at the site could be implemented as follows; *ART* wells could be placed in selected locations at the site downgradient of a product recovery system to provide containment, prevent free product migration, as well as treat ground water; a line of wells could be placed along the downgradient edges of the site near the river to form a containment/treatment barrier (*ART* wall) that will minimize the potential for free product to seep into the river.

To properly evaluate the cost-effectiveness of the *ART* technology, the following data will need to be collected:

- Soil air permeability and hydraulic conductivity;
- Ground water elevations and level changes associated with tidal and seasonal variations;
- Free product occurrence and thickness; and
- Chemical constituents concentrations in ground water.

These data will be collected as part of the proposed additional RI activities.

Cutoff Walls Near River

Cutoff walls are usually constructed by injecting a cementing agent such as cement grout into the subsurface via specialized mixing augers. Based upon current information, a cutoff wall at the site may be approximately 3 feet in thickness, and 200 feet in length. For cutoff walls to be most effective, they are typically extended vertically to a relatively low hydraulic conductivity soil section (aquitard). A dense clay stratum has been observed at the Astoria Area-Wide site at a depth of about 25 feet. Therefore, a cutoff wall may have to be extended to a depth approximately 25 feet below the ground surface. Cutoff walls are usually effective in reducing seepage for a period of up to 15 years. However, cracks can eventually be expected in the wall and routine maintenance will be required.

As pointed throughout this section, all data essential to selecting the most appropriate IRAM are not currently available. Additional data are necessary prior to final evaluation and selection of an IRAM to mitigate discharges of petroleum hydrocarbons to the Columbia River. Following collection of the additional information during the RI, a complete evaluation of technologies and IRAM alternatives will be presented.

5.0 ENDANGERMENT ASSESSMENT

An EA will be conducted consistent with OAR, and DEQ and EPA guidance. At the Astoria Area-Wide site, an human health evaluation and Level I scoping evaluation of ecological risk will be performed to evaluate the risk to human health and the environment posed by releases from the site and to support development of remedial action objectives. An addendum to this Work Plan specific to the evaluation of risk will be prepared as data for the RI are developed.

5.1 HUMAN HEALTH EVALUATION

The human health risk assessment will be developed based on OAR 340-122-084 and 340-122-205 through 360, DEQ risk assessment guidance documents, and EPA guidance documents. Two different DEQ programs address human health risk at cleanup sites: 1) the Underground Storage Tank program, which oversees releases of petroleum products from USTs and provides risk-based concentrations (RBCs) that are protective of human health under a number of exposure conditions (DEQ, 1999 [RBDM]); and 2) the cleanup program, which oversees the cleanup of hazardous substance releases, has guidance documents which specifically address deterministic human health risk assessment and ecological risk assessment, and utilizes EPA Region 9 preliminary remediation goal (PRG) concentrations, which are also protective of human health, in the screening step of deterministic human health risk assessments.

The equations and exposure factors used in the RBDM document are generally consistent with those discussed in "Guidance for Conduct of Deterministic Human Health Risk Assessments" (DEQ, 1998b). This document was developed for risk assessments being carried out under the DEQ Hazardous Substance Remedial Action Rules (OAR 340-122-0010 through 340-122-0115) and includes more exposure routes than are typical for sites limited to releases of petroleum-related constituents. The equations in the deterministic risk assessment guidance are written in a format that calculates average daily dose, whereas the equations included in the RBDM guidance document are rearranged to calculate risk-based concentrations (RBCs) that are protective of human health. As long as the COPCs are petroleum-related, the RBDM guidance may be applicable at the Astoria Area-Wide site. However, should constituents be identified that are not petroleum-related, then Oregon's deterministic risk assessment guidance and other related EPA documents would need to be used to evaluate risk on a site specific basis.

The human health evaluation will be composed of four distinct elements:

- Data evaluation and identification of COPCs;
- Exposure assessment;
- Toxicity assessment; and
- Risk characterization.

5.1.1 Data Evaluation and Identification of COPCs

A risk-based screening procedure will be conducted to identify COPCs for the site. Maximum concentrations of constituents detected in each medium will be compared to either RBCs or PRGs, depending on which guidance is applicable. Should it be determined that all constituents of interest are petroleum-related, the UST program RBCs (as defined in Oregon's RBDM guidance document) will be utilized for screening purposes. If, however, constituents of possible interest are identified that are not petroleum-related (i.e., outside of the scope of RBDM guidance) the use of Oregon's deterministic risk assessment guidance and other related EPA documents would be warranted.

Screening criteria are based on OAR 340-122-080(5), which allows for pre-baseline screening of contaminants. In this screening, contaminants detected at the site that have not been screened should be designated as "chemicals of interest" (COIs), while those that have been included after screening should be designated as "contaminants of potential concern" (COPCs). Following a deterministic baseline risk assessment, contaminants that did not meet acceptable risk levels should be designated as "contaminants of concern" (COCs). COIs are screened on the basis of frequency of detection, background levels of chemicals, and relative toxicity, to determine whether they qualify as COPCs that should be carried forward in the risk assessment.

Constituents with maximum detected concentrations below screening levels will be eliminated from further consideration. The identified COPCs will be further evaluated to calculate risk, from which site-specific risk-based cleanup goals can be derived, similar to EPA's PRGs.

5.1.2 Exposure Assessment

Exposure pathways will be selected based on potential receptors identified both onsite and offsite. Existing and potential reasonable future land use and the physical setting of the site, including climate, soil characteristics, river sediment characteristics, and hydrogeology will be considered in developing the conceptual site exposure model (CSM). Future land-use plans and zoning constraints of the site and surrounding area will be reviewed to identify reasonably likely future uses. Fate and transport of site-related chemicals also will be considered in the evaluation of potential exposure pathways. A preliminary CSM is presented in Section 2.4.

Exposure parameters will be identified for each potential exposure pathway, with fate-and-transport models used as needed. Site-specific information, along with DEQ and EPA guidance, will be considered when determining appropriate exposure assumptions for the selected exposure scenarios. Since it has been previously determined that vapor intrusion into indoor air will be a pathway for consideration, methodologies to model this pathway (Oregon RBDM guidance and EPA's Johnson and Ettinger Model) will be used as tools to assist in this evaluation.

Validated data that has undergone a quality assurance-quality control review will be used to calculate exposure point concentrations. For each COPC that is detected at a concentration below an analytical method reporting limit (MRL), one half of the MRL will be used as a representative concentration in calculations, as directed in DEQ and EPA risk assessment guidance.

5.1.3 Toxicity Assessment

If it is determined that the site meets the requirements of risk assessment utilizing DEQ's RBDM guidance, toxicity assessment will be conducted in accordance with that guidance; if, however, the site does not meet the requirements of Oregon RBDM guidance, a toxicity assessment will be conducted by compiling toxicity factors and adverse health effects for each COPC, as required under the deterministic risk assessment guidance. This information, combined with the chronic daily intake amounts calculated in the exposure assessment, will be used to calculate carcinogenic and noncarcinogenic risk related to site chemicals. This information can be used to calculate site-specific risk-based cleanup goals that are protective of human health. Toxicity factors for carcinogens (cancer slope factors) and for noncarcinogens (reference doses) will be obtained from EPA's Integrated Risk Information System (IRIS) or Health Effects Assessment Summary Tables (HEAST, 1997). If toxicity criteria are not available for a constituent from either of these sources, the toxicity factors available in the Region 9 PRG tables will be used. If toxicity factors for a chemical are not available in any source, then that chemical will be discussed qualitatively in the uncertainty section of the risk assessment, since it cannot be carried further through the risk assessment.

5.1.4 Risk Characterization

The results of the toxicity and exposure assessments will be combined to characterize potential risk to human health from site-related chemicals. If the work is conducted consistent with the RBDM guidance, decisions will be made based on exceedance of RBCs by maximum detected concentrations of contaminants. If the work is conducted consistent with the cleanup program, quantified levels of carcinogenic and noncarcinogenic risk will need to be addressed.

5.2 ECOLOGICAL RISK ASSESSMENT

The ecological risk assessment will be conducted consistent with DEQ's "Guidance for Ecological Risk Assessment: Levels I, II, III, IV (1998-1999-2000-2001)." The level I scoping ecological risk assessment (ERA) protocol is a conservative, qualitative determination of whether there is reason to believe that ecological receptors or ecologically important habitat are present at or in the locality of the facility. Scoping is intended to identify sites that are obviously devoid of ecologically important species or habitats and/or where potential exposure pathways are obviously incomplete. As the Columbia River, which is adjacent to the Astoria Area-Wide site, is in the Lower Columbia Nation Estuary Program, DEQ has requested a combined level I and II scoping and screening ERA.

The objectives of screening are to build a site description based on site reconnaissance, existing literature, preliminary assessment, and site history, and to identify site-specific ecologically important receptors, relevant and complete exposure pathways between each source media of concern and receptors identified, and contaminants of potential ecological concern (CPECs) from among COIs previously identified. A discussion of how physiochemical and toxicological properties of each CPEC may influence exposure pathways and potential adverse effects will then be prepared. This discussion will define ecologically appropriate assessment endpoints, and establish potential relationships between CPECs and responses in site-specific receptors by means of a preliminary conceptual site model, and conclude with an initial evaluation of the potential for site-related risk. The DEQ ERA guidance relies heavily on protocols stipulated in USEPA ecological risk assessment guidance.

The combined level I and II scoping and screening ERA will be submitted to the DEQ for review and approval. The results of the combined level I and II scoping and screening ERA will be used to determine whether further ecological risk assessment is necessary. Each level of ecological risk assessment entails more detailed work than previous levels. This site may require higher levels of ecological risk assessment due to its proximity to the Pacific Ocean and the Columbia River, which provide habitat for threatened or endangered salmonid species, and is located in the Lower Columbia National Estuary Program.

As part of the ecological risk assessment, a final conceptual ecological site exposure model will be developed. Exposure pathways will be selected based on potential receptors identified both onsite and offsite. The physical setting of the site, including climate, soil characteristics, river sediment characteristics, and hydrogeology will be considered in developing the conceptual ecological site exposure model. Fate and transport of site-related chemicals also will be considered in the evaluation of potential exposure pathways. A preliminary CSM is presented in Section 2.4.

6.0 FEASIBILITY STUDY

The objective of the FS for the Astoria Area-Wide site will be to develop and evaluate remedial action alternatives for contaminated media so that effective response actions may be selected for implementation, if applicable. The FS will be performed in accordance with OAR 340-122-0085. An addendum to this Work Plan specific to the feasibility study process may be prepared as data for the RI are developed and risk is evaluated. As described in the following sections, the FS process will include:

- Establish Remedial Action Objectives (RAOs);
- Identify General Response Actions;
- Identify and Screen Remedial Technologies;
- Assemble and Screen Remedial Measures;
- Complete Detailed Analysis of Remedial Alternatives;
- Compare Remedial Alternatives;
- Recommend Preferred Alternative; and
- Prepare Feasibility Study report.

The FS will include an evaluation of enhancements to the IRAMs, where appropriate.

6.1 REMEDIAL ACTION OBJECTIVES

RAOs, consisting of goals for protecting human health and the environment, will be established for the media and chemicals of concern. These objectives will be primarily driven by the cleanup standards that establish chemical concentrations and the risk assessment for reducing exposure pathways. The RAOs will be as specific as possible, but not so specific that the range of possible remedial alternatives would be unnecessarily limited. The RAOs will be quantitative, specifying the COCs, potential exposure pathways and receptors, and acceptable contaminant levels or range of levels for each exposure pathway, as appropriate. It is currently anticipated that the RAOs for the facility will address the following potential site risk issues:

- Potential for inhalation, ingestion, or direct contact with soil containing concentrations of hazardous substances above soil remediation goals;
- Potential for ingestion or direct contact with ground water containing concentrations of hazardous substances above ground-water remediation goals;
- Potential for cross-media (soil-to-air) transfer of hazardous substances that result in vapor concentrations above the applicable vapor inhalation goals for the site; and
- Potential for cross-media (soil-to-ground water) transfer of hazardous substances that result in ground-water concentrations above the applicable ground-water and/or surface water remediation goals for the site.

Available data suggest that ground water at the facility is not a current drinking water resource and is not likely to represent a viable future drinking water source. If these conditions are confirmed during the RI and it can be demonstrated that it is unlikely that migration of contaminated ground water will adversely affect a current or potential future drinking water source, RAOs for ground water and cross-media transfer may need to focus only on potential impacts to the local surface water.

The FS process will continue by defining the volumes or areas of affected media that must be addressed by some remedial response action. Soil volumes will be defined by evaluating the RI data and determining the points where compliance with the RAOs are not achieved. Generally, the definition of a volume of soil will require an interpretation of available data. This interpretation will be based on best professional judgment, which may be based on a statistical analysis of the data, as appropriate. In refining soil volumes, consideration will be given to the location of the soil in relation to other physical features, such as tanks, buildings, and foundations, which may restrict application of some technologies. Consideration also will be given to the location of soil with respect to the ground-water table and whether some soil volumes might be more effectively remedied through in situ rather than ex situ technologies.

Ground-water zones that require a remedial response to achieve compliance with RAOs will be defined in a similar manner.

6.2 GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS

General response actions that will attain the remedial action objectives will be identified. These general response actions will be used to further identify specific remediation technologies. Action-specific applicable or relevant and appropriate requirements (ARARs) will be used to screen the general response actions.

Based on available data, the general response actions for the various facility media are likely to include: no action, institutional controls, containment, and onsite treatment/management. However, the final selection of general response actions will depend on the RAOs, the volumes and locations of affected media, the types of contaminants to be remedied, and action-specific ARARs.

Once the general response actions have been identified, a broad range of technologies that may be able to attain the remedial action objectives will be evaluated. Process options will be identified for each viable alternative and screened based on effectiveness, implementability, and cost.

Potentially applicable technology types (e.g., capping, stabilization, thermal destruction, biological destruction, etc.) and process options (e.g., asphaltic capping, fly ash/lime stabilization, pyrolysis, bioremediation, etc.) will be identified by drawing on a variety of technical resources and experiences at similar sites.

During each phase of the FS, candidate technologies and process options will be screened to reduce the number of options to be considered during development of remedial alternatives. The screening will focus on the technical and institutional implementability, effectiveness, and cost of candidate technologies and process options, and will be conducted in accordance with CERCLA requirements and applicable Oregon regulations. Implementability and effectiveness will be the primary screening criteria. Cost will be used as a basis for screening out the more expensive option(s) when less expensive but adequately protective options can be identified. Upon completion of the screening and evaluation process, at least one process option will be selected to represent a potentially viable technology in the development of remedial alternatives.

6.3 REMEDIAL ALTERNATIVES

Those technologies and associated process options retained will be assembled to form complete remedial alternatives for further analysis. A detailed analysis will be conducted on the assembled alternatives for the site in accordance with OAR 340-122-0085. A comparative analysis will be conducted to determine the relative performance of each alternative against the selection criteria. In general, the comparison of the alternatives is made on a qualitative basis. An alternative(s) will be recommended based on the detailed and comparative analyses and in accordance with factors presented in OAR 340-122-0090.

6.3.1 Development

General response actions, including the process options chosen to represent the various technology types that could be applied to treat or contain contaminated media of concern, will be combined to form proposed remedial alternatives for the volumes of media addressed. The development and screening of alternatives will be completed in accordance with applicable guidance documents. Each alternative will be sufficiently defined to permit evaluation against certain screening criteria in an effort to reduce the number of alternatives that will undergo a more detailed comparative analysis. The description of each alternative will include the following information:

- Description of the remedial action and associated process option(s);
- Estimated time frame for implementation of the alternative and attainment of remedial action objectives;
- Comparison of anticipated performance to RAOs established for the media of concern;
- Technical and administrative implementability issues; and
- An estimate of the probable capital and long-term operation and maintenance costs (+50 percent to -30 percent).

6.3.2 Screening

Once technologies and process options have been assembled into remedial alternatives, the alternatives will be screened to reduce the number of alternatives carried forward to detailed analysis. Prior to screening, the scope and details of implementation for one or more of the remedial alternatives may be expanded to develop a basis for evaluating and comparing the alternatives against the screening criteria. In this regard, the volume of affected media addressed by each alternative may require refinement; the size and configuration of onsite equipment will be conceptualized; process flow rates will be evaluated and revised, if necessary; and time frames in which treatment, containment, or removal goals would possibly be achieved will be estimated.

After further defining the scope of the remedial alternatives, each alternative will be evaluated against the short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost, with the purpose of the screening to reduce the number of alternatives that will undergo a more thorough and extensive analysis. The evaluation of effectiveness focuses on the degree of protection that the alternative affords to human health and the environment. The degree that an alternative reduces the toxicity, mobility, or volume of contaminants at the facility also will be considered in this analysis. The evaluation of implementability estimates the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative. Technical feasibility refers to the ability to construct, reliably operate, and meet technology-specific regulations for process options, among other factors. The anticipated time to complete the remedial action using the technology proposed also is considered. Administrative feasibility refers to the ability to obtain the approvals for treatment, storage, and disposal services, when necessary, and the requirements for, and availability of, specific equipment and technical specialists. The cost evaluations will rely on estimates that range from +50 percent to -30 percent.

6.3.3 Treatability Investigations

Treatability studies may be required to obtain sufficient data to allow treatment alternatives to be fully developed and evaluated during the detailed analysis of alternatives. Ultimately, these treatability studies would be used to support the remedial design of the selected alternative or to reduce cost and performance uncertainties for treatment alternatives to acceptable levels so that a remedy can be selected. The need for treatability testing will be assessed as early in each RI/FS phase as possible. If it is determined that treatability testing is required to complete the FS evaluation, DEQ will be notified, and a treatability study work plan will be prepared and implemented.

6.3.4 Detailed Analysis

The overall objective of the detailed analysis is to compare the advantages and disadvantages of the alternatives retained after screening. As a first step in the process, the description of each alternative will be further refined and the details and assumptions underlying the implementation of the alternative will be presented. In completing this work, the results of treatability testing will be incorporated to size treatment equipment, modify equipment configurations, and revise estimates for treatment time and treatment costs.

The following evaluation criteria as presented in OAR 340-122-0090 will be used in the detailed analysis:

- The effectiveness of the alternative in achieving protection;
- The long-term reliability of the alternative;
- The technical and practical implementability of the alternative;
- Any short-term risk associated with implementing the alternative posed to the community, to the remedial contractor, or to the environment; and
- The cost reasonableness of the alternative.

Based on the results of the comparative analysis, a preferred alternative will be recommended for implementation at the facility. The preferred alternative will be one that provides a favorable balance in satisfying the evaluation criteria, while meeting the RAOs.

6.4 REPORT

The FS report will include sections prepared during the previously conducted tasks in addition to background information summarized from site investigation reports.

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7.0 REPORTING

This section describes the reports to be submitted to DEQ during the RI/FS process. The results of each RI, EA, and FS phase will be submitted to DEQ in separate draft reports for review and comment. Upon receipt of DEQ's comments, the Astoria Area-Wide PRP Group will revise and finalize each report. The reports will be prepared in accordance with the requirements specified in the Order and OAR.

7.1 RI REPORTS

Following validation, compilation, and evaluation of the field and laboratory data for each data collection task, technical memoranda will be prepared to document the findings. In addition to describing the methods and procedures used for data collection, raw data (for example laboratory reports, data validation memoranda, and boring logs) will be reported in these technical memoranda. Where appropriate, a discussion of modifications to the Work Plan will be presented. Figures presenting data analyses may also be presented as appropriate.

Technical memoranda will be the primary method for submittal of data developed during the RI to the DEQ and they will be incorporated into the RI Report by reference. In some cases, a technical memorandum will be a compendium of information developed by several PRPs, as in the case of a technical memorandum presenting the results of soil/source characterization efforts. The compendium will be organized into a technical memorandum format for submittal by *EnviroLogic Resources*, with sections prepared by individual PRPs. Where a data collection task is of an area-wide nature, for example a round of ground-water sampling, the technical memorandum will be prepared by *EnviroLogic Resources* and submitted to the DEQ with approval from the PRPs.

The RI Report will present information required in OAR 340-122-0080 collected during the phased RI implementation. The RI Report will include a summary of data developed at the Astoria Area-Wide site; tabulations and discussions of the RI data compared to previously-collected data; the resulting conclusions regarding COIs, COPCs, and COCs; the nature and extent of soil and ground-water contamination; the hydrogeologic properties that may influence contaminant fate and transport; and the anticipated rate and extent of potential migration of documented contamination. RI data will be presented in figures, tables, or graphs, as appropriate. Analytical data, water-level data, and sampling location information will be available in MS-Access 2000 format.

7.2 EA REPORTS

The EA report will include the results of the human health and ecological evaluations conducted at the Astoria Area-Wide site. Interim EA reports may be submitted to the DEQ as technical memoranda to document particular evaluations (e.g., a Level I ecological scoping technical memorandum). The baseline and/or residual risk assessment report will be submitted concurrently with the RI report.

7.3 FS REPORTS

Reports documenting the development of IRAMs will be prepared for submittal to DEQ. These technical memoranda will individually document IRAMs developed to solve specific problems and may be prepared by individual PRPs. Submittal of the documents to DEQ will be done through *EnviroLogic Resources* to maintain a consistent record of communications.

The FS report will include results of the FS process used in the development of a preferred remedial alternative. The results will include discussions on development of the remedial action objectives, identification and evaluation of appropriate remedial technologies and process options, development and evaluation of specific remedial alternatives, and selection of the preferred alternative.

7.4 PROGRESS REPORTS

Monthly reports will be prepared for submittal to DEQ by the 10th of each month the Order is in effect. These Technical Status Reports will present: 1) actions taken under the Order during the previous month; 2) action scheduled to be taken in the next two months; and 3) a description of any problems experienced during the previous month and actions taken to resolve them. The monthly progress reports will be submitted via electronic mail.

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8.0 RI/FS SCHEDULE

Phase 1 RI/FS work activity will begin within 10 days of DEQ approval of the final RI/FS and IRAM Development Work Plan. Figure 21 illustrates a proposed schedule for the RI/FS. Inherent within this schedule is the expectation that reviews of the progress of the work with DEQ personnel will occur periodically throughout the RI/FS process. The proposed schedule deviates from the schedule presented in the Order and reflects the current understanding of site conditions and the scope required to complete each phase of work. This project will require coordination among several PRPs, attorneys, and consultants. Document reviews will likely require longer than typical lengths of time in order to accommodate variable personal schedules and to reconcile comments among the parties.

The proposed RI/FS schedule includes mobilization and completion of field programs, laboratory analysis of the samples from the field programs, data validation, evaluations, and reporting of the data for each phase. The proposed schedule is based on assumptions consistent with current knowledge of the Astoria Area-Wide site and experience; the schedule may need to be changed if actual conditions or program implementation requires deviation from those assumptions.

Several elements of the scope of work cannot be planned in detail at this stage of the program. Addenda to the Work Plan will be prepared to provide the detailed plans for these tasks as information needed becomes available. Currently, the following addenda are planned as part of the implementation of the RI/FS:

- Storm-Water Monitoring Plan;
- Monitoring-Well Installation Plan;
- Ground-Water Monitoring Plan;
- Aquifer Testing Plan (if needed);
- IRAM Work Plan for Hydrocarbon Seep to Columbia River;
- IRAM Work Plan for Soil at the McCall Bulk Plant;

- IRAM Work Plan for Indoor Air Quality (if needed); and
- Any clarifications needed regarding this document (if needed).

9.0 PROJECT MANAGEMENT

Project management and coordination at the Astoria Area-Wide site will be conducted by Thomas J. Calabrese, RG, of *EnviroLogic Resources*. Mr. Calabrese will function as the point of contact between DEQ and the PRP group. Contact information is as follows:

Thomas J. Calabrese, RG, CWRE
Principal/Hydrogeologist
EnviroLogic Resources, Inc.
8948 SW Barbur Boulevard, #56
Portland, Oregon 97219-4047
Ph: 503-768-5121
Fx: 503-768-5122
tomcalabrese@h2ogeo.com

The project coordination program conceptualized by *EnviroLogic Resources* relies on one key factor for effective management: communication. Communication will be enhanced through a regular meeting and conference call schedule, required two-way communications on schedule issues, monthly progress reports, electronic mail, standardized distribution lists for different types of correspondence, facsimile messages, telephone, and overnight mail when required. Mr. Calabrese will disseminate information to individuals or groups as appropriate for implementation of project tasks, as well as to report progress to the DEQ and PRP Group. Project staff and consultants working for each PRP will provide Mr. Calabrese with frequent updates regarding progress on assigned tasks.

EnviroLogic Resources uses MS-Project 2000 as our tool for developing and tracking project schedules and budgets. *EnviroLogic Resources* uses MS-Project extensively for planning, tracking, and reporting project-related information. This project management tool allows us to perform detailed schedule and resource analyses quickly and efficiently.

Each PRP has retained a consultant to provide technical advice and perform work on their behalf, where appropriate. This work will be conducted under protocols approved by DEQ in the Work Plan and any addenda prepared by *EnviroLogic Resources* in consultation with other PRPs. The PRPs reserve the right to present additional information to the DEQ. In addition, where ambiguities in terminology or interpretation of tasks in the Work Plan or addenda exist (e.g., descriptions of geologic materials) guidance will be provided by *EnviroLogic Resources* to maintain consistency across the various properties being investigated under the Order. As discussed, ground-water sampling from the monitoring-well network will be performed by one sampling crew to limit sample variability resulting from different personnel and equipment across the site. The results of all work performed in response to the Order will be submitted to the DEQ through *EnviroLogic Resources* and the database of site information will be maintained by *EnviroLogic Resources*.

10.0 COMMUNITY RELATIONS PLAN

This plan has been developed by the Astoria Area-Wide PRP Group to help support the public involvement process during RI/FS being conducted at the site. The purpose of the RI/FS is to evaluate current environmental conditions at the site so that informed decisions can be made regarding potential health threats and remedial actions. The PRP Group believes that public awareness is an integral component of this project. The public involvement process ensures that people who may be interested in environmental issues associated with the site have opportunities for participation in the environmental decision-making process.

An effective public involvement process should communicate with concerned citizens, businesses, and organizations in ways that allows them to become better informed about the process of evaluating the implications of the site environmental data. The goal of the plan is to address concerns of the public early and openly to secure confidence in the process and outcome.

This public involvement plan serves as a blueprint for public information and participation during the assessment and evaluation of the effectiveness of institutional and engineering controls in preventing exposure to historical site contaminants and current environmental conditions at the site. This document identifies the process for identifying public and agency concerns, and suggests ways that the PRP Group will respond to those concerns. It also documents when and how public communication activities will be carried out.

10.1 OBJECTIVES

The objectives of the public involvement plan for the Astoria Area-Wide RI/FS are listed below:

- Provide for effective, regular communication opportunities to potentially affected and interested parties to voice their concerns and ideas; and
- Provide information on status of project and investigation results, including ecological and human health risk assessments.

10.2 ENVIRONMENTAL QUESTIONS RAISED

The primary environmental concerns are whether site-related contaminants are present in locations where they may, now or in the future, pose an unacceptable risk to fish, wildlife, or humans. The PRP Group is working with DEQ in an effort to assess current conditions at the site and establish what, if any, threat is posed by the presence of contaminated material. A proposal to conduct a RI/FS and IRAM at the Astoria Area-Wide site was submitted to the DEQ on January 21, 2002 (*EnviroLogic Resources*, 2002). The proposal provided a summary of activities and investigations to be conducted at the Astoria Area-Wide site to DEQ prior to the formalization of the Astoria Area Wide RI/FS and IRAM Development Work Plan. This Community Relations Plan is part of the Work Plan.

The primary objectives of the investigation are:

- Identify the hazardous substances released to the environment and develop a list of chemicals of interest (COI);
- Define the nature and extent of hazardous substances in affected media on and offsite;
- Evaluate the direction and rate of migration of hazardous substances in affected media;
- Generate or use data of sufficient quality for site characterization, risk assessment, and the selection of remedial alternatives;

- Identify migration pathways and receptors;
- Evaluate the risk posed to human health and the environment;
- Identify hot spots of contamination;
- Implement IRAMs, where appropriate, based on imminent threats; and
- Develop a remedial alternative or alternatives to remedy potential threats to human health or the environment, as appropriate.

10.3 AUDIENCE FOR PUBLIC INVOLVEMENT PROCESS

The public involvement process for the Astoria Area-Wide site will focus on parties potentially affected by site conditions or who are otherwise interested in the site. The public involvement process will also be directed to parties who have an interest or knowledge of current and future uses in the vicinity of the site. To initiate the public involvement process, the PRP Group assumes that nearby residents, nearby marine-oriented businesses; state, local, and regional authorities; and interested environmental and wildlife organizations fit this criterion. If any other organizations, groups, or community members perceive that they may be affected by decisions made at the site, they may participate in this process. The initial list of interested parties may be expanded, if necessary, depending on the results of additional findings, issues, and concerns to be raised in the near future.

The public is invited to stay informed regarding progress at the AAW site.

10.4 PLAN IMPLEMENTATION

The public involvement activities consist of various methods of communicating the status of work conducted at the site. A website (www.h2ogeo.com/astoria) will be setup for dissemination of information to interested parties. The website will include a link to the DEQ web page for the project.

The PRP Group will be responsible for performing the following tasks as part of implementing the public involvement plan.

- Continue to update the website with final documents and other pertinent information regarding the RI/FS.
- Periodically present a status report to the Port Commission for presentation at the Port Commission meetings.
- Place significant project documents in local information repositories including the Astoria Public Library and DEQ's Northwest Region office.
- Prepare fact sheets for DEQ to present on the DEQ web site about activities related to the AAW RI/FS.
- Communicate with residents who may be directly affected by the releases in the RSA.
- Monitor and evaluate the public involvement process to ensure that questions of concerned individuals or groups are appropriately answered.

10.5 SCHEDULE

The implementation of the public involvement plan for the Astoria Area-Wide site will proceed upon approval of the Work Plan by DEQ. The website will be updated on a monthly basis to add the most recent progress report and project documents that have been accepted and approved by DEQ. Fact sheets will be prepared periodically to summarize site conditions and progress. Specific fact sheets may be prepared to discuss certain phases of work (e.g., risk assessments, remedial measures, etc).

If necessary, the schedule may be modified by the AAW PRP Group depending on progress or completion of key project milestones.

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TABLES

TABLE 1

ABBREVIATIONS AND ACRONYMS

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

ARARs – applicable or relevant and appropriate requirements

ART – Accelerated Remediation Technologies, LLC

AST – aboveground storage tank

ASTM – American Society for Testing and Materials

Astoria Area-Wide – Astoria Area-Wide Petroleum Site

BTEX – benzene, toluene, ethylbenzene, xylenes

CAP – corrective action plan

CD – Compact Disk

ChevronTexaco – ChevronTexaco Products Company

COC – contaminant of concern

COI – chemical of interest

COPC – constituent of potential concern

CRL – Confirmed Release List

CSM – conceptual site model

CSO – combined sanitary/storm water sewer

Delphia – Delphia Oil Company

DEQ – Oregon Department of Environmental Quality

1,1-DCE – 1,1-dichloroethene

***cis*-1,2-DCE –** cis-1,2-dichloroethene

***trans*-1,2-DCE –** trans-1,2-dichloroethene

DGPS – differential global positioning system

DMEF – Dredged Material Evaluation Framework

DNAPL – dense nonaqueous phase liquid

DO – dissolved oxygen

TABLE 1

ABBREVIATIONS AND ACRONYMS

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

EA – Endangerment Assessment

EA – environmental audit

EM – electromagnetic

EPA – U.S. Environmental Protection Agency

ERA – Ecological Risk Assessment

FID – flame ionization detector

FSE – First Strike Environmental

FSP – Field Sampling Plan

Ft – feet

ft bgs – feet below ground surface

gal/day/ft^2 – gallons per day per foot squared

GPR – ground-penetrating radar

Harris/Van West – Flying Dutchman and Harris Enterprises

HASP – Health and Safety Plan

HCID – hydrocarbon identification

HEAST – Health Effects Assessment Summary Table

IDW – investigation-derived wastes

IRAM – Interim Removal Action Measures

IRIS – Integrated Risk Information System

IRM – Interim removal measure

K_{oc} – Partition coefficient of a compound between organic compound and water

LNAPL – light nonaqueous phase liquids (free product)

McCall – McCall Oil and Chemical Company

mg/kg – milligrams per kilogram

mg/L – milligrams per liter

µg/L – micrograms per liter

TABLE 1

ABBREVIATIONS AND ACRONYMS

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

MLLW – mean lower low water

MRL – method reporting limit

MSL – mean sea level

MW – monitoring well

NAPL – non-aqueous phase liquid

NFA – no further action

Niemi Oil – Ed Niemi Oil Company

ORP – oxidation-reduction potential

ORS – Oregon Revised Statutes

OSHD – State of Oregon, Department of Human Resources, Health Division

PAHs – polynuclear aromatic hydrocarbons

PCB – polychlorinated biphenyl

PCS – petroleum contaminated soil

PEL – Pacific Environmental Laboratory, Inc.

PID – photo-ionization detector

PNE – Pacific Northern Environmental

PNG – PNG Environmental, Inc.

PRG – preliminary remediation goal

PRPs – potentially responsible parties

PSU – Petroleum Services Unlimited, Inc.

QA/QC – quality assurance/quality control

QAPP – Quality Assurance Project Plan

Qwest – Qwest Communications International, Inc.

RAO – remedial action objective

RBDM – risk-based decision-making

RI/FS – Remedial Investigation/Feasibility Study

TABLE 1

ABBREVIATIONS AND ACRONYMS

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

RSA – Regional Study Area

RW – recovery well

RZA – Rittenhouse-Zeman and Associates

SA – Selective Availability

Shell – Shell Oil Company

SPCC – Spill Prevention, Control, and Countermeasure

SWPCP – Storm Water Pollution Control Plan

TCE – trichloroethene

The Order – DEQ Unilateral Order No. ECSR – NWR – 01 – 11

The Port – Port of Astoria

TPH – total petroleum hydrocarbons

USGS – U.S. Geological Survey

UST – underground storage tank

VOC – volatile organic compound

WRD – Oregon Water Resources Department

TABLE 2

POTENTIAL SOURCES

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

PRP	Name of Potential Source	Type of Potential Source	Construction Date	Removal Date	Historical Remedial Actions?
Chevron-Texaco Products Company					
	USTs and dispensers	Gasoline	1960s	1992	Yes
	1997 AST overfill	Gasoline	1995	Existing	Yes
Delphia Oil Company					
	Delphia Site west tank farm and loading rack	Diesel and gasoline ASTs	1930s through 1970s	Still in place	No
	Delphia site former warehouse, loading rack, and product lines	Petroleum products	1930s	1993	No
	Val's Texaco diesel UST and associated piping	Diesel UST	Unknown	Still in place	No
	Val's Texaco former gasoline and waste oil USTs and associated piping	Gasoline and waste oil USTs	Unknown	1996	Yes – No TPH detected

TABLE 2

POTENTIAL SOURCES

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

PRP	**Name of Potential Source**	**Type of Potential Source**	**Construction Date**	**Removal Date**	**Historical Remedial Actions?**
Delphia Oil (cont.)	Gasoline leaks to ground and to storm drain at Delphia Site during gasoline delivery in 1973 (volume unknown)	Gasoline	N/A	N/A	No
	Spill of 5 gallons of gasoline near Val's Texaco pump island in 1991. No indication that spill reached storm sewer.	5-gallon gasoline spill	N/A	N/A	No
McCall Oil and Chemical Company					
	McCall Oil Bulk Plant				
	Tank Bottoms	Bunker C Heating Oil	1924	2002	Yes
	AST releases	Bunker C Heating Oil	1924	2002	No
	Releases from Pumps	Bunker C Heating Oil	1924	2002	No
	Heating oil UST	Bunker C Heating Oil	1924	Existing	No

TABLE 2

POTENTIAL SOURCES

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

PRP	**Name of Potential Source**	**Type of Potential Source**	**Construction Date**	**Removal Date**	**Historical Remedial Actions?**
McCall Oil (cont.)	*McCall Oil Pipeline*				
	Petroleum pipeline	Diesel	1993	Existing	Yes
Ed Niemi Oil Company					
	Former Associated Oil Co. Facility – Eastern portion of 455 Industry Street				
	AST, pump house, two fueling racks and garage	Petroleum	circa 1927	Unknown	No
	Niemi Oil Cardlock/Former Burns Johansen Bulk Plant – 455 Industry St				
	Two 10,000 gal USTs	Diesel	1970s	Active	
	One 20,000-gal UST	Gasoline	1970s	Active	Yes
	Two 550-gallon USTs	Gasoline	1970s	1999	Yes

TABLE 2

POTENTIAL SOURCES

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

PRP	**Name of Potential Source**	**Type of Potential Source**	**Construction Date**	**Removal Date**	**Historical Remedial Actions?**
Niemi Oil (cont.)	Up to three ASTs ranging between 1,000 and 6,000 gallons in size.	Petroleum	1970s	Present	
	Overhead loading rack.	Petroleum	1970s	Active	Yes
	Single diesel dispenser island.	Diesel	1970s	1998	1997 - PNG
	Gasoline and diesel dispenser island.	Gasoline and diesel	1970s	Active	1997 – PNG
	Former Mobil Oil Bulk Plant – 490 Industry Street		1925	1998	
	Up to 10 gasoline ASTs ranging between 7,000 and 420,000 gallons. Two overhead truck loading racks, product pumps and below ground conveyance piping.	Petroleum	1925 - 1953	1977 - 1998	

TABLE 2

POTENTIAL SOURCES

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

PRP	Name of Potential Source	Type of Potential Source	Construction Date	Removal Date	Historical Remedial Actions?
Niemi Oil (cont.)					
	Vehicle garage and lube oil storage.	Petroleum	1925	Present	
	Steam boiler, cesspool, heating oil UST and 550-gallon drywell.	Unknown	1925	Approximately 1969	
	Former Niemi Oil Bulk Plant – 490 Industry Street		1976	1998	
	Five gasoline ASTs ranging between 750 to 35,000 gallons in size. Ancillary equipment included one overhead truck loading rack, product pumps and below ground conveyance piping.	Gasoline	1927 - 1978	1998	
	Vehicle garage and petroleum storage.	Petroleum	1925	Present	

TABLE 2

POTENTIAL SOURCES

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

PRP	Name of Potential Source	Type of Potential Source	Construction Date	Removal Date	Historical Remedial Actions?
Port of Astoria	*Former Furniture Manufacturing*				
	Furniture Finishing	Unknown	1920s	1973?	No
	Paint Shed	Unknown	1920s	1973?	No
	Glue Room	Unknown	1920s	1973?	No
	Boiler House	Unknown	1920s	1973?	No
	Former Steel Works				
	Black Smith	Unknown	1920s	1958 - 1963	No
	Boiler	Unknown	1920s	1958 – 1963	No
	Machine Shop	Unknown	1920s	1958 – 1963	No
	Transformer Bank	Unknown	1920s	1958 - 1963	No
	Fumigating Plant	Unknown	1920s	Unknown	No
	Former Transformer Vault	Transformer Oil	Unknown	Unknown	No
	Port Facilities				
	UST near Port Maintenance Shop	1,000-Gallon UST	Unknown	Decommissioned March 1993; NFA December 1993	Yes
	Paint Shop & Wash Rack	Unknown	1948	1969	No
	Gas & Oil Chemical Cart	Unknown	1948	1970	No

TABLE 2

POTENTIAL SOURCES

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

PRP	Name of Potential Source	Type of Potential Source	Construction Date	Removal Date	Historical Remedial Actions?
Port of Astoria (cont.)	Welding & Machine Shop	Unknown	1959	1965	No
	Welding	Unknown	1959	1970	No
	Astoria Oil Services				
	Paint Waste in drums	VOCs, metals	1983 – 1985	1986	Yes
	Solvent waste in drums	VOCs	1983 – 1985	1986	Yes
	Bolt Washing Area	VOCs	Unknown	Unknown	Yes
Qwest Corporation					
	10,000-gallon UST& piping	Petroleum	1962	1997 -- Decommissioned	Yes
	Fuel Dispenser	Petroleum	unknown	1997	Yes
Shell Oil Company					
	Former ASTs, filling dock, pump house, and ancillary on-site piping.	Petroleum fuel products.	1920s.	1973-1974.	No

TABLE 2

POTENTIAL SOURCES

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

PRP	**Name of Potential Source**	**Type of Potential Source**	**Construction Date**	**Removal Date**	**Historical Remedial Actions?**
Shell Oil (cont.)	6-inch bulk petroleum delivery pipeline (Pier 2 and onshore).	Petroleum fuel products.	1920s.	Unknown (likely abandoned in place 1973-1974).	No
	Two, 3-inch petroleum pipelines (product delivery to former Shell marine filling station (south end of Slip 2).	Petroleum fuel products.	1920s.	Unknown (likely abandoned in place 1973-1974).	No
Harris/Van West					
	4,000-gallon Regular Leaded UST (T-1)	Gasoline	≈1969	February 1991	Yes. Soil remediated & groundwater treated.
	4,000-gallon Regular Leaded UST (T-2)	Gasoline	≈1969	February 1991	Yes. No release detected.
	6,000-gallon Super Unleaded UST (T-3)	Gasoline	≈1969	February 1991	Yes. Soil remediated & groundwater treated.

TABLE 2

POTENTIAL SOURCES

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

PRP	Name of Potential Source	Type of Potential Source	Construction Date	Removal Date	Historical Remedial Actions?
	8,000-gallon Regular Unleaded UST (T-4)	Gasoline	≈1969	February 1991	Yes. No release detected.
	550-gallon Waste Oil UST (T-5)	Waste Oil	≈1969	October 1993	Yes. Soil remediated & groundwater treated.

TABLE 3

ENVIRONMENTAL HISTORY

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

PRP	DATE	INVESTIGATION
ChevronTexaco Products Company		
	Prior to June 1990	Petroleum hydrocarbon release
	June 1990	Subsurface Investigation
	August 1991	Subsurface Environmental Site Assessment
	January 1992	5 USTs decommissioned and removed
	April 1992	UST Closure Assessment
	November 1992	Soil Excavation & Ground-Water Sampling, Decommissioning
	June-November 1992	On-Site Soil Aeration
	1993	Environmental Site Assessment
	July 1993	Quarterly Monitoring – 2nd of 1993
	October 1993	Quarterly Monitoring – 3rd of 1993
	December 1993	Quarterly Monitoring – 4th of 1993
	March 1994	Quarterly Monitoring – 1st of 1994
	March 1994	No Further Action Issued by DEQ
	March 1994	Well Abandonment
	1995	Young's Bay Texaco constructed
	May 1997	Gasoline overfill of AST
	June-November 1997	Investigation and air sparging system installed
Delphia Oil Company		
	March 1991	25-gal gasoline spill near pump island at Val's Texaco; Spill response
	October 1996	5 gas USTs & 1 used oil UST Decommissioned at Val's Shell (Val's Texaco)

TABLE 3

ENVIRONMENTAL HISTORY

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

PRP	DATE	INVESTIGATION
McCall Oil and Chemical Company		
	1981	Employee identified hazardous waste in oil pits
	1984	52,000-gals of tank bottom waste removed
	1985	Tank bottom waste recycled and/or consolidated into one pit
	September 1987	Preliminary Assessment pursuant to US EPA contract
	May 1993	Line tightness test; pipeline failed test
	Oct 1993	Subsurface Investigations
	July 1994.	Storm Sewer Line Investigation; release from pipeline identified
	May 1995	NPDES issued for discharge of treated water to Columbia River
	July 1995	Ground-water treatment system installed
	July 1996	Site Assessment
	February 1997	Ground-Water Treatment System Operation Analysis
	2002	ASTs and structures decommissioned
	2002	Heating oil UST discovered
Niemi Oil Company		
Cardlock	1973	Burns-Johanson built bulk plant/cardlock facility. No investigation completed.
	1978	Sold to Niemi Oil
	December 1990	Off-site investigation and product recovery by Harris/Van West from release at 460 West Marine Drive.
	November 1997	Technical Memorandum: Current and Historic Petroleum Storage Sites Near the Former Shell Service Station
	1997	Confirmed Release List
	1997	Subsurface Investigation

TABLE 3

ENVIRONMENTAL HISTORY

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

PRP	DATE	INVESTIGATION
	1998	Focused Site Assessment
	1999	UST Decommissioning (two 550-gallon gasoline tanks)
Port of Astoria		
Astoria Oil Services	January 1986	Oregon DEQ inspected site; violations asserted
	1986	Soil investigations
	September 1986	Impacted soil excavated and disposed
Port of Astoria	Through 2001	Periodic/Annual dredging
	Through 2002	Storm-water sampling under the 1200Z NPDES permit. Data from the Pier3N and Pier3W outfalls in November 2001 shows the benchmarks limits for copper, lead, and zinc had been exceeded. An updated SWPCP has been completed.
	March 1993	1,000-gal UST used for diesel and gas decommissioned on N. side of maintenance shop
	March 1993	Two 10,000-gal diesel USTs decommissioned near West Mooring Basin
	July 1993	Investigation & Cleanup of UST Related Diesel Release to Soil
	September 1993	PCS treated by bioremediation on site
	September 1993	Request closure of soil aeration site
	December 1993	No Further Action issued by DEQ
	Various dates	Sediment Analysis
	August 1998	Toxicity of Dredge Site Sediments
Qwest Corporation		
	1997	UST Decommissioning
	December 1997	Site Contamination Investigation

TABLE 3

ENVIRONMENTAL HISTORY

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

PRP	DATE	INVESTIGATION
Shell Oil Company		The facility ceased operations in 1972 and all ASTs and associated above-ground piping were reportedly removed by 1974. No environmental investigations have been conducted on the site.
Van West (Flying Dutchman) / Harris Enterprises		
	1990	Inventory control records indicated losses
	October 1990	Tank and line testing
	December 1990	Pressure Line Tests
	December 1990	Liquid phase petroleum hydrocarbons discovered in sewer line near site
	December 1990	20-Day Release Report
	January 1991	NPDES Permit 1500J
	1991	Liquid phase petroleum recovery system installed
	February 1991	4 gasoline USTs and product piping removed
	March 1991	45-Day Release Report
	July 1991	Second Quarter, Groundwater Monitoring
	October 1992	Corrective Action Plan
	July 1992; Oct. 1993	Subsurface Investigation
	November 1993	UST Decommissioning
	1993	Soil Treatment Project
	March 1994	Quarterly Groundwater Monitoring
	October 1994	Quarterly Ground-Water Monitoring & Soil Matrix Cleanup
	February 1996	Request for Closure

TABLE 4
LOCATOR CONSTRUCTION DETAILS

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

LOCATOR	Well Depth (ft)	Drill Deptl (ft)	Date Installed	Location Coordinates Northing	Easting	Reference Elevation (ft-MSL)	Screened Interval (ft)	Gravel Pack (ft)	Borehole Size (in)	Casing Size (in)	Borehole Cross-Ref
1(C)	N/A	N/A	N/A	935929.585	7351621.121	N/A	N/A	N/A	N/A	N/A	N/A
1086(J)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10KN.End(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10KS.End(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
124603(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1E(D)	N/A	N/A	N/A	936312.021	7352213.22	N/A	N/A	N/A	N/A	N/A	N/A
1K-BottomE(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1K-BottomW(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1W(D)	N/A	N/A	N/A	936318.359	7352223.833	N/A	N/A	N/A	N/A	N/A	N/A
2(C)	N/A	N/A	N/A	935941.029	7351551.062	N/A	N/A	N/A	N/A	N/A	N/A
2A(P)				N/A	N/A						N/A
2E(D)	N/A	N/A	N/A	936303	7352197.492	N/A	N/A	N/A	N/A	N/A	N/A
2W(D)	N/A	N/A	N/A	936309.413	7352207.79	N/A	N/A	N/A	N/A	N/A	N/A
3(C)	N/A	N/A	N/A	935897.528	7351579.214	N/A	N/A	N/A	N/A	N/A	N/A
3A(P)				N/A	N/A						N/A
3E(D)	N/A	N/A	N/A	936295.333	7352201.935	N/A	N/A	N/A	N/A	N/A	N/A
3W(D)	N/A	N/A	N/A	936301.748	7352212.985	N/A	N/A	N/A	N/A	N/A	N/A
4E(D)	N/A	N/A	N/A	936304.44	7352217.374	N/A	N/A	N/A	N/A	N/A	N/A

ft: Feet (below ground surface for depth measure
Location Coordinates:
MSL: Surveyed to mean sea leve
Borehole Cross-Ref: Well from which lithologic description used to construct w
N/A: Not Available

LOCATOR	Well Depth (ft)	Drill Deptl (ft)	Date Installed	Location Coordinates Northing	Easting	Reference Elevation (ft-MSL)	Screened Interval (ft)	Gravel Pack (ft)	Borehole Size (in)	Casing Size (in)	Borehole Cross-Ref
4W(D)	N/A	N/A	N/A	936311.013	7352228.353	N/A	N/A	N/A	N/A	N/A	N/A
5E(D)	N/A	N/A	N/A	936297.381	7352221.013	N/A	N/A	N/A	N/A	N/A	N/A
5W(D)	N/A	N/A	N/A	936304.146	7352232.472	N/A	N/A	N/A	N/A	N/A	N/A
6A(P)				N/A	N/A						N/A
7A(P)				N/A	N/A						N/A
9640(C)				N/A	N/A						N/A
9640(Q)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
A1(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
A1,A2,A3,A4Composite	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
A2(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
A3(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
A4(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AOSI-001(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AOSI-002(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AOSI-003(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AOSI-004(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AOSI-005(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ASE(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AstoriaComposite(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AstoriaWater(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B1(C)	N/A	25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B-1(M)		11.5'	8/30/1993	936351.469	7351875.665			2' - 11.5'	9"		N/A

ft: Feet (below ground surface for depth measure

Location Coordinates:

MSL: Surveyed to mean sea leve

Borehole Cross-Ref: Well from which lithologic description used to construct w

N/A: Not Available

LOCATOR	Well Depth (ft)	Drill Deptl (ft)	Date Installed	Location Coordinates Northing	Easting	Reference Elevation (ft-MSL)	Screened Interval (ft)	Gravel Pack (ft)	Borehole Size (in)	Casing Size (in)	Borehole Cross-Ref
B-1(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B1,B2,B3,B4Composite	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B10(F)	N/A	40	12/4/1991	936127.386	7351957.249	N/A	N/A	0 - 40	N/A	N/A	B-10(F)
B11(F)	N/A	40	12/3/1991	936200.505	7351999.861	N/A	N/A	0 - 40	N/A	N/A	B-11(F)
B12(F)	N/A	25	12/4/1991	936123.591	7351937.202	N/A	N/A	0 - 25	N/A	N/A	B-12(F)
B14(N)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B15(N)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B2(C)	N/A	20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B-2(M)		11.5'	8/30/1993	936369.225	7351905.365			2' - 11.5'	9"		N/A
B-2(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B3(C)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B-3(M)		11.5'	8/30/1993	936309.946	7351809.79			2' - 11.5'	9"		N/A
B-3(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B4(C)	N/A	19	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B-4(M)		11.5'	8/30/1993	936208.568	7351641.12			2' - 11.5'	9"		N/A
B-4(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B5(C)	N/A	11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B-5(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B6(C)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B6(F)	N/A	20	12/21/1990	936146.618	7351919.323	N/A	N/A	0-20	N/A	N/A	N/A
B-6(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Astoria6(P)
B7(F)	N/A	20	12/21/1990	936142.996	7351906.083	N/A	N/A	0-20	N/A	N/A	N/A

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Location Coordinates:

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Borehole Cross-Ref: Well from which lithologic description used to construct w

N/A: Not Available

LOCATOR	Well Depth (ft)	Drill Deptl (ft)	Date Installed	Location Coordinates Northing	Easting	Reference Elevation (ft-MSL)	Screened Interval (ft)	Gravel Pack (ft)	Borehole Size (in)	Casing Size (in)	Borehole Cross-Ref
B-7(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Astoria7(P)
B8(F)	40'	40'	12/2/1991	N/A	N/A	99.94	10' - 40'	9' - 40'		2"	N/A
B9(F)		25'	12/4/1991	936108.007	7351917.777			0' - 25'			N/A
Boring#1(Q)	N/A	N/A	N/A	936157.505	7351681.029	N/A	N/A	N/A	N/A	N/A	N/A
Boring#1-A(Q)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boring#1-B(Q)	N/A	N/A	N/A	936169	7351676	N/A	N/A	N/A	N/A	N/A	N/A
Boring#1-C(Q)	N/A	N/A	N/A	936175	7351676	N/A	N/A	N/A	N/A	N/A	N/A
Boring#1-D(Q)	N/A	N/A	N/A	936183	7351680	N/A	N/A	N/A	N/A	N/A	N/A
Boring#1-D(Q)	N/A	N/A	N/A	936183	7351680	N/A	N/A	N/A	N/A	N/A	N/A
Boring#1-D(Q)	N/A	N/A	N/A	936183	7351680	N/A	N/A	N/A	N/A	N/A	N/A
Boring#1-D(Q)	N/A	N/A	N/A	936183	7351680	N/A	N/A	N/A	N/A	N/A	N/A
Boring#2(Q)	N/A	N/A	N/A	936174.483	7351692.238	N/A	N/A	N/A	N/A	N/A	N/A
Boring#3(Q)	N/A	N/A	N/A	936188.098	7351719.017	N/A	N/A	N/A	N/A	N/A	N/A
Boring#4(Q)	N/A	N/A	N/A	936200.759	7351739.497	N/A	N/A	N/A	N/A	N/A	N/A
Boring#5(Q)	N/A	N/A	N/A	936207.804	7351753.387	N/A	N/A	N/A	N/A	N/A	N/A
Boring#6(Q)	N/A	N/A	N/A	936221.025	7351775.399	N/A	N/A	N/A	N/A	N/A	N/A
Boring#7(Q)	N/A	N/A	N/A	936232.524	7351795.862	N/A	N/A	N/A	N/A	N/A	N/A
Boring1(Q)			8/7/1997	936157.505	7351681.029				8"		N/A
Boring1-A(Q)			8/7/1997	N/A	N/A				8"		N/A
Boring1-B(Q)			8/7/1997	N/A	N/A				8"		N/A
Boring1-C(Q)			8/7/1997	N/A	N/A				8"		N/A
Boring1-D(Q)			8/8/1997	N/A	N/A				8"		N/A

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Boring2(Q)			8/7/1997	N/A	N/A				8"		N/A
BoringA(A)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BoringB(Q)	N/A	N/A	N/A	936059.713	7351621.265	N/A	N/A	N/A	N/A	N/A	N/A
BoringB(Q)	N/A	N/A	N/A	936059.713	7351621.265	N/A	N/A	N/A	N/A	N/A	N/A
BoringB(Q)	N/A	N/A	N/A	936059.713	7351621.265	N/A	N/A	N/A	N/A	N/A	N/A
BoringB(Q)	N/A	N/A	N/A	936059.713	7351621.265	N/A	N/A	N/A	N/A	N/A	N/A
BoringB(Q)			8/8/1997	936059.713	7351621.265				8"		N/A
C1,C2,C3,C4Composite	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CAF(C)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CB-1(C)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CB-2(C)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CB-3(C)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Control (P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D1,D2Composite	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
DEQ1(A)	N/A	N/A	N/A	936369.84	7351493.528	N/A	N/A	N/A	N/A	N/A	N/A
DEQ2(A)	N/A	N/A	N/A	936368.478	7351494.083	N/A	N/A	N/A	N/A	N/A	N/A
DEQ3(A)	N/A	N/A	N/A	936247.654	7351494.083	N/A	N/A	N/A	N/A	N/A	N/A
DEQ4(A)	N/A	N/A	N/A	936375.498	7351860.775	N/A	N/A	N/A	N/A	N/A	N/A
DEQ5(A)	N/A	N/A	N/A	936293.161	7351845.543	N/A	N/A	N/A	N/A	N/A	N/A
DEQ6(A)	N/A	N/A	N/A	936487.375	7352051.303	N/A	N/A	N/A	N/A	N/A	N/A
DEQ7(A)	N/A	N/A	N/A	936518.843	7351927.792	N/A	N/A	N/A	N/A	N/A	N/A
DEQ8(A)	N/A	N/A	N/A	936432.23	7351789.301	N/A	N/A	N/A	N/A	N/A	N/A

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DUP(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E1,E2,E3,E4Composite	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EFF(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EFF(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Effluent(M)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
FBK(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gas Pit Water(C)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GP1(J)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GP2(J)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GP3(J)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GP4(J)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GP5(J)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GP6(J)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
HA(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
HA1(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
HA-12690(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
HA2(F)	N/A	N/A	N/A	936225.486	7351952.605	N/A	N/A	N/A	N/A	N/A	N/A
HA3(F)	N/A	N/A	N/A	936238.624	7351973.566	N/A	N/A	N/A	N/A	N/A	N/A
Hole1(Q)	N/A	N/A	N/A	936070.548	7351673.966	N/A	N/A	N/A	N/A	N/A	N/A
Hole2(Q)	N/A	N/A	N/A	936057.446	7351652.349	N/A	N/A	N/A	N/A	N/A	N/A
Hole3(Q)	N/A	N/A	N/A	936045.635	7351633.115	N/A	N/A	N/A	N/A	N/A	N/A
Hole4(Q)	N/A	N/A	N/A	936034.189	7351611.574	N/A	N/A	N/A	N/A	N/A	N/A

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Hole5(Q)	N/A	N/A	N/A	936075.382	7351646.841	N/A	N/A	N/A	N/A	N/A	N/A
Hole6(Q)	N/A	N/A	N/A	936069.83	7351603.482	N/A	N/A	N/A	N/A	N/A	N/A
Hole7(Q)	N/A	N/A	N/A	936049.81	7351603.702	N/A	N/A	N/A	N/A	N/A	N/A
Hole8(Q)	N/A	N/A	N/A	936052.755	7351628.595	N/A	N/A	N/A	N/A	N/A	N/A
Hole9(Q)	N/A	N/A	N/A	936069.661	7351619.389	N/A	N/A	N/A	N/A	N/A	N/A
INF(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
INF(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Influent(M)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Johnson(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
L1985(A)				N/A	N/A						N/A
L3524(A)				N/A	N/A						N/A
L3532(A)				N/A	N/A						N/A
LF-1(C)	N/A	N/A	N/A	935929.585	7351621.121	N/A	N/A	N/A	N/A	N/A	N/A
LF-2(C)	N/A	N/A	N/A	935941.029	7351551.062	N/A	N/A	N/A	N/A	N/A	N/A
LF-3(C)	N/A	N/A	N/A	935897.528	7351579.214	N/A	N/A	N/A	N/A	N/A	N/A
LF-4(C)	N/A	N/A	N/A	935967.861	7351594.505	N/A	N/A	N/A	N/A	N/A	N/A
LF-5(C)	N/A	N/A	N/A	935931.212	7351580.169	N/A	N/A	N/A	N/A	N/A	N/A
LF-6(C)	N/A	N/A	N/A	935960.666	7351685.963	N/A	N/A	N/A	N/A	N/A	N/A
LF-7(C)	N/A	N/A	N/A	935945.887	7351653.849	N/A	N/A	N/A	N/A	N/A	N/A
MW-1(C)	19.50	19.50	5/13/1991	935961.804	7351582.045	44.92'	9.5-19.5	8.5 - 19.5	12"	4"	N/A
MW-1(F)	38	38	12/7/1990	936211.803	7351990.415	N/A	16-38	N/A	N/A	4"	N/A
MW-1(F)	N/A	N/A	N/A	936211.803	7351990.415	N/A	N/A	N/A	N/A	N/A	N/A

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MW-1(M)	19.5		11/10/1994	936599.486	7351297.572	14.54	5.0 - 19.5			2	N/A
MW-10(M)	20.0		3/3/1995	936731.336	7351321.429	16.34	5.0 - 20.0			2"	N/A
MW-11(M)	20.0		3/3/1995	936729.24	7351467.813	16.36	5.0-20.0			2"	N/A
MW-2(C)	30	30	5/14/1991	935924.621	7351621.46	46.36	15-30	14 - 30	12	4	N/A
MW-2(F)	N/A	N/A	N/A	936106.063	7351931.473	N/A	N/A	N/A	N/A	N/A	N/A
MW-2(F)	40	40	12/9/1990	936106.063	7351931.473	N/A	20- 40	N/A	N/A	4"	N/A
MW-2(M)	20.0		11/10/1994	N/A	N/A	15.06	5.0 - 20.0			2"	N/A
MW-3(C)	18.5	18.5	5/14/1991	935909.093	7351573.09	46.02'	8.5 - 18.5	7.5-18.5	12"	4"	N/A
MW-3(F)	N/A	11.5	8/30/1993	936151.079	7351938.643	N/A	N/A	2-11.5	9"	N/A	N/A
MW-3(F)	26	26	12/21/1990	936151.079	7351938.643	N/A	11-26	N/A	N/A	2"	N/A
MW-3(M)	19.5'		11/10/1994	936568.313	7351406.763	15.45	5.0 - 19.5			2"	N/A
MW-4(C)	24.5	24.5	5/15/1991	936002.631	7351658.505	44.77	9.5-24.5	8.5 - 24.5	12	4	N/A
MW-4(F)	N/A	N/A	N/A	936152.191	7351975.237	N/A	N/A	N/A	N/A	N/A	B8(F)
MW-4(M)	25.0		11/11/1994	936477.915	7351421.833	15.50	5.0 - 25.0			2"	N/A
MW-5(C)	20.0	20.0	5/15/1991	935975.709	7351632.141	45.26'	5-20.0	4' - 20'	12"	4"	N/A
MW-5(M)	20.0		11/11/1994	936446.436	7351500.403	16.44	5.0 - 20.0			2"	N/A
MW-6(C)	20	21.5	5/14/1993	N/A	N/A	100.00'	10-20	N/A	8"	2"	N/A
MW-6(M)	20.0		11/30/1994	936550.238	7351279.371	13.79	5.0 - 20.0			2"	N/A
MW-7(M)	20.0		12/1/1994	936485.617	7351302.96	14.86	5.0 - 20.0			2"	N/A
MW-8(M)	20.0		12/1/1994	936633.137	7351313.88	15.25	5.0 - 20.0			2"	N/A
MW-9(M)	20.0		12/1/1994	936626.508	7351451.934	15.42	5.0 - 20.0			2"	N/A
MW-D(C)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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MW-X(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
OEX1(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
OEX2(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
OEX3(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
OEX4(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
OEX5(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pier3N(P)				N/A	N/A						
Pier3W(P)				N/A	N/A						
Port2(P)	N/A	N/A	N/A	936499.472	7351332.151	N/A	N/A	N/A	N/A	N/A	N/A
Port3(P)	N/A	N/A	N/A	936509.443	7351344.46	N/A	N/A	N/A	N/A	N/A	N/A
ProductFromManhole(A)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PSB(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
R-1(M)	28.0		12/1/1994	936619.28	7351336.572	13.75	5.0 - 28.0			6"	N/A
R-2(M)	28.0		3/3/1995	936650.673	7351447.581	15.16	5.0 - 28.0			6"	N/A
Reference Site(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
RW-1(F)	N/A	N/A	N/A	936202.623	7351910.776	N/A	N/A	N/A	N/A	N/A	N/A
RW-1(F)	N/A	N/A	N/A	936202.623	7351910.776	N/A	N/A	N/A	N/A	N/A	N/A
RW-1(N)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
RW-2(F)	32	32	12/8/1990	936162.634	7351913.829	N/A	12-32	N/A	N/A	6"	N/A
RW-2(F)	N/A	N/A	N/A	936162.634	7351913.829	N/A	N/A	N/A	N/A	N/A	N/A
S-1(C)	N/A	N/A	N/A	935927.052	7351577.14	N/A	N/A	N/A	N/A	N/A	N/A
S-1(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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Borehole Cross-Ref: Well from which lithologic description used to construct w

N/A: Not Available

LOCATOR	Well Depth (ft)	Drill Depth (ft)	Date Installed	Location Coordinates Northing	Easting	Reference Elevation (ft-MSL)	Screened Interval (ft)	Gravel Pack (ft)	Borehole Size (in)	Casing Size (in)	Borehole Cross-Ref
S-10(C)	N/A	N/A	N/A	935986.609	7351605.474	N/A	N/A	N/A	N/A	N/A	N/A
S-10(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
S-11(C)	N/A	N/A	N/A	935913.819	7351591.929	N/A	N/A	N/A	N/A	N/A	N/A
S-11(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
S-12(C)	N/A	N/A	N/A	935944.62	7351572.933	N/A	N/A	N/A	N/A	N/A	N/A
S-12(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
S-13(C)	N/A	N/A	N/A	935918.811	7351600.424	N/A	N/A	N/A	N/A	N/A	N/A
S-13(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
S-14(C)	N/A	N/A	N/A	935923.339	7351607.565	N/A	N/A	N/A	N/A	N/A	N/A
S-15(C)	N/A	N/A	N/A	935948.842	7351581.139	N/A	N/A	N/A	N/A	N/A	N/A
S-16(C)	N/A	N/A	N/A	935924.415	7351609.535	N/A	N/A	N/A	N/A	N/A	N/A
S-18(C)	N/A	N/A	N/A	935943.744	7351632.73	N/A	N/A	N/A	N/A	N/A	N/A
S-2(C)	N/A	N/A	N/A	935921.039	7351604.876	N/A	N/A	N/A	N/A	N/A	N/A
S-2(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
S-3(C)	N/A	N/A	N/A	935953.811	7351585.694	N/A	N/A	N/A	N/A	N/A	N/A
S-3(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
S-4(C)	N/A	N/A	N/A	935945.842	7351609.7	N/A	N/A	N/A	N/A	N/A	N/A
S-5(C)	N/A	N/A	N/A	935967.221	7351587.708	N/A	N/A	N/A	N/A	N/A	N/A
S-6(C)	N/A	N/A	N/A	935973.264	7351598.513	N/A	N/A	N/A	N/A	N/A	N/A
S-7(C)	N/A	N/A	N/A	935997.835	7351650.475	N/A	N/A	N/A	N/A	N/A	N/A
S-8(C)	N/A	N/A	N/A	935986.288	7351657.989	N/A	N/A	N/A	N/A	N/A	N/A
S-8(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

ft: Feet (below ground surface for depth measure

Location Coordinates:

MSL: Surveyed to mean sea leve

Borehole Cross-Ref: Well from which lithologic description used to construct w

N/A: Not Available

LOCATOR	Well Depth (ft)	Drill Deptl (ft)	Date Installed	Location Coordinates Northing	Easting	Reference Elevation (ft-MSL)	Screened Interval (ft)	Gravel Pack (ft)	Borehole Size (in)	Casing Size (in)	Borehole Cross-Ref
S-9(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SB-1(N)	N/A	8.0'	1/16/1997	936312.05	7351965.941	N/A	N/A	N/A	1.25"	N/A	N/A
SB-2(N)	N/A	8.0'	1/16/1997	936317.093	7351953.804	N/A	N/A	N/A	1.25"	N/A	N/A
SB-3(N)	N/A	12.0'	1/16/1997	936330.312	7351938.157	N/A	N/A	N/A	1.25"	N/A	N/A
SB-4(N)	N/A	12.0'	1/16/1997	936325.092	7351909.017	N/A	N/A	N/A	1.25"	N/A	N/A
SB-5(N)	N/A	12.0'	1/16/1997	936242.507	7351907.413	N/A	N/A	N/A	1.25"	N/A	N/A
SB-6(N)	N/A	12.0'	1/16/1997	936247.865	7351957.859	N/A	N/A	N/A	1.25"	N/A	N/A
Site 1,2,3 Composite(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Site1(P)				N/A	N/A						N/A
Site2(P)				N/A	N/A						N/A
Site3(P)				N/A	N/A						N/A
Site4(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Site5(P)				N/A	N/A						N/A
Site6(P)				N/A	N/A						N/A
Site7(P)				N/A	N/A						N/A
Site8(P)				N/A	N/A						N/A
Slip1(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Slip2(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sol.Blank(A)				N/A	N/A						N/A
SP-1(M)	N/A	16	9/30/1996	936099.368	7351049.631	N/A	N/A	N/A	2"	N/A	N/A
SP-1(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SP-10(M)	N/A	12	10/1/1996	935985.03	7350977.242	N/A	N/A	N/A	2"	N/A	N/A

ft: Feet (below ground surface for depth measure

Location Coordinates:

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SP-11(M)	N/A	12	10/1/1996	936000.069	7350969.362	N/A	N/A	N/A	2"	N/A	N/A
SP-12(M)	N/A	3	10/1/1996	N/A	N/A	N/A	N/A	N/A	2"	N/A	N/A
SP-13(M)	N/A	16	10/1/1996	936748.904	7351392.44	N/A	N/A	N/A	2"	N/A	N/A
SP-14(M)	N/A	12	10/1/1996	936802.811	7351337.299	N/A	N/A	N/A	2"	N/A	N/A
SP-15(M)	N/A	12	10/1/1996	936847.135	7351286.953	N/A	N/A	N/A	2"	N/A	N/A
SP-16(M)	N/A	12	10/1/1996	936195.671	7351039.944	N/A	N/A	N/A	2"	N/A	N/A
SP-17(M)	N/A	12	10/1/1996	936237.13	7351093.42	N/A	N/A	N/A	2"	N/A	N/A
SP-18(M)	N/A	12	10/1/1996	936270.761	7351148.459	N/A	N/A	N/A	2"	N/A	N/A
SP-19(M)	N/A	6.3	10/1/1996	936305.214	7351203.134	N/A	N/A	N/A	2"	N/A	N/A
SP-2(M)	N/A	12	9/30/1996	936151.95	7351075.32	N/A	N/A	N/A	2"	N/A	N/A
SP-2(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SP-20(M)	N/A	12	10/1/1996	936342.335	7351256.477	N/A	N/A	N/A	2"	N/A	N/A
SP-21(M)	N/A	12	10/2/1996	936024.643	7351042.028	N/A	N/A	N/A	2"	N/A	N/A
SP-22(M)	N/A	12	10/2/1996	936055.368	7351054.484	N/A	N/A	N/A	2"	N/A	N/A
SP-23(M)	N/A	12	10/2/1996	936045.25	7351142.706	N/A	N/A	N/A	2"	N/A	N/A
SP-24(M)	N/A	12	10/2/1996	936151.95	7351075.32	N/A	N/A	N/A	2"	N/A	N/A
SP-3(M)	N/A	12	9/30/1996	936118.663	7351019.498	N/A	N/A	N/A	2"	N/A	N/A
SP-3(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SP-4(M)	N/A	12	9/30/1996	936089.038	7351015.93	N/A	N/A	N/A	2"	N/A	N/A
SP-5(M)	N/A	12	9/30/1996	936059.917	7350982.193	N/A	N/A	N/A	2"	N/A	N/A
SP-6(M)	N/A	12	9/30/1996	936062.773	7350954.251	N/A	N/A	N/A	2"	N/A	N/A
SP-7(M)	N/A	12	9/30/1996	936035.97	7350911.368	N/A	N/A	N/A	2"	N/A	N/A

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Location Coordinates:

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SP-8(M)	N/A	12	10/1/1996	936002.481	7350914.131	N/A	N/A	N/A	2"	N/A	N/A
SP-9(M)	N/A	12	10/1/1996	935970.929	7350942.03	N/A	N/A	N/A	2"	N/A	N/A
SP-MW-1234(C)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SpoilsComposite(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#1(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#10(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#11(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#12(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#13(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#14(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#15(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#16(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#17(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#18(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#19(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#2(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#20(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#21(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#22(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#23(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#24(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#25(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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SS#26(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#3(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#4(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#5(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#6(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#7(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#8(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS#9(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS-1(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SS-2(P)	N/A	N/A	N/A	937137.224	7349892.537	N/A	N/A	N/A	N/A	N/A	N/A
SS-3(P)	N/A	N/A	N/A	937151.787	7349875.778	N/A	N/A	N/A	N/A	N/A	N/A
SS4(P)	N/A	N/A	N/A	937131.399	7349873.592	N/A	N/A	N/A	N/A	N/A	N/A
SS-5(P)	N/A	N/A	N/A	937103.73	7349861.206	N/A	N/A	N/A	N/A	N/A	N/A
SS-6(P)	N/A	N/A	N/A	937159.797	7349806.559	N/A	N/A	N/A	N/A	N/A	N/A
SS-7(P)	N/A	N/A	N/A	937247.902	7349775.229	N/A	N/A	N/A	N/A	N/A	N/A
SSP(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stockpile(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SUMP(C)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tank1(N)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tank2(N)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TB8(C)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TB9(C)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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N/A: Not Available

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TB-LB(C)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TestPitSoilsBehindDieselTanl	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TP1(C)	N/A	N/A	N/A	935956	7351609	N/A	N/A	N/A	N/A	N/A	N/A
TP1(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TP2(C)	N/A	N/A	N/A	935965	7351625	N/A	N/A	N/A	N/A	N/A	N/A
TP2(F)	N/A	N/A	N/A	936137	7351964	N/A	N/A	N/A	N/A	N/A	N/A
TP3(C)	N/A	N/A	N/A	935961	7351637	N/A	N/A	N/A	N/A	N/A	N/A
TP3(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TP4(C)	N/A	N/A	N/A	935987	7351601	N/A	N/A	N/A	N/A	N/A	N/A
TP4(F)	N/A	N/A	N/A	936174	7351974	N/A	N/A	N/A	N/A	N/A	N/A
TP5(C)	N/A	N/A	N/A	935995	7351617	N/A	N/A	N/A	N/A	N/A	N/A
TP5(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TP6(F)	N/A	N/A	N/A	936127	7351971	N/A	N/A	N/A	N/A	N/A	N/A
TP7(C)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TP7(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
T-Pit(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
US-37(Q)	N/A	N/A	N/A	936198.465	7351881.952	N/A	N/A	N/A	N/A	N/A	N/A
US-38(Q)	N/A	N/A	N/A	936132.443	7351774.17	N/A	N/A	N/A	N/A	N/A	N/A
US-39(Q)	N/A	N/A	N/A	936157.281	7351817.04	N/A	N/A	N/A	N/A	N/A	N/A
US-40(Q)	N/A	N/A	N/A	936176.591	7351847.225	N/A	N/A	N/A	N/A	N/A	N/A
US-41(Q)	N/A	N/A	N/A	936232.43	7351858.336	N/A	N/A	N/A	N/A	N/A	N/A
US-42(Q)	N/A	N/A	N/A	936233.853	7351807.87	N/A	N/A	N/A	N/A	N/A	N/A

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US-43(Q)	N/A	N/A	N/A	936185.12	7351861.873	N/A	N/A	N/A	N/A	N/A	N/A
US-44(Q)	N/A	N/A	N/A	936117.867	7351748.884	N/A	N/A	N/A	N/A	N/A	N/A
US-45(Q)	N/A	N/A	N/A	936103.354	7351725.071	N/A	N/A	N/A	N/A	N/A	N/A
US-46(Q)	N/A	N/A	N/A	936197.866	7351746.888	N/A	N/A	N/A	N/A	N/A	N/A
US-47(Q)	N/A	N/A	N/A	936194.014	7351874.214	N/A	N/A	N/A	N/A	N/A	N/A
US-48(Q)	N/A	N/A	N/A	936275.914	7351833.096	N/A	N/A	N/A	N/A	N/A	N/A
USW-31(Q)	N/A	N/A	N/A	936209.358	7351780.606	N/A	N/A	N/A	N/A	N/A	N/A
USW-32(Q)	N/A	N/A	N/A	936205.149	7351782.839	N/A	N/A	N/A	N/A	N/A	N/A
USW-33(Q)	N/A	N/A	N/A	936155.818	7351793.488	N/A	N/A	N/A	N/A	N/A	N/A
USW-34(Q)	N/A	N/A	N/A	936158.862	7351792.402	N/A	N/A	N/A	N/A	N/A	N/A
USW-35(Q)	N/A	N/A	N/A	936172.797	7351777.381	N/A	N/A	N/A	N/A	N/A	N/A
USW-36(Q)	N/A	N/A	N/A	936168.176	7351780.088	N/A	N/A	N/A	N/A	N/A	N/A
VH(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
VH-WEXS(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
W0(D)	N/A	N/A	N/A	936325.32	7352217.476	N/A	N/A	N/A	N/A	N/A	N/A
WS1(F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
X7500(A)				N/A	N/A						N/A
Yaquina Bay Control(P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

ft: Feet (below ground surface for depth measure
Location Coordinates:
MSL: Surveyed to mean sea leve
Borehole Cross-Ref: Well from which lithologic description used to construct w
N/A: Not Available

TABLE 5

CHEMICALS DETECTED IN ENVIRONMENTAL MEDIA

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

CHEMICALS DETECTED	SOIL (Max. Concentration mg/kg)	GROUND WATER (Max. Concentration mg/L)	SEDIMENT (Max. Concentration mg/kg)	STORM WATER (Max. Concentration mg/L)
1,2-Dibromoethane; ethylene dibromide		(5)		
1,2-Dichloroethane		(5)		
1,2,4-Trichlorobenzene			(0.003)	
2-Methylnaphthalene		(2100)	(0.003)	
4,4’-DDE			(0.002)	
Acenaphthene	(2)	(10)		
Acenaphthylene	(7)	(200)		
Acetone	(0.077)	(22,000)		
Acrolein	(0.025)			
Acrylonitrile	(0.025)			
Ammonia as nitrogen			(193)	
Anthracene		(1)		
Arsenic, total	(48)		(5)	
Barium, total	(56)			
Benz(a)anthracene		(1)	(0.026))	
Benzene	(51)	(15,600)		
Benzo(a)pyrene		(1)	(0.025)	
Benzo(b)fluoranthene		(2)	(0.023)	
Benzo(g,h,i)perylene		(2)	(0.019)	
Benzo(k)fluoranthene		(1)	(0.017)	
Bis(2-ethylexyl) phthalate			(0.038)	
Cadmium, total			(1)	
Carbon		(23)		
Carbon, Total Organic	(0.004)		(2)	X
Chromium, total	(57)		(18)	
Chrysene		(1)	(0.034)	
COD, Chemical Oxygen Demand				X
Copper, total			(33)	X
Dibenz(a,h)anthracene		(1)	(0.004)	
Dibenzofuran			(0.003)	
Diesel		(8,000)		
Diethyl phthalate			(0.010)	
Di-n-butyl phthalate			(0.011)	
Ethylbenzene	(130)	(320,000)		
Fluoranthene	(0.009)	(2)	(0.062)	
Fluorene		(2)	(0.008)	

TABLE 5

CHEMICALS DETECTED IN ENVIRONMENTAL MEDIA

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

CHEMICALS DETECTED	SOIL	GROUND WATER	SEDIMENT	STORM WATER
HCID	(27)			
Hydrocarbon	(23,000)	(540,000)		
Hydrocarbon-gas		(572)		
Indeno(1,2,3-c,d)pyrene		(1)	(0.027)	
Lead, total	(200)		(18)	(16,400)
M/p-Xylene	(260)	(20,100)		
Mercury			(1)	
Methylene Chloride		(260)		
MTBE, methyl tert-butyl ether		(200)		
Napththalene	(24)	(1,100)		
n-Butylbenzene	(1)			
Nickel, total			(12)	
Oil & Grease, Polar		(90,000)		
Oil & Grease, Total		(770,000)		
o-Xylene	(260)	(77,100)		
pH		(9)		
Phenanthrene		(1)	(0.029)	
Phosphorous, total				(150)
p-isopropyltoluene	(1)			
Pyrene		(8)	(0.059)	
sec-Butylbenzene	(1)			
Solids, Total Volatile			(9%)	
Toluene	(360)	(140,000)		
Total Solids - Metals	(92%)	(83%)		
TPH	(12,000)	(680,000)		
TPH-Diesel	(6,100)	(70,400)		
TPH-Gasoline	(23,000)	(91,000)		
TPH-Oil	(10,000)	(11,000)		
TSS, Total Suspended Solids				(62,000)
Xylene	(460)	(1,400,000)		
Zinc, total			(127)	(208)

TABLE 6
PROPOSED BORING LOCATIONS

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

Proposed boring Number	Area Sited (location)	Analytical Requirements
SB-100(C)	Former Waste Oil UST	TPH-Gx, TPH-Dx, RBDM VOCs, Lead, PAHs (If TPH-Dx)
SB-101(C)	Former Pump Island	TPH-Gx, TPH-Dx, RBDM VOCs, Lead, PAHs (If TPH-Dx)
SB-102(C)	Former UST	TPH-Gx, RBDM VOCs, Lead
SB-103(C)	Former UST	TPH-Gx, RBDM VOCs, Lead
SB-104(C)	Young's Bay Texaco AST	TPH-Gx, RBDM VOCs
SB-200(C)	Back Yard – Residual Bunker C Wastes	TPH-Dx, PAHs, metals
SB-201(C)	Back Yard – Residual Bunker C Wastes	TPH-Dx, PAHs, metals
SB-202(C)	Tank Yard – TPH and metals in soil	TPH-Dx, PAHs, metals
SB-203(C)	Tank Yard – TPH and metals in soil	TPH-Dx, PAHs, metals
SB-204(C)	Pump House – Stained soils	TPH-Dx, PAHs, metals
SB-300(D);	Delphia Oil: Inside west tank farm secondary containment area to a max. depth of 10' bgs (hand auger)	Soil: NWTPH-HCID, one-third of all samples with detections of gasoline-range TPH will be analyzed for BTEX and lead, one-third of all samples with detections of diesel- or oil-range TPH will be analyzed for PAHs.
SB-301(D);	Delphia Oil: Inside secondary containment area to a max. depth of 10' bgs (hand auger)	Soil: NWTPH-HCID, one-third of all samples with detections of gasoline-range TPH will be analyzed for BTEX and lead, one-third of all samples with detections of diesel- or oil-range TPH will be analyzed for PAHs.
SB-302(D);	Delphia Oil: Inside secondary containment area to a max. depth of 10' bgs (hand auger)	Soil: NWTPH-HCID, one-third of all samples with detections of gasoline-range TPH will be analyzed for BTEX and lead, one-third of all samples with detections of diesel- or oil-range TPH will be analyzed for PAHs.
SB-303(D)	Delphia Oil: Inside secondary containment area to a max. depth of 10' bgs (hand auger)	Soil: NWTPH-HCID, one-third of all samples with detections of gasoline-range TPH will be analyzed for BTEX and lead, one-third of all samples with detections of diesel- or oil-range TPH will be analyzed for PAHs.
SB-304(D)	Delphia Oil: North of west tank farm	Soil: NWTPH-HCID,one-third of all samples with detections of gasoline-range TPH will be analyzed for BTEX and lead, one-third of all samples with detections of diesel- or oil-range TPH will be analyzed for PAHs; Groundwater: BTEX and PAHs, lead if BTEX is detected.
SB-305(D)	Delphia Oil: East of the loading rack	Soil: NWTPH-HCID, one-third of all samples with detections of gasoline-range TPH will be analyzed for BTEX and lead, one-third of all samples with detections of diesel- or oil-range TPH will be analyzed for PAHs; Groundwater: hold pending analytical results.
SB-306(D)	Delphia Oil: Empty drum storage area	Soil: NWTPH-HCID, one-third of all samples with detections of gasoline-range TPH will be analyzed for BTEX and lead, one-third of all samples with detections of diesel- or oil-range TPH will be analyzed for PAHs; Groundwater: hold pending analytical results
SB-307(D)	Delphia Oil: North of and down-gradient of the former warehouse loading rack along the northern property boundary	Soil: NWTPH-HCID, one-third of all samples with detections of gasoline-range TPH will be analyzed for BTEX and lead, one-third of all samples with detections of diesel- or oil-range TPH will be analyzed for PAHs; Groundwater: hold pending analytical results

TABLE 6
PROPOSED BORING LOCATIONS

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

Proposed boring Number	Area Sited (location)	Analytical Requirements
SB-308(D)	Delphia Oil: Near the former aboveground product lines associated with the west tank farm and former loading rack to a depth of 5' bgs	Soil: NWTPH-HCID, one-third of all samples with detections of gasoline-range TPH will be analyzed for BTEX and lead, one-third of all samples with detections of diesel- or oil-range TPH will be analyzed for PAHs.
SB-309(D)	Delphia Oil: In the vicinity of the storm-water drainage system – north of the catch basin	Soil: NWTPH-HCID, one-third of all samples with detections of gasoline-range TPH will be analyzed for BTEX and lead, one-third of all samples with detections of diesel- or oil-range TPH will be analyzed for PAHs; Groundwater: hold pending analytical results
SB-310(D)	Delphia Oil: In the vicinity of the storm-water drainage system – along the subsurface drainage line (from the loading rack to the catch basin)	Soil: NWTPH-HCID, one-third of all samples with detections of gasoline-range TPH will be analyzed for BTEX and lead, one-third of all samples with detections of diesel- or oil-range TPH will be analyzed for PAHs; Groundwater: hold pending analytical results.
SB-311(D)	Delphia Oil: Along the northern property boundary – at the northwestern corner of the property	Groundwater: BTEX and PAHs, lead if BTEX is detected
SB-312(D)	Delphia Oil: Along the northern property boundary – north of the petroleum products warehouse	Groundwater: BTEX and PAHs, lead if BTEX is detected
SB-313(D)	Val's Texaco: In the vicinity of the former UST product lines	Soil: NWTPH-HCID,one-third of all samples with detections of gasoline-range TPH will be analyzed for BTEX and lead, one-third of all samples with detections of diesel- or oil-range TPH will be analyzed for PAHs; Groundwater: hold pending analytical results.
SB-314(D)	Val's Texaco: North (down-gradient) of the diesel UST	Soil: NWTPH-HCID, one-third of all samples with detections of gasoline-range TPH will be analyzed for BTEX and lead, one-third of all samples with detections of diesel- or oil-range TPH will be analyzed for PAHs; Groundwater: BTEX and PAHs, lead if BTEX is detected.
SB-315(D)	Val's Texaco: North of the diesel fuel dispenser to 15' bgs	Soil: NWTPH-HCID, one-third of all samples with detections of gasoline-range TPH will be analyzed for BTEX and lead, one-third of all samples with detections of diesel- or oil-range TPH will be analyzed for PAHs.
SB-316(D)	Val's Texaco: Along the active diesel product line (approx. midway between the UST and the dispenser) to 15' bgs	Soil: NWTPH-HCID, one-third of all samples with detections of gasoline-range TPH will be analyzed for BTEX and lead, one-third of all samples with detections of diesel- or oil-range TPH will be analyzed for PAHs.
SB-317(D)	Val's Texaco: North of the catch basin to 10' bgs	Soil: NWTPH-HCID, one-third of all samples with detections of gasoline-range TPH will be analyzed for BTEX and lead, one-third of all samples with detections of diesel- or oil-range TPH will be analyzed for PAHs.
SB-318(D)	Val's Texaco: North of the former UST excavation	Groundwater: BTEX and PAHs, lead if BTEX is detected
SB-400(F)	Perimeter of former soil removal excavation at approximately 2' and 15' bgs.	Soil: NWTPH-Gx/BTEX and NWTPH-Dx Groundwater: NWTPH-Gx/BTEX and NWTPH-Dx Follow-up analysis will include RBDM VOCs and PAHs, as appropriate, on the two hottest 2' and 15' soil samples from SB-400(F) through SB-404(F).

TABLE 6
PROPOSED BORING LOCATIONS

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

Proposed boring Number	Area Sited (location)	Analytical Requirements
SB-401(F)	Perimeter of former soil removal excavation at approximately 2' and 15' bgs.	Soil: NWTPH-Gx/BTEX and NWTPH-Dx Groundwater: NWTPH-Gx/BTEX and NWTPH-Dx Follow-up analysis will include RBDM VOCs and PAHs, as appropriate, on the two hottest 2' and 15' soil samples from SB-400(F) through SB-404(F).
SB-402(F)	Perimeter of former soil removal excavation at approximately 2' and 15' bgs.	Soil: NWTPH-Gx/BTEX and NWTPH-Dx Groundwater: NWTPH-Gx/BTEX and NWTPH-Dx Follow-up analysis will include RBDM VOCs and PAHs, as appropriate, on the two hottest 2' and 15' soil samples from SB-400(F) through SB-404(F).
SB-403(F)	Perimeter of former soil removal excavation at approximately 2' and 15' bgs.	Soil: NWTPH-Gx/BTEX and NWTPH-Dx Groundwater: NWTPH-Gx/BTEX and NWTPH-Dx Follow-up analysis will include RBDM VOCs and PAHs, as appropriate, on the two hottest 2' and 15' soil samples from SB-400(F) through SB-404(F).
SB-404(F)	Perimeter of former soil removal excavation at approximately 2' and 15' bgs.	Soil: NWTPH-Gx/BTEX and NWTPH-Dx Groundwater: NWTPH-Gx/BTEX and NWTPH-Dx Follow-up analysis will include RBDM VOCs and PAHs, as appropriate, on the two hottest 2' and 15' soil samples from SB-400(F) through SB-404(F).
SB-405(F)	Perimeter of former soil removal excavation at approximately 2' and 5' bgs.	Soil: NWTPH-Gx/BTEX and NWTPH-Dx Groundwater: NWTPH-Gx/BTEX and NWTPH-Dx
SB-406(F)	Perimeter of former soil removal excavation at approximately 2' and 5' bgs.	Soil: NWTPH-Gx/BTEX and NWTPH-Dx Groundwater: NWTPH-Gx/BTEX and NWTPH-Dx
SB-407(F)	Perimeter of former soil removal excavation at approximately 2' and 5' bgs.	Soil: NWTPH-Gx/BTEX and NWTPH-Dx Groundwater: NWTPH-Gx/BTEX and NWTPH-Dx
SB-408(F)	Perimeter of former soil removal excavation at approximately 2' and 5' bgs.	Soil: NWTPH-Gx/BTEX and NWTPH-Dx Groundwater: NWTPH-Gx/BTEX and NWTPH-Dx
SB-409(F)	Perimeter of former soil removal excavation at approximately 2' and 5' bgs.	Soil: NWTPH-Gx/BTEX and NWTPH-Dx Groundwater: NWTPH-Gx/BTEX and NWTPH-Dx
SB-500(M)	Approximately 200 feet west of 1993 diesel release, along pipeline near P-10	NWTPH-Dx and NWTPH-Gx
SB-501(M)	Approximately 100 feet west of 1993 diesel release, along pipeline near P-8	NWTPH-Dx and NWTPH-Gx
SB-502(M)	Location of 1993 diesel release	NWTPH-Dx and NWTPH-Gx
SB-503(M)	Approximately 100 feet east of 1993 diesel release, along pipeline near P-2	NWTPH-Dx and NWTPH-Gx
SB-504(M)	Approximately 200 feet east of 1993 diesel release, along pipeline	NWTPH-Dx and NWTPH-Gx
SB-505(M)	Near 1993 soil probe P-6	NWTPH-Dx and NWTPH-Gx
SB-506(M)	Data gap, SE corner of storage building	NWTPH-Dx and NWTPH-Gx
SB-507(M)	Near 1994 test pit TP-1	NWTPH-Dx and NWTPH-Gx
SB-508(M)	Near 1994 test pit TP-3	NWTPH-Dx and NWTPH-Gx
SB-509(M)	Near 1994 test pit TP-8	NWTPH-Dx and NWTPH-Gx
SB-510(M)	Near 1994 test pit TP-9	NWTPH-Dx and NWTPH-Gx
SB-600(N)	NW corner of Niemi cardlock, next to combined sewer line.	NWTPH-HCID and appropriate TPH follow-up; BETX+N; additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.
SB-601(N)	Western portion of Niemi cardlock, near 1994 soil boring SB-5(N).	NWTPH-HCID and appropriate TPH follow-up; BETX+N; additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.
SB-602(N)	Near northern property boundary of Niemi cardlock, near dispenser island and 1994 soil boring SB-4(N).	NWTPH-HCID and appropriate TPH follow-up; BETX+N; additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.

TABLE 6
PROPOSED BORING LOCATIONS

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

Proposed boring Number	Area Sited (location)	Analytical Requirements
SB-603(N)	Western portion of Niemi cardlock, near subsurface product piping and inferred downgradient direction of diesel USTs.	NWTPH-HCID and appropriate TPH follow-up; BETX+N; additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.
SB-604(N)	Western portion of Niemi cardlock, between diesel USTs, gasoline AST and fuel rack.	NWTPH-HCID and appropriate TPH follow-up; BETX+N; additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.
SB-605(N)	Center of Niemi cardlock, between diesel USTs, gasoline UST and overhead loading rack.	NWTPH-HCID and appropriate TPH follow-up; BETX+N; additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.
SB-606(N)	Near northern property boundary of Niemi cardlock, near former diesel dispenser island and 1994 soil boring SB-3(N).	NWTPH-HCID and appropriate TPH follow-up; BETX+N; additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.
SB-607(N)	Center of Niemi cardlock, near overhead loading rack and subsurface product piping.	NWTPH-HCID and appropriate TPH follow-up; BETX+N; additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.
SB-608(N)	Eastern portion of Niemi cardlock, near former Associated Oil Co. facilities.	NWTPH-HCID and appropriate TPH follow-up; BETX+N; additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.
SB-609(N)	Eastern portion of Niemi cardlock, near former Associated Oil Co. facilities.	NWTPH-HCID and appropriate TPH follow-up; BETX+N; additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.
SB-610(N)	NW corner of former Mobil and Niemi BP, within vehicle garage and near storm sewer line.	NWTPH-HCID and appropriate TPH follow-up; BETX+N; additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.
SB-611(N)	Along northern property boundary of former Mobil and Niemi BP, near former dispenser island.	NWTPH-HCID and appropriate TPH follow-up; BETX+N; additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.
SB-612(N)	Northern portion of former Mobil and Niemi BP, between former product pumps and AST.	NWTPH-HCID and appropriate TPH follow-up; BETX+N; additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.
SB-613(N)	Northeastern portion of former Mobil and Niemi BP, near former AST.	NWTPH-HCID and appropriate TPH follow-up; BETX+N; additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.
SB-614(N)	Northeastern portion of former Mobil and Niemi BP, near former large AST and product pipe.	NWTPH-HCID and appropriate TPH follow-up; BETX+N; additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.
SB-615(N)	Northern portion of former Mobil and Niemi BP, near former AST.	NWTPH-HCID and appropriate TPH follow-up; BETX+N; additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.
SB-616(N)	Western portion of former Mobil and Niemi BP, near overhead loading rack.	NWTPH-HCID and appropriate TPH follow-up; BETX+N; additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.
SB-617(N)	Western portion of former Mobil and Niemi BP, near former loading rack.	NWTPH-HCID and appropriate TPH follow-up; BETX+N; additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.

TABLE 6
PROPOSED BORING LOCATIONS

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

Proposed boring Number	Area Sited (location)	Analytical Requirements
SB-618(N)	Central portion of former Mobil and Niemi BP, near former AST.	NWTPH-HCID and appropriate TPH follow-up; BETX+N; additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.
SB-619(N)	Eastern edge of former Mobil and Niemi BP, between site's ASTs and 1996 soil borings DEQ-1(A) and DEQ-2(A)..	NWTPH-HCID and appropriate TPH follow-up; BETX+N; additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.
SB-620(N)	Eastern portion of former Mobil and Niemi BP, near former AST.	NWTPH-HCID and appropriate TPH follow-up; BETX+N; and additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.
SB-621(N)	Southern portion of former Mobil and Niemi BP, near former AST.	NWTPH-HCID and appropriate TPH follow-up; BETX+N; additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.
SB-622(N)	SW portion of former Mobil and Niemi BP, near catch basin and warehouse.	NWTPH-HCID and appropriate TPH follow-up; VOCs (full scan) by EPA Method 8260; SVOCs (full scan) by EPA Method 8270; lead, cadmium, chromium.
SB-623(N)	SE portion of former Mobil and Niemi BP, near former AST.	NWTPH-HCID and appropriate TPH follow-up; BETX+N; additional petroleum COIs (i.e., RBDM VOCs, PAHs and/or lead) dependent on results of TPH analysis.
SB-624(N)	Southern edge of former Mobil and Niemi BP, near former cesspool and boiler.	NWTPH-HCID and appropriate TPH follow-up; VOCs (full scan) by EPA Method 8260; SVOCs (full scan) by EPA Method 8270; and lead, cadmium, chromium; and PCBs.
SB-700(P); SB-701(P) SB-702(P); SB-703(P)	Former furniture manufacturing company, former fuel storage area	TPH-Gx[1], TPH-Dx[2,3], metals (EPA 6010/200.7), volatile organic compounds (EPA 8260), ground water samples held pending soil analytical results
SB-704(P); SB-705(P)	Former furniture manufacturing company, former boiler room, former glue room	TPH-Gx[1], TPH-Dx[2,3], metals (EPA 6010/200.7), volatile organic compounds (EPA 8260), formaldehyde (MASA 415), phenolics (EPA 600.4), ground water samples held pending soil analytical results
SB-706(P); SB-707(P)	Former steel works site and boiler building	TPH-Gx[1], TPH-Dx[2,3] and metals (EPA 6010/200.7), ground water samples held pending soil analytical results
SB-708(P)	Former steel works site: Transformer Bunk	TPH-Gx[1], TPH-Dx[2,3] and metals (EPA 6010/200.7), PCBs (EPA 8080), ground water samples held pending soil analytical results
SB-709(P); SB-710(P); SB-711(P); SB-712(P)	Former Astoria Oil Services	TPH-Gx[1], TPH-Dx[2,3] and volatile organic compounds (EPA 8260), ground water samples held pending soil analytical results
SB-713(P)	Former Transformer Vault (Pier 3)	TPH-Gx[1], TPH-Dx[2,3] and PCBs (EPA 8080), ground water samples held pending soil analytical results
SB-714(P); SB-715(P)	Former UST locations (previously decommissioned near the Port of Astoria Maintenance Shop)	TPH-Gx[1], TPH-Dx[2,3], ground water samples held pending soil analytical results
SB-716(P)	Former steel works site: Former machine shop	TPH-Gx[1], TPH-Dx[2,3], ground water samples held pending soil analytical results
SB-717(P)	Former steel works site: Former machine shop	TPH-Gx[1], TPH-Dx[2,3], ground water samples held pending soil analytical results
SB-718(P)	Northern side of former mill	TPH-Gx[1], TPH-Dx[2,3], ground water samples held pending soil analytical results

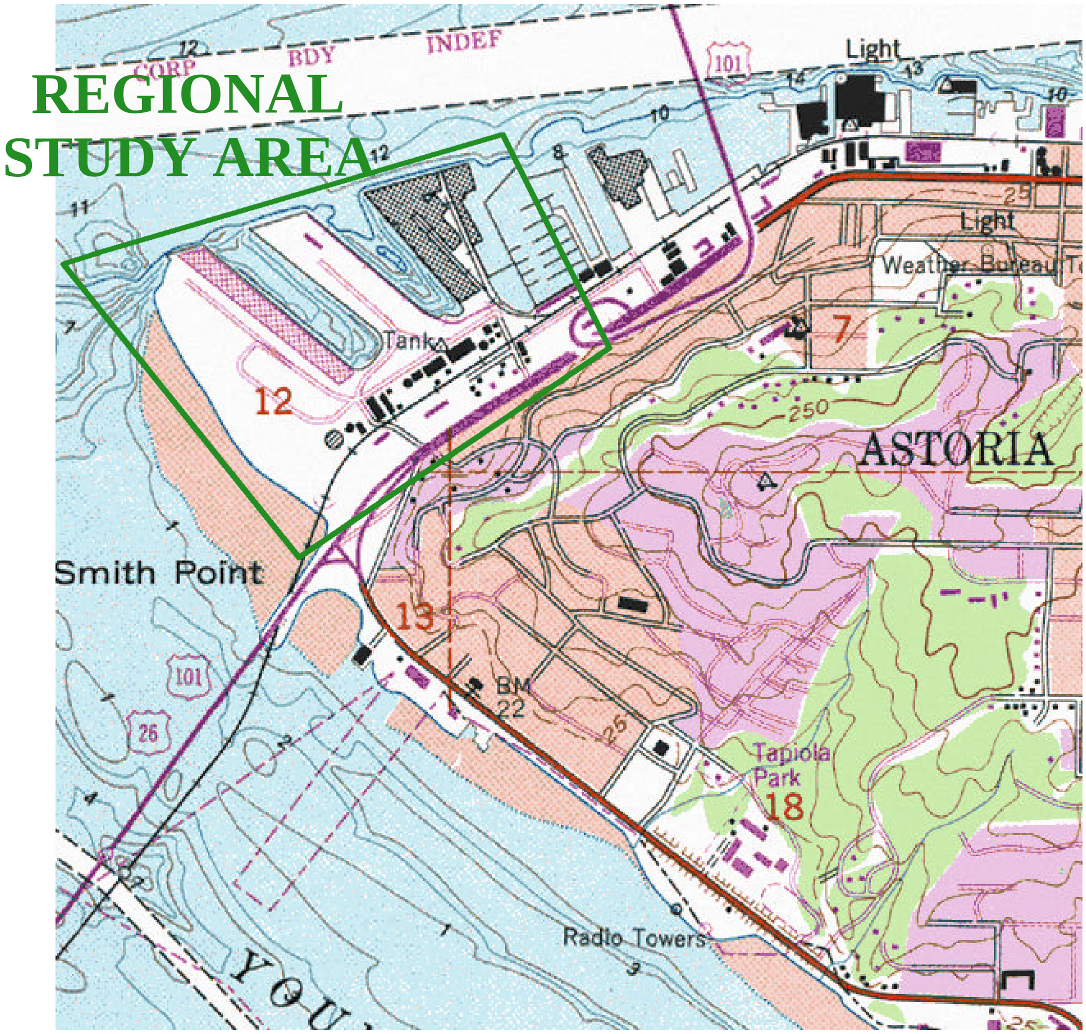
TABLE 6
PROPOSED BORING LOCATIONS

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

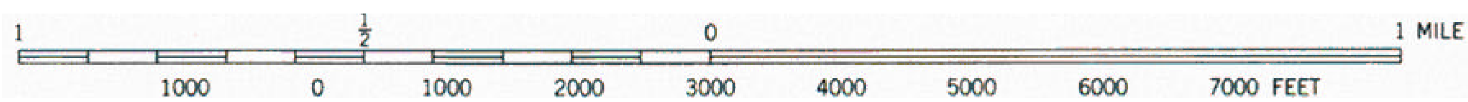
Proposed boring Number	Area Sited (location)	Analytical Requirements
SB-800(Q); SB-801(Q); SB-802(Q); SB-803(Q); SB-804(Q); SB-805(Q); SB-806(Q); SB-807(Q)	Along northern edge of the site, spaced 50-feet apart	Petroleum-hydrocarbons (NWTPH)
SB-808(Q); SB-809(Q); SB-810(Q); SB-811(Q); SB-812(Q); SB-813(Q): SB-814(Q)	Along southern boundary of property, spaced 25-feet apart	Petroleum-hydrocarbons (NWTPH)
SB-815(Q); SB-816(Q)	Along southern edge of property, spaced 50-feet apart	Petroleum-hydrocarbons (NWTPH)
SB-817(Q); SB-818(Q); SB-819(Q); SB-820(Q); SB-821(Q); SB-822(Q)	At the western and eastern edges of the property	Petroleum-hydrocarbons (NWTPH)
SB-823(Q); SB-824(Q); SB-825(Q); SB-826(Q); SB-827(Q); SB-828(Q)	Approximately 20-feet from Boring B inside the Qwest garage	Petroleum-hydrocarbons (NWTPH)
SB-829(Q); SB-830(Q); SB-831(Q); SB-832(Q): SB-833(Q)	At the perimeter of the excavation to remove contaminated soil in the vicinity of the former pump island	Petroleum-hydrocarbons (NWTPH)
SB-900(S)	Source soil characterization	TPH-Dx/Gx, Metals (including Cd, Cr, Pb)
SB-901(S)	Source soil characterization	TPH-Dx/Gx, BTEX, Metals (including Cd, Cr, Pb)[4]
SB-902(S)	Source soil characterization	TPH-Dx/Gx, BTEX, Metals (including Cd, Cr, Pb)[4]
SB-903(S)	Source soil characterization	TPH-Dx/Gx, BTEX, Metals (including Cd, Cr, Pb)[4]
SB-904(S)	Source soil characterization	TPH-Dx/Gx, BTEX, Metals (including Cd, Cr, Pb)[4]
SB-905(S)	Source soil characterization	TPH-Dx/Gx, BTEX, Metals (including Cd, Cr, Pb)[4]
SB-906(S)	Source soil characterization	TPH-Dx/Gx, BTEX, Metals (including Cd, Cr, Pb)[4]
SB-907(S)	Source soil characterization	TPH-Dx/Gx, BTEX, Metals (including Cd, Cr, Pb)[4]
SB-908(S)	Source soil characterization	TPH-Dx/Gx, BTEX, Metals (including Cd, Cr, Pb)[4]
SB-909(S)	Source soil characterization	TPH-Dx/Gx, BTEX, Metals (including Cd, Cr, Pb)[4]
SB-910(S)	Source soil characterization	TPH-Dx/Gx, BTEX, Metals (including Cd, Cr, Pb)[4]
SB-911(S)	Source soil characterization	TPH-Dx/Gx, BTEX, Metals (including Cd, Cr, Pb)[4]
TP-900(S)	Source soil and pipeline locate	TPH-Dx, Gx and BTEX

1. Soil samples with detection of gasoline-range petroleum hydrocarbons (result of analytical method NWTPH-Gx): soil and ground water samples from this boring will be further analyzed using EPA methods 8260 (specifically for ethylene dibromide, ethylene dichloride, methyl-t-butyl ether, 1,2,4-trimethyl benzene, 1,3,5-trimethyl benzene, benzene, toluene, ethyl benzene, o- and p-xylenes, m-xylene), and 6010/200.7 (specifically for lead).
2. Soil samples with detection of diesel-range petroleum hydrocarbons (result of analytical method NWTPH-Dx): soil and ground water samples from this boring will be further analyzed using EPA methods 8021 (specifically for benzene, toluene, ethyl benzene, o-, p-, and m-xylenes), and 8270 (specifically for acenaphthene, anthracene, benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorine, indeno(1,2,3-c,d)pyrene, naphthalene, and pyrene).
3. Soil samples with detection of oil-range petroleum hydrocarbons (result of analytical method NWTPH-Dx): soil and ground water samples from this boring will be further analyzed using EPA methods 8260, 8081 (specifically for polychlorinated biphenyls), and 6010/200.7 (specifically for arsenic, barium, chromium, cadmium, lead, mercury, selenium, and silver).
4. Shell – The 4 soil samples with the highest TPH/BTEX will also be analyzed for PAHs, PCBs, and RBDM VOCs. Two soil samples not containing TPH will be analyzed for PAHs, PCBs, and RBDM VOCs.

FIGURES



(from USGS, Astoria {1984}, OR 7.5' Quadrangles)



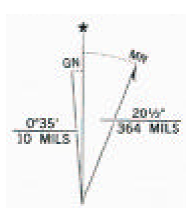


FIGURE 1

SITE LOCATION

Remedial Investigation/Feasibilty Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

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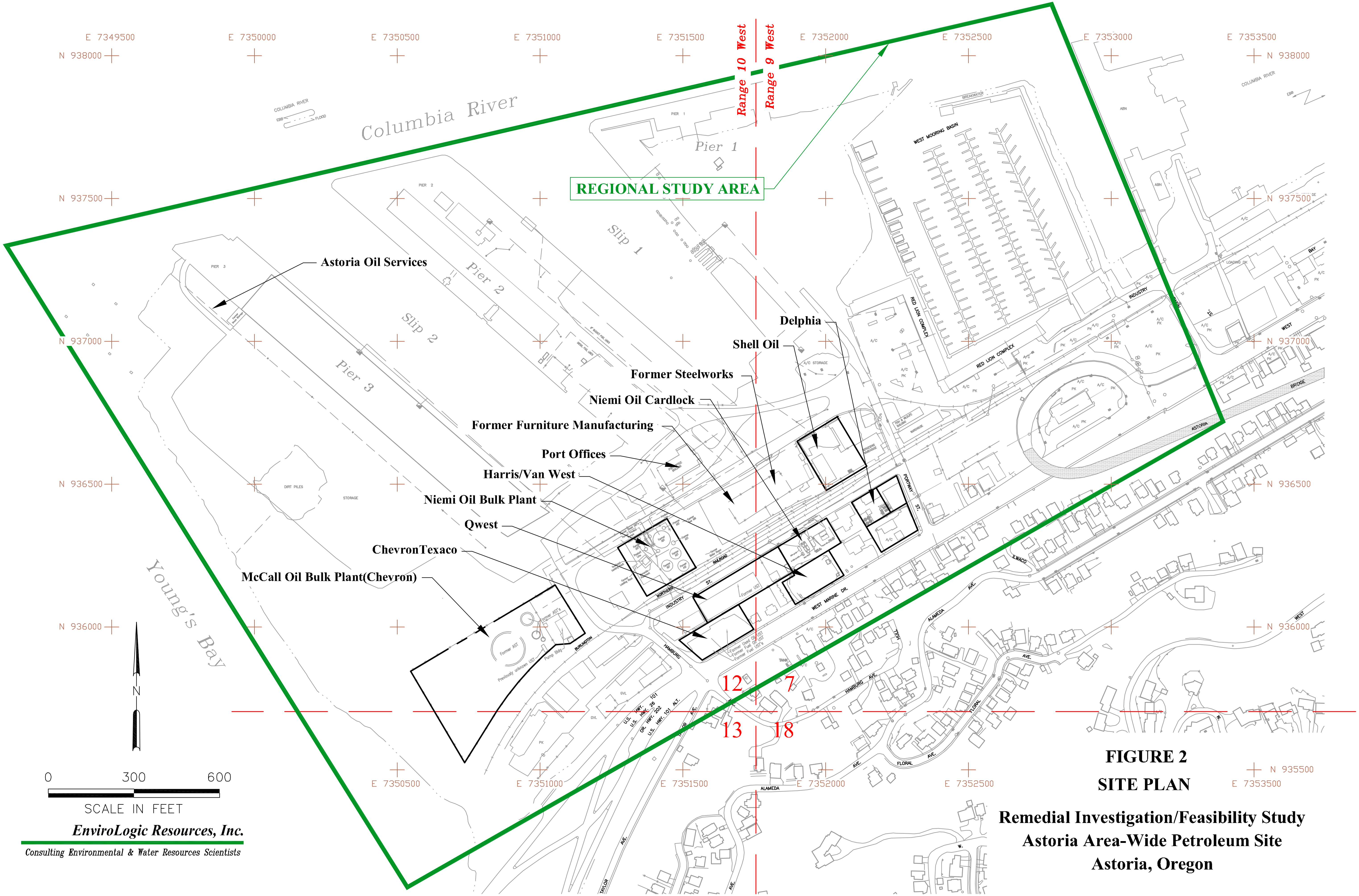
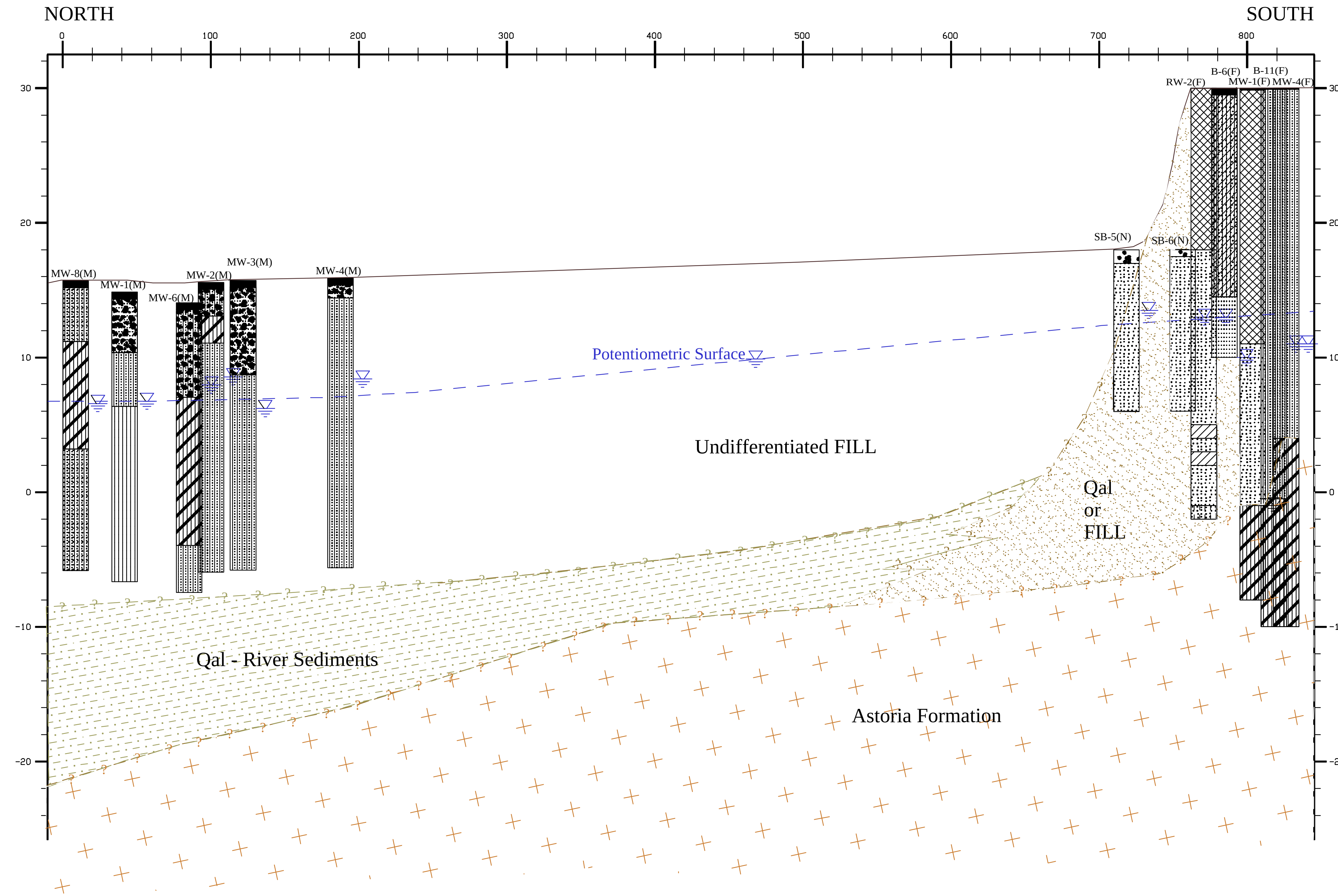


FIGURE 2
SITE PLAN

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon



EXPLANATION:

Vertical Exageration 10:1

Water Elevation

Strata symbols

- Paving
- Silty sand and sand
- Silty low plasticity clay
- Well graded gravel and sand
- Silty sand
- Silt
- Silty sand and gravel
- Poorly graded gravel
- Poorly graded sand
- Fill
- Low plasticity clay
- Poorly graded sand with silt
- Poorly graded clayey silty sand
- Well graded sand

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FIGURE 3

CONCEPTUAL HYDROGEOLOGIC MODEL

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

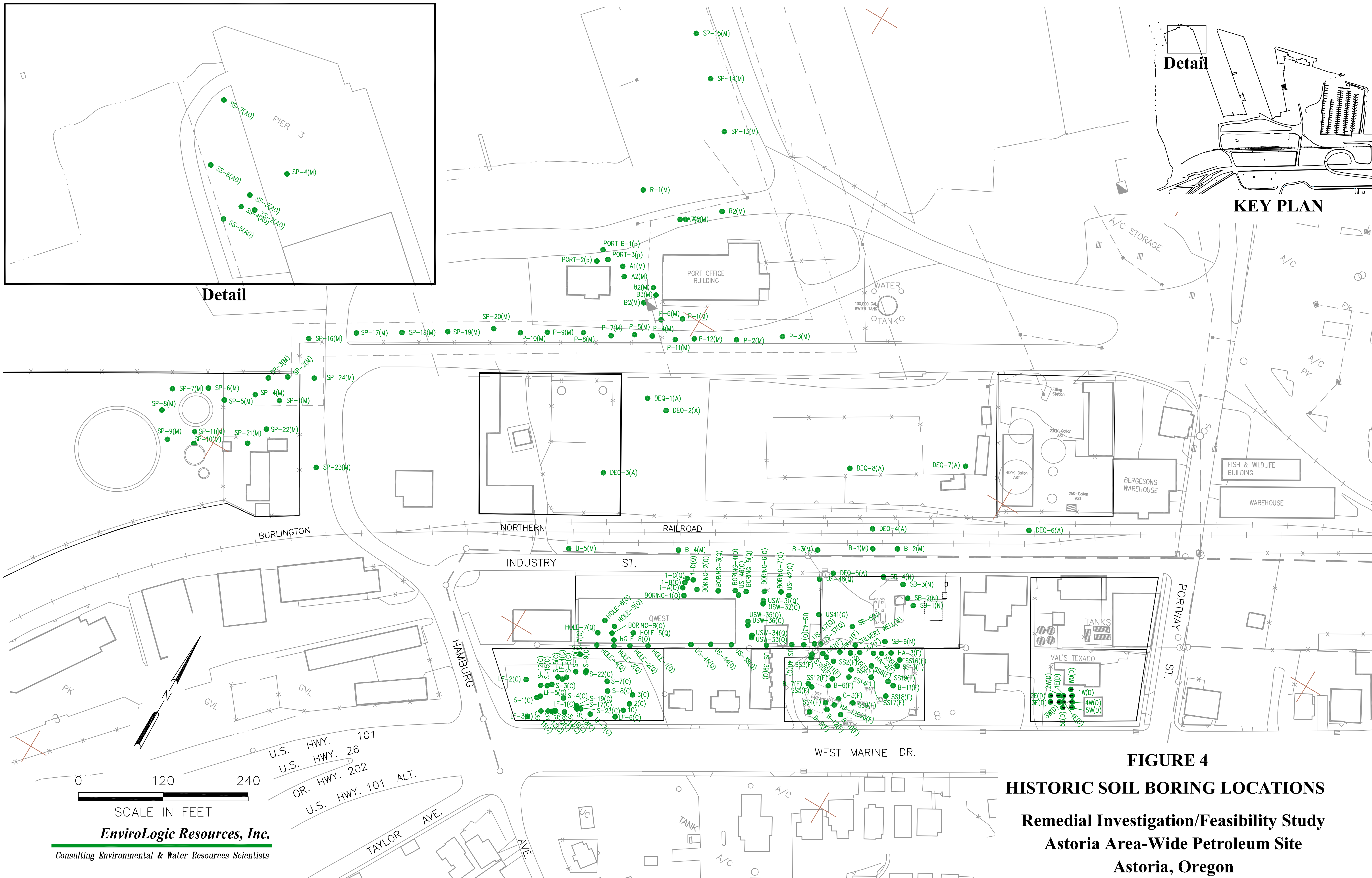

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FIGURE 4

HISTORIC SOIL BORING LOCATIONS

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

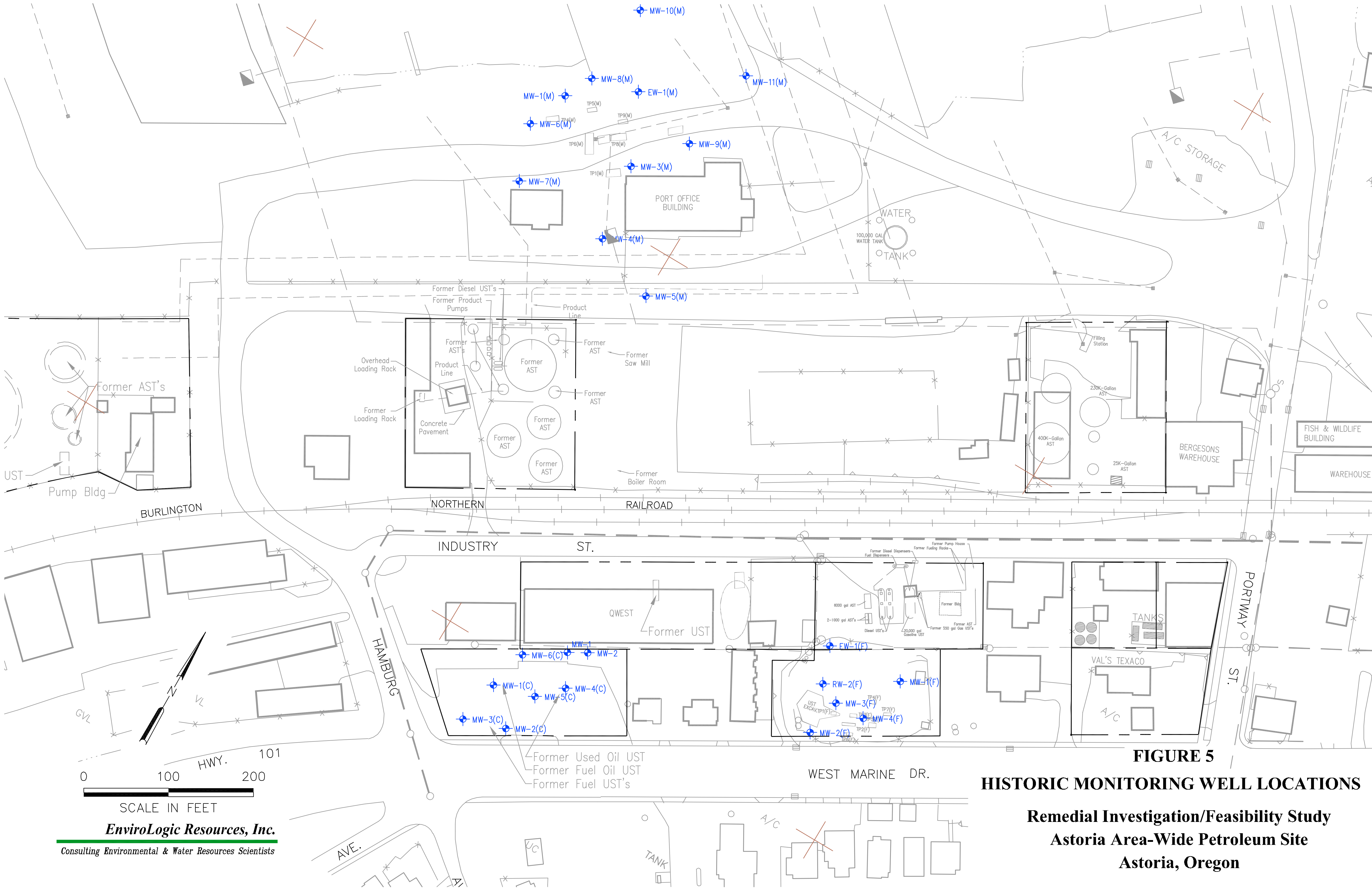

FIGURE 5

HISTORIC MONITORING WELL LOCATIONS

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

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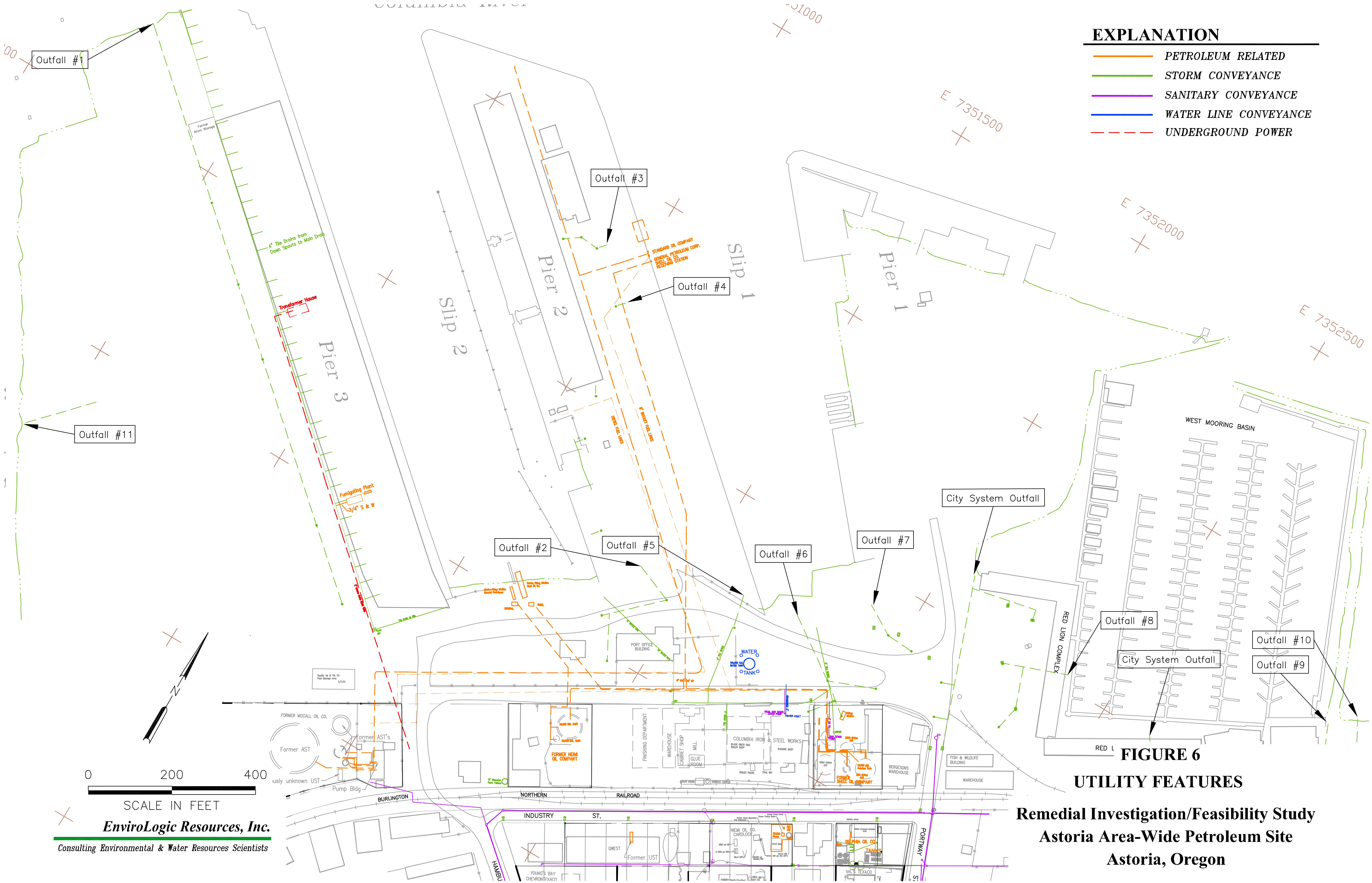

EXPLANATION

- PETROLEUM RELATED
- STORM CONVEYANCE
- SANITARY CONVEYANCE
- WATER LINE CONVEYANCE
- UNDERGROUND POWER

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FIGURE 6

UTILITY FEATURES

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

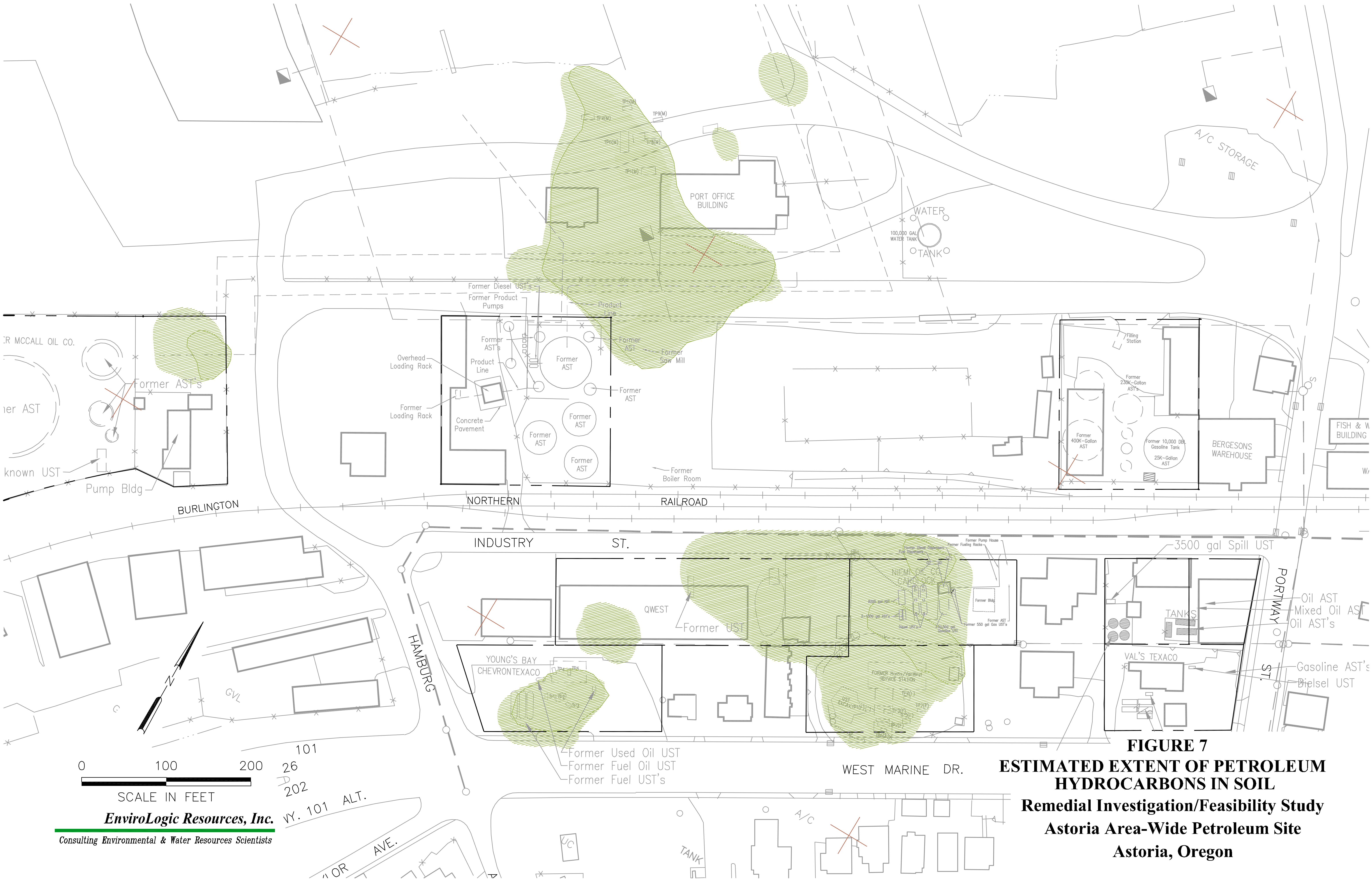

FIGURE 7
ESTIMATED EXTENT OF PETROLEUM HYDROCARBONS IN SOIL
Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

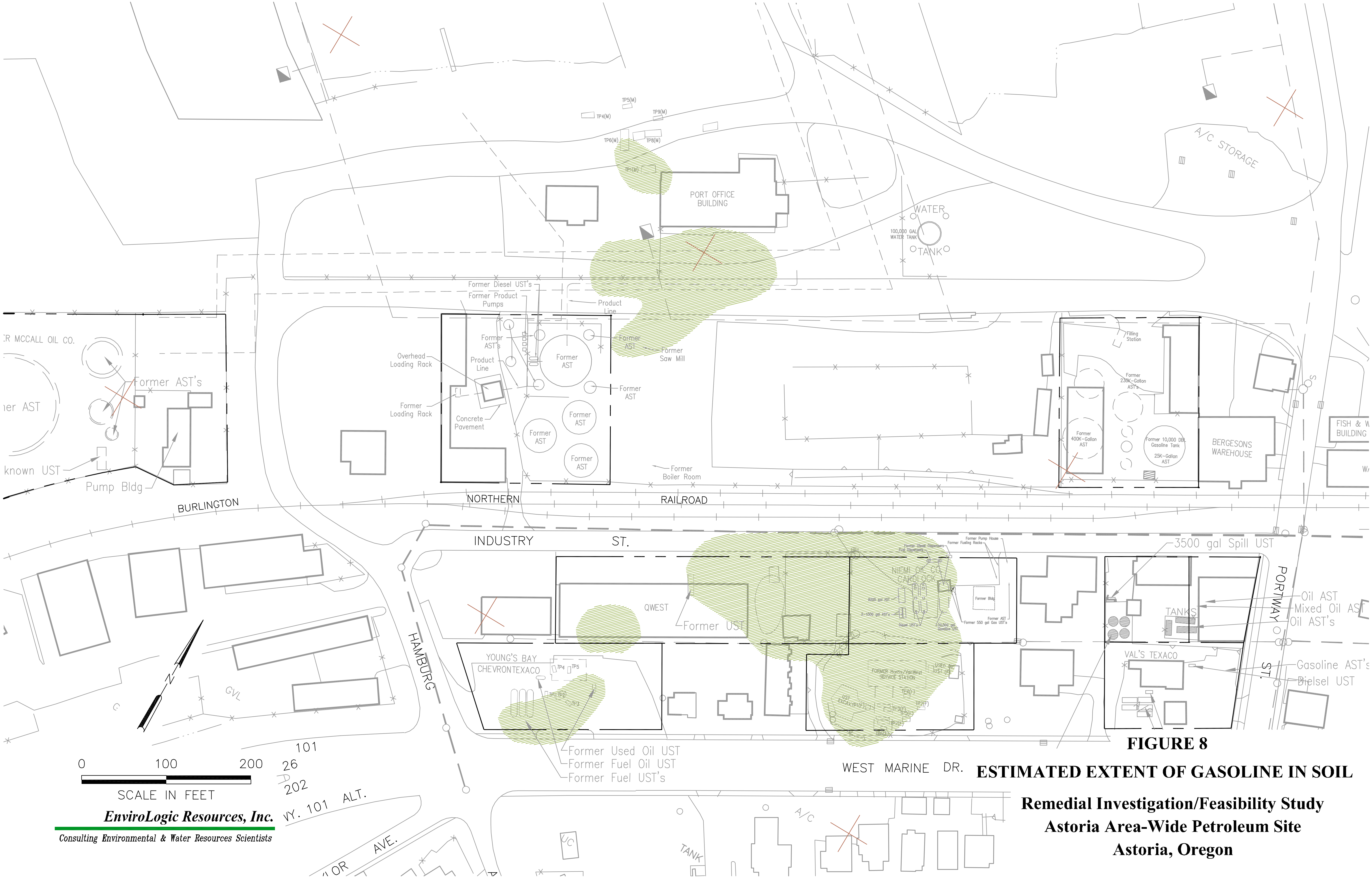

FIGURE 8

ESTIMATED EXTENT OF GASOLINE IN SOIL

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

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FIGURE 9

ESTIMATED EXTENT OF DIESEL IN SOIL

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

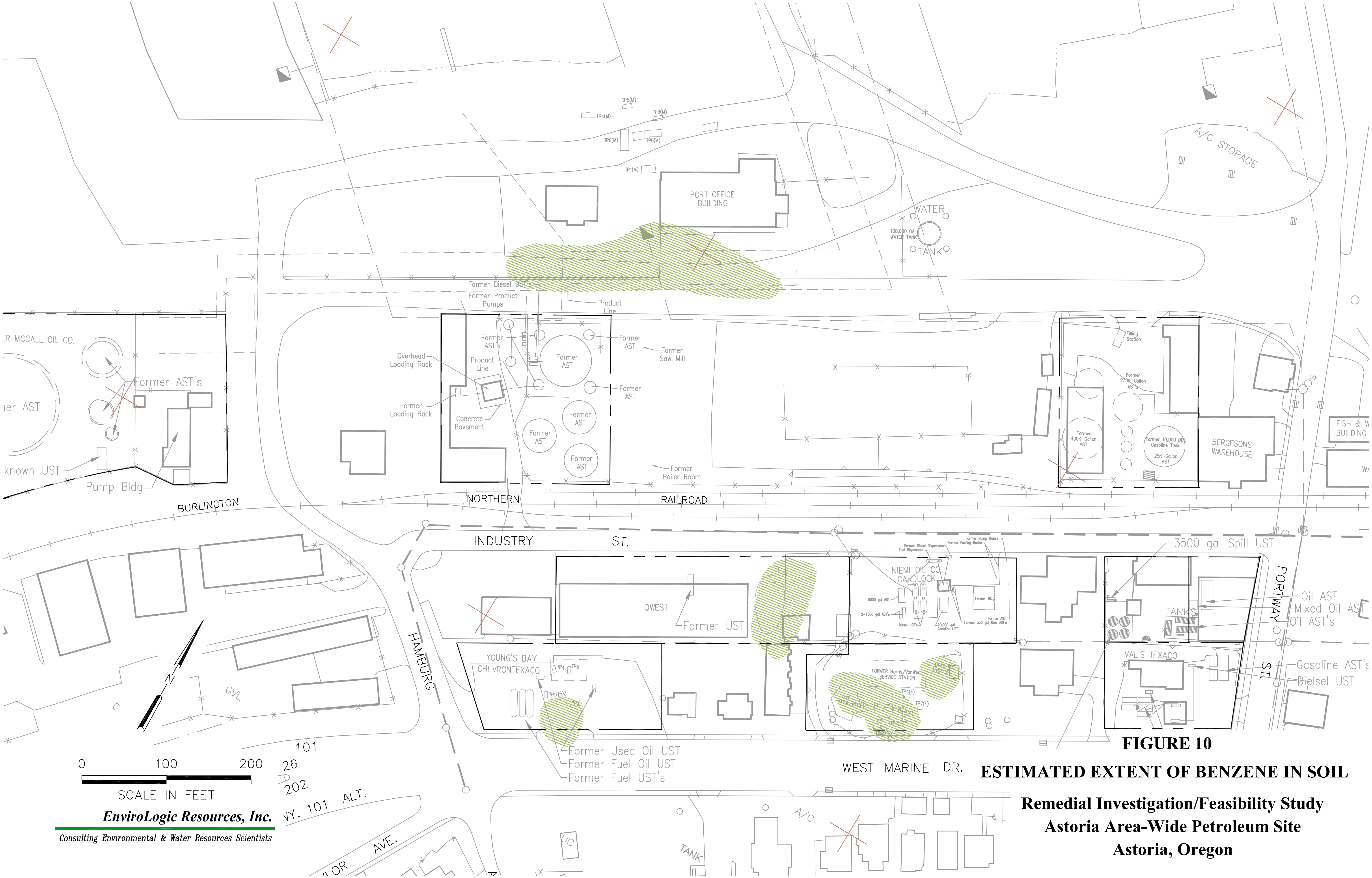

FIGURE 10

ESTIMATED EXTENT OF BENZENE IN SOIL

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

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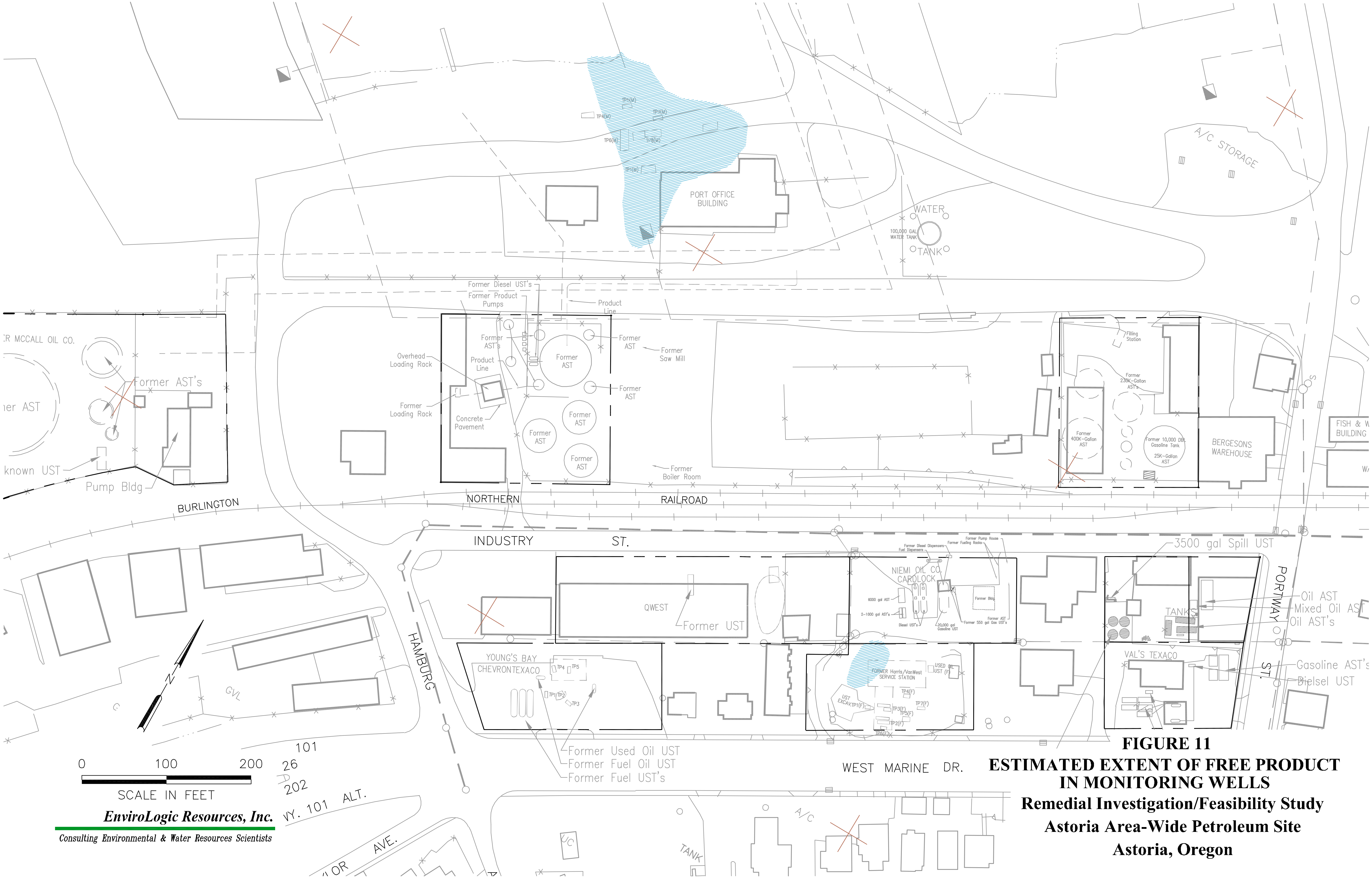


FIGURE 11
ESTIMATED EXTENT OF FREE PRODUCT IN MONITORING WELLS
Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

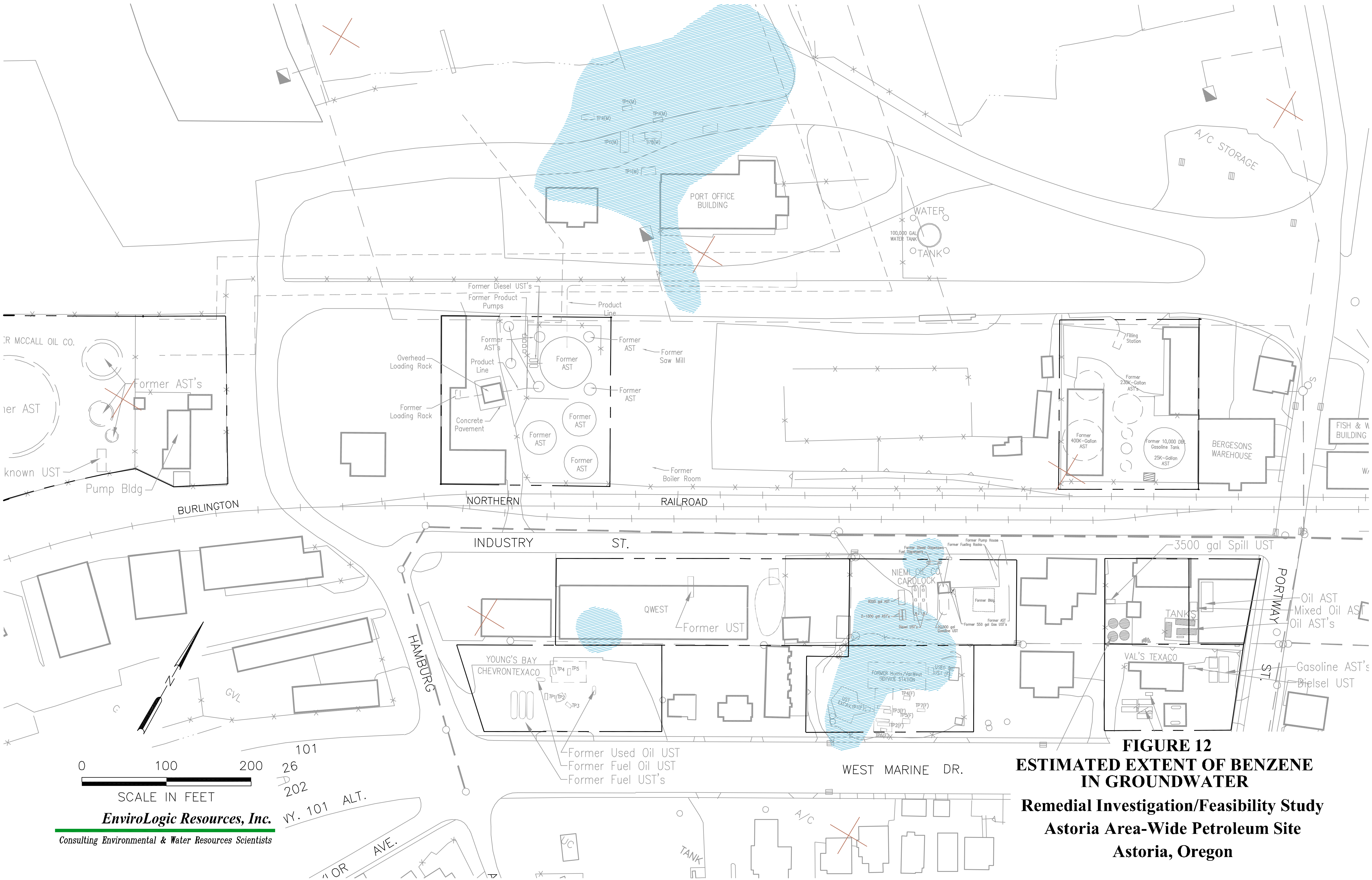
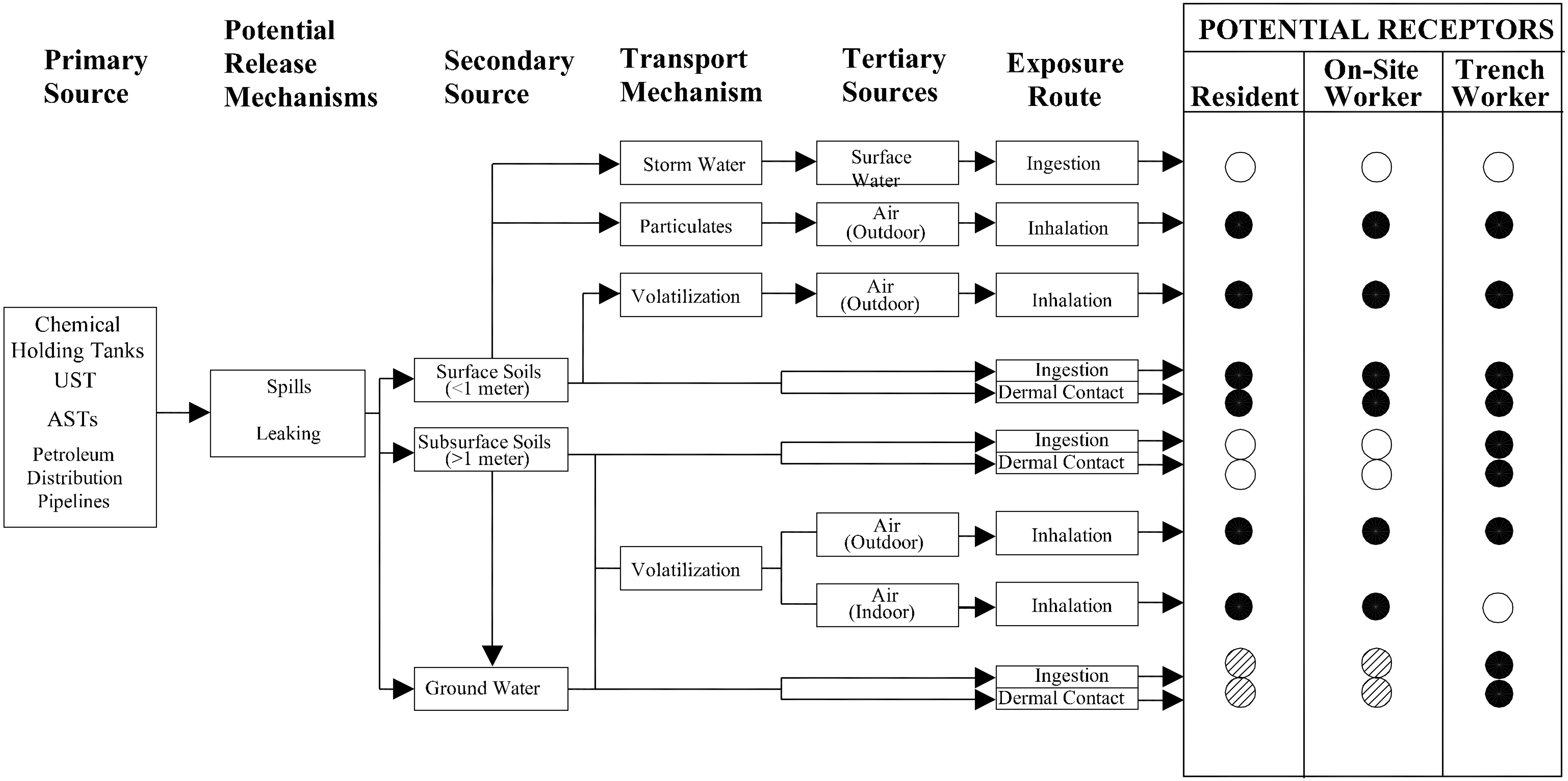


FIGURE 12
ESTIMATED EXTENT OF BENZENE IN GROUNDWATER
Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon



Explanation

- Pathway is potential route of exposure
- Not applicable because of lack of complete pathway, or no soil COPCs identified
- Not applicable because of lack of receptors
- Incomplete Pathway
- Complete Pathway

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FIGURE 13

CONCEPTUAL HUMAN HEALTH SITE EXPOSURE MODEL

Remedial Investigation/Feasibility Study

Astoria Area-Wide Petroleum Site

Astoria, Oregon

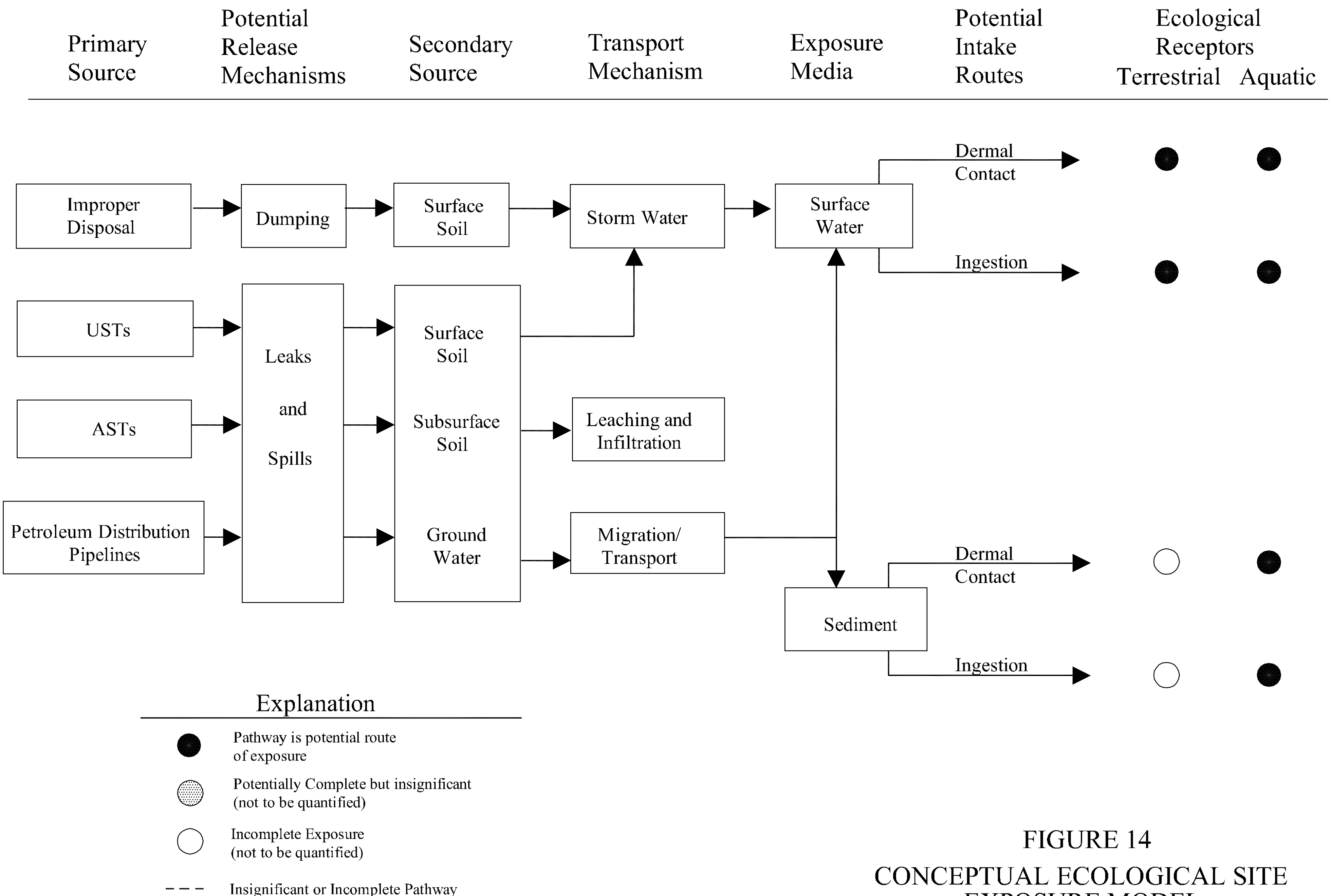

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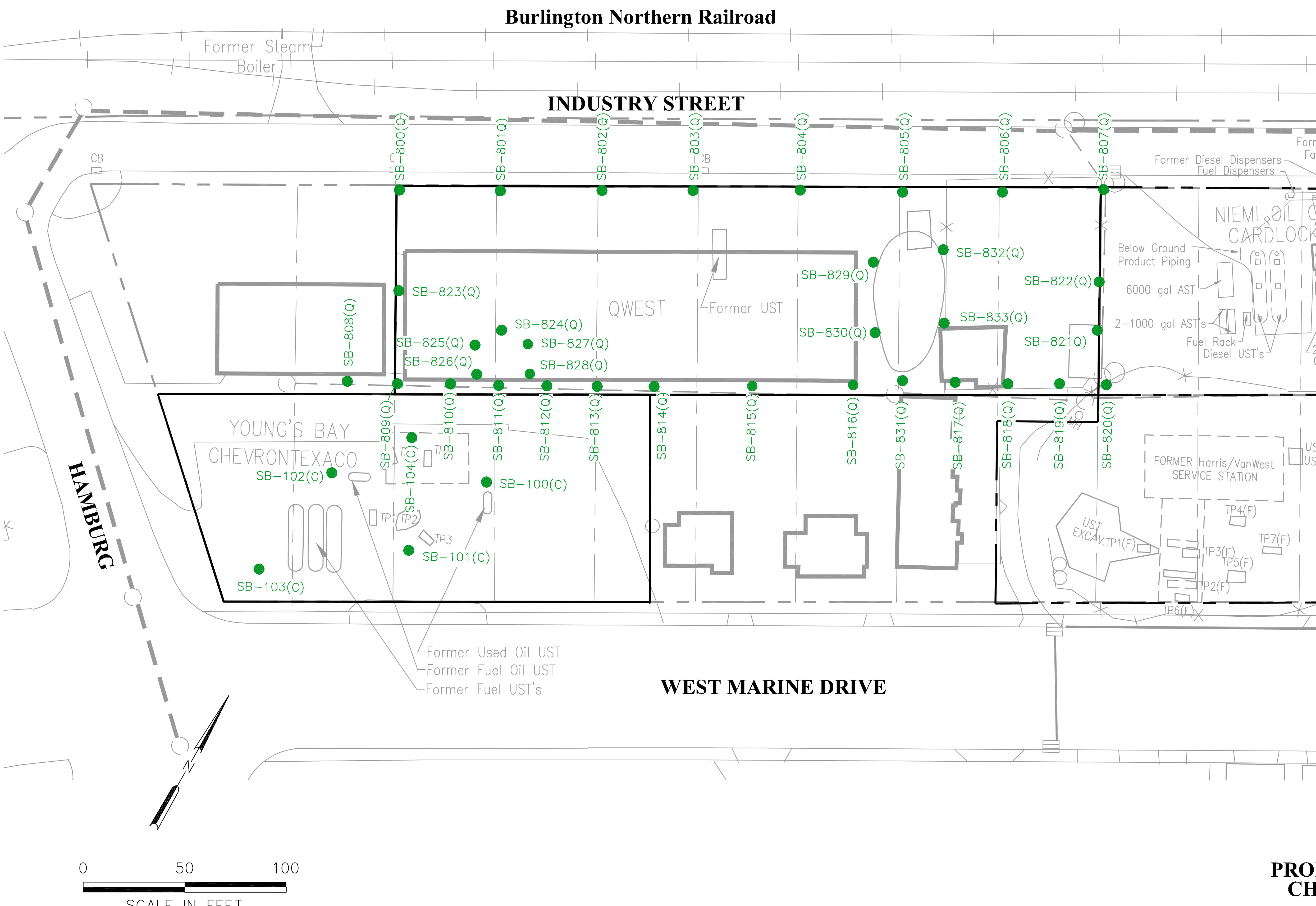
FIGURE 14

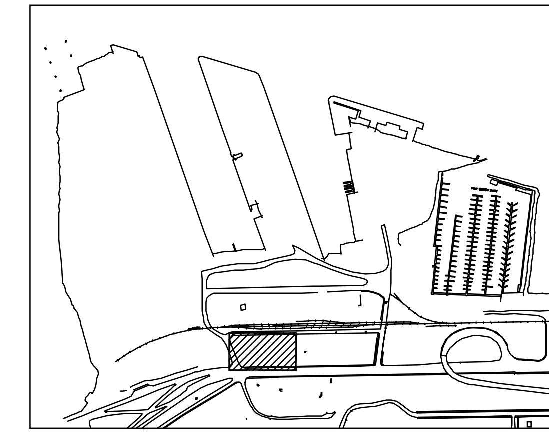
CONCEPTUAL ECOLOGICAL SITE EXPOSURE MODEL

Remedial Investigation/Feasibility Study

Astoria Area-Wide Petroleum Site

Astoria, Oregon





KEY PLAN

EXPLANATION

● PROPOSED BORING LOCATION

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FIGURE 15
PROPOSED BORING LOCATIONS
CHEVRONTEXACO & QWEST
Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

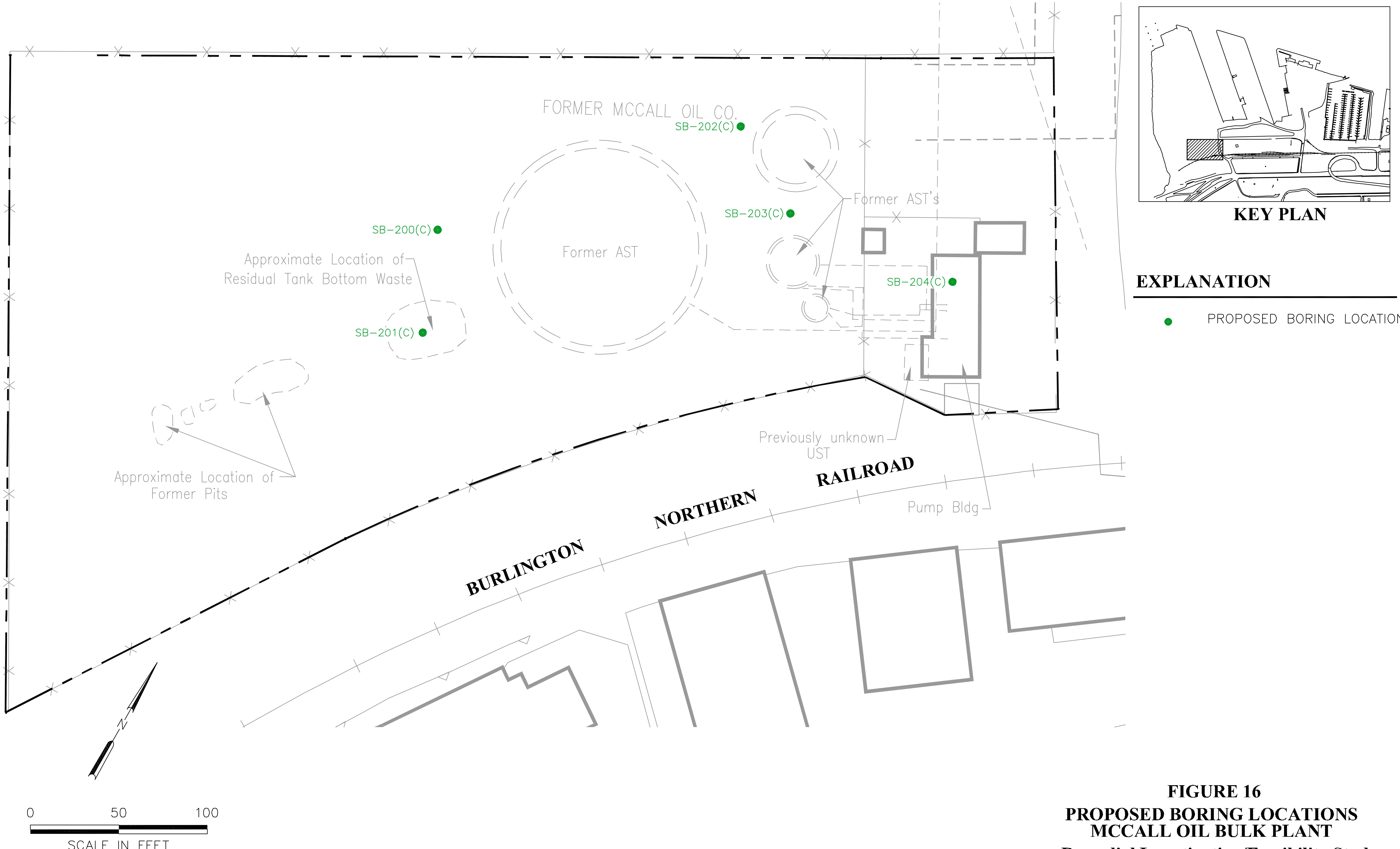

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FIGURE 16
PROPOSED BORING LOCATIONS
MCCALL OIL BULK PLANT
Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

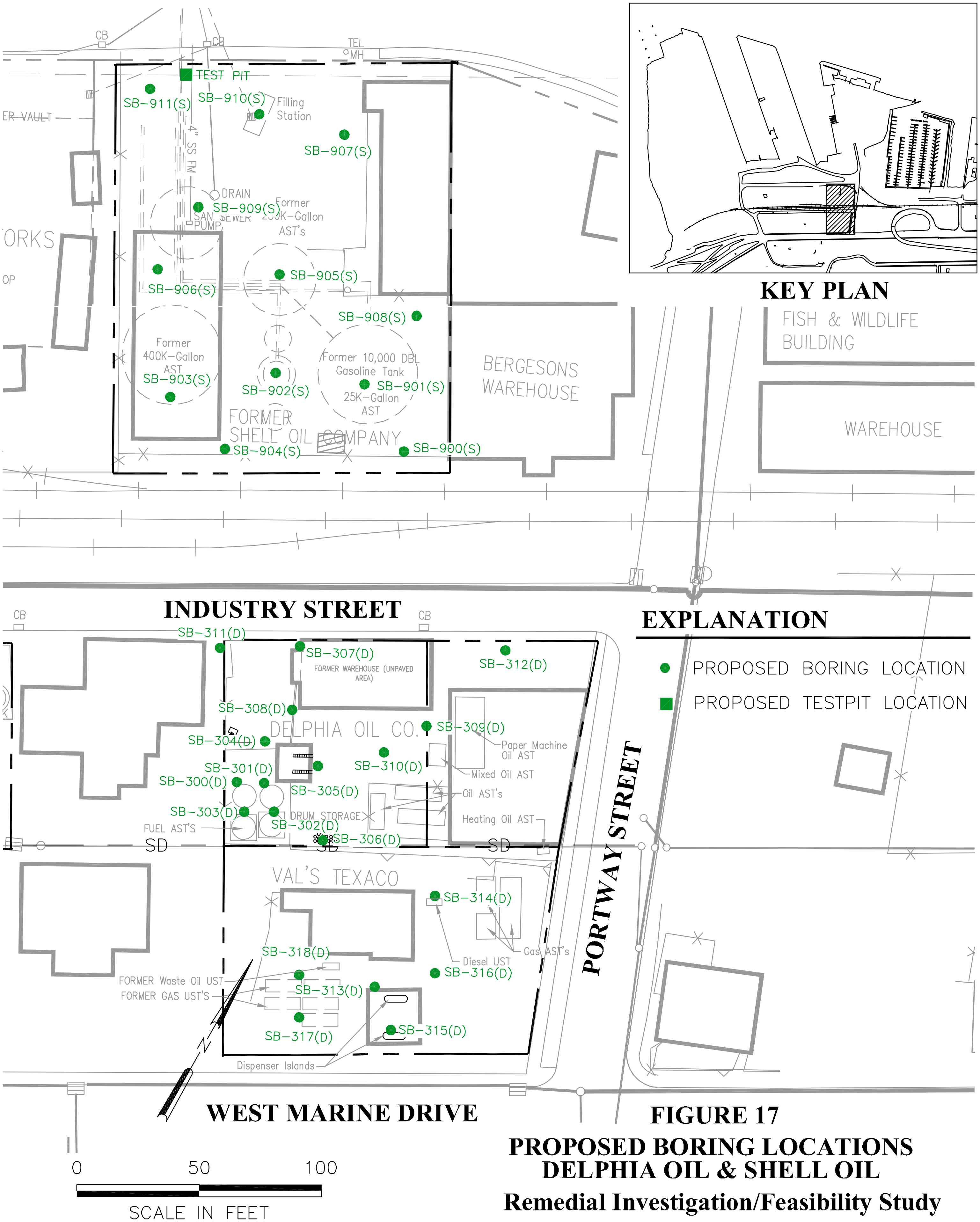

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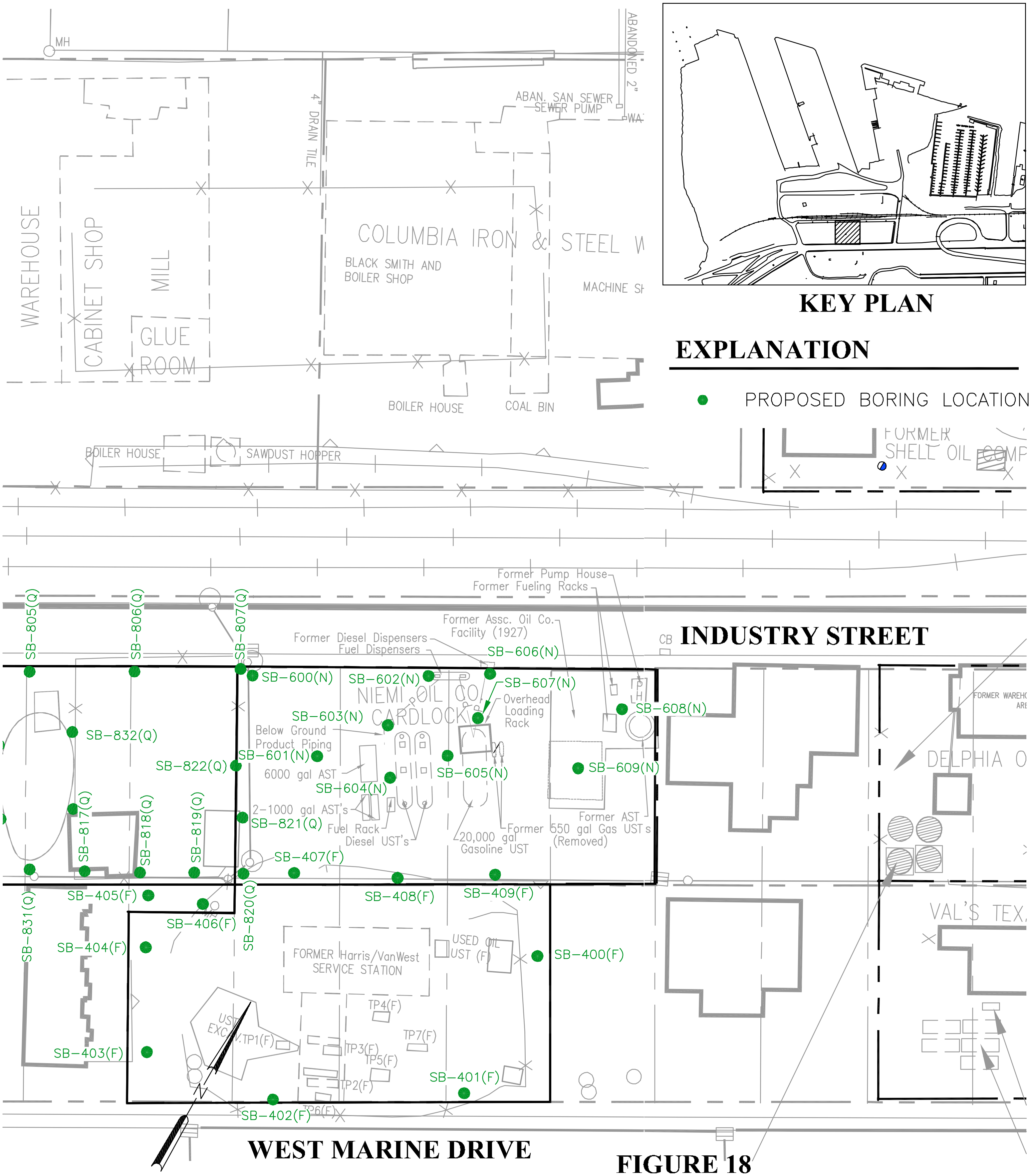
FIGURE 17

PROPOSED BORING LOCATIONS
DELPHIA OIL & SHELL OIL

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon



0 50 100

SCALE IN FEET

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FIGURE 18

PROPOSED BORING LOCATIONS

NIEMI CARDLOCK, HARRIS/VANWEST, & QWEST

Remedial Investigation/Feasibility Study

Astoria Area-Wide Petroleum Site

Astoria, Oregon

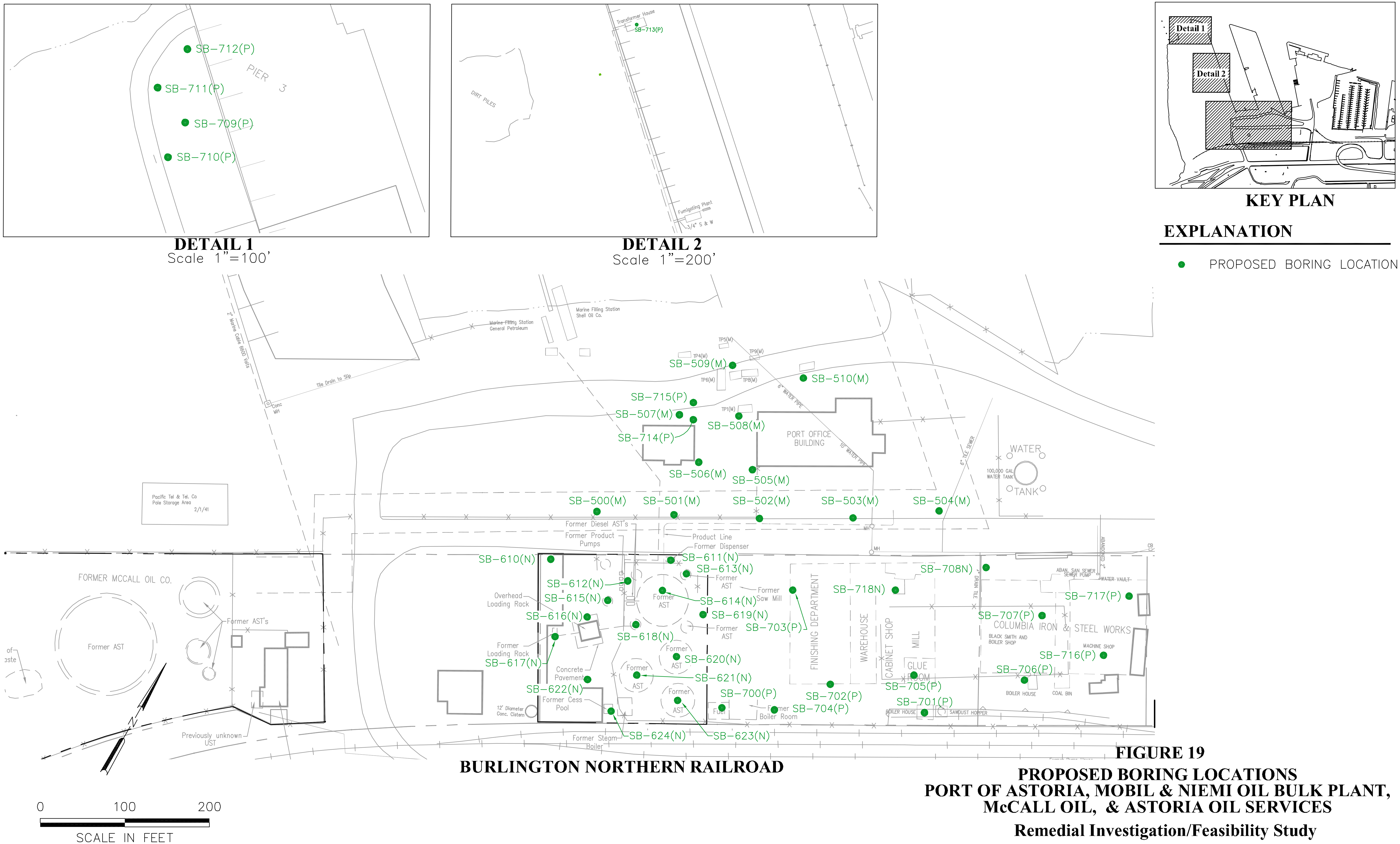

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FIGURE 19

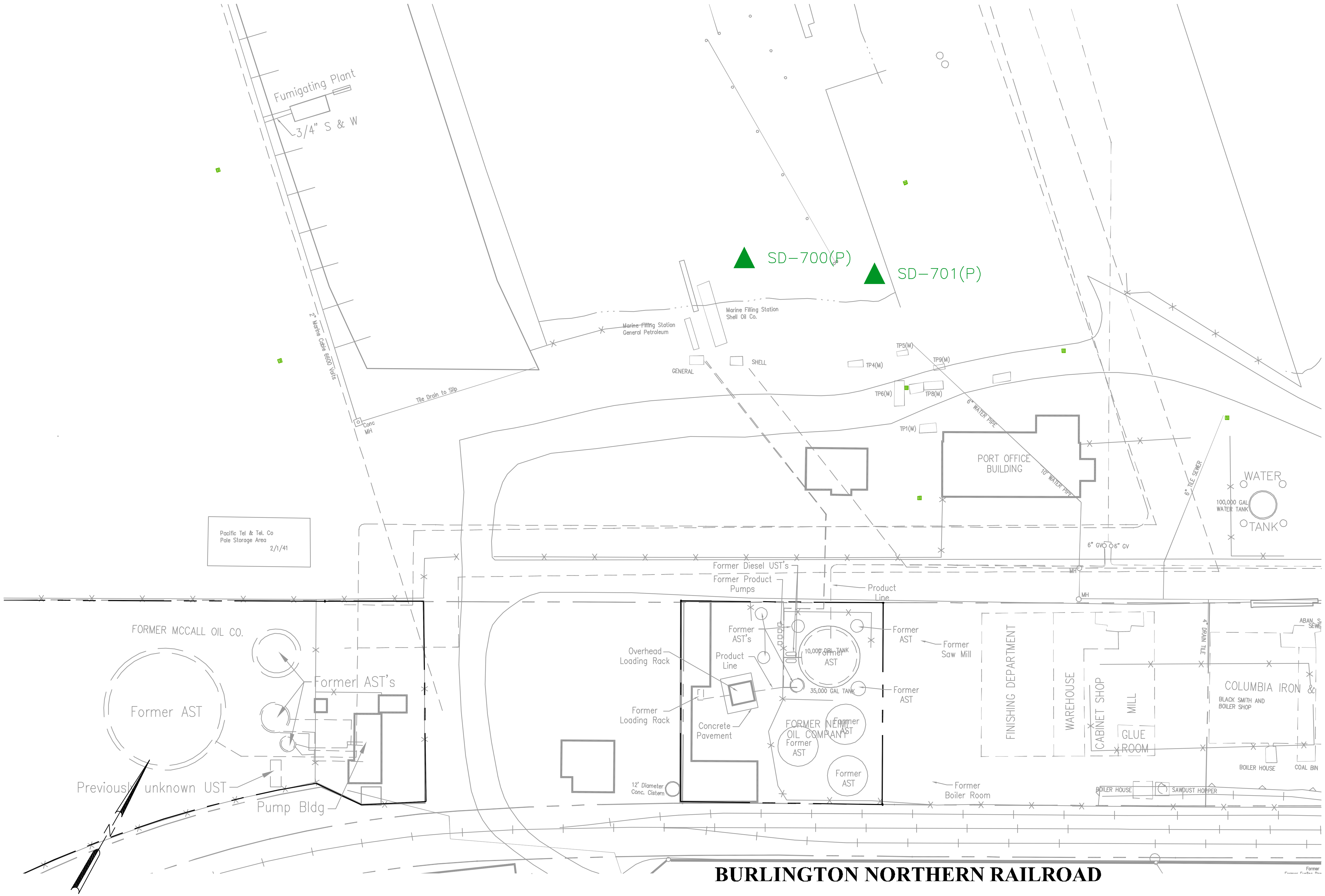
PROPOSED BORING LOCATIONS

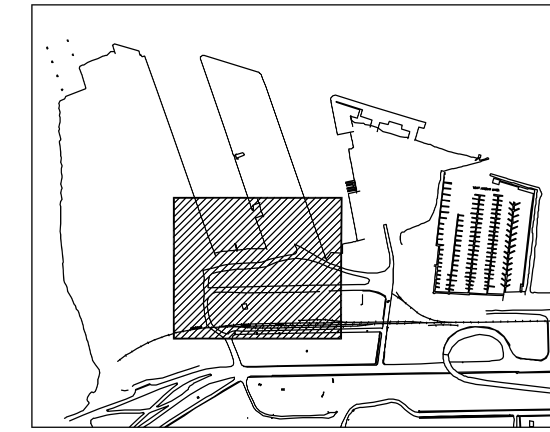
PORT OF ASTORIA, MOBIL & NIEMI OIL BULK PLANT, McCALL OIL, & ASTORIA OIL SERVICES

Remedial Investigation/Feasibility Study

Astoria Area-Wide Petroleum Site

Astoria, Oregon





KEY PLAN

EXPLANATION

▲ PROPOSED SEDIMENT SAMPLE LOCATION

0 100 200

SCALE IN FEET

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FIGURE 20

PROPOSED SEDIMENT SAMPLE LOCATIONS

Remedial Investigation/Feasibility Study

Astoria Area-Wide Petroleum Site

Astoria, Oregon

ID	Indicators	Task Name	Duration	Start	Finish
1		**ASTORIA AREA-WIDE PETROLEUM STUDY**	**605 days**	**Wed 1/9/02**	**Fri 5/21/04**
2					
3		**RI/FS and IRAM PROPOSAL**	**11 days**	**Wed 1/9/02**	**Mon 1/21/02**
4					
17					
18		**RI/FS and IRAM DEVELOPMENT WORK PLAN**	**124 days**	**Wed 1/9/02**	**Mon 7/1/02**
19					
57					
58		**PHASE 1 RI/FS and IRAM WORK PLAN IMPLEMENTATION**	**364 days**	**Mon 5/13/02**	**Thu 10/16/03**
59					
60		**FIELD PREPARATION**	**11 days**	**Thu 8/1/02**	**Thu 8/15/02**
61		DEQ Approval of Work Plan	1 day	Thu 8/1/02	Thu 8/1/02
62		Subcontracting	10 days	Fri 8/2/02	Thu 8/15/02
63		Equipment Acquisition	10 days	Fri 8/2/02	Thu 8/15/02
64		**UTILITY CLEARANCE SURVEY**	**4 days**	**Fri 8/16/02**	**Wed 8/21/02**
65		Mobilization	1 day	Fri 8/16/02	Fri 8/16/02
66		Utility Clearance	3 days	Mon 8/19/02	Wed 8/21/02
67		**SOURCE/SOIL CHARACTERIZATION**	**78 days**	**Mon 8/19/02**	**Thu 12/5/02**
68		**Drilling Program**	**21 days**	**Mon 8/19/02**	**Tue 9/17/02**
69		Mobilization/Demobilization	1 day	Mon 8/19/02	Mon 8/19/02
70		Install/Sample Borings	20 days	Tue 8/20/02	Tue 9/17/02
71		Field Data Reduction	15 days	Wed 8/21/02	Wed 9/11/02
72		**Analytical Program**	**45 days**	**Wed 8/21/02**	**Wed 10/23/02**
73		Laboratory Analyses	25 days	Wed 8/21/02	Wed 9/25/02
74		Data Validation	10 days	Thu 9/26/02	Wed 10/9/02
75		Analytical Data Compilation	10 days	Thu 10/10/02	Wed 10/23/02
76		**Reporting**	**41 days**	**Thu 10/10/02**	**Thu 12/5/02**
77		Draft Source/Soil Characterization TM	20 days	Thu 10/10/02	Wed 11/6/02
78		PRP Group Review	15 days	Thu 11/7/02	Wed 11/27/02
79		Final Source/Soil Characterization TM	5 days	Thu 11/28/02	Wed 12/4/02
80		Submittal to DEQ	1 day	Thu 12/5/02	Thu 12/5/02
81		**GROUND-WATER CHARACTERIZATION**	**302 days**	**Mon 8/12/02**	**Thu 10/16/03**
82		**Water-Level Measurement Program**	**234 days**	**Mon 8/12/02**	**Fri 7/11/03**
83		Install Data Loggers/Transducers	3 days	Tue 8/27/02	Thu 8/29/02
84		Water-Level Measurement	234 days	Mon 8/12/02	Fri 7/11/03
97		**Monitoring-Well Installation Plan**	**28 days**	**Thu 9/26/02**	**Mon 11/4/02**
98		Draft Monitoring-Well Installation Plan	10 days	Thu 9/26/02	Wed 10/9/02
99		PRP Group Review	10 days	Thu 10/10/02	Wed 10/23/02
100		Final Monitoring-Well Installation Plan	2 days	Thu 10/24/02	Fri 10/25/02
101		Submittal to DEQ	1 day	Mon 10/28/02	Mon 10/28/02
102		DEQ Approval	5 days	Tue 10/29/02	Mon 11/4/02
103		**Drilling Program**	**74 days**	**Tue 8/20/02**	**Mon 12/2/02**
104		Mobilization/Demobilization	5 days	Tue 10/29/02	Mon 11/4/02
105		Install/Develop Monitoring Wells	20 days	Tue 11/5/02	Mon 12/2/02
106		Redevelop Existing Monitoring Wells	5 days	Tue 8/20/02	Mon 8/26/02
107		Field Data Reduction	10 days	Wed 11/6/02	Tue 11/19/02
108		**4Q02 Ground-Water Analytical Program**	**54 days**	**Tue 12/3/02**	**Tue 2/18/03**
109		Mobilization/Demobilization	2 days	Tue 12/3/02	Wed 12/4/02
110		Ground-Water Sampling (4Q02)	10 days	Thu 12/5/02	Wed 12/18/02
111		Laboratory Analyses	20 days	Fri 12/6/02	Mon 1/6/03
112		Data Validation	5 days	Tue 1/7/03	Mon 1/13/03
113		Analytical Data Compilation	2 days	Tue 1/14/03	Wed 1/15/03
114		4Q02 Ground-Water Reporting	31 days	Tue 1/7/03	Tue 2/18/03
115		Draft 4Q02 Ground-Water Sampling TM	15 days	Tue 1/7/03	Mon 1/27/03
116		PRP Group Review	10 days	Tue 1/28/03	Mon 2/10/03
117		Final 4Q02 Ground-Water Sampling TM	5 days	Tue 2/11/03	Mon 2/17/03
118		Submittal to DEQ	1 day	Tue 2/18/03	Tue 2/18/03
119		**1Q03 Ground-Water Analytical Program**	**54 days**	**Mon 2/3/03**	**Fri 4/18/03**
130		**2Q03 Ground-Water Analytical Program**	**54 days**	**Thu 5/1/03**	**Thu 7/17/03**
141		**3Q03 Ground-Water Analytical Program**	**54 days**	**Fri 8/1/03**	**Thu 10/16/03**
152		**Hydraulic Characterization Program**	**33 days**	**Thu 12/19/02**	**Wed 2/5/03**
153		Slug Testing	5 days	Thu 12/19/02	Thu 12/26/02
154		Slug-Test Analysis	5 days	Fri 12/27/02	Fri 1/3/03
155		Reporting	23 days	Mon 1/6/03	Wed 2/5/03
156		Draft Slug-Testing TM	10 days	Mon 1/6/03	Fri 1/17/03
157		PRP Group Review	10 days	Mon 1/20/03	Fri 1/31/03
158		Final Slug-Testing TM	2 days	Mon 2/3/03	Tue 2/4/03
159		Submittal to DEQ	1 day	Wed 2/5/03	Wed 2/5/03
160		**STORM/SURFACE WATER CHARACTERIZATION**	**217 days**	**Mon 8/19/02**	**Tue 6/24/03**
161		Visual Confirmation of Storm Water System	2 days	Mon 8/19/02	Tue 8/20/02
162		Storm Water System Locating (if needed)	3 days	Thu 8/22/02	Mon 8/26/02
163		**3Q02 Storm Water Analytical Program**	**38 days**	**Tue 8/27/02**	**Fri 10/18/02**
164		Mobilization/Demobilization	1 day	Tue 8/27/02	Tue 8/27/02
165		Storm-Water Sampling (3Q02)	1 day	Wed 8/28/02	Wed 8/28/02
166		Laboratory Analyses	10 days	Thu 8/29/02	Thu 9/12/02
167		Data Validation	2 days	Fri 9/13/02	Mon 9/16/02
168		Analytical Data Compilation	1 day	Tue 9/17/02	Tue 9/17/02
169		3Q02 Storm-Water Reporting	26 days	Fri 9/13/02	Fri 10/18/02
170		Draft 3Q02 Storm-Water Sampling TM	10 days	Fri 9/13/02	Thu 9/26/02
171		PRP Group Review	10 days	Fri 9/27/02	Thu 10/10/02
172		Final 3Q02 Storm-Water Sampling TM	5 days	Fri 10/11/02	Thu 10/17/02
173		Submittal to DEQ	1 day	Fri 10/18/02	Fri 10/18/02
174		**4Q02 Storm Water Analytical Program**	**38 days**	**Fri 11/1/02**	**Tue 12/24/02**
185		**1Q03 Storm Water Analytical Program**	**38 days**	**Mon 2/3/03**	**Thu 3/27/03**
196		**2Q03 Storm Water Analytical Program**	**38 days**	**Thu 5/1/03**	**Tue 6/24/03**
207		**SEDIMENT CHARACTERIZATION**	**31 days**	**Tue 8/27/02**	**Wed 10/9/02**
208		Mobilization/Demobilization	1 day	Tue 8/27/02	Tue 8/27/02
209		Sediment Sampling	1 day	Thu 8/29/02	Thu 8/29/02
210		Laboratory Analyses	10 days	Fri 8/30/02	Fri 9/13/02
211		Data Validation	1 day	Mon 9/16/02	Mon 9/16/02
212		Analytical Data Compilation	1 day	Tue 9/17/02	Tue 9/17/02
213		Reporting	16 days	Wed 9/18/02	Wed 10/9/02
214		Draft Sediment Sampling TM	5 days	Wed 9/18/02	Tue 9/24/02
215		PRP Group Review	5 days	Wed 9/25/02	Tue 10/1/02
216		Final Sediment Sampling TM	5 days	Wed 10/2/02	Tue 10/8/02
217		Submittal to DEQ	1 day	Wed 10/9/02	Wed 10/9/02
218		**TOPOGRAPHIC SURVEY**	**61 days**	**Wed 9/18/02**	**Wed 12/11/02**
219		Mobilization/Demobilization	1 day	Wed 9/18/02	Wed 9/18/02
220		Survey Borings and Outfalls	3 days	Thu 9/19/02	Mon 9/23/02
221		Survey Monitoring Wells	2 days	Tue 12/3/02	Wed 12/4/02
222		Update Basemap	5 days	Thu 12/5/02	Wed 12/11/02
223		**GEOPHYSICAL SURVEY AT CERTAIN PROPERTIES**	**33 days**	**Fri 8/16/02**	**Wed 10/2/02**
224		Mobilization	1 day	Fri 8/16/02	Fri 8/16/02
225		Field Geophysical Survey	3 days	Mon 8/19/02	Wed 8/21/02
226		Data Evaluation	3 days	Thu 8/22/02	Mon 8/26/02
227		Reporting	26 days	Tue 8/27/02	Wed 10/2/02
228		Update Basemap	5 days	Tue 8/27/02	Tue 9/3/02
229		Draft Geophysical Technical Memorandum (TM)	15 days	Tue 8/27/02	Tue 9/17/02
230		PRP Group Review	5 days	Wed 9/18/02	Tue 9/24/02
231		Final Geophysical TM	5 days	Wed 9/25/02	Tue 10/1/02
232		Submittal to DEQ	1 day	Wed 10/2/02	Wed 10/2/02
233		**INDOOR AIR QUALITY IRAM DEVELOPMENT**	**70 days**	**Thu 11/7/02**	**Fri 2/14/03**
234		Comparison of Soil Data to Screening Levels	10 days	Thu 11/7/02	Wed 11/20/02
235		Indoor Air IRAM Development (if needed)	60 days	Thu 11/21/02	Fri 2/14/03
236		Technology Screening	15 days	Thu 11/21/02	Wed 12/11/02
237		Detailed Evaluation of Alternatives	15 days	Thu 12/12/02	Fri 1/3/03
238		Implementation Plan Proposal	30 days	Mon 1/6/03	Fri 2/14/03
239		**HYDROCARBON SEEP IRAM DEVELOPMENT**	**60 days**	**Mon 1/20/03**	**Mon 4/14/03**
240		Continue Technology Screening from WP	15 days	Mon 1/20/03	Fri 2/7/03
241		Detailed Evaluation of Alternatives	15 days	Mon 2/10/03	Mon 3/3/03
242		Implementation Plan Proposal	30 days	Tue 3/4/03	Mon 4/14/03
243		**TANK-BOTTOM WASTE IRAM DEVELOPMENT (McCALL B**	**25 days**	**Mon 5/13/02**	**Mon 6/17/02**
244		Technology Screening	10 days	Mon 5/13/02	Fri 5/24/02
245		Detailed Evaluation of Alternatives	10 days	Tue 5/28/02	Mon 6/10/02
246		Implementation Plan Proposal	5 days	Tue 6/11/02	Mon 6/17/02
247		**PHASE 1 RI REPORT (May be Superceded by TMs)**	**85 days**	**Tue 1/28/03**	**Wed 5/28/03**
248		Prepare Draft Phase 1 RI Report	60 days	Tue 1/28/03	Tue 4/22/03
249		DEQ Review	10 days	Wed 4/23/03	Tue 5/6/03
250		Final Phase 1 Report	15 days	Wed 5/7/03	Wed 5/28/03
251		**MEETINGS WITH DEQ**	**192 days**	**Mon 9/16/02**	**Mon 6/16/03**
256					
257					
258		**PHASE 2 RI and IRAM IMPLEMENTATION**	**210 days**	**Tue 1/28/03**	**Fri 11/21/03**
259		Draft Phase 2 RI Work Plan	30 days	Tue 1/28/03	Tue 3/11/03
260		Final Phase 2 RI Work Plan	30 days	Wed 3/12/03	Tue 4/22/03
261		Phase 2 Implementation	90 days	Wed 4/23/03	Thu 8/28/03
262		IRAM Implementation	90 days	Wed 4/23/03	Thu 8/28/03
263		Draft Phase 2 Report	30 days	Fri 8/29/03	Fri 10/10/03
264		Final Phase 2 Report	30 days	Mon 10/13/03	Fri 11/21/03
265					
266		**RISK ASSESSMENT**	**180 days**	**Tue 1/28/03**	**Fri 10/10/03**
267		Draft Risk Assessment Work Plan	15 days	Tue 1/28/03	Mon 2/17/03
268		Final Risk Assessment Work Plan	25 days	Tue 2/18/03	Tue 3/25/03
269		Draft Risk Assessment Report	120 days	Wed 3/26/03	Fri 9/12/03
270		Final Risk Assessment Report	20 days	Mon 9/15/03	Fri 10/10/03
271					
272		**FEASIBILITY STUDY**	**40 days**	**Tue 1/28/03**	**Tue 3/25/03**
273		Draft Feasibility Study Work Plan	15 days	Tue 1/28/03	Mon 2/17/03
274		Final Feasibility Study Work Plan	25 days	Tue 2/18/03	Tue 3/25/03
275					
276		**IRAM REPORTS**	**30 days**	**Fri 8/29/03**	**Fri 10/10/03**
277					
278		**RI/FS REPORT**	**126 days**	**Mon 11/24/03**	**Fri 5/21/04**
279		Draft RI/FS Report	95 days	Mon 11/24/03	Thu 4/8/04
280		Final RI/FS Report	30 days	Fri 4/9/04	Thu 5/20/04
281		Submittal to DEQ	1 day	Fri 5/21/04	Fri 5/21/04

Project: Astoria Area-Wide RI/FS
Date: Mon 7/15/02

Task	Milestone	Rolled Up Critical Task	Split
Critical Task	Summary	Rolled Up Milestone	External Tasks
Progress	Rolled Up Task	Rolled Up Progress	Project Summary