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Remedial Investigation Sampling and Analysis Work Plan

Former Circle K Site
2350 24th Avenue East
Seattle, Washington

7 April 2016

Prepared for

Washington State Department of Ecology
Toxics Cleanup Program
3190 160th Avenue SE
Bellevue, Washington 98008-5452

K/J Project No. 1696010*00

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Section 1: Introduction and Purpose

This document was prepared for the Washington State Department of Ecology (Ecology) and presents the Remedial Investigation (RI) Sampling and Analysis Work Plan (Work Plan) for the former Circle K site (Site) located at 2350 24th Avenue East in Seattle, Washington (see Figure 1). The purpose of this RI is to collect and evaluate data to characterize the current environmental conditions at the Site. Site data will be used to evaluate potential contaminant exposure pathways and support the evaluation of possible cleanup alternatives in a subsequent feasibility study (FS). (Note: The FS is not part of the scope of work for this Work Plan.)

The Site is a former gasoline service station property at which a release of gasoline from an underground storage tank (UST) occurred in 1989. The Site includes the former Circle K property, which currently includes a single one-story building being utilized as a retail dry cleaning store (Jay's Cleaners) and a convenience store (Mont Market), the adjoining City of Seattle right-of-way (ROW) areas, and possibly adjoining residential properties (see Figure 2).

The former Circle K property is approximately 0.26 acre in size and is located in the Montlake neighborhood southeast of the intersection between 24th Avenue East and East McGraw Street, approximately 1,800 feet south of Lake Washington. The area surrounding the Site consists mainly of residential houses and buildings, with some small commercial business, and a public library located west of the Site along 24th Avenue East.

The former Circle K property is located on King County tax parcel number 6788201335, described as follows on the King County imap website (gismaps.kingcounty.gov/iMap/):

- PIKES 2ND ADD TO UNION CITY 1 & 2 LESS E 6 FT; Plat Block: 29; Plat Lot: 1-2.

As described in previous reports for the Site, approximately 4,000 to 6,000 gallons of gasoline from a leaking UST was released to the subsurface in 1989. The USTs (four total) were located on the northern portion of the former Circle K property (see Figure 2), and the release primarily affected environmental media at and to the north of the former UST location; although, the extent of impacts has not been fully characterized. Affected media included soil, groundwater [including non-aqueous phase liquid (NAPL)], subsurface vapors, and possibly surface water and/or sediment via migration along a sanitary sewer utility corridor located in East McGraw Street. Additional background information is presented in Section 1.1 below, and maps showing historical soil and groundwater sample results are included in Appendix A.

1.1 Background

The former Circle K property was operated as a gasoline station and convenience store from 1968 to 1981 and was owned by Mr. George Renale. Prior to 1968, it is believed the property was residential. From 1981 to July 1990, the property was leased by Mr. Renale to Circle K Corporation, who also operated the facility as a gasoline station and convenience store. In November 1990, Mr. Kuk Jin Choung, the current owner, purchased the property from Mr. Renale and has operated it as a retail dry cleaning facility and mini-mart store since then. In February 1992, Mr. Choung entered into a Consent Decree with Ecology to begin investigation and remediation of contamination at the Site.

Following identification of the gasoline release in 1989, the USTs were removed and affected soil was excavated in the former UST area (GeoEngineers, 1990). Remedial activities also included initial NAPL removal and subsequent operation of a groundwater pump-and-treat system and soil vapor extraction (SVE) system. Ecology's 2009 Remedial Investigation/Feasibility Study (RI/FS) (Ecology, 2009) indicates the pump-and-treat system operation ceased in 2000, and the SVE system ceased in 1997. However, the available information indicates the initial excavation and subsequent interim remedial actions did not fully remediate the environmental impacts from the 1989 release. Groundwater samples collected in 2005 and 2006 (the most recent data available) indicated the presence of contaminants of concern (COCs) at concentrations above cleanup levels (see Section 2.5), including the presence of NAPL in Site monitoring wells MW-4, MW-8, MW-9, and MW-13 (EA Engineering, 2006a, 2006b, 2006c, 2006d).

In October 2009, Ecology prepared a draft RI/FS report based on the findings of the investigative activities performed prior to that time (Ecology, 2009). Refer to the 2009 RI/FS report and other referenced reports for additional information regarding Site history and previous investigation and remediation activities.

1.2 Data Gaps

Based on a review of the 2009 RI/FS report and other previous reports and documents, additional data needs (i.e., Data Gaps) for the Site were identified and summarized in a Technical Memorandum to Ecology (Kennedy/Jenks, 2016). The RI scope of work described in the following sections is based on the Data Gaps identified for the Site and evaluation of potential exposure pathways. For reference, the Data Gaps and preliminary pathways summary is provided in Appendix A, including maps depicting historical soil and groundwater data and a conceptualized geologic cross-section panel map (i.e., fence diagram).

1.3 RI Objectives and Approach

The primary objective of this RI is to characterize the nature and extent of chemical impacts to environmental media at the Site, including identification of potential human and ecological exposure pathways and receptors for Site COCs. The scope of work for this RI is intended to provide data of sufficient quality and quantity to delineate impacts to environmental media and support the evaluation of cleanup options in a subsequent FS.

Site environmental media to be directly evaluated (i.e., sampled and analyzed) during the RI include soil and groundwater. In addition, the potential for vapor migration and vapor intrusion (VI) into buildings on the former Circle K property and adjoining residential properties will be evaluated using analytical data and other relevant information (see Section 3.12) to assess whether collection and analysis of vapor samples is needed. If RI findings indicate potential impacts to surface water or sediment (via downstream discharge from sewer pipes located in McGraw Street), the need for additional sampling or other assessment will be evaluated.

As previously discussed, the scope of work for this RI will be based on the identified Data Gaps presented in Appendix A. Investigative activities will be performed in phases, beginning with an evaluation of current groundwater conditions, and each phase will provide data to facilitate the placement of subsequent sampling locations to meet the RI objectives. Initially, the existing Site monitoring wells will be evaluated, redeveloped if needed, and preliminary groundwater samples will be collected for laboratory analysis. Based on known Data Gaps and the initial groundwater

sampling results, soil boring locations for the first phase of soil and reconnaissance groundwater sampling will be identified.

Kennedy/Jenks Consultants anticipates the first phase of soil and groundwater sampling will include 12 to 16 soil borings located on the former Circle K property and East McGraw Street ROW. The anticipated approximate locations for the first phase of drilling are shown on Figure 2, but may be modified based on results of the initial groundwater samples, underground utility locations, access restrictions, or other considerations. The final proposed sampling locations will be submitted for the first phase of drilling to Ecology for review and approval following receipt and evaluation of the initial groundwater results.

A second phase of drilling, possibly including additional soil and reconnaissance groundwater sample locations and/or installation of new monitoring wells, will be performed after receipt and review of analytical data for the first phase. Proposed locations for additional soil borings and/or wells will be submitted to Ecology for review and approval prior to performing work for the second investigation phase (see Section 4.2).

Following completion of drilling and well installation work, two rounds of groundwater monitoring will be performed, with at least 3 months between monitoring events. Monitoring will include measurement of water level and NAPL, if any, and sample collection. The potential for vapor intrusion into Site buildings and adjoining residences will be evaluated based on the findings for soil and groundwater, including recommendations for sample collection, if any. The scope and field methodologies for each work task are described in Section 3.

1.4 Work Plan Organization

The remainder of this RI Work Plan is organized as follows:

- Section 2 provides an overview of Site geologic and hydrogeologic conditions, including a preliminary conceptual site model (CSM) and summary of preliminary cleanup levels (Table 1, Section 2.5).
- Section 3 describes the scope of work for this RI and presents the Sampling and Analysis Plan (SAP) for the Site.
- Section 4 provides a summary of the project schedule, submittals, and reporting requirements.
- References cited are listed in a separate section following Section 4.
- Table 2 – Summary of Sampling and Analysis Plan.
- Figure 1 – Site Location Map.
- Figure 2 – Site Plan and Preliminary Sampling Locations.

- Appendix A – Data Gaps and Preliminary Exposure Pathways (including historical data maps and a generalized preliminary cross-section diagram) and Boring Logs.
- Appendix B – Kennedy/Jenks Consultants Standard Operating Guidelines (SOGs).
- Appendix C – Site-Specific Health and Safety Plan (HASP).
- Appendix D – Quality Assurance Project Plan (QAPP).

Section 2: Site Setting and Conditions

This section provides a summary of anticipated Site geologic and hydrogeologic conditions based on the information presented in previous Site reports. This section also includes a discussion of known utilities at the Site, a summary of the preliminary CSM, and a summary of the preliminary cleanup levels (CULs) to be used for reference during the RI.

2.1 Geology

Based on boring logs (primarily from GeoEngineers, 1990) and other information provided in previous reports, three generalized stratigraphic units have been described at the Site, as summarized below:

- Silt – Typically encountered from the ground surface (i.e., beneath pavement and subgrade fill) to depths of approximately 2 to 8 feet below ground surface (bgs), but extends to greater depth (up to approximately 13 feet bgs) in the northern portion of the Site. The unit is generally described as soft to stiff, brown to gray, silt to sandy silt, locally with gravel and/or organics.

- Sand/silt – Typically encountered below the silt layer to depths of approximately 17 to 22 feet bgs, and typically described as gray to brown, fine sand, silty fine sand, or sandy silt locally containing cobbles. The unit is described as loose, medium dense, dense, and very dense with vertical and lateral variation. This unit may locally include the uppermost, possibly weathered, portion of the underlying glacial till unit.

- Till – Typically encountered below the sand/silt starting at approximately 17 to 22 feet bgs and generally described as gray silt, silty sand, or sandy silt with sand and gravel. The till unit is typically described as dense to very dense, hard to very hard, or stiff to very stiff.

No Site monitoring well or soil borings have been advanced through the till unit; however, a well installed by Landau Associates near Site well MW-4 in 2013 (Landau, 2013) was advanced to approximately 90 feet bgs (the well was part of an investigation for a separate site, Montlake Neighborhood Former Dry Cleaner, located west of the former Circle K Site). The log for the 2013 Landau well (designated MW-3) shows gray, fine to medium sand beneath (or possibly interbedded with) the till from approximately 80 to 90 feet bgs.

For reference, a preliminary generalized subsurface cross-section fence diagram for the Site is included in Appendix A. Appendix A also includes copies of historical boring logs for Site wells (from GeoEngineers, 1990) and for the 2013 Landau well.

2.2 Hydrogeology

Based on the available information, a single saturated zone has been identified beneath the Site. Based on historical monitoring results, the groundwater gradient beneath the Site appears to be generally to the east (toward Lake Washington), but may vary locally. A localized hydraulic depression has been observed in the vicinity of well MW-6 and may be related to a sewer utility line (see Section 2.3).

Historical water levels measured in Site wells have ranged from less than 3 feet bgs to greater than 14 feet bgs and appear to vary seasonally, with historical seasonal variation typically between 3 and 6 feet. The average depth to groundwater for measurements made between 2001 and 2006 is approximately 8 to 12 feet bgs.

NAPL has been identified historically at existing wells MW-4, MW-8, MW-9, and MW-13, including the most recent historical measurements (2005 to 2006). Soil materials at depths within the seasonal groundwater fluctuation range (i.e., the smear zone), including backfill material in the former UST excavation cavity, could have become impacted by Site COCs by contact with impacted groundwater and NAPL.

A preliminary well inspection and water/NAPL measurement of accessible existing Site wells (including MW-4, MW-6, MW-7, MW-8, MW-11, MW-13, MW-14, and MW-15; see Figure 2) was performed at the Site on March 8th, 2016, to observe current conditions to facilitate selection of RI sampling locations. Measureable NAPL was not identified in any of the observed wells, but hydrocarbon sheen or possible thin film was identified in wells MW-8, MW-14, and MW-15, with a petroleum-like odor also noted at well MW-8. Additional evaluation and preliminary sampling of existing wells is included in the RI scope of work (see Section 3.3).

2.3 Utilities

Utility corridors are present in the ROW areas of both 24th Avenue East and East McGraw Street. The approximate locations of ROW utilities, as marked for a public utility locate request submitted on March 2nd, 2016, are shown on Figure 2.

Based on information presented in previous reports for water levels and hydraulic gradients, the west-to-east oriented sewer utility corridor located in East McGraw Street to the north of the former USTs may represent a preferential transport pathway for groundwater COCs and possibly NAPL.

2.4 Preliminary Conceptual Site Model (CSM)

A preliminary assessment of potential COC transport and exposure pathways is summarized in the Data Gaps Technical Memorandum submitted to Ecology on February 24th, 2016 (Kennedy/Jenks 2016). A copy of the Data Gaps summary from the 2016 Technical Memorandum is attached for reference in Appendix A.

The CSM, including evaluation of potential exposure pathways, will be updated based on the data collected during the RI and presented in the RI report.

2.5 Preliminary Cleanup Levels

Preliminary Site CULs to be used as screening levels for comparison with soil and groundwater data collected during the RI will be based on Ecology's Model Toxics Control Act (MTCA) [MTCA; Washington Administrative Code (WAC) 173-340]. Potentially applicable MTCA cleanup levels to be used for RI screening purposes include Method A cleanup levels for unrestricted land uses and Method B cleanup levels. The lower of the Method A or Method B CULs for each COC and media, based on Ecology's August 2015 CLARC database, will be used for comparison with analytical results. Potential CULs and other potentially applicable or

relevant and appropriate requirements (ARARs) will be evaluated in the RI report. Preliminary CULs for RI screening purposes for the Site are summarized in Table 1 below:

Table 1. Summary of Preliminary Soil and Groundwater Cleanup Levels[a]

COC	Soil CUL	Groundwater CUL	CUL Basis[b][c]
TPH-Gasoline	100 mg/kg (w/o benzene) **30 mg/kg** (with benzene)	1,000 µg/L (w/o benzene) **800 µg/L** (with benzene)	MTCA Method A[d]
Benzene	**30 µg/kg** / 1.82E+04 µg/kg	5 µg/l / **0.795 µg/L**	MTCA Method A / MTCA Method B
Toluene	**7,000 µg/kg** / 6.40E+06 µg/kg	1,000 µg/L / **640 µg/L**	MTCA Method A / MTCA Method B
Ethylbenzene	**6,000 µg/kg** / 8.00E+06 µg/kg	**700 µg/L** / 800 µg/l	MTCA Method A / MTCA Method B
Xylenes	**9,000 µg/kg** / 1.60E+06 µg/kg	**1,000 µg/L** / 1,600 µg/l	MTCA Method A / MTCA Method B
MTBE	**100 µg/kg** / 5.56E+5 µg/kg	**20 µg/L** / 24.3 µg/L	MTCA Method A / MTCA Method B
EDB	**5 µg/kg** / 50 µg/kg	**0.01 µg/L** / 0.0219 µg/L	MTCA Method A / MTCA Method B
EDC	(MTCA A n/a) / **11,000 µg/kg**	5 µg/L / **0.481 µg/L**	MTCA Method A / MTCA Method B
Lead	**250 mg/kg** / (MTCA B n/a)	**15 µg/L** / (MTCA B n/a)	MTCA Method A / MTCA Method B

Notes:

(a) Cleanup levels and potential ARARs will be evaluated in the RI report.

(b) MTCA Method A/B cleanup levels based on Ecology's August 2015 CLARC database.

(c) MTCA Method A cleanup levels are based on unrestricted land uses.

(d) Tabulated values for MTCA Method B CULs are not available for TPH-gasoline. Evaluation of risk-based CULs for TPH may be performed, if needed, including analysis of TPH fractions using Ecology Methods for volatile petroleum hydrocarbons (VPH).

mg/kg = milligrams per kilogram.

µg/kg = micrograms per kilogram.

µg/L = micrograms per liter.

TPH = total petroleum hydrocarbons.

MTBE = methyl tertiary-butyl ether.

EDB = 1,2-dibromoethane (ethylene dibromide).

EDC = 1,2-dichloroethane (ethylene dichloride).

ARARs = Applicable or Relevant and Appropriate Requirements.

n/a = indicates cleanup level not available.

Bold values denote the lower of the listed MTCA Method A and B cleanup levels.

Section 3: Scope of Work / Sampling and Analysis Plan

This section describes the work tasks to be performed for the RI, including the Sampling and Analysis Plan (SAP) for the Site. Work will be performed in accordance with Kennedy/Jenks Consultants' SOGs, which are included in Appendix B and referenced below as appropriate.

A site Health and Safety Plan (HASP) that documents the specific procedures to be used to protect the health and safety of Kennedy/Jenks Consultants personnel during the RI is presented in Appendix C.

The scope of work for this RI is described in the following sections and includes the following:

- Section 3.1 – Utility Screening
- Section 3.2 – City Permitting
- Section 3.3 – Well Assessment and Preliminary Sampling
- Section 3.4 – First Phase: Soil and Reconnaissance Groundwater Sampling
- Section 3.5 – Second Phase: Monitoring Well Installation and Supplemental Soil and/or Reconnaissance Groundwater Sampling
- Section 3.6 – Quarterly Groundwater Monitoring
- Section 3.7 – Laboratory Analytical Methods
- Section 3.8 – Quality Assurance/Quality Control (QA/QC)
- Section 3.9 – Equipment Decontamination
- Section 3.10 – Investigation-Derived Waste (IDW) Management
- Section 3.11 – Site Surveying
- Section 3.12 – Vapor Assessment
- Section 3.13 – Terrestrial Ecological Evaluation (TEE)

3.1 Utility Screening

Prior to performing activities at the Site for each phase of invasive work, a private utility survey will be performed to evaluate the potential for underground utilities at each proposed soil boring/well location, including both surface detection and wire insertion methods, as needed. The utility survey will augment existing information provided by the property owner and public Utility Notification Center (One-Call). A One-Call utility locate request will be made at least 2 business days prior to intrusive sampling activities, and a private utility locator will be contracted to identify other potential underground utilities present at the Site. In addition, the upper portion of each soil boring will be advanced using air-knife techniques to minimize the potential for damage to potentially unknown subsurface installations.

3.2 City Permitting

Permits will be required by the City of Seattle (City) for work performed within ROW areas including the East McGraw Street ROW to the north of the former Circle K property and possibly the 24th Avenue East ROW to the west. Because the City classifies the two streets differently (24th Avenue is a main arterial, McGraw Street is not), separate permits are required for each ROW area.

A City permit will initially be obtained for work in the McGraw Street ROW, which will begin during the first phase of drilling (see Section 3.4). If the results of the first phase of drilling work indicate the need for additional characterization of soil and/or groundwater conditions to define the nature and extent of potential COCs in the 24th Avenue East ROW (i.e., a potential for migration of COCs into the ROW is identified), an additional permit will be obtained prior to the second phase of drilling work (see Section 3.5).

Specific submittal requirements for each ROW will differ based on the City's street classifications and the specific work to be performed and may include (in addition to the permit application) a site map, traffic control plan, construction plan, surface restoration plan, Letter of Authorization (from Ecology), or other materials or information requested by the City.

3.3 Well Assessment and Preliminary Sampling

Prior to performing drilling work at the Site, existing Site monitoring wells will be evaluated for suitability for RI sampling and evaluation purposes. The evaluation will be performed for nine existing Site wells (see Figure 2), and will include:

- Review of well construction details from previous Site reports and boring logs.
- Measurement of the total depth to identify potential silt accumulation.
- Measurement of water levels and screening for the presence of NAPL as described in SOG01 (Measuring Groundwater Levels).
- Evaluation of the suitability of existing wells for subsequent quarterly monitoring. This will include purging at a moderate rate [up to approximately 0.5 gallons per minute (gpm)] using a peristaltic or bladder pump to evaluate stabilization of turbidity and other field parameters (i.e., pH, temperature, conductivity, dissolved oxygen, and oxidation/reduction potential). Up to 10 gallons will be purged at each well location. If field parameters do not stabilize as described in SOG02 (Groundwater Sampling), full redevelopment will be performed.
- Redevelopment of wells in which field parameter stability was not achieved, or with measured turbidity greater than 50 nephelometric turbidity units (NTUs) regardless of stabilization. Redevelopment, if needed, will be performed using a submersible pump as described in SOG03 (Well Construction and Development).
- Groundwater samples will be collected for screening purposes at each well following purging and/or redevelopment and submitted for laboratory analysis of gasoline-range TPH and benzene, toluene, ethylbenzene, and total xylenes (BTEX) using the methods listed in Section 3.7.

All purge and development water will be contained onsite in 55-gallon drums pending characterization and disposal, as described in Section 3.10.

The results of the well assessment will be submitted to Ecology prior to the start of the first phase of drilling (see Section 3.4).

3.4 First Phase: Soil and Reconnaissance Groundwater Sampling

Up to approximately 16 soil borings will be advanced at the Site for the first phase of drilling work. Borings will initially be advanced at 12 locations, with up to four additional "step-out" borings advanced based on the findings for the initial 12 locations (see Figure 2). (Note: Potential first phase step-out locations will be screened for utilities at the same time as the initial borings, as shown on Figure 2). Drilling locations for the first phase will be located on the former Circle K property and the East McGraw Street ROW. Soil and reconnaissance groundwater samples will be collected at each soil boring as described below.

Soil borings will be advanced using a direct-push drill rig operated by Holt Drilling of Milton, Washington, as described in SOG04 (Direct-Push Sampling Procedures). Borings will be advanced to depths of up to approximately 20 feet bgs (but may be limited by "refusal" in some cases due to very dense soil conditions, see Section 2.1), and soil cores will be collected continuously for logging, field screening, and sample collection.

Borehole logging and screening will be performed in accordance with the ASTM visual-manual method as described in SOG05 (Borehole Logging). Soil samples will be collected as described in SOG04, SOG06 (Environmental Data Collection), and SOG07 (Surface and Shallow Soil Sampling). Soil samples for volatiles analysis will be collected using U.S. Environmental Protection Agency (EPA) 5035 sampling methodology.

At least four soil samples will be collected at each soil boring location as follows:

- One sample from the unsaturated zone (typically above 5 feet bgs)
- One sample from the presumed smear zone (typically in the 5- to 10-foot depth range)
- One sample from the saturated zone (typically in the 10- to 15-foot depth range)
- One sample from the bottom of the boring (up to approximately 20 feet bgs).

Additional soil samples will be collected if potential impacts are identified based on field screening observations, and the depth interval is not represented by other samples. If potential impacts are observed at the bottom of a soil boring, an attempt will be made to advance the boring to greater depth; however, refusal conditions may be encountered as described above.

Up to two soil samples from each soil boring will be submitted for initial laboratory analysis based on field observations. This will typically include the deepest sample that does not display indications of COC impacts. Other samples will be selected for initial laboratory analysis based on the magnitude of potential COC impacts identified by field screening tests and observations.

Soil samples not submitted for initial analysis will be archived by the analytical laboratory for possible follow-up analyses (archived samples will be frozen to extend hold times, if needed). Follow-up analyses may be requested for samples located above, below, or lateral to an initial sample in which COCs are detected as needed to characterize the extent of impacts. Additional analyses (such as fuel additives, for example) may also be requested for samples initially analyzed for gasoline-range TPH.

Soil samples submitted for laboratory analysis will be analyzed as follows using the analytical methods listed in Section 3.7:

- All soil samples will be analyzed for gasoline-range TPH and BTEX

- Select soil samples (up to five samples total) will be analyzed for fuel additives, including MTBE, EDB, EDC, and total lead, during the first phase or work. These will typically be samples with the greatest field indication of potential impacts. These samples may be selected for initial analysis based on field observations, or as follow-up analyses based on initial TPH results. If fuel additives are not detected at concentrations above the preliminary cleanup levels (refer to Table 1) in the first phase soil samples, fuel additive analyses may not be performed for subsequent work phases and quarterly monitoring. Proposed fuel additive sampling for subsequent work phases, if any, will be submitted to Ecology for review prior to the second phase of fieldwork (see Section 3.5).

- A limited number of soil samples may also be submitted for evaluation of MTCA Method B cleanup levels for petroleum hydrocarbons, possibly including volatile petroleum hydrocarbons (VPH) and/or extractable petroleum hydrocarbons (EPH) using the methods listed in Section 3.7. These analyses, if performed, would be done as follow-up analyses for the samples with the highest detected TPH concentrations.

Reconnaissance groundwater samples will also be collected at each soil boring location. Borings will be advanced approximately 5 feet into the shallow saturated zone, and a temporary polyvinyl chloride (PVC) well screen (with 0.010-inch slots) will be installed across the water table as described in SOG02 and SOG05. The pump intake tubing will be set approximately 2 to 3 feet below the water table for purging and sample collection.

Reconnaissance groundwater samples will be submitted for laboratory analysis of gasoline-range TPH and BTEX using analytical methods listed in Section 3.7. Analysis of fuel additives is not anticipated for reconnaissance groundwater samples, but may be added if warranted based on field observations. [Note: fuel additive analyses may also be included in the quarterly groundwater monitoring, if warranted (see Section 3.6).]

All soil and groundwater samples will be placed in a cooler with ice pending transport to the analytical laboratory and managed under chain-of-custody protocols. Sample handling is described in SOG08 (Sample Packaging and Shipping).

3.5 Second Phase: Monitoring Well Installation and Supplemental Soil and/or Reconnaissance Groundwater Sampling

The second phase of drilling work will be performed after receipt and evaluation of results for the first phase described in Section 3.4. Work tasks will include, at a minimum, installation and development of up to four new groundwater monitoring wells. Additional borings for soil and/or reconnaissance groundwater sampling may also be advanced, if needed, based on the findings from the first phase of drilling. Proposed boring and well locations for the second phase of drilling will be submitted to Ecology for review and approval prior to the start of phase two drilling.

Soil borings will be advanced, and soil and groundwater samples collected, in the same manner as described in Section 3.4. Wells will be installed and developed as described in SOG03. Wells will be installed by a licensed driller in accordance with Ecology's *Minimum Standards for Construction and Maintenance of Wells* (WAC 173-160; Ecology 2008). New wells may not be sampled immediately at the time of installation, but will be included in the quarterly monitoring described in Section 3.6.

Soil and reconnaissance groundwater samples will be selected and submitted for laboratory analysis in the same manner as described in Section 3.4, or at specific depth intervals to characterize impacts based on the findings from the initial phase of drilling.

If soil borings or new monitoring wells are needed in the 24th Avenue East ROW, City permit materials will be prepared and submitted prior to performing the second phase of work (the permitting process will be initiated immediately upon confirmation of the need to work in the 24th Avenue East ROW).

[Note: If soil borings or new monitoring wells are required, the Seattle Department of Transportation (DOT) access permit application for the 24th Avenue ROW will likely require several weeks or more to process, potentially delaying field activities (see Section 4.1 for a summary of the anticipated RI schedule).]

3.6 Quarterly Groundwater Monitoring

Following completion of drilling and well installation work, two rounds of quarterly groundwater monitoring will be performed at the Site. The first round of groundwater monitoring will be performed within approximately 1 month of completion of the second phase of drilling work, and the second round of groundwater monitoring will be performed approximately 3 months after the first.

Up to 12 wells will be selected for quarterly monitoring based on findings from previous tasks. The proposed wells and analyses will be submitted to Ecology for review and approval prior to starting quarterly monitoring activities.

Quarterly groundwater monitoring will include water elevation measurement, screening for the presence of NAPL, and collection of groundwater samples using low-flow methodology as described in SOG01 and SOG02.

Groundwater sample analyses may include the following, although the final suite of analyses for each specific location will be based on the findings for previous work tasks:

- Gasoline-range TPH and BTEX (all wells).
- Fuel additives MTBE, EDB, EDC, and total lead (up to three select wells per event), if warranted based on first phase analytical results (refer to Section 3.4).
- Natural attenuation parameters (see Section 3.7) for up to four select wells per monitoring event.

A limited number of groundwater samples may also be submitted for evaluation of MTCA Method B cleanup levels for petroleum hydrocarbons, possibly including VPH and/or EPH analyses using the methods listed in Section 3.7, if needed. Wells proposed for VPH and/or EPH analysis, if any, will be identified in the Ecology submittal described above for groundwater analyses.

3.7 Laboratory Analytical Methods

Soil and groundwater samples will be submitted under standard chain-of-custody protocol to Analytical Resources, Inc (ARI) of Seattle, Washington, (or equivalent laboratory) for analysis on a standard turn-around basis (typically 2 weeks). Laboratory analyses will be conducted in accordance with the QAPP presented in Appendix D and include the following analytical methods for soil and groundwater samples:

- Gasoline-range TPH by Northwest TPH Method Northwest Total Petroleum Hydrocarbons as Gasoline (NWTPH-G).
- BTEX by EPA Method 8260c.
- Volatile organic compounds (VOCs), including fuel additives MTBE, EDB, and EDB, by EPA Method 8260c.
- Total lead by EPA Method 6010 or 6020.
- VPH and EPH using Ecology Methods if evaluation of MTCA Method B CULs is performed for TPH.
- Natural attenuation parameters (groundwater only) including:
    - Nitrate (NO3-) using EPA Method 353.2 / SM 4500.
    - Sulfate (SO4-2) using EPA Method 375.2 / SM 4500.
    - Sulfide by EPA Method 376.2 / SM 4500.
    - Dissolved manganese and iron using EPA Method 6000 series.
    - Alkalinity using EPA Method 310.1.
    - Methane (dissolved) using EPA Method RSK-175.

Analytical methods, including container and preservative requirements and holding times, are discussed in greater detail in the attached QAPP (Appendix D).

3.8 Quality Assurance/Quality Control (QA/QC)

Samples will be collected for quality assurance and quality control (QA/QC) purposes during all drilling work (first and second phases) and quarterly groundwater monitoring. Field duplicate samples will be collected as described in the QAPP (Appendix D) and summarized below:

- Soil: One duplicate for every 20 soil samples analyzed.
- Reconnaissance Groundwater: One duplicate for each phase of work (up to two total).
- Groundwater: One duplicate for each quarterly monitoring event (two total), excluding natural attenuation samples.

Additional QA/QC samples may include trip blanks (for VOC analyses) and field and/or rinsate blanks. Field and laboratory QA/QC, including analytical laboratory guidelines, is discussed in greater detail in the QAPP provided in Appendix D.

3.9 Equipment Decontamination

Decontamination of sampling equipment helps minimize cross-contamination among sampling locations and helps ensure the integrity of samples collected at each sampling location. Equipment decontamination will vary depending on equipment used. Equipment decontamination procedures that will be followed by Kennedy/Jenks Consultants personnel and its subcontractors are detailed in SOG09 (Equipment Decontamination).

3.10 Investigation-Derived Waste (IDW) Management

Because wastes derived during this investigation may be contaminated, they will be containerized pending receipt of analytical results. Investigation-derived wastes include purge water from groundwater monitoring well development and sampling, soil cuttings from boreholes, and decontamination wastes. These materials will be placed in U.S. Department of Transportation-approved 55-gallon drums and temporarily stored onsite. All drums will be labeled with contents, the date and origin/location of collection, and level of personal protective equipment used during waste production (e.g., Level D).

Final disposal of the investigation-derived wastes will be completed by Kennedy/Jenks Consultants on behalf of Ecology. Handling and disposal of investigation-derived waste procedures that will be followed by Kennedy/Jenks Consultants personnel and its subcontractors are described in SOG10 (Handling and Disposal of Investigation-Derived Waste).

3.11 Site Surveying

Following completion of drilling work, including new well installations, locations, and elevations of Site soil borings and wells will be surveyed by a licensed surveyor (KPG of Tacoma, Washington). Horizontal locations will be surveyed to within approximately 0.1 foot, and vertical elevations will be surveyed to within approximately 0.02 foot. The survey point will be marked

on inner PVC well casings for future reference (typically the northern side). The survey will also include general ground surface elevations and locations of key Site features (such as building corners, marked utilities, property margins, etc.) to facilitate preparation of Geographic Information System (GIS)-based Site and sample location maps for the RI report.

Kennedy/Jenks Consultants personnel will also perform a preliminary survey of each sample location using a hand-held GPS unit.

3.12 Vapor Assessment

Previous Site reports and data indicate a potential for migration of vapors into Site and adjoining structures. Although vapor sampling is not part of this Work Plan, an assessment of the potential for vapor intrusion, including the main Site structure and adjoining residences, will be performed based on the EPA's *Technical Guide for Addressing Petroleum Vapor Intrusion at Leaking Underground Storage Tank Sites* (EPA, 2015).

The vapor intrusion assessment will include data collected during the utility screening, drilling, and groundwater monitoring tasks previously discussed. The results of the vapor intrusion assessment, including recommendations for further vapor evaluation or sampling, if any, will be included in the RI report.

3.13 Terrestrial Ecological Evaluation

Ecology's 2009 RI/FS report (Ecology 2009) suggests the Site qualifies for a TEE exemption, but it does not appear a formal evaluation has been performed. The RI report will include an assessment of TEE requirements for the Site, including potential CULs based on ecological receptors, if any. Kennedy/Jenks Consultants will notify Ecology if the Site cannot be exempted from a TEE, including the anticipated TEE requirements and scope of work, if any.

Section 4: Schedule and Reporting

This section provides a summary of the anticipated project schedule, expected submittals to Ecology during the project, and project reporting and deliverables.

4.1 Schedule

A preliminary schedule for implementation of the RI scope of work is presented below.

- City Permitting. Submit permit materials for McGraw Street in March 2016. If needed, submit permit material for 24th Avenue following the first phase of drilling.
- Initial well assessment. After receipt of City permits for McGraw Street, tentatively early- to mid-April 2016.
- First phase of drilling. Approximately 1 month after receipt and review of analytical data for initial well assessment findings, tentatively May 2016.
- Second phase of drilling. Approximately 1 month after receipt and review of phase one sample analytical data, tentatively June 2016. This task could be delayed if a City ROW permit is needed to 24th Avenue.
- Quarterly groundwater monitoring. The first monitoring event will be performed within 2 weeks following completion of phase two drilling, including installation and development of new wells, and the second will be performed approximately 3 months after the first. Tentatively planned for June 2016 and September 2016.
- Draft RI Report submittal. Within 90 days of receipt of final analytical data for the second quarterly monitoring event (currently planned to be the final sample collection event for the RI). Tentatively planned for December 2016. See Section 4.3 below.

[Note: This schedule includes items that are beyond Kennedy/Jenks Consultants control (such as City permitting, Ecology review time, and subcontractor availability); therefore, the time to complete the described scope of work may differ from that presented above. Kennedy/Jenks Consultants will notify Ecology of potential delays as soon as they are identified.]

4.2 Submittals to Ecology

During the course of the RI work, Kennedy/Jenks Consultants will periodically submit summaries of the findings, including proposed sampling locations, to Ecology for its review and approval, as discussed in previous sections. These submittals are expected, at a minimum, following each phase of work (i.e., initial well and utility assessment, first drilling phase, second drilling phase, and well installation) and will include proposed sampling locations based on the investigation findings. It is anticipated these submittals will be made via email to Ecology.

4.3 RI Report

A draft RI report will be submitted to Ecology within 90 days of receipt of analytical results for the second (i.e., final) quarterly groundwater monitoring event. The RI report will include a description of work performed for the RI, a summary of the data collected for the RI, an updated CSM, including assessment of potential exposure pathways, a summary of any remaining data needs, tabulated analytical and groundwater elevation monitoring results, boring and well construction logs, and Site conditions summary maps, including sample locations and results. A final RI report will be prepared following receipt of Ecology's comments on the draft RI report.

4.4 Environmental Information Management (EIM) Submittal

Data collected during the RI will be submitted to Ecology's Environmental Information Management (EIM) database at the time the draft RI report is submitted to Ecology.

References

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Washington State Department of Ecology. 2009. Remedial Investigation/Feasibility Study Report, Circle K Station #1461, Seattle, Washington. Dated October 2009.

United States Environmental Protection Agency. 2015. Technical Guide for Addressing Petroleum Vapor Intrusion at Leaking Underground Storage Tank Sites. EPA 510-R-15-001. June 2015.

Tables

Table 2: Summary of Sampling and Analysis Plan

Soil Boring or Monitoring Well Designation[a]	Sample Location[b]	Sample Location Data Needs Addressed and Rationale[c]	Soil Samples					Groundwater Samples							Possible First Phase Step-out Locations in Proximity to Initial Locations and General Notes[k]
			Sample Intervals[d]	Analyses[e]				Assessment[f] TPHg/BTEX Screening	Reconnaissance (from Temp Wells)[g]	Quarterly Monitoring Samples for Permanent Wells (2 events)[e,h]					
				TPHg/BTEX	FA VOCs[i]	FA Lead[i]	VPH/EPH[i]			TPHg/BTEX	FA VOCs[i]	FA Lead[i]	VPH/EPH[i]	NA Mon.[j]	
First Phase Initial Soil Borings[l]															
CK-B1	North of McGraw St. in grass median southwest of MW-15 and north of MW-9	Evaluate current extent of potential COC migration to the north toward residences and to the west toward 24th Avenue; sheen noted at MW-15 during March 8, 2016 measurement; NAPL historically in MW-9.	Standard	X	If needed (TBD)	If needed (TBD)	If needed (TBD)	n/a	X (TPHg/BTEX only)	n/a	n/a	n/a	n/a	n/a	No step-outs specified for first phase at this location. Step-outs may be added for second phase if needed based on sample results. Step-outs to north would require property owner notification and consent, and additional permitting for 24th Avenue would be needed for step-outs to the west.
CK-B2	North of McGraw St. in grass median south of and between MW-14 and MW-15	Evaluate current northern extent of potential impacts and potential COC migration to the north toward residences; sheen noted at MW-14, MW-15, and MW-8 during March 8, 2016 measurement.	Standard	X	If needed (TBD)	If needed (TBD)	If needed (TBD)	n/a	X (TPHg/BTEX only)	n/a	n/a	n/a	n/a	n/a	No step-outs specified for first phase at this location. Step-outs may be added for second phase if needed based on sample results. Step-outs to north would require property owner notification and consent.
CK-B3	North of McGraw St. in median west of MW-14	Evaluate the current extent of potential impacts to the north and east including potential COC migration toward residences; sheen noted at MW-14 during March 8th, 2016 measurement.	Standard	X	If needed (TBD)	If needed (TBD)	If needed (TBD)	n/a	X (TPHg/BTEX only)	n/a	n/a	n/a	n/a	n/a	Possible first phase step-out to the east in McGraw St. ROW median. Step-outs to north would require property owner notification and consent.
CK-B4	In McGraw St. ROW (driveway area) north of former UST excavation area	Evaluate current conditions to the north of the former UST release location; NAPL historically present in MW-4 and MW-13; historical UST north sidewall samples with COCs above CULs.	Standard	X	X	X	If needed (TBD)	n/a	X (TPHg/BTEX only)	n/a	n/a	n/a	n/a	n/a	Possible first phase step-out to the south; additional step-outs may be added for second phase if needed based on sample results.
CK-B5	In McGraw St. ROW (south median area) north of former UST excavation area (east of MW-4 and south of MW-6)	Evaluate current conditions to the north-northeast of the former UST release location; NAPL historically present in MW-4; historical UST north sidewall samples with COCs above CULs.	Standard	X	X	X	If needed (TBD)	n/a	X (TPHg/BTEX only)	n/a	n/a	n/a	n/a	n/a	No step-outs specified for first phase at this location. Step-outs may be added for second phase if needed based on sample results.
CK-B6	In McGraw St. ROW south median area west of MW-7	Evaluate current conditions to the east of the former UST release location; location is potentially downgradient of release area; area has not been previously evaluated.	Standard	X	If needed (TBD)	If needed (TBD)	If needed (TBD)	n/a	X (TPHg/BTEX only)	n/a	n/a	n/a	n/a	n/a	Possible first phase step-out to the south of MW-7 near the northwestern corner of the former Circle K property.
CK-B7	West of MW-13 near the northeastern corner of the Circle K property	Evaluate the current extent of potential impacts west of MW-13 including potential COC migration westward into the 24th Avenue ROW. NAPL has been present historically in MW-13.	Standard	X	If needed (TBD)	If needed (TBD)	If needed (TBD)	n/a	X (TPHg/BTEX only)	n/a	n/a	n/a	n/a	n/a	No step-outs specified for the first phase at this location. Step-outs may be added for second phase based on first phase results; an additional City permit would be required for work in the 24th Avenue ROW.
CK-B8	North of the Site building within the former UST excavation area	Evaluate current conditions in the former UST excavation area including potential for re-contamination of fill materials placed at the time of UST removal.	Standard	X	If needed (TBD)	If needed (TBD)	If needed (TBD)	n/a	X (TPHg/BTEX only)	n/a	n/a	n/a	n/a	n/a	No step-outs specified for first phase at this location. Step-outs may be added for second phase if needed based on sample results.
CK-B9	Alleyway east of the Site building, south of MW-7	Evaluate current conditions to the east and southeast of the former UST release location; location is potentially downgradient of release area; area has not been previously evaluated.	Standard	X	If needed (TBD)	If needed (TBD)	If needed (TBD)	n/a	X (TPHg/BTEX only)	n/a	n/a	n/a	n/a	n/a	Possible first-phase step-outs to the north and south of B9 within the alleyway; step-outs to the east would require adjoining property owner notification and consent.
CK-B10	West of the Site building near the former UST excavation southwestern corner	Evaluate current conditions to the west and south of the former UST release location; historical UST south and west sidewall samples had COCs above CULs.	Standard	X	X	X	If needed (TBD)	n/a	X (TPHg/BTEX only)	n/a	n/a	n/a	n/a	n/a	Possible first-phase step-out to the southeast of B10 near the main Site building entry and southwest of B10 in the parking lot area.
CK-B11	West of former UST excavation area near the 24th Ave. ROW	Evaluate current conditions along the western margin of the Circle K property, including potential COC migration westward into the 24th Avenue ROW.	Standard	X	If needed (TBD)	If needed (TBD)	If needed (TBD)	n/a	X (TPHg/BTEX only)	n/a	n/a	n/a	n/a	n/a	Possible first phase step-out to the south of B11 near the western property margin. Additional step-outs may be added to the west for the second phase, if needed based on first phase results, but an additional City permit would be required for the 24th Avenue ROW.
CK-B12	Central portion of the parking lot area west of the Site building	Evaluate current conditions in the vicinity of the former dispensers associated with the former USTs.	Standard	X	If needed (TBD)	If needed (TBD)	If needed (TBD)	n/a	X (TPHg/BTEX only)	n/a	n/a	n/a	n/a	n/a	Possible first phase step-outs to the north, east, west, and south of B12. Additional step-outs may also be added for the second phase if COC impacts are identified.
Second Phase Step-out Soil Borings, Typical[m]															
Step-Outs Borings and Wells TBD	Locations to be based on first phase findings	Additional borings for soil and reconnaissance groundwater sampling for second phase drilling will be identified as needed to characterize the extent of impacts based on the first phase findings.	Standard sampling intervals will be used unless otherwise specified based on specific data needs. Specific analyses TBD based on data needs identified following review of the results of the first phase of drilling investigation.					n/a	TBD	New monitoring wells will be developed at the time of installation and included in the quarterly groundwater monitoring program to be initiated following completion of second-phase Site field work and review of analytical findings. Quarterly groundwater sample analyses are listed in the following section.					Proposed second phase soil boring and monitoring well installation locations will be submitted to Ecology for review and approval prior to performing the second phase of drilling at the Site. Up to four second phase borings will be converted to permanent groundwater monitoring wells at locations TBD.

Table 2: Summary of Sampling and Analysis Plan

Soil Boring or Monitoring Well Designation[a]	Sample Location[b]	Sample Location Data Needs Addressed and Rationale[c]	Soil Samples					Groundwater Samples							Possible First Phase Step-out Locations in Proximity to Initial Locations and General Notes[k]
			Sample Intervals[d]	Analyses[e]				Assessment[f] TPHg/BTEX Screening	Reconnaissance (from Temp Wells)[g]	Quarterly Monitoring Samples for Permanent Wells (2 events)[e,h]					
				TPHg/BTEX	FA VOCs[i]	FA Lead[i]	VPH/EPH[i]			TPHg/BTEX	FA VOCs[i]	FA Lead[i]	VPH/EPH[i]	NA Mon.[j]	
Groundwater Monitoring Well Sampling[n]															
MW-4	North of the former UST excavation area	Evaluate current conditions; historical NAPL well with COC concentrations above CULs.	n/a	n/a	n/a	n/a	n/a	X	n/a	X	TBD	TBD	TBD	X	Proposed analyses based on current information. Analyses for quarterly monitoring may change based on first phase findings.
MW-6	McGraw St. north of former UST area near sewer line	Evaluate current conditions; some historical COC concentrations above CULs; proximity to potential preferential pathway (sewer line in McGraw).	n/a	n/a	n/a	n/a	n/a	X	n/a	X	TBD	TBD	TBD	TBD	Proposed analyses based on current information. Analyses for quarterly monitoring may change based on first phase findings.
MW-7	In sidewalk near northeastern corner of Circle K property	Evaluate current conditions; location is downgradient from UST release location.	n/a	n/a	n/a	n/a	n/a	X	n/a	X	TBD	TBD	TBD	TBD	Proposed analyses based on current information. Analyses for quarterly monitoring may change based on first phase findings.
MW-8	McGraw St. north of the former UST excavation area	Evaluate current conditions; historical NAPL well with COC concentrations above CULs.	n/a	n/a	n/a	n/a	n/a	X	n/a	X	TBD	TBD	TBD	X	Proposed analyses based on current information. Analyses for quarterly monitoring may change based on first phase findings.
MW-9	McGraw St. northwest of the former UST excavation area	Evaluate current conditions; historical NAPL well with COC concentrations above CULs.	n/a	n/a	n/a	n/a	n/a	X	n/a	X	TBD	TBD	TBD	TBD	Proposed analyses based on current information. Analyses for quarterly monitoring may change based on first phase findings.
MW-10	McGraw St. northeast of the former UST excavation area	Evaluate current conditions; proximity to potential preferential pathway (sewer line in McGraw).	n/a	n/a	n/a	n/a	n/a	X	n/a	X	TBD	TBD	TBD	TBD	Proposed analyses based on current information. Analyses for quarterly monitoring may change based on first phase findings.
MW-11	24th Ave ROW (grass median) to the north of the Site	No historical NAPL or CUL exceedances. The need for assessment and/or sampling at this location will be evaluated based on first phase findings.	n/a	n/a	n/a	n/a	n/a	Excluded based on location in 24th Ave. East ROW	n/a	?(see note)	TBD	TBD	TBD	TBD	**Note:** The Work Plan included up to 12 wells for quarterly monitoring. Depending on the number of new wells installed and first phase findings, this well may be excluded from quarterly monitoring.
MW-13	Near the northwestern corner of the former Circle K property	Evaluate current conditions, including potential COC migration into the 24th Avenue ROW; historical NAPL well with COC concentrations above CULs.	n/a	n/a	n/a	n/a	n/a	X	n/a	X	TBD	TBD	TBD	X	Proposed analyses based on current information. Analyses for quarterly monitoring may change based on first phase findings.
MW-14	Sidewalk in north McGraw St. ROW north of former UST excavation area	Evaluate current conditions including potential migration of COC toward residence to north; possible sheen present March 8, 2016.	n/a	n/a	n/a	n/a	n/a	X	n/a	X	TBD	TBD	TBD	TBD	Proposed analyses based on current information. Analyses for quarterly monitoring may change based on first phase findings.
MW-15	Sidewalk in north McGraw St. ROW north of former UST excavation area	Evaluate current conditions including potential migration of COC toward residence to north; well with historical COC concentrations above CULs.	n/a	n/a	n/a	n/a	n/a	X	n/a	X	TBD	TBD	TBD	TBD	Proposed analyses based on current information. Analyses for quarterly monitoring may change based on first phase findings.
MW-16	24th Ave. ROW crosswalk on the northern side of McGraw	No historical NAPL or CUL exceedances. The need for assessment and/or sampling at this location will be evaluated based on first phase findings.	n/a	n/a	n/a	n/a	n/a	Excluded based on location in 24th Ave. East ROW	n/a	?(see note)	TBD	TBD	TBD	TBD	**Note:** The Work Plan included up to 12 wells for quarterly monitoring. Depending on the number of new wells installed and first phase findings, this well may be excluded from quarterly monitoring.
New Wells TBD	Locations TBD	Locations and number of new wells (up to four) TBD based on findings of the first phase or work and initial well assessment.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	X	TBD	TBD	TBD	TBD	Proposed second phase monitoring well locations and analytical tests will be submitted to Ecology for review and approval based on first phase investigation findings.

Notes:

(a) Proposed soil boring initial designations and existing groundwater monitoring well designations. Actual field designations may vary.

(b) Proposed initial and possible step-out boring locations, and existing monitoring well locations, are shown on Figure 2. SOIL BORING LOCATIONS ARE PRELIMINARY AND MAY SHIFT BASED ON SUBSURFACE FEATURES, ACCESS, OR OTHER FIELD CONDITIONS.

(c) Rationale and locations are based on historical sample results and data gaps, including potential exposure pathways identified for the Site (refer to Appendix A for a preliminary data gaps and exposure pathways summary).

(d) Proposed soil sampling intervals are discussed in Work Plan Section 3.4. At least four soil samples will be retained for laboratory analysis or archival at each location. Selection of samples for initial laboratory analysis is discussed in Work Plan Section 3.4.

(e) All soil samples selected for laboratory analysis will be analyzed for TPHg/BTEX. Other proposed analyses are based on currently available information and may be modified for some samples based on field observations or results of initial analyses. Analytical methods for the listed soil and groundwater analyses are summarized in Work Plan Section 3.7. Sample container, preservative, and holding time requirements are summarized in the QAPP (Appendix D).

(f) Wells proposed for inclusion in the initial well assessment and sampling task (see Work Plan Section 3.3).

(g) Reconnaissance groundwater samples will be collected from the upper portion of the saturated zone through temporary wells screens installed in soil borings (see Work Plan Section 3.4).

(h) Quarterly monitoring will include up to 12 wells for two events beginning after completion of the second-phase of drilling (see Section 3.6). The proposed wells and analyses are based on currently available information and may vary based on project findings.

(i) Select soil and groundwater samples may be submitted for analysis of fuel additives including VOCs (MTBE, EDB, and EDC) and total lead, either initially based on field observations or as follow-ups based on TPHg/BTEX results. If evaluation of MTCA Method B CULs is needed, select soil and/or groundwater samples may also be submitted for anlaysis of VPH and/or EPH (see Work Plan Sections 3.4 and 3.6).

(j) Groundwater samples will be analyzed for natural attenuation (NA) parameters (nitrate, sulfate, sulfide, dissolved manganese and iron, alkalinity, and dissolved methane; see Work Plan Section 3.6) during quarterly monitoring events at up to four wells. Proposed wells for natural attenuation parameter monitoring are based on currently available information and may vary based on ongoing project findings.

(k) Possible step-out locations shown on Figure 2 will be utility-cleared for the first phase of drilling. Borings may be advanced at these locations during the first phase of work, if warranted based on field conditions, or possibly during the second phase of drilling based on analytical findings. THESE LOCATIONS ARE PRELIMINARY AND MAY CHANGE BASED FINDINGS AND FIELD CONDITIONS.

(l) First phase soil borings include 12 initial locations with possible field step-outs based on field observations and ongoing analytical findings. If a necessary step-out boring is not completed during the first phase, it will be performed during the second phase.

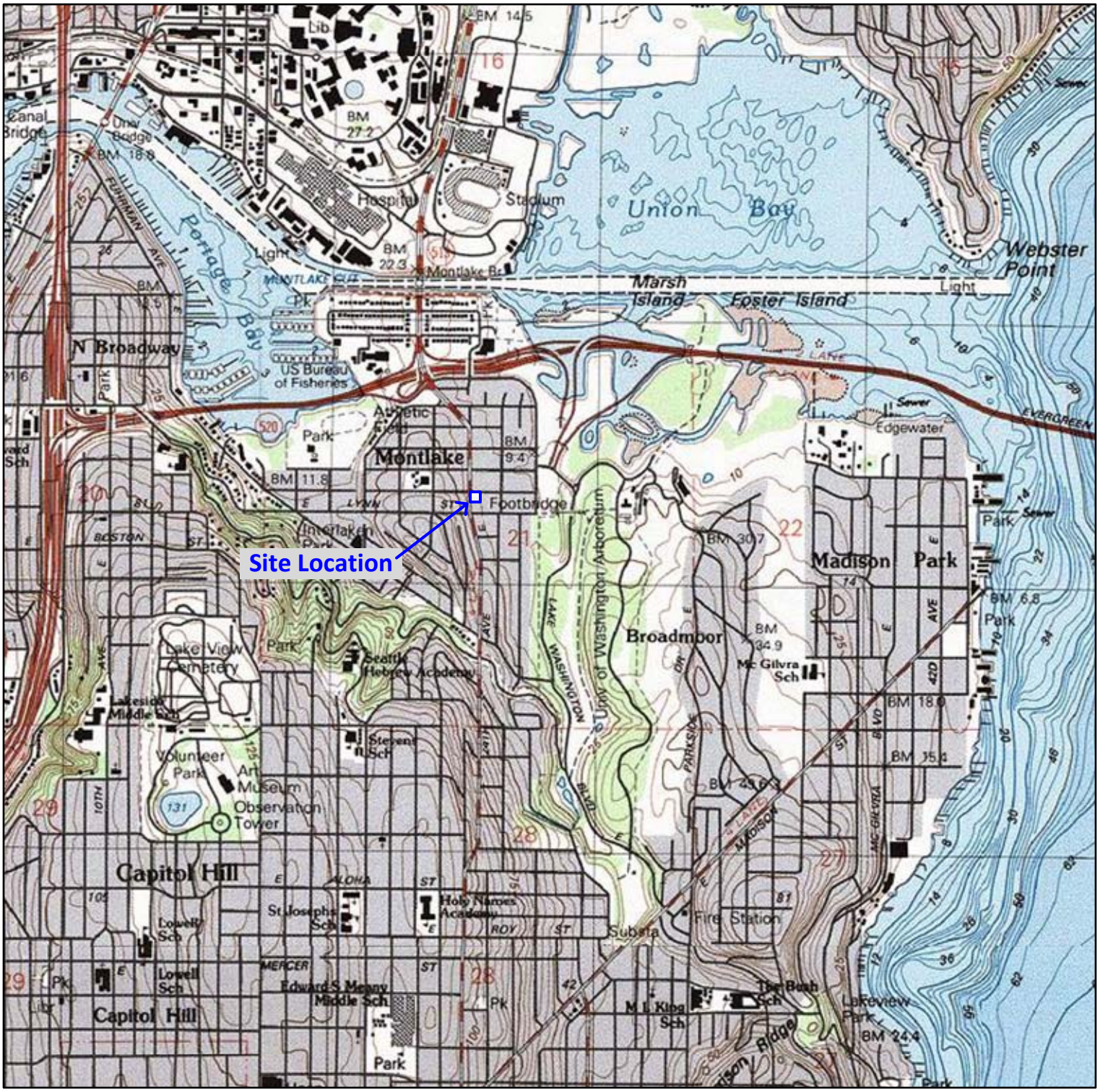
(m) Second phase boring locations and analytical testing requirements will be determined based on the results of the first phase. Second phase locations may include some of the possible step-out locations shown on Figure 2, or additional locations possibly including the 24th Avenue ROW west of the Site. If sampling in the 24th Street ROW is needed, an additional City ROW permit will be needed.

(n) The Work Plan (Section 3.6) provides for quarterly monitoring at up to 12 well locations (existing and new wells). Proposed wells are based on currently available information and may vary based on project findings and the number of new wells installed.

Acronyms:

BTEX	benzene, toluene, ethylbenzene, and xylenes
COC	contaminants of concern
CUL	cleanup level
EDB	ethylene dibromide (1,2-dibromoethane)
FA	fuel additives (EDC, EDB, MTBE, lead)
EDC	ethylene dichloride (1,2-dichloroethane)
EPH	Extractable Petroleum Hydrocarbons
MTBE	methyl tertiary-butyl ether
n/a	not applicable
NA Mon.	natural attenuation monitoring
NAPL	Non-Aqueous Phase Liquid (i.e., free product)
ROW	right-of-way
TBD	to be determined
TPHg	gasoline-range total petroleum hydrocarbons
UST	underground storage tank
VOCs	volatile organic compounds
VPH	volatile petroleum hydrocarbons

Figures



Source: USGS Seattle North E Topographic 1983.

Kennedy/Jenks Consultants

N

0 5,000

approximate scale in feet

Former Circle K Site
2350 24th Avenue East, Seattle, WA

RI Work Plan:
Site Location Map

FIGURE 1

Legend:

MW-4 — Site Monitoring Well Location and Designation

Site Monitoring Wells to be included in the initial well assessment and preliminary sampling task (see Work Plan Section 3.3)

9 / ? — Proposed approximate first phase soil and reconnaissance groundwater sample location. Numbered locations are primary sample locations, and those labeled "?" are possible first phase step-out sample locations (see Work Plan Section 3.4) and Table 2.

water / sewer / natural gas / power — Approximate locations of underground utilities based on information provided in previous reports and provided by the property owner, and as marked for a public locate request submitted on March 2nd, 2016. ALL UTILITY LOCATIONS ARE APPROXIMATE AND MUST BE VERIFIED BEFORE ANY INVASIVE WORK IS PERFORMED. PRELIMINARY LOCATIONS ARE PROVIDED FOR GENERAL INFORMATIONAL PURPOSES ONLY. ADDITIONAL UTILITIES MAY BE PRESENT.

Approximate utility manhole and catch basin locations
- M=Manhole
- H=Hydrant
- C=Catch Basin

Notes:

1. All locations are approximate
2. Additional sample locations, including new monitoring well locations, will be identified based on the result of the initial well assessment and first phase of drilling.
3. Utility, manhole, and catch basin locations are approximate and are provided for informational purposes only and must be field verified.

N

0 20 40 60

approximate scale in feet (1" = 20')

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Former Circle K Site
2350 24th Avenue East, Seattle, WA

RI Work Plan:
Site Overview and Proposed Sample Location Map

FIGURE 2

Appendix A

Data Gaps and Preliminary Pathways Memo, Historical Data Maps, Preliminary Cross-Section Map, and Historical Boring Logs

APPENDIX A

Initial Data Gaps and Exposure Pathways summarized from the Technical Memorandum submitted to Ecology February 24th, 2016.

PRELIMINARY DATA GAPS SUMMARY

Soil Data Gaps

The lateral and vertical extent of impacts to subsurface soil has not been fully characterized. The extent of impacts identified in historical samples (primarily from the former UST excavation area but also from soil borings) have not been delineated, and areas where impacts to soil are possible have not been previously investigated. Furthermore, available analytical data is over 25 years old in some cases and new data regarding current conditions is needed at some locations to complete the RI for the Site. Specific data gaps for Site soil include:

- Potential soil impacts have not been evaluated to the east and southeast of the former UST excavation area, including beneath and east of the existing Site building (i.e., between the former UST area and the east-adjoining residence).

- The former dispenser island and canopy area, including piping between the dispensers and former UST area, has not been evaluated for potential soil impacts (generally includes the western parking lot area of the Site, although the historical piping route is unknown).

- The extent (lateral and vertical) of soil impacts at locations where the former UST excavation sidewall samples contained COCs at concentrations above potential CULs (north, south, and west sidewalls) have not been characterized.

- The vertical extent of soil impacts has not been evaluated beneath the former UST excavation (i.e., bottom samples were not collected at the time of UST removal).

- Potential re-contamination of backfill placed in the former UST excavation has not been evaluated.

- Soil conditions (i.e., the lateral and vertical extent of impacts) in the historical NAPL-affected area north of the former UST area (i.e., the McGraw Street ROW; see Groundwater Data Gaps) have not been characterized. Seasonal groundwater (and NAPL) elevation fluctuations of up to several feet have been previously described for the Site, but soil conditions in the associated potential “smear zone” have not been evaluated.

- Based on the amount of time since most previous soil samples were collected, and because remediation systems (groundwater pump/treat and vapor extraction) were previously operated at the Site, current conditions need to be verified in proximity to previously characterized locations.

Groundwater Data Gaps

The extent of impacts to groundwater at the Site has not been fully characterized. Historical findings indicate that impacted groundwater was present to the north and west of the former

UST area (primarily beneath the McGraw Street ROW), but current conditions and the overall extent of groundwater impacts are unknown. In addition, the current extent and potential accumulation of NAPL (previously identified to the north and west of the former UST area) is unknown. As with the soil data, available groundwater analytical data is over 10 years old in some cases and new data regarding current Site conditions is needed at some locations to complete the RI. Specific data gaps for Site groundwater include:

- The current extent of COC impacts to groundwater is unknown (last sampled in 2006) and needs to be evaluated, as described below:
    - Potential migration of COCs in groundwater toward adjoining residences to the north, east, and northeast of the Site.
    - Current conditions and potential impacts to groundwater to the west (toward 24th Avenue East) and south (Circle K property parking lot) of MW-13, which had a gasoline-range TPH concentration of 109 mg/l in 2006.
    - Potential impacts to groundwater within and south of the former UST excavation area, including the former dispenser island area in the central portion of the current parking area.
    - Current groundwater conditions along the sewer utility line in McGraw Street (MW-6 and MW-10) and evaluation of migration within the utility corridor.
- Groundwater gradients need additional characterization to evaluate Site-wide and localized gradients and the potential for COC migration in groundwater, as described below:
    - Additional groundwater elevation data is needed to evaluate the overall groundwater gradient in the Site vicinity, and the potential effect of localized gradient variations on contaminant transport.
    - Additional data is needed to evaluate the localized water table drawdown, presumably related to the sewer utility in McGraw Street, which was previously documented at MW-6 (2006 water level measurements), and its potential effect on contaminant migration along the sewer and associated backfill material.
    - Additional data is needed to evaluate potential preferential pathways for contaminant transport in groundwater including utility corridors in 24th Avenue and McGraw Street (in addition to the sewer main described above).
    - The groundwater elevation in the former UST excavation area needs to be characterized to evaluate the potential for localized gradients (i.e., potential “bathtub” effects of groundwater within the tank excavation that could influence contaminant transport.
- The lateral extent of NAPL on the groundwater surface (and in soil) needs additional characterization to evaluate the potential for contaminant migration. Site locations and areas where current NAPL conditions and potential NAPL impacts need additional evaluation include the following:
    - The area north of MW-8 and MW-9, toward the adjoining residential property.
    - The area west of MW-9 (in McGraw Street).

- To the north (McGraw Street), west (24th Avenue ROW), and south (Circle K property) of MW-13.
- To the north and west of MW-4.
- Within the former UST excavation area.
- South of the former UST excavation area, including the former dispenser island area.
- East and southeast of the former UST excavation (i.e., east of the current Site building) toward the east-adjoining residential property.

Vapor Assessment Data Gaps

Based on the information provided in previous Site reports, migration of vapors from gasoline-affected soil and groundwater is possible at the Site. Specific data gaps for the potential vapor pathway evaluation include:

- Vapor migration beneath adjoining residences to the north, northeast, and east of the Site needs to be evaluated. This includes potential migration into residence interiors including basements (King County Assessor's property information indicates that the adjoining residences all have basements) and crawl spaces.

- Vapor migration beneath the existing Site building, and possible infiltration into the building interior, needs to be evaluated.

- Vapor migration into utility corridors/conduits (pipes and bedding materials) in City ROW areas (McGraw Street and 24th Avenue East) and on the Circle K property need to be evaluated.

- The overall extent of subsurface vapors (i.e., soil gas), if any, within and around the footprint of current and historical soil and groundwater impacts (particularly where NAPL may be present) needs to be evaluated.

NOTE: Vapor sampling at the Site was excluded from the current Scope of Work (at Ecology's direction); however, the vapor pathway will be evaluated using EPA's 2015 *Technical Guide for Addressing Petroleum Vapor Intrusion at Leaking Underground Storage Tank Sites*, including identification of potential future vapor sampling locations, if any.

Other General Data Gaps

Other potential data gaps identified for the Site include:

- The current condition of existing Site groundwater monitoring wells is unknown.
- The status of the existing extraction well and other possible subsurface facilities associated with the previously-installed remediation system (groundwater pump-and-treat and vapor extraction) is unknown. The above-ground portion of the remediation system was presumably removed when the Site building was expanded, but this needs to be verified along with the status of underground piping associated with the remediation system.

- The locations of all utility corridors (which could act as preferential transport pathways) in City ROWs need to be identified.
- The route and discharge location of the sanitary sewer line located in East McGraw Street needs to be identified.
- A Terrestrial Ecological Evaluation (TEE) has not been performed for the Site. Ecology's 2009 RI/FS for the Site indicated that the Site qualifies for a TEE exemption, but a formal evaluation is needed to verify.
- Additional characterization of Site geology is needed to verify the findings of previous investigations and to evaluate the continuity and correlation of stratigraphic units across the Site. This is also needed to update the CSM.

PRELIMINARY POTENTIAL EXPOSURE PATHWAYS SUMMARY

Based on our review of previous Site reports and documents provided by Ecology, the following exposure pathways may be complete and will be evaluated during the RI:

- Soil direct contact and/or ingestion for construction and utility workers.
- Soil to groundwater leaching, primarily in the "smear zone" related to seasonal water level fluctuations.
- Groundwater/NAPL to soil in the "smear zone" including possible recontamination of excavation backfill materials.
- Groundwater direct contact and/or ingestion by construction and utility workers.
- Groundwater/NAPL to surface water via utility pipes and/or bedding materials, particularly the sanitary sewer line located in East McGraw Street, including potential discharge to surface water bodies and uptake of contaminants by organisms.
- Vapor inhalation by construction and utility workers.
- Vapor intrusion into the Site building and adjoining residences, and inhalation by occupants and visitors.
- Potential exposure pathways for terrestrial organisms will be evaluated in the TEE.
- Potential consumption of groundwater if used for drinking water (a review of potential drinking water wells near the Site will be performed).

Attachments:

Map 1 – Draft Summary of Excavation and Boring Soil Sample Results
Map 2 – Draft Summary of Groundwater Wells and Sample Results
Map 3 – Draft Generalized Preliminary Geologic Cross-Section Fence Diagram

Map 1- Summary of Excavation and Boring Soil Sample Results

MW-11 (11')

MW-15 (8') (13')

MW-14 (13')

MW-16 (8')

MW-9 (10')

MW-8 (10')

MW-6 (8') (10')

MW-10 (10')

MW-12 (10')

MW-5 (8.5')

~300' East of MW-12 in road (not within map area)

WT-1 12'

MT-1 10'

MW-4 (8.5')

MW-3 (deep)

ET-3 10'

MW-7 (10')

MW-13 (8')

R-Well

MW-2 (8.5')

MW-3 (8.5')

NW-1 13'

NW-2 10'

WW-1 13'

Leaky UST

SW-1 9'

EW-1 10'

Approximate former UST and soil excavation area

Approximate sewer line locations identified during UST removal (1990)

Approximate former dispenser island and canopy area

MW-1 (8.5')

NOTE: All locations are approximate.

DRAFT

LEGEND:

UST Excavation Soil Sample Locations (1990):

- Soil sample with one or more COCs significantly above CULs
- Soil sample with one or more COCs slightly above CULs
- Soil sample with no COCs detected above CULs
- NW-2 10' — Excavation soil sample designation and depth

Monitoring Well Boring Soil Samples (1990):

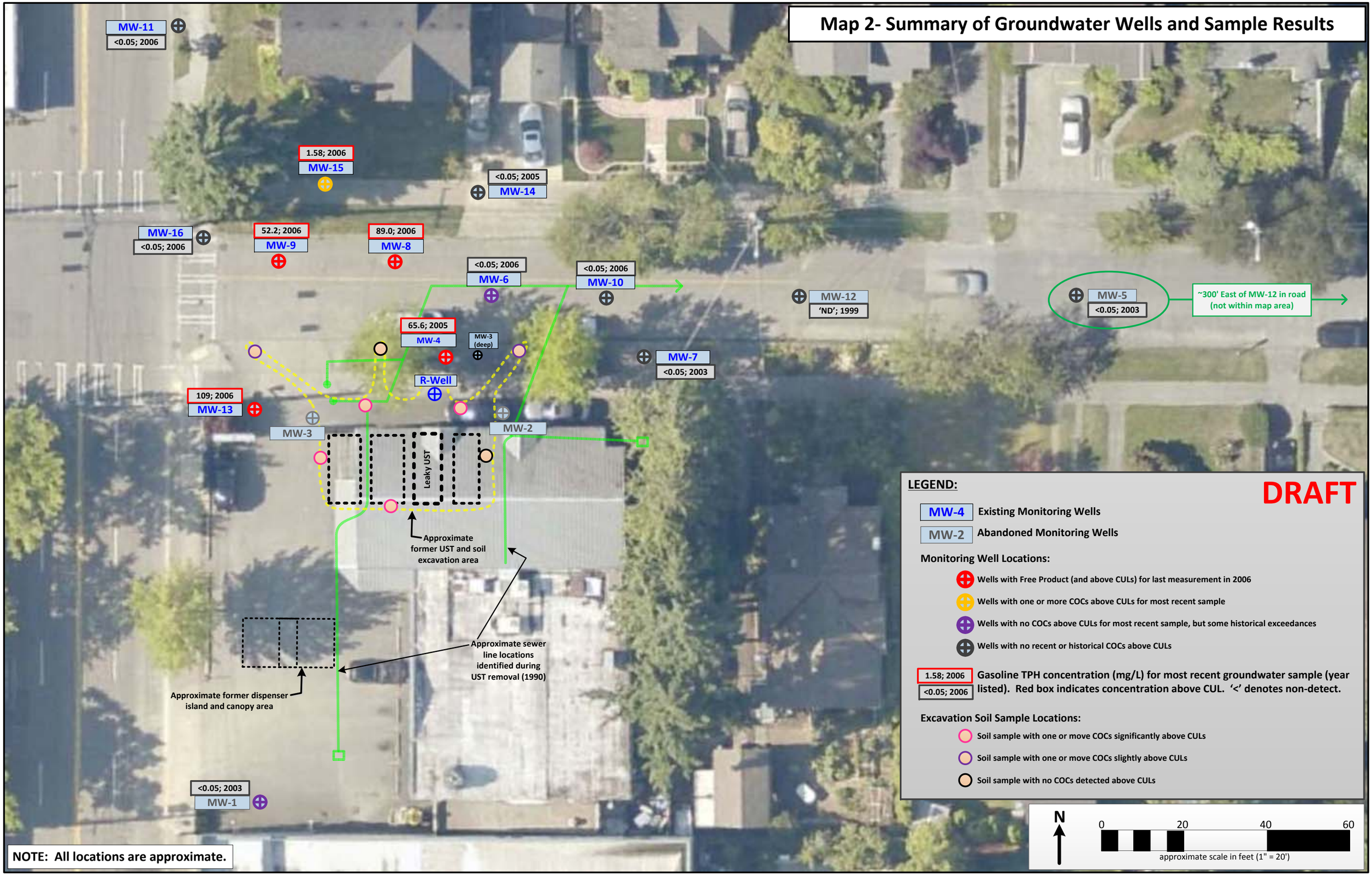
- Well boring soil samples with one or more COCs significantly above CULs
- MW-4 (8.5') — Existing monitoring well and soil sample depth
- MW-1 (8.5') — Abandoned monitoring well and soil sample depth

N

0 20 40 60

approximate scale in feet (1" = 20')

Map 2- Summary of Groundwater Wells and Sample Results



LEGEND:

DRAFT

- MW-4 — Existing Monitoring Wells
- MW-2 — Abandoned Monitoring Wells

Monitoring Well Locations:

- Wells with Free Product (and above CULs) for last measurement in 2006
- Wells with one or more COCs above CULs for most recent sample
- Wells with no COCs above CULs for most recent sample, but some historical exceedances
- Wells with no recent or historical COCs above CULs

1.58; 2006 / <0.05; 2006 — Gasoline TPH concentration (mg/L) for most recent groundwater sample (year listed). Red box indicates concentration above CUL. '<' denotes non-detect.

Excavation Soil Sample Locations:

- Soil sample with one or move COCs significantly above CULs
- Soil sample with one or move COCs slightly above CULs
- Soil sample with no COCs detected above CULs

N

0 20 40 60

approximate scale in feet (1" = 20')

NOTE: All locations are approximate.

Map 3 – Generalized Preliminary Geologic Cross-Section Fence Diagram
FOR INFORMATIONAL PURPOSES ONLY

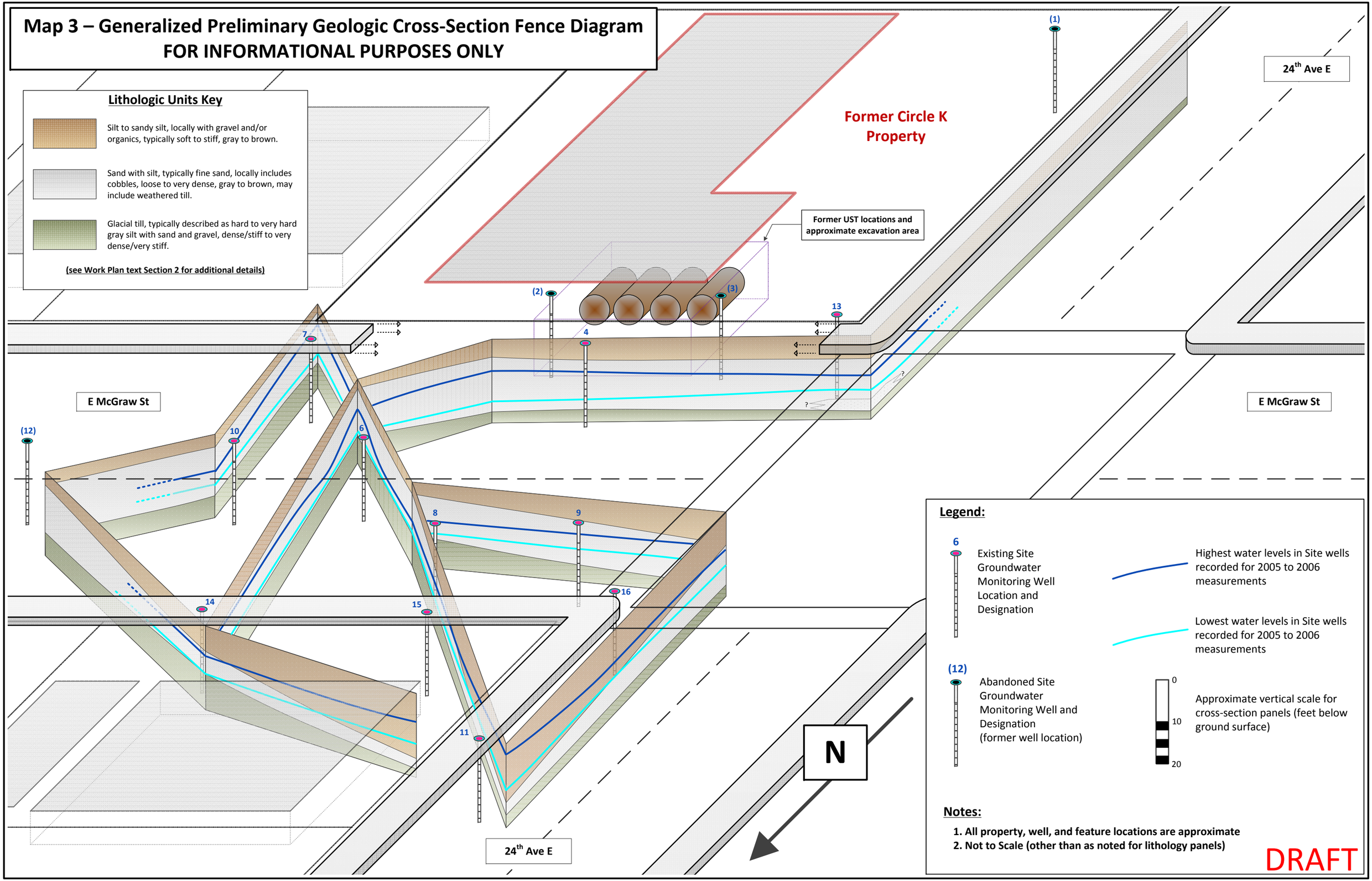
Lithologic Units Key

Silt to sandy silt, locally with gravel and/or organics, typically soft to stiff, gray to brown.

Sand with silt, typically fine sand, locally includes cobbles, loose to very dense, gray to brown, may include weathered till.

Glacial till, typically described as hard to very hard gray silt with sand and gravel, dense/stiff to very dense/very stiff.

(see Work Plan text Section 2 for additional details)



Legend:

6 — Existing Site Groundwater Monitoring Well Location and Designation

Highest water levels in Site wells recorded for 2005 to 2006 measurements

Lowest water levels in Site wells recorded for 2005 to 2006 measurements

(12) — Abandoned Site Groundwater Monitoring Well and Designation (former well location)

0 / 10 / 20 — Approximate vertical scale for cross-section panels (feet below ground surface)

Notes:

1. All property, well, and feature locations are approximate
2. Not to Scale (other than as noted for lithology panels)

DRAFT

Boring and Well Construction Logs for Existing and Previously-Abandoned Site Monitoring Wells

1. From GeoEngineers, 1990: Logs for MW-1 through MW-16. See Work Plan Figure 2 and the historical data maps attached to the Data Gaps Summary Memo in Appendix A for well locations.
2. From Landau Associates, 2013: Log for Landau well MW-3 (see Work Plan Figure 2)

SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVEL MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVEL	GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND MORE THAN 50% OF COARSE FRACTION PASSES NO. 4 SIEVE	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY-GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE GRAINED SOILS MORE THAN 50% PASSES NO. 200 SIEVE	SILT AND CLAY LIQUID LIMIT LESS THAN 50	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY LIQUID LIMIT 50 OR MORE	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1. Field classification is based on visual examination of soil in general accordance with ASTM D2488-83.
2. Soil classification using laboratory tests is based on ASTM D2487-83.
3. Descriptions of soil density or consistency are based on interpretation of blowcount data, visual appearance of soils, and/or

SOIL MOISTURE MODIFIERS:

Dry – Absence of moisture, dusty, dry to the touch

Moist – Damp, but no visible water

Wet – Visible free water or saturated, usually soil is obtained from below water table

LABORATORY TESTS:

CA Chemical Analysis

VAPOR CONCENTRATION DATA:

Vapor concentration given in parts per million

SHEEN CLASSIFICATION SYSTEM:

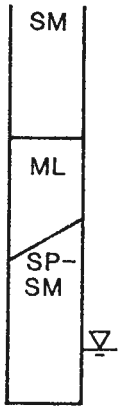
NS No visible sheen

SS Slight sheen

MS Moderate sheen

HS Heavy sheen

SOIL GRAPH:



Soil Group Symbol (See Note 2)

Distinct Contact Between Soil Strata

Gradual Change Between Soil Strata

Water Level

Bottom of Boring

BLOW-COUNT/SAMPLE DATA:

Blows required to drive a split-barrel sampler (2.4-inch I.D.) 12 inches or other indicated distances using 300 pound hammer falling 30 inches.

22 ■ Location of relatively undisturbed sample

12 ⊠ Location of disturbed sample

"P" indicates sampler pushed with weight of hammer or hydraulics of drill rig.

P □ Location of sampling attempt with no recovery

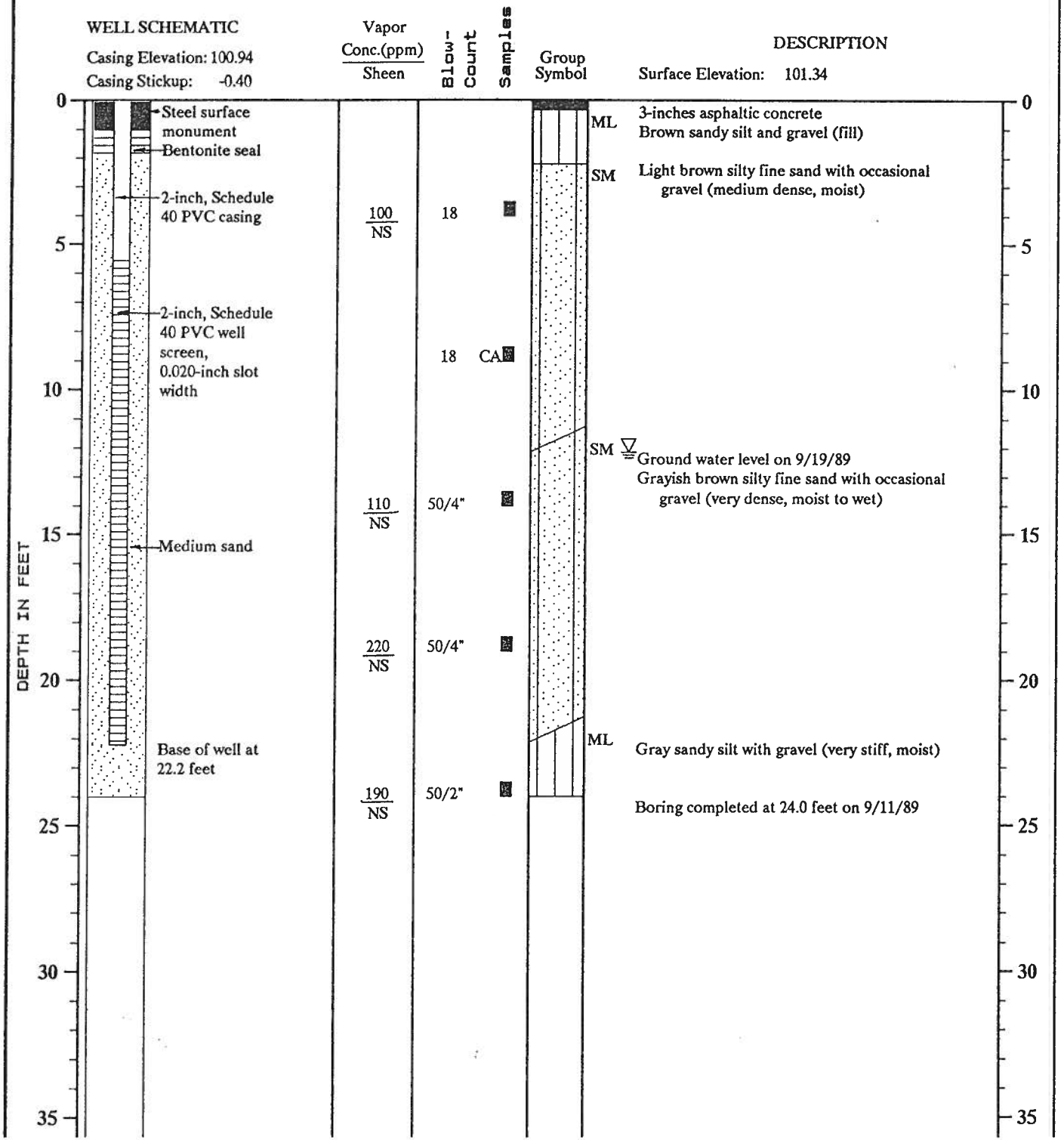
Blows required to drive a split-barrel sampler (1.5-inch I.D.) 12 inches or other indicated distances using 140 pound hammer falling 30 inches.

10 ◪ Location of sample attempt using Standard Penetration Test procedures

NOTES:

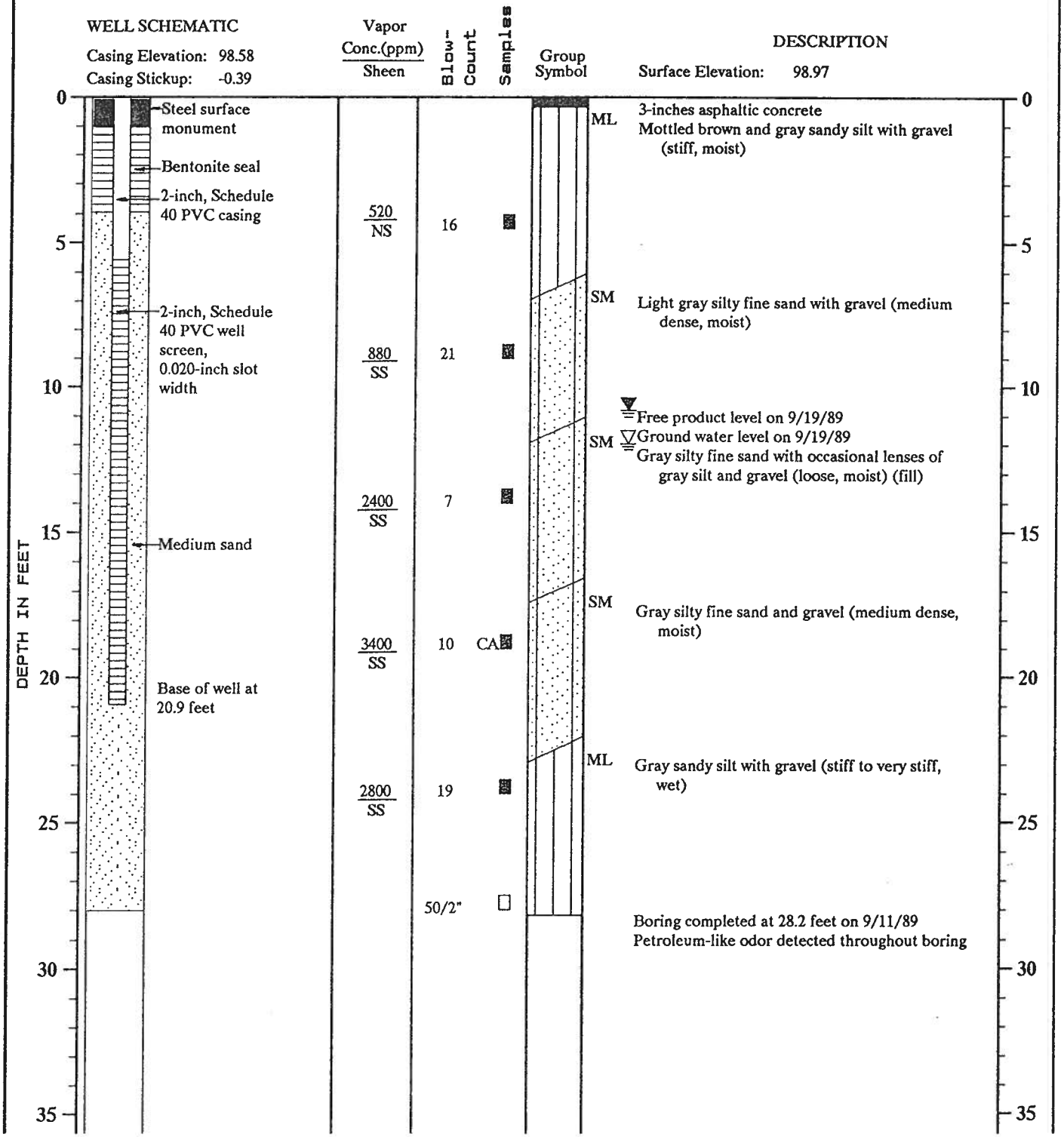
1. Information presented in the attached text and the Key To Boring Log Symbols is required to adequately explain the data on the boring logs.

MONITOR WELL NO. MW-1



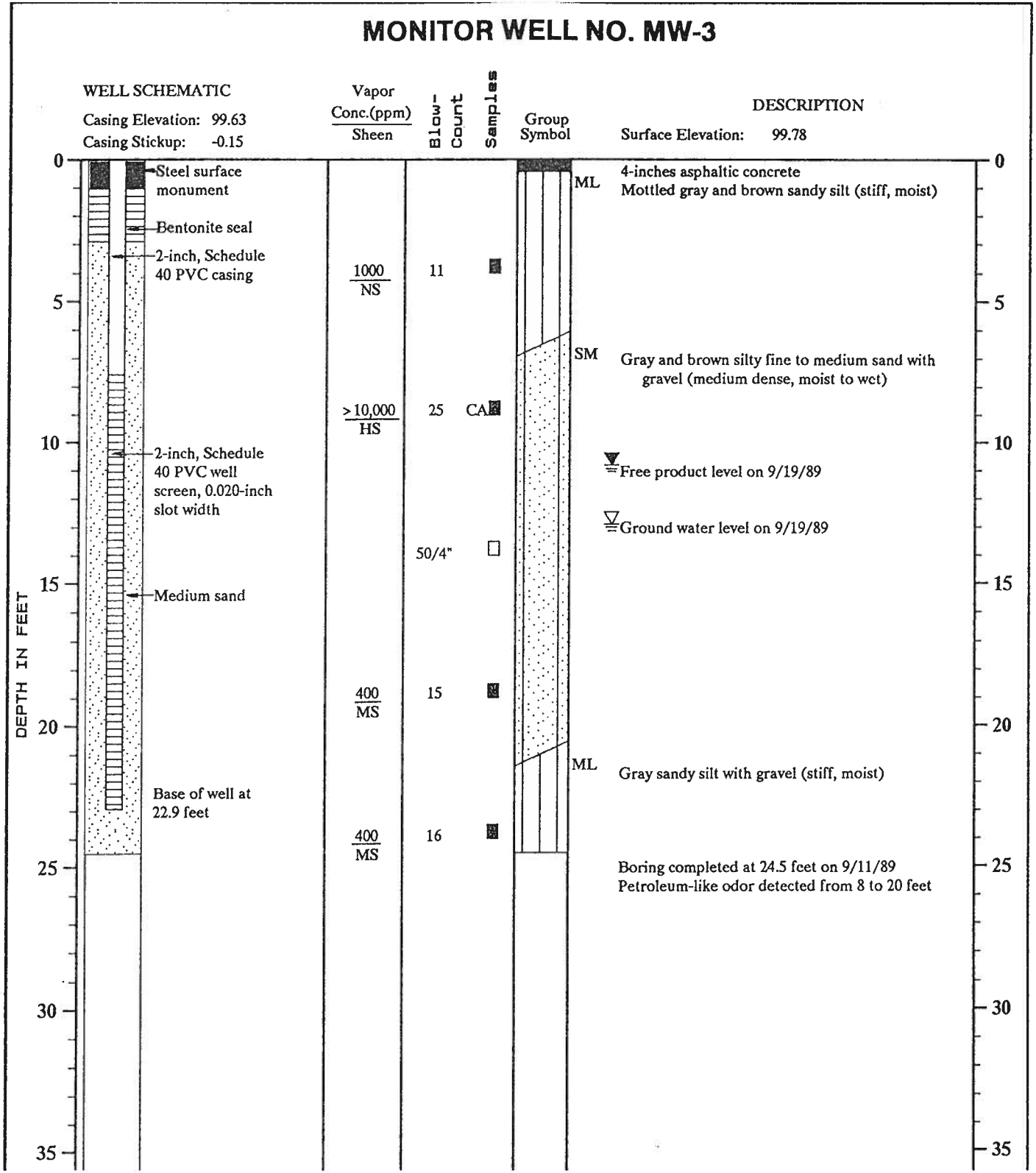
TEP:OKP:CDO 1/9/90

MONITOR WELL NO. MW-2



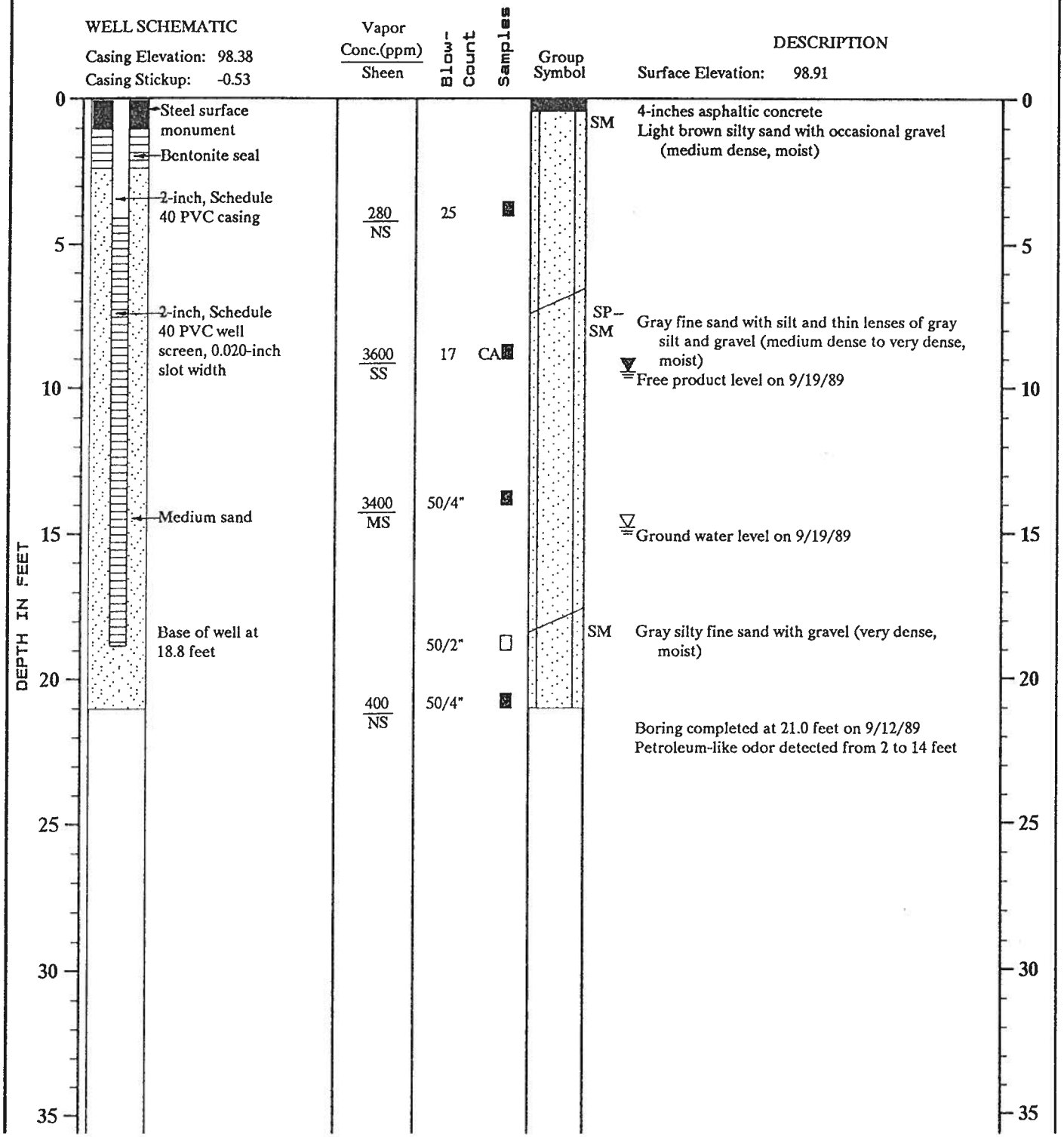
TEP:OKP:CDO 1/9/90

MONITOR WELL NO. MW-3



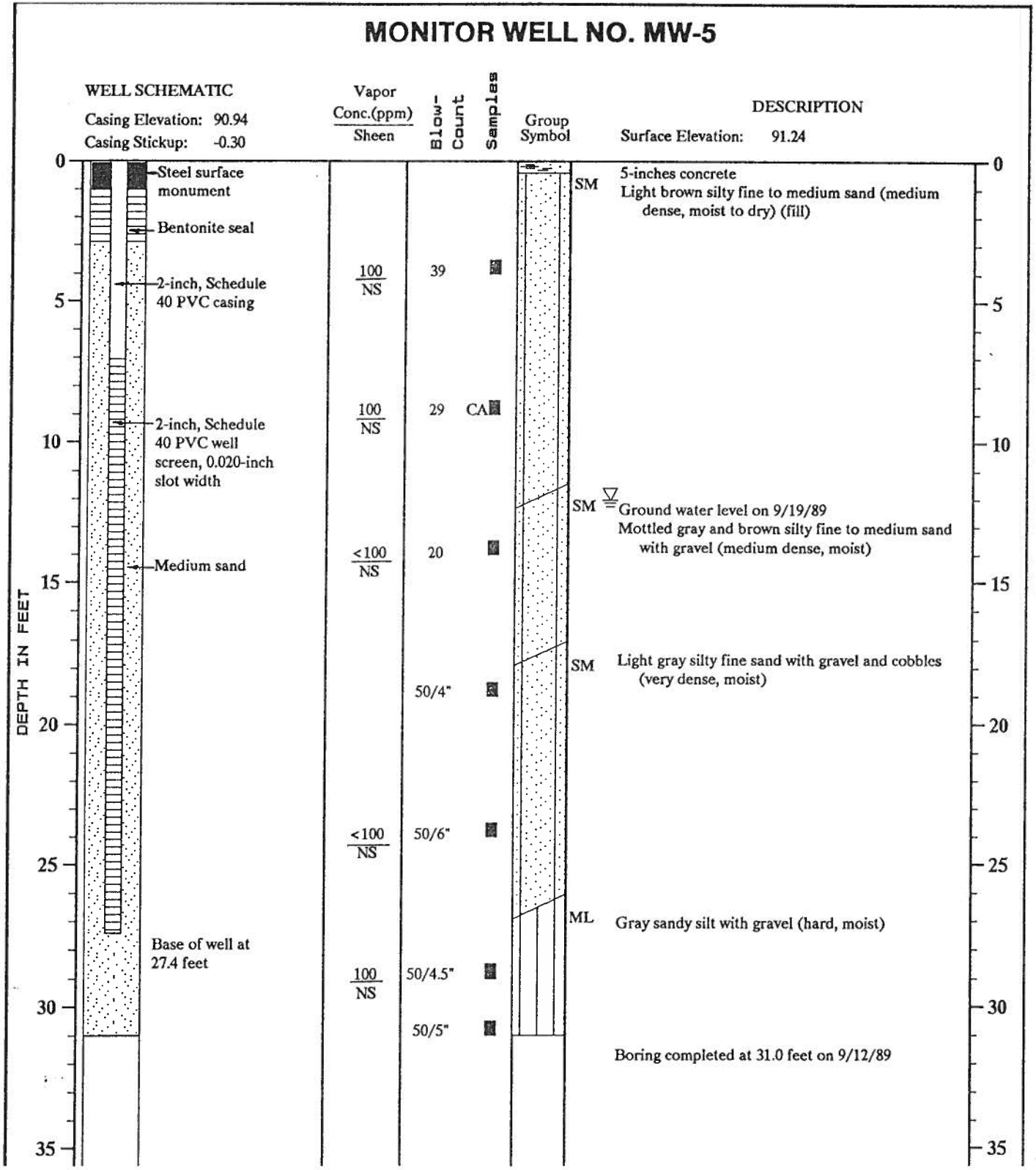
TEP:OKP:CDO 1/9/90

MONITOR WELL NO. MW-4



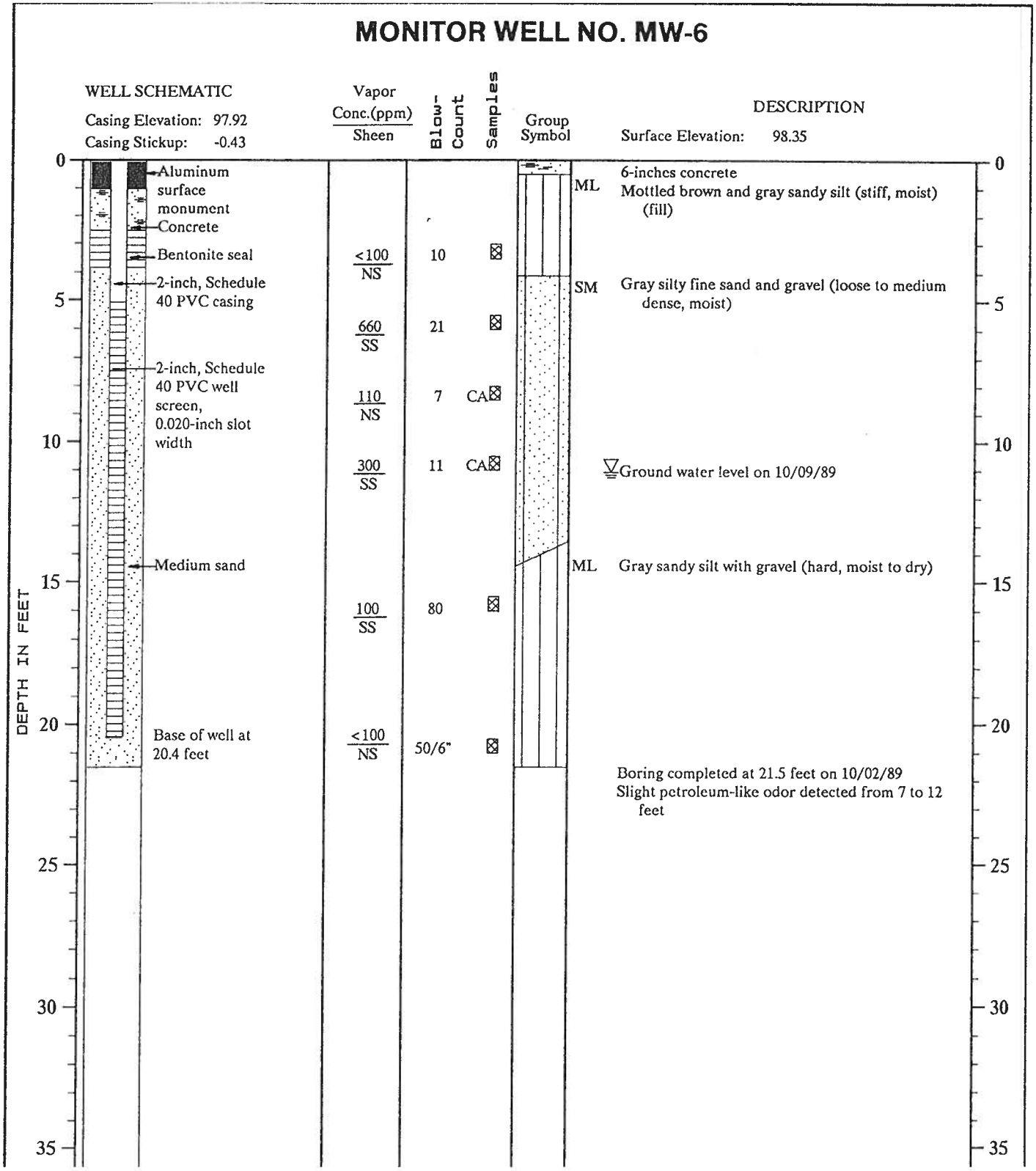
TEP:OKP:CDO 1/9/90

MONITOR WELL NO. MW-5



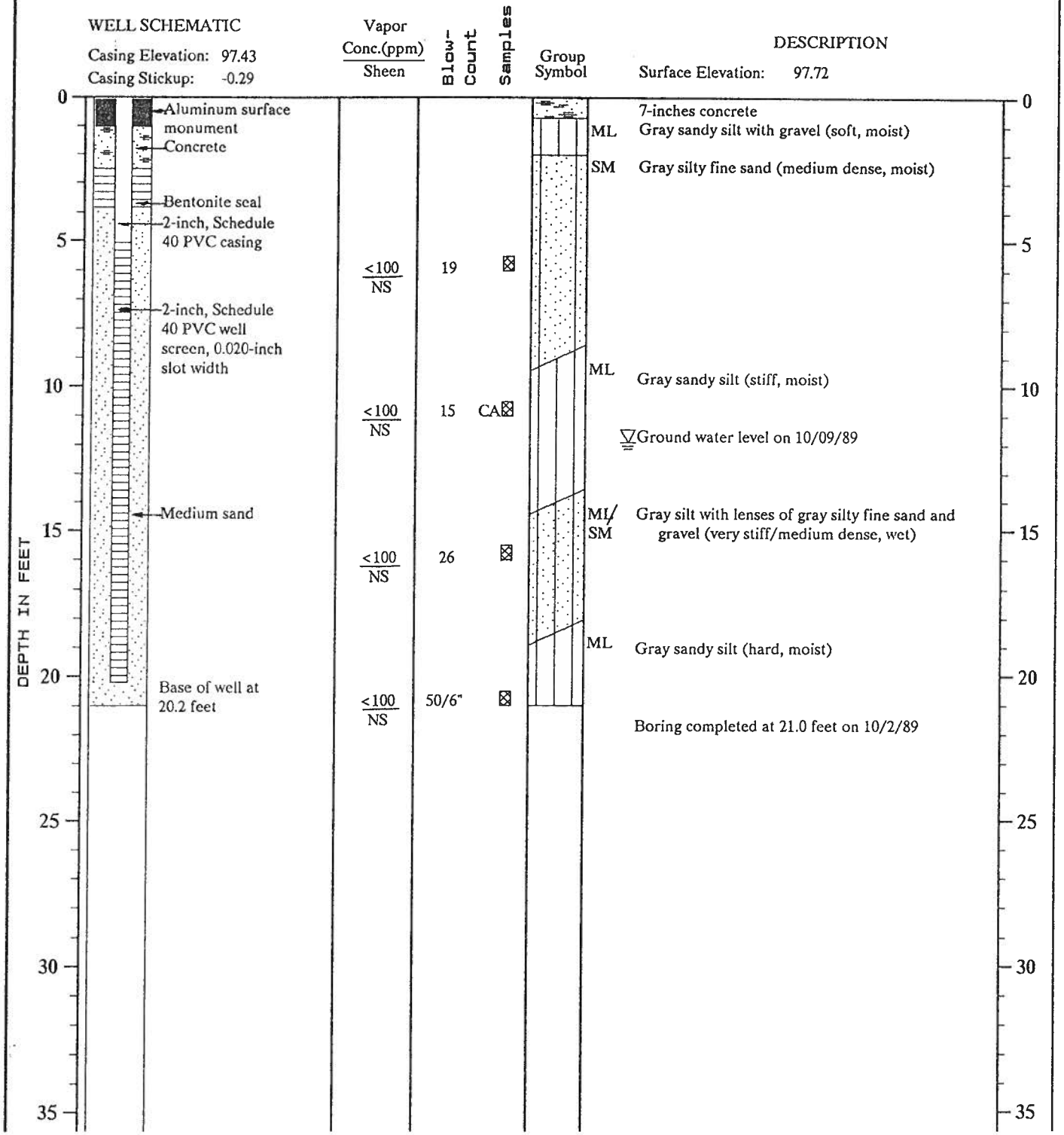
TEP:OKP:CDO 1/9/90

MONITOR WELL NO. MW-6



TEP:OKP:CDO 2/8/90

MONITOR WELL NO. MW-7



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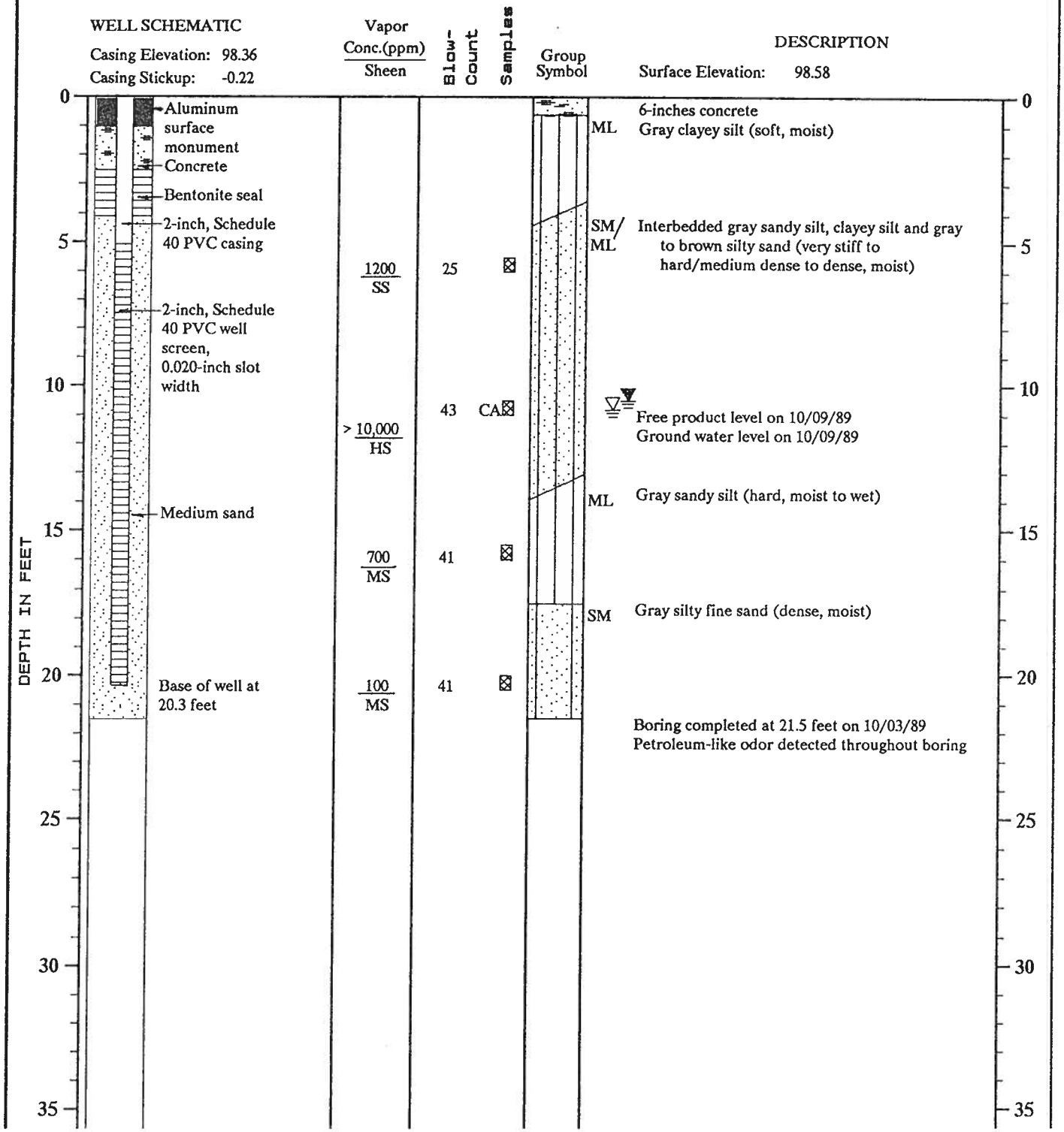
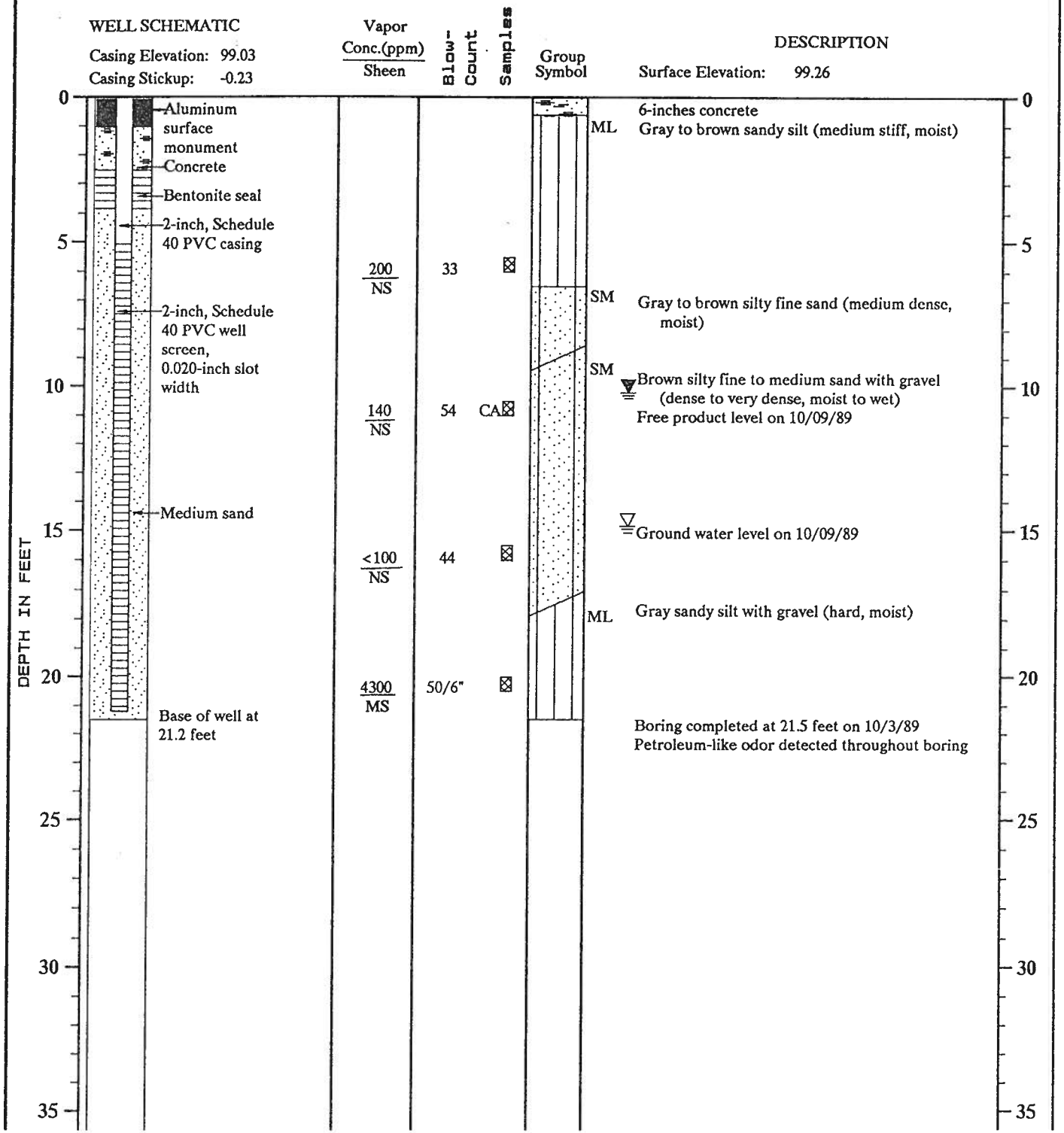
MONITOR WELL NO. MW-8



TEP:OKP:CDO 1/10/90

MONITOR WELL NO. MW-9



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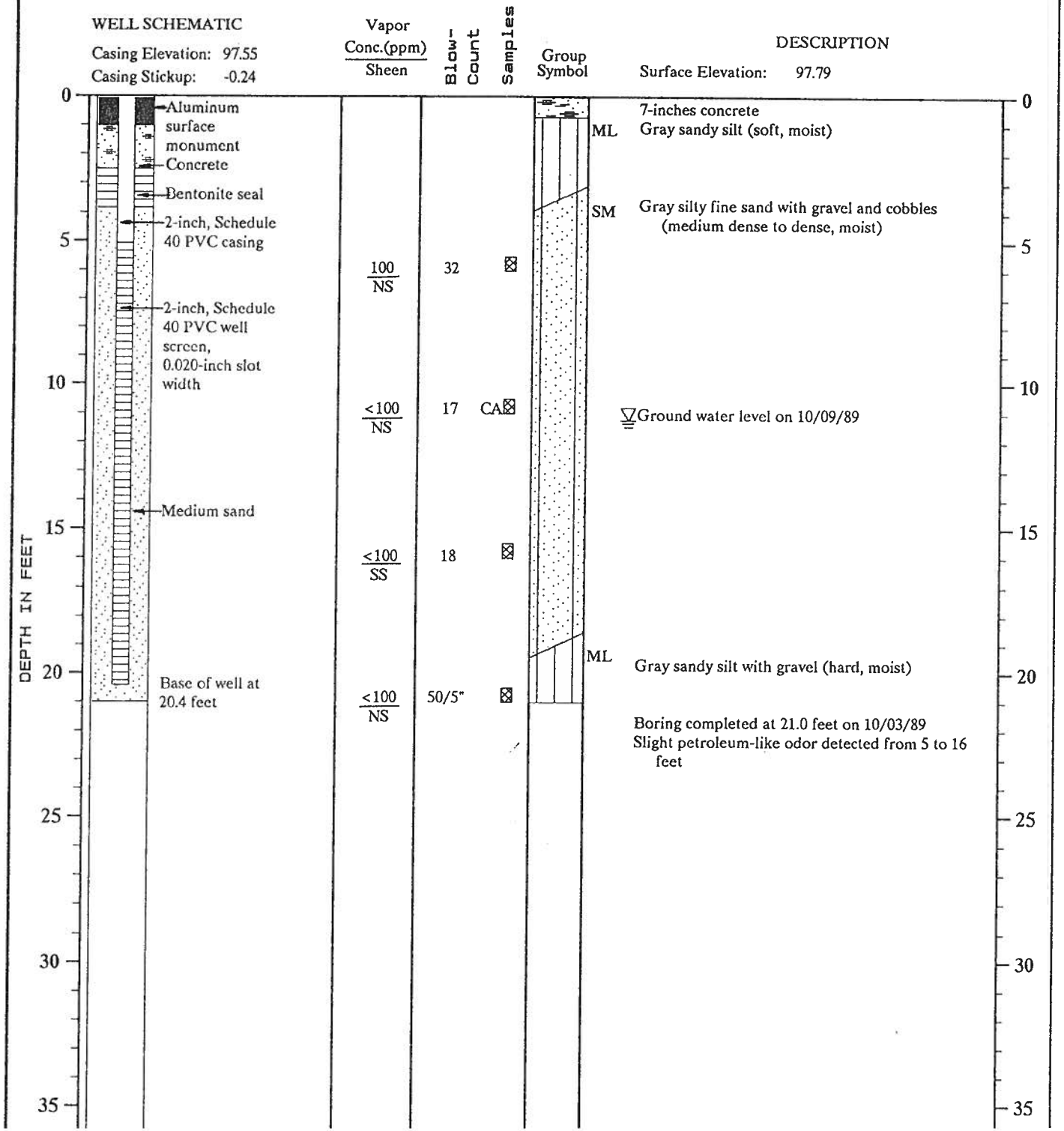
MONITOR WELL NO. MW-10



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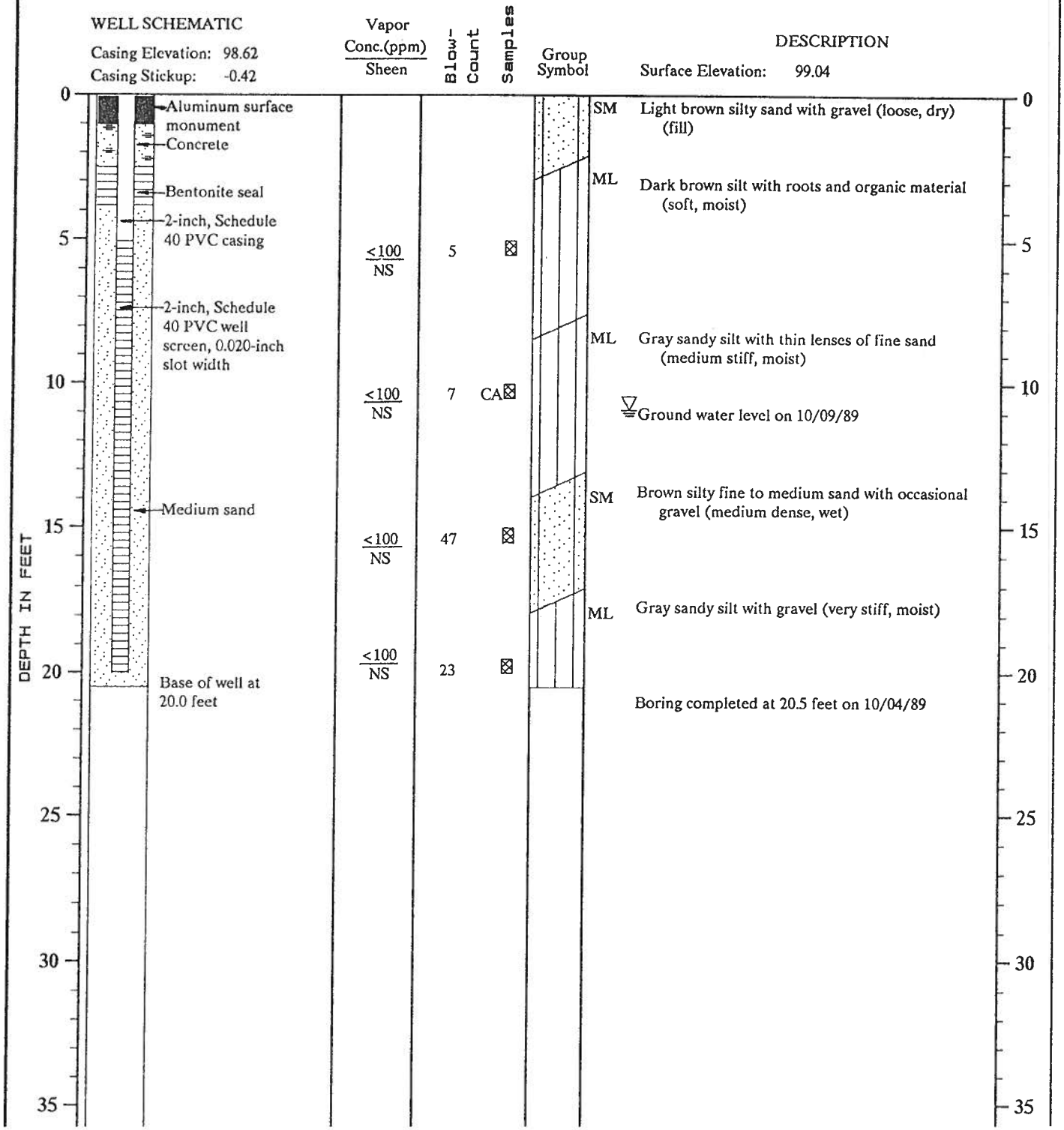

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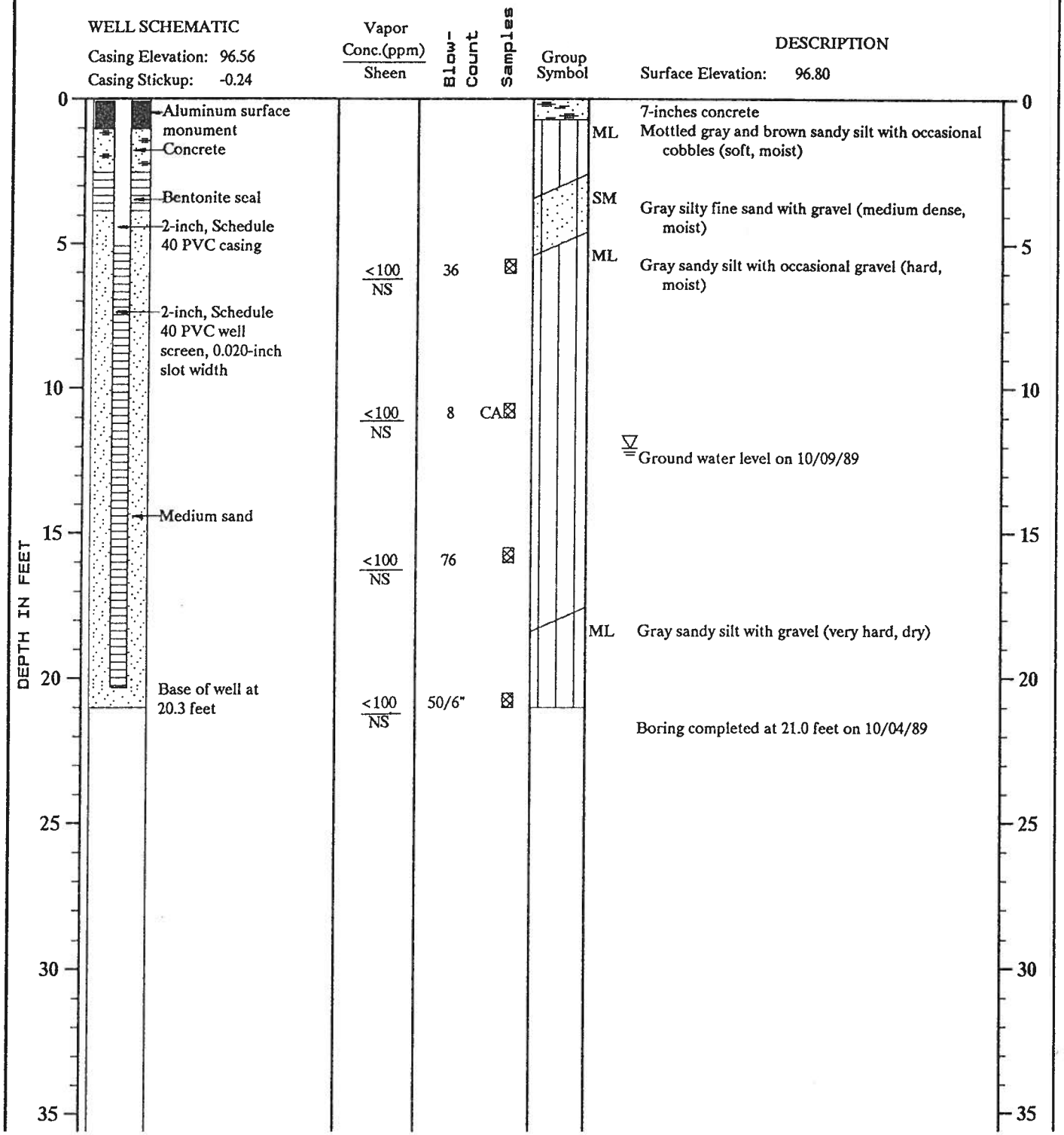
MONITOR WELL NO. MW-12



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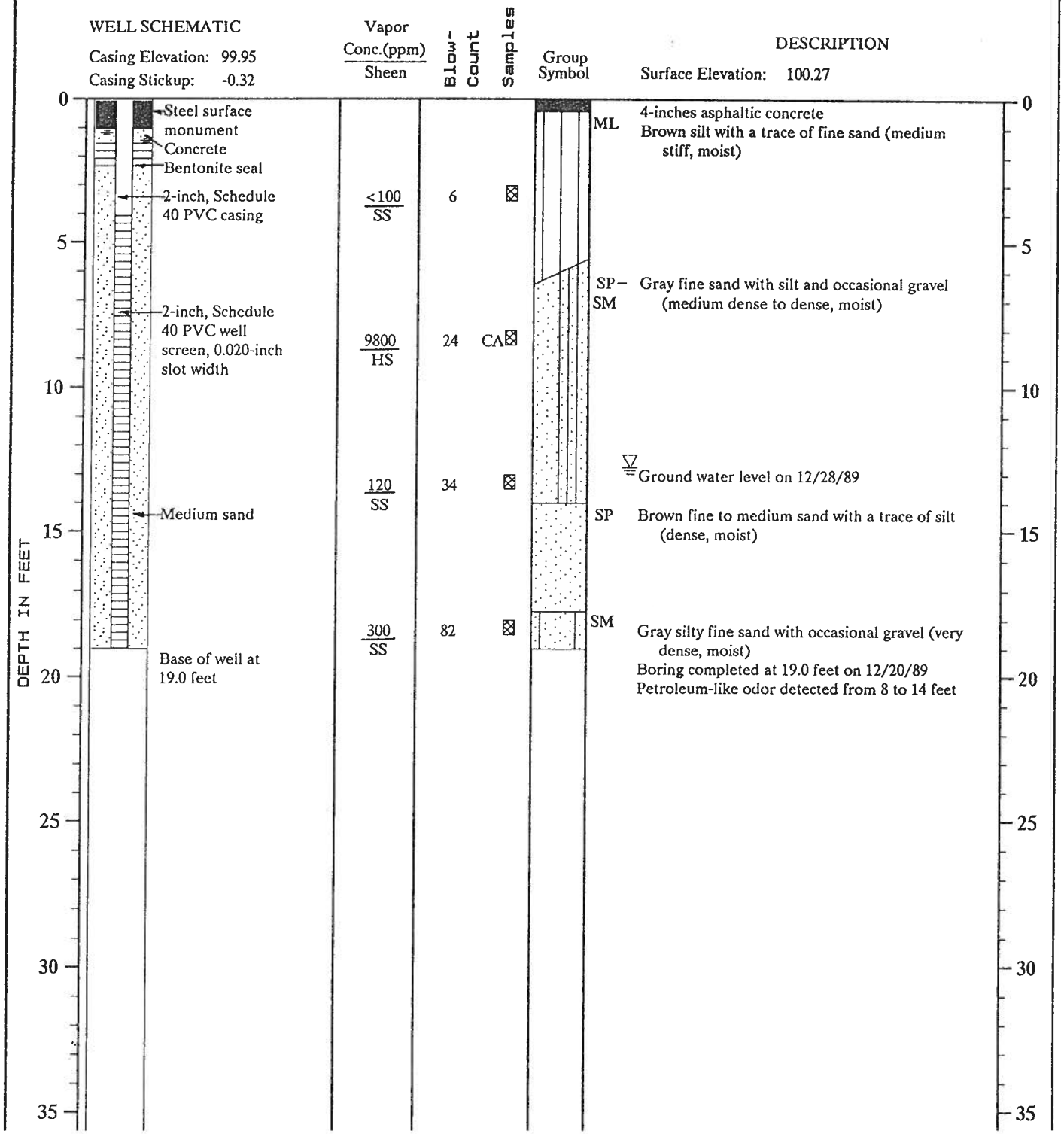
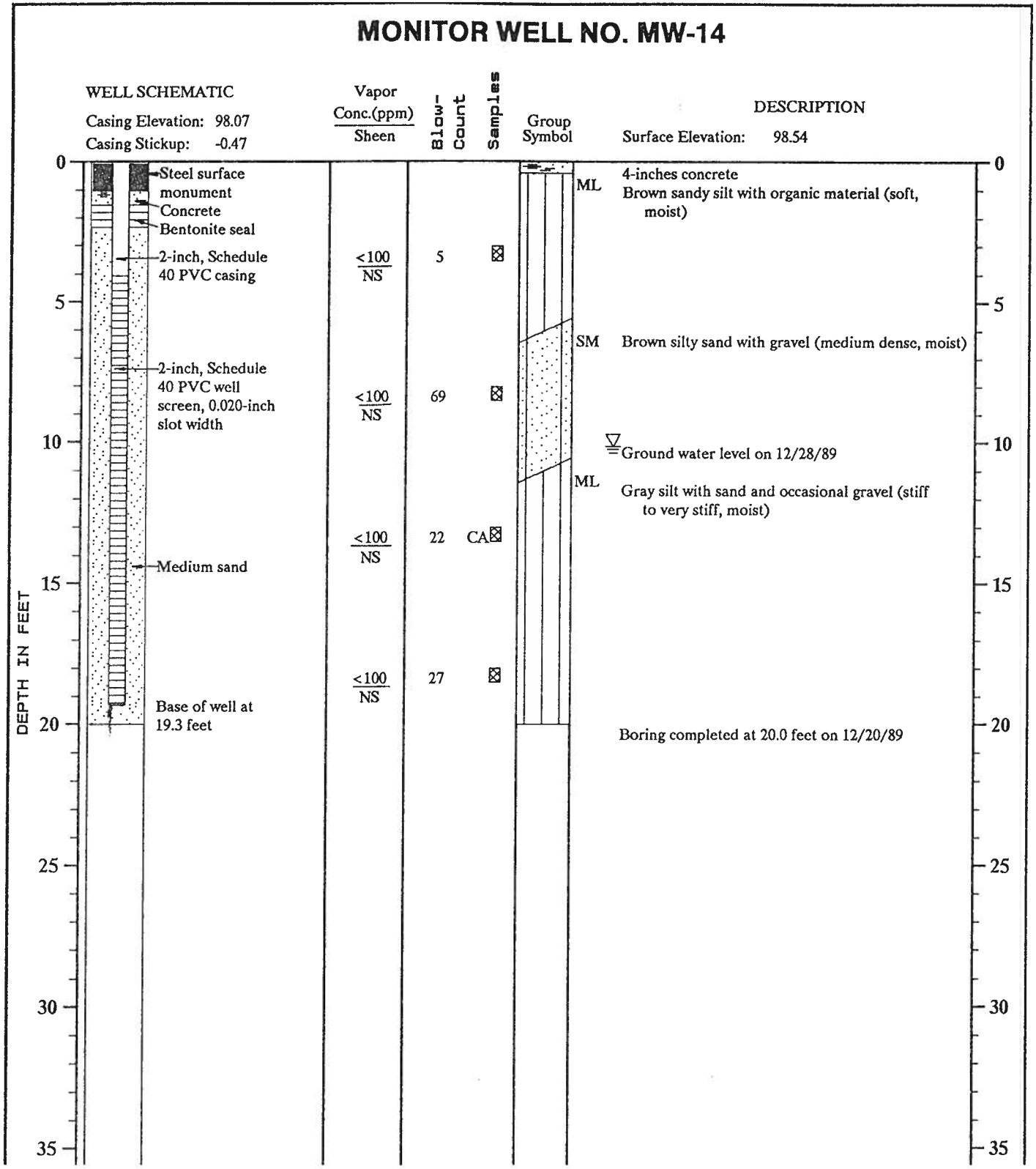
MONITOR WELL NO. MW-13



TEP:OKP:CDO 2/8/90

MONITOR WELL NO. MW-14



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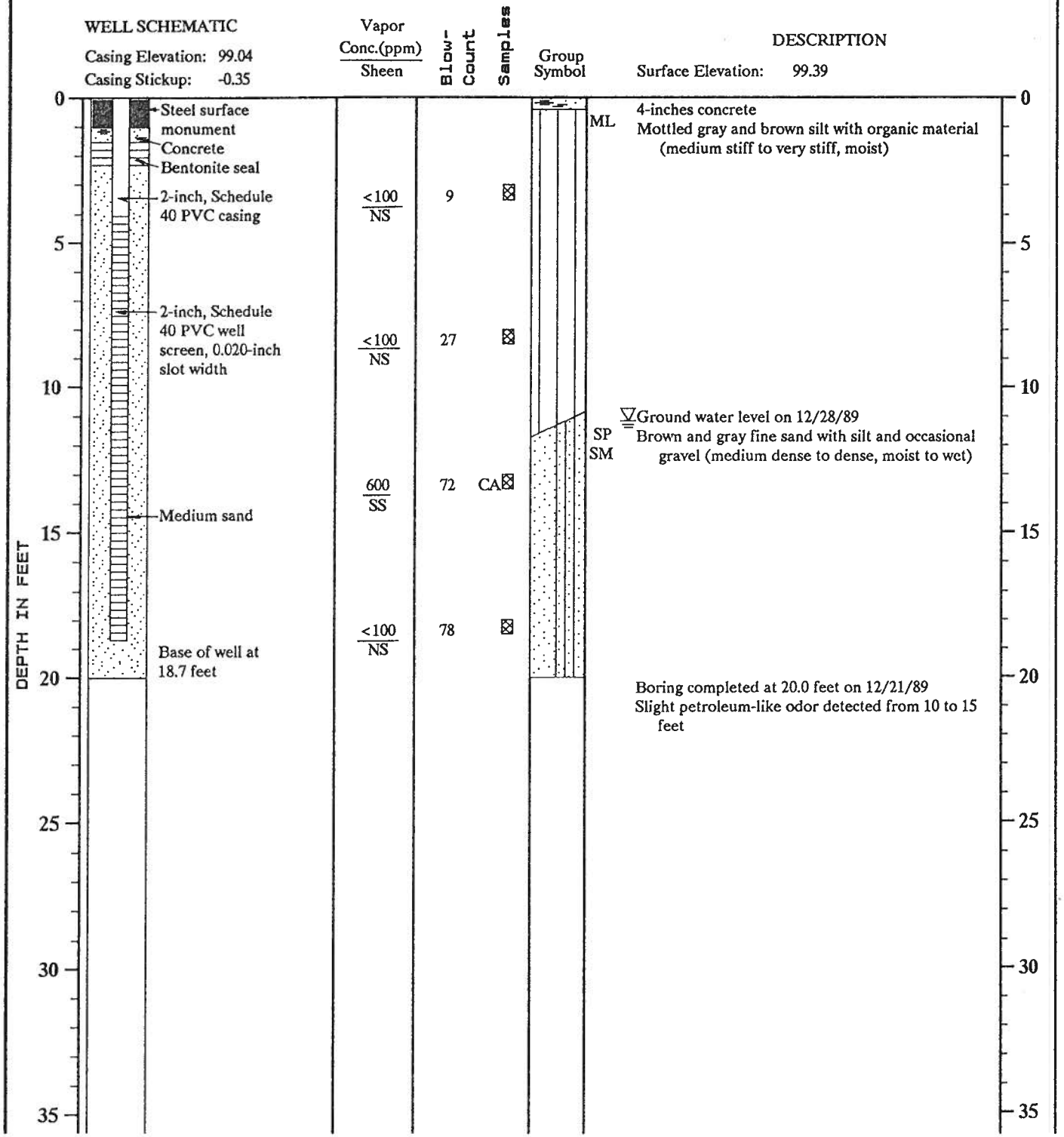
MONITOR WELL NO. MW-15



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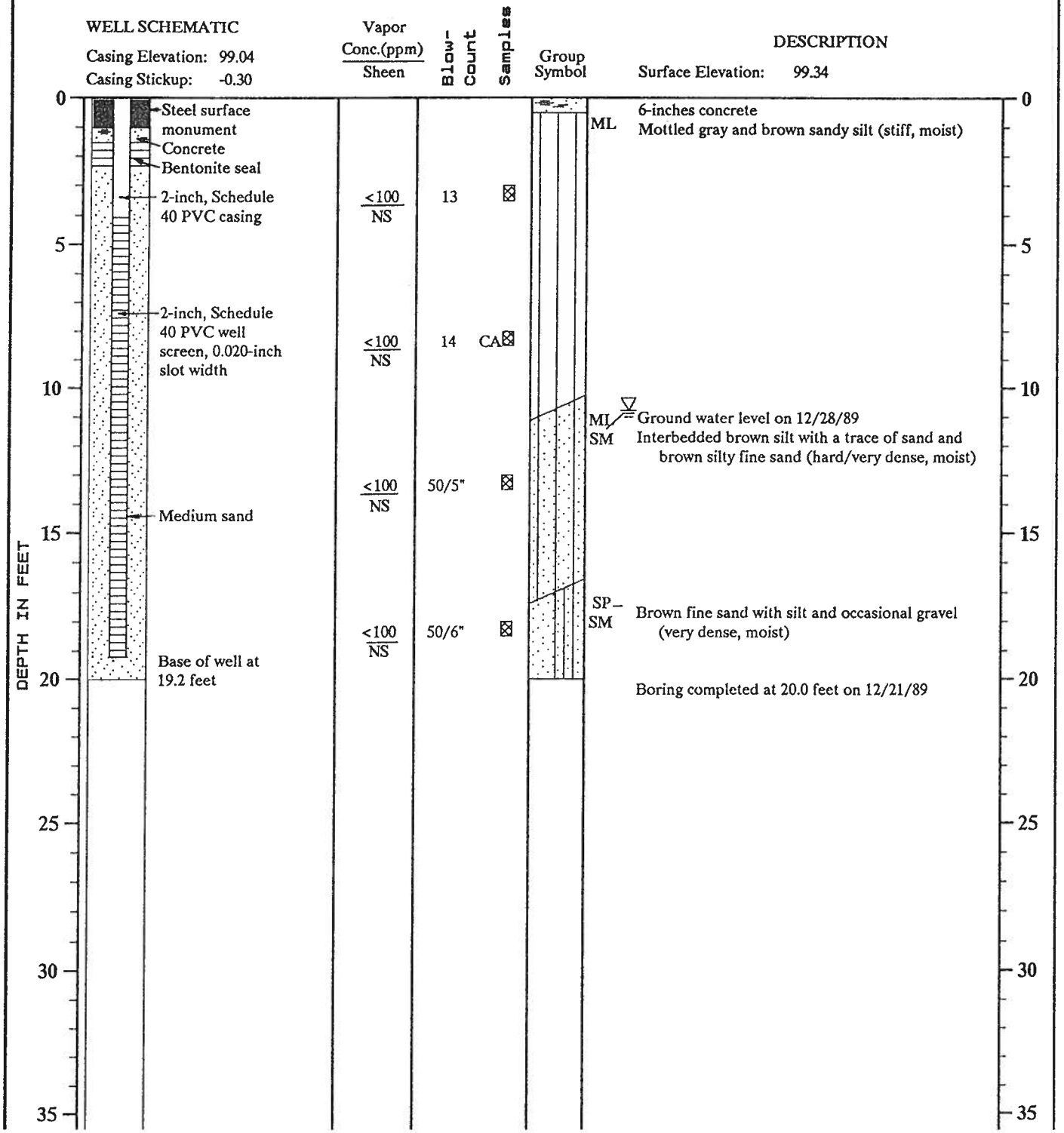
MONITOR WELL NO. MW-16



TEP:OKP:CDO 1/10/90

Soil Classification System

MAJOR DIVISIONS			GRAPHIC SYMBOL	USCS LETTER SYMBOL[1]	TYPICAL DESCRIPTIONS [2][3]
COARSE-GRAINED SOIL (More than 50% of material is larger than No. 200 sieve size)	GRAVEL AND GRAVELLY SOIL (More than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVEL (Little or no fines)		GW	Well-graded gravel; gravel/sand mixture(s); little or no fines
				GP	Poorly graded gravel; gravel/sand mixture(s); little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)		GM	Silty gravel; gravel/sand/silt mixture(s)
				GC	Clayey gravel; gravel/sand/clay mixture(s)
	SAND AND SANDY SOIL (More than 50% of coarse fraction passed through No. 4 sieve)	CLEAN SAND (Little or no fines)		SW	Well-graded sand; gravelly sand; little or no fines
				SP	Poorly graded sand; gravelly sand; little or no fines
		SAND WITH FINES (Appreciable amount of fines)		SM	Silty sand; sand/silt mixture(s)
				SC	Clayey sand; sand/clay mixture(s)
FINE-GRAINED SOIL (More than 50% of material is smaller than No. 200 sieve size)	SILT AND CLAY (Liquid limit less than 50)			ML	Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity
				CL	Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay
				OL	Organic silt; organic, silty clay of low plasticity
	SILT AND CLAY (Liquid limit greater than 50)			MH	Inorganic silt; micaceous or diatomaceous fine sand
				CH	Inorganic clay of high plasticity; fat clay
				OH	Organic clay of medium to high plasticity; organic silt
	HIGHLY ORGANIC SOIL			PT	Peat; humus; swamp soil with high organic content

OTHER MATERIALS	GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
PAVEMENT		AC or PC	Asphalt concrete pavement or Portland cement pavement
ROCK		RK	Rock (See Rock Classification)
WOOD		WD	Wood, lumber, wood chips
DEBRIS		DB	Construction debris, garbage

Notes:
1. USCS letter symbols correspond to symbols used by the Unified Soil Classification System and ASTM classification methods. Dual letter symbols (e.g., SP-SM for sand or gravel) indicate soil with an estimated 5-15% fines. Multiple letter symbols (e.g., ML/CL) indicate borderline or multiple soil classifications.
2. Soil descriptions are based on the general approach presented in the Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), outlined in ASTM D 2488. Where laboratory index testing has been conducted, soil classifications are based on the Standard Test Method for Classification of Soils for Engineering Purposes, as outlined in ASTM D 2487.
3. Soil description terminology is based on visual estimates (in the absence of laboratory test data) of the percentages of each soil type and is defined as follows:

Primary Constituent:	> 50% - "GRAVEL," "SAND," "SILT," "CLAY," etc.
Secondary Constituents:	> 30% and ≤ 50% - "very gravelly," "very sandy," "very silty," etc.
	> 15% and ≤ 30% - "gravelly," "sandy," "silty," etc.
Additional Constituents:	> 5% and ≤ 15% - "with gravel," "with sand," "with silt," etc.
	≤ 5% - "with trace gravel," "with trace sand," "with trace silt," etc., or not noted.

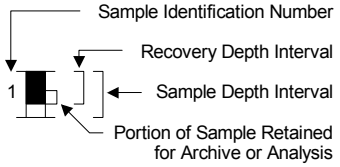
4. Soil density or consistency descriptions are based on judgement using a combination of sampler penetration blow counts, drilling or excavating conditions, field tests, and laboratory tests, as appropriate.

Drilling and Sampling Key

SAMPLER TYPE

Code	Description
a	3.25-inch O.D., 2.42-inch I.D. Split Spoon
b	2.00-inch O.D., 1.50-inch I.D. Split Spoon
c	Shelby Tube
d	Grab Sample
e	Single-Tube Core Barrel
f	Double-Tube Core Barrel
g	2.50-inch O.D., 2.00-inch I.D. WSDOT
h	3.00-inch O.D., 2.375-inch I.D. Mod. California
i	Other - See text if applicable
1	300-lb Hammer, 30-inch Drop
2	140-lb Hammer, 30-inch Drop
3	Pushed
4	Vibrocore (Rotosonic/Geoprobe)
5	Other - See text if applicable

SAMPLE NUMBER & INTERVAL



Field and Lab Test Data

Code	Description
PP = 1.0	Pocket Penetrometer, tsf
TV = 0.5	Torvane, tsf
PID = 100	Photoionization Detector VOC screening, ppm
W = 10	Moisture Content, %
D = 120	Dry Density, pcf
-200 = 60	Material smaller than No. 200 sieve, %
GS	Grain Size - See separate figure for data
AL	Atterberg Limits - See separate figure for data
GT	Other Geotechnical Testing
CA	Chemical Analysis

Groundwater

▽ Approximate water level at time of drilling (ATD)

▼ Approximate water level at time other than ATD

LANDAU ASSOCIATES

Montlake Neighborhood
Former Dry Cleaner
Seattle, Washington

Soil Classification System and Key

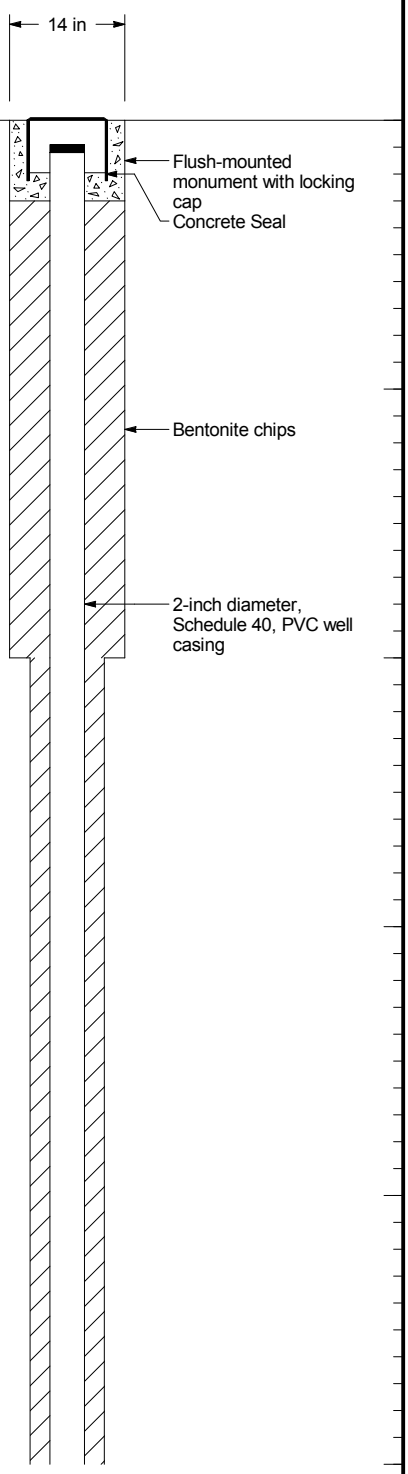
Figure
A-1

MW-3

Depth (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol	Soil Profile
							Drilling Method: Hollow-Stem Auger Ground Elevation (ft): 64.08
0							No samples collected between 0-12 ft bgs
10		a2	53	28.8		SP-SM	Gray, fine to medium SAND with silt and gravel (gasoline-like odor, no sheen) (medium dense, wet)
		a2	55	12.4			
		a2	30	0.8			grading to silty, fine SAND to SILT with fine sand and gravel
		a2	51	0.4		ML	
20		a2	100	0.3			Gray SILT with fine sand and gravel (no odor, no sheen) (very stiff to hard, moist)
		a2	70	0.4			
30		a2	50/6"	0.7			
		a2	50/6"	0.0			
40		a2	50/6"	0.0			
		a2	50/6"	0.0			
50							

Water Level: ATD

Monitoring Well Detail



Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1352001. 5/23/13 \\EDMDATA01\GINT\PROJECTS\1352001.GPJ WELL LOG

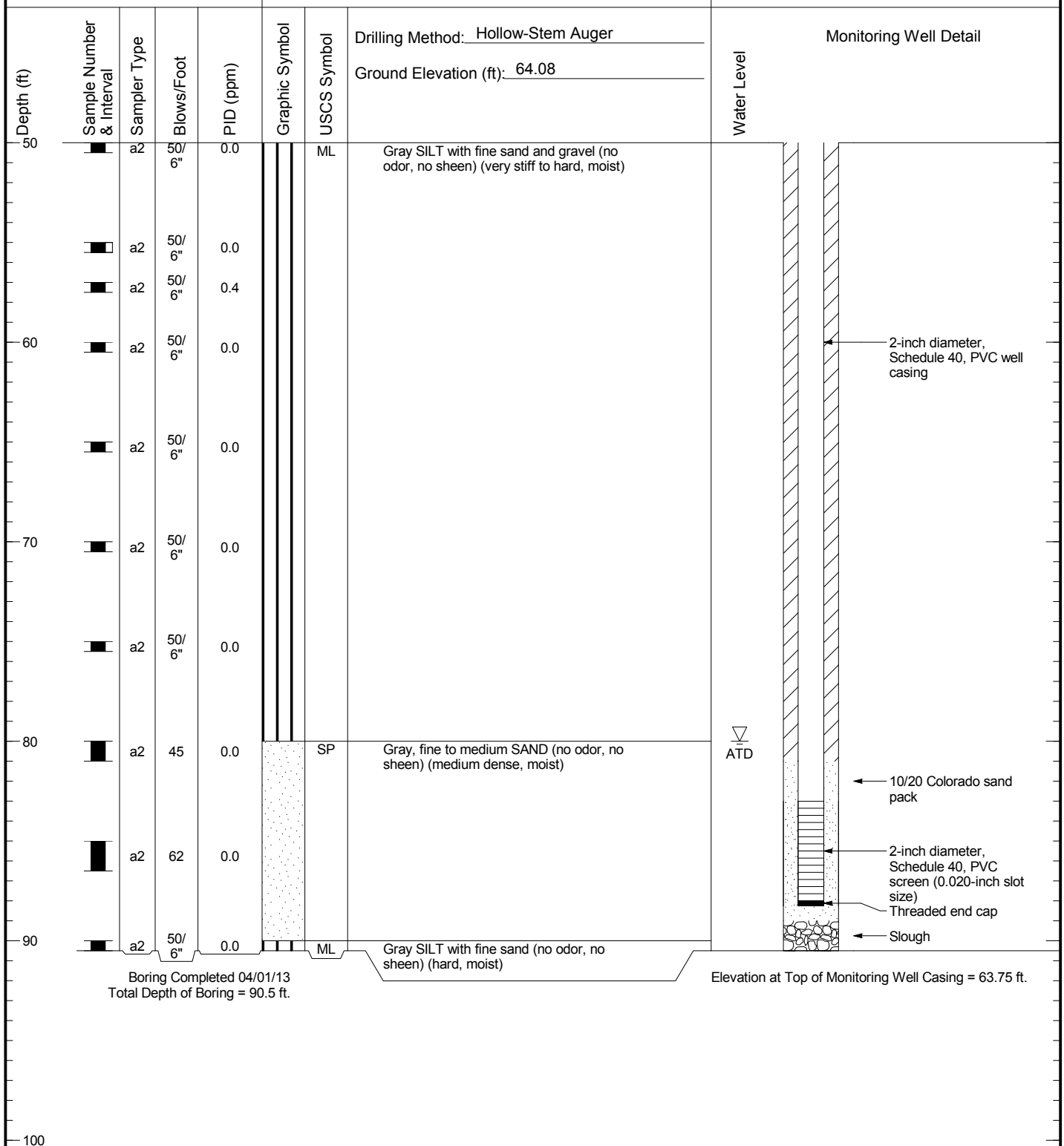
LANDAU ASSOCIATES

Montlake Neighborhood
Former Dry Cleaner
Seattle, Washington

Log of Monitoring Well MW-3

Figure
A-10
(1 of 2)

MW-3



Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1352001. 5/23/13 \\EDMDATA01\GINT\PROJECTS\1352001.GPJ WELL LOG

LANDAU ASSOCIATES

Montlake Neighborhood
Former Dry Cleaner
Seattle, Washington

Log of Monitoring Well MW-3

Figure
A-10
(2 of 2)

Appendix B

Standard Operating Guidelines

APPENDIX B

STANDARD OPERATING GUIDELINES

Table of Contents

Standard Operating Guideline
01 Measuring Groundwater Levels

Introduction

This guideline describes the field procedure typically followed by Kennedy/Jenks Consultants when measuring groundwater levels. Groundwater levels in wells will be measured prior to commencing developing, purging, sampling, and pumping tests.

Equipment

- Electronic water level monitoring probe or other measuring device
- Decontamination supplies (e.g., buckets, Alconox or similar, distilled water, squirt bottle)
- Field notebook
- Groundwater purge-and-sample form(s) if in conjunction with groundwater sampling
- Keys for locks (if necessary)
- Tools to open well covers (e.g., socket wrench, spanner wrench)
- Disposable gloves (as a minimum), and other protective clothing (as necessary).

Typical Procedure

1. If more than one well will be measured, begin depth measurement in the order in terms of lowest to highest chemical concentrations in the monitoring wells.
2. Remove well caps from all wells prior to initiation of water level measurement activities. This will allow wells to equilibrate, if necessary.
3. If the potential exists for floating product (LNAPL) to be present, use an electric oil-water interface probe or oil-sensitive paper to measure depth of the floating product and the electronic depth probe to measure the depth-to-water. Record both depths in field notebook and note the water depth as the "depth with oil layer present." Unless otherwise instructed, always measure depths to floating product layer and groundwater from the top of the north side of the well casing.
4. When floating product is not present, measure depth-to-water using a pre-cleaned water level probe from the top of the north side of the well casing, unless otherwise instructed.
5. Repeat measurements a minimum of three times or have field partner confirm measurement.
6. Record time of day the measurement was taken using military time (e.g., 16:00).
7. Measure the depth the bottom of the well to check for silt accumulation, if needed.
8. Decontaminate water level and/or oil-water interface probe and line prior to reuse (refer to SOG for Equipment Decontamination).

Standard Operating Guideline
02 Groundwater Sampling

Introduction

This Standard Operating Guideline (SOG) provides the procedures typically followed by Kennedy/Jenks Consultants personnel during the collection of groundwater samples from monitoring wells. This SOG provides guidance on procedures that are generally consistent with standard practices used in environmental sampling. Federal, state and/or local regulatory agencies may require groundwater sampling procedures that differ from those described in this SOG and/or may require additional procedures. As guidance, this SOG does not constitute a specification of requirements for groundwater sampling. Deviations from, and additions to, the procedures described herein may be appropriate based on project-specific sampling objectives, site-specific conditions, and/or regulatory requirements. The user of this SOG should modify the sampling procedures used, as appropriate, to conform to the project-specific requirements and then document such deviations from this SOG in the project-specific documentation of groundwater sampling activities.

This SOG does not address Quality Assurance/Quality Control (QA/QC) procedures for groundwater sampling in detail. While some general QA/QC procedures are addressed, project-specific QA/QC procedures should be developed and presented in a Quality Assurance Project Plan (QAPP), field sampling and analysis work plan, or other project- or activity-specific document.

This SOG contains the following sections:

- Field Equipment/Material
- Typical Procedures for Monitoring Well purging and Groundwater Sampling
- Stabilization Criteria for Adequacy of Monitoring Well Purging
- Typical Procedures for Groundwater Sampling using Passive Diffusion Bags (PDBs)
- Quality Control Guidance
- Investigation-Derived Waste (IDW) Management
- References

Field Equipment/Materials

Material/equipment typically required for the collection of groundwater samples from monitoring wells may include:

- Electric water-level monitoring probe
- Multi-phase interface monitoring probe
- Bladder pump, peristaltic pump, pre-cleaned, disposable, 2- or 4-inch bailers with disposable cord, inertial pump, submersible pump, passive diffusion bags or other suitable apparatus for purging the well and sampling
- Flexible discharge tubing [polyethylene (PE), Teflon™, or similar]

- Purge water collection container
- Multi-parameter water quality meter (temperature, pH, specific conductance, redox potential)
- Turbidity meter
- Flow-through cell
- Nitrocellulose filters (if conducting field filtering)
- Sample containers (laboratory-supplied) with appropriate preservatives
- Additional chemical preservatives (if necessary)
- Watch or stopwatch
- Sample labels, pens, field logbook, or other appropriate field forms (e.g., groundwater purge and sample forms, chain-of-custody forms), and access agreements and third-party sample receipts (if warranted)
- Previous purging and sampling data for monitoring wells to be sampled, including water levels, purging parameters, and laboratory analysis results.
- Monitoring well boring and construction log (including wellhead elevation survey and reference point information)
- Personnel and equipment decontamination supplies
- Sample shipping and packaging supplies
- Personal protective equipment as specified in the Health and Safety Plan (HASP).

Typical Procedures for Monitoring Well Purging and Groundwater Sampling

1. **Pre-Purging Data Collection and Purging Equipment Placement.** Record the data and information collected during this procedure on a groundwater purge and sample form. Perform the following prior to groundwater sampling:
   a. Calibrate the multi-parameter water quality meter, prior to beginning sampling and as necessary based on field conditions, in accordance with the instructions in the manufacturer's operation manual. Note that it may be appropriate to keep a written log of the calibration procedures and an instrument maintenance with the instrument.
   b. Examine the monitoring well to be sampled and associated protective surface enclosure for any structural damage, poorly fitting caps, and leaks into the inner casing. If notable conditions exist, they should be recorded on the sampling log for the well so that any necessary follow-up corrective actions can be planned and implemented.
   c. Record an initial measurement of the depth to water. Calculate the volume of water in the well casing if wetted-casing-volume-based purging is to be used to remove the so-called "stagnant water" from the well prior to sampling. The volume of water in the wetted well casing should be calculated using the formula: $V = (\pi r^2) \times L$ where r is one half of the inner diameter of the well casing/screen and L is the length of wetted casing/screen (calculated by subtracting the depth to water from the total well depth). Total well depth should not be measured at the start of a sampling event (due to the potential to cause turbidity). Measure the total well depth after sample collection. Note that some regulatory agencies require that the calculated "stagnant water" volume include the water contained in the pores space of the wetted portion of the monitoring well filter pack in

addition to the casing/screen. If this is a requirement, it should be defined in the project-specific sampling requirements.

d. If light non-aqueous phase liquid (LNAPL) is potentially present, measure the depth and thickness of the LNAPL and the static water level using a multiphase interface monitoring probe. Use one of the following devices for purging:
e. Bladder pump: adjust the pump intake at a depth approximately equal to the middle or just slightly below the middle of the well screen interval or water column unless another position is justified based on site-specific conditions.
f. Peristaltic pump: place the pump intake at a depth equal to the approximate middle or just slightly above the middle of the saturated well screen interval or water column unless another position is justified based on site-specific conditions. Note: If degassing of water is occurring when sampling with a peristaltic pump, alternative types of sampling equipment should be used for volatile organic compound (VOC) or volatile petroleum hydrocarbon (VPH) sample collection.
g. Inertial pump: place the pump intake at a depth approximate to the middle or just slightly below the middle of the well screen interval or water column unless another position is justified based on site-specific conditions. Note: Some studies suggest that the use of inertial pumps for purging and/or sampling may produce a low bias when collecting samples for VOC and VPH analyses. This should be considered along with regulatory requirements when selecting an inertial pump for purging and/or sampling.
h. Submersible pump: place the pump intake at a depth approximate to the middle or just slightly below the middle of the well screen interval unless another position is justified based on site-specific conditions.
i. Pre-cleaned or disposable bailers. Note: The use of bailers for low-flow purging/sampling is not appropriate.
j. Another suitable purging/sampling device may be selected for use depending upon project requirements.

2. **Monitoring Well Purging and Sampling.** When purging of a monitoring well prior to sampling is appropriate and/or required, purge the well using either (a) wetted-casing-volume-based purging or (b) low-flow purging as described in the following sections. If a well exhibits evidence of slow recharge, or produces excessively silty water, etc., the well may need to be redeveloped.
   a. Wetted-casing-volume-based purging.
      (1) Establish a purging rate to pump or bail approximately three wetted-casing volumes of groundwater without dewatering the well.
      (2) If using a pump, set-up the discharge tubing, flow-through cell, water quality meter, and purge water collection container. If turbidity is measured, collect the sample for turbidity measurement after groundwater passes through the flow-through cell in the vial provided with the turbidity meter. If using a bailer, maintain a clean plastic container next to the well for collecting observation samples. Begin purging the well.
      (3) At the beginning of purging and periodically thereafter, record the following information and water quality parameters/observations on the groundwater purge and sample form: As guidance, field parameters may be measured after one purge volume is removed and every ½ purge volume thereafter.
         - Date and time
         - Purge volume and/or flow rate

- Water depth
- Temperature
- pH
- Specific conductance
- Dissolved oxygen
- Oxidation-reduction potential (ORP)
- Other observations as appropriate (turbidity, color, presence of odors, sheen, etc).

(4) Continue purging until water quality parameters have stabilized (refer to "Stabilization Criteria for Adequacy of Monitoring Well Purging" below) and/or a minimum of three wetted-casing volumes of water have been removed from the well. If a well purges dry, let it recover to 80 percent of original water column, then sample. If the well takes a very long time to recover (i.e., longer than 2 hours), try to sample the well at the end of day or first thing the next day.

(5) Collect the sample in pre-cleaned sample containers suitable for the laboratory analyses to be performed.

(6) If sampling using a bailer, use a bottom-emptying device or other technique to avoid sample agitation. If the collected water is very turbid, or a bottom-emptying bailer is not used, properly transfer the water from the bailer into the appropriate sample containers. Be careful to avoid agitating the sample. When sampling for VOCs, turn the bottle upside down after filling the container to identify possible headspace. If bubbles are present, top off the sample container or resample.

b. Low-flow purging and sampling.

(1) Place the pump intake at a depth equal to the approximate middle or just slightly above the middle of the saturated well screen interval or water column or otherwise as dictated by well-specific soil stratigraphy and project-specific requirements**.** For example, it may be appropriate that the pump intake be set opposite to any preferential flow pathways (i.e., zones of higher permeability).

(2) Place an electronic water-level indicator probe in the well, approximately 0.5 to 3 inches below the piezometric surface. If available, a transducer of sufficient accuracy can also be used to measure depth to water when purging.

(3) Connect the pump discharge tube to a flow-through cell housing a water quality parameter probe.

(4) Activate the pump for purging at a flow rate ranging from approximately 0.1 to 0.5 liters per minute (L/min) or other flow rate as dictated by project-specific and/or site-specific requirements. (Note: Some regulatory agencies may require specific flow rates). Determine the flow rate by timing the rate at which the flow-through cell is filled.

(5) During purging, monitor the water level in the well to evaluate potential drawdown. The goal is to minimize drawdown to less than approximately 4 inches. If drawdown is observed (especially rapid drawdown at the beginning of purging), decrease the pumping rate.

(6) Measure water quality parameters at approximately 3- to 5-minute intervals during purging. Continue purging until water quality parameters have

stabilized (refer to "Stabilization Criteria for Adequacy of Monitoring Well Purging" below)

(7) Immediately after purging, collect the sample in pre-cleaned sampled containers suitable for the laboratory analyses to be performed using the same flow rate that was used during purging unless it is necessary to decrease the rate to minimize aeration or turbulent filling of sample containers. If sampling for VOCs or VPH reduce the flow rate to 0.1 L/min or less.

3. **Sampling with LNAPL Present in a Monitoring Well.** Wells containing LNAPL are typically not sampled for dissolved phase constituents in groundwater due to the potential for entrainment of LNAPL in the aqueous sample matrix. If such sampling is required, and purging is not required, make sure the pump intake is placed in the upper 2 feet of water column and collect the samples without purging in a manner that reduces the potential for mixing of the groundwater sample with air or LNAPL. If groundwater sampling is required from wells containing LNAPL for the purposes of characterizing VOCs, and purging is required, purge the well prior to sampling unless or until LNAPL becomes entrained in the sampling apparatus. If LNAPL will likely become entrained in the groundwater, the sample should be collected without purging. If LNAPL becomes entrained in the sampling apparatus then the sampling effort for VOCs should be aborted.
4. **Field Filtering Groundwater Samples.** Groundwater sample filtering and/or preservation should be performed in accordance with the requirements of the analytical method being specified and any other project-specific requirements. For example, samples collected for dissolved metals are typically filtered using a 0.45 µm filter.
5. **Sample Collection Considerations.** When multiple analyses will be performed, collect the samples in order of decreasing sensitivity to volatilization (i.e., VOC samples first and metals last). When sampling for VOCs, turn the sample container upside down after filling to identify possible headspace. If bubbles are present, top off the sample bottle or resample (do not reuse bottles, especially if they have been pre-preserved by the vendor or laboratory). If possible, the pump should not be moved or turned off between purging and sampling; however, the pump may need to be turned off for a very brief period (as a practical matter) so field personnel can handle samples and minimize the potential for water to splash on the ground surface. The ground surface should be protected from incidental splashing, especially if water from the well would be considered a hazardous waste for disposal purposes.
6. **Monitoring Wells with Slow Recharge.** If a well purges dry, let it recover to 80 percent of original water column, then sample. If the well takes a very long time to recover (i.e., longer than 2 hours), try to sample the well at the end of day or first thing the next day.
7. **Sample Container Filling and Shipping.** Fill the appropriate containers for the analyses to be requested and ensure that the required label information is completely and accurately filled in. Follow sampling packaging, shipping, and chain-of-custody procedures (see applicable SOG).
8. **Decontamination.** Follow personnel and equipment decontamination procedures (see SOG10).

Stabilization Criteria for Adequacy of Monitoring Well Purging

Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EPA 2001) states that "with respect to groundwater chemistry, an adequate purge is achieved when pH, specific conductance, and temperature of groundwater have stabilized and the turbidity has either stabilized or is below 10 Nephelometric Turbidity Units (NTUs). Wells should be considered stable when the criteria listed in the following table have been met for pH, specific conductance, temperature, and turbidity. Attempts should also be made to stabilize ORP and dissolved oxygen.

Field Parameter Stabilization Parameter Summary

Field Parameters	Stabilization Criteria for Three or More Consecutive Readings	Notes
pH	Difference between three or more consecutive readings is within ±0.2 units	–
Temperature	Difference between three or more consecutive readings is constant	–
Specific Conductance	Difference between three or more consecutive readings is within ±3%	–
Turbidity	Difference between three or more consecutive readings is within ±10% or three consecutive readings below 10 NTUs	Generally, turbidity is the last parameter to stabilize. Attempts should be made to achieve stabilization; however, this may not be possible. It should be noted that natural turbidity in groundwater may exceed 10 NTUs. If turbidity is greater than 50 NTU, redevelopment of the well may be warranted.
ORP	Difference between three or more consecutive readings is within ±20mV	Very sensitive. Attempts should be made to achieve stabilization; however, due to parameter sensitivity this may not be possible.
Dissolved Oxygen	Difference between three or more consecutive readings is within ±10% or ±0.2 milligrams per liter (mg/L), whichever is greater	Very sensitive. Attempts should be made to achieve stabilization, especially when collecting samples of VOC analysis; however, due to parameter sensitivity this may not be possible.

Attempts should be made to achieve the stabilization criteria. Because of geochemical heterogeneities in the subsurface environment, stabilization of field parameters during purging may not always be achievable. If field parameter measurements do not indicate stabilization, continued conventional purging may be required until a minimum of three wetted-casing volumes have been removed. During low-flow purging of a well containing a large volume of casing water, it may be practical to discontinue low-flow purging and proceed with sampling if field parameters have not stabilized within a reasonable period. This judgment must be made on a site-specific/project-specific basis.

Quality Control Guidance

Follow the quality control requirements specified in the Quality Assurance Project Plan (QAPP), project-specific field sampling and analysis work plan, and/or project-specific regulatory requirements, as applicable. The following may be used as guidelines.

1. Approximately one duplicate sample should be obtained for each sampling event or for each batch of samples (a batch is typically defined as 20 samples). Collect duplicate samples immediately after the original samples are collected. Purging is not performed between original sample collection and collection of duplicate samples. Original and duplicate samples are collected sequentially, without appreciable delay between collection cycles. Duplicate samples are to be submitted to the laboratory blind (i.e., not identified as a duplicate sample).
2. Typically, at least one type of field blank sample (rinsate or transfer) should be collected per day of water sampling. All field blank samples are to be collected, preserved, labeled, and treated like any other sample. Field blank samples are to be sent blind to the laboratory (i.e., not identified as a field blank). Record in the field notebook the collection of any blank sample (rinsate, transfer, trip). The types of field blank samples are discussed below.
    a. Rinsate blank samples. If rinsate field blank samples are required, prepare the sample by pouring deionized water over, around, and through the various reusable sampling implements contacting a natural sample. Rinsate blanks need not be collected when dedicated sampling equipment is used for purging and sampling the well. Rinsate blank samples are to be analyzed for the same parameters as the environmental samples.
    b. Transfer blank samples. Transfer blank samples are routinely prepared when no rinsate blank samples are collected. (The purpose of a transfer blank sample is to monitor for entrainment of contaminants into the sample from existing atmospheric conditions at the sampling location during the sample collection process.) A transfer blank sample is prepared by filling a sample container(s) with distilled or deionized water at a given sampling location. Transfer blank samples are to be analyzed for the same parameters as the environmental samples.
    c. Trip blank samples. Trip blank samples are submitted for VOC analysis to monitor for possible sampling contamination during shipment as volatile organic samples are susceptible to contamination by diffusion of organic contaminants through the Teflon-faced silicone rubber septum of the sample vial. Trip blank samples are prepared by the laboratory by filling VOA vials from organic-free water and shipped with field sample containers. Trip blank samples accompany the sample bottles through collection and shipment to the laboratory and are stored with the samples. It is suggested that a trip blank sample be included in each cooler of samples submitted for VOC analysis.

Investigation-Derived Waste (IDW) Management

Purge water is to be contained onsite in an appropriate labeled container for disposition by the client unless other project-specific procedures are defined. Other investigation-derived wastes, such as personal protective equipment, are to be properly handled and disposed. Preferably, PPE IDW should also be containerized and left onsite for disposal by the client. As a matter of practice, any waste, or potential waste, generated onsite, should remain onsite. Refer to SOG11.

REFERENCES

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U.S. Environmental Protection Agency. 2001. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM)*. Dated November 2001. U.S. EPA Region 4.

Vroblesky, Dan A. 2001. U.S. Geological Survey, User's Guide for Polyethylene Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells. Part 1: Deployment, Recovery, Data Interpretation, and Quality Control and Assurance. Water-Resources Investigations Report 01-4060. Columbia, South Carolina.

Standard Operating Guideline
03 Well Construction and Development

Introduction

This guideline describes procedures used by Kennedy/Jenks Consultants personnel for well construction and development following completion of boring and soil sampling procedures (described in Standard Operating Guideline, Boring and Subsurface Soil Sampling).

Well Construction Materials

- 2-inch or 4-inch Schedule 40 PVC blank casing
- 2-inch or 4-inch Schedule 40 PVC slotted casing, of appropriate slot size
- 2-inch or 4-inch Schedule 40 PVC threaded and slip caps
- 2-inch or 4-inch Schedule 40 stainless steel blank casing
- 2-inch or 4-inch Schedule 40 stainless steel wire wrapped casing, of appropriate slot size
- 2-inch or 4-inch stainless steel threaded and slip caps
- Stainless steel well centralizers
- 12-inch x 0.25-inch mild steel isolation casing with welded centralizers
- Hasp-locking standpipes
- Ground-level traffic-rated watertight well housing enclosure
- Locking expansion plugs
- Combination or key lock
- Filter pack sand (refer to Standard Operating Guideline, Design of Filter Packs and Selection of Well Screens for Monitoring Wells)
- Type I or II Portland cement
- Concrete
- Bentonite powder
- 0.25-inch bentonite pellets or chips.

Well Development Equipment

- 2-inch or 4-inch-diameter vented surge block
- 1-inch dedicated PVC hose for monitoring well development and purging
- Centrifugal surface pump
- Submersible pump (4-inch-diameter wells or larger)
- 55-gallon DOT-approved drums
- Teflon, stainless steel or PVC bailer
- Teflon-coated bailer retrieval wire
- Airlift pump with foot valve and compressor
- Bladder pump (2-inch diameter wells only)

Typical Procedure

1. Following completion of selected borings, install the monitoring well casing through the center of the hollow stem auger, drive casing, or open boring. The monitoring well consists of a PVC Schedule 40 slotted well casing of appropriate diameter and a blank casing with a threaded bottom cap and a slip or threaded top cap or watertight expansion plug. The casing string must be held in tension during initial installation.
2. Place clean, well graded sand around the slotted section of the monitoring well to serve as the filter pack. The grade of sand is chosen on the basis of aquifer units encountered (refer to Standard Operating Guideline, Design of Filter Packs and Selection of Well Screens for Monitoring Wells). The filter pack is emplaced as the auger or temporary casing is removed from the boring.
3. Ensure that filter pack sand for the well extends to approximately 3 feet above the top of the screened interval.
4. If required in the well construction permit, notify the appropriate inspector prior to placing the well seal.
5. Place a 2- to 3-foot thick bentonite pellet seal above the sand pack, as the auger and/or casing is removed from the boring. If the seal is placed above the water table, the bentonite pellets must be hydrated with potable water prior to placement of the annular seal.
6. Fill the remainder of the annulus between the well casing and the borehole wall with cement/bentonite grout (with approximately 5 percent bentonite), or a high-solids bentonite slurry (11 to 13 pounds per gallon), to a depth of approximately 1 foot below ground surface. If the water level is higher than the seal, use a tremie pipe to place the grout.
7. Install either a threaded cap or a locking watertight expansion plug on the monitoring well. Place a steel hasp-locking well housing over the top of the well and cement it into the annulus of the boring.
8. Place a traffic-rated precast concrete or steel well enclosure approximately 1 to 2 inches above grade, and cement it into place with concrete. Have a concrete apron constructed around the well housing enclosure to facilitate runoff.
9. For aboveground completion, ensure that the well casing extends approximately 3 feet above ground surface. An 8-inch diameter hasp-locking steel well housing surrounds the well casing. Traffic bollards can be installed around the well housing as necessary.
10. Repeat Steps 1 through 9 for all monitoring wells at site.
11. Following the curing of the grout (approximately 24 hours), each monitoring well is developed. Prior to development activities, measure the depth in each well to static water level and total casing depth.
12. Also prior to well development, if applicable, check the water interface of each monitoring well for the presence of floating product (NAPL). Use a clear bailer or color indicator paste for the inspection.
13. If a monitoring well has a water level of less than 25 feet, it may be developed by using a centrifugal surface pump with dedicated 1-inch I.D. clear flex suction hose, placed with the hose intake placed temporarily at all levels of the screened interval. If the well is greater than 25 feet deep, a submersible pump or airlift pump with air filter is used for development. In either case, a surge block of appropriate size can be moved up and down inside the screened section of the well casing to create a surging action that hydraulically stresses the filter pack.
14. During development of each well, ensure that field parameters and observations are recorded on a Kennedy/Jenks Consultants purge and sample form (attached). Information to be recorded includes, but is not limited to, the following items:

    Depth to water
    Development time and volume

Development (flow) rate
pH, temperature, specific conductivity, and turbidity
Other observations, as appropriate (e.g., color, presence of odors, or sheen)

15. Develop each monitoring well until water of relatively low turbidity is removed from the casing.
16. When development of each well is discontinued, record the following field parameters/observations:
    Depth to water
    Temperature
    pH
    Specific conductance
    Turbidity
    Color

Investigation-Derived Wastes

Place groundwater produced by well development in appropriately labeled containers for disposition by the client. Kennedy/Jenks Consultants is available to assist the client with options for disposition of groundwater.

Standard Operating Guideline
04 Typical Direct Push Sampling Procedures

Introduction

This guideline describes the equipment and procedures typically used by Kennedy/Jenks Consultants personnel for collecting soil and reconnaissance groundwater samples with a hydraulic push/drive system. Hydraulic push/drive sampling may be performed using a direct-push drill rig or using hand tools (for shallow samples).

Equipment

- Direct-push drill rig operated by a licensed driller
- Portable, hydraulic push/drive sampling system (for shallow samples)
- Stainless steel or brass liners and liner sealing materials (Teflon sheets, plastic end caps, Ziploc plastic bags), if needed.
- Sampler barrel and appropriate PVC liners, typically 4' to 5' feet long and 1.25", 2.25", or 3" (outside diameter)
- 1-inch O.D. Schedule 40 PVC screen (0.010-inch slot size)
- 1-inch O.D. Schedule 40 PVC blank casing
- 0.75-inch diameter stainless steel or Teflon bailer
- PID organic vapor analyzer
- Water level indicator and interface probe
- Temperature, specific conductivity and pH meters
- Equipment cleaning materials
    - Steam cleaner
    - Generator
    - Stiff-bristle brushes
    - Buckets
    - High-purity phosphate-free liquid soap
    - Deionized water
    - Rinsate collection system
- Personal protective equipment
- Appropriate groundwater sample containers
- Chain-of-custody forms
- Insulated sample storage container and ice substitute

Typical Procedures

1. Applicable drilling permits will be obtained prior to mobilization.
2. Sample locations will be cleared for underground utilities.
3. All downhole equipment will be steam cleaned prior to use at each location.
4. Soil borings will be advanced continuously until the desired bottom depth is reached, or refusal conditions are encountered. For each depth interval, the sampler barrel will be attached to drive rods and advanced by pushing and/or hydraulic hammering.

5. As the boring is advanced, continuous soil cores will be collected in the sample barrel. A new PVC liner will be installed in the sampler barrel prior to advancing each depth interval. Once each depth interval is reached, the sampler will be extracted and the inner PVC liner removed. The PVC liner will be cut open longitudinally to expose the soil core for sample collection and field logging. This process will be repeated until the desired depth is reached.
6. The soils will be classified in the field in approximate accordance with the visual-manual procedure of the Unified Soil Classification System (ASTM D-2488-93), and the Munsell Color Classification (see SOG 5).
7. Soil samples will be collected at selected intervals for laboratory analysis or archival as indicated in the Work Plan. Soil samples will be collected as described in SOG06 and SOG07.
8. Reconnaissance groundwater samples will be collected by installing a temporary PVC well screen in the boring once advanced to the desired depth as described in the Work Plan. Groundwater samples will then be collected from within the PVC casing using a peristaltic pump, or with a 0.75-inch diameter bailer if the water level is too deep for a peristaltic pump. Groundwater will be purged prior to collection of reconnaissance groundwater samples, at the discretion of the field personnel, to minimize sample turbidity. Purge water will be directed through a flow-through cell and field parameters will be measured as described in SOG02 (although parameter stability is not necessarily needed for reconnaissance samples).
9. The depth to groundwater and NAPL, if any, will be measured prior to groundwater sampling.
10. Groundwater samples will be transferred from the pump tubing or bailer directly into sample containers. The containers will be labeled to document the sample designation, type, date and time of collection, collector(s), location, and any additional information.
11. After collecting the reconnaissance groundwater sample, decant groundwater into a clean container and record the following field parameters/observations (in addition to standard field parameters):
    Color
    Odor
    Sheen/Film
    NAPL
12. After sample collection, the boring will be abandoned in accordance with Ecology's Well Regulations (WAC 173-160), typically with hydrated bentonite chips or granules.
13. The ground surface at each location will be patched to match existing conditions, or as otherwise indicated in the Work Plan. Locations will be field-surveyed using a hand-held GPS unit.

Equipment Cleaning

1. Downhole equipment (rods, sampler) will be steam cleaned prior to each borehole.
2. Sampling equipment (sampler) will be steam cleaned or washed with a brush in a solution of high-purity phosphate-free soap and potable water, then rinsed with potable water followed by double rinsing with deionized water prior to each sampling run (see SOG09).
3. Downhole equipment and vehicles which warrant it, will be steam cleaned prior to leaving site at completion of sampling.

Investigation-Derived Residuals

Soil cuttings will be placed in labeled 5-gallon DOT-approved pails with bolt-on covers. Decontamination water and groundwater residuals will be contained in labeled 55-gallon DOT-approved drums with bolt-on covers. All residuals generated during sampling activities will be stored at the site pending characterization and disposal (see SOG 10).

Standard Operating Guideline
05 Borehole Logging

Introduction

This Standard Operating Guideline (SOG) provides the procedures typically followed by Kennedy/Jenks Consultants personnel for classifying soils and preparing boring logs and other types of soil reports. The purpose of this SOG is to facilitate the acquisition of uniform descriptions of soils encountered during borehole programs and to promote consistency in the logging practices used by Kennedy/Jenks Consultants personnel. This SOG provides guidance on procedures that are generally consistent with standard practices used to classify soils. Deviations from, and additions to, the procedures described herein may be appropriate based on project-specific objectives, site-specific conditions, and/or regulatory requirements. The user of this SOG should modify the sampling procedures used, as appropriate, to conform to the project-specific requirements and then document such deviations from this SOG in the project-specific documentation of subsurface exploration activities.

Borehole logging is the systematic observation and recording of geologic and hydrogeologic information from subsurface borings and excavations. The Unified Soil Classification System (USCS) (ASTM D2487-00) is used to identify, classify, and describe soils principally for engineering purposes, and is based on laboratory tests.

For field applications, ASTM D2488-06 (Visual-Manual Procedure) is used as the general guide adopted under this SOG.

Both ASTM D2487 and ASTM D2488 utilize the same group names and symbols. However, soil reports should state that boring logs are not formal USCS laboratory determinations, but are based on the visual-manual procedures described in ASTM D2488.

This SOG contains the following sections:

- Field Equipment/Materials
- Typical Procedures
  - Soil Classification
  - Classification of Coarse-Grained Soil
  - Classification of Fine-Grained Soil including Organic Soils
- Other Logging Parameters
- Logging Refuse
- References.

Field Equipment/Materials

Material/equipment typically required for classifying soils and preparing boring logs may include:

- Pens, pencils, waterproof pens, and field logbook or other appropriate field forms (e.g., boring log forms), water-tight field case.
- Daily inspection report forms

- USCS (ASTM D 2488-06) table and classification chart
- Soil color chart (i.e., Munsell) If used, the edition of the Munsell chart should be specified on each borehole log as the color descriptions and hue, color values and chromas have changed between editions. Also, whenever possible, the newest version of Munsell's color charts should be used due to fading of color chips over time.
- American Geological Institute (AGI) Data Sheets
- Graph paper
- Engineer's scale
- Previous project reports and boring logs (if available)
- Pocket knife or putty knife
- Hand lens
- Supply of clean water
- Dilute hydrochloric acid (HCl) (make sure and MSDS for HCl is included in the project HASP)
- Aluminum foil, Teflon® sheets, and paper towels
- Sample containers (brass, stainless steel or aluminum liners, plastic or glass jars)
- Clean rags or paper towels
- Sample shipping and packaging supplies
- Personnel and equipment decontamination supplies
- Personal protective equipment as described in the Health and Safety Plan (HASP).

Typical Procedures

Soil classification and borehole logging should be conducted by a qualified geologist, engineer or other personnel trained and experienced in the classification of soils.

Soils are typically logged in conjunction with advancing boreholes and sampling subsurface soils. Although the guideline focuses on classifying soil samples obtained from boreholes, this particular procedure also applies to soils and sediments collected using other techniques (e.g., post hole digger, scoop, Ekman, Ponar, or Van Veen grab samplers, and backhoe).

The USCS as described in ASTM D2488-06 categorizes soils into 15 basic group names, each with distinct geologic and engineering properties. The following steps are required to classify a soil sample:

1. Observe basic properties and characteristics of the soil. These include grain-size grading and distribution and influence of moisture on fine-grained soil.
2. Assign the soil a USCS classification and denote it by the standard group name and symbol.
3. Provide a written description to differentiate between soils in the same group, if necessary.

Many soils have characteristics that are not clearly associated with a specific soil group. These soils might be near the borderline between groups, based on either grain-size grading and distribution, or plasticity characteristics. In this case, assigning dual group names and symbols might be appropriate (e.g., GW-GC or ML-CL).

The two basic soil groups are:

1. **Coarse-Grained Soils –** For soils in this group, more than half of the material is larger than No. 200 sieve (0.074 mm).
2. **Fine-Grained Soils (including Organic Soils) –** For soils in this group, one half or more of the material is smaller than No. 200 sieve (0.074 mm).

Note: No. 200 sieve is the smallest size that can be seen with the naked eye.

Classification of Coarse-Grained Soils

Coarse-grained soils are classified on the basis of:

1. Grain size and distribution
2. Quantity of fine-grained material (i.e., silt and clay)
3. Character of fine-grained material

Classification uses the following symbols:

Basic Symbols	**Modifying Symbols**
G - gravel	W - well graded
S - sand	P - poorly graded
	M - with silt fines
	C - with clay fines

The following are basic facts about coarse-grained soil classification:

- The basic symbol G is used if the estimated volume percentage of gravel is greater than that for sand. In contrast, the symbol S is used when the estimated volume percentage of sand is greater than the percentage of gravel.
- Gravels include material in the size range from 3 inches to 0.2 inches (i.e., retained on No. 4 sieve). Sand includes material in the size range from 0.2 inches to 0.003 inches. Use the grain size scale used by engineers (ASTM Standards D422-63 and D643-78) to further classify grain size as specified by the USCS.
- Although not specifically treated in ASTM D2488-06, cobbles range in size from 3 inches to 10 inches and boulders refer to particles with a single dimension greater than 10 inches. They are included here for the purpose of completeness and for their hydrogeologic significance.
  Note: The ASTM grain size scale differs from the Modified Wentworth Scale used in teaching most geologists. Also, it introduces a distinction between sorting and grading (i.e., well graded equals poorly sorted and poorly graded equals well sorted.)
- The modifying symbol W indicates good representation of a range of particle sizes in a soil.
- The modifying symbol P indicates that there is a predominant excess or absence of particle sizes.

- The symbol W or P is only used when a sample contains less than 15 percent fines.
- Modifying symbol M is used if fines have little or no plasticity.
- Modifying symbol C is used if fines have low to high plasticity (clayey)

The following rules apply for the written description of the soil group name:

Types of Soil	**Rule**
Sands and gravels (clean)	Less than 5 percent fines
Sands (or gravels) with fines	5 to 15 percent fines
Silty (or clayey) sands or gravels	Greater than 15 percent fines

- Other descriptive information may include:
  - Color (e.g., Munsell Soil Color chart, specify edition). Soil color is named and coded using the Munsell Soil Color chart if required for the project. The code should be in parentheses immediately following the written description. Presence of mottling and banding is also recorded. For example, “dk brn (7.5 YR, 3/4).”
  - Relative Density/Penetration Resistance. For cohesionless materials use very loose, loose, medium, dense, or very dense estimated from drive sample hammer blows or other field tests. Blow counts may be used, if reliable.
  - Maximum grain size (fine, medium, coarse, as described in AGI data sheets or USCS). Note the largest cross-sectional dimension measured in tenths of an inch for grains larger than sand size.
  - Composition of grains (mineralogy)
  - Approximate percentage of gravel, sand, and fines (use a percentage estimation chart as provided in the AGI data sheets)

Modifiers	**Description**
Trace	Less than 5 percent
Few	5 to 10 percent
Little	15 to 25 percent
Some	30 to 45 percent
Mostly	50 to 100 percent

  - Angularity (round, subround, angular, subangular)
  - Shape (flat or elongated)
  - Moisture Condition (dry, moist, wet)
    - Dry - Absence of moisture to the touch.
    - Damp - Contains enough water to keep the sample from being brittle, dusty or cohesionless; is darker in color than the same material in the dry state.
    - Moist - Leaves moisture on your hand, but displays no visible free water.
    - Wet - Displays visible free water.
  - HCl Reaction (none, weak, strong)
  - Cementation (Crumbles under finger pressure: weak, moderate, or strong)
  - Range of Particle Sizes (sand, gravel, cobble, boulder)
  - Maximum Particle Size (fine, medium, coarse)
  - Cementation (weak, moderate, or strong)
  - Hardness (breaks with hammer blow)
  - Structure (stratified, laminated, fissured, slickensided, blocky, lensed, homogeneous)
  - Organic material
  - Odor
  - Iridescent sheen (based on sheen test)
  - Debris (e.g., paper, wood, plastic, cloth, concrete, construction materials, etc.).

- Additional Comments (e.g. roots or rootholes, difficult drilling, borehole caving, presence of mica, contact and/or bedding dip, bedding features, sorting, structures, fossils, cementation, geologic origin, formation name, minerals, oxidation, etc.

Classification of Fine-Grained Soils

Fine-grained soils are classified on the basis of:

1. Liquid limit

4. Plasticity

Classification uses the following symbols:

Basic Symbols	**Modifying Symbols**
M - silt	L - low liquid limit
C - clay	H - high liquid limit
O - organic	
Pt - peat	

The following rules apply for the written description of the soil group name:

Types of Soil	**Rule**
Silts and clays with sand and/or gravel	5 to 15 percent sand and/or gravel
Sandy or gravelly silts or clays	Greater than 15 percent sand and/or gravel

The following are basic facts about fine-grained soil classification:

- The basic symbol M is used if the soil is mostly silt, while symbol C applies if it consists mostly of clay. Use of symbol O indicates that organic matter is present in an amount sufficient to influence soil properties. The symbol Pt indicates soil that consists mostly of organic material.
- Modifying symbols are based on the following hand tests conducted on a soil sample:
  - Dry strength (crushing resistance : none, low, medium, high, very high)
  - Dilatancy (molded ball reaction to shaking: none, slow, rapid)
  - Toughness (resistance to rolling or kneading near plastic limit : low, medium, high)
  - Plasticity (non-plastic, low, medium, high).
- Soil designated ML has little or no plasticity and can be recognized by none to low dry strength, slow to rapid dilatency, and low toughness.
- CL (lean clay) indicates soil with medium plasticity, which can be recognized by medium to high dry strength, no or slow dilatency, and medium toughness.
- OL is used to describe an organic, fine-grained soil that is less plastic than CL soil and can be recognized by low to medium dry strength, medium to slow dilatency, and low toughness. In some cases, it may be possible to differentiate organic silts (OL) from organic clays (OH), based on correlations between dilatancy, dry strength, toughness, or laboratory tests.
- MH soil has low to medium plasticity and can be recognized by low to medium dry strength, no to slow dilatency, and low to medium toughness.
- Soil designated CH (fat clay) has high plasticity and is recognizable by its high to very high dry strength, no dilatency, and high toughness.

- OH is used to describe an organic fine-grained soil that is less plastic than CH soil and can be recognized by medium to high dry strength, slow dilatency, and low to medium toughness. In some cases, it may be possible to differentiate organic silts (OL) from organic clays (OH), based on correlations between dilatancy, dry strength, toughness, or laboratory tests.

Note: PT (peat) is used to describe a highly organic soil composed primarily of vegetable tissue with a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor.

- Other descriptive information includes:
  - Color (e.g., Munsell) Soil color is named and coded using the Munsell Soil Color chart if required for the project. The code should be in parentheses immediately following the written description. Presence of mottling and banding is also recorded. For example, “reddish brn (5YR, 4/4).”
    - Moisture condition,
  - Omit moisture terms below the regional water table and when drilling with mud or air-mist rotary systems.
  - Consistency (thumb penetration test: very soft, soft, firm, hard, very hard. For fine sediments use very soft, soft, medium, stiff, very stiff, and hard.) These are estimated from drive sample hammer blows or other field tests. Blow counts may also be used, if reliable.
    - Structure (same descriptors as coarse grain)
    - Compactness (loose, dense) for silts
    - Odor
    - Iridescent sheen (based on sheen test)
    - Debris (e.g., paper, wood, plastic, cloth, concrete, construction materials, etc.).
    - HCl Reaction (none, weak, strong).
  - Additional Comments (e.g. roots or rootholes, difficult drilling, borehole caving, presence of mica, , contact and/or bedding dip, bedding features, cementation, structures, fractures, fracture fillings, fossils, formation name, minerals, oxidation).

Fine-Grained Rock Description

- Textural Classification
- Color. Rock color is named and coded using the Geological Society of America rock color chart. The code should be in parentheses immediately following the written description. Presence of mottling and banding is also recorded. For example, “gry grn (5G, 5/2).”
- Hardness. Very hard, hard, medium, soft, very soft..
- Moisture Content. Dry, damp, moist, wet (saturated).
- Size Distribution. Approximate percentage of gravel, sand, and fines (silt and clay).
- Estimated Permeability. Very low, low, moderate, or high. This is based primarily on grain size, sorting, and cementation. Estimate secondary permeability due to natural rock fractures when applicable.
- Miscellaneous. Odor, contact and/or bedding dip, cementation, bedding, inclusions, secondary mineralization, fossils, structures, formation name, and fractures.

- Fractures are identified by depth, angle, width, and associated mineralization if applicable. The interpretation of the fracture type (i.e., as natural [N], coring induced [CI], or handling induced [HI]) should be stated. For example, “NF @90.8', 25 deg to axis, 0.1” wide, minor calcite.”
- Coarse-Grained Rock Description
- Textural Classification.
- Color. Rock color is named and coded using the Geological Society of America rock color chart. The code should be in parentheses immediately following the written description. Presence of mottling and banding also is recorded. For example, “gry olive grn (5GY, 3/2).”Hardness. Very hard, hard, medium, soft, very soft.
- Moisture Content. Dry, damp, moist, and wet (saturated).
- Size Distribution. Approximate percentage of gravel, sand, and fines (silt and clay).
- Grain Shape. Angular, subangular, subrounded, rounded, or well-rounded, for grains larger than sand size.
- Grain Size. The largest cross-sectional dimension measured in tenths of an inch for grains larger than sand size.
- Miscellaneous. Odor, contact and/or bedding dip, cementation, bedding, inclusions, secondary mineralization, fossils, structures, formation name, and fractures.
- Fractures are identified by depth, angle, width, and associated mineralization, if applicable. The interpretation of the fracture type (i.e., as natural [N], coring induced [CI], or handling induced [HI]), should be stated. For example, “NF @126.1', 35 deg to axis, 0.1” wide, minor calcite.”

Other Logging Parameters

Rock Quality Designation

This designation generally follows ASTM D6032-08 Standard Test Method for Determining Rock (RQD) of Rock Core.

The RQD denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. This method is generally applied to core barrel samples.

Standard Penetration Tests

This method generally follows ASTM D1586-08A Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils. This method provides a means of assigning a relative density to the soil by counting the number of hammer blows (blow counts) required to advance a split-barrel sampler a specified distance into the undisturbed soil ahead of the lead auger. This method is not applicable to boreholes advanced with direct-push sampling equipment. It is used primarily in conjunction with hollow stem auger drilling apparatus as the test can be performed through the auger string without removal of the augers thereby allowing the borehole to remain open to the bottom of the drill string without risk of caving. As the sampler is advanced by the repeated drop of a hammer of known weight, the blow counts are recorded on the log and used to provide a relative density descriptor to the soil penetrated during the test.

The number of blows required to drive the sampler 6 in. by a 140-lb hammer falling 30 in. Fifty blow counts per 6-in drive is considered “refusal,” and sampling at this depth is usually terminated. In addition, a total of 100 blow counts per 18-in. drive, or no observed advance of the sampler during ten successive hammer blows, is also considered “refusal.” During coring, leave this section blank. Normally, the second and third 6-in. intervals are recorded and added as the number of blows per feet.

Sampler Type/Depth. Give sampler type by the letter code listed below and identify the depth at the top of the sampling interval in feet below ground surface (bgs).

Sampler type	Inside diameter (in.)	Code
Standard penetrometer	1.38	SP
Split-barrel (small)	2.0	SBS
Split-barrel (large)	2.5	SBL
HQ wireline core	2.3	PC

Those descriptors are as follows for coarse grained soils:

Very Loose	0 to 3 SPT Sampler	0 to 4 Mod CA Sampler
Loose	4 to 7 SPT Sampler	5 to 10 Mod CA Sampler
Medium Dense	8 to 23 SPT Sampler	11 to 30 Mod CA Sampler
Dense	24 to 38 SPT Sampler	31 to 50 Mod CA Sampler
Very Dense	> 38 SPT Sampler	>50 Mod CA Sampler

Relative Density Descriptors for fine grained soils are as follows:

Very Soft	<1 SPT Sampler	0 to 1 Mod CA Sampler
Soft	1 to 3 SPT Sampler	2 to 4 Mod CA Sampler
Firm	4 to 6 SPT Sampler	4 to 8 Mod CA Sampler
Stiff	7 to 12 SPT Sampler	8 to 15 Mod CA Sampler
Very Stiff	13 to 23 SPT Sampler	15 to 30 Mod CA Sampler
Hard	> 23 SPT Sampler	>30 Mod CA Sampler

Regardless of the degree of adherence to the ASTM Standard Method, split barrel samplers are used as the preferred method of undisturbed sample acquisition in a hollow stem auger drilling. Upon retrieval of the sampler from the borehole, the sampler should be opened without making contact with its interior contents and the logging personnel should record the percent recovery or length of the sample recovered. Sample containers should be removed with a clean gloved (gloves may not be needed, depending upon requirements of HASP) hand and placed in a clean, dry area for examination and logging. The sample will be described per the above. Any lithologic changes that may be observable in the exposed ends of the intact core over the sampled interval should be recorded on the log before any disturbance thereof. The depth of the lithologic changes should be estimated and recorded on the boring log. The least disturbed sample container of the two deeper six-inch sample increments should be secured with Teflon® or aluminum end sheets and snug fitting plastic end caps, sealed with silicon tape, depending upon testing, sampler may be filled with one inch rings instead of 6 inch. Sealing material should also be compatible with subsequent testing requirements.

Ambient Temperature Head-Space:

Organic vapor analyzers such as photoionization detectors (PIDs) or flame ionization detectors (FIDs) are generally used to assess the relative concentration of volatile hydrocarbons in the soil as the borehole is advanced and recorded as a value in parts per million on the boring log. This can be done by placing a uniform amount of soil in a Ziploc® bag, glass jar or other clean container, allowing the soil in the container to equilibrate to the ambient temperature, then inserting the probe of the PID or FID into the sealed container and recording the maximum PID or FID reading.

Non-Aqueous Phase Liquid (NAPL) Containing Soil

Appropriate observations of NAPL containing soil should include the following:

Appearance: If a separate phase liquid appears to be present, it might be described as “dark brown viscous fluid or liquid observed in the soil matrix.” This remark should follow the lithologic description in the borehole log. Observations of color should be made such as “black streaks” or “mottled gray to “olive brown”; however, it should not be inferred or remarked that the color is a necessary consequence of petroleum staining.

Odor: If the soil smells like petroleum it might be remarked that it has a “petroleum like” or “solvent like” odor. The use of terms like “strong” or “slight” should be avoided because there is no way to ensure that these terms can be applied uniformly in the field between various persons performing the logging (i.e. ,each persons olfactory sense is different). The use of terms like “chemical odor” should also be avoided as there is no common reference point. Notations regarding the type of petroleum distillate present (e.g., “diesel-like odor” or “gasoline odor”) are inappropriate as these are determination s that can only be accurately made by laboratory analysis.

Logging Refuse

This procedure applies to the logging of subsurface samples collected from a landfill or other waste disposal sites:

1. Observe refuse as it is brought up by the hollow stem auger, bucket auger, or backhoe.
2. If necessary, place the refuse in a plastic bag to examine the sample.

3. Record observations according to the following:
   a. Composition (by relative volume), e.g., paper, wood, plastic, cloth, cement, construction debris. Use such terms as "mostly" or "at least half." Do not use percentages.
   b. Moisture content: dry, damp, moist, wet.
   c. State of decomposition: highly decomposed, moderately decomposed, slightly decomposed, etc.
   d. Color: obvious mottling included.
   e. Texture: spongy, plastic (cohesive), friable.
   f. Odor.
   g. Combustible gas indicator readings (measure downhole).
   h. Miscellaneous: dates of periodicals and newspapers, degree of drilling effort (easy, difficult, very difficult).

References

Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils. ASTM D1586-08A

Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). ASTM D2488-06.

Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System. ASTM D2487-00

Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core. ASTM D6032-08.

Grain Size Scale Used by Engineers. ASTM D422-63 and ASTM D643-78.

Compton, R. R. 1962. *Manual of Field Geology*. New York: John Wiley & Sons, Inc.

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International Society for Rock Mechanics. Commission on Classification of Rocks and Rock Masses. Int. J. Rock Mech. Min. Sci. & Geomech. Abstr. 1981, Vol. 18, pp. 85-110, Great Britain.

Standard Operating Guideline
06 Data Quality - Environmental Data Collection

Introduction

This guideline describes recommended procedures to be followed by Kennedy/Jenks Consultants when collecting environmental data. The guideline is divided into Pre-field Procedures and Field Procedures for ease of use.

Pre-Field Procedures

The following procedures represent the minimal effort appropriate for most environmental data collection projects. Refer to project-specific plans for additional data collection procedures.

1. Review the work plan or sampling plan prior to initiating fieldwork, and discuss any questions with project manager or field leader.

2. Review the Health and Safety Plan.

3. Set up subcontract with analytical laboratory for type and quantity of analyses, documentation and delivery format, both hard copy and electronic data deliverables (EDDs) and turnaround time requirements. Establish contacts at the laboratory, field and home office (Project Manager or person responsible) for all communications.

4. Notify the analytical laboratory of the upcoming fieldwork and advise about the following:

    a. Number of samples per medium

    b. Analyses needed

    c. Dates of sample delivery, coordinate for Saturday pick-up if necessary

    d. Means of delivery (e.g., courier, FedEx)

    e. Turnaround time required

    f. Level of quality control (QC) reporting required

    g. Delivery format, for both hard copy and EDDs. (If EDDs will be uploaded into a database, refer to the Database Use Data Quality SOG.)

5. Order the sample containers from the laboratory. Determine whether field personnel will preserve the samples in the field or if pre-preserved sample containers will be provided. It is preferable to order containers with appropriate preservatives.

6. Arrange for delivery or pickup of sample containers.

7. Request the laboratory fax or email you chain-of-custody forms and laboratory receipt documents immediately after receiving the samples.

8. Check the chain-of-custody form to verify the correct samples were collected and correct analyses were requested. Double check the laboratory receipt documents to verify there are no typographical errors for samples.

   If changes are required, request change in writing, via email, do not request over the phone. Request the laboratory to include all change request documentation in the laboratory summary report.

Field Procedures

1. At the beginning of each field day, identify planned work and document field conditions in the field notes.

2. Hold Tailgate Safety Meeting and have all present sign the form.

3. Complete sample identification labels for each sampling container using an indelible pen. Use the sample identification protocol described in the work plan or sampling plan. It is recommended that pre-printed labels be created at the office prior to going to the field site, if possible.

4. Complete the chain-of-custody form, accounting for each sample. Verify that sample identifications, sampling times, and requested analyses on the chain-of-custody form match the sample identifications, sampling times, and requested analyses on the sample labels.

5. Verify that the appropriate QC samples (field duplicate samples, trip blanks samples, etc.) required in the work plan or sampling plan were collected. If applicable, document blind duplicate parents in field notes, and if using a database, supply a summary table of your parent and duplicate samples to your database coordinator.

6. Verify, where applicable, that the appropriate sample volume was collected to enable the analytical laboratory to perform QC analyses (e.g., matrix spike and matrix spike duplicate analysis). (For example, if a water sample is being analyzed for polynuclear aromatic hydrocarbons, 1 liter of sample is required for the analysis, and another 2 liters are required for the matrix spike and matrix spike duplicate analyses.)

7. Collect, preserve, and transport samples to the analytical laboratory in accordance with the work plan or sampling plan.

8. Provide adequate ice in coolers so that the coolers arrive at the laboratory at a temperature of 4 degrees C ± 2 degrees C.

9. Keep in contact with the project manager or other team member to report any problems, unusual observations, etc.

10. Verify that samples were received by the analytical laboratory and that the laboratory understands the chain-of-custody and requested analyses prior to beginning analyses.

11. If samples are sent by overnight delivery, be sure to include the tracking number and time released to the delivery service on the chain-of-custody form.

Standard Operating Guideline
07 Surface and Shallow Soil Sampling

Introduction

This guideline describes the equipment and procedures that are used by Kennedy/Jenks Consultants personnel for collecting surface and shallow soil samples. This guideline is applicable for the upper portions of soil borings where air-knife excavation is performed.

Equipment

- Stainless steel or plastic scoops
- Hand auger
- Split-spoon drive sampler (2.5-inch or 2.0-inch I.D.) and associated drill rods, wrench and other tools needed to break down equipment
- Slide hammer
- 2.5-inch or 2.0-inch brass liners and sealing materials (plastic end caps, Teflon seals, silicon tape, zip-lock plastic bags)
- Shovel
- Post hole digger
- Pick
- Breaker bar
- OVM
- Measuring tape or measuring wheel
- Stakes or spray paint for sampling grid
- Sampler cleaning equipment
  - Steamcleaner (if needed)
  - Generator (if needed)
  - Stiff-bristle brushes
  - Buckets
  - High priority phosphate-free liquid soap, such as Liquinox
  - Methanol (if necessary)
  - 0.1N nitric acid (if necessary)
  - Deionized water
  - Potable water
- Insulated sample storage and shipping containers
- Personal protective equipment (as specified in site safety plan)

Typical Procedure

1. Obtain applicable drilling and well construction permits, prior to mobilization, if necessary.

2. Clear locations for underground utilities and structures by Underground Service Alert (USA) and subcontractors, if necessary.

3. Measure and mark sampling locations prior to initiation of the sampling program, as specified in the sampling and analysis plan. If sampling locations are based on a grid pattern, stakes can be used to define the grid layout.

4. Collect soil samples for chemical analysis by using precleaned scoops or a hand auger, or by driving a split-spoon drive sampler.

5. If overlying soil is to be removed (as specified in the sampling and analysis plan), use shovels, picks, or post-hole diggers, as needed.

6. Collect soil samples for lithologic logging purposes.

7. If applicable, as described in the site safety plan, use an OVA to analyze *in situ* air samples from the breathing zone and other locations as necessary.

8. Classify soils in approximate accordance with the visual-manual procedure of the Unified Soil Classification System (ASTM D 2488-90) and the Munsell Color Classification (refer to SOG05).

9. Prior to each sampling event, wash sampling equipment (scoops, hand auger, split-spoon drive sampler, and brass liners) with high purity phosphate-free soap. Double-rinse it with deionized water and methanol, and/or 0.1N nitric acid, as appropriate.

10. At each sampling interval, collect soil and place it in the appropriate sampling container. Fill the sample container and compact the soil to minimize air space. Minimize handling of the soil, especially if it is being collected for analysis of volatile compounds.

11. If a split-spoon drive sampler is being used, select one brass liner for potential laboratory analysis. Cover the ends of this sample in Teflon sheets, seal it with plastic caps, and wrap it with silicon or Teflon tape. Place a completed sample label on the brass liner.

12. Place the selected samples in appropriate containers and store them at approximately 4 °C.

13. As a field screening procedure (if applicable), for each sampling interval, place soil not selected for chemical analysis in an airtight container (e.g., plastic bag or jar) and allow it to equilibrate. After this, monitor the headspace in the container using a PID. Record the headspace concentration in the field notes.

14. Complete chain-of-custody forms in the field and transport the selected samples in insulated containers, at an internal temperature of approximately 4°C, to the analytical laboratory (refer to SOGs 3).

15. For soil samples collected from shallow air-knife borings, advance the sampling device to approximately one foot below the bottom of the boring. This is particularly important if samples are to be collected for volatiles analysis.

Equipment Cleaning

Prior to collection of each soil sample, the sampling equipment should be either steamcleaned or hand washed. If the sampling equipment is hand washed, wash excavation equipment with a brush, in a solution of high purity phosphate-free soap and potable water. Rinse the equipment with potable water and methanol, and/or 0.1N nitric acid, as appropriate. Follow this with double-rinsing using distilled water (refer to SOG10).

Standard Operating Guideline
08 Sample Packaging and Shipping

Introduction

This guideline presents methods for packaging and shipping non-hazardous environmental soil and groundwater samples to analytical laboratories.

Equipment

- Coolers or ice chests
- Sorbent material
- Bubble-wrap
- Strapping tape
- Labels and pens
- Chain-of-Custody forms
- Chain-of-Custody seals
- UPS, Federal Express, or Greyhound manifests

Samples shipped to each analytical laboratory may be sent by UPS or Federal Express on a next-day basis unless other arrangements are made. Most laboratories offer local daily courier service as well. Preferably, if a suitable laboratory is located locally, samples will be picked up onsite by the analytical laboratory, or transported daily to the laboratory by the field crew. Ice chests, used to refrigerate perishable items, will be used to convey non-hazardous samples to the analytical laboratory.

Absorbent pads should be placed in the bottom of the shipping container to absorb liquids in the event of sample container breakage. Transportation regulations require absorbent capacity of the material to equal the amount of liquid being shipped; each pad absorbs approximately 1 quart of liquid. Liquid samples in glass jars or bottles should also be wrapped in plastic bubble wrap. A small amount of air space is desirable in filled plastic containers. This often prevents the cap of the container from coming off should the container undergo compression. Volatile organics analysis (VOA) vials should be packed in sponge holders. Additionally, exposure of filled VOA vials to other types of sample containers, by placement in the same shipping container, is not recommended. Various non-VOA sample containers are solvent-rinsed which may contaminate the VOA vials before or after sample collection. Therefore, a separate shipping container for VOA vials is recommended. An equal weight of ice substitute should be used to keep the samples below 4 degrees Centigrade for the duration of the shipment (up to 48 hours). Care in choosing a method of sample chilling should be observed so that the collected samples are not physically or chemically damaged. Re-usable blue ice blocks, block ice, ice cubes, or dry-ice are suitable for keeping samples chilled. Labels of samples may get wet. Use of waterproof pens and labels is desirable for identification of sample containers. Use of clear tape to cover each affixed sample label is helpful in ensuring sample identification. Strong adhesive tape should be used to band the coolers closed. Additionally, it is recommended that the drain plug be covered with adhesive tape to prevent any liquid from escaping.

Specific requirements for packaging materials may apply if the samples being shipped are known to be hazardous materials as defined in 49 CFR 171.8 (samples are not considered hazardous waste and therefore manifest requirements do not apply). UPS holds shippers responsible for damage occurring in the event of accidents when a hazardous material is shipped as a non-hazardous material. Samples which obviously are hazardous materials should therefore be shipped as such, and samples which most likely are not hazardous materials should be shipped in coolers. Guidelines for shipping hazardous materials by UPS are provided in the *Guide for Shipping Hazardous Materials* available from UPS. Specific labels for shipping of hazardous materials are available.

Chain-of-custody documentation should accompany shipments of samples to the analytical laboratory. Often, the chain-of-custody document contains an analytical request section which may be completed following sample collection. Chronological listing of collected samples is desirable. A copy of the completed chain-of-custody form should be retained in the event that the original form is lost or destroyed.

It should be noted that samples retained by the analytical laboratory which are not chosen for analysis may be assessed a fee for disposal. Often a disposal fee is assigned to a sample, typically soil, that has been retained beyond standard analytical holding periods. Therefore, consultation with project management is recommended to determine which samples may be of interest. Contacting the selected analytical laboratory regarding disposal policies is also recommended. Arrangements may be made with the analytical laboratory for return of the unanalyzed samples for later disposal to the area of origin.

Standard Operating Guideline
09 Equipment Decontamination

Introduction

This guideline describes field procedures typically followed by Kennedy/Jenks Consultants personnel during the decontamination of sampling and monitoring equipment. Proper decontamination procedures minimize the potential for cross-contamination among sampling points on a single site or between separate sites.

Equipment

- Two or three containers (e.g., 5-gallon buckets, or 5- or 10-gallon plastic tubs) for dip rinsing, washing, and collection of rinse water.
- Two or three utility brushes or test tube brushes for removal of visible contamination. A test tube brush (or similar) can be stapled to the end of a dowel and used to clean the inside of a bailer.
- Non-phosphate Alconox, Liquinox, or trisodiumphosphate (TSP) to be mixed with potable or distilled water.
- Rinse solutions, such as methyl alcohol (methanol), dilute nitric acid (0.1 molar), deionized or distilled water, and/or tap water. Deionized water is preferable to distilled water because the deionization process typically results in greater removal of organic compounds as discussed below:

  Acid rinse (inorganic desorption) 10% nitric or hydrochloric acid solution reagent grade nitric or hydrochloric acid and deionized water (1% to be used for low carbon steel equipment).
  Solvent rinse (organic desorption isopropanol, acetone, or methanol; pesticide grade).
  Deionized water is preferable to distilled water because the deionization process typically results in greater removal of organic compounds.
- Multi-gallon storage containers filled with potable water to be used for rinsing or washing.
- Spray bottles, squirt bottles, or garden sprayers to apply rinse liquid. A separate bottle should be used for each liquid.
- Solvex or neoprene gloves that extend, as a minimum, halfway up the forearm. In cooler weather, it is advisable to use different resistant chemicals neoprene gloves that provide better insulation against cold temperatures.
- Paper towels to wipe off gross contamination.
- Garbage bags, or other plastic bags, and aluminum foil to wrap clean sampling equipment after decontamination, to store sampling equipment or and to dispose of decontamination debris.
- Sample bottles for rinsate blanks. For these blanks, Laboratory Type II (millipore) water should be used. Purified water from the selected analytical laboratory is recommended. This water is often filtered and boiled to remove impurities.
- DOT-approved container (e.g., 55-gallon drum) to store contaminated wash and rinse water. Contained decontamination should be labeled appropriately.
- Steamcleaner with power source and water supply, if needed.

Procedures

In most cases, the following procedures are adequate to remove contamination.

1. Preclean sampling equipment. If there is gross contamination on equipment, wipe it off with paper towels and/or rinse it off with water. Additional internal decontamination may be possible by circulation of water or cleaning solutions.
2. Wash all parts of equipment with detergent water and scrub with brushes. Take equipment apart when appropriate to remove visible contamination.
3. Steamclean sampling equipment, if needed. The steamcleaner is effective in removing contamination, especially volatile hydrocarbons. Steamcleaning is highly recommended in most cases and sometimes is the only method for decontaminating equipment that is grossly contaminated with hydrocarbons.
4. Rinse equipment by dipping in rinse solution, spraying, or pouring solution over it. Dip rinsing can introduce contaminants into solution. Spraying might not allow a thorough rinsing of the equipment, but it is a more efficient rinsing method because less rinse solution is used. Appropriate rinsing solutions are specified in the project sampling and analysis plan. Some typical solutions are indicated in the equipment section of this SOG.

   Methanol (used to remove organic compounds)

   Dilute acids (used to remove metals and other cations)

   Tap water

   Deionized/distilled water.
5. Rinse the sampler with generous amounts of deionized water. Pouring water over the sampler is best, although spraying or using a squirt bottle to apply rinse water might be adequate if you are trying to minimize waste.
6. Prepare rinsate blanks. To ensure proper decontamination, submit a rinsate blank for analysis. It is best to do this just before sampling. The blank should be analyzed for the same chemicals the samples are being checked for and for the chemical used to decontaminate equipment, if appropriate.

   [Note: The heading for this section indicates procedures to remove contamination.]

   To prepare a rinsate blank, pour millipore analyte-free water through or over the sampler. Collect the rinsate water in a clean bottle. Pour the collected rinsate water into the appropriate sample container(s). It is advisable to prepare one rinsate blank every day in the field. Use water specifically for blank preparation.
7. Wipe sampling equipment with a paper towel or allow it to air dry.
8. Place samplers in clean plastic bags or sealed containers, or wrap them in aluminum foil for storage in an undisturbed location that is free of contamination.

Investigation-Derived Residuals

For details of handling investigation-derived residuals refer to the project sampling and analysis plan.

Special Notes

- To reduce the potential for cross-contamination, samples should be collected so that the least contaminated stations areas are sampled first. Subsequent sampling should be completed in the order of increasing contamination. Areas that typically have lower levels of contamination include those upgradient of source, background areas, and the periphery of the contaminated area.
- Prepare rinsate blanks. To ensure proper decontamination, submit a rinsate blank for analysis. It is best to do this just before sampling. The blank should be analyzed for the same chemicals the samples are being checked for and for the chemical used to decontaminate equipment, if appropriate.
- To prepare a rinsate blank, pour analyte-free water through or into the sampler. Pour the collected rinsate water into the appropriate sample container(s). It is advisable to prepare one rinsate blank every day in the field. Use water specifically for blank preparation.
- Monitoring instruments that come into contact with sampled materials must be decontaminated, along with sampling devices. They should be washed, or at least rinsed before monitoring other sampling sites.
- As determined from analysis of rinsate blanks, decontamination using soap and water is adequate in removing detectable quantities of contaminants. This type of decontamination has been compared to laboratory procedures for decontaminating sampling bottles. Using methanol as a rinse does help in cases of contamination with organic compounds.

References

U.S. Environmental Protection Agency. 1987. *Handbook: Groundwater*. U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, Ohio.

Washington Department of Ecology. 1982. *Methods for Obtaining Waste Samples*. Ch. 173-303 WAC. Washington State Department of Ecology, Olympia, Washington.

Standard Operating Guideline
10 Handling and Disposal of Investigation-Derived Waste

Introduction

Environmental site investigations usually result in generation of some regulated waste, particularly if the project involves drilling and construction of monitoring wells. Any potentially hazardous or dangerous material that is generated during a site investigation must be handled and disposed of in accordance with applicable regulations (22 CCR, Chapter 30). This guideline provides a procedure to be used for dealing with investigation-derived wastes that have the potential of being classified as hazardous or dangerous, including soil cuttings, well development water, and decontamination water.

Equipment

- DOT-approved packaging (typically DOT 17E or 17H drums)
- Funnel
- Bushing wrench
- 15/16-inch socket wrench
- Shovel
- Appropriate markers (spray paint, paint pen)
- Plastic sheeting
- Drip pans
- Pallets

Typical Procedures

Preparing Containers

1. Place each container on a pallet if it is to be moved with a fork lift after it is full.
2. Place plastic sheeting under containers for soil and drip pans under containers used to hold water.
3. Ensure that packaging materials are compatible with the wastes to be stored in them. Bung-type drums should be used to contain liquids. If a liquid is corrosive, a plastic or polymer drum should be used.
4. Solids should be placed in open-top drums. Liners are placed in the drums if the solid material is corrosive or contains free liquids. Gaskets are also used on open-top drums.

Storing Wastes

1. As waste materials are generated, place them directly into storage containers.
2. Do not fill storage drums completely. Provide sufficient outage so that the containers will not be overfull if their contents expand.
3. After filling a storage drum, seal it securely, using a bung wrench or socket wrench, for a bung-type or open-top drum, respectively.
4. Label drums or other packages containing hazardous or dangerous materials and mark them for storage or shipment. To comply with marking and labeling requirements, affix a properly filled out yellow hazardous waste marker and a DOT hazard class label to each waste container. Do

not mark drums with Kennedy/Jenks Consultants' name. All waste belongs to the client. Mark accumulation start date.

5. During an ongoing investigation, use a paint marker to mark the contents, station number, date, and quantity of material on each drum or other container. Do not mix investigation-derived wastes with one another or with other materials. Do not place items such as Tyvek, gloves, equipment, or trash into drums containing soils or liquids, and do not mix water and soil. Disposable protective clothing, trash, soil, and water materials should be disposed of in separate containers.
6. Upon completion of field work, or the portion of the project that generates wastes, notify the client as to the location, number, contents, and waste type of waste containers. Remind the client of the obligation to dispose of wastes in a timely manner and in accordance with applicable regulations.

Regulations

22 CCR, Chapter 30 *California Hazardous Waste Regulations*.

49 CFR 100-177, *Federal Transportation of Hazardous Materials Regulations*.

EPA Region X, Technical Assistance Team. 1984. *Manual for Sampling, Packaging, and Shipping Hazardous Materials*. Seattle, WA: EPA.

Standard Operating Guideline
11 Slug Tests

Introduction

This Standard Operating Guideline provides the procedures typically followed by Kennedy/Jenks Consultants personnel during performance of slug tests. This SOG provides guidance on procedures that are generally consistent with standard practices that are described in ASTM D 4044-96 - Standard Test Method for (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers as well as other published references and consensus among various practitioners. This guideline will discuss, in detail, one of several variations on the method involving the insertion of a mechanical "slug" into the water column.

This SOG contains the following sections:

- Field Equipment/Materials
- Summary of the Method
- Typical Slug Test Procedures
- Reporting
- References

Several methods are available to interpret field data derived from the slug test.

Field Equipment/Materials

- Water level probe.
- Pressure transducer and data logger or pressure transducer with built-in data logger.
- Watertight weighted slug of known volume (a small diameter casing filled with sand, capped at each end with eye bolt and rope). The slug diameter should be approximately 1 inch smaller than the inside casing diameter, long enough to displace sufficient water and short enough to be totally immersed in the water column.
- Field portable computer and power supply loaded with data transfer software.
- Weighted tape
- Stop watch

Summary of the Method

The slug test method involves causing a sudden change in hydraulic head within a single control well by either injecting or removing a known quantity or "slug" of water from the well or inserting a weighted "slug" of known volume into the water column. This guideline will discuss the weighted "slug" method. In all of the above cases, the amount of total displacement and water level recovery to the static condition are monitored using a pressure transducer and/or hand held water level probe. It is advantageous to monitor both the displacement (falling head) and recovery (rising head) portions of the test and compare the results. The rising head portion of the test is considered to be more representative of the actual aquifer hydraulic conductivity as it is not subject to the same early filter pack effects seen in the falling head portion of the test.

Notes
There is no fixed requirement for the magnitude of head change. Some considerations include a magnitude of change that can be readily measured with the apparatus selected; for example, head change should be such that the method of measurement should be accurate to 1% of the maximum head change. Generally, an induced head change of from one-third to one meter is adequate. Although the induced head change should be sufficient to allow the response curve to be defined, excessive head change should be avoided to reduce the possibility of introducing large frictional losses in the well bore (ASTM D 4044-96)

The slug test method is not applicable to wells larger than 6 inches in diameter.

Typical Slug Test Procedures

1. Decontaminate all downhole equipment prior to its placement within the well. Measure the total depth of the well with a weighted tape and the static water level with a water level probe to determine the thickness of the water column.
2. Install the pressure transducer inside the test well to the desired depth and secure its cable at the surface so that it will not move for the duration of the test. If necessary, mark the transducer cable where it meets the measuring point at the top of the well so that it can be repositioned in the unfortunate event of slippage.
3. Allow the water level to stabilize and measure the static water level of the well.
4. Periodically measure and record water levels using the manual water level probe.
5. Establish communication between the data logger and computer with the appropriate cable. Program the data logger to collect water level measurements at increasing rates starting at one measurement per second to approximately one measurement every 60 seconds. Zero the transducers at equilibrium. Program data logger so that drawdown level is in negative numbers, rises in positive numbers. Slug tests are not anticipated to run longer than one hour each for the displacement (falling) and recovery (rising) portions of the test.
6. Insert slug of known volume and monitor water level rise and fall. When the water level has reached equilibrium and returned to within 95 percent of static conditions, reset the data logger sampling time base and remove the slug. This starts the recovery portion of the slug test.
7. Upon conclusion of the test, the monitoring data will be downloaded to a diskette using a laptop computer and all downhole equipment will be decontaminated prior to reuse.
8. Document all field measurements on calculation worksheet.
9. Record name and model number of data logger and pressure transducers as well as the serial number of the transducer.
10. Make a preliminary analysis of data before leaving the field and evaluate the test to determine if the test should be rerun.

Reporting

All test reports should include the following:

1. Date, time, and well identification,
2. Whether the test is a falling head or a rising head test,
3. Inside diameter of well screen and well casing above the screen,
4. Volume of the Slug

Establish and record the measurement point from which all measurements of water level are made. Record date, time, and depth to water level below measurement point of all water levels.

Water levels measured during the test should be recorded with information on date, clock time, and time since the test started.

References

Standard Test Method for (Field Procedure) for Instantaneous Change of Head (Slug) Tests for Determining Hydraulic Properties of Aquifers. ASTM D 4044-96 (Reapproved 2008),

Bouwer, H., and R.C. Rice. 1976. A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers With Completely or Partially Penetrating Wells, Water Resources Research, 12(3):423-428.

Cooper, H.H., Jr., J.D. Bredehoeft, and J.S. Papadapulos. 1967. Response of a Finite Diameter Well To an Instantaneous Charge of Water. Water Resources Research, 3:263-269.

Hvorslev, M.J. Time Lag and Soil Permeability in Ground-Water Observations. U.S. Army Corps. of Engineers. 1951. P. 49

U.S. Bureau of Reclamation. 1977. Ground Water Manual. First Edition.

Appendix C

Health and Safety Plan

Kennedy/Jenks Consultants

32001 32nd Avenue South
Federal Way, Washington 98001
253-835-6400
FAX: 253-952-3435

Site-Specific Health and Safety Plan (HASP)

Former Circle K Site
2350 24th Avenue East
Seattle, Washington

1 March 2016

Prepared for

Washington State Department of Ecology
3190 160th Avenue Southeast
Bellevue, Washington 98008

Project No. 1696010*00

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Prepared by	Dean Malte	**Date**	3/1/16
Project Manager	Ty Schreiner	**Office**	Federal Way

Field Services Description

Field Services Date(s) March 2016 through December 2016

Site Name Former Circle K

Location 2350 24th Avenue East, Seattle, WA

Client Contact Dale Myers **Client Site Telephone** 425-649-4446

Type of Investigation:

Sampling Investigation:
- ☒ Hand Auger
- ☒ Drilling
- ☐ Trenching
- ☒ Well Installation
- ☒ Soil Sampling
- ☒ Groundwater Sampling
- ☒ Other: Air-Knife Excavation (drilling locations)

Site Remediation:
- ☐ Excavation
- ☐ Treatment System Installation
- ☐ UST Removal

☒ Site Walk-through ☐ Other:

Section 1: Introduction

This Site-Specific Health and Safety Plan (SSHSP), also referred to as a Health and Safety Plan (HASP), developed in accordance with Occupational Safety and Health Administration (OSHA) standards for hazardous waste operations (29 CFR 1910.120), and CAL/OSHA Standards (8 CCR 5192), establishes general health and safety protocols for Kennedy/Jenks Consultants (K/J) personnel at Washington State Department of Ecology's Former Circle K site (Site) located at 2350 24th Avenue East in Seattle, Washington.

As needed, addenda containing activity-specific health and safety protocols will be prepared and attached to this HASP prior to the initiation of each additional field activity. The HASP and activity-specific addenda, as a minimum, contain the following information:

- Names of key personnel and alternates responsible for site health and safety and appointment of a Site Safety Officer (SSO).
- A job hazard analysis (JHA) for each site task and operation (see Appendix A for example).
- Personal protective equipment (PPE) to be used by employees for each site task and operations being conducted.
- Medical surveillance requirements.
- Frequency and types of air monitoring, personal monitoring, and environmental sampling techniques and instrumentation to be used. Methods of maintenance and calibration of monitoring and sampling equipment to be used.
- Site control measures.
- Decontamination procedures.
- An Emergency Response Plan that addresses effective site response to emergencies.
- Procedures to report injuries or illness, property damage, or near miss incidents

For informational purposes only, this plan may be provided to subcontractors of Kennedy/Jenks Consultants involved in activities at the site, interested regulatory agencies, or others. However, entities and personnel other than Kennedy/Jenks Consultants shall be solely responsible for their own health and safety and shall independently assess onsite conditions and develop their own health and safety protocols to meet the minimum health and safety requirements.

Kennedy/Jenks Consultants has developed a Health & Safety Operations Manual (Kennedy/Jenks Consultants, Corporate Health and Safety Program, March 2015). The Corporate Health & Safety Program, upon which the manual is based, complies with current health and safety regulations, including OSHA 29 CFR 1910.120 and Hazardous Waste Operations and Emergency Response. Many of the protocols of the corporate program are conducted on a routine basis (general training, respirator fit testing, general medical record

keeping, etc.) and are not repeated herein. The Health and Safety Operations Manual is available to Kennedy/Jenks Consultants employees upon request during normal business hours. Questions regarding the program should be referred to the Kennedy/Jenks Consultants Industrial/Environmental Business Unit Health & Safety Manager (H&S Manager) John Jindra, or the Director of Health, Safety, and Environment (Director of HS&E) Bert Drews.

A copy of this HASP, along with any addenda containing activity-specific health and safety information, will be kept in a conspicuous location at all times while work is being conducted at the site.

Section 2: Key Health and Safety Personnel

Kennedy/Jenks Consultants SSO will be designated by the Project Manager, as appropriate. The current SSOs for the projects are Dean Malte and Julia Schwarz. In the absence of an SSO during field activities, a member of the field investigation team will be designated as Kennedy/Jenks Consultants SSO. The SSO is responsible for the following.

- Conducting daily tailgate safety briefings (TSBs) for Kennedy/Jenks Consultants personnel at the beginning of each workday and documenting that subcontractors are also conducting TSBs. Kennedy/Jenks Consultants staff may combine TSBs with the subcontractor in lieu of conducting separate safety meetings. Combined TSB meetings will be led by the subcontractor and must include emphasis provided by the subcontractor relative to the subcontractor's work. Other participants, including Kennedy/Jenks Consultants and any regulatory personnel in attendance, should also discuss their respective health and safety issues and oversight specific to their activities. The TSB Record is attached to this HASP as Appendix A, and a copy of each day's executed form for Kennedy/Jenks Consultants' TSB must be obtained for the project files, signed by all Kennedy/Jenks employees attending the TSB meeting. Any subcontractors must provide the SSO with a daily copy of the subcontractor's own safety briefing form for the project file.

- Observing field activities for compliance with this HASP, applicable addenda, and Kennedy/Jenks Consultants Health and Safety Operations Manual.

- Maintaining onsite medical surveillance, if required, and emergency medical treatment programs, and assisting in onsite emergencies.

- Modifying health and safety protocols or terminating field work when unsafe work conditions exist.

- Assuring all project team members participating in field activities have read and signed this HASP and have had the opportunity to ask safety-related questions regarding this project.

- Familiarizing personnel with health and safety protocols.

- Observing field personnel wear appropriate PPE.

- Recording data from direct reading instruments on field logs (as appropriate) and evaluating potential hazards.

- Monitoring decontamination procedures.

- Recording occurrence of any site injury, illness, property damage or near miss incident.

If unsafe conditions are encountered, if illness or injury occurs, or if the level of protection needs to be changed, the SSO will consult, in a timely manner, with the Project Manager, Ty Schreiner; the H&S Manager, John Jindra, or the Director of HS&E, Bert Drews.

Section 3: Site Description and History

The Site is associated with a former gasoline service station property located at 2350 24th Avenue East in Seattle, Washington. In 1989, approximately 4,000 to 6,000 gallons of gasoline from a leaking underground storage tank (UST) was released to the subsurface at the Site. Based on available information, the related contaminant plume has extended off-property beneath adjacent streets and residential properties.

The property is approximately 0.26 acre in size and is located in the Montlake neighborhood southeast of the intersection between 24th Avenue East and East McGraw Street, approximately 1,800 feet south of Lake Washington. The area surrounding this Site consists mainly of residential houses and buildings, with some small commercial business located west of the Site along the 24th Avenue East. The property consists of a one-story building and a newer addition to it, which are presently being utilized as a retail dry cleaning store and a convenience store, known as Jay's Cleaners and Mont Market.

The property was operated as a gasoline station and convenience store from 1968 to 1981, owned by Mr. George Renale. Prior to 1968, it is believed the property was residential. From 1981 to July 1990, the property was leased by Mr. Renale to Circle K Corporation, who also operated the facility as a gasoline station and convenience store. In November 1990, Mr. Kuk Jin Choung, the current owner, purchased the property from Mr. Renale and has operated it as a retail dry cleaning retail store since then. In February 1992, Mr. Choung entered into a Consent Decree with Ecology to begin investigation and remediation of contamination at the Site.

In October 2009, EA Engineering, Science and Technology, Inc. prepared an initial draft Remedial Investigation/Feasibility Study (RI/FS) report on behalf of Ecology based on the investigative activities performed at that time. Based on a review of the initial RI/FS, several data gaps and deficiencies were identified. K/J was contracted by Ecology to perform a supplemental RI to address data gaps and characterize current conditions at the Site.

The scope of field work for the supplemental RI includes location of underground utilities, evaluation and redevelopment of existing Site monitoring wells, advancement of soil borings for collection of soil and reconnaissance groundwater sampling, installation and development of new monitoring wells, and quarterly groundwater monitoring (elevation measurement and sampling).

Additional information regarding Site background, current conditions, and anticipated sample locations is available in the RI Work Plan.

Section 4: Planned Site Activities

Type of Investigation:

Sampling Investigation:
- ☒ Hand Auger
- ☒ Drilling
- ☐ Trenching
- ☒ Well Installation
- ☒ Soil Sampling
- ☒ Groundwater Sampling
- ☐ Other: _____

Site Remediation:
- ☐ Excavation
- ☐ Treatment System Installation
- ☐ UST Removal

☒ Site Walk-through

☒ Other: Air-Knife Excavation (at drilling locations)

☒ Onsite Inspection or Construction-Related Services

☒ Entry into a Confined Space or Excavation[1]

☐ Work Along a Leading Edge Requiring Fall Protection

☐ Entry into an Excavation or Trench with a Depth of 5 feet or Greater (4 feet in Oregon and Washington)

☒ Field Investigation Requiring
- ☐ a. Entry into (potentially) hazardous area
- ☒ b. Interruption of vehicular traffic
- ☐ c. Interruption of plant processes
- ☐ d. Operation of pilot plant

☐ Chemical Use[2]

☐ Other - *specify*

[1] Completion of K/J Confined Space Pre-entry Checklist and Entry Authorization is required or review of Client's Confined Space Procedures.

[2] A Field Chemical Use Plan must be completed.

Potential Hazards:

☒ Organics
☐ Inorganics
☒ Metals
☐ Acids
☒ Solvents
☐ Pesticides
☐ Bases
☐ Fire/Explosion
☒ Other: Traffic

Personal Protective Equipment:

☐ Level C
☒ Level D

The Site is currently operated as a retail mini-mart and dry cleaners with limited parking onsite. Field investigation activities will require coordination with the current property owner/operator to consider appropriate means to protect facility operations and workers/customers. In addition, traffic control services will be needed for work in City of Seattle right-of-way areas.

Section 5: Hazard Assessment

5.1 Potential Physical & Environmental Hazards

Every job must be scrutinized for potential hazards, which may cause an injury, illness, property damage, or an near miss incident. The preferred method of assessing a job for hazards is to break down each job into smaller tasks. Each task may then be scrutinized by performing a JHA.

While a documented JHA is not required, Kennedy/Jenks Consultants JHA form provides examples to assist employees in performing their own JHA. The JHA process is intended to provide a brief, consistent means of identifying and addressing hazards, which may injure employees.

Potential hazards may include, but are not limited to, the following:

- Heavy equipment
- Excavations and Trench work
- Traffic in parking lot and right-of-way areas
- Confined Space Entry
- Chemical exposure
- Fire/explosion hazard
- Tripping and falling hazards
- Heat stress
- Cold exposure.

5.1.1 Heavy Equipment

Field personnel should be cognizant of potential physical hazards associated with use of heavy equipment and electrical equipment during field operations. Appropriate precautions include the following:

- American National Standards Institute (ANSI)-approved hardhats, Class II reflective safety vests (when outside), safety glasses or goggles, and safety-toe boots will be worn.
- Loose clothing that may catch in moving parts will not be worn.

- Hearing protection will be worn if a preliminary noise survey or past experience indicates maximum noise levels will exceed 85 decibels at any time during site operations or if sound levels become uncomfortable or prevent conversation at normal levels.

- Maintain visual contact with the equipment operator at all times within or near the equipment operating radius.

Prior to conducting drilling, a survey shall be conducted and discussed in the TSB to identify overhead electrical hazards and potential ground hazards, such as hazardous agents in the soil or underground utilities. Kennedy/Jenks Consultant's staff will stay at least 25 feet from active drilling rig when possible. Coordinate collection of samples with equipment operator. Wear hearing protection when equipment is operating.

5.1.2 Excavation

Field personnel should enter an excavation or trench only as a last resort. Any excavation or trench exceeding 5 feet (4 feet in Washington and Oregon) in depth must be properly shored, braced, or sloped, and a safety ladder must be provided for ready access or egress. Excavation work for this project includes air-knife 'potholing' at drilling locations; no other excavation work is planned.

5.1.3 Confined Space Entry

Kennedy/Jenks Consultants personnel will not enter any confined space without advanced specific preparation, planning, training, and supervision by the H&S Manager or Director of HS&E. Training will include a thorough review of Kennedy/Jenks Consultants Confined Space Entry Program and completion of the Kennedy/Jenks Consultants Pre-Entry Checklist and Entry Authorization forms (see Appendix B).

A confined space is defined by OSHA as the concurrent existence of the following conditions.

- Is large enough and so configured that an employee can bodily enter and perform assigned work; and

- Has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and

- Is not designed for continuous employee occupancy.

Potential confined space entry at the Site includes a recovery well vault located north of the main Site building. In entry into the vault is necessary, and it is determined to be a confined space, entry will be performed under the K/J Confined Space Entry Program, including completion of the K/J Pre-Entry Checklist and Entry Authorization forms.

5.1.4 Tripping and Falling Hazards

Other potential physical hazards include falling and tripping on slippery, uneven, or unpaved surfaces

Extra care should be taken in the event of frozen ground, sleet, or snow. Modify walking activities accordingly, paying close attention to exposed bare surfaces, such as stairs, platforms, concrete walkways, truck beds, etc.

5.1.5 Heat Stress

Adverse climate conditions, primarily heat, are important considerations in planning and conducting site operations. Maximum daytime temperature may exceed 85 degrees Fahrenheit (°F) at the site, and heat stress is an associated concern. Provisions of Kennedy/Jenks Consultants Heat Illness Prevention Program, Appendix D, will be applied to all projects when Kennedy/Jenks Consultants employees are subjected to sustained temperatures of 85 °F or greater.

Preventative measures include the following:

- Water and/or commercial electrolyte solutions will be available, and drinking these fluids will be encouraged. When temperatures exceed 85 °F, sufficient water will be provided to accommodate each employee with 1 quart of water per hour. Water will be kept cool by means of a portable cooler with ice or similar means. Water and ice are also available in the mini-mart at the Site.

- Suitable acclimation periods will be provided for workers to gradually establish their resistance to heat stress.

Personnel exhibiting symptoms of heat stress (nausea, cramps, dizziness, clammy skin) will be removed from the work area, cooled, and provided with water, and the personnel will be observed (see Appendix C, Heat Stress Card). Personnel exhibiting symptoms of heat stroke (hot dry skin, mental confusion, unconsciousness) will be immediately cooled and taken to the hospital. A map and written directions to the local medical facility are included as Attachment 1.

5.1.6 Cold Exposure

Cold injury (e.g., frostbite and hypothermia) and impaired ability to work are dangers encountered at low temperatures and high wind-chill factors. To guard against these conditions, if cold weather is an important consideration at this site, field personnel should wear appropriate clothing, have access to readily available warm shelter, take carefully scheduled work and rest periods, and monitor physical conditions of other workers. See Appendix D, Cold Stress Fact Sheet.

5.1.7 Underground/Overhead Utilities

The site may contain underground and aboveground utilities, including buried electrical, natural gas, water, sewer and fuel lines, and aboveground utilities, such as high-voltage transmission lines. These utilities present a potential hazard if they are struck or can arc if equipment is located too close to them. Kennedy/Jenks Consultants will use the following notification, documentation and clearance procedures to clear all boring or excavation locations of utilities prior to subsurface invasive activities. Subsurface invasive work includes excavations, borings, surface grading, and hand augering soil samples when depths penetrate more than 6 inches

below ground surface (bgs). Work is not to proceed where there is doubt regarding the location of underground utilities or obstructions. Invasive Activities – Utility Location Standard Operating Procedures are included as Appendix E.

Notification Procedures: Notification is made through the One-Call Center (811) for all subsurface invasive work located on public property. Kennedy/Jenks Consultants or its designated subcontractor will call for a universal underground notice at least 2 business days before drilling or subsurface invasive activities are to begin.

Document time of the call, names of utilities to be contacted, and obtain a ticket number for the call on Kennedy/Jenks Consultants Utility Location and Acknowledgement Form included as Appendix F. On private property not covered by the Utilities Underground Location Center, Kennedy/Jenks Consultants may be required to contact and receive utility clearance approval from a combination of other public and private entities, as well as private landowners, City officials, and State of Washington entities to obtain clearance approval who may have underground utilities in the work area.

Documentation: All proposed subsurface excavations, boring, and well locations are to be marked on the ground surface using **white** paint in accordance with American Public Works as shown on the American Public Works Association (APWA) Uniform Color Code. A Kennedy/Jenks Consultants Utility Location and Acknowledgement Form must be filled out for each proposed well, boring, or excavation location. Obtain signatures from each private or public utility owner to document clearance on the each form, as required.

At all locations where drilling, probing, or well installation will be performed, an air knife or similar form of suction potholing will be performed to assess possible underground utilities in the upper 6 to 8 feet of soils (depending on local conditions and expected depth of utilities). Potholing is required at **all drilling locations**, except in remote areas where the likelihood of encountering underground utilities is very low and only as approved by a Risk Manager, Resource/Operations Manager or Officer of the company familiar with underground utilities. (Note: Use of an air knife will be appropriate for most invasive drilling and probing work, but may not be appropriate for certain activities like very shallow borings (less than 1-foot deep), certain hand-auger borings, remedial injections using probe equipment, and test pitting.) Case-by-case exceptions for activities may be provided.

Should an underground line or pipe or other obstruction be encountered unexpectedly or disturbed (broken, damaged, or undermined) immediately discontinue invasive activities and contact the Project Manager. If the Project Manager cannot be reached, contact an officer of Kennedy/Jenks Consultants. Secure the area to prevent further disturbance/damage.

When clearing the site for utilities, **ALWAYS REMEMBER TO LOOK UP for overhead utilities**. Kennedy/Jenks Consultants will direct its subcontractors to limit the proximity of equipment to overhead power transmission lines according to the following schedule:

Power Line	Distance from Power Line
50 kilovolts (kV) or below	10 feet
50 KV - 200 kV	15 feet
200 KV - 350 kV	20 feet
350 KV - 500 kV	25 feet

500 kV - 750 kV	35 feet
750 kV – 1,000 kV	45 feet

If the voltage of a power line is unknown, assume it is 1,000 kV.

5.1.8 Other Safety Considerations

When working at the site, personnel should be aware of the following situations or activities:

- Vehicle, truck, and equipment traffic on residential streets and nearby service roads. Use barricades, signage, and/or a traffic control plan, where appropriate. Kennedy/Jenks Consultants personnel are NOT trained in and are NOT authorized to set up traffic control or work as a highway flagger.

  Work in City right-of-way areas is anticipated for the Site. Traffic control (setup and flagging) will be performed by a subcontractor specializing in traffic control. Traffic control will be performed in accordance with a traffic control plan that will be submitted to the City of Seattle as part of the right-of-way use permitting process.

- Working with hand and small power tools. Utilize tools only for the purpose for which they were designed. Inspect all tools and equipment before they are used. Immediately remove from service any tool or piece of equipment that is damaged. Be aware of the potential of a burning hazard should equipment get hot during use.

- Do not wear any jewelry (including finger rings) or loose fitting clothes that may get caught in equipment while conducting field activities.

- Personnel should be aware of the potential presence of black widow spiders, wasp/hornets, or snakes in wellhead or other enclosures.

- When driving, personnel should be aware of the potential for wildlife to be on the road, or run into the road. Driving after dark should be limited as much as possible.

- When driving, personnel should be aware of the potential of falling asleep at the wheel and take rest stops and breaks, at regular intervals or as needed. Do not drive to and from the site if weather conditions make road travel unsafe.

5.2 Potential Chemical Hazards

Contaminants of concern (COC) identified for this site include gasoline-range organics (GRO), and benzene, toluene, ethylbenzne, and xylenes (BTEX). Other possible related COCs include gasoline additives such as methyl-tert-butyl-ether (MTBE), 1,2-dichloroethane (EDC), 1,2-dibromoethane (EDB), and total lead. Although not previously detected at the site, a dry cleaning business is present on the site indicating a potential for the presence of chlorinated solvents such as tetrachloroethylene (PCE).

Field personnel could potentially be exposed to COCs at the site by direct contact with soil or groundwater, through inhalation of dusts containing organic chemicals or through inhalation of organic chemical vapors.

Field personnel will minimize potential chemical hazards by 1) avoiding direct contact with groundwater and soil, 2) performing air monitoring to determine necessary level of personal protective equipment, and 3) avoiding generation of dust. Ingestion of particulate matter containing chemicals is another general exposure route. However, for site personnel, the potential for this type of exposure is minimal. Safe work practices, including restriction of eating, drinking, or smoking to certain times and places, will be enforced at the work site.

5.2.1 Groundwater Samples

Chemicals detected in groundwater from the site and the highest detected concentrations are listed in Table 1. The highest COC concentrations in groundwater are typically for samples collected from wells in which free-phase product [i.e., non-aqueous phase liquid, (NAPL)] has been present historically.

5.2.2 Soil Samples

COCs have been detected in subsurface soil samples collected at the site. The highest reported concentrations are listed in Table 2.

Available Threshold Limit Values (TLV) or Permissible Exposure Limits (PEL) published for the chemicals detected in soil and groundwater are listed in Table 3.

5.2.3 Chemical Use Plan and Material Safety Data Sheets (MSDS)/Hazard Communication

In addition to site-related chemicals, Kennedy/Jenks Consultants field personnel may work with compressed gasses, decontamination materials, and other materials that present potential health and safety issues. Typical chemicals that may be brought to the site are listed below.

- Isobutylene compressed gas cylinders for PID calibration
- Alconox or Liquinox soap for equipment decontamination

Laboratory-supplied sample containers may also contain chemical preservatives. Preservatives that may be included in laboratory-prepared sample containers that may be brought to the site include hydrochloric acid, nitric acid, phosphoric acid, and methanol.

Copies of the MSDS for the chemicals preservatives listed above are provided in Appendix F.

Section 6: Community Hazard Analysis

Generally, insignificant particulate and vapor emissions are generated during routine soil and groundwater sampling activities. During construction-related activities, particulate and vapor emissions may increase above concentrations generated during routine soil and groundwater sampling activities. Therefore, activity-specific health and safety addenda will be developed for activities where elevated particulate and vapor emissions may develop. Onsite worker exposure to chemicals at concentrations of concern is not expected. Potential exposures to the surrounding community will likely be much less than potential onsite worker exposure and is, therefore, also not expected to be of concern.

Use of barricades, caution tape, or signage to keep the general public away from working areas should be used where and when appropriate. At a minimum, keep public and non-essential personnel at least 50 feet away from an active drilling area. This can be accomplished using barricades, cones, vehicles, and caution tape.

The anticipated drilling and sampling locations include portions of the City of Seattle right-of-way west of the Site (24th Avenue East) and north of the Site (East McGraw Street). Traffic control plans will be developed and submitted to the City, as appropriate, and a traffic control subcontractor will provide flagging and traffic control services during work in the right-of-way areas.

The City may limit the hours during which work may be performed in the right-of-way areas. In addition, because the surrounding properties include residential uses, the City may limit the hours during which some work (such as drilling) may be performed at the Site.

Section 7: Protective Actions

7.1 PPE

Field personnel will wear equipment to protect against potential physical and chemical hazards, which have been identified herein and those that become apparent in the field. Guidelines for Contaminants Commonly Encountered at Kennedy/Jenks Consultants Sites provide guidance in assessing potential hazards and selecting the appropriate protection. Level D protection will be required at a minimum for field activities at the site.

The level of protection employed may be upgraded, as deemed necessary by the SSO. If non-routine field activities are initiated, the level of protection will be specified in the activity-specific health and safety addenda. Level D personal protective equipment to be used may include all items that are marked on the following list:

Personal Protective Equipment (PPE) and Monitoring Equipment

- ☒ Eyes: ☒ Safety Glasses ☐ Face Shield
- ☒ Boots: ☒ Safety-Toe ☐ Work ☐ Rubber ☐ Other
- ☒ Class II High-Visibility Reflective Safety Vest
- ☒ Hard hat
- ☒ Ear Muffs/Plugs
- ☒ Work Gloves ☐ *Neoprene* ☐ *Rubber* ☒ *Nitrile*
- ☐ Suits: ☐ *Cotton* ☐ *Tyvek* ☐ *Nylon* ☐ *Other*
- ☐ Respirator: (Type/Cartridge: *specify)*
- ☒ Emergency Eyewash ☐ Emergency Shower
- ☐ Spill Kit
- ☒ Fire Extinguisher
- ☒ First Aid Kit
- ☐ Life Jackets ☐ Rescue Life Ring
- ☐ Safety Belt/Harness/Tripod
- ☒ Lights *(type: Flashlight)*
- ☒ Camera/Video
- ☒ Cell Phone
- ☐ Lockout Tags and Locks
- ☐ Ventilator/Fan
- ☐ Volt/Ampere Meter
- ☐ Four Gas Meter *(calibration date: specify)*
- ☒ OVA *(calibration date: specify)*
- ☐ OVM *(calibration date: specify)*
- ☐ Hydrogen Sulfide Meter *(calibration date: specify)*
- ☐ Draeger Detection Tubes
- ☐ Soil Sampling Kit
- ☐ pH Meter/Paper
- ☐ Conductivity/Temperature Meter
- ☐ Metal Detector
- ☐ Air Sampling Equipment
- ☐ Peristaltic Pump (Tank Sampling)
- ☐ Other: specify
- ☐ Other: specify

If confined space entry is performed, any additional required PPE will be specified in the confined space Pre-Entry Checklist and Entry Authorization described in Section 5.1.3.

7.2 Work Zones

Work areas will be clearly marked in the field by cones, caution tape, barricades, or other similar means to create a clear visual perimeter and limit access to the general public. The work area perimeter will be established at each work location before any work is performed. Work zones in right-of-way areas will be established in accordance with traffic control plans and City permits.

Separate work zones including designation of an Exclusion Zone, a Contamination Reduction Zone, and a Support Zone will be established for any field activity which requires Level C protection or greater, but is not anticipated for this project.

7.3 Monitoring

7.3.1 Hazardous Substances

As appropriate, field personnel will perform air monitoring at least twice daily with a direct reading organic vapor analyzer (OVA, OVM, or HNU) in the breathing zone at each work location. All readings shall be recorded in field logs. All direct reading instruments shall be calibrated according to the manufacturer's specifications. The following action levels will be used.

- If OVA readings for a particular work area consistently exceed 5 parts per million (ppm) above background, then sampling will cease and personnel will withdraw from the work area.
- If concentrations persist above 5 ppm, then Level C protection will be required if work is to continue.
- If OVA readings exceed 10 ppm in the breathing zone while workers are in Level C protection, then work will cease, and the source of the emission will be determined and eliminated before work continues.
- Periodic measurements of the area will be taken before re-entry to ensure lower exposure limit (LEL) has been reduced to safe working levels.

7.3.2 Explosive Limits

If conditions encountered during drilling or sampling suggest potentially explosive conditions may exist, the SSO will direct explosimeter monitoring be conducted. The following explosimeter monitoring action levels will be used:

Site wide:

- If gas or vapor concentration is less than 10 percent of its LEL, continue investigation.
- If concentrations are between 10 and 25 percent of its LEL, continuously monitor site and continue investigation with extreme caution.
- If concentrations are greater than 25 percent of LEL, withdraw from area immediately.

Within a confined space (if any):

- If a gas or vapor's concentration is less than 10 percent of its lower explosive limit (LEL), continue investigation and air monitoring.

- If a gas or vapor's concentration is10 percent or greater of its lower explosive limit (LEL), all personnel will immediately evacuate the space.

7.3.3 Oxygen Content

If site activities involve confined space entry, oxygen concentrations within the space will be measured with an oxygen concentration meter. The following oxygen monitoring action levels will be used.

- If concentrations are less than 19.5 percent, withdraw from area until a breathable atmosphere has been re-established.
- If concentrations are between 19.5 and 23.5 percent, continue investigation and monitoring.
- If concentrations are greater than 23.5 percent, withdraw from area immediately (fire hazard potential).

7.3.4 Noise

Hearing protection will be worn during all drilling and air-knife excavation work. Hearing protection will also be worn for any activity where maximum noise levels will exceed 85 decibels at any time during site operations.

The OSHA permissible noise exposure limit is 90 decibels as an average exposure over an 8-hour work period. If an employee's 8-hour time-weighted average noise exposure for any day is in excess of 85 decibels, the employee must participate in a hearing conservation program. For most field activities, it is unlikely the employee exposure in excess of 85 decibels for 8 hours will occur. Although a written hearing conservation program is not required, Kennedy/Jenks Consultants will provide field personnel with appropriate hearing protection (i.e., earmuffs or plugs) whenever noise levels have the potential to exceed 85 decibels.

All contractors are responsible to ensure whether a hearing conservation program is warranted per site conditions and are to ensure compliance with applicable OSHA regulations.

7.4 Site Control

Work zones will not be established for Level D activities. Individuals not directly involved in ongoing work will be requested to stay at least 50 feet away from Level D activities; however, this may not be practicable given the small size of the Site (including parking areas), proximity to streets and a bus stop, and ongoing retail operations at the Site. The primary means of site control will be the visual barriers established around each work location as previously described. For work inside a building, access will be controlled using building access control.

7.5 Decontamination

For activities requiring Level D protection and modified Level C protection without established work zones, it is unlikely major decontamination will be necessary. At the conclusion of each

day or work period, disposable gloves and coveralls will be removed and disposed of in onsite containers.

If full Level C protection is required, minimum decontamination procedures associated with Level C protection will be followed and established within the Contamination Reduction Zone. These procedures are presented in Table 4.

7.6 Training

Kennedy/Jenks Consultants personnel participating in field activities will have completed the Hazardous Waste Operations and Emergency Response 40-hour health and safety training course (29 CFR 1910.120), or have equivalent training, and have undergone annual 8-hour refresher training. Training requirements are discussed in Kennedy/Jenks Consultants Health and Safety Operation Manual. Prior to each work day, a TSB meeting will be held at the site to familiarize personnel with health and safety issues, protective equipment, emergency information, and supplies and to discuss special topics.

7.7 Medical Monitoring

Kennedy/Jenks Consultants personnel participating in field activities will be included in a medical monitoring program. The program includes a baseline physical examination, pulmonary function test, and blood and urine tests. Periodic (annual) examinations will be provided to employees who are exposed to hazardous substances or health hazards at or above the established PEL, above the published exposure levels for these substances, without regard to the use of respirators, for 30 days or more a year. Annual examinations will also be provided to Kennedy/Jenks Consultants employees who wear a respirator for 30 days or more a year or as required by 1910.134. Details of the medical program are included in the Kennedy/Jenks Consultants Health and Safety Operations Manual.

7.8 Sanitation and Illumination

The site may have drinking water, washing water, and restroom facilities available. If drinking water is not available at the site, a sufficient amount of water will be provided to accommodate each employee with 1 quart of water per hour. The water will be kept cool by means of a portable cooler with ice or similar means.

No eating, drinking, smoking, or gum or tobacco chewing is allowed in restricted work areas.

Activities will take place during daylight hours. Because natural illumination (approximately 50- to 200-foot candles) will be sufficient to meet the 5-foot candle requirement for general site areas, no additional illumination will be required.

Section 8: Emergency Response Plan

Hazard recognition is an essential part of the Emergency Response Plan. Initiation of the contingency plan relies on the employee's ability to recognize an emergency or potential for an emergency. The following is a list of events that will immediately initiate emergency procedures:

- Explosion
- Fire
- Release of organic vapors or particulate above the action levels
- Personal injury
- Failure or expected failure of runon/runoff control measures
- Natural occurrences (i.e., lightning, tornado, high winds, etc.)
- Spills.

8.1 Emergency Communications

Emergency communications will consist of four methods.

8.1.1 Verbal Communication

Verbal communication will be the primary method of emergency communication between onsite personnel, distance permitting.

8.1.2 Hand Signals

- Hands clasped on wrists will indicate personnel to stop work and exit Exclusion Zone.
- Hands on throat indicate inability to breathe.
- Thumbs up indicates OK.
- Thumbs down indicates not OK.

8.1.3 Air Horn/Vehicle Horn

As appropriate, air horns will be carried by personnel entering any established Exclusion Zone and stationed in the Support Zone. If air horns fail or are lost, vehicle horns may be used as a substitute. Air horns will be the primary alarm system and used in the following manner:

One long blast: Evacuate Exclusion Zone by nearest exit. Proceed to assembly area.

Two short blasts: Localized problem. Avoid area, move to decontamination Reduction Zone for further instruction.

Three short blasts: All clear, resume work.

8.1.4 Telephones

Telephones are used for routine communication and to notify offsite agencies of incidents and request assistance. Emergency telephone numbers are given in Section 9. All K/J personnel will carry cell phones while onsite.

8.2 Emergency Protocol

When an event recognized as an emergency occurs, the alarm system will be used to notify personnel. As soon as the alarm system is activated, the SSO will be notified.

The SSO will take into account the following information:

- Nature of emergency
- Wind direction
- Location of personnel
- Monitoring results
- Emergency equipment available
- Offsite population.

Based on this information, the SSO will direct appropriate emergency action and agency notification. After the emergency has been controlled and the site is considered safe to re-enter, the SSO, in coordination with the Project Manager, will direct remedial action to restore the site to full operating condition.

The SSO will investigate the nature and cause of the incident so work procedures can be modified to minimize the likelihood of the incident's recurrence.

All incidents must be reported in a timely, appropriate manner to the Director of HS&E or H&S Manager. An incident is any unplanned event resulting in injury, damage, loss of assets, adverse publicity, or which requires notification of a regulatory agency, regardless of severity. All Kennedy/Jenks Consultants personnel should report an incident to the SSO. The SSO will report to the Project Manager, who is responsible for notifying the Director of HS&E or H&S Manager..

Each incident will be investigated and a Root Cause Analysis Report will be generated and forwarded to the Project Manager and the H&S Manager.

If work zones are established, the Exclusion Zone will have several emergency exits, which will allow safe egress in multiple directions from any point onsite. The exit selection will be based on the emergency location, type of emergency, and wind direction. Upon hearing the evacuation signal or otherwise being notified of an evacuation, employees will immediately travel to the assembly area located at the decontamination station.

Employees will follow a route that avoids locations downwind from the emergency. If emergency exits are used, employees will proceed to the assembly area by the quickest route possible. When the assembly area is reached, employees will immediately check in with the SSO. The site will remain evacuated until the all clear signal has been given.

8.3 Emergency Supplies

The following is a list of emergency equipment available to take to the site:

- Portable emergency eye wash
- First aid supplies.
- Absorbent-spill control
- Extra batteries for radios, monitoring equipment, etc.

All personnel will have a thorough understanding of the HASP before starting work. It will be reviewed periodically to keep it current with new or changing site conditions or information.

8.4 Injury Response

In the event of an employee injury in a contaminated area, consideration must be given before moving the injured and contaminated employee to outside the restricted contamination area. The nature of the injury, hazards posing an immediate danger, and other factors must all be weighed before moving an injured employee who is wearing contaminated PPE. Initial responders should follow directions from 9-1-1 personnel or the Director of HS&E or H&S Manager.

Section 9: Section 9: Reporting (Injury/Illness, Property Damage, or Near Miss)

9.1 Injury/Illness Care and Notification Procedures

9.1.1 Emergency Services (9-1-1)

Call 9-1-1 for critical injuries or illnesses (i.e., head injuries, uncontrolled bleeding, difficulty breathing, chest pain, or altered level of consciousness) or if an employee or his/her supervisor has immediate concerns about an injury or illness.

9.1.2 Injury/Illness Intervention

Kennedy/Jenks Consultants has retained WorkCare, a team of occupational physicians, to provide our employees with effective treatment of non-critical work-related injuries and illnesses. WorkCare provides on the spot, 24/7 employee consultations at the time an on-the-job incident occurs, as well as post-accident follow-up and consultation.

9.1.3 When to Call WorkCare

In the instance of a non-critical workplace injury or illness, an employee should call WorkCare at (888) 449-7787 to receive instruction on how to contact one of its clinicians and contact their immediate supervisor as soon as possible. Common non-critical workplace injuries/illnesses include:

- Back sprains
- Slips, trips, falls
- Shoulder strains
- Contact with a harmful substance.

9.1.4 Employee Role

The injured employee, if able, must do the following:

- Report any non-critical injuries/illness to WorkCare at (888) 449-7787 and, as soon as possible, to their immediate supervisor. WorkCare will notify the Director of HS&E and the H&S Manager of the injury or illness. The Director of HS&E will immediately notify the appropriate Business Unit President and Director of Operational Excellence of the injury or illness.

- If WorkCare determines medical attention is required, transportation must be provided for the injured employee. An injured employee must not transport himself/herself to a facility for medical treatment. If a co-worker is not available to transport the injured employee, an ambulance, a taxi, or other means of transportation must be provided, unless the employee is working in a remote area and no other form of transportation is available. WorkCare will send the employee to an approved local facility and inform the treating physician the injury is work related.

9.1.5 Project Manager Role

The Project Manager must do the following:

- Make sure the injured employee contacts WorkCare and is provided transportation to immediately obtain any required medical care from an approved doctor or hospital, if required.
- Provide emergency ambulance service if needed for critical injuries or illnesses, if required.
- Notify the Director of HS&E and Business Unit H&S Manager of the injury or illness.

9.1.6 Injured Subcontractor or Other Non-Kennedy/Jenks Consultants Employee

In the case of injuries or illness to non-employees, the appropriate staff member should ensure they receive proper medical attention and their supervisor and the Director of HS&E are notified immediately. The Director of HS&E will notify senior management.

9.2 Property Damage and Near Miss Incident Investigation

All work-related property damage and near miss incidents will be investigated by Kennedy/Jenks Consultants in a timely manner. Minor incidents and "near misses" will also be investigated so the risk of serious occurrences can be reduced in the future. All serious incidents and serious "near misses" will be investigated by the Director of HS&E or the H&S Manager.

- Near Miss. Incidents where no property was damaged and no personal injury sustained, but where, given a slight shift in time or position, damage and/or injury easily could have occurred.
- Rule of Thumb. If you need to ask yourself if the incident was a near miss or not, you have answered the question, and it is a near miss.

9.3 Forms

The Injury/Illness, Property Damage Incident, and Near Miss Reporting Forms are included as Appendix G.

Section 10: Emergency/Team Contacts & Approvals

Emergency Telephone Numbers

	Name	Phone
Client Site Contact	Dale Myers (DOE)	425-649-4446
WorkCare (Non-Critical Injuries)	WorkCare	888-449-7787
Fire Department[1]		9-1-1
Hospital:[2]	UW Medical Center 1959 NE Pacific Street, Suite 207 Seattle, WA 98105	206-598-4000
Directions to hospital[2]:	See map and directions in Attachment 1	
Ambulance		9-1-1
Police Department		9-1-1
Kennedy/Jenks Consultants:		
Project Manager	Ty Schreiner	253-835-6428 (office) 206-419-0048 (cell)
Business Unit Health and Safety Manager	John Jindra	253-835-6466 (office) 253-254-1079 (cell)
Site Safety Officer	Dean Malte or Julia Schwarz	253-835-6400 (office) Cell TBD
Director of Health, Safety and Environment	Bert Drews	415-243-2526 (office) 415-350-7804 (cell)

[1] The local fire department prefers the public use 911 to assure the proper assistance in case of accident or injury.
[2] Attach written directions and map showing route to urgent care and hospital (see Attachment 1).

Project Team Members Participating in Field Activities

Name	Affiliation	Responsibility	Signature
Julia Schwarz	Kennedy/Jenks Consultants	Fieldwork/SSO	Julia Schwarz
Diane Rauch	Kennedy/Jenks Consultants	Fieldwork/SSO	Diane Rauch
Joe Sawdey	Kennedy/Jenks Consultants	Fieldwork/SSO	
Dean Malte	Kennedy/Jenks Consultants	Fieldwork/SSO	Dean Malte

Approvals

	Name	Signature/Date
Project Manager	Ty Schreiner	Ty C. Schreiner 3/2/16
Business Unit Health and Safety Manager	John Jindra	John P Jindra 3/2/16

CC: Project File
PM Portal

Tables

Table 1: Chemicals Detected In Groundwater Monitoring Samples

Chemical	Maximum Concentrations (mg/L)	Sample Location
TPH[a] (GRO)[b]	historical: 464 recent: 109	MW-8[c] (2001) MW-13[c] (2006)
Benzene	historical: 54 recent: 7.26	MW-13 (1990) MW-13 (2006)
Toluene	historical: 28 recent: 14.7	MW-4[c] (2001) MW-13 (2006)
Ethylbenzene	historical: 50 recent: 27.7	MW-13 (1990) MW-8 (2006)
Total Xylenes	historical: 17.1 recent: 15.5	MW-4 (2001) MW-13 (2006)
MTBE	15.5 ug/L	MW-15 (2003)

Notes:
(a) Total petroleum hydrocarbon
(b) Gasoline-range organics
(c) Non-aqueous phase liquid (NAPL) has been present historically in wells MW-4, -8, -9, and -13.
mg/L = milligrams per liter
ug/L = micrograms per liter

Table 2: Chemicals Detected in Soil Samples

Chemical	Maximum Concentrations (mg/kg)	Sample Location
TPH[a] (GRO)[b]	1700	NW-1 (north side of former UST excavation area) at 13 feet bgs[c] (1990)
Benzene	31	NW-1 (north side of former UST excavation area) at 13 feet bgs (1990)
Toluene	55	NW-1 (north side of former UST excavation area) at 13 feet bgs (1990)
Ethylbenzene	140	NW-1 (north side of former UST excavation area) at 13 feet bgs (1990)
Total Xylenes	300	NW-1 (north side of former UST excavation area) at 13 feet bgs (1990)

Notes:
(a) Total petroleum hydrocarbon
(b) Gasoline-range organics
(c) Below ground surface
mg/kg = milligrams per kilogram

Table 3: Chemical Allowable Exposure Values and Exposure Symptoms

Chemical	TLV TWA[(a)]	STEL[(b)]	PEL[(b)]	Acute Exposure Symptoms[(c)]	Target Organs[(c)]
Benzene	0.5 ppm	5 ppm	1 ppm	Irritant to eyes, nose respiratory system nausea.	Skin[(d)], liver, kidneys, respiratory system, cardiovascular system, central nervous system.
Ethylbenzene	100 ppm	125 ppm	100 ppm	Irritant to eyes, mucous membranes, dermatitis, narcosis coma.	Skin, liver, kidneys, respiratory system, cardiovascular system, central nervous system.
Toluene	50 ppm	300 ppm ceiling	100 ppm	Fatigue, weakness, confusion, euphoria, dizziness, headache, dilated pupils.	Central nervous system, liver, kidneys, skin.
Xylene	100 ppm	150 ppm	100 ppm	Dizziness, excitement, vomiting.	Central nervous system, eyes, gastrointestinal (GI) tract, blood, liver, kidneys, skin.
Methanol (preservative)	100 ppm	250 ppm	200 ppm IDLH 6,000 ppm	Eye, skin and mucus irritant, dizziness, nausea.	Optic nerve, liver, and other organ damage.
Lead	0.05 mg/m^3	----	0.05 mg/m^3 IDLH 100 mg/m^3	Weakness, lassitude, insomnia, facial pallor, abdominal pain, anemia, tremor, eye irritation, liver and kidney disease.	Eyes, GI tract, CNS, kidneys, blood, gingival tissue.
Gasoline	None Developed	----	None Developed	Irritant to eyes, skin, mucous membranes, dermatitis, lassitude, blurred vision, dizziness, slurred speech, confusion, convulsions.	Eyes, skin, respiratory system, CNS, liver, kidneys.
Ethylene dichloride (1,2-DCE; EDC)	1 ppm (Ca TWA[(c)])	2 ppm (ST REL[(c)])	50 ppm TWA	Irritant to eyes, corneal opacity, CNS depression, nausea, vomiting, dermatitis.	Eyes, skin kidneys, liver, CNS, cardiovascular system.
Ethylene dibromide (1,2-DBE; EDB)	0.045 ppm (Ca TWA[(c)])	----	20 ppm TWA	Irritant to eyes, skin, respiratory system, dermatitis with vesiculation..	Eyes, skin, respiratory system, liver, kidneys, reproductive system.
Tetrachloroethylene (PCE)	50 ppm	----	25 ppm	Irritant to eyes, nose, throat; nausea, flush face, neck; vertigo; dizziness; incoherence; headache; sleepiness; skin redness.	Eyes, skin, respiratory system, heart, liver, kidneys, CNS.

Notes:

(a) TLV TWA = threshold limit value – 8-hour time-weighted average.
STEL = short term exposure limit.
American Conference of Governmental Industrial Hygienists. TLV and Biological Exposure Indices for 1997.
TLV TWA reported in ppm represents parts of vapor per million parts of air by volume at 25 degrees Celsius (°C) and 760 torr. TLV - TWA reported in milligrams per cubic meter (mg/m^3) represents milligrams of substance per cubic meter of air.

(b) PEL = Federal Occupational Safety and Health Administration (OSHA) (29 CFR 1910 Subpart Z) Permissible Exposure Level based on 8-hour time weighted average.

(c) Source: U.S. Department of Health and Human Services. National Institute for Occupational Safety and Health (NIOSH) Pocket Guide to Chemical Hazards. June 1994. Sittig, Marshall. 1985. Handbook of Toxic and Hazardous Chemicals and Carcinogens. Park Ridge, New Jersey. Noyes Publications.

(d) Skin notation indicates route of exposure through cutaneous absorption.

(e) CNS = central nervous system.

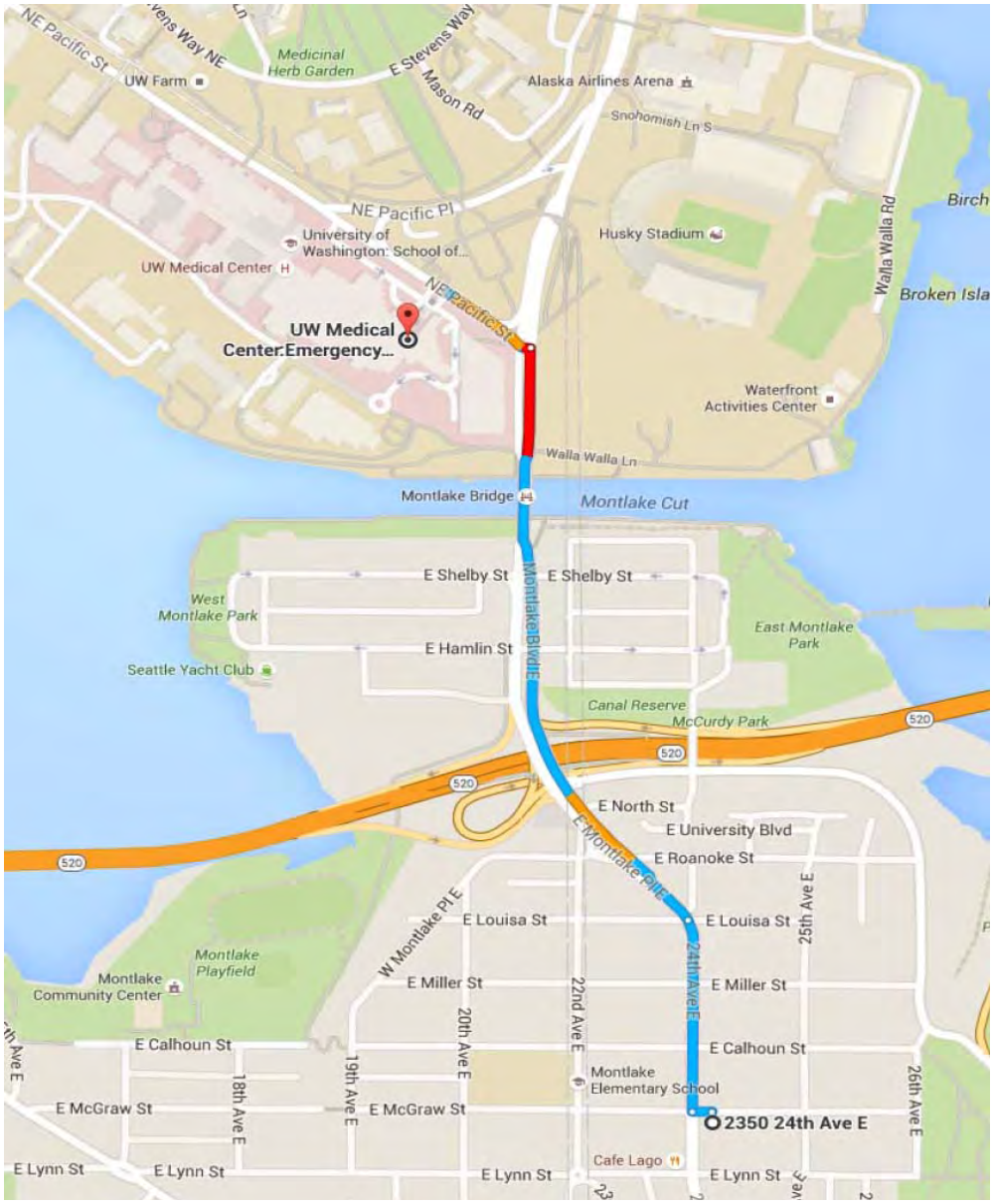
ppm = parts per million
mg/m^3 = milligrams per cubic meter
IDLH = immediately dangerous to life and health

Table 4: Measures for Level C Decontamination

Station	Description
1	**Equipment Drop** Deposit equipment used onsite (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths. Segregation at the drop reduces the probability of cross contamination. During hot weather operations, a cool down station may be set up within this area.
2	**Outer Garment, Boots, and Gloves Wash and Rinse** Scrub outer boots, outer gloves, and splash suit with decon solution or detergent water. Rinse off using copious amounts of water.
3	**Outer Boot and Glove Removal** Remove outer boots and gloves. Deposit in container with plastic liner.
4	**Canister or Mask Change** If worker leaves Exclusion Zone to change canister (or mask), this is the last step in the decontamination procedure. Worker's canister is exchanged, new outer gloves and boot covers donned, joints taped, and worker returns to duty.
5	**Boot, Gloves and Outer Garment Removal** Boots, chemical-resistant splash suit, inner gloves removed and deposited in separate containers lined with plastic.
6	**Face Piece Removal** Face piece is removed. Avoid touching face with fingers. Face piece is deposited on plastic sheet.
7	**Field Wash** Hands and face are thoroughly washed. Shower as soon as possible.

Attachment 1

Map and Written Directions to Local Hospital



- From the Site, turn north onto 24th Avenue East.
- Follow 24th Avenue northbound; 24th Avenue becomes East Montlake Place E and then Montlake Blvd East (north of SR 520).
- Follow Montlake Blvd northbound to NE Pacific Street.
- Turn left (westbound) onto NE Pacific Street.
- Turn left from NE Pacific Street to UW Medical Center.

Appendix A

Tailgate Safety Briefing Record

Kennedy/Jenks Consultants
DAILY TAILGATE SAFETY BREIFING

Project Name: _____ Date: _____

Project No.: _____ Conducted By: _____ Contractor(s): _____

Check the Topics/Information Reviewed:

O emergency procedures & evacuation route	O insects/snakes/biological hazards	O scaffolding
O site-specific safety plan, review and location	O daily scope of work	O cell phone usage / prohibitions
O fire prevention/safety/fire extinguishers	O directions to hospital	O personal protective equipment
O training/certification	O stop work authority	O hard hats, safety vest, steel-toe boots
O equipment and machinery familiarization	O pinch points	O strains and sprains
O sharp objects, rebar, and scrap metals	O lifting techniques	O buddy system
O slips, trips, and falls	O site housekeeping	O tool safety
O vehicle safety and driving/road conditions	O parking and lay down areas	O public safety
O overhead utility locations and clearances	O backing-up hazards	O traffic safety
O open pits and excavations	O location of utilities	O hearing & eyewear protection
O drinking water and restroom locations	O noise hazards	O flying debris hazards
O smoking in designated areas only	O equipment movement	O fire extinguisher locations
O eye wash station locations	O decontamination procedures	O heavy equipment hazards
O Hazard Communication//MSDS locations	O first aid	O dust and/or vapor control
O site control/security	O no horseplay	O drug and alcohol policy
O heat and cold stress	O visitors / media / passers-by	O weather hazards
O confined spaces	O lockout/tagout	O electrical hazards
O fall protection	O ladders safety	O other _____

***Discussion/Comments/Questions/Near Misses/Follow-up Actions*:**

List Any Special Site Conditions / H&S Precautions Reviewed

By signing below, I acknowledge that I have participated in this safety briefing. I am aware that a site-specific safety plan exists for this project and that it is available to me upon request.

NAME	*SIGNATURE*	*COMPANY*

Appendix B

Confined Space Entry Procedures and Pre-Entry Checklist and Entry Authorization Form

Kennedy/Jenks Consultants

303 Second Street, Suite 300 South
San Francisco, California 94107
415-243-2150
FAX: 415-896-0999

Confined Space Entry Procedures for Entrant and Attendant

December 2010

(Revised August 2015)

Table of Contents

LIST OF APPENDICES

The written Kennedy/Jenks Consultants confined space entry program is intended to comply with requirements set forth in the Federal Code of Regulations (CFR), Section 1910.146, California Code of Regulations (CCR) Title 8, Subchapter 7, Sections 5157 and 5158, and other state equivalent regulations

Section 1: Confined Space Entry – An Overview

Many job sites contain spaces that are considered to be "confined" because their configurations hinder the activities of Kennedy/Jenks Consultants employees who must enter into, work in, or exit from them. In many instances, Kennedy/Jenks Consultants employees who work in confined spaces also face increased risk of exposure to serious physical injury from hazards, such as entrapment, engulfment, and hazardous atmospheric conditions. Confinement itself may pose entrapment hazards, and work in confined spaces may keep employees closer to hazards, such as energized equipment, than they would be otherwise. For example, confinement, limited access, and restricted airflow can result in hazardous conditions that would not normally arise in an open workplace.

Confined space means a space that:

1. Is large enough and so configured employees can bodily enter and perform assigned work; and
2. Has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and
3. Is not designed for continuous employee occupancy.

The terms "permit-required confined space" and "permit space" refer to confined spaces that meet Occupational Safety and Health Administration's (OSHA) definition of a "confined space" and contain health or safety hazards. For this reason, OSHA requires workers to have a permit to enter these spaces.

By definition, **a permit-required confined space** has one or more of these characteristics:

- Contains or has the potential to contain a hazardous atmosphere;
- Contains a material with the potential to engulf someone who enters the space;
- Has an internal configuration that might cause an entrant to be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross section; and/or
- Contains any other recognized safety or health hazards.

Entry means the action by which a person passes through an opening into a confined space. Entry includes ensuing work activities in that space and is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space.

Confined space entry requirements are set by the Owner (host employer) but must meet 29 CFR 1910.146 requirements as a minimum.

Examples of confined spaces encountered by Kennedy/Jenks Consultants include:

- Manholes (sewers, storm drain, electrical communication, etc.).
- Vaults (valve, meter, electrical, communication, etc.).
- Pipelines and conduits (sewers, storm drains, water, etc.).

- Tanks (water storage, digesters, treatment process basins, tanks, and filters, even if open top, etc.).
- Tank and container spill containment basins.
- Wet wells.
- Pump station dry pits, machinery rooms, pipe galleries, etc., if they have limited or restricted access (access by other than standard staircase and door); if they do not have a fully operational ventilation system that operates continuously; or if they are operating under an emergency condition (leak, failure of a system, etc.).
- Excavations with potential hazards (such as presence of toxic gases, etc.).
  Note: excavations must be in compliance with 29 CFR 1926.651 or state equivalent regulation (sheeting, shoring, sloping, etc., requirements).

Preparing for an Entry

Kennedy/Jenks Consultants is not the Owner of any confined spaces. As a consultant (considered a "contractor") to an Owner who is retained to perform confined space entry operations Kennedy/Jenks Consultants shall:

1. Obtain any available information regarding confined space hazards and entry procedures from the Owner.
2. Complete the Owner's "Confined Space Pre-Entry Check List and Entry Authorization" or equivalent Owner's documentation for the Owner's review and signature. If the Owner does not have a confined space entry program in place, or the Owner's program is considered by Kennedy/Jenks Consultants to be inadequate, Kennedy/Jenks Consultants is to prepare the attached Kennedy/Jenks Consultants Confined Space Pre-Entry Check List and Entry Authorization (attached as Appendix B) for the Owner's review and signature.
3. Coordinate entry operations with the Owner and the Corporate Safety Specialist (CSS) or Business Unit Health and Safety Manager (H&S Manager) when Kennedy/Jenks Consultants employees will be working in or near confined spaces.
4. Inform the Owner of the confined space of any hazards encountered or created in the confined space, either through a debriefing or during the entry operation.

Section 2: Potential Hazards

Confined spaces are notorious for concealing potential hazards capable of causing injury or fatalities. Potential hazards found in association with confined spaces include:

- Engulfment by liquid or finely divided (flowing) solids.
- Presence of toxic gases. Equal to or more than 10 parts per million (ppm) hydrogen sulfide. If the presence of other toxic contaminants is suspected, specific monitoring programs will be developed.
- Presence of explosive/flammable gases. Equal to or greater than 10% of the lower flammable limit (LFL).
- Oxygen Deficiency. A concentration of oxygen in the atmosphere equal to or less than 19.5% by volume.
- Slipping and falling on slime or sludge accumulation.
- Falling objects, materials, or tools from above.
- Animals and insects.

Section 3: Certification

If an Owner does not have a Confined Space Entry Program in place, a Kennedy/Jenks Consultants Confined Space Pre-Entry Check List and Entry Authorization must be completed for each planned entry.

Permit Required Entry

Entry into confined spaces requires special equipment, training, review, and authorization from the Director of Health, Safety, and Environment (Director of HS&E) or the Business Unit H&S Manager (H&S Manager. All spaces to be entered by Kennedy/Jenks Consultants employees shall be considered permit-required confined spaces requiring completion and approval of the Kennedy/Jenks Consultants Confined Space Pre-Entry Check List and Entry Authorization form by the Director of HS&E or H&S Manager.

Kennedy/Jenks Consultants policy prohibits employees from performing work, which requires Level A or B personal protective equipment. If entry into a space requires the use of Level A or B personal protective equipment, the Owner should perform such work, or arrangements should be made to utilize the services of a qualified subcontractor.

Any employee required or permitted to pre-check or enter a confined space shall have successfully completed, as a minimum, training specified in Section 8 of these procedures. A copy of this program and Kennedy/Jenks Consultants Confined Space Pre-Entry Check List and Entry Authorization shall be kept at the entry point for the duration of the authorized work.

If circumstances cause an interruption in the work or a change in the alarm conditions for which entry was approved, a new Kennedy/Jenks Consultants Confined Space Pre-Entry Check List and Entry Authorization must be completed.

Section 4: Control of Hazards

Lockout/Tagout

All pumps and lines, which may reasonably cause contaminants to flow into the space, shall be disconnected, blinded and locked out, or effectively isolated by other means to prevent development of dangerous air contamination or engulfment. Not all laterals to sewers or storm drains require blocking. However, where experience or knowledge of industrial use indicates there is a reasonable potential for contamination of air or engulfment into an occupied sewer, then all affected laterals shall be blocked. Blocking, isolating, disconnecting, lock outs, etc., shall be done by the Owner and verified by Kennedy/Jenks Consultants.

The interior of the confined space should also be surveyed for energized equipment and all energy sources (electrical, mechanical, hydraulic, pneumatic, chemical, thermal, and other energy sources) should be identified and tagged and/or lockout out prior to initiating work in the confined space.

Ventilation

Mechanical ventilation systems, where applicable, shall be set at 100% outside air. Additional manholes will be opened, where possible, to increase air circulation. Use portable blowers to augment natural circulation, if needed. After a suitable ventilating period, repeat the testing. Entry may not begin until testing has demonstrated the hazardous atmosphere has been eliminated.

Surveillance

Surrounding areas shall be surveyed to avoid hazards, such as drifting vapors, from tanks, piping or sewers, foot or vehicle traffic, and foreign objects entering the space. The interior of the space should be survey for the presence of animals and insects before work begins.

Section 5: Testing

The atmosphere within the space will be tested without entering the space to determine whether dangerous air contamination and/or oxygen deficiency exists. Testing shall be performed by the task (entrant or attendant) that has successfully completed the gas detector training for the monitor that will be used. The minimum parameters to be monitored are oxygen deficiency/saturation, LFL, carbon monoxide, and hydrogen sulfide concentration.

1. Atmospheric oxygen must remain between 19.5% and 23.5%. Oxygen deficiency below 19.5% or oxygen saturation above 23.5% will require immediate removal of all personnel from confined space.
2. Flammable gas or vapor in excess of 10% of its LFL will require immediate removal of all personnel from confined space.
3. Flammable dust, which obscures vision at 5 feet or less, will require immediate removal of all personnel from confined space.
4. Atmospheric concentration of any toxic substance exceeding recommended minimum dosage or permissible exposure levels (PEL) for personnel will require immediate removal of all personnel from confined space. PEL for carbon monoxide is 25 ppm. PEL for hydrogen sulfide is 10 ppm.

A written record of the pre-entry test results shall be made and kept at the entry point for the duration of the job. The task manager will certify in writing, based upon the results of pre-entry testing, that all hazards have been eliminated. Affected personnel shall be able to review the testing results. The most hazardous conditions shall govern when work is being performed in two adjoining, connecting spaces.

Section 6: Entry Procedures

Kennedy/Jenks Consultants policy requires that any task requiring entry into a confined space be accomplished by a minimum of two employees (entrant and attendant). If there are no non-atmospheric hazards present, or if the space can be maintained in a safe condition for entry by mechanical ventilation alone, as provided in 1910.146 (c) (5), and if the pre-entry tests show there is no dangerous air contamination and/or oxygen deficiency within the space and there is no reason to believe that any is likely to develop, entry into and work within may proceed.

Continuous testing of the atmosphere in the immediate vicinity of the workers within the space shall be conducted. All workers will immediately leave the permit space when any of the gas monitor alarm set points are reached as defined. Workers will not return to the area until the Owner has evaluated the space and connecting system and determined it is safe to enter.

All Kennedy/Jenks Consultants employees entering a confined space will wear a safety harness with a connection point located between the shoulder blades on the upper back of the entrant. A safety belt is not acceptable. Although the use of a winch is not required when entering a confined space that meets all criteria of the Kennedy/Jenks Pre-Entry Check List and Entry Authorization, Kennedy/Jenks Consultants encourages the use of a winch and other safety equipment that may be identified in the project Health and Safety Plan or Hazard Appraisal and Recognition Plan. Always be conservative in project safety planning. Kennedy/Jenks Consultants policy prohibits employees from performing work that requires Level A or B personal protective equipment.

Section 7: Rescue

Attendant shall have necessary emergency phone numbers readily available and in hand. He/she is directed to call the pre-designated rescue agency in the event of an emergency. It is understood that not all local fire departments are confined space rescue qualified. The attendant shall have phone contact information for the nearest confined space rescue agency. This may require entrant/attendant to contact the local fire department to verify its rescue capabilities prior to entry. Kennedy/Jenks Consultants' Health and Safety staff can assist with this requirement. **Under no circumstances are Kennedy/Jenks Consultants attendants to enter a confined space to attempt or to assist in a rescue.**

Initiating a confined space non-entry rescue is acceptable. A non-entry rescue involves attempting to extricate an incapacitated person without having anyone else enter the confined space. This can be done via a safety line attached to the employee in the confined space or by grabbing the personnel with a rope, strap, or pole and pulling them to safety. For most vertical entries, a non-entry rescue can be accomplished using a harness and tripod rescue system.

Section8: Training

H&S Manager with assistance from Director of HS&E shall ensure authorized entrants and attendants have received proper training as required by Kennedy/Jenks Consultants Corporate Health and Safety program and Kennedy/Jenks Consultants Confined Space Entrant and Attendant Training (see form in Appendix A) prior to initial assignment and, at least, annually thereafter.

KENNEDY/JENKS CONSULTANTS

CONFINED SPACE ENTRANT AND ATTENDANT TRAINING

1. Review of Kennedy/Jenks Consultants Policy and Entrant and Attendant Procedures for Confined Space Entry.
2. Review of Duties of Entrants:
   a. Know the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure.
   b. Properly use equipment.
   c. Communicate with the attendant as necessary to enable the attendant to monitor entrant status and enable the attendant to alert entrants of the need to evacuate the space.
   d. Alert the attendant whenever:
      1) The entrant recognizes any warning sign or symptom of exposure to a dangerous situation, or
      2) The entrant detects a prohibited condition.

e. Exit from the space immediately whenever:
   1) An order to evacuate is given by the attendant.
   2) The entrant recognizes any warning sign or symptom of exposure to a dangerous situation.
   3) The entrant detects a prohibited condition, or
   4) An evacuation alarm is activated.

3. Review of Duties of Attendants:
   a. Know the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure.
   b. Be aware of possible behavioral effects of hazard exposure in authorized entrants.
   c. Continuously maintain an accurate count of authorized entrants in the space.
   d. Remain outside the space during entry operations until relieved by another attendant.
   e. Communicate with authorized entrants as necessary to monitor entrant status and to alert entrants of the need to evacuate the space.
   f. Monitor activities inside and outside the space to determine if it is safe for entrants to remain in the space and orders the authorized entrants to evacuate the space immediately under any of the following conditions:
      1) If the attendant detects a prohibited condition.
      2) If the attendant detects the behavioral effects of hazard exposure in an authorized entrant.
      3) If the attendant detects a situation outside the space that could endanger the authorized entrants; or
      4) If the attendant cannot effectively and safely perform all the duties required.

g. Summon rescue and other emergency services as soon as the attendant determines that authorized entrants may need assistance to escape from confined space hazards.

h. Take the following actions when unauthorized persons approach or enter a confined space while entry is underway.
   1) Warn the unauthorized persons that they must stay away from the space.
   2) Advise the unauthorized persons that they must exit immediately if they have entered the space; and
   3) Inform the authorized entrants if unauthorized persons have entered the confined space.

i. Perform non-entry rescues.

j. Perform no duties that might interfere with the attendant's primary duty to monitor and protect the authorized entrants.

4. Review of Equipment:

   a. ☐ Project Specific Atmosphere Monitor Type

   b. ☐ Safety Harness and/or Lift

   c. ☐ Mechanical Ventilation Equipment

   d. ☐ Other _____

5. Review of Kennedy/Jenks Consultants' Entrant and Attendant Procedures for Confined Space Entry:

   Signatures:

   a. Trainee _____ Date_____

   b. Trainer _____ Date_____

6. Distribution:

   cc: Corporate H&S Officer (original)
   Human Resources (copy)
   Trainee (copy)

KENNEDY/JENKS CONSULTANTS
CONFINED SPACE PRE-ENTRY CHECK LIST
AND ENTRY AUTHORIZATION

This permit should be used to authorize entry into permit required and non-permit required confined spaces.

CONFINED SPACE ENTRY ROSTER

This document must be located at the entry point of the designated confined space.

Entry Location: _____ Date: _____

Entrant Names	Date	Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit
Attendant Names	Date	On Duty	Off Duty	On Duty	Off Duty	On Duty	Off Duty	On Duty	Off Duty
Entry Supervisor	Date	On Duty	Off Duty	On Duty	Off Duty	On Duty	Off Duty	On Duty	Off Duty

KENNEDY/JENKS CONSULTANTS
CONFINED SPACE PRE-ENTRY CHECK LIST
AND ENTRY AUTHORIZATION

Date _____

Project Title _____ Project Number _____

Work Site _____ Work to be done _____

☐ Owner has received, reviewed and will keep on file the Confined Space Pre-Entry Check List and Entry Authorization and find that it meets the requirements of their Confined Space Entry Requirements.

_____
Owner Name

1. Initial Atmospheric Check

   Atmospheric Monitor Type _____ Calibration Date _____

Oxygen	_____	%
Explosive	_____	% LFL (Lower Flammable Limit)
Toxic	_____	PPM (Hydrogen Sulfide)
Other Toxic	_____	PPM
Time	_____	

2. Engulfment Source Isolation: (Work to be done by Owner and verified by Kennedy/Jenks Consultants Task Manager)

	N/A	Yes	No
Piping (blinded, disconnected, blocked)	____	____	____
Pumps/Equipment (locked out, tagged)	____	____	____
Shoring/Excavation Sloping	____	____	____

3. Ventilation Modification

	N/A	Yes	No
Mechanical	____	____	____
Natural Only	____	____	____

4. Surveillance

	Yes	No
a. Surveillance of surrounding area show it to be (all must be yes to authorize entry):		
1) Free from drifting vapors	____	____
2) Guarded from traffic	____	____
3) Protected from foreign objects entering the space	____	____

5. Pre-Entry Atmospheric Check: (Immediately prior to entry)

Oxygen	_____	% (must be >19.5% and <23.5%)
Flammable	_____	'% LFL (must be <10%)
Toxic	_____	PPM (must be <10 PPM H_2S)
Other Toxic	_____	PPM
Time	_____	

6. Training

Entrant: I,_____ , have received the Kennedy/Jenks Consultants Confined Space Entrant
(print name)
and Attendant Training and training on the use of the atmospheric monitor identified above.

_____
(Signature)

Attendant: I,_____ , have received the Kennedy/Jenks Consultants Confined Space Entrant
(print name)
and Attendant Training and training on the use of the atmospheric monitor identified above.

_____
(Signature)

7. Rescue Procedure: Contact the local fire department in the event of an emergency.

   CALL _____

8. Entry Authorization (all criteria stated above must be met).

   Has Project Manager _____ been contacted prior to entry? ☐ Yes ☐ No

   Has Health and Manger _____ been contracted prior to entry ☐ Yes ☐ No

9. Testing During Work and at Exit (Entrant must wear a continuous atmospheric monitor with visual readout and audible alarm if oxygen is $\leq$19.5%, LFL is $\geq$10% and H_2S is $\geq$10 ppm).

Time	_____	_____	_____	_____	_____
Oxygen %	_____	_____	_____	_____	_____
Explosive % LFL	_____	_____	_____	_____	_____
Toxic H=S PPM	_____	_____	_____	_____	_____
Other Toxic	_____	_____	_____	_____	_____

10. This Confined Space Pre-Entry Check List and Entry Authorization is not valid for more than one continuous 8-hour period and shall be kept at the job site during the work. Upon completion of the authorized work, return this original to the Business Unit H&S Manager for review and for record.

Appendix C

Heat Stress Prevention Program

Heat Stress Card

Kennedy/Jenks Consultants

303 Second Street, Suite 300 South
San Francisco, California 94107
415-243-2150
FAX: 415-896-0999

Heat Illness Prevention Program

March 2015

Table of Contents

1. Program Overview

This Kennedy/Jenks (K/J) policy is intended to comply with the requirements set forth in the California Code of Regulations (CCR) Title 8, Subchapter 7, Sections 3395 and 1524.

This Heat Illness Prevention Program applies to all work operations at K/J offices and to all K/J field operations when Heat Illness is recognized as a potential hazard. This written program is available to all employees and managers during regular business hours and is located on the KJ Intranet. Hard copies are available upon request during normal business hours from the Director of Health, Safety, & Environment (HSE) or Business Unit Health & Safety Manager.

This written program has been developed for the purpose of providing information and training on the procedures to prevent heat illness to all supervisory and non-supervisory employees. All K/J staff will participate in Heat Illness Prevention training and will have the opportunity to ask questions regarding preventing heat illness.

Effective training in the following topics shall be provided to each supervisory and non-supervisory employee before the employee begins work that should reasonably be anticipated to result in exposure to the risk of heat illness:

Included in this program is detailed information regarding:

- The environmental and personal risk factors for heat illness;
- The employer's procedures for complying with the requirements of this standard including, but not limited to, the employer's responsibility to provide water, shade, cool-down rests, and access to first aid as well as the employees' right to exercise their rights under this standard without retaliation;
- The importance of frequent consumption of small quantities of water, up to 4 cups per hour, when the work environment is hot and employees are likely to be sweating more than usual in the performance of their duties;
- The concept, importance, and methods of acclimatization pursuant to the employer's procedures;
- The different types of heat illness, the common signs and symptoms of heat illness and appropriate first aid and/or emergency responses to the different types of heat illness, and that heat illness may progress quickly from mild symptoms and signs to serious and life threatening illness;
- The importance to employees of immediately reporting to the employer, directly or through the employee's supervisor, symptoms or signs of heat illness in themselves, or in co-workers;
- The employer's procedures for responding to symptoms of possible heat illness, including how emergency medical services will be provided should they become necessary;
- The employer's procedures for contacting emergency medical services, and if necessary, for transporting employees to a point where they can be reached by an emergency medical service provider;

- The employer's procedures for ensuring that, in the event of an emergency, clear and precise directions to the work site can and will be provided as needed to emergency responders.

Prior to supervising employees performing work that should reasonably be anticipated to result in exposure to the risk of heat illness, effective training on the following topics shall be provided to the supervisor:

- The information required to be provided as identified above.
- The procedures the supervisor is to follow to implement the applicable provisions in this section.
- The procedures the supervisor is to follow when an employee exhibits signs or reports symptoms consistent with possible heat illness, including emergency response procedures.
- Training on how to monitor weather reports and how to respond to hot weather advisories.

2. Definitions

The following definitions, as set forth by the California Occupational Safety & Health Administration, shall be adopted by K/J employees in establishing effective Heat Illness Prevention measures. K/J is committed to providing a safe workplace for all employees. While it is recognized that several state occupational safety and health programs do not require a Heat Illness Prevention Plan, K/J believes it is in the best interests of all its employees to abide by the requirements set forth in the following procedures.

"Acclimatization" means temporary adaptation of the body to work in the heat that occurs gradually when a person is exposed to it. Acclimatization peaks in most people within four to fourteen days of regular work for at least two hours per day in the heat.

"Heat Illness" means a serious medical condition resulting from the body's inability to cope with a particular heat load, and includes heat cramps, heat exhaustion, heat syncope and heat stroke.

"Environmental risk factors for heat illness" means working conditions that create the possibility that heat illness could occur, including air temperature, relative humidity, radiant heat from the sun and other sources, conductive heat sources such as the ground, air movement, workload severity and duration, protective clothing and personal protective equipment worn by employees.

"Personal risk factors for heat illness" means factors such as an individual's age, degree of acclimatization, health, water consumption, alcohol consumption, caffeine consumption, and use of prescription medications that affect the body's water retention or other physiological responses to heat.

"Preventative recovery period" means a period of time to recover from the heat in order to prevent heat illness.

"Shade" means blockage of direct sunlight. Canopies, umbrellas and other temporary structures or devices may be used to provide shade. One indicator that blockage is sufficient is when objects do not cast a shadow in the area of blocked sunlight. Shade is not adequate when heat in the area of shade defeats the purpose of shade, which is to allow the body to cool. For example, a car sitting in the sun does not provide acceptable shade to a person inside it, unless the car is running with air conditioning.

3. Heat Illness Prevention Procedures

Prior to commencing outdoor activities, the Project Manager will obtain local weather information affecting the designated job location. If weather conditions are forecasted to be 80 degrees Fahrenheit (F) or greater at anytime during outdoor activities, sufficient water, shade, and work breaks will be provided. The following procedures will also be required when K/J employees are conducting indoor activities and indoor temperatures are expected to exceed 80 degrees F.

Special procedures will be implemented when temperatures are expected to reach 95 degrees F. These High Heat procedures include:

- Ensuring that effective communication by voice, observation, or electronic means is maintained so that employees at the work site can contact a supervisor when necessary. An electronic device, such as a cell phone or text messaging device, may be used for this purpose only if reception in the area is reliable.
- Observing employees for alertness and signs or symptoms of heat illness. The supervisor shall ensure effective employee observation/monitoring by implementing one or more of the following:
    - Supervisor or designee observation of 20 or fewer employees or
    - Mandatory buddy system or
    - Regular communication with sole employee such as by radio or cellular phone, or
    - Other effective means of observation.
- Designating one or more employees on each worksite as authorized to call for emergency medical services, and allowing other employees to call for emergency services when no designated employee is available.
- Reminding employees throughout the work shift to drink plenty of water.
- Pre-shift meetings before the commencement of work to review the high heat procedures, encourage employees to drink plenty of water, and remind employees of their right to take a cool-down rest when necessary.

Humidity and winds will also be taken into account. All supervisory and non-supervisory employees should be aware that humidity and winds may affect temperature by as much as 15 degrees F. For example, 78 degree F weather with 90 percent humidity and no wind should be identified as weather requiring Heal Illness Prevention measures.

Where possible, the Project Manager will attempt to conduct work-related activities during the cooler parts of the day. However, if any portion of the activities is conducted while temperatures are at or above 80 degrees F, the Project Manager must implement these procedures.

If warm conditions are anticipated, the Project Manager will review the importance of proper hydration with all affected K/J employees. Employee participation will be documented on the Site-Specific Health & Safety Plan (SSHSP), Tailgate Safety Meeting Form or Job Safety Briefing Form

The Project Manager will also take into account the process of acclimatization. All employees shall be closely observed by a supervisor or designee during a heat wave. For purposes of this section only, “heat wave” means any day in which the predicted high temperature for the day will be at least 80 degrees F and at least ten degrees F higher than the average high daily temperature in the preceding five days.

An employee who has been newly assigned to a high heat area shall be closely observed by a supervisor or designee for the first 14 days of the employee's employment.

K/J Project Managers will verify that a sufficient supply of drinking water will be provided. Employees shall have access to potable drinking water that is fresh, pure, suitably cool, and provided to employees free of charge. The water shall be located as close as practicable to the areas where employees are working. Where drinking water is not plumbed or otherwise continuously supplied, it shall be provided in sufficient quantity at the beginning of the work shift to provide one quart per employee per hour for drinking for the entire shift. Employers may begin the shift with smaller quantities of water if they have effective procedures for replenishment during the shift as needed to allow employees to drink one quart or more per hour. The frequent drinking of water shall be encouraged.

Shade shall be present when the temperature exceeds 80 degrees F. When the outdoor temperature in the work area exceeds 80 degrees F, the employer shall have and maintain one or more areas with shade at all times while employees are present that are either open to the air or provided with ventilation or cooling. The amount of shade present shall be at least enough to accommodate 25% of the number of employees on the shift at any time recovery or rest periods, so that they can sit in a normal posture fully in the shade without having to be in physical contact with each other. The shaded area shade shall be located as close as practicable to the areas where employees are working. Subject to the same specifications, the amount of shade present during meal periods shall be at least enough to accommodate the number of employees on the meal period who remain onsite.

Shade shall be available when the temperature does not exceed 80 degrees F. When the outdoor temperature in the work area does not exceed 80 degrees F employers shall either provide shade or provide timely access to shade upon an employee's request.

Employees shall be allowed and encouraged to take a preventative cool-down rest in the shade for a period of no less than five minutes at a time when they feel the need to do so to protect them from overheating. Such access to shade shall be permitted at all times. An individual employee who takes a preventative cool-down rest (A) shall be monitored and asked if he or she is experiencing symptoms of heat illness; (B) shall be encouraged to remain in the shade; and (C) shall not be ordered back to work until any signs or symptoms of heat illness have abated, but in no event less than 5 minutes in addition to the time needed to access the shade.

If an employee exhibits signs or reports symptoms of heat illness while taking a preventative cool-down rest or during a preventative cool-down rest period, the employer shall provide appropriate first aid or emergency response.

Measures detailing the provisions of water, shade, and recovery periods will be included in the SSHSP, whether it is a Hazard Appraisal & Recognition Plan (HARP) or Health and Safety Plan (HASP) as required under CFR 1910.120.

The SSHSP will also provide emergency medical contact information in the event of heat related illness. Information includes, but is not limited to, the phone numbers for the local fire department and nearest hospital, map to the nearest hospital, and location of nearest land line telephone in the event cell phone service cannot be established. All employees, supervisory and non-supervisory, involved with the project and exposed to potential heat-related illness hazards will read and sign the appropriate SSHSP to document their participation and understanding of these Heat Illness Prevention Procedures.

The Project Manager will verify that effective Emergency Response Procedures have been implemented including:

- Ensuring that effective communication by voice, observation, or electronic means is maintained so that employees at the work site can contact a supervisor or emergency medical services when necessary. An electronic device, such as a cell phone or text messaging device, may be used for this purpose only if reception in the area is reliable. If an electronic device will not furnish reliable communication in the work area, the employer will ensure a means of summoning emergency medical services.

- Responding to signs and symptoms of possible heat illness, including but not limited to first aid measures and how emergency medical services will be provided.

    - If a supervisor observes, or any employee reports, any signs or symptoms of heat illness in any employee, the supervisor shall take immediate action commensurate with the severity of the illness.

    - If the signs or symptoms are indicators of severe heat illness (such as, but not limited to, decreased level of consciousness, staggering, vomiting, disorientation, irrational behavior or convulsions), the employer must implement emergency response procedures.

    - An employee exhibiting signs or symptoms of heat illness shall be monitored and **shall not** be left alone or sent home without being offered onsite first aid and/or being provided with emergency medical services in accordance with the employer's procedures.

- Contacting emergency medical services and, if necessary, transporting employees to a place where they can be reached by an emergency medical provider.

- Ensuring that, in the event of an emergency, clear and precise directions to the work site can and will be provided as needed to emergency responders.

4. Signs and Symptoms of Heat Illness

Several factors may contribute to one's susceptibility to heat illness. These factors include:

- Weather conditions
- Physical conditioning
- Weight
- Duration in warm weather
- Amount of last fluid intake
- Time since last fluid intake

Heat illness affects people in different ways. No two individuals should ever be compared to one another for the purposes of analyzing heat illness. Each person must be evaluated separately using the criteria listed below.

a. Signs of Heat Cramps

Heat cramps are painful muscle spasms that occur because of an imbalance between water and electrolytes. Profuse sweating, thirst, and flushed skin may accompany heat cramps. Heat cramps often affect the larger leg muscles first. Abdominal cramping and muscle cramps in other parts of the body on a warm day must be recognized as possible early stages of heat illness.

The stage of Heat Illness when heat cramps become present is sometimes referred to as heat stress. Heat stress should be recognized as a serious condition and treated similar to heat cramps and heat exhaustion.

b. Signs of Heat Exhaustion

A person with heat exhaustion will be near collapse and will have profuse sweating, flushed skin, elevated temperature, dizziness, hyperventilation, and rapid pulse. Confusion, nausea, and slurred speech may also become present. An indicator of concern is cool, dry skin on a warm day. This may indicate that the person's self cooling mechanism (sweating) is beginning to fail. While thirst is often present in heat exhaustion, some individuals may report not being thirsty due to an altered level of consciousness. An individual with signs of heat exhaustion may or may not be experiencing heat cramps. This is considered a serious medical condition.

c. Signs of Heat Stroke

Heat exhaustion, if not immediately treated, may develop into a critical condition called heat stroke. Signs of heat stroke include sudden collapse or loss of consciousness, pale skin, lack of perspiration, hot and dry skin, and body temperature in excess of 104 degrees. In the event of heat stroke, the body losses its ability to dissipate heat through sweating. The internal cooling mechanism has failed or is near failure. Heat stroke can occur suddenly and without warning.

An employee who is not acclimatized to the heat is especially susceptible to heat stroke. This is due to the body's inability to dissipate heat. Treat heat stroke as a critical medical emergency.

5. First Aid for Heat Illness

Heat Illness can be classified into three conditions: Heat Cramps, Heat Exhaustion, and Heat Stroke. All three conditions should be considered serious. Heat Stroke is a critical, life-threatening condition.

First Aid for Heat Illness always includes shade and rest. Specific guidelines are listed below. When treating Heat Illness, it is important to recognize that the condition developed gradually. Patient recovery will be gradual as well. A person with Heat Illness will not have the condition resolved following a 10 minute break. Extended shade, rest and rehydration may be necessary.

a. First Aid for Heat Cramps

Heat cramps may be prevented by adequate hydration prior to activity. Drink fluids early and often. Beginning one hour before activity in warm weather, each person should drink one quart of water each hour. To treat heat cramps, rehydrate by increasing oral intake of water and discontinue all strenuous activity for 24 hours. Rest in a shaded area for at least one hour. Proper fluids for rehydration include water and electrolyte drinks. Carbonated and caffeinated beverages such as soda and coffee are not acceptable means of hydration. Caffeine produces a dehydrating effect on the body.

b. First Aid for Heat Exhaustion

Heat exhaustion is a condition requiring immediate attention. It has the potential to become a life-threatening emergency. Immediate treatment requires stopping all strenuous activity and initiating significant oral intake of fluids. The affected person should drink at least one quart of water per hour for the next several hours. Remove the affected person from any warm environment. Remove excessive or wet clothing. Remain with the affected person. Contact WorkCare at (888) 449-7787 if the person's condition does not improve within the next hour.

c. First Aid for Heat Stroke

Heat Stroke is a critical, life-threatening emergency. Call 9-1-1 for medical aid. Cool the person off as quickly as possible. Move person to a shaded area. Remove all clothing from the person. Cover the person with copious amounts of cool, not cold, water. Increase air circulation around the person by use of hand or mechanical fans. Place ice, if available, at the base of the neck, in the armpits, and in the groin area. If trained in CPR, maintain an open airway and monitor breathing.

HEAT EXHAUSTION

What happens to the body:

Headaches, dizziness, or light-headedness, weakness, mood changes, irritability or confusion, feeling sick to your stomach, vomiting, fainting, decreased and dark-colored urine, and pale, clammy skin.

What should be done:

- Move the person to a cool, shaded area. Don't leave the person alone. If the person is dizzy or light-headed, lay him on his back and raise his legs about 6-8 inches. If the person is sick to his stomach, lay him on his side.
- Loosen and remove heavy clothing.
- Have the person drink some cool water (a small cup every 15 minutes) if he is not feeling sick to his stomach.
- Try to cool the person by fanning him. Cool the skin with a cool spray mist of water or wet cloth.
- If the person does not feel better in a few minutes call for emergency help (ambulance or 911.)

If heat exhaustion is not treated, the illness may advance to heat stroke.

PUBLICATION F417-218-909 (05-2008)

HEAT STROKE - A Medical Emergency

What happens to the body:

Dry, pale skin, sweating may still be present; hot, red skin (looks like a sunburn); mood changes; irritability, confusion, and not making any sense; seizures or fits, and collapse (will not respond).

What should be done:

- Call for emergency help (ambulance or 911.)
- Move the person to a cool, shaded area. Don't leave the person alone. Lay him on his back and if the person is having seizures; remove objects close to him so he won't hit them. If the person is sick to his stomach, lay him on his side.
- Remove heavy and outer clothing.
- Have the person drink small amounts of cool water if he is alert enough to drink anything and not feeling sick to his stomach.
- Try to cool the person by fanning him or her. Cool the skin with a cool spray mist of water, wet cloth, or wet sheet.
- If ice is available, place ice packs in armpits and groin area.

PREVENTING HEAT-RELATED ILLNESS

- Drink a lot of water, about 1 cup every 15 minutes.
- Know the signs/symptoms of heat-related illness; monitor yourself and co-workers.
- Block out direct sun or other heat sources.
- Use cooling fans/air-conditioning; rest regularly.
- Wear lightweight, light colored, loose-fitting clothes.
- Avoid alcohol, caffeinated drinks, or heavy meals.

Washington State Department of Labor & Industries
Division of Occupational Safety and Health

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Washington State Department of Labor & Industries
Division of Occupational Safety and Health

Appendix D

Cold Stress Fact Sheet

Protecting Yourself from
Cold Stress

Workers who are exposed to extreme cold or work in cold environments may be at risk of cold stress. Extremely cold or wet weather is a dangerous situation that can cause occupational illness and injuries such as hypothermia, frostbite, trench foot, and chilblains.

Hypothermia

A condition in which the body uses up its stored energy and can no longer produce heat. Often occurs after prolonged exposure to cold temperature.

Early symptoms

- Shivering
- Fatigue
- Loss of coordination
- Confusion and disorientation

Late symptoms

- No shivering
- Blue skin
- Dilated pupils
- Slowed pulse and breathing
- Loss of consciousness

First Aid

- Request immediate medical assistance.
- Move the victim into a warm room or shelter.
- Remove wet clothing.
- Warm the center of their body first—chest, neck, head, and groin—using an electric blanket; or use skin-to-skin contact under loose, dry layers of blankets, clothing, or towels.
- If conscious, warm beverages may help increase the body temperature. Do not give alcohol.
- Once temperature has increased keep them dry and wrapped in a warm blanket, including the head and neck.
- If no pulse, begin CPR.

Frostbite

An injury to the body that is caused by freezing, which most often affects the nose, ears, cheeks, chin, fingers, or toes.

Symptoms

- Reduced blood flow to hands and feet
- Numbness
- Aching
- Tingling or stinging
- Bluish or pale, waxy skin

First Aid

- Get into a warm room as soon as possible.
- Unless necessary, do not walk on frostbitten feet or toes.
- Immerse the affected area in warm (not hot) water, or warm the affected area using body heat. Do not use a heating pad, fireplace, or radiator for warming.
- Do not massage the frostbitten area; doing so may cause more damage.

Trench Foot

An injury of the feet resulting from prolonged exposure to wet and cold conditions that can occur at temperatures as high as 60 °F if the feet are constantly wet.

Symptoms

- Reddening of the skin
- Numbness
- Leg cramps
- Swelling
- Tingling pain
- Blisters or ulcers
- Bleeding under the skin
- Gangrene (foot may turn dark purple, blue, or gray)

First Aid

- Remove shoes/boots and wet socks.
- Dry feet.
- Avoid walking on feet, as this may cause tissue damage.

Chilblains

Ulcers formed by damaged small blood vessels in the skin, caused by the repeated exposure of skin to temperatures just above freezing to as high as 60 °F.

Symptoms

- Redness
- Itching
- Possible blistering
- Inflammation
- Possible ulceration in severe cases

First Aid

- Avoid scratching.
- Slowly warm the skin.
- Use corticosteroid creams to relieve itching and swelling
- Keep blisters and ulcers clean and covered.

Protect Yourself

- Monitor your physical condition and that of your coworkers.
- Wear appropriate clothing.
  - Wear several layers of loose clothing for insulation.
  - Tight clothing reduces blood circulation to the extremities.
- Be aware that some clothing may restrict movement resulting in a hazardous situation.
- Protect the ears, face, hands and feet in extremely cold or wet weather.
  - Boots should be waterproof and insulated.
  - Wear a hat to reduce the loss of body heat from your head.
- Move into warm locations during breaks; limit the amount of time outside.
- Carry extra socks, gloves, hats, jacket, blankets, a change of clothes and a thermos of hot liquid.
- Include chemical hot packs in your first aid kit.
- Avoid touching cold metal surfaces with bare skin.

Appendix E

Utility Location Standard Operations Procedures

Utility Location and Acknowledgement Form

KENNEDY/JENKS CONSULTANTS

STANDARD OPERATING PROCEDURES

INVASIVE ACTIVITIES - UTILITY LOCATION PROCEDURES

Below is a summary of the minimum requirements for location of potential underground utilities where invasive activities are planned. Invasive activities include, but are not limited to, drilling soil borings, installing wells, hand-auger borings, excavating test pits, remedial injections, and other similar activities which penetrate the ground surface.

Minimum Procedures

1. Contact the client or property owner where invasive activities will be performed to inquire about possible underground utilities and request maps or drawings documenting the location of the utilities. Document your request for information (e.g., written email request for information).

2. Contact the local/regional underground utility location center to document planned activities and request all underground utilities be located. In most (if not all) US states, this can be initiated by dialing "811". Contacting the local underground utility center is also required by state law. Contacting the local utility location center is required for each episode (event) of invasive work. It is preferred to arrange a field meeting with utility representatives to confirm the absence of utilities at each drilling location. Maintain a written record for each boring/invasive location and get signatures from the locators documenting the locations are clear of utilities. This can be performed on a site map or KJ's *Utility Locate Form & Acknowledgment Form* (provided in the KJ Safety Zone). The goal is to have written acknowledgement that all final drilling locations are free of underground utilities.

3. At all locations where drilling, probing or well installation will be performed, an air-knife or similar form of suction pot-holing will be performed to assess possible underground utilities in the upper 6 to 8 feet of soils (depending on local conditions and expected depth of utilities). Potholing is required at **all drilling locations**, except in remote areas where the likelihood of encountering underground utilities is very low and only as approved by a Risk Manager, Resource Manager or Officer of the company familiar with underground utilities. (Note: Use of an air knife will be appropriate for most invasive drilling and probing work, but may not be appropriate for certain activities like very shallow borings (less than 1-foot deep), certain hand-auger borings, remedial injections using probe equipment and test pitting.) Case by case exceptions for activities may be provided.

Optional Step – While it is recommended under most conditions, an optional additional step includes coordinating (including establishing a written contract) with a private utility locator to perform an independent utility evaluation to locate "all underground utilities" at the proposed locations of invasive work. Maintain written record for each boring/invasive location and get signatures from the locators. *[Note: This step is typically not too expensive and can save costs incurred during suction pot-holing by focusing the areas of the borings (i.e., provides prior knowledge of possible utilities).]*

KENNEDY/JENKS CONSULTANTS
UTILITY LOCATION & ACKNOWLEDGEMENT FORM
Call 811 for Utility Locate at Least 48 Hours Prior to Work

Project Location: _____

Project Number: _____

Project Name: _____

Planned Start Date of Field Activities: _____

Kennedy/Jenks Personnel: _____

Private Utility Locator Name: _____

811 Contact Date and Time (48 hours before work begins): _____

KJ One-Call Contractor ID# (varies by state) _____

Ticket Number: _____

Utility Clearance Information

How Were Boring/Excavation Locations Cleared:

Utilities Contacted by 811	Utility Contact Number	Utility Contacted by Telephone	Marked in Field	Other (Describe)

Contact information verified by (K/J Staff):_____

Scheduled On-Site Meeting Location (if applicable):

Public Utility_____

Private Utility Locator_____

Use back of sheet to sketch of identified utilities and proposed boring/excavation locations **OR** attach figure. Include north arrow and structures if applicable.

Notes:

Mark all proposed borings and excavations with WHITE paint per APWA Utility Color Codes.

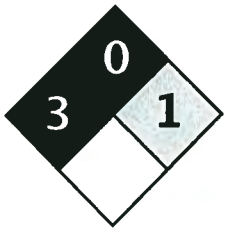
Request locator to mark utilities as required by their standard operating procedures or at least within 25 feet of boring/excavation, whichever is greater, with paint/flags.

Utility marks are valid for 14 calendar days and must be remarked if work continues beyond 14 days.

Appendix F

Material Safety Data Sheets (MSDSs)

ScienceLab.com
Chemicals & Laboratory Equipment



Health	3
Fire	0
Reactivity	1
Personal Protection	

Material Safety Data Sheet
Hydrochloric acid MSDS

Section 1: Chemical Product and Company Identification

Product Name: Hydrochloric acid

Catalog Codes: SLH1462, SLH3154

CAS#: Mixture.

RTECS: MW4025000

TSCA: TSCA 8(b) inventory: Hydrochloric acid

CI#: Not applicable.

Synonym: Hydrochloric Acid; Muriatic Acid

Chemical Name: Not applicable.

Chemical Formula: Not applicable.

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call: 1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Hydrogen chloride	7647-01-0	20-38
Water	7732-18-5	62-80

Toxicological Data on Ingredients: Hydrogen chloride: GAS (LC50): Acute: 4701 ppm 0.5 hours [Rat].

Section 3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (irritant, corrosive), of ingestion, . Slightly hazardous in case of inhalation (lung sensitizer). Non-corrosive for lungs. Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Severe over-exposure can result in death. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential Chronic Health Effects:
Slightly hazardous in case of skin contact (sensitizer).
CARCINOGENIC EFFECTS: Classified 3 (Not classifiable for human.) by IARC [Hydrochloric acid].
MUTAGENIC EFFECTS: Not available.

TERATOGENIC EFFECTS: Not available.
DEVELOPMENTAL TOXICITY: Not available.
The substance may be toxic to kidneys, liver, mucous membranes, upper respiratory tract, skin, eyes, Circulatory System, teeth.
Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation. Repeated or prolonged exposure to spray mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.

Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion:
If swallowed, do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion: Not available.

Fire Hazards in Presence of Various Substances: of metals

Explosion Hazards in Presence of Various Substances: Non-explosive in presence of open flames and sparks, of shocks.

Fire Fighting Media and Instructions: Not applicable.

Special Remarks on Fire Hazards:
Non combustible.
Calcium carbide reacts with hydrogen chloride gas with incandescence.
Uranium phosphide reacts with hydrochloric acid to release spontaneously flammable phosphine.
Rubidium acetylene carbides burns with slightly warm hydrochloric acid.
Lithium silicide in contact with hydrogen chloride becomes incandescent. When dilute hydrochloric acid is used, gas spontaneously flammable in air is evolved.
Magnesium boride treated with concentrated hydrochloric acid produces spontaneously flammble gas.
Cesium acetylene carbide burns hydrogen chloride gas.
Cesium carbide ignites in contact with hydrochloric acid unless acid is dilute.
Reacts with most metals to produce flammable Hydrodgen gas.

Special Remarks on Explosion Hazards:
Hydrogen chloride in contact with the following can cause an explosion, ignition on contact, or other violent/vigorous reaction: Acetic anhydride AgClO + CCl4 Alcohols + hydrogen cyanide, Aluminum Aluminum-titanium alloys (with HCl vapor), 2-Amino ethanol, Ammonium hydroxide, Calcium carbide Ca3P2 Chlorine + dinitroanilines (evolves gas), Chlorosulfonic acid Cesium carbide Cesium acetylene carbide, 1,1-Difluoroethylene Ethylene diamine Ethylene imine, Fluorine, HClO4 Hexalithium disilicide H2SO4 Metal acetylides or carbides, Magnesium boride, Mercuric sulfate, Oleum, Potassium permanganate, beta-Propiolactone Propylene oxide Rubidium carbide, Rubidium, acetylene carbide Sodium (with aqueous HCl), Sodium hydroxide Sodium tetraselenium, Sulfonic acid, Tetraselenium tetranitride, U3P4 , Vinyl acetate.
Silver perchlorate with carbon tetrachloride in the presence of hydrochloric acid produces trichloromethyl perchlorate which detonates at 40 deg. C.

Section 6: Accidental Release Measures

Small Spill:
Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. If necessary: Neutralize the residue with a dilute solution of sodium carbonate.

Large Spill:
Corrosive liquid. Poisonous liquid.
Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Use water spray curtain to divert vapor drift. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Neutralize the residue with a dilute solution of sodium carbonate. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep locked up.. Keep container dry. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, organic materials, metals, alkalis, moisture.
May corrode metallic surfaces. Store in a metallic or coated fiberboard drum using a strong polyethylene inner package.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area.

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:

Face shield. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Boots.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
CEIL: 5 (ppm) from OSHA (PEL) [United States]
CEIL: 7 (mg/m3) from OSHA (PEL) [United States]
CEIL: 5 from NIOSH
CEIL: 7 (mg/m3) from NIOSH
TWA: 1 STEL: 5 (ppm) [United Kingdom (UK)]
TWA: 2 STEL: 8 (mg/m3) [United Kingdom (UK)]Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid.

Odor: Pungent. Irritating (Strong.)

Taste: Not available.

Molecular Weight: Not applicable.

Color: Colorless to light yellow.

pH (1% soln/water): Acidic.

Boiling Point:
108.58 C @ 760 mm Hg (for 20.22% HCl in water)
83 C @ 760 mm Hg (for 31% HCl in water)
50.5 C (for 37% HCl in water)

Melting Point:
-62.25°C (-80°F) (20.69% HCl in water)
-46.2 C (31.24% HCl in water)
-25.4 C (39.17% HCl in water)

Critical Temperature: Not available.

Specific Gravity:
1.1- 1.19 (Water = 1)
1.10 (20%and 22% HCl solutions)
1.12 (24% HCl solution)
1.15 (29.57% HCl solution)
1.16 (32% HCl solution)
1.19 (37% and 38%HCl solutions)

Vapor Pressure: 16 kPa (@ 20°C) average

Vapor Density: 1.267 (Air = 1)

Volatility: Not available.

Odor Threshold: 0.25 to 10 ppm

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water, diethyl ether.

Solubility: Soluble in cold water, hot water, diethyl ether.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Incompatible materials, water

Incompatibility with various substances:
Highly reactive with metals.
Reactive with oxidizing agents, organic materials, alkalis, water.

Corrosivity:
Extremely corrosive in presence of aluminum, of copper, of stainless steel(304), of stainless steel(316).
Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Reacts with water especially when water is added to the product.
Absorption of gaseous hydrogen chloride on mercuric sulfate becomes violent @ 125 deg. C.
Sodium reacts very violently with gaseous hydrogen chloride.
Calcium phosphide and hydrochloric acid undergo very energetic reaction.
It reacts with oxidizers releasing chlorine gas.
Incompatible with, alkali metals, carbides, borides, metal oxides, vinyl acetate, acetylides, sulphides, phosphides, cyanides, carbonates.
Reacts with most metals to produce flammable Hydrogen gas.
Reacts violently (moderate reaction with heat of evolution) with water especially when water is added to the product. Isolate hydrogen chloride from heat, direct sunlight, alkalies (reacts vigorously), organic materials, and oxidizers (especially nitric acid and chlorates), amines, metals, copper and alloys (e.g. brass), hydroxides, zinc (galvanized materials), lithium silicide (incandescence), sulfuric acid(increase in temperature and pressure)
Hydrogen chloride gas is emitted when this product is in contact with sulfuric acid.
Adsorption of Hydrochloric Acid onto silicon dioxide results in exothmeric reaction.
Hydrogen chloride causes aldehydes and epoxides to violently polymerize.
Hydrogen chloride or Hydrochloric Acid in contact with the folloiwng can cause explosion or ignition on contact or

Special Remarks on Corrosivity:
Highly corrosive. Incompatible with copper and copper alloys. It attacks nearly all metals (mercury, gold, platinium, tantalum, silver, and certain alloys are exceptions).
It is one of the most corrosive of the nonoxidizing acids in contact with copper alloys.
No corrosivity data on zinc, steel.
Severe Corrosive effect on brass and bronze

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation.

Toxicity to Animals:
Acute oral toxicity (LD50): 900 mg/kg [Rabbit].
Acute toxicity of the vapor (LC50): 1108 ppm, 1 hours [Mouse].
Acute toxicity of the vapor (LC50): 3124 ppm, 1 hours [Rat].

Chronic Effects on Humans:
CARCINOGENIC EFFECTS: Classified 3 (Not classifiable for human.) by IARC [Hydrochloric acid].
May cause damage to the following organs: kidneys, liver, mucous membranes, upper respiratory tract, skin,

eyes, Circulatory System, teeth.

Other Toxic Effects on Humans:
Very hazardous in case of skin contact (corrosive, irritant, permeator), of ingestion, .
Hazardous in case of eye contact (corrosive), of inhalation (lung corrosive).

Special Remarks on Toxicity to Animals:
Lowest Published Lethal Doses (LDL/LCL)
LDL [Man] -Route: Oral; 2857 ug/kg
LCL [Human] - Route: Inhalation; Dose: 1300 ppm/30M
LCL [Rabbit] - Route: Inhalation; Dose: 4413 ppm/30M

Special Remarks on Chronic Effects on Humans:
May cause adverse reproductive effects (fetoxicity).
May affect genetic material.

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects:
Skin: Corrosive. Causes severe skin irritation and burns.
Eyes: Corrosive. Causes severe eye irritation/conjuntivitis, burns, corneal necrosis.
Inhalation: May be fatal if inhaled. Material is extremely destructive to tissue of the mucous membranes and upper respiratory tract. Inhalation of hydrochloric acid fumes produces nose, throat, and larryngeal burning, and irritation, pain and inflammation, coughing, sneezing, choking sensation, hoarseness, laryngeal spasms, upper respiratory tract edema, chest pains, as well has headache, and palpitations. Inhalation of high concentrations can result in corrosive burns, necrosis of bronchial epithelium, constriction of the larynx and bronchi, nasospetal perforation, glottal closure,
occur, particularly if exposure is prolonged. May affect the liver.
Ingestion: May be fatal if swallowed. Causes irritation and burning, ulceration, or perforation of the gastrointestinal tract and resultant peritonitis, gastric hemorrhage and infection. Can also cause nausea, vomitting (with "coffee ground" emesis), diarrhea, thirst, difficulty swallowing, salivation, chills, fever, uneasiness, shock, strictures and stenosis (esophogeal, gastric, pyloric). May affect behavior (excitement), the cardiovascular system (weak rapid pulse, tachycardia), respiration (shallow respiration), and urinary system (kidneys- renal failure, nephritis).
Acute exposure via inhalation or ingestion can also cause erosion of tooth enamel.
Chronic Potential Health Effects:
dyspnea, bronchitis. Chemical pneumonitis and pulmonary edema can also

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: Class 8: Corrosive material

Identification: : Hydrochloric acid, solution UNNA: 1789 PG: II

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
Connecticut hazardous material survey.: Hydrochloric acid
Illinois toxic substances disclosure to employee act: Hydrochloric acid
Illinois chemical safety act: Hydrochloric acid
New York release reporting list: Hydrochloric acid
Rhode Island RTK hazardous substances: Hydrochloric acid
Pennsylvania RTK: Hydrochloric acid
Minnesota: Hydrochloric acid
Massachusetts RTK: Hydrochloric acid
Massachusetts spill list: Hydrochloric acid
New Jersey: Hydrochloric acid
New Jersey spill list: Hydrochloric acid
Louisiana RTK reporting list: Hydrochloric acid
Louisiana spill reporting: Hydrochloric acid
California Director's List of Hazardous Substances: Hydrochloric acid
TSCA 8(b) inventory: Hydrochloric acid
TSCA 4(a) proposed test rules: Hydrochloric acid
SARA 302/304/311/312 extremely hazardous substances: Hydrochloric acid
SARA 313 toxic chemical notification and release reporting: Hydrochloric acid
CERCLA: Hazardous substances.: Hydrochloric acid: 5000 lbs. (2268 kg)

Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).
EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada):
CLASS D-2A: Material causing other toxic effects (VERY TOXIC).
CLASS E: Corrosive liquid.

DSCL (EEC):
R34- Causes burns.
R37- Irritating to respiratory system.
S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S45- In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

HMIS (U.S.A.):

Health Hazard: 3

Fire Hazard: 0

Reactivity: 1

Personal Protection:

National Fire Protection Association (U.S.A.):

Health: 3

Flammability: 0

Reactivity: 1

Specific hazard:

Protective Equipment:
Gloves.
Full suit.
Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate.
Face shield.

Section 16: Other Information

References:
-Hawley, G.G.. The Condensed Chemical Dictionary, 11e ed., New York N.Y., Van Nostrand Reinold, 1987.
-SAX, N.I. Dangerous Properties of Indutrial Materials. Toronto, Van Nostrand Reinold, 6e ed. 1984.
-The Sigma-Aldrich Library of Chemical Safety Data, Edition II.
-Guide de la loi et du règlement sur le transport des marchandises dangeureuses au canada. Centre de conformité internatinal Ltée. 1986.

Other Special Considerations: Not available.

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Health	3
Fire	0
Reactivity	0
Personal Protection	

Material Safety Data Sheet
Nitric acid, 65% MSDS

Section 1: Chemical Product and Company Identification

Product Name: Nitric acid, 65%

Catalog Codes: SLN2161

CAS#: Mixture.

RTECS: Not applicable.

TSCA: TSCA 8(b) inventory: Water; Nitric acid, fuming

CI#: Not applicable.

Synonym: Nitric Acid, 65%

Chemical Name: Not applicable.

Chemical Formula: Not applicable.

Contact Information:

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1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Water	7732-18-5	35
Nitric acid, fuming	7697-37-2	65

Toxicological Data on Ingredients: Nitric acid, fuming: VAPOR (LC50): Acute: 244 ppm 0.5 hours [Rat]. 344 ppm 0.5 hours [Rat].

Section 3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (irritant, corrosive), of ingestion, . Slightly hazardous in case of inhalation (lung sensitizer). Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Prolonged exposure may result in skin burns and ulcerations. Over-exposure by inhalation may cause respiratory irritation. Severe over-exposure can result in death. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: Not available.

MUTAGENIC EFFECTS: Not available.
TERATOGENIC EFFECTS: Not available.
DEVELOPMENTAL TOXICITY: Not available.
The substance may be toxic to lungs, mucous membranes, upper respiratory tract, skin, eyes, teeth.
Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation. Repeated or prolonged exposure to spray mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.

Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion:
If swallowed, do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion: Not available.

Fire Hazards in Presence of Various Substances: of combustible materials

Explosion Hazards in Presence of Various Substances:
Explosive in presence of reducing materials, of organic materials, of metals, of alkalis.
Non-explosive in presence of open flames and sparks, of shocks.

Fire Fighting Media and Instructions: Not applicable.

Special Remarks on Fire Hazards:
Flammable in presence of cellulose or other combustible materials.
Phosphine, hydrogen sulfide, selenide all ignite when fuming nitric acid is dripped into gas.
(Nitric Acid, fuming)

Special Remarks on Explosion Hazards:
Reacts exlposively with metallic powders, carbides, cyanides, sulfides, alkalies and turpentine.
Can react explosively with many reducing agents.
Arsine, phosphine, tetraborane all oxidized explosively in presence of nitric acid.
Cesium and rubidium acetylides explode in contact with nitric acid.
Explosive reaction with Nitric Acid + Nitrobenzene + water.
Detonation with Nitric Acid + 4-Methylcyclohexane.
(Nitric acid, fuming)

Section 6: Accidental Release Measures

Small Spill:
Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. If necessary: Neutralize the residue with a dilute solution of sodium carbonate.

Large Spill:
Corrosive liquid. Oxidizing material. Poisonous liquid.
Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Avoid contact with a combustible material (wood, paper, oil, clothing...). Keep substance damp using water spray. Do not touch spilled material. Use water spray curtain to divert vapor drift. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Neutralize the residue with a dilute solution of sodium carbonate. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep locked up.. Keep container dry. Keep away from heat. Keep away from sources of ignition. Keep away from combustible material.. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as reducing agents, combustible materials, organic materials, metals, acids, alkalis, moisture. May corrode metallic surfaces. Store in a metallic or coated fiberboard drum using a strong polyethylene inner package.

Storage:
Keep container tightly closed. Keep container in a cool, well-ventilated area. Separate from acids, alkalies, reducing agents and combustibles. See NFPA 43A, Code for the Storage of Liquid and Solid Oxidizers. Do not store above 23°C (73.4°F).

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:
Face shield. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Boots.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be

used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
TWA: 2 STEL: 4 (ppm) from ACGIH (TLV) [United States]
TWA: 2 STEL: 4 from OSHA (PEL) [United States]
Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid.

Odor: Acrid. Disagreeable and choking. (Strong.)

Taste: Not available.

Molecular Weight: Not applicable.

Color: Colorless to light yellow.

pH (1% soln/water): Acidic.

Boiling Point: 121°C (249.8°F)

Melting Point: -41.6°C (-42.9°F)

Critical Temperature: Not available.

Specific Gravity: 1.408 (Water = 1)

Vapor Pressure: 6 kPa (@ 20°C)

Vapor Density: 2.5 (Air = 1)

Volatility: Not available.

Odor Threshold: 0.29 ppm

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water, diethyl ether.

Solubility:
Easily soluble in cold water, hot water.
Soluble in diethyl ether.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Incompatible materials

Incompatibility with various substances:
Highly reactive with alkalis.
Reactive with reducing agents, combustible materials, organic materials, metals, acids.

Corrosivity:
Extremely corrosive in presence of aluminum, of copper.
Non-corrosive in presence of glass, of stainless steel(304), of stainless steel(316), of brass.

Special Remarks on Reactivity:
A strong oxidizer.
Reacts violently with alcohol, organic material, turpene, charcoal.
Violent reaction with Nitric acid + Acetone and Sulfuric acid.
Nitric Acid will react with water or steam to produce heat and toxic, corrosive and flammable vapors.
(Nitric acid, fuming)

Special Remarks on Corrosivity:
In presence of traces of oxides, it attacks all base metals except aluminum and special chromium steels.
It will attack some forms of plastics, rubber, and coatings.
No corrosive effect on bronze.
No corrosivity data for zinc, and steel

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation. Ingestion.

Toxicity to Animals:
LD50: Not available.
LC50: Not available.

Chronic Effects on Humans:
Contains material which may cause damage to the following organs: lungs, mucous membranes, upper respiratory tract, skin, eyes, teeth.

Other Toxic Effects on Humans:
Extremely hazardous in case of inhalation (lung corrosive).
Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (corrosive), of ingestion, .

Special Remarks on Toxicity to Animals: LDL - Lowest Published Lethal Dose [Human] - Route: Oral; Dose: 430 mg/kg (Nitric acid, fuming)

Special Remarks on Chronic Effects on Humans:
May cause adverse reproductive effects (effects on newborn and fetotoxicity) based on animal data. (Nitric acid, fuming)

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects:
Skin: Severely irritates skin. Causes skin burns and may cause deep and penetrating ulcers of the skin with a characteristic yellow to brownish discoloration. May be fatal if absorbed through skin.
Eyes: Severely irritates eyes. Causes eye burns. May cause irreversible eye injury.
Ingestion: May be fatal if swallowed. Causes serious gastrointestinal tract irritation or burns with nausea, vomiting, severe abdominal pain, and possible "coffee grounds" appearance of the vomitus . May cause perforation of the digestive tract.
Inhalation: May be fatal if inhaled. Vapor is extremely hazardous. Vapor may cause nitrous gas poisoning. Effects may be delayed. May cause irritation of the mucous membranes and respiratory tract with burning pain in the nose and throat, coughing, sneezing, wheezing, shortness of breath and pulmonary edema. Other symptoms may include nausea, and vomiting.
Chronic Potential Health Effects:
Repeated inhalation may produce changes in pulmonary function and/or chronic bronchitis. It may also affect behavior (headache, dizziness, drowsiness, muscle contaction or spasticity, weakness, loss of coordinaton, mental confusion), and urinary system (kidney faillure, decreased urinary output after several hours of

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: Class 8: Corrosive material

Identification: : Nitric acid UNNA: 2031 PG: II

Special Provisions for Transport: Marine Pollutant

Section 15: Other Regulatory Information

Federal and State Regulations:
New York release reporting list: Nitric acid, fuming
Rhode Island RTK hazardous substances: Nitric acid, fuming
Pennsylvania RTK: Nitric acid, fuming
Florida: Nitric acid, fuming
Minnesota: Nitric acid, fuming
Massachusetts RTK: Nitric acid, fuming
New Jersey: Nitric acid, fuming
TSCA 8(b) inventory: Water; Nitric acid, fuming
SARA 302/304/311/312 extremely hazardous substances: Nitric acid, fuming
SARA 313 toxic chemical notification and release reporting: Nitric acid, fuming 65%
CERCLA: Hazardous substances.: Nitric acid, fuming: 1000 lbs. (453.6 kg);

Other Regulations: OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).

Other Classifications:

WHMIS (Canada):
CLASS D-1A: Material causing immediate and serious toxic effects (VERY TOXIC).
CLASS D-2A: Material causing other toxic effects (VERY TOXIC).
CLASS E: Corrosive liquid.

DSCL (EEC):
R8- Contact with combustible material
may cause fire.
R35- Causes severe burns.
S23- Do not breathe gas/fumes/vapour/spray
[***]

S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S36- Wear suitable protective clothing.
S45- In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

HMIS (U.S.A.):

Health Hazard: 3

Fire Hazard: 0

Reactivity: 0

Personal Protection:

National Fire Protection Association (U.S.A.):

Health: 4

Flammability: 0

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves.
Full suit.
Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate.
Face shield.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

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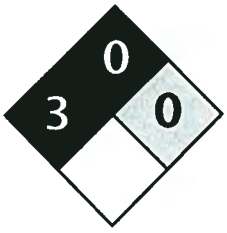

Health	3
Fire	0
Reactivity	0
Personal Protection	

Material Safety Data Sheet
Phosphoric acid, 85% MSDS

Section 1: Chemical Product and Company Identification

Product Name: Phosphoric acid, 85%

Catalog Codes: SLP5569, SLP4555, SLP1732

CAS#: Mixture.

RTECS: Not applicable.

TSCA: TSCA 8(b) inventory: Phosphoric Acid; Water

CI#: Not available.

Synonym: Phosphoric Acid 85%; Phosphoric Acid; Orthophosphoric acid

Chemical Name: Not applicable.

Chemical Formula: Not applicable.

Contact Information:

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International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Phosphoric Acid	7664-38-2	85-88
Water	7732-18-5	12-15

Toxicological Data on Ingredients: Phosphoric Acid: ORAL (LD50): Acute: 1530 mg/kg [Rat]. DERMAL (LD50): Acute: 2740 mg/kg [Rabbit]. DUST (LC50): Acute: >850 mg/m 1 hours [Rat].

Section 3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, . Hazardous in case of skin contact (corrosive, permeator), of eye contact (corrosive). Slightly hazardous in case of inhalation (lung sensitizer). Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Severe over-exposure can result in death. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: Not available.

MUTAGENIC EFFECTS: Not available.
TERATOGENIC EFFECTS: Not available.
DEVELOPMENTAL TOXICITY: Not available.
The substance may be toxic to blood, liver, skin, eyes, bone marrow.
Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation. Repeated or prolonged exposure to spray mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.

Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion: Not available.

Fire Hazards in Presence of Various Substances: of metals

Explosion Hazards in Presence of Various Substances: Non-explosive in presence of open flames and sparks, of shocks.

Fire Fighting Media and Instructions: Not applicable.

Special Remarks on Fire Hazards:
Reacts with metals to liberate flammable hydrogen gas.
Formation of flammable gases with aldehydes, cyanides, mercaptins, and sulfides.

Special Remarks on Explosion Hazards: Mixtures with nitromethane are explosive. (Phosphoric Acid)

Section 6: Accidental Release Measures

Small Spill:
Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. If necessary: Neutralize the residue with a dilute solution of sodium carbonate.

Large Spill:
Corrosive liquid. Poisonous liquid.
Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Use water spray curtain to divert vapor drift. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Neutralize the residue with a dilute solution of sodium carbonate. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Do not ingest. Do not breathe gas/fumes/ vapor/spray. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, combustible materials, metals, alkalis.
May corrode metallic surfaces. Store in a metallic or coated fiberboard drum using a strong polyethylene inner package.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area.

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:
Face shield. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Boots.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
Phosphoric Acid
TWA: 1 STEL: 3 (mg/m3) from ACGIH (TLV) [United States]
TWA: 1 STEL: 3 (mg/m3) from OSHA (PEL) [United States]
TWA: 1 STEL: 3 (mg/m3) from NIOSH
TWA: 1 STEL: 3 (mg/m3) [Mexico]Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid. (Syrupy liquid Viscous liquid.)

Odor: Odorless.

Taste: Acid.

Molecular Weight: Not applicable.

Color: Clear Colorless.

pH (1% soln/water): Acidic.

Boiling Point: 158°C (316.4°F)

Melting Point: 21°C (69.8°F)

Critical Temperature: Not available.

Specific Gravity: 1.685 @ 25 C (Water = 1)

Vapor Pressure: 0.3 kPa (@ 20°C)

Vapor Density: 3.4 (Air = 1)

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water.

Solubility:
Easily soluble in hot water.
Soluble in cold water.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Incompatible materials

Incompatibility with various substances: Reactive with oxidizing agents, combustible materials, metals, alkalis.

Corrosivity:
Extremely corrosive in presence of copper, of stainless steel(304), of stainless steel(316).
Highly corrosive in presence of aluminum.
Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Reacts with metals to liberate flammable hydrogen gas.
Incompatible with sodium tetrahydroborate producing a violent exothermic reaction.
Heat generated with: alcohols, glycols, aldehydes, amides, amines, azo-compounds, carbamates, caustics, esters, ketones, phenols and cresols, organophosphates, epoxides, combustible materials, unsaturated halides, organic peroxides.
Formation of flammable gases, with aldehydes, cyanides, mercaptins, and sulfides.

Formation of toxic fumes with cyanides, fluorides, halogenated organics, sulfides, and organic peroxides.
Do not mix with solutions containing bleach or ammonia.
Incompatible with nitromethane, chlorides + staiinless steel.
(Phosphoric Acid)

Special Remarks on Corrosivity:
Minor corrosive effect on bronze.
Severe corrosive effect on brass.
Corrosive to ferrous metals and alloys.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation. Ingestion.

Toxicity to Animals:
Acute oral toxicity (LD50): 1530 mg/kg [Rat].
Acute dermal toxicity (LD50): 2740 mg/kg [Rabbit].

Chronic Effects on Humans: May cause damage to the following organs: blood, liver, skin, eyes, bone marrow.

Other Toxic Effects on Humans:
Extremely hazardous in case of inhalation (lung corrosive).
Very hazardous in case of skin contact (irritant), of ingestion, .
Hazardous in case of skin contact (corrosive, permeator), of eye contact (corrosive).

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: Not available.

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects:
Skin: Corrosive and causes severe skin irritation and can cause severe skin burns. May affect behavior (somnolence or excitement) if absorbed through skin.
Eyes: Corrosive. Liquid or vapor causes severe eye irritation and can cause severe eye burns leading to permanent corneal damage or chemical conjunctivitis.
Ingestion: May be harmful if swallowed. Causes irritation and burns of the gastrointestinal (digestive) tract. Causes severe pain, nausea, vomiting, diarrhea hematemesis, gastrointestinal hemmorrhaging, and shock. May cause corrosion and permanent tissue destruction of the esophagus and digestive tract. May affect behavior and urinary system, liver (hepatocellular damage, hepatic enzymes increased), blood (blood dyscrasia). May also

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:

Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: Class 8: Corrosive material

Identification: : Phosphoric acid (Phosphoric Acid) UNNA: 1805 PG: III

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
Connecticut hazardous material survey.: Phosphoric Acid
Illinois toxic substances disclosure to employee act: Phosphoric acid
Illinois chemical safety act: Phosphoric acid
New York release reporting list: Phosphoric acid
Rhode Island RTK hazardous substances: Phosphoric acid
Pennsylvania RTK: Phosphoric acid
Minnesota: Phosphoric acid
Massachusetts RTK: Phosphoric acid
Massachusetts spill list: Phosphoric acid
New Jersey: Phosphoric acid
New Jersey spill list: Phosphoric acid
Louisiana spill reporting: Phosphoric acid
California Director's list of hazardous substances: Phosphoric acid
TSCA 8(b) inventory: Phosphoric Acid; Water
SARA 313 toxic chemical notification and release reporting: Phosphoric acid
CERCLA: Hazardous substances.: Phosphoric acid: 5000 lbs. (2268 kg)

Other Regulations: OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).

Other Classifications:

WHMIS (Canada): CLASS E: Corrosive liquid.

DSCL (EEC):
R34- Causes burns.
S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S45- In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

HMIS (U.S.A.):

Health Hazard: 3

Fire Hazard: 0

Reactivity: 0

Personal Protection:

National Fire Protection Association (U.S.A.):

Health: 3

Flammability: 0

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves.
Full suit.
Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate.
Face shield.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

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Last Updated: 11/06/2008 12:00 PM

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Material Safety Data Sheet
Instant FAME/Instant Anaerobe Methods
Methanol

SECTION 1 – CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

MSDS Name: Methanol
MSDS Preparation Date: 06/19/2009
Synonyms or Generic ID for Methanol: Carbinol; Methyl alcohol; Methyl hydroxide; Monohydroxymethane; Wood alcohol; Wood naptha; Wood spirits; Columbian spirits; Methanol.
Chemical Family: Methanol Family
Formula: CH_3OH
Molecular Weight: N/A
PIN (UN#/ NA#): UN1230
Company Identification:

Microbial ID.
125 Sandy Drive
Newark, DE 19713

For Information, call: (800)276-8068, (302)737-4297
For Domestic CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

SECTION 2 – COMPOSITION, INFORMATION ON INGREDIENTS

67-56-1	Methanol	<99%	200-659-6	Irritant, Flammable

NFPA Rating: (estimated) Health: 1; Flammability: 3; Instability: 0

State: Liquid	Appearance: colorless	Odor: Alcohol-like, weak odor
Boiling Point: 64.7°C@760mmHg	pH: Not available	Specific Gravity: 7910g/cm3@20°C
Vapor Pressure (mm Hg): 128mmHg @20°C	Vapor Density (AIR=1): 1.11	
Flash Point: 12°C	Solubility in Water: miscible	

SECTION 3 – HAZARDS IDENTIFICATION

Appearance: Colorless liquid, Flash Point: 12°C, 53.6°F.

Danger! Poison! May be fatal or cause blindness if swallowed. Vapor harmful. **Flammable liquid and vapor.** Harmful if swallowed, inhaled, or absorbed through the skin. Causes eye, skin, and respiratory tract irritation. May cause central nervous system depression. Cannot be made non-poisonous.
Target Organs: Eyes, nervous system, optic nerve.

Potential Health Effects
Eye: May cause painful sensitization to light. Methanol is a mild to moderate eye irritant. Inhalation, ingestion or skin absorption of methanol can cause significant disturbance in vision, including blindness.
Skin: Causes moderate skin irritation. May be absorbed through the skin in harmful amounts. Prolonged and or repeated contact may cause defatting of skin and dermatitis. Methanol can be absorbed through the skin, producing systemic effects that include visual disturbances.
Ingestion: May be fatal or cause blindness if swallowed. Aspiration hazard. Cannot be made non-poisonous. May cause gastrointestinal irritation with nausea, vomiting and diarrhea. May cause systematic toxicity with acidosis. May cause central nervous system depression, characterized by excitement, followed by headache, dizziness, drowsiness, and nausea. Advanced stages may cause collapse, unconsciousness, coma, and possible death due to failed respiratory failure. May cause cardiopulmonary system effects.

Inhalation: Methanol is toxic and can very readily form extremely high vapor concentrations at room temperature. Inhalation is the most common route of occupational exposure. At first, methanol causes CNS depression with nausea, headache, vomiting, dizziness and incoordination. A time period with no obvious symptoms follows (typically 8-24 hrs). This latent period is followed by metabolic acidosis and severe visual effects which may include reduced reactivity and/or increased sensitivity to light, blurred, doubl and/or snowy vision, and blindness. Depending on the severity of exposure and the promptness of treatment, survivors may recover completely or may have permanent blindness, vision disturbances and/or nervous system effects.
Chronic: Prolonged or repeated skin contact may cause dermatitis. Chronic exposure may cause effects similar to those of acute exposure. Methanol is only very slowly eliminated from the body. Because of this slow elimination, methanol should be regarded as a cumulative poison. Though a single exposure may cause no effect, daily exposures may result in the accumulation of a harmful amount. Methanol has produced fetotoxicity in rats and teratogenicity in mice exposed by inhalation to high concentrations that did not produce significant maternal toxicity.

SECTION 4 – FIRST AID MEASURES

Eyes: In case of contact, immediately flush eyes with plenty of water for a t least 15 minutes. Get medical aid.
Skin: In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical aid immediately. Wash clothing before reuse.
Ingestion: Potential for aspiration if swallowed. Get medical aid immediately. Do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If vomiting occurs naturally, have victim lean forward.
Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.
Notes to Physician: Effects may be delayed.
Antidote: Ethanol may inhibit methanol metabolism.

SECTION 5 – FIRE FIGHTING MEASURES

General Information: Ethanol may inhibit methanol metabolism. As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion. Use water spray to keep fire-exposed containers cool. Water may be ineffective. Material is lighter than water and a fire may be spread by the use of water. Vapors are heavier than air and may travel to a source of ignition and flash back. Vapors can spread along the ground and collect in low or confined areas.
Extinguishing Media: For small fires, use dry chemical, carbon dioxide, water spray or alcohol-resistant foam. Water may be ineffective. For large fires, use water spray, fog or alcohol-resistant foam. Do NOT use straight streams of water.
Flash Point: 12 deg C (53.60 deg F)
Autoignition Temperature: 455 deg C (851.00 deg F)
Explosion Limits, Lower:6.0 vol %
Upper: 31.00 vol %
NFPA Rating: (estimated) Health: 1; Flammability: 3; Instability: 0

SECTION 6 – ACCIDENTAL RELEASE MEASURES

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks: Use water spray to disperse the gas/vapor. Remove all sources of ignition. Absorb spill using an absorbent, non-combustible material such as earth, sand, or vermiculite. Do not use combustible materials such as sawdust. Use a spark-proof tool. Provide ventilation. A vapor suppressing foam may be used to reduce vapors. Water spray may reduce vapor but may not prevent ignition in closed spaces.

SECTION 7-HANDLING AND STORAGE

Handling: Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Ground and bond containers when transferring material. Use spark-proof tools and explosion proof equipment. Avoid contact with eyes, skin, and clothing. Empty containers retain product residue, (liquid and/or vapor), and can be dangerous. Keep container tightly closed. Do not ingest or inhale. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose empty containers to heat, sparks or open flames. Use only with adequate ventilation. Keep away from heat, sparks and flame. Avoid use in confined spaces.
Storage: Keep away from heat, sparks, and flame. Keep away from sources of ignition. Store in a cool, dry, well-ventilated area away from incompatible substances. Flammables-area. Keep containers tightly closed.

SECTION 8 – EXPOSURE CONTROL/ PERSONAL PROTECTION

Engineering Controls: Use explosion-proof ventilation equipment. Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.

Chemical Name	ACGIH	NIOSH	OSHA – Final PELs
Methanol	200 ppm TWA; 250 ppm STEL; Skin - potential significant contribution to overall exposure by the cutaneous route	200 ppm TWA; 260 mg/m3 TWA 6000 ppm IDLH	200 ppm TWA; 260 mg/m3 TWA

OSHA Vacated PELs: Methanol: 200 ppm TWA; 260 mg/m3 TWA
Personal Protective Equipment
Eyes: Wear chemical splash goggles.
Skin: Wear butyl rubber gloves, apron, and/or clothing.
Clothing: Wear appropriate protective clothing to prevent skin exposure.
Respirators: Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

SECTION 9 – PHYSICAL AND CHEMICAL PROPERTIES

Physical State: Clear liquid
Appearance: clear, colorless - APHA: 10 max
Odor: alcohol-like - weak odor
pH: Not available.
Vapor Pressure: 128 mm Hg @ 20 deg C
Vapor Density: 1.11 (Air=1)
Evaporation Rate:5.2 (Ether=1)
Viscosity: 0.55 cP 20 deg C
Boiling Point: 64.7 deg C @ 760 mmHg
Freezing/Melting Point:-98 deg C
Decomposition Temperature: Not available.
Solubility: miscible
Specific Gravity/Density:.7910 g/cm3 @ 20°C
Molecular Formula:CH4O
Molecular Weight:32.04

SECTON 10 – STABILITY AND REACTIVITY

Chemical Stability: Stable under normal temperatures and pressures.
Conditions to Avoid: High temperatures, ignition sources, confined spaces.
Incompatibilities with Other Materials: Oxidizing agents, reducing agents, acids, alkali metals, potassium, sodium, metals as powders (e.g. hafnium, raney nickel), acid anhydrides, acid chlorides, powdered aluminum, powdered magnesium.
Hazardous Decomposition Products: Carbon monoxide, irritating and toxic fumes and gases, carbon dioxide, formaldehyde.
Hazardous Polymerization: Will not occur.

SECTION 11 – TOXICOLOGICAL INFORMATION

RTECS#:
CAS# 67-56-1: PC1400000
LD50/LC50:
CAS# 67-56-1:

Draize test, rabbit, eye: 40 mg Moderate;
Draize test, rabbit, eye: 100 mg/24H Moderate;
Draize test, rabbit, skin: 20 mg/24H Moderate;
Inhalation, rabbit: LC50 = 81000 mg/m3/14H;
Inhalation, rat: LC50 = 64000 ppm/4H;
Oral, mouse: LD50 = 7300 mg/kg;
Oral, rabbit: LD50 = 14200 mg/kg;
Oral, rat: LD50 = 5600 mg/kg;
Skin, rabbit: LD50 = 15800 mg/kg;

Human LDLo Oral: 143 mg/kg; Human LDLo Oral: 428 mg/kg; Human TCLo Inhalation; 300 ppm caused visual field changes & headache; Monkey LDLo Skin: 393 mg/kg. Methanol is significantly less toxic to most experimental animals than humans, because most animal species metabolize methanol differently. Non-primate species do not ordinarily show symptoms of metabolic acidosis or the visual effects which have been observed in primates and humans.
Carcinogenicity:
CAS# 67-56-1: Not listed by ACGIH, IARC, NTP, or CA Prop 65.

Epidemiology: No information found
Teratogenicity: There is no human information available. Methanol is considered to be a potential developmental hazard based on animal data. In animal experiments, methanol has caused fetotoxic or teratogenic effects without maternal toxicity.
Reproductive Effects: See actual entry in RTECS for complete information.
Mutagenicity: See actual entry in RTECS for complete information.
Neurotoxicity: ACGIH cites neuropathy, vision and CNS under TLV basis.

SECTION 12 – ECOLOGICAL INFORMATION

Ecotoxicity: Fish: Fathead Minnow: 29.4 g/L; 96 Hr; LC50 (unspecified)Fish: Goldfish: 250 ppm; 11 Hr; resulted in deathFish: Rainbow trout: 8000 mg/L; 48 Hr; LC50 (unspecified)Fish: Rainbow trout: LC50 = 13-68 mg/L; 96 Hr.; 12 degrees CFish: Fathead Minnow: LC50 = 29400 mg/L; 96 Hr.; 25 degrees C, pH 7.63Fish: Rainbow trout: LC50 = 8000 mg/L; 48 Hr.; UnspecifiedBacteria: Phytobacterium phosphoreum: EC50 = 51,000-320,000 mg/L; 30 minutes; Microtox test No data available.
Environmental: Dangerous to aquatic life in high concentrations. Aquatic toxicity rating: TLm 96>1000 ppm. May be dangerous if it enters water intakes. Methyl alcohol is expected to biodegrade in soil and water very rapidly. This product will show high soil mobility and will be degraded from the ambient atmosphere by the reaction with photochemically produced hyroxyl radicals with an estimated half-life of 17.8 days. Bioconcentration factor for fish (golden ide) < 10. Based on a log Kow of -0.77, the BCF value for methanol can be estimated to be 0.2.
Physical: No information available.
Other: No information available.

SECTION 13 – DISPOSAL CONSIDERATIONS

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.

RCRA P-Series: None listed.

RCRA U-Series:

CAS# 67-56-1: waste number U154 (Ignitable waste).

SECTION 14 – TRANSPORT INFORMATION

	US DOT	CANADA TDG
Shipping Name:	Methanol	Methanol
Hazard Class:	3	3
UN Number:	UN1230	UN1230
Packing Group:	II	II
Additional Information		Flash Point 12°C

SECTION 15 – REGULATORY INFORMATION

US FEDERAL

TSCA

CAS# 67-56-1 is listed on the TSCA inventory.

Health & Safety Reporting List

None of the chemicals are on the Health & Safety Reporting List.

Chemical Test Rules

None of the chemicals in this product are under a Chemical Test Rule.

Section 12b

None of the chemicals are listed under TSCA Section 12b.

TSCA Significant New Use Rule

None of the chemicals in this material have a SNUR under TSCA.

CERCLA Hazardous Substances and corresponding RQs

CAS# 67-56-1: 5000 lb final RQ; 2270 kg final RQ

SARA Section 302 Extremely Hazardous Substances

None of the chemicals in this product have a TPQ.

SARA Codes

CAS # 67-56-1: immediate, fire.

Section 313

This material contains Methanol (CAS# 67-56-1, > 99%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.

Clean Air Act:

CAS# 67-56-1 is listed as a hazardous air pollutant (HAP).

This material does not contain any Class 1 Ozone depletors.

This material does not contain any Class 2 Ozone depletors.

Clean Water Act:

None of the chemicals in this product are listed as Hazardous Substances under the CWA.

None of the chemicals in this product are listed as Priority Pollutants under the CWA.

None of the chemicals in this product are listed as Toxic Pollutants under the CWA.

OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

STATE

CAS# 67-56-1 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

California Prop 65
California No Significant Risk Level: None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives
Hazard Symbols:
T F
Risk Phrases:
R 11 Highly flammable.
R 23/24/25 Toxic by inhalation, in contact with skin and if swallowed.
R 39/23/24/25 Toxic : danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.

Safety Phrases:
S 16 Keep away from sources of ignition - No smoking.
S 36/37 Wear suitable protective clothing and gloves.
S 45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
S 7 Keep container tightly closed.

WGK (Water Danger/Protection)
CAS# 67-56-1: 1
Canada - DSL/NDSL
CAS# 67-56-1 is listed on Canada's DSL List.
Canada - WHMIS
This product has a WHMIS classification of B2, D1B, D2B.
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by those regulations.
Canadian Ingredient Disclosure List
CAS# 67-56-1 is listed on the Canadian Ingredient Disclosure List.

SECTION 16 – Other Information

This Material Safety Data Sheet has been prepared in accordance with 29 CFR 1910.1200 and contains information believed to be accurate and complete at the date of preparation. The statements contained herein are offered for informational purposes only and are based upon technical data. MIDI Inc. believes them to be accurate but does not purport to be all-inclusive. The above-stated product is intended for use only by persons having the necessary technical skills and facilities for handling the product at their discretion and risk. Since conditions and manner of use are outside our control, we (MIDI Inc.) make no warranty of merchantability or any such warranty, express or implied with respect to information and we assume no liability resulting from the above product or its use. Users should make their own investigations to determine suitability of information and product for their particular purposes.

Appendix G

Injury/Illness, Property Damage Incident, and Near Miss Reporting Forms

Injury/Illness Report Form

This form should only be used for reporting an incident resulting in employee injury/illness. Prior to completing this form, verify that the appropriate notifications have been made as identified below. Use the Property Damage Incident Report Form to document property damage. Use the Near-Miss Report Form to document Near-Misses.

Name and job title of injured/illness employee:

Employee's address and telephone number:

Time, Date, and Location where the injury/illness occurred:

Address of K/J site contact:

Check the appropriate nature of injury/illness(s):

Sprain ___ Strain ___ Fracture ___ Abrasion ___ Bruise ___ Laceration ___ Puncture ___

Avulsion (amputation) ___ Burn ___ Impact/Compression Injury ___ Allergic Reaction ___

Eye Injury ___ Hearing-Related Injury ___ Heat/Cold Exposure ___ Altered level of Consciousness ___

Respiratory/Cardiac-Related Event ___ Chemical/Substance Exposure ___ Nausea ___

Identify the body part affected:

What was the employee doing when the injury/illness occurred?

What action, mechanism, or piece of equipment directly contributed to the injury/illness?

What other processes or items may have indirectly contributed to the employee injury/illness?

Description of accident, accident scene and if accident scene has been instrumentally altered by employees, bystanders and/or emergency personnel and equipment:

How might have this injury/illness been avoided?

Was the injury/illness immediate or did it gradually evolve over time?

If this event occurred at a job site, was a site-specific safety plan prepared and approved? If so, please attach to this form.

If this event occurred at a job site, was a job hazard analysis completed for the task which the employee was performing at the time of injury/illness? If so, please attach.

What were weather conditions at the time of the injury/illness?

Was the employee's supervisor notified? When?

Did the employee contact WorkCare for medical direction? When?

List emergency medical services, fire, or law enforcement agencies summoned for the injured employee:

Provide names and phone numbers of witnesses:

Injured employee was transported to:

Name of person preparing this report: _____

Title: _____ Date: _____

Property Damage Incident Report Form

This form should be used only for an incident resulting in property damage without injury to employees involved. Use the Injury/Illness Report Form to document employee injuries. Use the Near-Miss Report Form to document Near-Misses.

Name(s) of employee(s) involved:

Time, Date, and Location where the incident occurred:

Description of the incident:

What was the employee doing when the incident occurred?

What action, mechanism, or piece of equipment may have directly contributed to the incident?

What other processes or items may have indirectly contributed to this incident?

If this incident occurred at a job site, was a site-specific safety plan prepared and approved? If so, please attach to this form.

Detail any corrective actions taken.

Provide names and phone numbers of witnesses:

Name of person preparing this report: _____

Title: _____ Date: _____

Signature of H&S Manager: _____ Date:_____

Signature of Project Manager: _____ Date:_____

Near-Miss Report Form

This form should only be used for Near-Miss events which did NOT result in injury or property damage. Use the Injury/Illness Report Form to record injuries or illness. Use the Property Damage Incident Report Form to record property damage.

Date: _____ Location: _____

Time: _____ ☐a.m. ☐p.m.

Weather Conditions: _____

Please check all that apply:

☐Unsafe Act ☐Unsafe Condition ☐Unsafe Equipment ☐Unsafe Use of Equipment

Description of Near-Miss in detail:

Employee Name _____ Date: _____

This section to be completed by Health & Safety Manager or Representative.

Cause of Near-Miss:

Corrective action(s) taken:

Business Unit H&S Manager _____ Date: _____

Appendix D

Quality Assurance Project Plan

Kennedy/Jenks Consultants

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APPENDIX D

Quality Assurance Project Plan (QAPP)

Remedial Investigation Work Plan
Former Circle K Site
2350 24th Avenue East
Seattle, Washington

April 2016

Washington State Department of Ecology
Toxics Cleanup Program
3190 160th Avenue Southeast
Bellevue, Washington 98008-5452

K/J Project No. 1696010.00

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Section 1: Introduction

The purpose of this Quality Assurance Project Plan (QAPP) is to identify the quality assurance and quality control (QA/QC) protocols necessary to achieve the project-specific data quality objectives for sample collection and analysis for the remedial investigation (RI) at the former Circle K site located at 2350 24th Avenue East in Seattle, Washington (Site).

The objectives of the RI for the Site, including background, project description and scope of work, sampling procedures and requirements, and project schedule are described in the main RI Sampling and Analysis Work Plan (Work Plan) text.

The remainder of this QAPP is organized as follows:

- Section 2: Summarizes the quality objectives for the Site.
- Section 3: Summarizes the analytical methods to be used for Site sample analysis.
- Section 4: Summarizes quality control objectives for the Site.
- Section 5: Describes the data management objectives for the Site.
- Section 6: Summarizes audits and reports.
- Section 7: Summarizes data tracking, reduction, and verification to be performed for the Site.
- Table 1 provides a summary of laboratory analytical methods anticipated for the Site including sample container requirements, preservatives, and holding times.

Section 2: Quality Objectives

Data quality objectives (DQOs) for this project are to describe and implement field and laboratory procedures that ensure 1) data will be representative of actual environmental conditions, and 2) data are of known and acceptable quality. Measurements will be made to yield accurate and precise results representative of the media and conditions measured. Data will be calculated and reported in units consistent with those used by regulatory agencies to allow for comparability of data.

Accuracy, precision, completeness, representativeness, comparability, and sensitivity are terms used to describe the quality of analytical data. Routine procedures for measuring precision and accuracy include use of quality control samples (i.e., replicate analyses, check or laboratory control samples, matrix spikes, and procedural blanks). These indictors of data quality are discussed below.

2.1 Precision

Precision is an appraisal of the reproducibility of a set of measurements. Precision can be better defined as the variability of a group of measurements compared to their average value. Variability for environmental monitoring programs contains both an analytical component and a field component.

Analytical precision will be evaluated by the analyses of matrix spike duplicate and laboratory duplicate samples, which can be mathematically expressed as the relative percent difference (RPD) between duplicate sample analyses. RPD is calculated using the following equation:

$$RPD = \frac{C_1 - C_2}{\overline{C}} \; x\,100$$

where:

C1 = First concentration value or recovery value measured for a variable

C2 = Second concentration value or recovery value measured for a variable

The frequency of the performance of matrix spike duplicate and laboratory duplicate samples, where applicable, is usually one per batch (which typically consists of up to 20 samples) for each sample matrix received.

Field duplicate samples will be submitted blind to the laboratory as a means to determine field variability. Frequency of field duplicate samples is discussed in the main Work Plan text (Section 3.8).

Precision quantities will be calculated for analyses with method reporting limits of the same order of magnitude and with detected concentrations greater than or equal to five times the method reporting limits. In instances where no criteria have been established (e.g., field duplicates), relative percent difference project goals will be 50 percent for well-homogenized soil samples and 30 percent for water samples.

2.2 Bias and Accuracy

Bias is the systematic or persistent distortion of a measurement process that causes error in one direction. Accuracy refers to how close a measurement is to the true value. Bias and accuracy will be evaluated by the analysis of matrix spike samples and laboratory control samples and can be mathematically expressed as the percent recovery of an analyte that has been used to fortify a field sample or clean laboratory matrix sample at a known concentration prior to analysis. The percent recovery (R) for a matrix spike sample is calculated as follows:

$$R = \frac{(\text{SSR} - \text{SR})}{\text{SA}} * 100$$

where:

SSR = Spiked sample result

SR = Sample result

SA = Spike added.

The following calculation is used to determine R for a laboratory control sample or reference material:

$$R = \frac{RM}{RC} * 100$$

where:

RM = Reference material result

RC = Known reference concentration

Results of matrix spike and laboratory control samples will be evaluated to the laboratory's control limits. Control limits are defined as the mean recovery, plus or minus three standard deviations, of the 20 data points, with the warning limits set as the mean, plus or minus two standard deviations. The laboratory will review the QC samples and surrogate standard recoveries for each analysis to ensure that internal QC data lie within the limits of acceptability. The laboratory will investigate any suspect trends and take appropriate corrective actions

Field blank samples and method blank samples will also be used to evaluate bias of the data. Results for field and method blanks can reflect systematic bias that results from contamination of samples during collection or analysis. Analytes detected in field or method blank samples will be evaluated as potential indicators of bias.

2.3 Representativeness

Representativeness concerns the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Where appropriate, sampling locations will be selected on both systematic and biased (judgmental) sampling bases in an attempt to spatially cover the study area. Sampling locations and methods for selection of those sampling locations are discussed in the main Work Plan text (Section 3).

2.4 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system. Completeness will be measured for each set of data received by dividing the number of valid measurements actually obtained by the number of valid measurements that were planned. Although 100 percent is the goal for completeness, 90 percent is the minimum acceptable level.

2.5 Comparability

Comparability is a qualitative QA criterion that expresses the confidence in the ability to compare one data set with another. Comparability among data sets is achieved through the use of similar sampling procedures and analytical methods. Sampling procedures will be performed as specified in the main Work Plan text and Standard Operating Guidelines (SOGs) in the main Work Plan. Analytical procedures will be conducted according to the methods discussed in this QAPP.

2.6 Sensitivity

Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest. The method detection limit (MDL) is defined as the statistically calculated minimum amount that can be measured with 99 percent confidence that the reported value is greater than zero. MDLs are specified in the individual methods and are developed by the laboratory for each analyte of interest representing the aqueous and solid matrices within the capability of an analytical method.

The method reporting limit (MRL) or practical quantitation limit (PQL) is the lowest value to which the laboratory will report an unqualified quantitative result for an analyte. The PQL is always greater than the statistically determined MDL. The PQLs required for this project are such that data can be compared to the lowest possible applicable, relevant, and appropriate requirements (ARARs) suitable for the site.

Section 3: Analytical Procedures

The analytical laboratory(s) selected to analyze samples for this project will be certified by Washington State Department of Ecology (Ecology) for all the analytical methods required for the project.

Analysis of the soil and groundwater samples will be performed using the methods listed below and in the Work Plan. The analytical methods and applicable sample containers and holding times are summarized in Table 1.

Analyses for primary constituents of concern (COCs) for soil and groundwater samples include:

- Gasoline-range organics (GRO) using Ecology Method Northwest Total Petroleum Hydrocarbons as Gasoline (NWTPH-G).
- Benzene, toluene, ethylbenzene, and total xylenes (BTEX) using U.S. Environmental Protection Agency (EPA) Method 8260c.

Additional analyses for soil and groundwater samples may include:

- Total lead using EPA Method 6010 or 6020.
- Volatile organic compounds (VOC) [methyl tert-butyl ether (MTBE), ethylene dichloride (EDC), ethylene dibromide (EDB)] using EPA Method 8260c.

Some groundwater samples will also be analyzed for natural attenuation parameters including:

- Nitrate (NO3-) using EPA Method 353.2 / SM 4500.
- Sulfate (SO4-2) using EPA Method 375.2 / SM 4500.
- Sulfide by EPA Method 376.2 / SM 4500.
- Dissolved metals (manganese and iron) using EPA Method 6000 series.
- Alkalinity using EPA Method 310.1.
- Methane (dissolved) using EPA Method RSK-175.

Any other analytical method employed will be determined with laboratory concurrence and submitted to Ecology for review and approval prior to beginning sample analysis. In addition, field parameters will be measured during groundwater sampling as described in the Work Plan text (Section 3.6) and SOGs.

Section 4: Quality Control

QC samples will be assessed for both field and laboratory operations to evaluate overall precision/bias and accuracy throughout the project. Field QC samples will include field duplicate and blank samples as summarized in the main Work Plan text (Section 3.8). The types and frequency of QC samples are also discussed below.

4.1 Laboratory Quality Control

Laboratory QC parameters, criteria, and frequency will be performed in accordance with the analytical methods referenced in Section 3. Comparison of QC sample results against established criteria is performed during the data validation process as described in Section 7.3. Laboratory QC data may include:

- Laboratory control and laboratory duplicate samples
- Matrix spikes and matrix spike duplicate samples
- Laboratory duplicates
- Surrogate standards
- Internal standards
- Method and instrument blanks
- Post-digestion spikes.

The frequency of analysis for laboratory control samples, matrix spike samples, matrix spike duplicate samples, laboratory duplicate samples, and method blank samples will be one for every 20 samples or one per batch, where applicable, or as specified in the analytical methods. Surrogate spikes and internal standards will be added to samples as required by the methods. Laboratory control limits and performance-based criteria presented in the methods will be used to establish the acceptability of the data or the need for re-analysis of a sample. Analytical data will be evaluated by the laboratory based on the following criteria, where applicable:

- Performance of analytical method tests
  - Holding times
  - Matrix spike and matrix spike duplicate results
  - Calibration data using check compound and system performance check with compound analysis results
  - Laboratory blank sample analysis results
  - Interference check sample analysis results
  - Laboratory check sample analysis results
  - Comparison of calibration and sample analyses
  - Linearity of response and linear range.

- Analytical results of internal standards and the calculation of percent recoveries
- Reporting limits obtained
- Accuracy and precision of matrix spike/matrix spike duplicate analysis
- Comparison of the percentage of missing or undetected substances among duplicate samples.

During data validation, analytical results will be evaluated against the performance criteria noted in this QAPP and the individual analytical methods.

4.2 Field Quality Control Samples

Field duplicate samples are designed to monitor overall sampling and analytical precision. In general, duplicate samples will be collected at a frequency of approximately one duplicate sample per 20 samples (soil samples) or one duplicate sample per batch of samples (groundwater samples).

Soil duplicate and split samples will consist of collecting a sample, homogenizing the sample, and splitting the sample into two equal aliquots. If the sample is to be analyzed for volatile organics the sample will not be homogenized before collection of primary or duplicate sample.

For duplicate water samples, sample containers will be alternately filled. The locations for duplicate sample collection will be determined in the field. Duplicate samples will be treated as separate samples from the originals (assigned unique sample numbers), and not identified to the laboratory as duplicate samples. Field duplicate samples will be documented on the daily field report, in the field logbook, or other appropriate field form.

Trip blanks for VOC analysis will be requested from the analytical laboratory and analyzed for each batch of samples submitted with VOC analyses requested. Volatile organic samples are susceptible to contamination by diffusion of organic contaminants through the sample vials. Therefore, trip blank samples will be analyzed to monitor for possible sampling contamination during shipment. If samples for VOC analysis are not collected, a field blank or rinsate blank may be collected each day.

Trip blank samples will be prepared by the analytical laboratory by filling volatile organic analysis (VOA) vials with organic-free water and shipping the blank samples with the clean sample containers. Trip blank samples will accompany the sample containers through collection and shipment to the laboratory and will be stored with the samples.

Section 5: Data Management

5.1 Documentation and Records

Records will be maintained documenting activities performed and data generated during implementation of the remedial action. The types of documents that will be generated during implementation of the remedial action are discussed below.

5.1.1 Field Documentation

Field personnel will document their field activities on either a daily field log or in a field logbook and complete other field forms applicable to the field activities being performed. The daily field logs and field logbooks will document information regarding who was present during field activities (field personnel, subcontractors, visitors), weather conditions, work conducted that day, problems encountered and corrective actions, if any, etc. Field logs will be filed in the project files.

Field logbooks and other types of field forms (e.g., groundwater purge and sample forms, boring log/well construction logs, test pit excavation logs) will be used to record data obtained during various field activities. The individual field personnel will be responsible for maintaining these forms. Field daily logs, field logbooks, and other field forms will then be archived in the project files.

5.1.2 Laboratory Documentation

Records related to sample analysis will be documented by the laboratory. The laboratory will be required to submit data that are supported by sufficient backup information and QC results to enable reviewers to determine the quality of the data. The laboratory will submit the data in electronic and paper format. The paper format (i.e., hard copy) data packages from the laboratory will consist of the following information, where applicable:

- A cover letter for each sample batch will include a summary of any QC, sample, shipment, or analytical problems, and will document internal decisions. Problems will be outlined and final solutions documented. A copy of the signed chain-of-custody form for each batch of samples will be included in the deliverable.

- Sample concentrations will be reported on standard data sheets in proper units and to the appropriate number of significant figures. For undetected values, the lower limit of detection for each compound will be reported separately for each sample. Dates of sample extraction or preparation and analysis will be included.

- Method blank results.

- Surrogate percent recoveries.

- Laboratory duplicate results, where applicable.

- Laboratory control sample results, where applicable, with percent recoveries and spiking concentrations.

- Matrix spike/matrix spike duplicate percent recoveries, with spiking concentrations and calculated relative percent differences.
- A list of the detection limits calculated for laboratory instruments for all analytes.
- Laboratory data qualifier codes appended to analyte concentrations, as appropriate, and a summary of code definitions.

Sample holding times will be calculated by comparing the date of sample collection (shown on the chain-of-custody form) with the date of sample extraction/analysis. Analytical laboratory deliverables will be validated as described in Section 7 of the QAPP.

The analytical laboratory will routinely archive raw laboratory data, including initial and continuing calibration data, chromatograms, and quantitation reports for at least 5 years.

5.2 Instrument/Equipment Calibration and Frequency

Field instruments will be operated, calibrated, and maintained by qualified personnel, according to manufacturer's guidelines and recommendations. At a minimum, instruments will be calibrated before use each day or more frequently as necessary. Calibration records will be recorded in the daily field log, field logbook, or other appropriate forms.

Laboratory instruments will be calibrated and maintained in accordance with the requirements of analytical methods and normal operating standards associated with good laboratory practices. Calibration requirements are specified in each laboratory's QA manual. Calibration records are documented in laboratory logbooks.

5.3 Instrument/Equipment Testing, Inspection, and Maintenance

Sampling equipment that will be used during field activities is discussed in the main Work Plan text. Preventive maintenance of equipment is essential if project resources are to provide accurate results and are to be used cost-effectively. Preventive maintenance will take two forms: 1) implementation of a schedule of preventive maintenance activities to reduce downtime and maintain accuracy of measurement systems and 2) availability of critical spare parts and backup systems and equipment.

Qualified operators will perform routine inspections and maintenance for field instruments in accordance with manufacturers' recommendations. Field equipment will be inspected prior to the start of sampling activities. Maintenance activities, if performed, will be documented in the daily field log or field logbook. As most types of field equipment that will be used for this project are standard (i.e., used frequently in environmental sampling), replacement parts are readily available. The field personnel will be responsible for maintaining the field equipment.

The laboratory's QA manual discusses preventive maintenance for laboratory equipment and instruments. Maintenance and inspection records are documented in laboratory logbooks.

Section 6: Audits and Reports

6.1 Performance Evaluation Audits

Performance evaluation audits are an independent means of establishing the quality of measurement data by analysis of samples provided specifically for the evaluation.

During a performance evaluation audit, the performance of the laboratory technicians and the instrumentation or analytical systems on which they work are evaluated. A performance evaluation audit is accomplished by providing performance evaluation samples containing specific pollutants (in appropriate matrices) whose identities and/or concentrations are unknown to the technician. Laboratories participate in both internal and external performance testing to examine the overall laboratory performance as well as to qualify for various federal, state, and independent certification programs.

The laboratory will be responsible for implementing corrective action for analytical procedures. Corrective action procedures are described in the individual methods or are described in the laboratory's QA manual. If QC data are unacceptable, the cause will be determined and corrected. Corrective actions that affect the integrity of the project analytical data will require re-analysis of the affected sample or qualifying of these data in the final data report. If corrective actions are warranted by a laboratory, the laboratory will document and forward the corrective action(s).

6.2 System and Technical Laboratory Audits

System and technical audits are performed by the laboratory QA Manager according to a predetermined schedule and when requested by laboratory management. An independent audit may be conducted should corrective actions be needed during implementation of the Work Plan (e.g., a laboratory repeatedly does not meet QC criteria, or overall performance of the laboratory is questionable). This audit will be project-specific and will focus only on the performance of the laboratory for this project. A laboratory audit report will be prepared, if necessary.

6.3 Field Operations

A readiness review will be conducted prior to initiation of each field task requiring sampling to verify that the necessary preparations have been made for efficient and effective completion of the task-related field activities. The Project Manager will verify that the necessary field equipment has been assembled for the field activity and that the applicable subcontractors, if necessary, have been scheduled. Any deficiencies noted during this readiness review will be corrected prior to initiation of field activities.

Field personnel are required to maintain continual communication with project members during the duration of field activities. Thereby, should issues arise during field activities, corrective actions can be implemented.

Section 7: Data Tracking, Reduction, and Validation

7.1 Sample Data Tracking System

During field activities, field personnel will be responsible for overseeing field measurements and data recording. Information on field forms will be verified that the following conditions have been met:

- Samples are properly documented in daily field logs, field logbooks and/or other field forms appropriate to the field activities being conducted.
- Chain-of-custody forms are complete and accurate.
- Samples collected are properly documented and field forms are completed.
- Samples and analyses specified in the Work Plan have been collected.
- Correct number of field QC samples was collected.

In addition, upon receipt of samples at the laboratory, it will be verified that samples were received at the appropriate temperature and in good condition (i.e., no excessive headspace, broken sample containers, etc.). If a sample does not arrive at the laboratory at the appropriate temperature or the integrity of the sample is in question, the potential implication of the anomaly will be evaluated and a course of action will be determined.

7.2 Data Reduction

Both field and laboratory data will be collected during implementation of the cleanup action. Data obtained during sample collection will be manually entered onto daily field logs, field logs book, and other field forms.

The laboratory will provide analytical data in electronic and/or paper form. Electronic data will be loaded into project databases and verified with the paper copy.

Some data from these sources (such as sample location name and coordinates, water levels, and field parameters) may also be manually entered into project databases or various programs such as computer-aided drafting and design (CADD). Manually entered data will be reviewed by a second individual.

The central data management tool for the laboratory is the laboratory information management system (LIMS). The LIMS is used for sample processing, including sample log in and tracking, instrument data storage and processing, generating data reports, and verifying results. Data collected from each laboratory instrument, either manually or electronically, are reviewed and confirmed by the analyst prior to reporting. Laboratory records including chain-of-custody forms, bench sheets, and analytical results, whether in electronic or hard copy format, are stored chronologically by batch or project.

7.3 Data Review and Verification

Field and laboratory data generated during implementation of the cleanup action will be reviewed and verified. Field data entered into databases will be verified. Errors identified during the verification of data will be corrected prior to release of the final data.

The laboratory is responsible for verifying analytical results prior to the submittal of the final laboratory data report. Initially, all analytical data generated by the laboratory are verified by the laboratory. During the analysis process, the analyst and the laboratory QA Manager verify that the results have met various performance-based control limits (e.g., surrogate recoveries and continuing calibration). Non-conformance of various method QC requirements and control limits warrants the re-analysis and/or re-extraction of a sample.

Finally, the data will be verified based on the quality objectives specified in this QAPP and performance-based criteria specified in the analytical methods in accordance with applicable portions of EPA's Contract Laboratory Program National Functional Guidelines for Organic and Inorganic Data Review (EPA 2004; 2008). If data do not meet required criteria, they will be flagged with data qualifiers as specified under the action portion of each requirement of the functional guidelines (EPA 2004; 2008).

Data verification will be conducted to assess the laboratory's performance in meeting the quality objectives identified in the QAPP (e.g., reporting limits and control limits) and performance-based criteria specified in the analytical methods, including the following components:

- Holding times
- Method blank results
- Surrogate recovery results for organic analyses
- Laboratory control sample results
- Field duplicate results
- Field blank results
- Laboratory duplicate results, where applicable
- Matrix spike/matrix spike duplicate (MS/MSD) results for all relevant analyses
- Completeness
- Reported detection limits for analyses.

If data do not meet the quality objectives and required criteria, they will be flagged with data qualifiers as specified under the action portion of each requirement of the functional guidelines (EPA 2004; 2008). Typical data qualifiers include, but are not limited to, "J," used to indicate an estimated value, "B," used to indicate blank contamination, and "R," used to indicate a rejected value. The findings of the data validation will be presented in the RI Report. Limitations to the usability of the data will also be discussed in the report.

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Table

Table 1: Summary of Sample Containers, Preservatives, and Holding Times[a]

Analyte	Method	Soil Samples			Water Samples		
		Container	Preservative	Holding Time	Container	Preservative	Holding Time
Gasoline Range Organics	NWTPH-G	2-40 mL GV / 1-2 oz WMGS	Methanol; Cool≤6ºC	14 days	2-40 mL GV[b]	HCl; Cool≤6ºC	7 days© / 14 days
Diesel Range Organics	NWTPH-Dx	8 oz WMG	Cool≤6ºC	14 days	2-500 mL AG	Cool≤6ºC	7 days
VOCs (BTEX, MTBE, EDC, EDB)	USEPA 8260C	4-40 mL GV / 1-2 oz WMGS	2xSodium Bisulfate, 2xMethanol; Cool≤6ºC	2 days[c] / 14 days	3-40 mL GV [b]	HCl; Cool≤6ºC	7 days[c] / 14 days
Total/Dissolved Metals	USEPA 6010/6020/200 Series	4 oz WMG	Cool≤6ºC	6 months	500 mL HDPE	HNO_3; Cool≤6ºC	6 months
Nitrate	USEPA 353.2/SM 4500				500 mL HDPE	H_2SO_4; Cool≤6ºC	48 hours[c] / 28 days
Sulfate	USEPA 375.2/SM 4500				500 mL HDPE	Cool≤6ºC	28 days
Sulfide	USEPA 376.2/SM 4500				500 mL HDPE	Zinc Acetate+NaOH; Cool≤6ºC	7 days
Alkalinity	USEPA 310.1				500 mL HDPE	Cool≤6ºC	14 days
Methane (dissolved)	USEPA RSK-175				3-40 mL GV[b]	Cool≤6ºC	14 days

Notes:

(a) All sampling requirements and holding times to be verified by the selected analytical laboratories prior to collection of samples.
(b) No headspace in sample container.
(c) Holding time if unpreserved.

Abbreviations:

ºC = degrees Celsius
AG = Amber Glass Boston Round Bottle
AWMG = Amber Wide Mouth Glass Jar
BTEX = benzene, toluene, ethylbenzene, xylenes
GV = glass vial
H_2SO_4 = sulfuric acid
HCl = hydrochloric acid
HDPE = high density polypropylene
HNO_3 = nitric acid
mL = milliliters
MTBE = methyl tert-butyl ether
NaOH = sodium hydroxide
NWTPH-G = Northwest Total Petroleum Hydrocarbons as Gasoline.
oz = ounce
PCB = polychlorinated biphenyl
SM = Standard Method
USEPA = United States Environmental Protection Agency Method
VOCs = volatile organic compounds
SIM = select ion monitoring
WMG = Wide Mouth Glass Jar
WMGS = Wide Mouth Glass Jar with Septa

Grayed cells indicate analyte will not be sampled for that matrix.