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ENVIRONMENT

Ms. Libby Goldstein
Project Manager, Toxics Cleanup Program
Washington State Department of Ecology
3190 160th Ave SE
Bellevue, Washington 98008

Subject:
Soil Vapor Extraction Well Installation and Pilot Test Work Plan for the Former ARCO Facility No. 00862, Lynnwood Convention Center, 3711 196th Street SW, Lynnwood, Washington

Date:
February 14, 2012

Contact:
Kevin M. Freeman

Phone:
509-981-4747

Email:
Kevin.Freeman@arcadis-us.com

Our ref:
GP09BPNA.WA04

Dear Ms. Goldstein:

ARCADIS U.S. Inc. (ARCADIS) has prepared this Soil Vapor Extraction (SVE) Well Installation and Pilot Test Work Plan (the "SVE Work Plan") for the former ARCO Facility No. 00862 located at 3701 196th Street SW, Lynnwood, Washington (the "Site"), shown on **Figure 1**. The Site is currently enrolled in the Washington State Department of Ecology (Ecology) Voluntary Cleanup Program (VCP) as Site ID NW2452. This Work Plan summarizes the proposed currently proposed at the Site.

SITE DESCRIPTION

The Site is situated in the southeast quarter (SE¼) of the southwest quarter (SW¼) of Section 15, Township 27 North, Range 4 East, Willamette Meridian, Snohomish County, Washington (47° 49' 16" N, 122° 16' 57" W, NAD83). The site located at the northwest corner of 37th Avenue W and 196th Street SW in Lynnwood, Washington. A Site Vicinity Map is presented as Figure 1. The Site is currently occupied by the Lynnwood Convention Center (LCC) at 3711 196th Street SW in Lynnwood. The present site features consist of the LCC building, landscaped areas, concrete and aggregate, and a large fountain sculpture near the building's rear entrance at the southeast corner. Site features also include landscaping along both streets and asphalt parking areas. The local topography slopes to the northeast and the approximate elevation of the site is 420 feet above mean sea level (msl).

The Site is bounded on the north and west by commercial businesses, by 196th Street SW to the south, and 37th Avenue W to the east. To the east of the LCC (northeast corner of the intersection) are a Lamps Plus retail store and additional

commercial businesses. The property to the south of the LCC (southwest corner of the intersection of 196th Street SW and 37th Avenue W) is a vacant lot that is mostly covered with gravel and shrubs, with asphalt patches remaining. On and off-ramps for the I-5 freeway are present to the southeast.

The Site was previously operated by Atlantic Richfield Company as a retail gasoline station and subsequently as a privately owned muffler repair shop. Former site features during operation as a gasoline station included the station building, two dispenser islands, five underground storage tanks (USTs), and associated fueling system components. The USTs were previously located in a common excavation in the northeast portion of the property and the service station building was located in the central portion of the site. The fuel dispensers were located in the south-central and east-central portions of the site. The surface of the site was asphalt and concrete with some landscaped areas around the perimeter. The USTs, dispensers and product distribution lines were removed in 1989 by the previous site owner Pacific Centers, Inc.

SITE GEOLOGY AND HYDROGEOLOGY

The Site is located in the Puget Sound Lowland, bound by the North Cascade Mountains to the east, South Cascade Mountains to the south, and Puget Sound and Olympic Mountains to the west. Continental glaciers advanced into the region several times during the Pleistocene Epoch (between 2 million and 10,000 years ago). This part of the Cordilleran ice sheet is known as the Puget Lobe. As a result of the glacial and fluvial activity and erosion during the Pleistocene Epoch, the study area is underlain by unconsolidated sediments of both glacial and non-glacial origin. Beneath these deposits are consolidated Tertiary rocks. The thickness of the entire assemblage of unconsolidated deposits varies considerably, but averages about 500 feet thick, with a maximum thickness of more than 1,200 feet. The deposits are thickest in western Snohomish County and are thinner to the east where the Tertiary bedrock is at or near land surface.

The Site is located within the Puget-Willamette Trough Regional Aquifer System, which is a linear elongated basin stretching from the Canadian border in Washington to central Oregon. The Site is situated on Pleistocene-age Vashon Formation till deposits (the Vashon Till unit). Vashon Till typically consists of compact, unsorted sand, gravel, and boulders in a matrix of silt and clay with some lenses of sand and gravel. The till typically acts as confining unit within the formation, but can yield usable amounts of water from thin lenses of sand and gravel.

Subsurface lithology at the Site varies laterally and with depth. Sediments consist primarily of silty sand to clayey-silt from ground surface to approximately 15 feet bgs, underlain by silt with varying amounts of clay from approximately 15 to 23 feet bgs. Silty sand is present from 23 feet bgs to the total depth of the Site borings. Historically, depth to groundwater measured in monitoring wells at the Site ranges from approximately 20 to 25 feet bgs. Groundwater flow direction is toward the southwest. Groundwater gradient is calculated at approximately 0.05 feet per foot (ft/ft).

PROPOSED SCOPE OF WORK

To assess the effectiveness of a Soil Vapor Extraction (SVE) system at the Site, ARCADIS proposes to advance two soil borings and convert them into SVE wells (VE-1 and VE-2). Following the installation of VE-1 and VE-2, an SVE pilot test will be conducted to determine the potential effectiveness of an SVE system at the Site. The proposed locations of wells VE-1 and VE-2 are shown on **Figure 2**.

Preparation of a Site-Specific Health and Safety Plan

ARCADIS will prepare a site-specific Health and Safety Plan (HASP) for the activities covered under the Work Plan. The HASP will address physical, chemical, and biological hazards associated with typical activities related to the proposed Scope of Work, specify the appropriate means to mitigate or control these hazards, and delineate general safety procedures to be followed while conducting field activities at the Site.

The HASP is prepared with the best knowledge currently available of the site and planned Scope of Work. All project personnel must sign the Certification Page included with the HASP, acknowledging that they have read, understand, and abide by the HASP. The HASP will be updated as additional information becomes available, site-specific hazards are identified that are not addressed, and prior to any additional tasks being performed. Updates to the HASP will be immediately communicated to project personnel and discussed prior to site activities or during the next Tailgate Meeting. The site-specific HASP is supplemented by appropriate Job Loss Analyses (JLAs) for all safety-critical jobs conducted on site. The JLAs are modified in the field by the personnel conducting the tasks to integrate real time conditions and hazards at the time of the job.

All tasks conducted under this Work Plan are carried out in compliance with the BP Tranche 1 Programmatic Health and Safety Plan (BPPHASP), ARCADIS Health and Safety Procedures, and the ARCADIS Field Health & Safety (H&S) Handbook.

Access

ARCADIS will coordinate timing and access to the LCC property with the Lynnwood Public Facilities District prior to initiating investigation activities.

Utility Clearance

ARCADIS will mark the proposed boring locations shown on Figure 2 and consult with the Washington State One Call. Also, ARCADIS will contract a private utility locating company (APS of North Bend, Washington) to locate underground utilities prior to the initiation of drilling activities. ARCADIS staff will also conduct a visual site inspection of the property to identify potential utility lines. In this way ARCADIS will establish three lines of evidence of utility location prior to implementation of drilling activities.

SVE Well Installation

Vapor extraction wells VE-1 and VE-2 will be advanced to depths of 20 feet bgs. Well VE-1 will be installed approximately 10 feet west from well MW-7R and well VE-2 will be installed approximately 17 feet east from well VE-1. The initial 6.5-feet of the boreholes will be cleared using manual methods to reduce the potential for damage to underground improvements. The borings will then be advanced using Sonic drilling methods.

Due to the use of Sonic drilling methods, a continuous core of soil will be available for field screening for VOCs using a photo-ionization detector (PID). The PID readings, soil types, and other pertinent geologic data will be recorded on the boring logs by an ARCADIS geologist.

Upon reaching the total depth of the boreholes, SVE wells VE-1 and VE-2 will be installed within the annulus of the hollow-stem augers. Depth to water at monitoring well MW-7R ranges from 18.36 to 21.71 feet bgs. The SVE wells will be constructed of 4-inch diameter, Schedule 40 PVC. Well screen will consist of 0.02-inch wide horizontally slotted pipe. The screened interval will be placed from an anticipated depth of 10 to 20 feet bgs. However, the screened interval will begin upon reaching

native soils, which may vary slightly from this estimated interval. Number 2/12 sand will be used as the filter pack from the total depth of the wells to one foot above the screened interval. A 8-foot hydrated bentonite seal will be placed above the filter pack. The remaining well annulus will be backfilled with bentonite chips. The wells will be capped with a locking water tight well plug and a traffic-rated well box installed at grade.

Soil Vapor Extraction System Pilot Test

ARCADIS will conduct an SVE system pilot test using the newly installed extraction wells VE-1 and VE-2. Data collected from this pilot test will be used to determine a radius of influence (ROI) in soils at the Site, and to determine if a SVE remedial strategy will be successful in removing residual hydrocarbon impacts from vadose zone soils at the Site. The pilot test will address residual petroleum hydrocarbons and potential LNAPL that remain in the sand and sandy silt layers near the former dispenser island. The pilot test will predominately focus vapor extraction on impacted soils observed between 10 and 20 feet bgs as well as LNAPL in smear zone soils. The initial SVE pilot test will be conducted over several days. Results from the initial SVE event will determine the scope and duration for subsequent temporary mobile SVE events or the installation of a permanent SVE remediation system compound. The scope of work for the SVE pilot test will include a flow rate step test and a constant rate test.

Pilot Test Vacuum Monitoring Points

During pilot testing activities, induced vacuum will be measured on existing monitoring wells MW-7a, MW-7B, MW-7C, MW-7R, MW-11, MW-12, and the newly installed SVE wells VE-1 and VE-2 to determine adequate spacing of vapor extraction wells for a full scale SVE system design. Initially, a vacuum will be applied to VE-1, while VE-2 and MW-7C will be used as observation wells. Following this, a vacuum will be applied to VE-2, while VE-1 and MW-7Cwill be used as observation wells. Magnahelic vacuum gauges will be attached to well head adaptors at each well and induced vacuum measurement will be recorded periodically throughout the pilot test.

Pilot Test Equipment

A trailer mounted SVE blower will be temporarily placed onsite within the vicinity of VE-1 and VE-2. The mobile trailer will be connected to a portable generator and will

include a SVE blower and catalytic oxidizer treatment train. A two-inch diameter Spiralite® vacuum hose will be connected to a temporary SVE manifold containing differential pressure gauge connected to a pitot tube for air flow measurements, a vapor sampling port, a vacuum gauge and flow control valve. Above ground hose will connect the manifold to the extraction well heads creating an airtight seal. Extracted vapor will run through a moisture separator and then treated through an electrical catalytic oxidizer prior to discharge to the air through the effluent stack.

During the pilot test, system readings including runtime, pre and post treatment flow rates, pre and post treatment VOC concentrations, process temperatures and system vacuum will be measured periodically.

Pilot Test Procedures

Initial SVE testing will involve the incremental increase of extraction flow rates to determine the flow capacity of the extraction well. A target extraction rate of approximately 18 cfm is calculated due to subsurface soil conditions encountered during previous soil boring activities. The target flow rate may change based geotechnical samples collected from the screen interval during the installation of VE-1 and VE-2. The target extraction rate is calculated based on a pore volume exchange rate of three pore volumes per day as follows:

$$Q = \pi \times r^2 \times d \times n \times \varepsilon$$

Where:

- Q = flow rate in cubic feet per minute (cfm)
- r = target radius of influence [30 feet based on silty sand soils]
- d = well screen length [10 feet]
- n = soil porosity [30 percent based on silty sand soils]
- ε = pore volume exchange rate [3 pore volume per day]

Flow from the mobile SVE unit should be adjusted to pull an initial flow rate of 9 cfm or 50 percent of the target estimated flow rate. This flow rate should be sustained until stable readings are observed at vacuum monitoring points. Once stable readings are observed (approximately three data points), flow should be increased until the maximum sustainable flow rate and vacuum from the well is achieved. Steps should increase to 75 percent, 100 percent and 150 percent of the target flow rate.

During each step test, vapor extraction flow rates influent vapor concentrations and vacuum readings will be monitored and recorded from flow meters, vacuum gauges and sampling ports located at the manifold, the monitoring wells, the pre-treatment air stream and from the post treatment effluent stack every five minutes.

Once the maximum sustainable flow rate is achieved, a constant rate test will be performed for a maximum of 48 hours to evaluate long-term sustainability of the selected vacuum rate. During the constant rate test, vapor extraction flow rates, influent vapor concentrations and vacuum readings will be recorded as proposed in the step test on a graduated basis:

Elapsed Time (hours)	Frequency
0 to 0.5	5 minutes
0.5 to 1	10 minutes
1 to 2	15 minutes
2 to 4	30 minutes
4 to 10	1 hour

System pretreatment vapor samples will be collected from SVE wells VE-1 and VE-2 at the manifold sampling point using a sampling pump and Tedlar bag. The initial vapor samples will be collected within the first 30 minutes of SVE constant rate test. Additional effluent samples will be collected for lab analysis based on peak effluent PID readings and at the end of the test during stable PID readings. Vapor samples will be collected in Tedlar bags and submitted to a Washington State-certified laboratory for the following chemical analyses:

- Gasoline-range organic (GRO) petroleum hydrocarbons by Northwest Method NWTPH-Gx;
- Benzene toluene, ethylbenzene, and xylenes (BTEX) by EPA Method 8260B;
- Methane by EPA Method 18 Modified, and;
- Oxygen and Carbon Dioxide by ASTM Method D1946.

Waste Management

Soil cuttings and waste water generated during the field activities will be contained in Department of Transportation-approved, 55-gallon steel drums. These drums will be appropriately labeled and temporarily stored on-site pending analytical results. The drums will be stored at a location to be determined by the LCC. Upon receipt of soil and water analytical results, the drums will be removed from the Site and transported to an off-site disposal facility. Temporary storage of the drums at the LCC will not exceed a period of 30 days from the completion of drilling activities.

Well Survey

A Washington State-licensed land surveyor will survey the horizontal location and vertical elevation of the wells relative to a known benchmark.

Summary Report Preparation

A report summarizing well installation field activities will be prepared by ARCADIS subsequent to receipt of final analytical data. The report will be provided to the Lynnwood PFD for review and comment prior to submission of the report to Ecology. The Site is currently enrolled with the VCP and is awaiting assignment of a Case Manager.

SCHEDULE

ARCADIS presents the following schedule for currently anticipated remedial investigation activities at the Site:

- March 5, 2012 – APS Utility Locate
- March 12, 2012 – Drilling activities covered under this Work Plan.
- Week of March 19th – Perform SVE Pilot Test.
- Middle of April – Prepare a report summarizing findings.

This schedule does not take into account possible delays or extensions related to third-party negotiation, review, or comment for both on- and off-site proposed

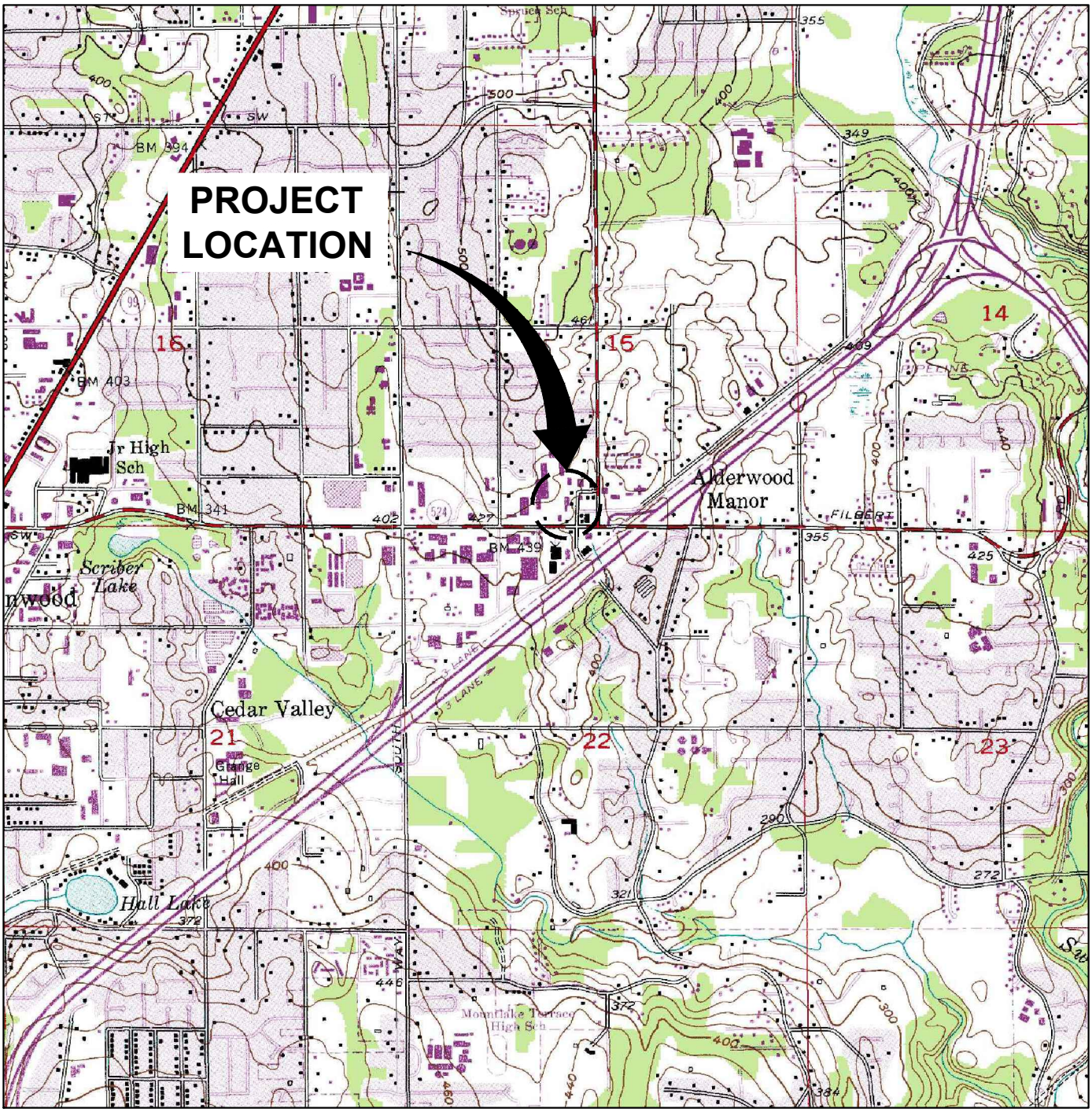
activities If you have questions or comments regarding this Work Plan, please contact myself at 509.535.7225 or by email at Kevin.Freeman@arcadis-us.com

Sincerely,

ARCADIS U.S., Inc.

Kevin M. Freeman
Principal Hydrogeologist

Copies:
Mr. Grant Dull – Lynnwood Public Facilities Department
Ms. Dana Carlie - GeoEngineers



REFERENCE: BASE MAP USGS 7.5. MIN. TOPO. QUAD. EDMONDS EAST, WA, 1983.

0 2000' 4000'

Approximate Scale: 1 in. = 2000 ft.

ATLANTIC RICHFIELD COMPANY.
FORMER ARCO STATION NO. 0862
3711 196TH STREET SOUTH WEST, LYNNWOOD, WASHINGTON

SOIL VAPOR EXTRACTION PILOT TEST WORK PLAN

SITE LOCATION MAP

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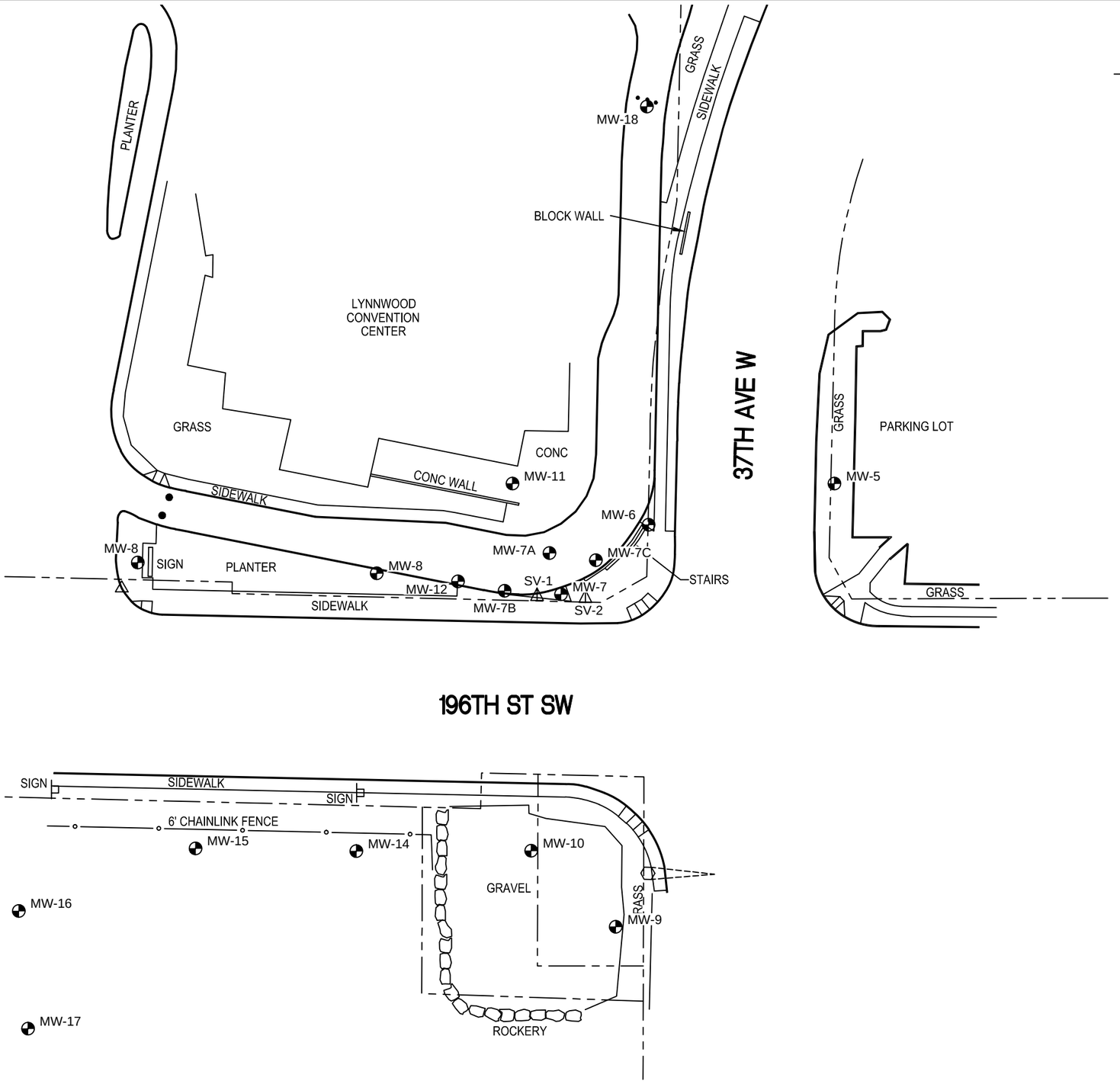
FIGURE 1



LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- MW-3 GROUNDWATER MONITORING WELL LOCATION
- SV-2 PROPOSED SOIL VAPOR EXTRACTION (SVE) WELL LOCATION

0 60' 120'

GRAPHIC SCALE

ATLANTIC RICHFIELD COMPANY
FORMER ARCO STATION NO. 0862
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SOIL VAPOR EXTRACTION PILOT TEST WORK PLAN

SITE PLAN

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FIGURE
2