VIA ELECTRONIC MAIL

April 18, 2025

Jessica Bluth
New York State Department of Environmental Conservation – Region 1
Division of Environmental Remediation
50 Circle Road
Stony Brook, New York 11790-3409

Subject: **Revised Pre-Design Investigation Work Plan, Brownfield Cleanup Program Site No. C130164**
175 Roger Avenue, Inwood, New York

Dear Ms. Bluth:

WSP USA Inc., on behalf of our client, AIREF JFK IC LLC (AIREF), is pleased to submit this revised work plan for pre-design investigations at the 175 Roger Avenue site in Inwood, New York (Figure 1). This work plan details groundwater and soil vapor evaluations that will aid in optimizing corrective measures to address chlorinated volatile organic compound-affected (VOC-affected) media at the site. The investigation data will be used to refine the *in situ* chemical reduction (ISCR) remedial action previously approved for addressing the dissolved chlorinated VOCs, determine if a soil vapor extraction (SVE) remedy is warranted, and, if so, inform the design of the remedy.

The chlorinated VOCs were released, along with petroleum-related (aromatic) constituents, from underground storage tanks (USTs) maintained by past sheet metal fabrication businesses operating at the site between 1954 and the mid-1980s. Investigations in 2008 and, later in 2020 as part of a 2020 Brownfields Cleanup Program (BCP) evaluation, determined that releases had impacted the soil surrounding the tanks, the underlying groundwater, and the soil gas. The extent of the affected soil was generally limited to the areas around the former USTs with the dissolved aromatics distributed in the shallow water-bearing zone around the tanks (Sheet 1). Chlorinated VOCs, including tetrachloroethene (PCE) and trichloroethene (TCE), were also identified in the groundwater northwest and southeast of the source area with most of the dissolved mass detected around 30 feet below ground surface (bgs). Affected soil gas was detected in samples collected to the southeast of the former UST area with the highest concentrations of chlorinated VOCs found in samples collected near the eastern property line.

A 2022 New York State Department of Environmental Conservation-approved (NYSDEC-approved) BCP remedial action[1] removed the affected soil within the former UST area and treated the shallow groundwater using reactive zero-valent iron (ZVI) powder placed in the base of the open tank excavation (Sheet 1). The action was successful at addressing the identified soil source; laboratory testing concluded that no regulated compounds were detected above the evaluation criteria in the post-remediation soil confirmation samples. The NYSDEC issued a BCP *Certificate of Completion* for the site in April 2023. Supplemental investigations performed by WSP in late 2023 and early 2024, determined that the remedy decreased the concentrations of the dissolved aromatics and chlorinated VOCs in the upper few feet of the water-bearing zone near the former UST area. Those investigations also found that higher chlorinated VOC concentrations remain in the deeper water-bearing zone (i.e., the affected groundwater below about 20 feet bgs) with the bulk of the dissolved chlorinated mass detected between 27 and 33 feet bgs above a low permeability layer. The investigation results also confirmed earlier findings that the release from the USTs occurred over a groundwater divide. Chlorinated VOC-affected groundwater is present along the flow directions from that divide to the north along the northern property line (within and near the former UST excavation), and portions of the eastern and southern site boundaries (Sheet 1). Chlorinated VOCs desorbing from this affected groundwater (or impacted soil, if present) have the potential, via vapor intrusion, to impact the indoor air quality for onsite buildings (a warehouse will be built during the site redevelopment).

[1] The remedial action conducted by Fleming Lee Shue, of New York, New York, included the removal of previously closed in-place USTs; the excavation and removal (for offsite disposal) of affected soil from the UST area in the northern portion of the property; the application of 13,000 pounds of zero-valent iron in the base of the UST excavation; and the cleanout of sludge and sediment containing semivolatile organic compounds and metals from 10 drywells located in the southwestern portion of the site. The affected soil gas was to be addressed by installing a vapor barrier and a sub-slab depressurization system for any buildings constructed at the site during its redevelopment. See Fleming Lee Shue's Final Engineering Report, dated March 2023, for additional information.

The proposed groundwater and soil vapor evaluations detailed in this work plan are intended to further characterize the affected media and develop appropriate corrective measures. The proposed work includes:

- installing and sampling four pre-design groundwater monitoring wells screened where the higher chlorinated VOC concentrations were detected in groundwater;
- conducting an *in situ* microcosm (ISM) test to evaluate the effectiveness of specific ISCR amendment formulations;
- installing and sampling 23 soil gas sampling probes positioned at select locations around the site;
- conducting an SVE pilot test using temporary vapor recovery and vacuum monitoring wells to evaluate the vacuum radius of influence (ROI) within the unsaturated zone;
- installing and sampling groundwater monitoring wells at select locations near the northern, eastern, and southern property boundaries.

The groundwater investigation will collect data that will be used to aid in the design of the ISCR remedy for the affected groundwater at the site (the presumptive remedy, based on the October 2021 Decision Document[2]). The groundwater activities will include the installation of four pre-design wells at key locations around the site. The sample results from these wells will be used to characterize the geochemical and ecological conditions within the water bearing zone. Those data, in turn, will be used to inform the selection of appropriate remedial amendment formulations to treat the chlorinated VOCs. The efficacy of the identified amendments will be evaluated under the site conditions during the ISM evaluation performed after the groundwater sampling.

The groundwater investigation work will also include the installation and sampling of eleven additional[3] monitoring wells near the northern and southern property lines of the site. The wells, added to the investigation at the request of NYSDEC, will be installed in co-located well clusters that are screened at differing depths within the water column. The wells will be gauged to verify the groundwater elevations, flow directions and vertical hydraulic gradients beneath the property, and sampled concurrent with the proposed pre-design monitoring wells. Sample data from the wells will be used to determine the water quality near the boundaries of the site.

The soil vapor investigation includes the collection of soil gas samples over most of the site to assess the current distribution of VOCs in soil gas, evaluate the potential for offsite migration of soil gas, and determine if additional mitigation (beyond the approved sub-slab depressurization [SSD] system for the future building) is warranted. Mitigation methods could include, depending on the data, the construction of an SVE system to both capture affected soil gas beneath future site building and limit potential offsite migration of the affected soil gas. The proposed investigation includes an SVE system pilot test to evaluate the effective vacuum ROI at the site. The vacuum measurements collected during the test will be used to design a full-scale SVE system at the site, if necessary.

It is important to note that this letter work plan is intended as a follow-on to the *Groundwater Investigation Work Plan*, dated November 1, 2023, the *Investigation Results* letter report, dated March 22, 2024, and, as such, is not intended to be comprehensive. Historical investigations, including the 2008 *Remedial Investigation* performed by ATC Associates, Inc. (ATC) of New York, New York; and the 2020 *Supplemental Remedial Investigation* and the 2023 *Final Engineering Report* (FER) prepared by Fleming Lee Shue of New York, New York, are summarized, where appropriate, for context but are otherwise not detailed in this work plan.

The site background, the approach and the methods for the pre-design activities are presented below.

BACKGROUND

The site is located at 175 Roger Avenue in Inwood, Nassau County (Long Island), New York (Figure 1). The 3.5-acre site formerly consisted of a 155,000 square foot one and two-story warehouse and office complex (main building) built on a peninsula extending into the east side of Jamaica Bay. The property was used by an unnamed sheet metal fabrication firm after the site was developed in 1954 through the 1960s and, later, by Rockaway Metal Products (another sheet metal business). Rockaway's operations began in 1971 and included enamel painting of sheet metal products, such as office cabinets and interior office partitions. Waste from the operations, such as spent solvents, recovered paint products, and waste oil were containerized and staged in an outside drum storage area and, later,

[2] The October 2021 Decision Document identifies ISCR as the selected remedy to treat VOCs in groundwater at the site. The Decision Document further states that additional remedial action such as ISCR will occur to address any residual VOCs that remain in groundwater.

[3] The property line evaluation includes two of the proposed pre-design monitoring wells, which will serve to provide both the pre-design data and groundwater quality data. The location and sampling of the dual purpose wells is detailed below.

transferred to a 5,000-gallon tanker trailer parked near the main building. The firm operated at the site for more than 15 years.

Rockaway abandoned the property in 1987 reportedly leaving behind hazardous waste material generated while they were in business. A 1992 US Environmental Protection Agency (EPA) site inspection, conducted at the behest of the NYSDEC, found deteriorating drums; dry wells filled with sludge-like material; the 5,000-gallon tanker trailer; and USTs containing heating oil, xylene, and a paint solvent compound known by the trade name Solvesso. The EPA conducted an Emergency Removal Action in 1993 removing the drums, tanker trailer, and one 1,000-gallon UST containing heating oil. The balance of the tanks, a 5,000-gallon heating oil UST, a 1,000-gallon xylene UST, and a 1,000-gallon UST containing the solvent Solvesso, all located in the UST area near the northern property line, were reportedly cleaned out and abandoned in-place (Sheet 1).

The site was acquired by Nassau County after the removal action in 1995. The County leased the property to several tenants for use as a warehouse (Long Island Party Rental) or an automobile repair facility (Gunter Auto Shop) through 2004, after which the site was vacant. The main building, damaged by fire in 2011, was eventually demolished by Nassau County in 2019. The site remains vacant with no buildings on the property.

PREVIOUS INVESTIGATION AND REMEDIATION

Environmental investigations and remediation were conducted in three phases following the departure of the building tenants in 2004. Those three phases include:

- preliminary investigations and, later, a Remedial Investigation (RI) performed between 2005 and 2009 by ATC Associates, Inc. (ATC), of New York, NY;
- a Supplemental Remedial Investigation (SRI) was conducted by Fleming, Lee Shue (FLS) of New York, NY, in 2020;
- a remedial action focused on the affected soil and shallow groundwater near former USTs in 2022.

ATC performed the first phase of investigation beginning in 2005. Samples collected from soil borings and monitoring wells[4] installed by ATC contained dissolved concentrations of chlorinated VOCs, including PCE and TCE, and petroleum compounds that were presumed to have been released from the former UST area (Sheet 1). ATC also detected petroleum-related VOCs and metals in the soil and sediment sampled from the dry wells in the western portion of the site. The subsequent 2009 RI confirmed the preliminary findings. The highest concentrations of petroleum related compounds, including xylenes and 1,2,4-trimethylbenzene, were detected in the soil and groundwater within and near the former UST areas. ATC concluded, based on these data, that the release occurred in the former tank area.

The 2005 RI samples were also used to further characterize the chlorinated VOCs. Only trace levels of TCE were detected in the soil samples; however, groundwater samples contained dissolved concentrations of PCE (up to 15,000 micrograms per liter [µg/l]) and TCE (up to 6,100 µg/l) with both compounds detected in sub-slab soil gas samples. Notably, the highest concentrations of dissolved chlorinated VOCs were detected in groundwater samples collected between 30 and 35 feet bgs. ATC's interpretation was that the chlorinated VOCs released at or near the surface migrated vertically through the water column before encountering a low permeability layer (i.e., an interval of clay and silt) around 35 feet bgs. ATC's RI did not define the extent of chlorinated groundwater at the site.

The 2020 SRI conducted under the BCP was intended to verify the earlier ATC findings and collect information necessary to design a remedy for the impacted media. The results generally confirmed ATC's findings that the highest concentrations of the petroleum-related compounds were detected in soil samples from within the former UST area (Sheet 1). Groundwater samples contained dissolved concentrations of the petroleum-related compounds near the former UST area and concentrations of chlorinated VOCs near the former UST area at depths up to 35 feet bgs, albeit at comparatively lower concentrations than those detected by ATC. Concentrations of PCE and TCE detected in SRI soil gas samples led to the incorporation of an SSD system in the proposed site remedy.

[4] The location of select historical monitoring wells and soil borings are depicted on Sheet 1 for reference. Individual sample locations and the associated results are not detailed in this work plan for simplicity.

PREVIOUS REMEDIATION

Remediation at the site was implemented by the previous owner as a Volunteer under the BCP guidelines. The NYSDEC-approved *Remedial Action Work Plan* (RAWP)[5] prepared by FLS was designed to treat the identified affected media and remove the likely ongoing source of compounds to the underlying groundwater. The remedial action included four elements:

- excavation of the former UST area to remove affected soil and concrete for offsite disposal;
- removal of the identified USTs that were previously closed in-place for offsite disposal;
- placement of reactive ZVI powder in the base of the excavation (in advance of backfilling) to treat affected groundwater; and
- the cleanout of impacted sludge identified in the 10 drywells in the western portion of the property (Sheet 1).

The RAWP did not propose direct remediation of affected groundwater beyond the former UST area or chlorinated VOC-affected groundwater detected between 27 and 33 feet bgs.

The remediation was conducted by FLS between June and September 2022. The work included the activities outlined above plus the removal of piping, concrete and metal structures (described by FLS as process pits), and other material and debris encountered in the UST excavation area. The onsite activities resulted in:

- the removal and disposal of approximately 3,310 tons of impacted soil and sediment and 300 tons of stained or hazardous concrete;
- the management, removal and disposal of more than 84,000 gallons of liquid waste (groundwater and rainwater) from the dewatering activities;
- the cleanout and removal of three previously closed in-place USTs consisting of one 5,000-gallon petroleum tank and two 1,000-gallon solvent tanks;
- the placement of approximately 13,000 pounds of reactive ZVI powder[6] in the open UST excavations; and
- the decommissioning of 13 existing monitoring wells (Sheet 1).

The remediation was approved by the NYSDEC, and the Department issued a *Certificate of Completion* for the remediation conducted under the BCP on April 25, 2023.

WSP INVESTIGATIONS

WSP conducted post-remediation groundwater investigations at the site in late 2023 and early 2024. The work included the use of a membrane interface probe and hydraulic profiling tool (MiHPT) to simultaneously evaluate the soil and groundwater quality and provide a detailed understanding of the subsurface stratigraphy. The MiHPT work was followed by *in situ* groundwater investigation with samples targeted to those depth intervals where VOCs were detected during previous investigations or where a significant response was noted during the MiHPT evaluation. Groundwater samples were collected for analysis of VOCs, select monitored natural attenuation (MNA) parameters to characterize the groundwater geochemistry, and to assess the microbial ecology.

The investigation confirmed the presence of two relatively conductive stratigraphic intervals that were separated and underlain by less conductive units. The upper (surficial) sand interval extended from the surface to a depth of approximately 22 feet bgs with the lower unit, a silty sand, present between about 27 and 33 feet bgs (Sheet 2). These two flow zones, shallow and deep, are separated by a low permeability layer of silt and silty clay between 22 and 27 feet bgs. The site is underlain by a second low permeability interval that is primarily silty clay and clay, which extends below 45 feet bgs.

Water level measurements in monitoring wells during previous investigations on site indicate the depth to groundwater on site can be as shallow as 6 feet bgs. Groundwater, based on the MiHPT logs and observations made during the *in situ* sampling, was encountered at the site at depths[7] up to 11.5 feet bgs.

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[5] The approved approach also includes the installation of SSD systems in future buildings.

[6] The Ferox PRB-brand ZVI, manufactured by Hepure Technologies of Hillsborough, New Jersey, was placed in the excavation and mixed with the upper 2 feet of saturated soil in the base of the excavation.

[7] The depth to groundwater measurements from the MiHPT investigation are based on hydraulic profile tooling (the depth where hydraulic measurements were possible using the remote sensing tool) and may not equate to the depth to groundwater at the site.

The investigation results also showed that the highest concentration of dissolved chlorinated VOCs (i.e., those previously identified at the site by ATC and FLS) were in the MiHPT responses and *in situ* samples from the deeper high conductivity zone (i.e., the deep water-bearing zone between 27 and 33 feet bgs; Sheet 2). The concentrations of the chlorinated VOCs were highest directly below the former UST area in the northern portion of the site with affected groundwater extending to the northwest and southeast.

The data from the concurrent MNA evaluation provided only limited insight into the groundwater geochemistry. Temporary (*in situ*) sampling is not well suited for evaluating the ambient conditions within the water-bearing zone. The ecology results were likewise equivocal. The *in situ* sampling method is not ideal for biological assays due to the relatively high turbidity levels in the recovered groundwater, which can result in matrix interference (the filtering media become obstructed with sediment impacting the analyses). Additional geochemical and biological data will be collected from permanent wells to evaluate the conditions within the water-bearing zone at the site.

APPROACH

The proposed groundwater and soil vapor evaluations detailed below are intended to provide the data necessary to develop full-scale remedial action or mitigation strategies for the site. That data includes an evaluation of the groundwater elevation and flow beneath the site, a current assessment of the geochemistry of the water-bearing zone, an assessment of the indigenous microbial community, and groundwater quality along the interpreted flow lines leading from the release area (i.e., to the north, east, and south). The presumptive groundwater remedy, ISCR, will likely include ZVI and a fermentable carbon source introduced into the subsurface before building construction using temporary direct-push injectors. The dissolved chlorinated VOCs will be mineralized via direct contact with the ZVI or sequentially reduced over time by indigenous (or inoculated, if necessary) halorespiring microorganisms, such as *Dehalobacter spp*. (DHBt) and *Dehalococcoides spp.* (DHC). The specific formulation of the amendment, including the use of buffers, carbon sources, and an inoculant, will depend on the ambient geochemical conditions (e.g., the reduction-oxidation potential [ORP], pH, levels of dissolved organic carbon, etc.), an assessment of whether the water-bearing zone is hospitable for halorespiring microbes, and a census of the ecological community already present in affected water-bearing zones at the site. These characterization data will be collected using wells that are screened in the areas likely to be treated by ISCR. WSP will also evaluate the efficacy of specific amendment formulations (selected based on the characterization data) using ISM samplers deployed in select pre-design monitoring wells. These data will be used to determine if reductive dechlorination (hydrogenolysis) is occurring and what amendments may need to be introduced into the subsurface to facilitate the mineralization of the dissolved chlorinated VOC compounds.

The releases that occurred at the site impacted the soil gas near the former UST area and other portions of the property that are underlain by affected groundwater (Sheet 1). The onsite soil gas was assessed during the 2020 BCP investigations, when much of the site was covered by the concrete floor slabs of the former facility and well in advance of the remedial action and the data do not reflect current conditions after removing the concrete floor slabs and conducting remediation. In August 2023, a consultant working for NYSDEC collected soil gas samples from locations in the public right of way to the north, east and south of the site. The off-site soil gas samples also contained concentrations of chlorinated VOCs.

The proposed soil vapor evaluation will assess the current (post-remediation) extent of chlorinated VOC-affected soil gas by sampling those portions of the site that may be impacted by the residual soil or the underlying groundwater. Specifically, samples will be collected from the northern portion of the site, including the area around the former USTs; the eastern portion of the site where relatively high concentrations of chlorinated VOCs were detected near the property line, and along the southern boundary of the site where the 2023 and 2024 investigations detected dissolved chlorinated VOCs in groundwater. Data from the soil gas samples will be used to map the soil gas concentrations and assess the potential for offsite soil gas migration. The results will also be used to evaluate the need for a SVE system to either supplement the approved SSD system for the future building at the site, mitigate the potential for offsite migration of affected soil gas, or both. The SVE pilot test will be used to determine the vacuum response should a system be installed at the site.

SCOPE OF WORK

The pre-design investigation work includes:

- the installation and subsequent gauging and sampling of four pre-design groundwater monitoring wells at select locations where ISCR injections may be conducted;
- the installation, gauging, and water quality sampling of eleven wells positioned near the northern and southern property lines;
- the design, deployment, and recovery of amended ISM samplers (in select pre-design monitoring wells) to evaluate the effectiveness of specific ISCR formulations;
- the installation and sampling of soil gas probes positioned throughout the site;
- the installation of a shallow vapor recovery test well and nearby vacuum monitoring points; and
- a SVE pilot test to evaluate the vacuum ROI within the unsaturated zone at the site.

The pre-design groundwater monitoring wells, designated MW-1P, MW-2P, MW-3PD, and MW-4P, will allow direct *in situ* measurements and low turbidity samples for analysis of select MNA parameters, and for a census of the type and population of microbes within the water bearing zones, including halorespiring organisms (Sheet 3). These data will be used to determine if hydrogenolysis is occurring under ambient conditions and evaluate the type of amendments that may be effective at facilitating the attenuation of the chlorinated VOCs. The candidates will be tested using the ISM samplers spiked with the amendments that are suspended in pre-design wells and allowed to incubate under actual site conditions. The specific ISCR formulation selected for remedial injections will be based on the efficacy of the amendments in the ISM samplers (i.e., those that were effective under the site conditions).

The proposed property line groundwater monitoring wells will be used to determine the depth to groundwater, verify the groundwater flow direction and vertical hydraulic gradient and assess groundwater quality at multiple depths along the flow paths leading away from the groundwater high (i.e., beneath the former UST area). The wells will be installed as co-located sets with the shallow well (designated with an *S* suffix) screened as water table wells in the upper sand interval (i.e., the shallow water-bearing zone), a deeper well screened near the base of the shallow water-bearing zone (designated with a *M* suffix) and a deep well (designated with a *D* suffix) screened in the sand unit between 27 and 33 feet bgs (i.e., the deep water-bearing zone). The specific locations and screen intervals were selected based on NYSDEC comments, the results of the MiHPT investigation, as detailed in the *2024 Investigation Results Report*. The scope of work associated with the groundwater pre-design and property line monitoring wells is presented below.

The soil gas samples will be collected following the installation of the monitoring wells in select locations around the site near the former UST area or in portions of the site underlain by affected groundwater. Twenty-three temporary soil gas collection points (i.e., the soil gas implants), designated SG-1P through SG-23P[8], will be installed with a direct-push drill rig and abandoned once the sampling is complete (Sheet 3). The analytical results will be used to evaluate the size and distribution of the affected gas beneath the surface, and, if necessary, the size and scope of an SVE system. WSP recognizes that the deployment, configuration, and operation of an SVE system will depend on the soil gas results; however, other parameters, such as the vacuum ROI, will be important in designing an extraction system. WSP will perform an SVE pilot test to measure the vacuum response in the southeastern portion of the site using one vertical soil vapor extraction well, designated SVE-1, and four vacuum monitoring wells, designated SVE-2 through SVE-5 (Sheet 4). The location was selected to provide vacuum data representative of the native soil conditions on the property rather than those in and around the former UST area where the soil has been disturbed. The test data will provide a conservative estimate of the vacuum required, which will be used to determine the vacuum blower size and other aspects of any future SVE system. The soil gas sampling methods, and the construction and operation of the SVE pilot test cell is detailed below.

A New York-licensed land surveyor will mobilize to the site in advance of the planned groundwater monitoring well installation, soil gas sampling, and SVE pilot test well construction to locate the investigation locations (Sheets 3 and 4). The well and soil gas sample locations will be marked by a wooden stake with the pre-assigned sample identification numbers (e.g., SG-1P, SG-2P, MW-1P, etc.) written on the wood or on attached fluorescent flagging. The locations will be measured to the nearest 0.1 foot relative to the New York State Plane Coordinates, North American Datum of 1983 (NAD83). Prior to the start of field activities, the New York One Call utility locating service will be notified to locate known utilities in public locations (e.g., adjacent streets and rights-of-way) and each well and boring location will be

[8] At the request of NYSDEC, the locations of soil gas sampling points SG-9P and SG-16P were moved approximately 40 feet east of the location proposed in the November 5, 2024, pre-design investigation work plan. The new locations are depicted on Sheet 3.

checked for underground utilities by a private utility locator using ground penetrating radar or other appropriate remote sensing device.

The surveyor will return after the groundwater monitoring well installation is completed to survey the well locations and elevations, as detailed below. WSP does not anticipate surveying any of the soil gas sample points or the SVE extraction and vapor monitoring wells. The direction and distance of any soil gas sample or SVE pilot test locations moved due to conflicts with utilities or other subsurface obstacles will be recorded in the field notebook.

The investigation work will be conducted following the procedures outlined in the NYSDEC's *Technical Guidance for Site Investigation and Remediation* (DER-10), dated May 2010; the New York State Department of Health (NYSDOH) Guidance for Evaluating Soil Vapor Intrusion (SVI Guidance), dated October 2006, with updates in 2017 and 2024; and WSP's Standard Operation Procedures (SOPs). A copy of the referenced SOPs is provided in Enclosure A.

GROUNDWATER INVESTIGATION

The groundwater investigation will include the installation of four groundwater monitoring wells, designated MW-1P, MW-2P, MW-3PD and MW-4P, positioned in areas of the site that will be in or near the likely ISCR injection zones (Sheet 3). Monitoring well MW-1P, for example, will be installed within the outline of the former UST area where the highest chlorinated VOC concentrations were detected in 2023 and 2024. The location, about 45 feet south of the northern property line, was selected to provide geochemical and biological data in the deep water-bearing zone beneath the identified source area. Monitoring well MW-2P will be installed approximately 170 feet east-southeast of MW-1P. Sample data from this well will be used to evaluate the shallow water-bearing zone conditions along the eastern property line near where relatively high concentrations of chlorinated VOCs were detected during the 2023 and 2024 investigations. This well, which will be screened across the water table, will also aid in determining the groundwater elevation and flow direction beneath the property.

The two remaining pre-design monitoring wells, MW-3PD and MW-4P, will be positioned in the southern portion of the site (Sheet 3). Monitoring well MW-3PD will be installed approximately 300 feet south-southeast of MW-1P near the southern property line. Sample results from this well will be used to characterize the deep water-bearing zone geochemistry and microbial community in the southeastern corner of the site downgradient of the former UST area. Monitoring well MW-4P will be positioned 230 feet south-southwest of well MW-1P. Samples from this well will be used to evaluate conditions within the deep water-bearing zone between the former tank area and the southern property line. Both MW-3PD and MW-4P are positioned in areas with relatively low concentrations of chlorinated VOCs (as compared to the former UST area) based on the most recent investigation.

The property line monitoring well sets at the MW-3, MW-5, MW-6 and MW-7 locations will be installed concurrent with the pre-design monitoring wells (Sheet 3). Co-located monitoring wells MW-5S, MW-5M, and MW-5D will be installed approximately 110 feet northwest of the former UST area. Co-located wells MW-6S, MW-6M, and MW-6D will be installed approximately 85 feet northeast of the former UST area (as measured from the center of the former UST area). Data from these well sets will be used to verify the water table elevation, vertical hydraulic gradient and flow direction and to evaluate groundwater quality in both water-bearing units. Co-located wells MW-7S, MW-7M and MW-7D will be installed approximately 350 feet southwest of the former UST area. The perimeter wells MW-3S and MW-3M will be co-located with pre-design well MW-3PD approximately 285 feet south of the former UST area. Depth to groundwater measurements and samples from these wells will be used to assess the elevation, flow regime, and groundwater quality in both water-bearing units near the southern property line. The groundwater elevation and water quality along the eastern property line will be determined using measurements and data from pre-design well MW-2P. All the shallow wells (including pre-design well MW-2P[9]) will be constructed to straddle the water table.

WSP will gauge and collect groundwater samples from the pre-design and property line monitoring wells after they have been developed and allowed to stand undisturbed for a minimum of two weeks (to allow for equilibration with the surrounding formation). The wells will be sampled in accordance with low-flow sampling techniques specified in the U.S. Environmental Protection Agency's (EPA's) *Low-flow (Minimal Drawdown) Groundwater Sampling Procedures* (EPA 1996) and WSP's SOP 11 (Enclosure A). The samples from all the wells will be analyzed for VOCs. Samples will be collected from the pre-design wells for analysis of select MNA parameters, dissolved gases, and advanced

[9] The location of pre-design monitoring well MW-2P was selected based on the results of the MiHPT and *in situ* groundwater investigations performed in 2023 and early 2024. The well screen, initially targeted at the base of the shallow water-bearing unit, was extended upward to ensure the well straddled the groundwater interface. This approach was adopted to ensure an accurate assessment of the water table elevation and flow regime at the site.

diagnostics including the microbial ecology (detailed below). The well gauging, sample collection procedures and the specific analytical methods used are detailed below.

MONITORING WELL CONSTRUCTION

The proposed monitoring wells will be installed by a New York-licensed drilling company using a vehicle-mounted drill rig equipped with 4.25-inch inside diameter (ID) hollow-stem augers (HSAs). The boreholes for pre-design monitoring wells MW-1P, MW-3PD, and MW-4P, and property line wells MW-5D, MW-6D, and MW-7D, will be advanced from the ground surface to the base of the site-wide low permeability layer, which is anticipated, based on the MiHPT investigation, to be located at a depth of approximately 33 feet bgs (Sheet 2). These wells will be constructed with screens positioned within the deep water-bearing zone (Table 1). The borehole for dual purpose monitoring well MW-2P will be advanced from the ground surface to a depth of approximately 18 feet bgs, near the low permeability layer separating the shallow and deep water-bearing zone . The well will be constructed with a longer screened interval (up to 12 feet long) to ensure that it straddles the water table.

Table 1. Location and Screened intervals for Proposed Monitoring Wells

Well ID	Type	Rationale	Screened Interval
Pre-Design Monitoring Wells			
MW-1P	Pre-Design	Evaluate the deep water-bearing zone beneath the identified source (the former UST area)	27 to 33 feet bgs
MW-2P	Pre-Design and Perimeter	Determine the groundwater elevation and evaluate groundwater quality in the shallow water-bearing zone east of former UST area near eastern property line	6 to 18 feet bgs
MW-3PD	Pre-Design and Perimeter	Evaluate the deep water-bearing zone southeast of former UST area near southern property line	27 to 33 feet bgs
MW-4P	Pre-Design	Evaluate the deep water-bearing zone southwest of the former UST area	27 to 33 feet bgs
Perimeter Property Line Monitoring Wells			
MW-3S MW-3M	Perimeter	Determine the groundwater elevation and evaluate water quality at the groundwater interface (MW-3S) and near the base of the shallow water-bearing zone (MW-3M) southeast of the former UST area. The deep water-bearing zone is being evaluated by dual purpose well MW-3PD	6 to 16 feet bgs (MW-3S) 17 to 22 ft bgs (MW-3M)
MW-5S MW-5M MW-5D	Perimeter	Determine the groundwater elevation and evaluate water quality at the groundwater interface (MW-5S), near the base of the shallow water-bearing zone (MW-5M), and within the deep water-bearing zone (MW-5D) northwest of the former UST area	6 to 16 ft bgs (MW-5S) 17 to 22 ft bgs (MW-5M) 27 to 33 ft bgs (MW-5D)
MW-6S MW-6M MW-6D	Perimeter	Determine the groundwater elevation and evaluate water quality at the groundwater interface (MW-6S), near the base of the shallow water-bearing zone (MW-6M), and within the deep water-bearing zone (MW-6D) northeast of the former UST area	6 to 16 ft bgs (MW-6S) 17 to 22 ft bgs (MW-6M) 27 to 33 ft bgs (MW-6D
MW-7S MW-7M MW-7D	Perimeter	Determine the groundwater elevation and evaluate water quality at the groundwater interface (MW-7S), near the base of the shallow water-bearing zone (MW-7M), and within the deep water-bearing zone (MW-7D) southwest of the former UST area.	6 to 16 feet bgs (MW-7S) 17 to 22 ft bgs (MW-7M) 27 to 33 feet bgs (MW-7D)

Notes: bgs = below ground surface; monitoring wells MW-2P and MW-3PD are dual purpose wells that are part of both the pre-design and property line investigations. See text for further information.

The boreholes for the shallow property line monitoring wells MW-3S, MW-5S, MW-6S, and MW-7S will be advanced from the surface to a depth approximately 8 feet below the groundwater interface, which is anticipated to lie between 6 and 11 feet bgs. The 10-foot-long screens will be positioned to straddle the water table. The boreholes for wells MW-3M, MW-5M, MW-6M and MW-7M will be advanced to a depth of approximately 22 feet bgs to characterize the groundwater near the base of the shallow water-bearing zone. The construction details for the proposed groundwater monitoring wells are presented in Table 1 above. The actual location, depth and final construction of the wells will be determined by the onsite WSP geologist.

Continuous soil samples will be collected ahead of the HSAs using a 2-inch ID split-spoon sampler (or equivalent) to allow for soil classification (in accordance with WSP's SOP 9; Enclosure A), organic vapor screening (using a calibrated photoionization detector [PID] with a 10.6 electron volt [eV] lamp), and proper positioning of the 5-foot well screens within the conductive zone between 27 and 33 feet bgs. The onsite geologist will adjust the final location and depth of the wells, if necessary, based on the field conditions, soil classification and screening results.

The boreholes will be converted to groundwater monitoring wells once the target depth has been achieved by installing the appropriate lengths of 2-inch ID, flush-threaded 0.010-inch continuous-wrap polyvinyl chloride (PVC) screen fitted with enough 2-inch ID flush-threaded blank PVC casing to reach the surface. The wells will be completed by installing

an appropriately sized sand filter pack from the base of the borehole to a level approximately 2 feet above the top of the screened interval, which will be topped with a minimum of 2 feet of hydrated bentonite to form a seal. The remaining annular space will be backfilled with bentonite grout with each well completed with a water-tight gripper plug and an aboveground steel protective cover with lock. The concrete pad for the wells will extend a minimum of 1-foot bgs and will be installed such that the concrete extends below (and inside) the protective cover skirt to form a robust surface seal.

The newly installed monitoring wells will be developed 24 hours or later after installation of the well seal. The water column will be surged using dedicated development pump and surge blocks, as appropriate, until the purge water is relatively free of sediments. Field measurements of the development discharge will be collected at periodic intervals to verify that the groundwater temperature, pH and conductivity were stable (to within 10 percent) of the previous measurements. Groundwater generated during the monitoring well development activities will be contained in appropriately labeled Department of Transportation-compliant (DOT-compliant) 55-gallon steel drums in accordance with WSP's SOP 5 (Enclosure A). The drums will be staged onsite for later offsite disposal in accordance with state and federal regulations.

The newly installed monitoring wells will be surveyed following installation. The horizontal locations will be measured to the nearest 0.1 foot relative to NAD83, and vertical elevations will be measured to the nearest 0.01 foot relative to the 1929 National Geodetic Vertical Datum.

The monitoring wells will be allowed to stand undisturbed for a minimum of two weeks after completing the well development activities to allow for equilibration with the surrounding formation.

GROUNDWATER GAUGING AND SAMPLE COLLECTION

WSP will collect depth-to-groundwater measurements and analytical samples from the newly installed monitoring wells to characterize the water-bearing zones (Sheet 3). Each well will be uncapped and allowed to stand for a minimum of 15 minutes and then gauged using an electronic water-level indicator. The depth-to-water measurements will be made to the nearest 0.01-foot using an electronic water level meter with the results recorded in the field notebook.

The purge and subsequent groundwater sampling of the monitoring wells will be conducted using a QED Environmental Systems, Inc., (QED) MP-15 Controller® (to adjust the flow rates) and Sample Pro® portable bladder pump equipped with disposable bladder and tubing (or equivalent). The bladder pump will be positioned at the midpoint of each monitoring well screen and purged at a rate between 0.2 and 0.5 liters per minute. The extracted groundwater will be monitored (during the purge) for temperature, specific conductance, dissolved oxygen (DO), pH, oxygen reduction potential (ORP), and turbidity using a calibrated Horiba U-52 water quality meter equipped with a flow-through cell (or equivalent). Purging will continue until water quality parameters stabilized (±10-percent for temperature, turbidity, DO, and ORP; ±0.1 unit for pH; ± 3-percent for specific conductance; and drawdown variance less than 0.3 feet). Groundwater analytical samples will be collected directly from the pump's discharge tubing once the purge parameters have stabilized, and the flow-through cell removed.

The analytical samples, including the appropriate quality assurance and quality control (QA/QC) samples (outlined below), will be placed in the laboratory-supplied glassware, labeled, and packed in coolers with wet ice. The samples will be shipped via overnight express to SGS North America (SGS) of Dayton, New Jersey, an Environmental Laboratory Accreditation Program-certified (ELAP-certified[10]) analytical laboratory for analysis.

Groundwater samples collected from all pre-design and perimeter monitoring wells will be analyzed for VOCs by U.S. EPA Method 8260D. The samples from the four pre-design wells will also be analyzed for the following MNA parameters and ecology assessment:

- Alkalinity by Method SM 2320B;
- Chloride, nitrate, nitrite, and sulfate by EPA Method 300;
- Dissolved gases ethane, ethene, methane, and carbon dioxide by Method AM20GAX;
- Ferrous iron by Method HACH 8146;
- Sulfide by EPA Method SM4500S2 F2011; and,
- Dissolved organic carbon by EPA Method SM 5310B.

[10] New York Laboratory ID No. 10983.

The quantitative polymerase chain reaction (qPCR) analysis for the microbial assays (pre-design wells MW-1P, MW-2P, MW-3PD, and MW-4P only) will be performed by Microbial Insights, Inc. (Microbial Insights), of Knoxville, Tennessee. The analysis will determine:

- total Eubacteria, Methanogens, DHBt, DHC; and,
- dechlorination enzymes (i.e., the key functional genes) tceA reductase, BAV1 vinyl chloride reductase, and vinyl chloride reductase.

All the samples will be handled and shipped in accordance with WSP's SOP 3 (Enclosure A).

IN SITU MICROCOSM STUDY

The ISM samplers are specialized devices manufactured by Microbial Insights. The ISM sampler (deployed on a lift line in the well) is an assembly of smaller sampling devices, including a Bio-Trap® sampler, a passive diffusion bag (PDB) sampler, volatile organic analysis (VOA) vial sampler with nylon-screened caps (i.e., a grab sampler), all of which are contained within a 1.25-inch ID, 15-inch-long Schedule 40 slotted PVC housing. The individual sampling devices provide biological, chemical and geochemical data regarding the performance of the amendments under the prevailing conditions with the water-bearing zones. The Bio-Trap® sampler, which consists of a 4-inch long, 0.75-inch ID section of screened PVC pipe filled with a sterile microbial growth substrate (Bio-Sep® beads, 3 to 4 millimeter-diameter spherical beads engineered from a composite of Nomex® and powdered activated carbon), is used to colonize microbes for the purpose of understanding the groundwater microbial ecology and gauge their response to the amendment. The organisms on the trap are evaluated using the same qPCR techniques detailed in the groundwater sampling section above. Samples for VOC analysis will be collected from the PDB sampler in each ISM, which is a heat-sealed, low density polyethylene bag that is designed to allow chlorinated VOCs to pass through the membrane and equilibrate with the deionized water within the sampler. Samples for analysis of anions, geochemical parameters and dissolved gases will be collected from the VOA vial sampler. Sample analysis will be conducted using the methods listed in the groundwater section above or other standard methods.

In situ microcosm samplers can also be used to evaluate potential groundwater treatments by including a slow-release (i.e., continuous feed) sponge that is spiked with the amendment (i.e., stimulant, augmentation, or a combination of the two). The deployment of the amendment within the ISM sampler allows the efficacy of that formulation to be tested within the water-bearing zone under the site-specific conditions. The units have a typical incubation time of 30 to 60 days with some formulations requiring up to 90 days in the well.

The ISMs with the selected ISCR candidates will be deployed in well MW-1P to characterize the response of each amendment in the area directly beneath the historical source area (i.e., the former UST Area; Sheet 3). This area, based on the groundwater investigation data, contains the highest concentrations of dissolved chlorinated VOCs detected, which should provide a definitive indication of whether the amendments selected for the evaluation are effective (i.e., there will be a high signal-to-noise ratio). The specific amendments to be evaluated may include ZVI (consistent with ZVI approved for use in the base of the former UST excavation); bio-stimulants designed to create more favorable conditions for dechlorination, such as a ZVI and fermentable iron bio-chemical compound; or a hydrogen release compound (a proprietary controlled release electron donor); an inoculant, such as SD-9 (a microbial culture that includes *DHC*); or some combination of each. The determination of the specific amendments to evaluate, if any, will be made based on the characterization groundwater sampling conducted during the first phase of work. The control for the ISM evaluation will be deployed in well MW-3PD rather than in MW-1P to avoid any potential impact to the control from the amendment-containing samplers.

SOIL GAS SURVEY

The soil gas samples will be collected using a direct-push drill rig to install temporary subsurface sampling probes in accordance with the NYSDOH's SVI Guidance and WSP's SOP 15 (Enclosure A). Boreholes for all 23 soil gas sample locations, designated as SG-1P through SG-23P, will be advanced from the ground surface to a depth of approximately 5 feet bgs using 1.25-inch-diameter drilling rods fitted with an expendable point (Sheet 3). The actual depth of installation may be adjusted in the field to avoid installing the sample probe at or below the water table (or within the

capillary fringe), which has been previously reported[11] as shallow as 6 feet bgs. Teflon® or Teflon®-lined tubing will be connected to a 6-inch-long stainless-steel screen implant that, once the target depth has been achieved, will be inserted through the hollow drill string, and screwed into the top of the expendable point. The drilling rods will then be retracted leaving the implant with the expendable point in the bottom of the borehole and tubing leading to the surface. A clean sand filter pack will be installed in the annular space around the screened interval to a minimum depth of approximately 6 inches above the top of the screen (i.e., 1-foot-deep total). The filter pack with be capped with bentonite slurry to form a seal between the implant and the surface.

The integrity of the sample probe will be verified using a tracer gas (helium) in accordance with the NYSDOH guidelines and WSP's SOP 15 before sampling (Enclosure A). Each sample point will be covered with a laboratory-supplied 18-inch-diameter stainless-steel dome equipped with two stainless-steel quick-lock fittings (or equivalent). Teflon® or Teflon®-lined tubing connected to the sample point will be fitted to one of the quick-lock connectors on the inside of the dome. The quick-lock connector will allow monitoring of the sub-slab soil gas outside of the dome using a laboratory-supplied electronic helium detector and an additional short length of Teflon®-lined tubing. The dome will be charged with helium (via the second quick-lock connector) and the sample point monitored for a period of 2 minutes to verify that the system did not short-circuit to the helium atmosphere inside the dome. Samples will be collected following satisfactory seal tests.

SOIL GAS SAMPLING

The soil gas samples will be collected using 1-liter evacuated stainless steel canisters[12] fitted with a dedicated flow controller pre-set by the laboratory to collect the soil gas sample over a 1-hour period. WSP will record the canister pressures in the field notebook at the start and end of the 1-hour period. The sample canister and regulator will be disconnected from each location at the completion of the 1-hour period and labeled with the sample name, location, time, and date of collection. The sample regulator and canister number, and the analytical method will be recorded on the chain-of-custody and field notebook.

The canisters, including appropriate QA/QC samples (see below), will be shipped under ambient conditions via overnight carrier to Centek Laboratories of Syracuse, New York, an ELAP- certified [13] laboratory. Centek will analyze the samples for VOCs by EPA Method TO-15 with minimum detection limits of 1 microgram per cubic meter ($\mu g/m^3$) for all chlorinated VOCs. The shipping and handling of the samples will be performed in accordance with WSP's SOP 3 (Enclosure A).

The soil gas probe tubing will be removed from the subsurface for each location once the sample collection has been completed. The boreholes will be backfilled with bentonite and capped with material to match the surrounding ground cover.

QUALITY ASSURANCE/QUALITY CONTROL

Field QA/QC procedures for the proposed groundwater and soil gas sampling activities will include the collection and analysis of blind duplicate samples, matrix spike and matrix spike duplicates (MS/MSD), equipment rinsate blanks (for non-dedicated sample equipment used during the groundwater sampling work), and trip blanks (VOCs only). The blind duplicate samples will be analyzed with the other samples to evaluate the reproducibility of the sample collection and analytical procedures, and the MS/MSD samples will be collected to evaluate the effect of the matrix on the analytical protocol. The groundwater sampling equipment rinsate blanks will be collected by pouring analyte-free water over the decontaminated sampling equipment used to collect the groundwater samples. The rinsate blank is used to determine if contaminants are being inadvertently introduced from the sampling equipment or by the sampling procedures. Finally, a trip blank will accompany the sample containers from the laboratory to the field and the samples from the field to the

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[11] Saturated conditions were observed in the MiHPT logs at approximately 11.5 feet bgs; however, this data may not reflect the groundwater interface. Historical well gauging indicate that the water table may be as shallow as 6 feet bgs. WSP will gauge the pre-design and perimeter wells installed in advance of the soil gas survey to make an accurate determination of the water table elevation and adjust the depths of the soil gas implants, if necessary.

[12] WSP will use stainless steel evacuated canisters that are 100-percent certified clean by the laboratory (not batch certified), and are consistent with EPA Method TO-15, as detailed in the EPA's *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air Second Edition - Compendium Method TO-15*.

[13] New York Laboratory ID No. 11830.

laboratory. The trip blank is used to assess cross-contamination during transit. Quality assurance and quality control samples will be collected during the proposed activities in accordance with WSP's SOP 4 (Enclosure A).

The laboratory data will be validated in accordance with the EPA Contract Laboratory Program National Functional Guidelines. The validation will include a *Data Usability Summary Report* (DUSR) in accordance with DER-10 and the NYSDEC's PFAS sampling guidance.

SOIL VAPOR EXTRACTION SYSTEM PILOT TEST

An SVE pilot test will be conducted to determine a representative vacuum response and ROI for the subsurface conditions at the Site. This information in conjunction with the soil gas sampling results, will determine if an SVE system is necessary, and if so, the locations and spacing of SVE wells.

The SVE pilot test cell will include the temporary vapor extraction well, SVE-1, and four temporary vacuum observation wells, SVE-2 through SVE-5, arranged radially around SVE-1 at distances of 5, 10, 20, and 30 feet, respectively (Sheet 4). The pilot test cell will be located near the southern property boundary in an area that was not disturbed during the remediation work conducted in 2022. This portion of the site was selected for the pilot test because of the potential need for an SVE system to mitigate soil gas migration towards the residential properties south of the Site and would be representative of the native soil conditions near the southern property boundary.

SVE PILOT TEST VAPOR WELL INSTALLATION

The SVE pilot test wells will be installed by a New York-licensed drilling company using a vehicle-mounted drill rig equipped with 4.25-inch (vacuum observation wells) or 6.25-inch (vapor extraction well) ID HSAs. The boreholes for all the vapor wells will be advanced from the ground surface to a minimum depth of 5 feet bgs. The actual depth of installation may be adjusted in the field to avoid installing vapor wells at or below the water table and capillary fringe, which may be as shallow as 6 feet bgs. Continuous soil samples will be collected using a 2-inch ID split-spoon sampler (or equivalent) to allow for soil classification in accordance with WSP's SOP 9 (Enclosure A), organic vapor screening (using a calibrated PID), and proper positioning of the wells within the vadose zone.

The borehole for the vapor extraction well SVE-1 will be converted into a well by inserting a 2 to 3-foot-long section (depending on the overall depth of the well) of 4-inch ID flush-threaded 0.020-inch slotted PVC screen fitted with enough 4-inch ID flush-threaded blank PVC casing to reach the ground surface (Sheet 4). The vacuum observation wells (SVE-2, -3, -4 and -5) will be constructed by installing 2 to 3-foot-long section (to match the extraction well dimensions) of 1-inch ID flush-threaded 0.020-inch slotted PVC screen fitted with enough 1-inch ID flush-threaded blank PVC casing to reach ground surface. Both types of vapor wells will be completed by installing an appropriately sized sand filter pack from the base of the borehole to a level approximately 1 foot above the top of the screened interval. The filter pack will be topped with a minimum of 2 feet of hydrated bentonite to form a seal. Additional hydrated bentonite will be used if necessary to fill the balance of the annular space to the ground surface level. The wells will be fitted with well plugs that contain built-in ports that will allow vacuum, flow, and PID readings to be measured during the SVE test.

The vapor wells will be allowed to stand undisturbed for a minimum of 12 hours following their installation to allow the bentonite to cure and reduce the potential for short-circuiting.

PILOT TEST

The SVE pilot test shall be conducted to determine the recommended operating conditions and well spacing in the event a full-scale SVE system is required . A vacuum will be applied to the SVE test well using a three-horsepower regenerative blower (Rotron Model DR656, 230V single phase, or equivalent) to extract soil gas for the purpose of determining the vacuum ROI and off-gas treatment design. Vacuum will be applied to the SVE test well using at least two distinct levels to allow for comparison of flow rates and vacuums at the observation wells. Vacuum, flow rate and PID readings will be monitored at the blower and the SVE test well for each vacuum condition applied. To allow for stabilization of the vacuum readings in the subsurface, the vacuum will be applied at a constant level for at least 20 minutes prior to taking the vacuum and PID readings at each observation well. Emissions from the blower will be treated through one 50-pound vapor-phase granular activated carbon (GAC) vessel. For each vacuum condition, the influent and effluent of the GAC vessel will be monitored with a PID to document VOC concentrations in the vapor stream.

PILOT TEST WELL DECOMMISSIONING

The vapor extraction and observation wells will be decommissioned following the completion of the SVE pilot test. The wells will be abandoned in accordance with NYSDEC's *Groundwater Monitoring Well Decommissioning Policy* (CP-43), dated November 3, 2009. Documentation of this activity will be provided to the NYSDEC in the report detailing the SVE pilot test activities.

AIR MONITORING

Air monitoring will be conducted during investigation activities in accordance with the *Community Air Monitoring Program* (CAMP) provided in Enclosure B.

HEALTH AND SAFETY

The investigations will be conducted in accordance with the site-specific Health and Safety Plan (HASP) provided in Enclosure C. The scope of work in the HASP in Enclosure C includes investigation activities such as soil sampling that will be conducted under a separate work plan submitted to the NYSDEC.

DECONTAMINATION PROCEDURES

All downhole drilling equipment used for the groundwater monitoring well, soil gas implant, and vapor well installations will be cleaned before, between, and after each borehole using a portable steam jenny (or equivalent) for the HSAs and drilling rods. A dedicated decontamination pad will be constructed at the site to contain decontamination rinsate and soil cuttings. Soil sampling equipment (e.g., split spoon samplers, cutting shoes, etc.) and development tools (e.g., surge blocks, submersible pumps) will be decontaminated using a non-phosphate detergent (e.g., Alconox®-brand detergent, or equivalent) followed by a potable-water rinse.

Decontamination rinse water collected in the decontamination pad or bucket wash will be transferred to labeled DOT-compliant 55-gallon steel drums and staged for offsite disposal. All decontamination and handling of the rinsate will be completed in accordance with WSP's SOP 6 (Enclosure A).

INVESTIGATION-DERIVED WASTES

Investigation-derived waste (IDW) generated during the drilling and sampling activities, including decontamination rinsate, residual soil cuttings, and purge water will be placed in DOT-approved 55-gallon steel drums in accordance with WSP's SOP 5. Waste characterization samples will be collected and analyzed to determine the waste classification for disposal. The drums will be staged onsite for later offsite disposal in accordance with state and federal regulations.

REPORTING

Following the completion of the SVE pilot test activities WSP will prepare an SVE Pilot Test Report and Design Document summarizing and documenting the activities conducted. The report will include a figure that will be generated based on the results of the SVE pilot test that will determine the estimated radius of influence with the blower used and recommendations for full-scale SVE design, if warranted. Based on soil gas and SVE pilot test data, WSP will identify any areas recommended for installation of a full-scale SVE system and design the SVE system to be installed in those areas at the same time as warehouse construction and site development. The SVE Pilot Test Report and Design Document will be prepared and submitted to the NYSDEC before the Corrective Measures Optimization Plan (CMOP). The advance submittal (and the subsequent Department approval) will allow the SVE system design to be integrated with the site utilities and warehouse design and streamline the building process.

The SVE design document will also discuss the integrated operation and monitoring of the SVE system and the SSDS previously approved by the NYSDEC and the NYSDOH. The submittal will discuss the installation and operation of both the SVE system and the SSDS. The SVE design document will include an SVE/SSDS monitoring plan that includes both vacuum monitoring and collecting and analyzing soil vapor samples to demonstrate the effectiveness of the systems. The SVE design document will also propose criteria that will be used to evaluate the need for continued SVE system operation.

Based on the data collected during the pre-design groundwater and soil gas investigations, including the ISM data, WSP will select the ISCR amendment to be injected, design the injection program, and prepare a CMOP for NYSDEC review and approval. The CMOP will present a comprehensive site history (background, previous investigation, and remediation), the pre-design investigation findings, and the design and proposed implementation of a supplemental ISCR groundwater remedy conducted before the start of warehouse construction on site. The CMOP will function as a modified Feasibility Study (FS) for the site. The CMOP will include a groundwater monitoring program to be conducted during and after warehouse construction to evaluate the effectiveness of the ISCR remedy.

PROJECT SCHEDULE

The pre-design investigation field activities will be initiated following NYSDEC approval of this work plan, depending on weather and subcontractor availability. The NYSDEC will be notified at least 15 calendar days before the start of any intrusive work at the site. The well installation work is anticipated to require approximately 15 field days with the planned soil gas implant installation and the subsequent sampling requiring an additional five days. The groundwater sampling will be conducted a minimum of 14 days after the well installation and is projected to require approximately five days to complete. Analytical samples collected from the soil gas implants, and the pre-design and property line monitoring wells will be analyzed on a standard basis (two-week turnaround time) for the soil gas samples, and an expedited one-week turnaround-time for VOCs and MNA. The microbial assays are expected to require a minimum of four weeks to complete. The final soil gas, and groundwater VOC and MNA will be assessed for data usability by an appropriate validator within four weeks of receiving the results from the final laboratory data. The biological assays will not be validated.

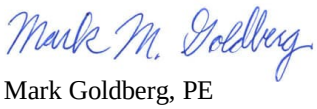
The vapor extraction and monitoring wells associated with the SVE pilot test will be installed after the soil gas sampling activities have been completed. The well installation is expected to require about two days to complete with the follow-on SVE pilot test, and the subsequent abandonment of the wells requiring up to three additional field days.

The evaluation of the pre-design sampling data and the corresponding preparation of the ISM samplers is anticipated to require four to six weeks to complete. WSP will conduct this work concurrent with the data validation and SVE pilot test activities to minimize the delay between the phases of work. The deployment of the ISM samplers will require one field day to complete, with another field day required for the ISM recovery. The incubation time between ISM deployment and retrieval is expected to be 30 to 60 days, but could be as high as 90 days, depending on the microbial ecology data and the amendments included in the ISM samplers (some amendment formulations require more incubation time for microbial growth or the reduction of the dissolved chlorinated VOCs). The final ISM results are anticipated within six weeks of retrieving the ISM samplers. The CMOP will be submitted to NYSDEC for review and approval within six weeks of receiving the ISM results.

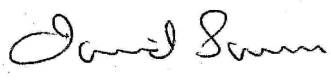
CERTIFICATION

I, Mark M. Goldberg, certify that I am currently a New York State registered professional engineer (License No. 084326) and that this Pre-Design Investigation Work Plan was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10).Please do not hesitate to contact David Sarr at (571) 217-3628 or Mark Goldberg at (475) 882-1708, if you have any questions or comments regarding this work plan.

Kind regards,



Mark Goldberg, PE
Lead Environmental Engineer

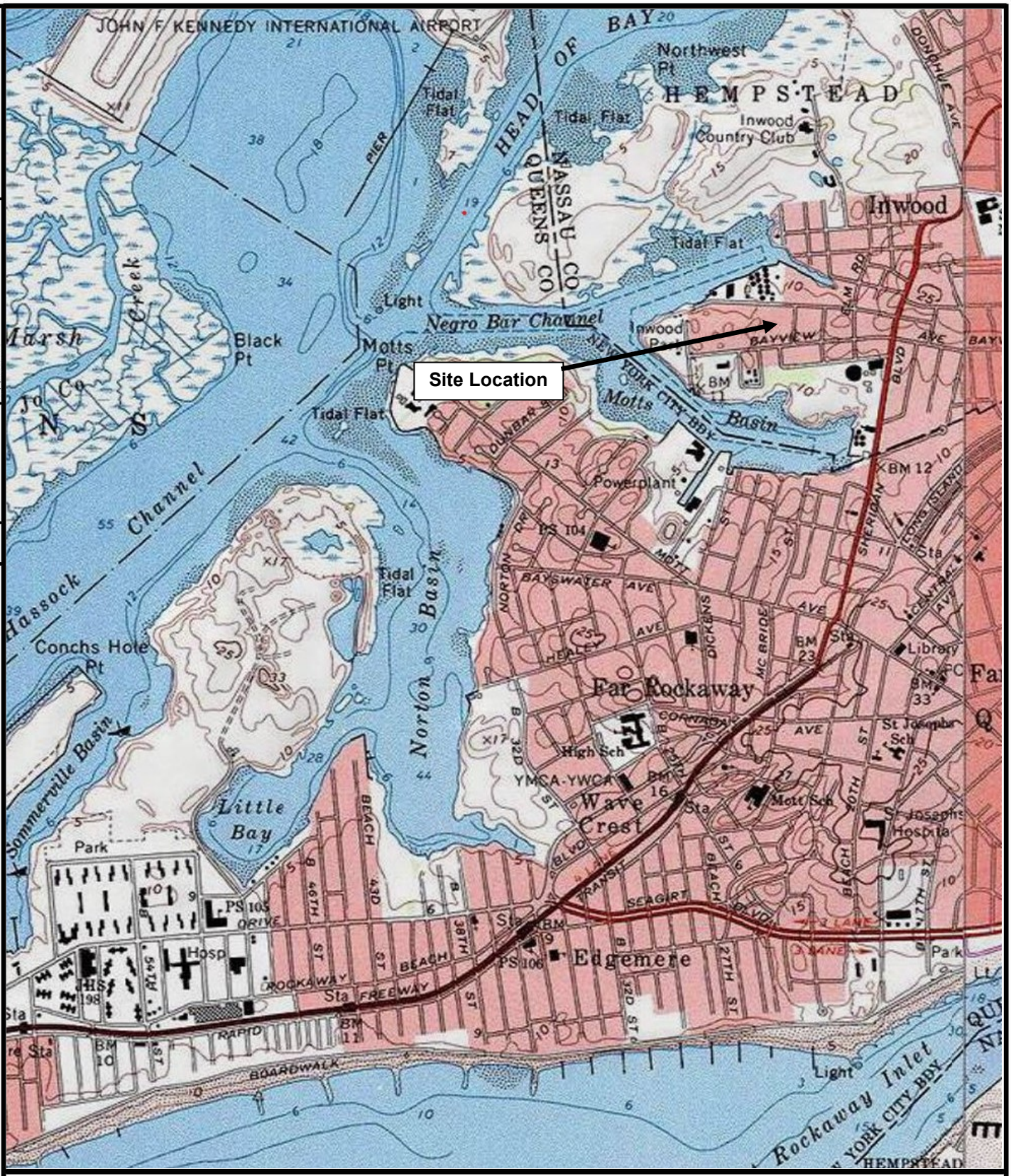


David Sarr
Vice President

Enclosures

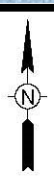
cc: Richard Mustico, NYSDEC
Girish Desai, NYSDEC
Daniel Tucholski, NYSDOH
Mark Foley, AIREF JFK IC LLC
Jonathan Isser, AIREF JFK IC LLC

FIGURE AND SHEETS



Reference
7.5 Minute Series Topographic Quadrangle
Far Rockaway, New York (2019)
Scale 1:24,000





0 1000 2000 4000
SCALE, FEET

DWG Name:
Checked:
Approved:
Drawn By:
A

WSP USA Inc.
100 SUMMER STREET, 13TH FLOOR
BOSTON, MASSACHUSETTS 02116
TEL: +1 617.426.7330

FIGURE 1

SITE LOCATION MAP

175 ROGER AVENUE — INWOOD, NEW YORK

PREPARED FOR
AIREF JFK IC LLC
Rutherford, New Jersey

LEGEND

- IS-12 — IN-SITU GROUNDWATER SAMPLE (2024)
- MP-2 — MEMBRANE INTERFACE PROBE/HYDRAULIC PROFILING TOOL SAMPLE (2023)
- MW-14 — FORMER MONITORING WELL (ABANDONED 2022)
- TMP-6/SB-6 — TEMPORARY MONITORING WELL (2020)
- SSB-4 — SHALLOW SOIL SAMPLE (2020)
- DW-5 — FORMER DRYWELL
- UTILITY POLE
- SEWER MANHOLE
- OHE — OVERHEAD ELECTRIC LINE
- FORMER BUILDING (DEMOLISHED 2019)
- SITE PROPERTY LINE
- OFFSITE PROPERTY LINE
- 4.3 — INTERPOLATED GROUNDWATER ELEVATION CONTOUR IN FEET ABOVE MEAN SEA LEVEL

NOTE:

DEPTH–TO–GROUNDWATER MEASUREMENTS AND THE CORRESPONDING GROUNDWATER ELEVATIONS WERE OBTAINED FROM THE REMEDIAL INVESTIGATION REPORT, DATED JULY 8, 2009, PREPARED BY ATC ASSOCIATES, INC., OF NEW YORK, NEW YORK.

ROGER AVENUE

GATES AVENUE

CERRO STREET

BAYVIEW AVENUE

FORMER MAIN BUILDING (DEMOLISHED FEBRUARY 2019)

FORMER UST EXCAVATION AREA (APPROXIMATE)

ONE STORY MASONRY DWELLING

SHED

ONE STORY FRAME GARAGE

ONE STORY MASONRY BUILDING

ONE STORY FRAME GARAGE

RESIDENTIAL AREA

RESIDENTIAL AREA

MW-13, MW-14, MW-15, MW-17, MW-18, MW-8, MW-9, MW-3, MW-6, MW-2, MW-20, MW-22, MW-1, BW-6

MP-1, MP-2, MP-3, MP-4, MP-5, MP-6, MP-7, MP-8, MP-9, MP-10, MP-11, MP-12, MP-13, MP-14

IS-1, IS-2, IS-3, IS-4, IS-5, IS-6, IS-7, IS-8, IS-9, IS-10, IS-11, IS-12, IS-13

DW-1, DW-2, DW-3, DW-4, DW-5, DW-6, DW-7, DW-8, DW-9

SSB-1, SSB-2, SSB-3, SSB-4, SSB-5

TMP-1/SB-1, TMP-2/SB-2, TMP-3/SB-3, TMP-4/SB-4, TMP-5/SB-5, TMP-6/SB-6, TMP-7/SB-7, TMP-8/SB-8, TMP-9/SB-9, TMP-10/SB-10, TMP-11/SB-11, TMP-12/SB-12, TMP-13/SB-13, TMP-14/SB-14

HA-1, HA-2, HA-3, HA-4, HA-5, HA-6, HA-7, HA-8, HA-9, HA-10, HA-11, HA-12, HA-13

4.0, 4.1, 4.2, 4.3, 4.4, 4.5

SCALE, FEET: 25 0 25 50

REFERENCES:

FLEMING, LEE SHUE ENVIRONMENTAL MANAGEMENT & CONSULTING DRAWINGS TITLED, "GROUNDWATER FLOW DIRECTION", FIGURE 4, "SOIL RESULTS ABOVE SOIL CLEANUP OBJECTIVES", FIGURE 5, AND "GROUNDWATER RESULTS (µg/l) ABOVE TOGS GA AWQS", FIGURE 6, DATED JULY 2020, PROJECT NUMBER 10188–017.

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SITE LAYOUT WITH HISTORICAL SAMPLE LOCATIONS

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SHEET 1

Drawing Number
314P7196.000–D22

A
NORTH

A'
SOUTH

NORTHERN PROPERTY LINE

MP-2 (EAST OF PLANE SECTION)

MP-5 (WEST OF PLANE SECTION)

MP-8 (WEST OF PLANE SECTION)

MP-14 (WEST OF PLANE SECTION)

MP-11 (EAST OF PLANE SECTION)

MP-12 (EAST OF PLANE SECTION)

SOUTHERN PROPERTY LINE

GROUND SURFACE

FORMER UNDERGROUND STORAGE TANK AREA

FEET BELOW GROUND SURFACE

0
3
6
9
12
15
18
21
24
27
30
33
36
39
42
45

SAND AND SILTY SAND (SURFICIAL UNIT)

SILT AND SILTY CLAY (LOCALLY INTERBEDDED)

SILTY SAND

SILTY CLAY AND CLAY

CROSS SECTION A-A'

HORIZONTAL SCALE, FEET: 0 6 12 24

VERTICAL SCALE, FEET: 0 1 2 3 6

NOTES:

1. CROSS SECTION DEVELOPED USING THE SOIL ELECTRICAL CONDUCTIVITY, THE HYDRAULIC PRESSURE, AND HYDRAULIC FLOW OBTAINED DURING THE INSTALLATION OF FOURTEEN MEMBRANE INTERFACE PROBE AND HYDRAULIC PROFILING TOOL (MiHPT) BORINGS IN NOVEMBER 2023. THE HYDRAULIC CONDUCTIVITY IS CALCULATED FROM THE PRESSURE AND FLOW MEASUREMENTS. SEE TEXT FOR EXPLANATION.

2. HYDRAULIC PRESSURE AND ESTIMATED HYDRAULIC CONDUCTIVITY LOGS SHOWN FOR BORINGS ALONG THE NORTH–SOUTH SECTION LINE DEPICTED IN THE KEY MAP. THE ESTIMATED HYDRAULIC CONDUCTIVITY LOG IS SHOWN OFFSET FROM THE PRESSURE LOG FOR CLARITY.

LEGEND

HYDRAULIC PRESSURE LOG (HIGHER PRESSURE [i.e., LOWER FLOW] PROJECTED TO THE RIGHT)

ESTIMATED HYDRAULIC CONDUCTIVITY (HIGHER FLOW PROJECTED TO THE RIGHT)

LITHOLOGIC CONTACT

INTERPRETED GROUNDWATER SURFACE



KEY MAP

SCALE, FEET: 0 50 100 150 300

D

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GENERALIZED GEOLOGIC CROSS SECTION A–A'

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SHEET 2

Drawing Number
314P7196.000–D23

LEGEND

- SG-2P — PRE-DESIGN SOIL GAS SAMPLE
- MW-2M — GROUNDWATER MONITORING WELL
- UTILITY POLE
- SEWER MANHOLE
- OHE — OVERHEAD ELECTRIC LINE
- FORMER BUILDING (DEMOLISHED 2019)
- SITE PROPERTY LINE
- OFFSITE PROPERTY LINE
- 4.3 — INTERPOLATED GROUNDWATER ELEVATION CONTOUR IN FEET ABOVE MEAN SEA LEVEL

NOTE:

1. CO-LOCATED WELL PAIRS, DESIGNATED BY THE SUFFIX "S" (SHALLOW) AND "D" (DEEP), WILL BE INSTALLED TO SELECT DEPTHS BASED ON THE RESULTS OF PREVIOUS GROUNDWATER INVESTIGATIONS AT THE SITE. SEE TEXT FOR EXPLANATION.

2. DEPTH-TO-WATER MEASUREMENTS AND THE CORRESPONDING GROUNDWATER ELEVATIONS WERE OBTAINED FROM THE REMEDIAL INVESTIGATION REPORT, DATED JULY 8, 2009, PREPARED BY ATC ASSOCIATES, INC., OF NEW YORK, NEW YORK.

ROGER AVENUE

GATES AVENUE

CERRO STREET

BAYVIEW AVENUE

SG-1P, MW-5S, MW-5D, MW-5M, SG-2P, SG-3P, MW-6S, MW-6D, MW-6M, SG-4P, SG-5P, MW-1P, SG-6P, SG-7P, SG-8P, FORMER UST EXCAVATION AREA (APPROXIMATE), SG-9P, SG-10P, SG-11P, SG-12P, SG-13P, MW-2P, SG-14P, FORMER MAIN BUILDING (DEMOLISHED FEBRUARY 2019), MW-4P, SG-15P, SG-16P, SG-20P, SG-21P, ONE STORY MASONRY DWELLING, SHED, SG-22P, MW-3M, MW-3S, MW-3PD, SG-23P, SG-17P, SG-18P, MW-7S, MW-7D, MW-7M, SG-19P, [ND], ONE STORY FRAME GARAGE, ONE STORY MASONRY BUILDING, ONE STORY FRAME GARAGE, RESIDENTIAL AREA, RESIDENTIAL AREA

N

25 0 25 50
SCALE, FEET

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REFERENCES:

FLEMING, LEE SHUE ENVIRONMENTAL MANAGEMENT & CONSULTING DRAWINGS TITLED, "GROUNDWATER FLOW DIRECTION", FIGURE 4, "SOIL RESULTS ABOVE SOIL CLEANUP OBJECTIVES", FIGURE 5, AND "GROUNDWATER RESULTS (µg/l) ABOVE TOGS GA AWQS", FIGURE 6, DATED JULY 2020, PROJECT NUMBER 10188-017.

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APPROVED — SS 04/15/25

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PROPOSED PRE-DESIGN SOIL GAS SAMPLE LOCATIONS AND MONITORING WELLS

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SHEET 3

Drawing Number
314P7196.000-D32

LEGEND

- SVE-1 — TEMPORARY SVE PILOT TEST VACUUM WELL
- SVE-0 — TEMPORARY SVE PILOT TEST OBSERVATION WELL
- UTILITY POLE
- S — SEWER MANHOLE
- SVE — SOIL VAPOR EXTRACTION
- OHE — OVERHEAD ELECTRIC LINE
- SITE PROPERTY LINE
- OFFSITE PROPERTY LINE
- 4.3 — INTERPOLATED GROUNDWATER ELEVATION CONTOUR IN FEET ABOVE MEAN SEA LEVEL

NOTE:

DEPTH–TO–WATER MEASUREMENTS AND THE CORRESPONDING GROUNDWATER ELEVATIONS WERE OBTAINED FROM THE REMEDIAL INVESTIGATION REPORT, DATED JULY 8, 2009, PREPARED BY ATC ASSOCIATES, INC., OF NEW YORK, NEW YORK.

ROGER AVENUE

GATES AVENUE

CERRO STREET

BAYVIEW AVENUE

FORMER UST EXCAVATION AREA (APPROXIMATE)

ONE STORY MASONRY DWELLING

SHED

ONE STORY FRAME GARAGE

ONE STORY MASONRY BUILDING

ONE STORY FRAME GARAGE

SVE-1 SVE-2 SVE-3 SVE-4 SVE-5

RESIDENTIAL AREA

RESIDENTIAL AREA

N

25 0 25 50
SCALE, FEET

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REFERENCES:

BOHLER ENGINEERING NY, PLLC DRAWING TITLED, "DRAINAGE AND UTILITY PLAN", SHEET NO.: C–501 DATED 6/18/2021, REVISION 16 – 12/15/23, PROJECT: "PROPOSED SITE PLAN DOCUMENTS", PROJECT NO.: N20218, CAD I.D.: N20218–X–TTB–SPP.

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PROPOSED TEMPORARY SOIL VAPOR EXTRACTION PILOT TEST WELL LOCATIONS

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SHEET 4

Drawing Number
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ENCLOSURE A – STANDARD OPERATING PROCEDURES

FIELD STANDARD OPERATING PROCEDURE #3

SAMPLE PACKAGING AND SHIPMENT PROCEDURE

Shipping samples is a basic but important component of field work. The majority of field activities include the collection of environmental samples. Proper packing and preservation of those samples is critical to ensuring the integrity of our work product. The user is advised to read the entire standard operating procedure (SOP) and review the site health and safety plan (HASP) and/or project safety plan (PSP) before beginning any onsite activities. In accordance with the HASP or PSP, proper personal protective equipment (PPE) must be selected and used appropriately.

3.1 ACRONYMS AND ABBREVIATIONS

CFR	Code of Federal Regulations
DOT	U.S. Department of Transportation
IATA	International Air Transport Association
HASP	Health and safety plan
PPE	Personal protective equipment
PSP	Project safety plan
SOP	Standard operating procedure

3.2 MATERIALS

- Suitable shipping container (e.g., plastic cooler)
- Chain-of-custody forms
- Custody seals
- Sample container custody seals (as necessary)
- Mailing address labels (as necessary)
- Shipping form (with account number, as necessary)
- Tape (e.g., strapping, clear packing)
- Permanent marker
- PPE
- Bubble wrap or other packing material

Temperature-preserved samples:

- Large plastic garbage bag
- Wet ice
- Heavy-duty zipper-style plastic bags
- Universal sorbent materials

Note: Some materials will be supplied by the laboratory, while others are must be supplied by the sampler. Confirm supplier of materials prior to mobilizing to the field.

3.3 PRECONDITIONS AND BACKGROUND

This SOP has been prepared as part of the company's Environmental Quality Management Plan and is designed to provide detailed procedures for common field practices. Compliance with the methods presented in this document is mandatory for all field personnel

and will ensure that the tasks are performed in a safe and consistent manner, are in accordance with federal and state guidance, and are technically defensible.

This SOP is written for the sole use of company employees and will be revised periodically to reflect updates to company policies, work practices, and the applicable state and/or federal guidance. Employees must verify that this document is the most recent version of the company SOPs. Employees are also strongly advised to review relevant state and/or federal guidance, which may stipulate program-specific procedures, in advance of task implementation.

WSP requires that all personnel performing specific project assignments be appropriately qualified, including having required certifications or licenses, and properly trained in accordance with the requirements of their assignment, the Environmental Service Line's field standard operating procedures, and the Quality Management System.

This SOP is designed to provide the user with a general outline for shipping samples and assumes the user is familiar with basic field procedures, such as recording field notes (SOP 1), sample collection and quality assurance procedures (SOP 4), and investigation derived waste management procedures (SOP 5).

Most environmental samples are classified non-hazardous materials due to unknown characteristics and hazardous classes, however environmental samples can meet the definition of U.S. Department of Transportation (DOT) hazardous materials when shipped by air, ground, or rail from a project site to the laboratory (e.g., free product, samples preserved with a hazardous material [TerraCore® samplers]). As such, field staff must work with their assigned company compliance professional to determine whether the sample shipment is subject to any specific requirements (e.g., packaging, marking, labeling, and documentation) under the DOT hazardous materials regulations.

3.4 SAMPLE SHIPMENT PROCEDURES

The two major concerns in shipping samples are incidental breakage during shipment and complying with applicable DOT and courier requirements for hazardous materials shipments.

> **NOTE: Many couriers, including Federal Express and United Parcel Service, have requirements that the company register with them before shipping hazard materials. In most cases, it is the sampling location, not the company office address, which needs to be registered. Therefore, each project will likely have unique requirements. Please contact your company compliance professional to determine whether or not you will be required to register for your shipment.**

Protecting the samples from incidental breakage can be achieved using "common sense." Pack all samples in a manner that will prevent them from moving freely about in the cooler or shipping container. Do not allow glass surfaces to contact each other. When possible, repack the sample containers in the same materials that they were originally received in from the laboratory. Cushion each sample container with plastic bubble wrap, styrofoam, or other nonreactive cushioning material. A more detailed procedure for packing environmental samples is presented below.

3.4.1 NON-HAZARDOUS MATERIAL ENVIRONMENTAL SAMPLES

The first step in preparing your samples for shipment is securing an appropriate shipping container. In most cases, the analytical laboratory will supply the appropriate container for bottle shipment, which can be used to return samples once they have been collected. Be sure that the container is large enough to contain the samples plus a sufficient amount of packing materials, and if applicable, enough wet ice to maintain the samples at the preservation temperature (usually 4 degrees Celsius). Use additional shipping containers as needed so that sample containers are protected from breakage due to overcrowding. Do not use lunch-box sized coolers or soft sided coolers, which do not offer sufficient insulation or protection from damage.

3.4.1.1 TEMPERATURE-PRESERVED SAMPLE CONTAINER PREPARATION

Temperature-preserved samples should be shipped to the laboratory in an insulated container (e.g., cooler). If using a plastic cooler with a drain, securely tape the inside of the drain plug with duct tape or other material to ensure that no water leaks from the cooler during shipment. Place universal sorbent materials (e.g., sorbent pads) in the bottom of the insulated container. The amount of sorbent material must be sufficient to absorb any condensation from the wet ice and a reasonable volume of water from melted wet ice (if a bag were to rupture) or a damaged (aqueous) sample container.

The next step is to line the insulated container with a large, heavy-duty plastic garbage bag. If shipping breakable sample containers (e.g., glass), place bubble wrap or other packing materials on the bottom of the container. Place the samples, including a temperature blank, on the packing materials with sufficient space to allow for the addition of more bubble wrap or other packing material between the sample containers. Place large or heavy sample containers on the bottom of the cooler with lighter samples placed on top to minimize the potential for breakage. Place all sample containers in the shipping container right-side up. Do not overfill the cooler with samples; room must be left for a sufficient volume of wet ice. Wet ice must be double-bagged in heavy-duty zipper-style plastic bags (1 gallon-sized, or less); properly seal both bags before placing in the insulated container. Place the bags of ice on top of or between the samples. Place as much ice as possible into the cooler to ensure the samples arrive at the lab at the required preservation temperature, even if the shipment is delayed. Fill any remaining space in the container with bubble wrap or other packing material to limit the airspace and minimize the shifting of the sample containers and in-transit melting of ice. Securely close the top of the heavy-duty plastic bag and knot or seal with tape.

3.4.1.2 NON-TEMPERATURE-PRESERVED SAMPLE CONTAINER PREPARATION

Non-temperature-preserved samples should be shipped to the laboratory in a durable package (e.g., hard plastic container or cardboard box). If shipping breakable sample containers (e.g., glass), place bubble wrap or other packing materials on the bottom of the container. Place the samples on the packing materials with sufficient space to allow for the addition of more bubble wrap or other packing material between and on top of the sample containers. Place large or heavy sample containers on the bottom of the container with lighter samples placed on top to minimize the potential for breakage. Place all sample containers within the shipping container right-side up. Fill any remaining space in the container with bubble wrap or other packing material to limit the airspace and minimize the shifting of the sample containers and in-transit melting of ice.

3.4.1.3 CONTAINER SHIPMENT

Samples in the container should be cross-checked against the chain-of-custory before signing off on the form and sealing the cooler. Place the original chain-of-custody form (i.e., laboratory copy) into a heavy-duty zipper-style plastic bag, affix/tape the bag to the shipping container's inside lid, and then close the shipping container; as required, include return shipping labels for the laboratory to return company-owned coolers. Only one chain-of-custody form is required to accompany one of the shipping containers per sample shipment; the other coolers in the shipment do not need to include chain-of-custody forms, unless required by the project. At this point, sample shipment preparations are complete if using a laboratory courier.

Once the shipping container is sealed, shake test the shipping container to make sure that there are no loose sample containers. If loose sample containers are detected, open the shipping container, repack the contents, and reseal the shipping container. If sending the sample shipment through a commercial shipping vendor, place two signed and dated chain-of-custody seals on alternate sides of the shipping container lid so that it cannot be opened without breaking the seals. Securely fasten the top of the shipping container shut with clear packing tape; carefully tape over the custody seals to prevent damage during shipping.

Affix a mailing label with the ship to and return to addresses to the top of the shipping container using clear shipping tape. Use the pre-printed return mailing label from the laboratory, if provided, or complete a new mailing label from the shipping carrier. Ship environmental samples to the contracted analytical laboratory using an appropriate delivery schedule. **Note: Samples can be shipped for Saturday delivery once the lab has been verified to be open and receiving samples on the weekend.**

Verify whether the shipment cost should be billed to the sender or recipient, and ensure the internal billing reference section on the mailing label includes either the laboratory's billing reference number, if the shipment is billed to the laboratory, or the project billable number, if the shipment is billed to WSP.

Declare the value of samples on the shipping form for insurance purposes, if applicable. When shipping samples to a lab, identify a declared value equal to the carrier's default value ($100); additional fees will be charged based on a higher value declared. Our preferred carrier, Federal Express, will only reimburse for the actual value of the cooler and its contents if a sample shipment is lost; they will not reimburse for the cost of having to re-collect the samples. [Please note: if you are shipping something other than samples, such as field equipment, declare the replacement value of the contents.]

Record the tracking numbers from the shipping company forms (i.e., the airbill number) in the field book and retain a copy of the shipping airbill. On the expected delivery date, confirm sample receipt by contacting the laboratory or tracking the package using the tracking number; provide this confirmation information to the project manager.

> **NOTE: Most shipping carriers adhere to transit schedules with final pickup times each day; these schedules are subject to change and vary by service location. If shipping containers are dropped off at a service location after the final pickup time, transit to the laboratory will not be initiated until the following day, and samples may not be properly preserved. Therefore, confirm transit schedules in advance of each sampling event, and ensure samples are delivered to the carrier before the final pickup time of the day.**

3.4.2 HAZARDOUS MATERIALS SAMPLES

Employees rarely ship hazardous materials due to DOT shipping requirements. If you find that your samples could be considered a DOT hazardous material, first coordinate with the assigned company compliance professional and project manager to make a hazardous material classification and, if necessary, establish the necessary protocols and to receive the appropriate training/certification.

> **NOTE: Employees shipping samples regulated as hazardous materials or exempt hazardous materials by air must have International Air Transport Association (IATA) training. IATA training is a separate training required in addition to DOT hazardous materials training for such shipments. Most of our employees do not have IATA training and therefore, anyone who needs to ship by air MUST consult with a company IATA-trained compliance professional.**

FIELD STANDARD OPERATING PROCEDURE #4

SAMPLE COLLECTION AND QUALITY ASSURANCE PROCEDURE

The purpose of this procedure is to assure that sample volumes and preservatives are sufficient for analytical services required under U.S. Environmental Protection Agency (EPA) or other agency approved protocols. This operating procedure describes sample identification procedures, sampling order for select analytes, quality control and quality assurance (QA/QC) sampling procedures, and custody documentation. The user is advised to read the entire standard operating procedure (SOP) and review the site health and safety plan (HASP) and/or project safety plan (PSP) before beginning any onsite activities. In accordance with the HASP, proper personal protective equipment (PPE) must be selected and used appropriately.

4.1 ACRONYMS AND ABBREVIATIONS

ºC	degrees Celsius
COC	chain-of–custody [form]
DI	laboratory-grade, analyte-free deionized water
DOT	US Department of Transportation
EDD	electronic data deliverable
EPA	US Environmental Protection Agency
HASP	health and safety plan
ID	identification [number]
MS/MSD	matrix spike and matrix spike duplicate
MSA	master services agreement
PPE	personal protective equipment
PSP	project safety plan
QA	quality assurance
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
SOP	standard operating procedure
VOCs	volatile organic compounds

4.2 MATERIALS

- Field book
- Indelible (waterproof) markers or pens
- PPE
- Sampling containers and labeling/shipping supplies

- Deionized (DI) water
- Cleaned or dedicated sampling equipment

4.3 PRECONDITIONS AND BACKGROUND

This SOP has been prepared as part of the company's Environmental Quality Management Plan and is designed to provide detailed procedures for common field practices. Compliance with the methods presented in this document is mandatory for all field personnel and will ensure that the tasks are performed in a safe and consistent manner, are in accordance with federal and state guidance, and are technically defensible.

This SOP is written for the sole use of employees and will be revised periodically to reflect updates to company policies, work practices, and the applicable state and/or federal guidance. Employees must verify that this document is the most recent version of the company's SOPs. Employees are also strongly advised to review relevant state and federal guidance, which may stipulate program-specific procedures, in advance of task implementation.

WSP requires that all personnel performing specific project assignments be appropriately qualified, including having required certifications or licenses, and properly trained in accordance with the requirements of their assignment, the Environmental Service Line's field SOPs, and the Quality Management System.

This SOP is designed to provide the user with a general outline for collecting environmental and quality assurance samples and assumes the user is familiar with basic field procedures, such as recording field notes (SOP 1), sample shipment procedures (SOP 3), investigation derived waste management procedures (SOP 5), and equipment decontamination (SOP 6). This SOP does not cover investigation planning, nor does it cover the analysis of the analytical results. These topics are more appropriately addressed in a site-specific work plan or a dedicated quality assurance project plan (QAPP). This SOP does not include an special handling requirements for specific parameters such as low-level mercury or per- and polyfluoroalkyl substances. These requirements should be included in the QAPP.

4.4 SAMPLE IDENTIFICATION PROCEDURES

All sample containers (e.g., glass bottles, plastic jars, foil bags, plungers, etc.) should be identified by an affixed sample label. Unless otherwise approved by your project manager or specified in your site-specific work plan/QAPP, information on the sample container labels must include the site/project name, project/task number, unique alpha-numeric sample identification (ID) number, sample collection date, time of collection using the military or 24-hour clock system (i.e., 0000 to 2400 hours), analytical parameters, preservative, and the initials of the sampling personnel. Employees are advised to use pre-printed waterproof mailing labels (e.g., Avery® 5xxx-series Waterproof Address Labels) for all sample identification. Electronic label templates are available.

The sample identification (ID) number must, unless otherwise approved by your project manager or specified in your site-specific work plan/QAPP, follow the company's naming protocol. This protocol was developed to aid in determining the type of sample collected (e.g., soil, groundwater, vapor, etc.), the sample location, and, where appropriate, the sample depth. This protocol was also designed to ensure consistency across the company.

Construct sample IDs in the following format:

SB-10A (4-6)

Where, in this example:

- SB = the first two or three characters will define the sample type (see list of approved prefixes below); in this case, a soil boring
- 10A = the next two or three alpha-numeric digits (separated by a dash from the sample type identifier) indicate the location of the boring on the site; in this case, boring number 10A
- (4-6) = the depth the sample was collected, with the first number (including decimals, if necessary) indicating the top of the sample interval (in feet) and the second number indicating the bottom of the sample interval (in feet); not all sample types will include depth information.

Additional label information may be added after the last character of the sample ID number (e.g., sample date, underground storage tank number, area of concern number, "Area" number, client identifier, etc.). Separate any additional information from the required portion of the sample name by dash(es).

Sample Prefix	Permitted Use
AA	Ambient outdoor air sample
CC	Concrete core/chip sample
CS	Confirmation/verification soil sample collected from an excavation
HA	Soil sample collected with a hand auger
IAB	Indoor air sample – basement
IAC	Indoor air sample – crawl space
IAF	Indoor air sample – first floor
MW	Soil sample collected from a monitoring well borehole or a groundwater sample collected from a monitoring well
PZ	Groundwater sample collected from a piezometer
SB	Soil sample collected from boreholes that will not be converted to monitoring wells
SED	Sediment sample
SG	Soil gas sample other than a sub-slab sample (e.g., sample collected from a temporary or permanent polyvinyl chloride sample point or stainless steel screen implant)
SL	Sludge sample
SS	Surface soil sample collected using hand tools (e.g., trowel, spoon, etc.) and typically at depths less than 2 feet below ground surface
SSV	Sub-slab vapor sample
SW	Surface water sample
TC	Tree core sample
TP	Soil sample collected from a test pit
WC	Waste characterization sample
WP	Wipe sample
WW	Wastewater

4.5 SAMPLE CONTAINERS, PRESERVATIVES, AND HOLDING TIMES

The first step in sample collection is to verify that the correct number and type of sample containers were provided, and that each contains the appropriate preservatives for the proposed project (i.e., check against the sampling plan requirements outlined in the site-specific QAPP or, for those projects without a site-specific QAPP, the laboratory Task Order). Inspect all containers and lids for flaws (cracks, chips, etc.) before use. Do not use any container with visible defects or discoloration. Report non-receipt and any discrepancies of specific types of sample containers to the team leader or project manager immediately. Make arrangements to have missing or additional sampling containers provided on an expedited basis.

Precautions must be taken to prevent cross-contamination and contamination of the environment when collecting samples. Wear a clean pair of new, disposable gloves each time a different sample is collected and don the gloves immediately prior to collection. This limits the possibility of cross-contamination from accidental contact with gloves soiled during collection of the previous sample. The gloves must not contact the medium being sampled and must be changed any time during sample collection when their cleanliness is compromised. ***In no case should gloved hands be used as a sampling device: always use the appropriate sampler to move the sample from the sampling device to the laboratory-supplied containers.***

Sample collection must follow all appropriate SOPs, state and federal regulations, or guidance, for the collection of environmental samples; the recommended order of sample collection is:

- Geochemical measurements (e.g., temperature, pH, specific conductance)
- Volatile organic compounds (VOCs)
- Extractable organics, petroleum hydrocarbons, aggregate organics, and oil and grease
- Per- and Polyfluoroalkyl substances
- Total metals
- Dissolved metals
- Inorganic non-metallic and physical and aggregate properties
- Microbiological samples
- Radionuclides

Fill the sample bottles to the appropriate level for the parameter analyzed including eliminating head space, as appropriate. Collected samples that require thermal preservation must be immediately (within 15 minutes) placed in a cooler with wet ice and maintained at a preservation temperature of 4° Celsius (ºC).

4.6 FIELD QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

Field quality assurance/quality control (QA/QC) samples may include equipment blanks, trip blanks, temperature blanks, duplicates, matrix spike and matrix spike duplicate samples, field blanks, and split samples. The project manager or QAPP must specify the type and frequency of QA/QC sample collection. The QA/QC sample identification number must, unless otherwise approved by your project manager or specified in your site-specific work plan, follow the company's naming protocol as discussed in the sections below. QA/QC samples must be clearly identified on our copy of the chain-of-custody (COC) form (described below) and in the field book. Failure to properly collect and submit required QA/QC samples can result in invalidation of an entire sampling event.

Several blanks, discussed below, require laboratory-grade analyte-free, deionized water (DI) be used. Only if all options to obtain laboratory-grade DI have been exhausted should store-grade distilled water be used to prepare blanks. If store-grade distilled water is used, be sure to record the source and lot number in the field book.

Collect, preserve, transport and document split samples using the same protocols as the related samples.

4.6.1 EQUIPMENT BLANKS

Equipment blanks, or rinsate blanks, are used to document contamination attributable to using non-dedicated equipment (i.e., equipment that must be decontaminated after each use). Collect equipment blanks in the field at a rate of one per type of sampling equipment per day, unless otherwise specified. If the site-specific work plan or QAPP indicates that an equipment blank is to be collected from dedicated sampling equipment, collect the equipment blank in the field before sampling begins. If field decontamination of sampling equipment is required, prepare the equipment blanks after the equipment has been used and field-decontaminated at least once.

Prepare equipment blanks by filling or rinsing the pre-cleaned equipment with DI and collecting the rinsate in the appropriate sample containers. Record the type of sampling equipment used to prepare the blank and how the equipment blank was generated in the field book. Decontamination of the equipment following equipment blank procurement is not required.

The samples must be labeled, preserved, and filtered (if required) in the same manner as the environmental samples. Have the equipment blanks analyzed for all the analytes for which the environmental samples are being analyzed, unless otherwise specified. Designate equipment blanks using "EB", followed by the date, and in the order of equipment blanks collected that day. For example, the first equipment blank collected on July 4, 2015, would be designated EB070415-1.

4.6.2 TRIP BLANKS

Trip blanks are used to document VOC contamination attributable to shipping and field handling procedures. Trip blanks are only required when analyzing samples for VOCs. The blanks are prepared by the analytical laboratory and shipped along with the empty sample containers. These pre-filled blanks should accompany the environmental sample containers wherever they are stored onsite (i.e., keep the trip blank sample bottles in the same shipping container used to ship and store VOC sample bottles during the sampling event). Never open the laboratory-supplied trip blank sample bottles. Only as a last resort, store-grade distilled water, can be poured into empty VOC sample bottles to generate event-specific trip blanks (or augment the laboratory-supplied ones, if they are provided in insufficient numbers).

The trip blanks, even those provided by the analytical laboratory, should be labeled in the field like other environmental samples collected during the investigation activities. Identify trip blanks using the prefix "TB", followed by the date. For example, the trip blank shipped with a cooler of samples on July 4, 2019, would be designated TB070419-1. If a second trip blank is needed on that same day, the designation would be TB070419-2. A minimum of one trip blank should accompany each shipping container of VOC samples, unless more stringent project requirements are in place. The number of trip blanks needed per shipment can be minimized by shipping all the VOC samples in the same shipping container (if possible).

4.6.3 FIELD BLANKS

The field blank is analogous to the trip blank in that it is designed to assess and document any contamination to the environmental samples that can be attributable to the (ambient) field conditions. Not all projects require the use of field blanks. Their use, if required, and the frequency of collection (often 1 blank per 10 or 20 environmental samples collected) is detailed in the QAPP and the site-specific work plan. The sample is collected by pouring DI water into empty glassware at the site during the sampling event. The intent is to expose the field blank to the same conditions in the atmosphere as those present when the environmental samples were collected.

Identify field blanks using the prefix "FB", followed by the date. For example, the field blank shipped collected on August 22, 2019, would be designated FB082219. If a second field blank is needed on that same day, the designation would be FB082219-2. At least one field blank should be collected for each analytical parameter identified in the sampling event.

4.6.4 TEMPERATURE BLANKS

Temperature blanks are used to determine if the samples are at the appropriate temperature for preservation at the time the sample container (cooler) is received by the analytical laboratory. The temperature is determined by measuring the temperature blank, which provides a proxy for the temperature of the sample container upon arrival at the laboratory. These temperature blanks are typically provided by the laboratory and should be included in each sample cooler used to ship and store the sample bottles during the sampling event. If laboratory-provided temperature blanks are not available, fill a clean, unpreserved sample bottle with potable, DI, or store-grade distilled water and identify the bottle as a temperature blank.

4.6.5 DUPLICATES

Duplicate samples, which are used for measuring the variability and documenting the precision of the sampling process, should be collected at a rate of at least 1 duplicate per 20 environmental samples collected, unless specific project requirements (as detailed in a QAPP) are in place. Be sure that the location selected for duplication has sufficient sample volume and is within the area of contamination, if known. Under no circumstances can equipment or trip blanks be used as duplicates.

Collect each duplicate sample at the same time, from the same sample aliquot, and in the same sampling order (i.e., volatile organic compounds, then semivolatile organic compounds, then inorganics, etc.) as the corresponding environmental sample. Sample bottle aqueous duplicate samples, for example, should be alternately filled with the environmental sample bottles (i.e., the actual sample bottle and the bottle to be used for the duplicate) from the same sampling device. If the sampling device does not hold enough volume to fill the sample containers, fill the first container with equal portions of the sample, and pour the remaining sample into the next

sample containers. Obtain additional sample volume and pour the first portion into the last sample container, and pour the remaining portions into the first containers. Continue with these steps until all containers have been filled.

Duplicate samples will be assigned arbitrary sample ID and a false collection time so that they are not identified as duplicates by the laboratory (i.e., submit the duplicates samples as *blind* to the lab). The blind duplicate sample "location designation" will be left up to the project manager; however, in no case will "Dup" be allowed to appear in the sample name. The duplicate samples should be analyzed for the same analytes as the original environmental sample. Be sure to record the sampling method, duplicate sample ID, the false time, and the actual time of collection in the field notebook. The duplicate should also be indicated in separate documentation, such as on our carbon copy of the chain-of-custody (i.e., the yellow copy), and not on the original chain-of-custody that accompanies the samples to the laboratory.

4.6.5 MATRIX SPIKE AND MATRIX SPIKE DUPLICATES

Matrix spike and matrix spike duplicate samples (i.e., MS/MSD samples) are used to determine the bias (accuracy) and precision of an analytical method for a specific sample matrix. Many of the company's projects require the collection of MS/MSD samples; however, laboratory generated MS/MSD samples are sufficient for some projects (as detailed in the QAPP or site-specific work plan). Collect MS/MSD samples at a rate of 1 MS and 1 MSD (i.e., 2 samples) for every 20 environmental samples, unless more stringent project requirements (as detailed in a QAPP) are in place. Clearly convey the MS/MSD identity to the laboratory by adding "MS" or "MSD" after the sample name (e.g., MW-01MS) and/or in the comments section of the chain-of-custody on the same line as the parent sample. Under no circumstances can equipment or trip blanks be used as MS/MSD samples.

4.6.6 SPLIT SAMPLES

Split samples may be collected as a means of determining compliance or as an added measure of quality control. Split samples measure the variability between laboratories and not the variability of sample collection and laboratory procedures (i.e., they are not equivalent to duplicate samples). The split samples must be subsamples of the same parent material used for the environmental sample: soil should be collected from the same in-place material (for VOCs) or, for non-discrete samples, the same mixing vessel after homogenization. Collect aqueous split samples using the same alternating bottle approach detailed in the duplicate sample description above. These procedures will ensure that the split samples are valid and are representative of the environmental sample collected as part of the investigation.

Collecting split samples of soil, sediment, waste, and sludge is not recommended because the homogenization necessary for a true split sample in these matrices is not possible and the resulting laboratory results would not be comparable.

Spilt samples should have the same sample location designation (e.g., MW-01, SB-03 (4-6), but are differentiated from each other by inserting the laboratory analyzing or the agency/consultant collecting the sample after the sample location (e.g., MW-01-WSP and MW-01-EPA).

4.7 CUSTODY DOCUMENTATION

Sample custody protocols are used to demonstrate that the samples and sample containers were handled and transferred in such a manner as to prevent tampering. Legal COC begins when the pre-cleaned sample containers are dispatched to the field from the laboratory and continues through sample analysis and eventual disposal of the sample and sample containers. Maintaining custody requires that samples must be in the actual possession or view of a person who is authorized to handle the samples (e.g., sample collector, laboratory technician, etc.), secured by the same person to prevent tampering, or stored in a designated secure area.

It is a good idea to limit, to the extent possible, the number of individuals who physically handle the samples. Samples must be placed in locked storage (e.g., locked vehicle, locked storeroom, etc.) when not in the possession or view of authorized personnel. Do not leave samples in unoccupied motel or hotel rooms or other areas where access cannot be controlled by the person(s) responsible for custody without first securing samples and shipping or storage containers with tamper indications in place (i.e., custody seals).

The COC form is used to trace sample possession from the time of collection to receipt at the analytical laboratory. It is recommended that the company's COC be used rather than the laboratory-supplied COC form to ensure that all necessary data are recorded. Submit one COC form per sample shipment, unless more stringent project requirements are in place (as detailed in the QAPP or site-specific work plan). The COC needs to have a unique COC number (pre-printed on the form), accompany all the samples, and include all appropriate project-specific information, such as:

- Project number, name, and location
- Sampler's printed name(s) and signature(s)
- Sample identification number
- Date and time (using the 24-hour clock) of collection
- Sample matrix (e.g., soil, aqueous, solid, etc.)
- Total number of containers per sample
- Parameters requested for analysis including number of containers per analyte.
- Remarks (e.g., irreducible headspace, field filtered sample, expected concentration range, specific turn-around time requested, etc.)
- Signatures of all persons involved in the chain of possession in chronological order
- Requested turn-around-time
- Name and location of analytical laboratory
- Custody seal numbers
- Shipping courier name and tracking information
- Internal temperature of shipping container upon shipment to laboratory, as needed
- Internal temperature of shipping container upon delivery to laboratory
- Employee contact information

Affix custody seals to all storage and shipping container closures when transferring or shipping sample container kits or samples to an off-property party. Place the seal so that the closure cannot be opened without breaking the seal. In the field book, record the time, date and signatures of responsible personnel affixing and breaking all seals for each sample container and shipping container. Affix new custody seals every time a seal is broken until continuation of evidentiary custody is no longer required.

FIELD STANDARD OPERATING PROCEDURE #5

INVESTIGATION DERIVED WASTE MANAGEMENT PROCEDURE

The purpose of this standard operating procedure (SOP) is to provide instructions for handling, storing, and managing investigation derived waste (IDW) pending disposal. All IDW, which includes (but is not limited to) soil cuttings, development water, purge water, drilling fluids, decontamination fluids, personal protective equipment (PPE), and sampling equipment, must be managed in compliance with applicable or relevant and appropriate requirements. The user is advised to read the entire SOP and review the site health and safety plan (HASP) and/or project safety plan (PSP) before beginning any onsite activities. In accordance with the HASP or PSP, proper PPE must be selected and used appropriately.

5.1 ACRONYMS AND ABBREVIATIONS

DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
HASP	health and safety plan
IDW	investigation derived waste
PCB	polychlorinated biphenyl
PPE	personal protective equipment
PSP	project safety plan
RCRA	Resource Conservation and Recovery Act
SOP	standard operating procedure
TSCA	Toxic Substances Control Act

5.2 MATERIALS

- Pre-printed weatherproof waste labels (e.g., non-hazardous waste, hazardous waste, polychlorinated biphenyls [PCBs], etc.)
- IDW log (Figure 1)
- Permanent ink marking pen, paint, stick/pen
- Sampling equipment (refer to sampling SOPs)
- Impermeable covers (tarps), as needed
- Duct tape, rope, or other material to secure tarp
- Copy of the waste manifest or bill of lading

5.3 PRECONDITIONS AND BACKGROUND

This SOP has been prepared as part of the company's Environmental Quality Management Plan and is designed to provide detailed procedures for common field practices. Compliance with the methods presented in this document is mandatory for all field personnel and will ensure that the tasks are performed in a safe and consistent manner, are in accordance with federal and state guidance, and are technically defensible.

This SOP is written for the sole use of company employees and will be revised periodically to reflect updates to company policies, work practices, and the applicable state and/or federal guidance. Employees must verify that this document is the most recent version

of the company SOPs. Employees are also strongly advised to review relevant state and/or federal guidance, which may stipulate program-specific procedures, in advance of task implementation.

WSP requires that all personnel performing specific project assignments be appropriately qualified, including having required certifications or licenses, and properly trained in accordance with the requirements of their assignment, the Environmental Service Line's field standard operating procedures, and the Quality Management System.

This SOP is designed to provide the user with a general outline for handling, storing, and managing IDW pending disposal and assumes the user has received current U.S. Department of Transportation (DOT) training, Hazardous Waste Operations and Emergency Response training, and Resource Conservation and Recovery Act (RCRA) training (if required) and is familiar with basic field procedures, such as recording field notes (SOP 1), sample shipment procedures (SOP 3), sample collection and quality assurance procedures (SOP 4), and equipment decontamination (SOP 6). The SOP does not cover investigation planning; DOT, RCRA, and Toxic Substances Control Act (TSCA) regulations; nor does it cover the evaluation of the analytical results. **Consult and involve the company's compliance professionals during all phases of IDW management and disposal.**

It is important to note that information contained in this SOP is based on federal regulations and interpretive guidance provided by the U.S. Environmental Protection Agency (EPA) and other federal regulatory sources; therefore, information provided in this SOP may be superseded by state or local-specific statutes or regulations. Field personnel must plan for and discuss the handling procedures with the project manager and assigned company compliance professional before mobilizing to the field.

5.4 IDW GENERAL PROCEDURES

Nearly all intrusive field activities will generate solid or liquid wastes. Examples include:

Solid Waste

- Soil cuttings
- Drilling mud
- Plastic sheeting
- Spent carbon or filters
- PPE (e.g., Tyvek coveralls, gloves, respirator cartridges)
- Disposable or dedicated sampling equipment (e.g., bailers, hoses, clamps, buckets, cartridge filters)
- Field analytical waste (e.g., HACH kits, Chlor-n-Soil kits, Gastech tubes)
- Compressed gas cylinders (e.g., isopropylene, helium)
-
- Disposable cleaning materials (e.g., wipes or rags)

Liquid Waste

- Decontamination water
- Development water
- Drilling fluids
- Purge water
- Soap or wash solutions
- Reagents (e.g., hexane, nitric acid, methanol)

The specific procedures for dealing with these materials after the field activities have been completed will vary depending on whether the materials are considered to be non-hazardous, RCRA hazardous (characteristic or listed wastes), TSCA-regulated PCB waste, and/or DOT hazardous materials. The characterization of the wastes to be generated should be determined in conjunction with a company compliance professional before the field event occurs, based on previously generated data; however, in some cases, particularly for new sites, the status of the wastes may not be known. In these cases, handle IDW as hazardous waste until the status can be verified. Field personnel must consult their assigned company compliance professionals for assistance in proper waste characterization and to determine waste management requirements applicable to the site.

5.4.1 WASTE MINIMIZATION

As possible, select investigation methods and techniques that will minimize the amount of wastes generated during field activities, particularly if the IDW is hazardous. Examples include using direct-push methods instead of hollow stem augers (to minimize soil cuttings) during a soil investigation, if appropriate, eliminating the use of solvents or solvent-based cleaners for decontamination, if

possible, and limiting contact with the materials to reduce the amount of PPE required. Minimizing the amount of waste generated will reduce handling requirements and overall project costs, and is consistent with the company's corporate goals for sustainability.

5.5 ONSITE IDW MANAGEMENT PROCEDURES

Onsite handling procedures typically involve containerization of the IDW for offsite disposal at a regulated facility or, in the case of certain non-hazardous wastes, onsite disposal. Should more than one waste stream be present onsite, segregate the IDW containers by waste stream to facilitate the future waste disposal. The procedures for each type of waste are presented below.

5.5.1 NON-HAZARDOUS WASTE MANAGEMENT

If the IDW is classified as non-hazardous waste, the following procedures must be implemented only if approved by the applicable regulatory agency and after being discussed and approved by the project manager, project compliance professional, client, and facility personnel:

- Soil can be either:
  - spread around the borehole or other onsite location
  - placed back in the boring or excavated test pit
  - containerized and disposed of offsite
- Groundwater and decontamination fluids can be either:
  - poured onto the ground next to the well to allow infiltration
  - discharged to either the publically-owned treatment works or storm sewer
  - discharged to the onsite wastewater treatment plant
  - containerized and disposed of offsite
- After rendering the IDW unusable (e.g., cutting or tearing material), PPE, plastic sheeting, disposable cleaning materials, and spent bag filters can be double bagged and disposed of as general trash or containerized and disposed of offsite.
- Compressed gas cylinders should be depressurized and disposed of as general trash, recycled as scrap metal, or containerized and disposed of offsite.
- Field analytical waste (e.g., HACH® kits, Chlor-n-Soil® kits) can be disposed of in accordance with the manufacturer's instructions provided the disposal method is approved by the company's project manager and compliance professional.
- Minimize the volume of reagents as much as possible. Consult a company compliance professional to determine the proper disposal of any quantity of unused reagents. Empty reagent containers may be disposed of as general trash after removing all chemical name and warning labels, or may be containerized and disposed of offsite.
- Spent water treatment media (e.g., carbon, resin) should be containerized and disposed of offsite.
- Exploration and production exempt waste derived from material that was downhole at an oil and gas production site.

If the IDW is containerized and is classified as non-hazardous, the following procedures will apply:

- Place the non-hazardous IDW in DOT-compliant containers (e.g., 55-gallon drum, roll-off container, or temporary storage tank). Before placing IDW in the containers, ensure that the containers are in good condition and will not leak.
- Drums used as containers must remain closed except when adding, sampling, or inspecting the waste. The drums cannot be used as a work surface once waste is put in the container.
- Mark the container with the appropriate waterproof, self-adhesive non-hazardous waste label. The label must include a description of the contents of the container (e.g., soil cuttings, purge water) and the generator name (the client or the facility, never the company). **Field personnel must consult the project compliance professional for help in properly completing the labels.**
- Complete the IDW Log (Figure 1) before leaving the site. Present one copy of the log to the site contact and the original to the project manager.
- The IDW containers must be properly closed, wiped clean, and stored in a secure onsite location.

5.5.2 HAZARDOUS WASTE MANAGEMENT

If site data or generator knowledge indicates that the IDW is RCRA hazardous, the following procedures will apply:

- Place IDW in DOT-compliant containers (e.g., 55-gallon drum, roll-off container, or temporary storage tank). Before placing IDW in the containers, ensure that the containers are appropriate for the type of IDW generated (e.g., solid in containers authorized for transport of solids), in good condition and will not leak.

- Containers must remain closed except when adding, sampling, or inspecting the material. The containers cannot be used as a work surface once waste is put in the container.
- Mark the container with an appropriate waterproof, self-adhesive hazardous or radiological waste label. The label must include the accumulation start date, a description of the contents of the container (e.g., soil cuttings, purge water), the EPA identification number, the generator name (the client or the facility, never the company), and the hazardous waste codes, if known. **Field personnel must consult the project compliance professional for help in properly completing the labels.**
- The IDW containers must be properly closed, wiped clean, and stored in a secure onsite location (i.e., a designated facility hazardous waste storage area) to limit access. At a minimum, place the drums on an impermeable surface (if available) in an area of limited access. If stored outside, cover the containers with a secured tarp at the end of each field day until the containers are picked up for disposal.
- Complete the IDW Log (Figure 1) before leaving the site. Present one copy of the log to the site contact and the original to the project manager.
- If applicable, ensure that weekly inspections are conducted, and the proper inspection forms for documentation are completed during the entire time the waste is stored onsite. **Field personnel must consult the project compliance professional for help to determine if weekly inspections are required.**

If the IDW is presumed to be hazardous and sampling is required to confirm its classification, it must be labeled "Hazardous Waste-Pending Analysis" and sampled for the parameters specified by the project compliance professional or project manager before leaving the site. Any waste confirmation samples must be collected in accordance with the company's SOPs. Treatment, storage, and disposal facilities will usually specify the required analysis for waste profiles.

5.5.3 PCB WASTE MANAGEMENT

If information exists to classify PCB-containing IDW as TSCA-regulated IDW (i.e., PCBs greater than 50 milligrams per kilogram), the following procedures must be implemented:

- Place the PCB-containing IDW in DOT-compliant containers (e.g., 55-gallon drum, roll-off container, or temporary storage tank). Before placing IDW in the containers, ensure that the containers are in good condition and will not leak.
- Containers must remain closed except when adding, sampling, or inspecting the material. The containers cannot be used as a work surface once waste is put in the container.
- Mark the container with an appropriate waterproof, self-adhesive yellow label with the words "Caution Contains PCBs", the "removed from service" date (the accumulation start date), and a description of the contents of the container (e.g., soil cuttings). Complete the label with the name and phone number of the company personnel to contact in the event of an accident or spill. **Field personnel must consult the project compliance professional for help in properly completing the labels.**
- The IDW containers must be properly closed, wiped clean, and stored in a secure PCB storage area onsite. If a PCB storage area is not available, construct a temporary PCB storage area. Cover the containers with a secured tarp at the end of each field day until the drums are picked up for disposal. Place one yellow 6" x 6" "Caution Contains PCBs" label on the outside of the tarp, and note the "Removed from service date" on the label.
- Complete the IDW Log (Figure 1) before leaving the site. Present one copy of the log to the site contact and the original to the project manager.
- If applicable, inspect the area and the containers for leaks once every 30 days in accordance with TSCA requirements during the entire period the waste is stored onsite. **Field personnel must consult the project compliance professional for help to determine if weekly inspections are also required.**

5.6 POST-FIELD IDW MANAGEMENT ACTIVITIES

Field personnel must follow up on the management of the IDW after returning from the field. RCRA hazardous and TSCA-regulated PCB-containing wastes have storage time limits and periodic inspection requirements to remain in compliance with federal, state, or local regulations. Arrangements for proper disposal of wastes must be made within the required time limits and must be consistent with all applicable regulatory requirements, as well as the company's contracting procedures and policies for waste disposal. Copies of waste disposal documentation (e.g., bill of lading, waste manifest, land disposal restriction form, etc.) should be provided to the project manager and saved with the project files.

INVESTIGATION DERIVED WASTE LOG

Date/Time:_____

Site Information:
Site Name: _____ Site EPA ID #: _____
Site Contact: _____ Site Address: _____
Site Contact Telephone No: _____

Origin of Material: _____
Type of Waste Generated:
- ☐ Soil Cuttings ☐ PPE ☐ Decontamination Water
- ☐ Groundwater ☐ Storm Water ☐ Drilling Fluids
- ☐ Other (Describe): _____

Field Activities that Generated the Waste:
- ☐ Soil Borings ☐ Well Sampling ☐ Well Installation
- ☐ Decontamination ☐ Excavation ☐ Pumping Tests
- ☐ Other (Describe): _____

Generation Date: _____ ***90/180/270-Day Deadline(for hazardous waste)***: _____
Quantity of Waste Generated and Container Type: _____
_____
Storage Location: _____
Waste Identification:
- ☐ Non-hazardous Waste (pending analysis)
- ☐ Non-hazardous Waste (based on site information or generator knowledge)
- ☐ Hazardous Waste (pending analysis)
- ☐ Hazardous Waste (based on site information or generator knowledge)
- ☐ PCB-containing Waste
- ☐ Radiological Waste

If generator knowledge or site information was used for identification, explain: _____
_____
_____
Type of Label Applied to Container: ☐ Non-hazardous ☐ Hazardous ☐ PCB ☐ Radiological
WSP Information (Note: One copy to site contact - the original copy to project manager)
Personnel/Contact: _____ Project No.:_____
Telephone: _____

Date Removed: _____ Signature: _____

FIELD STANDARD OPERATING PROCEDURE #6

DECONTAMINATION PROCEDURE

The decontamination procedures outlined in this standard operating procedure (SOP) are designed to ensure that all sampling equipment is free from the analytes that could potentially interfere with sample results. The user is advised to read the entire SOP and review the site health and safety plan (HASP) and/or project safety plan (PSP) before beginning any onsite activities. In accordance with the HASP or PSP, proper personal protective equipment (PPE) must be selected and used appropriately.

6.1 ACRONYMS AND ABBREVIATIONS

DI	deionized water
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
HASP	health and safety plan
PPE	personal protective equipment
PSP	project safety plan
QAPP	quality assurance project plan
SOP	standard operating procedure

6.2 MATERIALS

- Field book
- PPE
- Polyethylene sheeting and/or garbage bags
- Laboratory-grade non-phosphate detergent[1] (e.g., Luminox® or Liquinox®)
- Cleaning reagents, as needed (e.g., isopropyl alcohol, methanol, hexane, nitric acid)
- Potable water
- Deionized (DI) water
- Containers (e.g., plastic buckets)
- Bristle brushes
- Aluminum foil
- Spray bottles
- Paper towels
- Pressurized steam cleaner (e.g., steam jenny), as needed
- Waste collection containers (e.g., drums), as needed
- Decontamination pad, as needed

6.3 PRECONDITIONS AND BACKGROUND

This SOP has been prepared as part of the company's Environmental Quality Management Plan and is designed to provide detailed procedures for common field practices. Compliance with the methods presented in this document is mandatory for all field personnel

[1] Not all laboratory-grade detergents are phosphate free. Be sure to verify the detergent's phosphate content before use.

and will ensure that the tasks are performed in a safe and consistent manner, are in accordance with federal and state guidance, and are technically defensible.

This SOP is written for the sole use of company employees and will be revised periodically to reflect updates to company policies, work practices, and the applicable state and/or federal guidance. Employees must verify that this document is the most recent version of the company's SOPs. Employees are also strongly advised to review relevant state and/or federal guidance, which may stipulate program-specific procedures, in advance of task implementation.

WSP requires that all personnel performing specific project assignments be appropriately qualified, including having required certifications or licenses, and properly trained in accordance with the requirements of their assignment, the Environmental Service Line's field SOPs, and the Quality Management System.

This SOP is designed to provide the user with a general outline for decontamination and assumes the user is familiar with basic field procedures, such as recording field notes (SOP 1), sample shipment procedures (SOP 3), sample collection and quality assurance procedures (SOP 4), and investigation-derived waste management procedures (SOP 5). All decontamination references must be available for consultation in the field, including:

- Company's SOPs
- Applicable state and federal guidelines or procedures
- Manufacturer's manuals
- Project-specific work plan, PSP and/or HASP, and QAPP

6.4 GENERAL PROCEDURES

The cleaning and decontamination procedures described below are designed to ensure that the equipment used for sample collection is free of analytes that could potentially alter the analytical results. These procedures are primarily targeted at preventing the incidence of cross-contamination (i.e., compounds of interest being transferred on the sampling equipment from one sample to another) in order to produce high quality, representative sample results. As with all analytical sampling, the effectiveness of the cleaning procedures must be demonstrated with the collection of equipment blanks; equipment blank sample collection procedures and frequency are discussed in SOP 4.

6.4.1 EQUIPMENT AND REAGENT SELECTION

It is important for employees to evaluate the expected types of contamination before mobilization to a site. State programs (or the U.S. Environmental Protection Agency [EPA], depending on the site) may require more stringent decontamination procedures than those listed in this SOP, specify the types and grades of various cleaning detergents and reagents (e.g., acids and solvents), or allow the use of phosphate-containing detergents, such as Liquinox® liquid detergent (preferred[2]) or the powdered Alconox®. Decontamination equipment (e.g., spray bottles, brushes, etc.) should be constructed of non-reactive, non-leachable materials (e.g., metal, glass, Teflon®-coated, polyethylene, etc.) which are compatible with the reagents and solvents being used for decontamination.

Many of the cleaning reagents (e.g., nitric acid, hexane, methanol) are U.S. Department of Transportation (DOT) hazardous materials and must be shipped using a ground delivery service. The Safety Data Sheets (SDSs) for any hazardous cleaning reagents to be used onsite must be reviewed before the commencement of work, and the potential hazards and protective measures to be employed must be addressed in the HASP. Do not use decontamination liquids that have been improperly stored (e.g., unsealed containers).

In specific cases, it may be necessary to steam clean the field equipment before proceeding with the decontamination steps presented in Section 6.5 (e.g., hollow stem augers). Generally, the company's subcontractors are responsible for bringing or building a decontamination pad, if necessary, to contain the spray from a steam jenny. As possible, decontamination pads should be constructed on a level, paved surface in an area known or believed to be free of surface contamination, and should be of sufficient size to contain the decontamination water. Equipment that is steam cleaned should be placed on racks or saw horses and not on the floor of the

[2] Liquinox® liquid detergent, manufactured by Alconox, Inc., is phosphate-free and does not contribute to nutrient loading or algae blooms in the environment.

decontamination pad. Decontamination water should be removed from the decontamination pad frequently to minimize the potential for leaks or overflow.

Consult and involve the company's compliance professionals for storage procedures and disposal requirements of cleaning reagents, detergents, wastes, and other decontamination-related materials.

6.4.2 OTHER CONSIDERATIONS

In preparing for decontamination, you should perform the following activities (with all observations and measurements noted in the field book):

- Perform a quick reconnaissance of the site to identify a decontamination (pad) area and evaluate the accessibility to and safety of the location.
- If working in a hazardous waste exclusion area, the decontamination area should be located in the contaminant reduction zone.
- Record a description of the decontamination (pad) area.

Survey the breathing zone around the decontamination area with the appropriate air quality meter(s), as necessary (see HASP), to ensure that the level of PPE is appropriate. When decontaminating equipment, it is important to find a suitable location away from any sources of cross-contamination that could compromise the integrity of the decontamination. As possible, position the decontamination area away from fuel-powered equipment, such as drill rigs or excavators, and upwind of other site activities (e.g., purging, sampling).

6.5 DECONTAMINATION PROCEDURES

The decontamination procedures described below are a four- to nine-step process, depending on the the applicable federal or state guidelines, the project-specific work plan, or the QAPP. Sampling activities must be initiated with clean, decontaminated equipment. Decontaminate all non-dedicated equipment that contacts the sample directly (e.g., spoons, trowels, pumps), before and between each sample location and sampling interval. record decontamination procedures in the field book. Disposable, single use items, such as bailers or tubing, do not require decontamination.

The decontamination process includes the following four basic steps:

1. Physical removal of soil or debris
2. Wash with non-phosphate detergent, such as Liquinox®, and nylon brush
3. Potable water rinse
4. Laboratory-supplied deionized (DI), analyte-free water rinse (distilled water can be used as a substitute, if necessary)

The first step is to remove as much soil or other debris from the sampling device as possible near the sampling area to limit the spread of potentially-contaminated materials into clean areas of the site. Containerize all soil or debris in DOT-compliant containers in accordance with SOP 5 or the project-specific work plan. Dispose of all wastes in conformance with the project-specific work plan and applicable regulations.

Cleaning and decontamination should occur at a designated area(s) (i.e., decontamination pad) on the site. If gross contamination or an oily film or residue is observed on the equipment, use a steam jenny or wash by hand, using a brush, to remove the particulate matter or surface film. Heavy oils or grease may be initially removed with paper towels soaked with isopropyl alcohol.

The physical removal of debris process is followed by soaking (a simple dunk of the equipment is insufficient) and hand scrubbing the equipment with a solution of potable water and non-phosphate detergent (mixed to the manufacturer's instructions) followed by a potable water rinse. If not using a decontamination pad, the most common set-up uses multiple 5-gallon plastic buckets (or equivalent) for washing and rinsing. The decontamination containers should be labeled as to their contents and pertinent information from original source, such as the date opened or transferred, and the expiration date (as well as any applicable hazardous labels), placed on polyethylene sheeting (to contain drips of decontamination fluids during the decontamination process), and sealed when not in use to prevent accidental release of the fluids. If decontaminating sealed submersible pumps, pump both the non-phosphate detergent wash

fluid and the potable water rinse through the pump body itself (usually done in separate buckets) to ensure that the internal components are thoroughly cleaned. Replace the detergent solution and rinse water at least daily or when it becomes oily or silty.

Next, place the DI water for the rinse in a small spray bottle or pour over the equipment after the potable water rinse.

Typically, this level of decontamination (i.e., steps 1 through 4) is sufficient.

Following Steps 1 through 4, additional decontamination (steps 5 through 9) may be required by the applicable federal or state guidelines, the project-specific work plan, or the QAPP. Typically, these decontamination steps are performed when sampling for inorganics or oil-related substances using non-motorized equipment. These steps include:

5 10% nitric acid rinse (if metals are part of the analyses)
6 Laboratory-supplied DI water rinse
7 Pesticide-grade solvent rinse (e.g., acetone [preferred], hexane, or isopropyl alcohol)
8 Air dry (solvent must evaporate)
9 Laboratory-supplied DI water rinse

Isopropyl alcohol is the recommended solvent for organic contaminants because it is readily available and is not a DOT hazardous material; where possible, lab-grade isopropyl alcohol should be used . However, other solvents (e.g., hexane and methanol) may be more effective in removing certain contaminants, such as oils or polychlorinated biphenyls, but any waste generated using these solvents must be managed accordingly. Solvents are never used for decontamination if sampling for volatiles organic compounds.

Handle the solvents and acid with care and store unused chemicals in their original, labeled, protective containers when not in use. It is a good idea to transfer small quantities of each solution into labeled, laboratory-grade spray bottles, which offer a convenient and controllable way to rinse the equipment. The equipment can then be rinsed over a 5-gallon plastic bucket or other suitable container placed on plastic sheeting as with the first part of the cleaning process. Nitric acid rinses must be used only on non-carbon steel sampling devices. Do not spray acid or solvent into pumps.

Decontamination steps used at sites where radioactive materials are contaminants of concern are similar with a few special considerations. Radiation contamination monitoring is used to help locate contamination and guide the success of the decontamination process. The liberal use of water and fluids as a decontamination agents are minimized, where practicable, because of the expense that can be incurred with disposing of radioactively contaminated decontamination water. Containerized decontamination wastes must be evaluated for radioactive content and disposed of appropriately depending on their content.

6.6 HANDLING DECONTAMINATED EQUIPMENT

Handle any decontaminated equipment using clean gloves to prevent re-contamination. Place the equipment away (preferably upwind) from the decontamination area once the process has been completed on clean plastic sheeting to allow it to air-dry. Once the equipment is dry, protect it from re-contamination by securely wrapping and sealing with aluminum foil (shiny side out) or clean, disposable plastic bags (inorganics only). Plastic bags may be wrapped directly around wet or dry equipment except when the expected contaminants include volatile and extractable organics; under those circumstances, allow the equipment to completely dry or wrap it in aluminum foil.

All sampling equipment must be decontaminated at the end of the investigation (i.e., prior to departure from the site). Label each piece of equipment with the date of decontamination, the initials of personnel performing the decontamination, and the type of decontamination solution(s) used. Containerize all decontamination fluids, and other disposable decontamination materials in DOT-compliant containers in accordance with SOP 5 or the project-specific work plan. Dispose of all wastes, including open and unused solvents or acids, in conformance with the project-specific work plan and applicable regulations.

FIELD STANDARD OPERATING PROCEDURE #9

SOIL SAMPLING PROCEDURE

The soil sampling procedures outlined in this standard operating procedure (SOP) are designed to ensure that collected soil samples are representative of current site conditions. Soil samples can be collected for onsite screening or for laboratory analysis. The user is advised to read the entire SOP and review the site health and safety plan (HASP) and/or project safety plan (PSP) before beginning any onsite activities. In accordance with the HASP, proper personal protective equipment (PPE) must be selected and used appropriately.

9.1 ACRONYMS AND ABBREVIATIONS

ºF	degrees Fahrenheit
HASP	health and safety plan
IDW	investigation derived waste
PID	photoionization detector
PPE	personal protective equipment
PSP	project safety plan
QAPP	quality assurance project plan
QA/QC	quality assurance/quality control
SOP	standard operating procedure
USCS	Unified Soil Classification System

9.2 MATERIALS

- Field book
- PPE
- Air quality monitoring equipment, (e.g., photoionization detector [PID]), as needed
- Field test kits, as needed
- Sampling containers and labeling/shipping supplies
- Ruler or tape measure
- Zipper-style plastic bags, as needed
- Plastic sheeting
- Soil sampling method specific materials, as needed:
- Stainless steel trowels, probes, or shovels
- Stainless steel spatulas or spoons
- Bucket augers, auger extension rods, auger handle, pipe wrenches
- Split-spoon samplers, pipe wrenches
- Direct-push acetate liners, including catchers and opening tools, as needed
- Shelby tube samplers, plastic or wax caps
- Mixing tray or bowl
- Munsell color chart
- Decontamination supplies

9.3 PRECONDITIONS AND BACKGROUND

This SOP has been prepared as part of the company's Environmental Quality Management Plan and is designed to provide detailed procedures for common field practices. Compliance with the methods presented in this document is mandatory for all field personnel and will ensure that the tasks are performed in a safe and consistent manner, are in accordance with federal and state guidance, and are technically defensible.

This SOP is written for the sole use of company employees and will be revised periodically to reflect updates to company policies, work practices, and the applicable state and/or federal guidance. Employees must verify that this document is the most recent version of the company SOPs. Employees are also strongly advised to review relevant state and/or federal guidance, which may stipulate program-specific procedures, in advance of task implementation.

WSP requires that all personnel performing specific project assignments be appropriately qualified, including having required certifications or licenses, and properly trained in accordance with the requirements of their assignment, the Environmental Service Line's field SOPs, and the Quality Management System.

This SOP is designed to provide the user with a general outline for conducting soil sampling and assumes the user is familiar with basic field procedures, such as recording field notes (SOP 1), utility location (SOP 2), sample shipment procedures (SOP 3), sample collection and quality assurance procedures (SOP 4), investigation-derived waste (IDW) management procedures (SOP 5), equipment decontamination (SOP 6), and use and calibration of sampling and monitoring equipment (SOPs 7 and 8). This SOP does not cover investigation planning, nor does it cover the evaluation of the analytical results. These topics are more appropriately addressed in a project-specific work plan. Before soil sampling, be sure to review the project-specific work plan or Quality Assurance Project Plan (QAPP) and any applicable state and federal guidelines or sampling procedures.

Consult and involve your assigned compliance professional during all phases of soil sampling. Do not ship hazardous waste samples without first consulting a company compliance professional.

All sampling and monitoring references must be available for consultation in the field, including:

- Company's SOPs
- Applicable state and federal guidelines or sampling procedures
- Manufacturer's manuals
- Project-specific work plan, PSP and/or HASP, and QAPP

9.4 GENERAL PROCEDURES

Soil samples are collected using a variety of techniques and equipment, depending on the type (e.g., surface, subsurface) and purpose (e.g., lithological logging, headspace evaluation, laboratory analysis) of the sampling, and most sampling events employ more than one equipment type or methodology. Subsurface soil sampling, for example, often includes sample collection from split-spoon, macro-core, or other dedicated sampling devices advanced into the subsurface. Recovered cores are often logged (using a Munsell color chart and other logging aids), screened for volatile organic compounds (VOCs) using a PID, and sampled for laboratory analysis using disposable stainless steel spoons or other discrete sampling devices.

Each sampling configuration is associated with a unique set of sampling equipment requirements and techniques. The selected procedures and equipment are project-specific and should be discussed by the project team before arriving onsite. All types of soil sampling, regardless of the equipment used, share common handling and management procedures that are designed to ensure the integrity of the samples collected. These procedures include:

- The use of new, disposable or decontaminated sampling equipment
- The use and rotation of the appropriate PPE
- Selection of a suitable sampling location and staging area

Wear a clean pair of new, disposable gloves each time a different sample is collected and don the gloves immediately prior to collection. This limits the possibility of cross-contamination from accidental contact with gloves soiled during collection of the

previous sample. The gloves must not come in contact with the medium being sampled and must be changed any time during sample collection when their cleanliness is compromised. ***Gloved hands should not be used as a sampling device; always use the appropriate equipment to move the sample from the sampling device to the laboratory-supplied containers.*** If the soil cannot be transferred directly from the sampling device to the laboratory-supplied containers, use a stainless steel spoon or spatula to transfer the soil from the sampling device to the laboratory-supplied containers.

9.4.1 EQUIPMENT SELECTION

Collect all samples using either new, disposable equipment, such as polyethylene liners or single-use stainless steel spoons; or properly decontaminated sampling equipment, such as hand augers, split-spoon samplers, or trowels. Soil sampling equipment should be selected based on the analytical requirements of the project and the project-specific conditions likely to be encountered. The equipment should be constructed of non-reactive, non-leachable materials (e.g., stainless steel, Teflon®, Teflon®-coated steel, polyethylene, polypropylene) which are compatible with the chemical constituents at the site. When choosing sampling equipment, give consideration to:

- the types of soil or fill present
- the required depth of the sample
- the volume of sample required
- the analytes of interest

Select the types of equipment and decontamination procedures based on the types of sampling to be performed. Decontamination may require multiple steps or differing cleaning methods, depending on the sampling goals (see SOP 6 for decontamination procedures). In no case should disposable, single use materials (e.g., acetate liners, soil baskets) be used to collect more than one sample.

9.4.2 SAMPLING CONSIDERATIONS

In preparing for sampling, you should perform the following activities (with all observations and measurements noted in the field book):

- Perform a quick reconnaissance of the site to identify sampling locations and evaluate the accessibility (physical obstructions, slope, overhead and underground utilities) to the sampling location.
- Record the approximate ambient air temperature, precipitation, wind (direction and speed), tide, and other field conditions in the field book. In addition, any site-specific conditions or situations that could potentially affect the samples should be recorded.
- Record a description of the sampling location and the approximate distance to and direction from at least one permanent feature.
- Should any sample location require a vertical or horizontal offset from the proposed location, indicate the reason and record the actual sample location in the field book.

Survey the breathing zone around the sampling location with the appropriate air quality meter(s), as necessary (see HASP), to ensure that the level of PPE is appropriate. When sampling soil, it is important to find a suitable sampling location away from any sources of cross-contamination that could compromise the integrity of the samples. Consider the following:

- Position the sample collection area away from fuel-powered equipment, such as drill rigs or excavators, and upwind of other site activities (e.g., purging, sampling, decontamination) that could influence the sample. This is particularly important when screening samples in the field for VOCs with a PID, but should not be limited to the active sample collection.
- Store samples already collected from the field for laboratory analysis in clean containers in an ice-filled cooler (as required) and securely stage, if possible, in an uncontaminated area of the site.

9.5 SOIL SAMPLE COLLECTION

Soil samples can be collected from surface or subsurface depths, depending on the project requirements. Surface soils are generally those collected at depths less than 2 feet below ground surface (bgs) and can be collected using trowels, soil probes, shovels, or hand augers. Be aware that some states have specific definitions of what constitutes a surface soil sample. Subsurface soils are generally

deeper and require specialized equipment to recover the samples. In most cases, subsurface soils will be collected using a drill rig or excavator to prevent the soil from being mixed with soils from a shallower interval.

Push or drive the method-specific sampling equipment (e.g., trowel, hand auger, hollow corers, split-spoon, direct push sampler, rotosonic core barrel sampler, excavator bucket) into the soil to the desired sampling depth using decontaminated equipment. Record in the field book the depth interval through which the sampler was advanced and, when using a drilling rig and split-spoon sampler, the number of blows needed to drive the sampler 6 inches. If additional soil is needed to provide sufficient sample volume, repeat this step taking care to ensure that the same depth interval is collected during the resample. Use core catchers on the leading end of the sampler (if available) for soils that lack cohesiveness and are subject to falling out of the sampler (i.e., poor recovery).

Withdraw the sampling equipment from the interval, open the sampler (as appropriate), and collect the sample in a safe location (e.g., avoid entering an excavation by collecting the sample from an excavator bucket at ground surface). When collecting a sample from an excavator bucket, the sampler should watch the bucket as the excavated material is retrieved and collect the sample from the desired sampling material.

Recovered soils should be placed on plastic sheeting in a consistent manner such that the orientation of the sample (i.e., which end is "up") and the depth interval is readily apparent to the sampling personnel. Measure the length of the material recovered relative to the interval the sampler was advanced in percent notation (e.g., 75%) or as a fraction of the total length of the sample interval (i.e., [3/4] indicating 3 out of 4 feet) and record this information in the field book. If field screening for organic vapors is required, break or cut the soil core every 3 to 4 inches and quickly scan the breaks in the core material with the appropriate air quality monitoring equipment (e.g., PID) and record the readings and approximate depth in the field book. These measurements can be used to select appropriate soil samples for VOC or headspace analysis, if required (see procedures below).

9.5.1 UNDISTURBED SAMPLE COLLECTION

Undisturbed soil samples collected for geotechnical parameters (e.g., porosity, permeability) generally require the use of specialized undisturbed sampling equipment (e.g., Shelby tube or sealed Geoprobe® liner) and collection procedures. The sampling device, once retrieved, is typically capped or sealed (to maintain the sample in its relatively undisturbed state), labeled with the sample name, orientation of the sample (i.e., top and bottom), depth interval, and shipped to the appropriate geotechnical laboratory. Follow sample labeling, preparation, and shipping procedures in SOPs 3 and 4.

9.5.2 VOLATILE ORGANIC COMPOUND SAMPLING

Analytical soil samples for VOC analysis should be collected immediately after screening with the PID to avoid loss of constituents to the atmosphere. Transfer the soil from the portion of the soil core to be sampled (usually the area where the highest PID readings were observed) directly into the sample containers; do not homogenize soils for VOC analysis. Place the soil in the sampling container such that no headspace is present above the soil when the cover is placed on the jar. If U.S. Environmental Protection Agency Method 5035 (e.g., Encore® samplers) is required, follow manufacturer's specifications and company recommended shipping procedures. Collect quality assurance/quality control (QA/QC) samples, if appropriate, in accordance with SOP 4, the project-specific work plan, and the QAPP.

9.5.3 SOIL HEADSPACE ANALYSIS

Collect soil samples for field-based headspace analysis, if required as part of the project-specific work plan, after collecting the VOC sample. First, examine the soil and remove coarse gravel, organic material (e.g., roots, grass, and woody material) and any other debris. Transfer the soil from the portion of the soil core to be sampled and place in a heavy-duty zipper-style plastic bag and seal the bag. Label the sample indicating the sampling location, depth, and date. Shake the sample vigorously for approximately 15 seconds to disaggregate the sample and expose as much surface area of the soil as possible (to release the VOCs to the atmosphere within the bag). If necessary, warm the sample to room temperature (70º Fahrenheit, [ºF]) by placing the bag in a heated room or vehicle. This step is critical when the ambient temperature is below 32ºF.

The VOCs, if present, will volatilize into the sealed bag. Allow the bag to stand (to achieve equilibrium) for approximately 15 minutes. Carefully open the bag slightly and place the tip of the PID into the opening. Do not insert the tip of the probe into the soil material and avoid the uptake of water droplets. Allow the PID to equilibrate and record the highest PID measurement noted. Erratic PID responses may result from high organic vapor concentrations or elevated headspace moisture. If these conditions exist, qualify the headspace data in the field book. It is also important to record the ambient temperature, humidity, and whether moisture was present in plastic bag. Duplicate 10% of the headspace samples by collecting two samples from the same location. Generally, duplicate sample values should be consistent to ±20%. Samples collected for headspace screening cannot be retained for laboratory analysis.

9.5.4 SEMI- AND NON-VOLATILE ANALYTICAL SAMPLE COLLECTION

For metal sulfide analysis, sediment should be maintained in anoxic conditions to limit exposure to oxygen. Samples should be collected immediately and stored with zero headspace.

Collect remaining organic samples then inorganic samples in the following order of volatilization sensitivity:

- Extractable organics, petroleum hydrocarbons, aggregate organics, and oil and grease
- Metals
- Inorganic non-metallic and physical and aggregate properties
- Microbiological samples
- Radionuclides

If homogenization is required, mix the soils (using stainless steel bowls and spoons, or other appropriate equipment) to a homogeneous particle size and texture. Transfer the soils from the sampler or mixing bowl to the sample container using a decontaminated or dedicated stainless steel spoon or spatula. Collect QA/QC samples in accordance with SOP 4, the project-specific work plan, and the QAPP.

If approved by the appropriate regulatory agency and specified in the project-specific work plan, composite soil samples can be collected to minimize the total number of analytical samples. Composite samples consist of equal aliquots (same sample size) of soil from each location being sampled (e.g., from each borehole or from multiple areas of a soil pile), by mixing the soil to a homogeneous particle size and texture using new or decontaminated stainless steel bowls and a stainless steel spoon or trowel. Transfer the contents to the appropriate laboratory supplied sample container using a stainless steel spoon. Collect QA/QC samples in accordance with SOP 4, the project-specific work plan, and the QAPP, if required.

If necessary, conduct field tests or screening on soils in accordance with the project-specific work plan and manufacturer's specifications for field testing equipment.

9.5.5 SAMPLE LABELING AND PREPARATION FOR SHIPMENT

Once collected, prepare the soil samples for offsite laboratory analysis:

1. Clean the outside of the sample container with paper towels or appropriate materials, if necessary
2. Affix a sample tag or label to each sample container and complete all required information (sample number, date, time, depth interval, sampler's initials, analysis, preservatives, place of collection)
3. Place clear tape over the tag or label (if non-waterproof labels are used)
4. Preserve samples immediately after collection by placing them into an insulated cooler filled with bagged wet ice to maintain a temperature of approximately 4°Celcius (if required by analytical method)
5. Record the sample designation, date, time, depth interval, number of sampling containers, analytical methods, and the sampler's name in the field book and on the chain-of-custody form
6. Complete the chain-of-custody forms with appropriate sampling information, including:
   - Location
   - Sample name
   - Sample collection date and time

- Number of sample containers
- Analytical method

7 Complete sample packing and ship in accordance with proper procedures

Do not ship hazardous waste samples without first consulting a company compliance professional.

9.6 SOIL CLASSIFICATION

Soil classification should be performed whenever soil samples are being collected to provide context for the analysis. Unless required to follow a different soil classification (e.g., US Department of Agriculture), follow the Unified Soil Classification System (USCS) logging procedures as described in ATSM D2488[1] . The emphasis of soil classification in the field must be on describing the soils using ALL of the required descriptors; categorization of the USCS group name or symbol alone may not provide details about the soils that could later prove useful. Avoid geologic interpretation or the use of local formation names, which are often difficult to determine in the field without the regional framework. Record ALL of the following information for each sample interval/soil type in the field book:

- Depth interval
- USCS group name (e.g., lean clay, elastic silt, well-graded gravel)
- USCS group symbol (e.g., cl, mh, gw)
- Color, using Munsell chart (in moist condition)
- Percent of cobbles, boulders, gravel, sand, and fines (approximate; by volume). Use the following standard descriptors for the textural percentages:
- Trace: <5%[2]
- Few: 5-10%
- Little: 15-25%
- Some: 30-45%
- Mostly: 50-100%
- Particle-size range:
- Gravel—fine (0.2-inch to 0.75-inch), medium, coarse (0.75-inch to 3 inch)
- Sand—fine (0.003-inch to 0.02-inch), medium (0.02-inch to 0.08-inch), coarse (0.08-inch to 0.2-inch)
- Fines – clay or silt
- For gravel and sand:
- Particle angularity: angular, subangular, subrounded, rounded
- Particle shape: (if appropriate) flat, elongated, flat and elongated
- Maximum particle size or dimension
- Hardness (under hammer blow) of coarse sand and larger particles
- For fine-grained soil (i.e., clay and silt):
- Plasticity: non-plastic, low, medium, high
- Dry strength: none, low, medium, high, very high
- Dilatancy: none, slow, rapid
- Toughness: low, medium, high
- Odor (mention only if organic or unusual; factual descriptions only, no interpretations)
- Moisture: dry, moist, wet
- Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

For intact samples also include:

- Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
- Structure: stratified, laminated, fissured, lensed, homogeneous

[1] Note that certain states/regulatory programs may require soil classification under a secondary system (e.g., US Department of Agriculture) or the use of hydrochloric acid to test the reaction with soil (none, weak, strong).

[2] The use of "Trace" for describing the fraction of clay soils is inappropriate for field-based logs as clay contents of less than 20% in fine-grained soils cannot be reliably determined in the field.

- Cementation: weak, moderate, strong

Example descriptions, using the information listed above, would read as follows:

- 8-10' – Well Graded Sand, SW (5YR 2/6) fine- to medium-grained sand, trace medium sub-angular rounded gravel (less than 0.5-inch diameter); medium dense to dense; wet; moderate petroleum-like odor between 9 feet bgs and 10 feet bgs.
- 10-12' – Lean Clay with Gravel, CL (5YR 2/6) some fine- to coarse-grained angular to subangular gravels (less than 0.25-inch diameter), trace fine- to medium-grained rounded sands; very stiff; low plasticity; low dry strength; no dilatancy; moist; no odors.

9.7 CLOSING NOTES

Once sampling is completed, restore and mark all sample locations with spray paint, stakes, or other appropriate marker for future reference or survey, including collecting Global Positioning System coordinates and photographs, or survey in accordance with the project-specific work plan. Decontaminate all equipment prior to departure and properly manage all PPE and IDW in conformance with SOP 6, the project-specific work plan, and applicable regulations.

FIELD STANDARD OPERATING PROCEDURE #11

GROUNDWATER SAMPLING PROCEDURE

Groundwater sampling procedures outlined in this Standard Operating Procedure (SOP) are designed to ensure that collected samples are representative of current site conditions. These procedures can be applied to permanently or temporarily installed monitoring wells, direct-push sample points, water supply wells with installed plumbing, extraction wells for remedial groundwater treatment systems, and excavations where groundwater is present. The user is advised to read the entire SOP and review the site health and safety plan (HASP) and/or project safety plan (PSP) before beginning any onsite activities. In accordance with the HASP, proper personal protective equipment (PPE) must be selected and used appropriately.

11.1 ACRONYMS AND ABBREVIATIONS

ID	inside diameter
DI	deionized
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
DTW	depth-to-water
HASP	health and safety plan
IDW	investigation-derived waste
l/min	liters per minute
LNAPL	light non-aqueous phase liquid
mg/l	milligrams per liter
mV	millivolts
NAPL	non-aqueous phase liquid
NTU	nephelometric turbidity unit
ORP	oxygen reduction potential
PID	photoionization detector
PPE	personal protective equipment
PSP	project safety plan
QAPP	quality assurance project plan
SOP	standard operating procedure
SU	standard units
TD	total depth
TOC	top-of-casing
VOCs	volatile organic compounds

11.2 MATERIALS

- Field book
- PPE
- Air quality monitoring equipment (e.g., photoionization detector [PID]) with calibration reagents and standards, as needed
- Electronic water level indicator or interface probe
- Water quality meter(s) with a flow-through cell, and calibration reagents and standards, as needed
- Field test kits, as needed
- Adjustable wrench or manhole wrench, as needed
- Well key(s), as needed
- Power supply, as needed
- Sampling containers and labeling/shipping supplies
- Deionized (DI) water
- Container(s) for water storage (e.g., bucket, drum)
- Pump or bailers, tubing, and associated lanyard materials
- Filters, as needed
- Decontamination supplies

11.3 PRECONDITIONS AND BACKGROUND

This SOP has been prepared as part of the company's Environmental Quality Management Plan and is designed to provide detailed procedures for common field practices. Compliance with the methods presented in this document is mandatory for all field personnel and will ensure that the tasks are performed in a safe, consistent manner; are in accordance with federal and state guidance; and are technically defensible.

This SOP is written for the sole use of company employees and will be revised periodically to reflect updates to company policies, work practices, and the applicable state and/or federal guidance. Employees must verify that this document is the most recent version of the company SOPs. Employees are also strongly advised to review relevant state and/or federal guidance, which may stipulate program-specific procedures, in advance of task implementation.

WSP requires that all personnel performing specific project assignments be appropriately qualified, including having required certifications or licenses, and properly trained in accordance with the requirements of their assignment, the Environmental Service Line's field SOPs, and the Quality Management System.

This SOP is designed to provide the user with a general outline for conducting groundwater sampling and assumes the user is familiar with basic field procedures, such as recording field notes (SOP 1), utility location (SOP 2), sample shipment procedures (SOP 3), sample collection and quality assurance procedures (SOP 4), investigation derived waste (IDW) management procedures (SOP 5), equipment decontamination (SOP 6), and use and calibration of all sampling and monitoring equipment (SOPs 7 and 8). This SOP does not cover investigation planning, nor does it cover the analysis of the analytical results. These topics are more appropriately addressed in a project-specific work plan. Before groundwater sampling, be sure to review the project-specific work plan or quality assurance project plan (QAPP) and any applicable state and federal guidelines or sampling procedures. All sampling and monitoring references must be available for consultation in the field, including:

- Company SOPs
- Applicable state and federal guidelines or sampling procedures
- Manufacturer's manuals
- Project-specific work plan, PSP and/or HASP, and QAPP

11.4 GENERAL PROCEDURES

Although the techniques used to sample groundwater are varied, most sampling events can be broken down into a three-step sequence:

1. Gauging: The measurement of the water column height (i.e., total well depth less depth-to-water) within the well.

2 Purging: The removal of stagnant water from the well bore to ensure that samples collected are representative of groundwater conditions in the water-bearing zone surrounding the well.
3 Sample Collection: After purging, the collection of aliquots of groundwater in method-specific, preserved (as needed) containers.

The procedures and equipment that are used to accomplish these steps are project-specific and should be discussed by the project team before arriving onsite. All types of groundwater sampling, however, regardless of the equipment used, share common handling and management procedures that are designed to ensure the integrity of the samples collected. These procedures include:

- The use of new, disposable, decontaminated, or dedicated sampling equipment
- The use and rotation of the appropriate PPE
- Selection of a suitable sampling location and staging area

Wear a clean pair of new, disposable gloves each time a different sample is collected and don the gloves immediately prior to collection. This limits the possibility of cross-contamination from accidental contact with gloves soiled during collection of the previous sample. The gloves must not contact the medium being sampled and must be changed any time during sample collection when their cleanliness is compromised. ***Gloved hands should not be used as a sampling device; always use the appropriate equipment to move the sample from the sampling device to the laboratory-supplied containers.***

11.5 EQUIPMENT SELECTION

Collect all samples using either new, disposable equipment or properly decontaminated sampling equipment. Groundwater purging and sampling equipment should be selected based on the analytical requirements of the project and the project-specific conditions (e.g., well diameter, depth to water, dissolved constituents, etc.) likely to be encountered. The equipment should be constructed of non-reactive, non-leachable materials (e.g., stainless steel, Teflon®, Teflon®-coated steel, polyethylene, polypropylene, etc.) that are compatible with the chemical constituents at the site. Note that project or regulatory guidance may limit the type of equipment for groundwater sampling.

Consider the following when choosing groundwater purging and sampling equipment:

- the diameter and depth of the well
- the depth to groundwater
- the volume of water to be withdrawn
- the sampling and purging technique
- the volume of sample required
- the analytes of interest

Select the decontamination procedures based on the types of sampling to be performed and media encountered; decontamination may require multiple steps or differing cleaning methods (see SOP 6 for decontamination procedures). In no case, should disposable, single-use materials be used to collect more than one sample.

11.6 PRE-SAMPLING CONSIDERATIONS

You should perform the following activities in preparing for sampling with all observations and measurements noted in the field book and on the project-specific groundwater monitoring log, if appropriate:

- Perform a quick reconnaissance of the site to identify sampling locations and evaluate the accessibility to the sampling location.
- Record the approximate ambient air temperature, precipitation, wind (direction and speed), tide, and other field conditions. In addition, any site-specific conditions or situations that could potentially affect the samples at the sample locations should be recorded.
- Record temporary sampling locations with respect to approximate distance to and direction from at least one permanent feature.
- Survey the breathing zone around the sampling location with the appropriate air quality meter(s), as necessary (see HASP), to ensure that the level of PPE is appropriate.
- Install the pump, tubing, passive sampler or other appropriate sampling equipment to the depth prescribed in the project-specific work plan or QAPP.

- Containerize and manage purge water in accordance with the project-specific work plan.

It is important to minimize any sources of cross-contamination that could compromise the integrity of the groundwater samples. Consider the following:

- Position fuel-powered equipment away from the sample collection area, such as drill rigs or excavators, and upwind of other site activities (e.g., purging, sampling, decontamination) that could influence the sample. This is particularly important when screening samples in the field for volatile organic compounds with a PID but should not be limited to the active sample collection.
- Establish a secure sample staging area in an uncontaminated area of the site.

11.7 GAUGING PROCEDURES

All wells should be opened to the atmosphere in advance of sampling to allow any pressure differentials, which could artificially raise or depress the water column in the well, to dissipate. The wells should be inspected to ensure that the protective casing is intact and has not been damaged. Remove the well covers and all standing water around the top of the well casing (for flush mounted-protective covers), as necessary, before opening the inner well cap or plug. Unlock and carefully remove well cap and allow the well to stand undisturbed for a minimum of 15 minutes, or as required by the project-specific work plan, before conducting any down-hole testing or measurements. If required by the HASP, survey the open well casing and the breathing zone around the wellhead with a PID to ensure that the level of PPE is appropriate.

11.7.1 GROUNDWATER LEVEL AND TOTAL DEPTH MEASUREMENT PROCEDURES

Depth to water (DTW) and total depth (TD) measurements are collected prior to sampling and are used to determine the volume water to be purged from the well (if using techniques other than no-purge or low flow sampling). The DTW measurements are also used after the field event to establish the groundwater elevation, flow direction, and gradient. Unless otherwise directed, do not place any objects inside the casing of private water wells; accordingly, DTW and TD measurements should not be collected at private water wells. Measurements of TD are not required for low flow and no-purge sampling applications and should not be measured before sampling the well.

Water level measurements must be collected within the shortest interval possible from all the wells to be gauged during the event before beginning any purge and sampling procedures at the site. This will ensure a nearly instantaneous snapshot of the water levels before the formations are disturbed by pumping or acted upon by other outside influences, such as tides, precipitation, barometric pressure, river stage, or intermittent pumping of production, irrigation, or supply wells.

Record the following observations and measurements (and the time when they were collected) in the field book:

- Measure the casing inside diameter (ID) and record in inches
- Measure the DTW with an electronic water level indicator (or an interface meter, if non-aqueous phase liquid [NAPL] is potentially present – see procedures below) from the top-of-casing (TOC) at the surveyor's mark, if present, and record the depth (to the nearest 0.01 foot) in feet below TOC
- If no mark is present, measure from the north side of the casing and mark the measuring point with a knife, metal file (if the inner casing is metal) or indelible marker for future reference
- Measure the TD from TOC at the surveyor's mark or north side of the casing, as appropriate.

Measuring the depth of deep wells with long water columns can be problematic due to tape buoyancy and weight effects or sediment in the bottom of the well casing. Care must be taken, and proper equipment selection must be used in these situations to ensure accurate measurements. Multiple TD measurements in silt-laden wells can provide a more precise assessment of the bottom depth.

11.7.2 GAUGING WELLS WITH NON-AQUEOUS PHASE LIQUID

If NAPL is potentially present at the site, the DTW and NAPL thickness measurements are collected using an interface meter capable of distinguishing between the NAPL and the groundwater, or a weighted tape coated with the appropriate reactive indicator paste for the suspected NAPL. Measuring NAPL thicknesses must be done with care to avoid agitating the liquids and generating an emulsion. This is particularly the case for light NAPL (LNAPL; those having a density less than water), which are typically viscous oils that

cling to the probe. Oil coating the probe can result in thickness measurements that are biased high (i.e., overestimate the thickness of the NAPL).

Conduct the following procedures to ensure an accurate measurement of the NAPL thickness:

- For LNAPL, slowly lower the electronic interface probe in the well casing until the electronic tone indicates the probe is at the top of the LNAPL layer; measure the depth below the TOC to the nearest 0.01 foot.
- To gauge the NAPL thickness, advance the probe slowly through the layer until the electronic tone indicates top of the water column and then slowly bring the probe back up to the bottom of the LNAPL. Repeat this process several times to ensure an accurate measurement of the bottom of the LNAPL layer (which can include bubbles and an emulsion layer).
- For dense NAPL (DNAPL), advance the probe through the water column until the tone indicates the top of the DNAPL layer; record the depth below TOC.
- To gauge the DNAPL thickness, advance the probe through the layer to the bottom of the well.

11.8 GROUNDWATER PURGING PROCEDURES

Purging is a process whereby potentially stagnant water is removed allowing the collection of samples that are representative of groundwater conditions in the water-bearing zone. The water in a well bore that has not been purged may be different than the surrounding formation due to exposure to ambient air. There are several purging (and no-purge) methods that may be used, depending on specific conditions encountered (e.g., DTW, hydraulic conductivity of the formation, etc.) and the sampling requirements. The purge/no purge options are described below.

- *Multiple Volume Purge:* Traditional well purging technique that relies on the withdrawal of the volume of the well bore and the surrounding filter pack (if present); three to five well volumes are typically removed using pumps or bailers. This methodology relies on equipment that is easy to obtain and use and is generally accepted in most states as an appropriate purging method.
- *Temporary Well Purge:* A variation of the multiple volume purge technique that often uses inertia lift pumps, peristaltic pumps, or bailers to remove water from a temporary well or discrete groundwater sampler (e.g., a groundwater profiler or direct-push screen point sampler). This is a less stringent technique that is typically done to minimize the turbidity of the samples, which can be high due to the lack of a well filter pack.
- *Private Water Well or In-Place Plumbing Purge:* A variation on the multiple volume purge technique whereby a tap or faucet is opened on a fixed water supply pipe and is allowed to remain open until the potentially stagnant water within the well casing and other components of the system (e.g., fixed piping, pressure tanks, etc.) has been removed and groundwater representative of the water-bearing zone is discharged at the tap.
- *Low Flow (Minimal Drawdown/Low Stress) Purge (and Sampling):* A modified purging technique that establishes an isolated, discrete, horizontal flow zone directly adjacent to the pump intake; this method requires the pump to be placed within a screened-interval or open borehole. Pumping rates are typically 0.1 to 0.5 liters per minute (l/min) or less to minimize the stress on the surrounding formation and reduce the geochemical alteration of the groundwater caused by pumping.
- *No-Purge/Passive Sampling Techniques:* These techniques use specialized equipment, such as trap-style samplers or permeable diffusion bags, to sample the undisturbed water column within a screened interval or open borehole. This methodology assumes that the water in the well is representative of the surrounding formation. This approach is well suited for some volatile organic compounds (VOCs), metals, and hydrophobic compounds, depending on the sampling device used.

11.8.1 CALCULATING ONE PURGE VOLUME

Multiple volume purging techniques require that a ***minimum*** of three well volumes of water must be removed before sample collection. The actual amount of water removed may be greater than the three volumes, depending on geochemical parameter stabilization (the field measurement of these parameters is discussed below).

Calculate the volume of water in a well or boring using the following equation:

$$\textbf{Volume (gallons)} = (\textbf{TD} - \textbf{DTW}) \times \textbf{ID}^2 \times \textbf{0.041}$$

where:

TD = total depth (feet)

DTW = depth to water (feet)

ID = inner diameter (inches)

Alternately, the volume of water in a well or boring may also be calculated by multiplying the water column height by the gallons per foot of water for the appropriate well or boring diameter:

ID	Gallons per foot of water	Gallons per three water columns
1-inch	0.04	0.12
2-inch	0.16	0.48
3-inch	0.37	1.11
4-inch	0.65	1.98

Calculate the total volume of the pump, associated tubing and container for in situ measurements (flow-through cell), using the following equation:

Volume (in gallons) = P + ((0.0041)*D2*L) + fc

where:

P = volume of pump (gallons)
D = tubing diameter (inches)
L = length of tubing (feet)
fc = volume of flow-through cell (gallons)

11.8.2 MULTIPLE VOLUME PURGE PROCEDURES

Begin purging at a rate that will not cause excessive turbulence and drawdown in the well; commonly less than 1 gallon per minute for a typical 2-inch diameter monitoring well. You may need to observe the water elevation after the pump is started and adjust the flow rate to minimize the amount of drawdown in the well casing. The objective is to remove the stagnant water in the casing and surrounding filter pack or open borehole allowing water from the surrounding water-bearing zone to enter the well for sampling with as little disturbance as possible. Excessive pump rates or well dewatering can result in higher turbidity, potential volatilization, and geochemical alteration of dissolved parameters.

Typically collect geochemical parameters (i.e., pH, specific conductance, dissolved oxygen [DO], oxygen-reduction potential [ORP], and temperature) at a minimum frequency of once for every well volume of water removed during the purge process. Record the measurements in the field book along with any other pertinent details, such as the visual quality of the water (e.g., color, odor, and presence of suspended particulates) and the approximate withdrawal rate (this can be estimated using a calibrated container and stopwatch). Review the geochemical measurements to ensure that readings have stabilized (after the minimum purge volume has been achieved). This is a proxy for determining that you are purging formation water rather than potentially stagnant water in the casing. Stabilization occurs when at least three consecutive measurements are within the following tolerances:

Multiple Volume Purge Stabilization Parameters	
pH	± 0.1 standard units (SU)
Specific Conductance	± 3%
Temperature	± 3%
Dissolved Oxygen (DO)	± 0.2 milligrams per liter (mg/l) or 10% (flow-through cell only)
Turbidity	± 10% for values greater than 10 nephelometric turbidity units (NTU)
Oxygen Reduction Potential (ORP)	± 10 millivolts (mV; flow-through cell only)

Parameter stabilization that does not occur within five well volumes may require you consult your project manager to decide whether to collect a sample or to continue purging. Wells with extremely slow recharge may also be problematic. Purging these wells, in some cases, may result in dewatering the well before the minimum purge can be completed. Allow wells or borings purged dry to recharge to a level of approximately 90% of the static (pre-purge) water elevation and proceed immediately to sample collection. If recovery exceeds 2 hours, sample as soon as sufficient sample volume is available, in accordance with applicable regulations.

11.8.3 LOW FLOW PURGE PROCEDURES

Low flow purging and sampling is used to obtain representative groundwater samples without removing all the water within the well. The protocol uses relatively low pumping rates (i.e., less than 0.5 l/min) to establish an isolated zone around the inlet of the pump where flow is horizontal (i.e., from the water bearing zone) rather than from the stagnant water in the well casing above and below the pump. Selection of an appropriate pump is critical to establishing the flow zone: it must be well suited for both low pumping rates and the analytes being sampled. Bailers are not appropriate for low flow sampling.

The set-up for low flow sampling includes positioning the pump at the appropriate depth within the casing such that the pump inlet is within the screened section of the well. Slowly lower the pump, where appropriate, and tubing into the water column to avoid agitating the water column; use of a lanyard is recommended (i.e., do not use the extraction tubing to lift or lower the pump). Secure the pump and/or tubing at the wellhead once the specified sampling depth has been achieved and record the depth in the field book. Avoid contacting the bottom of the well by using pre-cut tubing at the appropriate length or by lowering the pump/tubing simultaneously with an electronic water level indicator. Once the pump/tubing has been inserted and secured, allow the water levels to return to static conditions before initiating the purge.

The discharge tubing must be connected to an in-line flow-through cell equipped with a multi-parameter real-time water quality meter. The flow-through cell minimizes the exposure of the groundwater to ambient air, which can influence DO and ORP measurements.

Start the pump and maintain a steady flow rate that results in a stabilized water level (less than 0.3 feet of drawdown or as specified in the project-specific work plan). The pumping rate may need to be adjusted depending on the response of the water levels in the well. Record each adjustment made to the pumping rate and the water level measured immediately after each adjustment. Purging should not exceed 0.5 l/min.

During purging, monitor and record the flow rate and geochemical parameters at 30 seconds to 5-minute intervals (depending on the hydraulic conductivity of the aquifer, diameter of the well, and pumping rate). Stabilization occurs once the following criteria have been met over three successive measurements made at least three minutes apart:

Low Flow Purge Stabilization Parameters	
Water Level Drawdown	<0.3 feet
pH	± 0.1 SU
Specific Conductance	± 3%
Temperature	± 3%
DO	± 0.2 mg/l or 10% (flow-through cell only)
Turbidity	± 10% for values greater than 10 NTU
ORP	± 10 mV (flow-through cell only)

Record any other notable observations in the field book (e.g., groundwater color).

11.8.4 NO-PURGE SAMPLING TECHNIQUES

Several alternate sampling devices are available, such as equilibrated grab samplers, passive diffusion samplers, and other in situ sampling devices, that will allow sample collection without purging the well. These devices may be particularly useful for sampling low permeability geologic materials, assuming the device is made of materials compatible with the analytical parameters, meets data quality objectives, and has been properly evaluated.

No-purge grab or trap samplers are placed in the well before sampling and typically remain closed (i.e., no water is allowed into the sampler during insertion) until the sampler is activated. This allows the sampler device to equilibrate with the surrounding groundwater (to prevent adsorption to the sampler materials) and for the groundwater to recover and re-establish the natural flow after the disturbance caused by the sampler insertion into the well. Typical equilibration times depend on the well recovery rates and the type of sampler used. Samples recovered using the no-purge devices are either transferred to containers at the well head or the sampler itself is shipped to the laboratory for analysis. Examples of equilibrated grab samplers include HydraSleeve™, Snap Sampler™, and Kemmerer samplers.

Equilibration time for diffusion samplers are generally dictated by the diffusion rate through the permeable membrane and, thus, are less sensitive to changes induced within the well during deployment. Most diffusion bag samplers have a minimum equilibration time of 14 days prior to sample collection. The samplers may be deployed for an extended period (e.g., three months or longer), although the continuous exchange between the sampler and the well water means that the sampler will likely reflect only the conditions in the few days preceding the sample collection.

11.8.5 TEMPORARY WELL PURGE PROCEDURES

Procedures used to purge temporary groundwater monitoring wells differ from permanent wells because temporary wells are installed for immediate sample acquisition. Wells of this type may include open bedrock boreholes, standard polyvinyl chloride well screen and riser placed in open boreholes, or drilling rod-based sampling devices (e.g., Wellpoint®, Geoprobe® screen point or Hydropunch® samplers). Purging temporary wells of this type may not be necessary because stagnant water is typically not present. However, if water is used in the drilling process, purging would be necessary. Purging can minimize the turbidity in the sample, which can be significant due to the disturbance caused by the sampler installation and to rinse the sampling system with groundwater. The exception is for groundwater profiling applications (e.g., using a Waterloo Profiler®) where a more rigorous purge is used (using the multiple volume purge techniques described above) to limit the potential for cross-contamination between sample intervals.

11.8.6 PRIVATE WATER WELL OR IN-PLACE PLUMBING PURGE PROCEDURES

The configuration and construction of private water wells varies widely and access points for obtaining groundwater samples may be limited. WSP personnel should coordinate with the property owner or site representative to access functioning ports and valves to avoid causing any inadvertent damage.

Collect the groundwater sample as close to the well as possible (e.g., from a sample port at the well head) to ensure the sample is representative. Ideally, the sample should be collected upstream of the piping and treatment equipment (e.g., particulate filter, water softener, carbon filters, ultra-violet lights), heating unit, or storage tanks. The following potential sampling locations are presented in order of preference:

- Sampling port or spigot near the well head or piping system prior to entry into the storage tank
- Sampling port or spigot at storage tank
- Sampling port or spigot downstream of the pressure tank or holding tank but upstream of any water treatment equipment
- Tap or faucet

If purging from a tap or faucet, try to remove any aerators, filters, or other devices from the tap before purging and work with the property owner or site representative to bypass any water treatment systems. Document where the sample was collected and any steps that were taken to minimize the potential alteration of the water sample in the field book.

Purge the system by opening the tap or spigot and allowing the water to run for several minutes. Observe and record the purge rate for the system. The minimum purge volume must be more than the combined volume of the pump, tanks, piping, etc. Review the geochemical measurements (after the minimum purge volume has been removed) to ensure that readings have stabilized using the same procedures as those used for the multiple volume purge detailed above. Purge the system for a minimum of 15 minutes if the minimum volume is unknown. Sample only after the geochemistry parameters have stabilized and no there are no suspended particles (e.g., iron or rust) visible. Record the final purge volume in the field book and any water quality observations.

11.9 GROUNDWATER SAMPLE COLLECTION PROCEDURES

Collect groundwater samples as soon as possible after the geochemical parameters indicate representative groundwater is present. As practically possible, reduce the pump flow rate, but maintain a flow rate high enough to deliver a smooth stream of water without splashing or undue agitation. Collect samples directly from the tubing as it exits the well bore; do not sample on the downstream side of flow-through cells or any other instrumentation. If using a bailer for sample collection, lower and raise the bailer slowly and smoothly to minimize the disturbance to the water within the well.

Collect groundwater samples in order of volatilization sensitivity with organic compounds sampled first followed by inorganic compounds:

- VOCs
- Extractable organics, petroleum hydrocarbons, aggregate organics, and oil and grease
- Per- and Polyfluoroalkyl substances
- Total metals
- Dissolved metals (see filtering procedures below)
- Inorganic non-metallic and physical and aggregate properties
- Microbiological samples
- Radionuclides

Collect quality assurance/quality control samples in accordance with SOP 4 and the project-specific work plan or QAPP.

As necessary, conduct field tests or screening in accordance with the project-specific work plan and manufacturer's specifications for field testing equipment. Field samples must be directly transferred from the sampling equipment to the container that has been specifically prepared for that given parameter; intermediate containers should be avoided. If field chemical preservation is required, check the pH preservation by pouring a small portion of sample onto a pH test strip Adjust pH with additional preservative, if necessary.

Record the sample depth interval, if applicable, in the field book. Note the volume, phases, odor, and color of the groundwater.

11.9.1 GROUNDWATER FILTRATION PROCEDURES

Filtered groundwater samples are sometimes used for field kit analyses and should only be collected for laboratory analysis after approval from the appropriate regulatory agency or project manager. The filtered samples can be collected by attaching the in-line filter directly to the outlet tubing for a pressurized bailer, a submersible pump or a peristaltic pump. Intermediate containers can be used with a peristaltic pump if the well is too deep to use the pump to recover the sample directly. The intermediate container should be unpreserved laboratory-supplied glassware to avoid any cross-contamination during the filtering process.

Filtered samples using pumps should use the following procedures:

- Use a variable speed peristaltic pump with the in-line filter fitted on the outlet end of the tubing and the pump inlet tubing into the intermediate container holding the unpreserved groundwater sample; or,
- If a submersible pump is used to collect the groundwater sample, attached the in-line filter to the outlet end of the tubing (do not allow the groundwater to pass through flow-through cells or any other instrumentation while sampling)

Once the filter is connected:

- Turn on the pump and maintain a flow rate high enough to deliver a smooth stream of water without splashing or undue agitation. Hold the filter upright with the inlet and outlet in the vertical position and pump groundwater through the filter until all atmospheric oxygen has been removed and the minimum volume of water has been flushed through the filter, in accordance with the manufacturer's specifications
- Collect the filtered samples by placing the filtered output directly into the sample container
- If sediment is visible in the sample container after filtration, filter break-through has occurred and the sampling and filtering process should be repeated
- Discard the tubing and filter appropriately

Record sample filtration in the field book.

11.9.2 NON-AQUEOUS PHASE LIQUID SAMPLING PROCEDURES

Non-aqueous phase liquid is typically sampled to identify the compound, usually through an analytical "fingerprint" analysis. If samples are to be collected, the sampling options and techniques should be discussed with the assigned WSP compliance professional and project manager to ensure that the NAPL is either not considered to be a hazardous material for shipping to the laboratory or is properly shipped by qualified personnel using appropriate shipping containers (SOP 3). Samples of NAPL should be collected using the same procedures as above and placed in the appropriate laboratory-supplied containers, packed on ice, and shipped to the analytical laboratory using procedures outlined in SOP 3.

11.9.3 SAMPLE LABELING AND PREPARATION FOR SHIPMENT

Groundwater samples for offsite laboratory analysis should be prepared as follows:

1. Clean the outside of the sample container, if necessary
2. Affix a sample tag or label to each sample container and complete all required information (sample number, date, time, sampler's initials, analysis, preservatives, place of collection)
3. Place clear tape over the tag or label (if non-waterproof labels are used), as needed
4. If needed, preserve samples immediately after collection by placing them into an insulated cooler filled with bagged wet ice to maintain a temperature of approximately 4°Celcius
5. Record the sample designation, date, time, and the sampler's initials in the field book and on a sample tracking form, if appropriate
6. Complete the chain-of-custody forms with appropriate sampling information, including:
   - location
   - sample name
   - sample collection date and time
   - number of sample containers

- analytical method
- field filtration status

7 Secure the sample packing and shipping in accordance with proper procedures

Do not ship hazardous waste samples without first consulting a WSP compliance professional.

11.10 CLOSING NOTES

Secure and restore the site once sampling is completed. This may include locking permanent monitoring wells, staging the IDW, and disposing of (in conformance with applicable regulations) sampling expendables, such as plastic sheeting, tubing, and PPE. All locations where temporary wells or other sampling devices (e.g., profilers or direct-push equipment) should be marked with spray paint, stakes, or other appropriate method for future reference or survey, including collecting Global Positioning System coordinates and photographs, in accordance with the project-specific work plan. Decontaminate all equipment prior to departure and properly manage all PPE and investigation-derived wastes in conformance with SOP 6, the project-specific work plan, and applicable regulations.

FIELD STANDARD OPERATING PROCEDURE #15

SOIL VAPOR SAMPLING PROCEDURES

Soil vapor sampling involves the collection of samples from the vadose zone and may be conducted within or outside a building footprint. The procedures outlined in this Standard Operating Procedure (SOP) are designed to ensure that soil vapor samples are representative and have not been altered or contaminated by the sampling and handling methods. Soil vapor sampling is generally conducted to assess the presence of volatile organic compounds (VOCs) in the vadose zone, but, in special cases, may also include semivolatile organic compounds, such as naphthalene, elemental metals, such as mercury, or other organic compounds, such as polychlorinated biphenyls. The user is advised to read the entire SOP and review the site health and safety plan (HASP) and/or project safety plan (PSP) before beginning any onsite activities. In accordance with the HASP or PSP, proper personal protective equipment (PPE) must be selected and used appropriately.

15.1 ACRONYMS AND ABBREVIATIONS

IDW	investigation derived waste
HASP	health and safety plan
PID	photoionization detector
PPE	personal protective equipment
PSP	project safety plan
QAPP	quality assurance project plan
SOP	standard operating procedure
VI	vapor intrusion
VOCs	volatile organic compounds

15.2 MATERIALS

- Field book
- PPE
- Air quality monitoring equipment (e.g., photoionization detector [PID]) with calibration reagents and standards, as needed
- Camera
- Portable weather station, as needed
- Sampling containers and labeling/shipping supplies
- Sample point installation materials:
  - Soil vapor point assembly
  - Teflon®, Teflon®-lined, or stainless steel tubing
  - Tube fittings (e.g. Swagelok®, Qwik-Lok®)
  - Sand pack material as specified in the project-specific work plan or regulatory guidance
  - Non-volatile sealant material (e.g., hydrated bentonite chips, granular bentonite, or bentonite slurry)
  - Permanent cover assembly, if necessary
  - Potable water
- Leak testing materials, as needed:
  - Tracer compound detector (e.g., helium gas detector)
  - Tracer compound gas (e.g., helium)
  - Shroud (e.g., 5-gallon bucket or stainless steel dome)

  - Shroud sealant material (e.g., bentonite pellets or modeling clay)
  - Tedlar® bags (to capture purged soil gas), as required
- Tubing (e.g., Teflon®, Tygon®)
- Air purging pump or vapor syringe, as needed
- Adjustable wrenches, as needed
- Air sampling pump, as needed
- Inline flow meter , as needed

15.3 PRECONDITIONS AND BACKGROUND

This SOP has been prepared as part of the company's Environmental Quality Management Plan and is designed to provide detailed procedures for common field practices. Compliance with the methods presented in this document is mandatory for all field personnel and will ensure that the tasks are performed in a safe and consistent manner, are in accordance with federal and state guidance, and are technically defensible.

This SOP is written for the sole use of company employees and will be revised periodically to reflect updates to company policies, work practices, and the applicable state and/or federal guidance. Employees must verify that this document is the most recent version of the company's SOP. Employees are also strongly advised to review relevant state and/or federal guidance, which may stipulate program-specific procedures, in advance of task implementation.

WSP requires that all personnel performing specific project assignments be appropriately qualified, including having required certifications or licenses, and properly trained in accordance with the requirements of their assignment, the Environmental Service Line's field SOPs, and the Quality Management System.

This SOP is designed to provide the user with a general outline for conducting soil vapor sampling activities and assumes the user is familiar with basic field procedures, such as recording field notes (SOP 1), utility location (SOP 2), sample shipment procedures (SOP 3), sample collection and quality assurance procedures (SOP 4), investigation derived waste (IDW) management procedures (SOP 5), equipment decontamination (SOP 6), and the use and calibration of soil vapor sampling and monitoring equipment (SOP 7). This SOP does not cover other air or vapor sampling activities, such as air sampling (SOP 13) or sub-slab vapor sampling (SOP 14). Additionally, this SOP does not cover investigation planning, nor does it cover the analysis of the analytical results. These topics require a significant amount of planning and are more appropriately addressed in a project-specific work plan. Before implementing the soil vapor sampling, be sure to review the project-specific work plan or Quality Assurance Project Plan (QAPP) and any applicable state and federal guidelines or sampling procedures.

All sampling and monitoring references must be available for consultation in the field, including:

- Company SOPs
- Applicable state and federal guidelines or sampling procedures
- Manufacturer's manuals
- Project-specific work plan, PSP and/or HASP, and QAPP

15.4 GENERAL PROCEDURES

Soil vapor can be affected by temporal, structural, and meteorological factors. The user should also be aware that a number of regulatory agencies have specific guidelines as to timing or the sequence of the sampling activities, particularly if performed as part of a vapor intrusion (VI) investigation.

Although the specific procedures used to sample soil vapor vary between investigations, most sampling can be broken down into a five-step sequence:

1. Inspection (if sampling is performed within a building footprint): a detailed survey of the subject building, including an evaluation of all materials used or stored in the structure that could potentially interfere with the sample collection
2. Sample Point Installation: installing the soil vapor point in the vadose zone.

3 Leak Testing: testing the integrity of the soil vapor sample point (if required).
4 Purging: removing any non-representative vapor from the soil vapor sample point.
5 Sample Collection: collecting samples over a specified period (typically grab, 1-hour, or 8-hour), using a laboratory-supplied container, such as an evacuated sample canister with the appropriate regulator, or a Tedlar® bag with an air sampling pump.

Information regarding weather conditions, including temperature, barometric pressure, wind speed and direction, and precipitation, should be noted and recorded in the field notebook during all steps. A portable weather station is often required for documenting the weather conditions. Consult the project-specific work plan and applicable regulatory guidance to determine if fixed weather monitoring during the sample collection is required.

The project team should discuss the project-specific sampling procedures and equipment in advance of site mobilization. While the investigation is underway, the project team should avoid other environmental activities which may release volatile vapors into the investigation area, including soil sampling, excavation, and groundwater monitoring.

To ensure the integrity of the samples collected, the following common procedures shall be employed:

- The use of new, disposable or decontaminated sampling equipment
- The use, changing, and disposal of the appropriate PPE
- Selection of a suitable sampling location and staging area

Wear a clean pair of new, disposable gloves each time a different sample is collected and don the gloves immediately prior to collection. This limits the possibility of cross-contamination from accidental contact with gloves soiled during collection of the previous sample. The gloves must not contact the medium being sampled and must be changed any time during sample collection when their cleanliness is compromised.

15.4.1 PRE-SAMPLING CONSIDERATIONS

In preparing for sampling, you should perform the following activities (with all observations and measurements noted in the field book):

- Perform a quick reconnaissance of the site to identify sampling locations.
- Record the approximate ambient air temperature, precipitation, wind (direction and speed), tide, and other field conditions in the field book. Any site-specific conditions or situations that could potentially affect the samples at the sample locations should also be recorded.
- Record sampling locations with respect to approximate distance to and direction from at least one permanent feature. Survey the breathing zone around the sampling location with a PID, as necessary (see HASP), to ensure that the level of PPE is appropriate.
- Establish a secure sample staging area in an uncontaminated area of the site. All construction materials must be selected in accordance with the project-specific work plan and relevant regulatory guidance.

15.5 BUILDING INSPECTION AND MATERIALS SURVEY

If soil vapor sampling is performed within a building footprint, a building inspection and materials inventory may be required as a prerequisite activity. The scope of this activity, including completion of an inspection questionnaire (with a building representative, if possible), shall be performed in accordance with the project-specific work plan and applicable regulatory guidance. Before embarking on the inspection, confirm that there are no access limitations for the inspection, sampling activities, or photography.

Components of a typical building walkthrough and survey include:

- Identification of potential background sources of volatile compounds, such as vapor releases from neighboring properties, or materials stored within the building, such as paint, fuels, solvents, cleaners, etc. Some states may require scanning of the potential background sources with an appropriately-sensitive PID.
- Review of current and historical building operations and chemical use.
- Assessment of the building construction and condition (e.g., whether or not a basement is present, poured or block foundation, concrete slab present, air flow, etc.).
- Identifying areas of potential VI into a building (e.g., cracks in the concrete slab or walls, pipe penetrations, sumps, etc.).

- Inspection and photographic documentation, if necessary, of proposed sample locations.
- Identification of building pressure/ventilation system location and specifications.

At the conclusion of the building inspection and survey, discuss the sampling procedures with building occupants and prepare the structure for the soil vapor sampling in accordance with the project-specific work plan. Building preparations typically include requesting that the building occupants close windows, and remove sources of background VOCs (e.g., paint, fuels, solvents, household cleaners, beauty items), and that they refrain from smoking in the investigation area during sampling activities.

15.6 SOIL VAPOR POINT INSTALLATION

Ensure each proposed soil vapor boring location is clear of potential hazards, including utilities prior to breaking the ground surface (see SOP 2). Advance the soil vapor boring from the ground surface to the target depth using decontaminated drilling equipment; typically a direct-push drill rig such as a Geoprobe®, or equivalent, equipped with 1.25-inch inside diameter drilling rods and an expendable point is used to install the soil vapor boring. Record the actual depth interval in the field book once the drilling has been completed. Insert the soil vapor sampling point, which typically consists of Teflon® or Teflon®-lined tubing attached to a polyethylene or stainless steel soil gas implant, through the hollow drill string and screwed into the top of the expendable point. Retract the rods, leaving the implant with the expendable point in the bottom of the borehole and tubing leading to the surface. As detailed in the project-specific work plan, install a clean sand filter pack in the annular space around the screened interval to a minimum depth of approximately 6 inches above the top of the screen (i.e., 1-foot deep total) and place a hydrated bentonite seal (e.g., bentonite chips, granular bentonite, or bentonite slurry) to the ground surface. Attach the appropriate fittings (e.g., a 3-way valve) and additional tubing, if appropriate. Ensure that the tubing is clamped or otherwise closed off to avoid discharging vapor to the air.

Soil vapor sampling must not be performed until the subsurface equilibrium has been re-established and, if sampling indoors as part of a VI investigation, any vapors that have escaped from the subsurface during the implant installation have had a chance to dissipate. Equilibrium is typically re-established approximately 24 hours following sample point installation, or as otherwise specified in the project-specific work plan or regulatory guidance.

15.7 LEAK TESTING PROCEDURES

If required by the project-specific work plan or regulatory guidance, verify the integrity of the seal between the ground surface (or finished floor, if the sampling is within a building) and sample point assembly using a tracer gas such as helium. This type of leak testing is typically performed before sampling and involves creating an enclosure above the sample point, which is then charged with the tracer gas. A meter capable of detecting the tracer is then connected to the sampling tube and monitored to ensure that the gas (an analog for ambient air) is not passing through the seal and being introduced into the sample train.

The user should verify the leak testing procedures in the project-specific work plan and/or relevant regulatory guidance.

Typical leak testing procedures are:

1. Select a container to serve as the shroud (e.g., 5-gallon bucket or stainless steel dome). This device should be of sufficient size to cover the soil vapor sample point. Dedicated testing shrouds with fittings and sample ports are available from some laboratories or can be purchased/constructed.
2. Fit the shroud with two hose barbs or quick-lock connectors, one sized appropriately to connect to the sample tubing and the other sized appropriately for tubing from the tracer gas. These fittings allow the tracer gas to be introduced to the enclosure and the soil vapor sample point tubing to be connected to the detector outside of the shroud.
3. Connect the sample tubing to the appropriate connector inside the shroud and then place it over the sample point and aboveground tubing and fittings. The shroud should be sealed to the ground surface or floor using modeling clay, bentonite, or other appropriate material.
4. Connect the detector to the shroud via a short length of tubing and start the detector. The detector's pump rate should be adjusted to not exceed a maximum of 200 milliliters per minute.

5 Charge the shroud with a tracer gas through the second hose barb or quick-lock connector. A target concentration of 10% to 20% is generally recommended for within the shroud, or as otherwise specified in the project-specific work plan and relevant regulatory guidance.
6 Monitor the tracer compound concentrations by alternatingly connecting the gas detector to the first and second quick-lock connectors.
7 Monitor the soil vapor sample point over a period of at least 2 minutes, or as otherwise specified in the site-specific work plan and/or regulatory guidance. A leak is occurring if the tracer gas is detected within the sample train above background concentrations, or as otherwise specified in the project-specific work plan and relevant regulatory guidance. If a leak is detected, the seal around the soil vapor sample point must be repaired or augmented and the process repeated until the results indicate the seal is competent.
8 Record the leak detection procedures and observations in the field book.
9 Disassemble the shroud

15.8 SOIL VAPOR POINT PURGING PROCEDURES

Before collecting a soil vapor sample, the sample point and sample train (tubing, connectors, valves, etc.) must be purged to remove ambient air. Purging can be accomplished by connecting a hand-powered air pump or vapor syringe to the soil vapor discharge tubing. A "low-flow" purge rate (typically a maximum of 200 milliliters per minute) is required by many regulatory agencies to avoid potential short-circuiting or desorbing of volatile compounds from soil particles; a calibrated sampling pump or inline flow meter may be used to ensure the flow rate is maintained. Purge a minimum of 3 tubing/point volumes from the soil vapor sampling assembly prior to sample collection. The volume is calculated as follows:

Purge Volume = (3* π *r2*h)point + (3* π *r2*h)tubing

Where:

r = the inner radius of the point and connecting tubing
h = the height of the point and the connected tubing

Purged vapor from the soil vapor point should be contained in Tedlar® bags to prevent the release of soil vapor into the air (if the sampling is being conducted inside a building as part of a VI investigation). As required by the project-specific work plan or regulatory guidance, collect air quality readings from the purged air (e.g., PID).

15.9 SOIL VAPOR SAMPLE COLLECTION

Soil vapor samples are collected using clean, evacuated stainless steel canisters (e.g., Entech-style or SUMMA®-equivalent), or active (requires a pump) equipment, such as a Tedlar® bag and hand-powered pump. The canister sampling equipment typically includes a canister under vacuum, a flow regulator with an in-line vacuum gauge, and in-line particulate filters. The flow regulator is pre-set by the laboratory to collect a sample over the collection period specified in the project-specific work plan and the laboratory task order. Instructions for connecting the sample canister to the flow regulator are typically provided by the laboratory. Tedlar® bag sampling is only appropriate for "grab" samples.

At each sampling location, record the initial conditions at the sample location in accordance with the project-specific work plan or regulatory guidance, often including the weather conditions (e.g., precipitation, barometric pressure, and indoor and outdoor temperature), PID readings, and any observations. Record sample locations with respect to a permanent feature and record a description of the sampling location.

Collect quality assurance/quality control samples in accordance with SOP 4 and the project-specific work plan. Duplicate samples may be collected by using a "T" fitting attached to the sample tubing.

15.9.1 CANISTER SAMPLING

1. Connect the sample canister to its dedicated[1], pre-set flow controller with an inline vacuum gauge. If using a SUMMA®-equivalent canister, tighten (hand-tight) the fitting with adjustable wrenches. Do not over tighten. If using an Entech-style canister, connect the canister to the flow controller by sliding back the collar on the female end of the regulator's fitting and inserting it into the male end of the canister's fitting.
2. Ensure that the canister is in a stable position and will not fall or be relocated during the sampling process. Place physical and visual barriers around the canisters, as necessary, so they are not disturbed during sample collection.
3. Open the appropriate valve port on the soil vapor discharge tubing to allow vapor flow from the soil vapor point to the sample canister.
4. Open the canister's intake valve, record initial vacuum, and begin sample collection. Do not use canisters that show unacceptable (as detailed in the laboratory instructions or project-specific work plan) initial vacuum readings.
5. Attach a label to the sample container and enter information (sample number, start date, start time, sampler's initials, analysis, initial vacuum readings, and place of collection).
6. Check the canister vacuum gauge reading at least once during the sample collection period to ensure the canister's pressure is changing at the appropriate rate. If the canister's pressure is not changing at the appropriate rate, contact your project manager.
7. Once the sample collection period is completed, record the final vacuum, close the canister's intake valve, close the valve port connected to the soil vapor discharge tubing, disconnect the sample canister's intake port to the tubing from the soil vapor point, and disconnect the pre-set flow controller from the canister. Residual vacuum should be measurable after the collection period is completed; recommended residual vacuum is typically between -2 and -5 inches of mercury. The sample results may be subject to rejection during validation if vacuum was not maintained during the entire sample collection period. If vacuum readings are outside of the recommended range, inform your project manager as soon as possible. Enter the remaining information on the sample label and field book (stop date, stop time, and final vacuum reading).
8. Record the final conditions at the sample location in accordance with the project-specific work plan or regulatory guidance, often including the weather conditions (e.g., precipitation, barometric pressure, and air temperature), PID readings, and any observations (e.g., odor, staining, or spills).

15.9.2 TEDLAR® BAG SAMPLING

1. Attach a new, appropriately-sized section of Teflon® or Teflon®-lined tubing to the air sampling pump.
2. Purge the tubing by operating the pump in accordance with the manufacturer's specifications (this will remove whatever air was present in the tube and pump mechanism allowing the air to be sampled to enter the sampling assembly).
3. Connect the pump's intake to the soil vapor discharge tubing, and the pump's discharge to the Tedlar® bag sample port.
4. Open Tedlar® bag valve and the appropriate valve port for the soil vapor discharge tubing to allow air flow from the soil vapor point to the Tedlar® bag.
5. Turn on the air sampling pump (or use the hand-powered pump) and begin filling the Tedlar® bag. Ensure the air sampling pump's flow rate meets any requirements in the project-specific work plan or regulatory guidance, using a calibrated air sampling pump or inline flow meter.
6. Once the Tedlar® bag is approximately two-thirds full, close the valve on the Tedlar® bag and the valve on the soil vapor discharge tubing.
7. Discontinue the pump operation and disconnect the air sampling pump from the Tedlar® bag.
8. Attach a label to each bag and enter information (sample number, date, start/stop time, sampler's initials, analysis, and place of collection).

[1] [1] Some laboratories match and pre-test specific flow controller and canister assemblies at the laboratory prior to shipment to the field for sample collection; be sure to assemble the equipment in the field using the matched components.

9 Record the final conditions at the sample location in accordance with the project-specific work plan or regulatory guidance, often including the weather conditions (e.g., precipitation, barometric pressure, and air temperature), PID readings, and any observations (e.g., odor, staining, or spills).

15.10 SAMPLE LABELING AND PREPARATION FOR SHIPMENT

Once sample collection is complete, prepare the sample canisters for offsite laboratory analysis:

1 Clean the outside of the sample container, if necessary.
2 Ensure all required information is completed on each sample label (see above).
3 Record sample designation, date, time, and the sampler's initials in the field book.
4 Complete chain-of-custody forms with appropriate sampling information, including:
   - Location
   - Sample name
   - Sample collection start and end date and times
   - Initial vacuum measurement, if applicable
   - Ending vacuum measurement, if applicable
   - Sample regulator number, if applicable
   - Sample canister number, if applicable
   - Analytical method
5 Complete sample packing and ship in accordance with proper procedures.

Note that air samples are typically shipped under ambient temperatures.

15.11 CLOSING NOTES

Once sampling is completed, secure the sample port or abandon the location boreholes/locations in accordance with the project-specific project work plan. Mark all sample locations with spray paint, stakes, or other appropriate marker for future reference, as needed, or survey, including collecting Global Positioning System coordinates and photographs, in accordance with the project-specific work plan. Decontaminate all equipment prior to departure and properly manage all PPE and IDW in conformance with SOP 6, the project-specific work plan, and applicable regulations.

ENCLOSURE B – COMMUNITY AIR MONITORING PLAN

Enclosure B
Community Air Monitoring Plan
Soil and Groundwater Investigation Activities
175 Roger Avenue, Inwood NY

This Community Air Monitoring Plan (CAMP) specifies the real-time monitoring for volatile organic compounds (VOCs) and particulates (i.e., dust) that must be conducted when certain activities are being conducted at the 175 Roger Avenue site in Inwood NY (subject property). The CAMP is intended to provide a measure of protection for the downwind community (i.e., offsite receptors including residences and businesses) from potential airborne contaminant releases as a direct result of onsite investigation activities. The action levels specified in this CAMP require increased monitoring, corrective actions to abate emissions, and/or work shutdown. Following this CAMP helps to confirm that work activities do not spread contamination offsite through the air.

Reliance on the CAMP will not preclude simple, common-sense measures to keep VOCs and dust at a minimum around the work areas.

Continuous, real-time monitoring for VOCs and particulate will be conducted during all ground intrusive activities including, but not limited to, the installation of soil borings, monitoring wells, SVE pilot test wells, soil vapor sample points, and test pits.

Periodic monitoring for VOCs will be conducted during non-intrusive, ancillary activities such as the sampling the existing monitoring wells. "Periodic" monitoring during sample collection will consist of taking readings upon arrival at a sample location, during active sample collection, and prior to leaving a sample location.

Particulate Monitoring and Action Levels

During ground intrusive activities, particulate concentrations must be monitored continuously at the upwind and downwind perimeters of the property at temporary particulate monitoring stations. The particulate monitoring must be performed using real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) and capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level. The equipment must be equipped with an audible alarm to indicate exceedance of the action level. In addition, fugitive dust migration should be visually assessed during all work activities.

- If the downwind PM-10 particulate level is 100 micrograms per cubic meter (µg/m) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques must be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 µg/m^3 above the upwind level and provided that no visible dust is migrating from the work area.
- If, after implementation of dust suppression techniques, downwind PM-10 particulate levels are greater than 150 µg/m^3 above the upwind level, work must be stopped and a re-evaluation of activities initiated. Work can resume if dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 µg/m^3 of the upwind level and in preventing visible dust migration

All readings shall be recorded in the field logbook and be available for review by the New York Departments of Environmental Conservation [NYSDEC] and health [NYSDOH], if requested.

Organic Vapor Monitoring and Action Levels

VOCs must be monitored at the downwind perimeter of the property on a continuous basis or as otherwise specified. Upwind concentrations should be measured at the start of each workday and periodically thereafter to establish background conditions, particularly if wind direction changes. The monitoring work should be performed using equipment appropriate to measure the types of contaminants known or suspected to be present. The equipment should be calibrated at least daily for the contaminant(s) of concern or for an appropriate surrogate. The equipment should be capable of calculating 15-minute running average concentrations, which will be compared to the levels specified below.

- If the ambient air concentration of total organic vapors at the downwind perimeter of the work area or exclusion zone exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities will be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities will resume with continued monitoring.
- If total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist at levels more than 5 ppm over background but less than 25 ppm, work activities will be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities will resume if the total organic vapor level 200 feet downwind of the exclusion zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less - but in no case less than 20 feet, is below 5 ppm over background for the 15-minute average.
- If the organic vapor level is above 25 ppm at the perimeter of the work area, activities will be shutdown.

All 15-minute readings shall be recorded in the field logbook and be available for NYSDEC and NYSDOH review. Instantaneous readings, if any, used for decision purposes shall also be recorded in the field logbook.

ENCLOSURE C – HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN

175 ROGER AVENUE

AIREF JFK IC LLC

PROJECT NO.: 31407196.000
DATE: APRIL 2025

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1 INTRODUCTION

This Health and Safety Plan (HASP) was prepared to address potential health and safety related issues at 175 Roger Avenue in Inwood, New York (Figure 1). The site, the location of a former sheet metal products manufacturer, was investigated and, later, remediated by the previous owner under the New York State Brownfield Cleanup Program (BCP; # C130164). The approved remedy, an excavation of affected soil within a former underground storage tank (UST) area and a localized groundwater treatment, was completed in the fall of 2022. The New York State Department of Environmental Conservation (NYSDEC) issued a BCP *Certificate of Completion* for the site in April 2023 following the completion submission of the final engineering report. The property was subsequently sold to AIREF JFK IC LLC (AIREF) for redevelopment. All buildings on 175 Roger Avenue have been razed at the site is vacant.

An evaluation of the site for AIREF revealed chlorinated volatile organic compound-affected (VOC-affected) groundwater beneath the property that was not fully investigated or addressed by the former owners under the BCP. WSP, in response, has proposed to conduct additional investigations at the site, which will include[1]:

- groundwater monitoring well installation and sampling;
- soil gas implant installation and soil gas sampling;
- soil vapor extraction and monitoring well installation;
- a soil vapor extraction (SVE) pilot test; and
- soil sampling.

The proposed work at the site is designed to further characterize affected soil, soil gas, and groundwater at the site and evaluate potential remedies for the impacted media. The investigation work plans for the proposed work have been reviewed by the NYSDEC and the New York State Department of Health (NYSDOH). Comments and suggestions received by the Departments on the proposed scope of work have been incorporated into the investigation approach and the summary of work provide in this document. A review of the site background, including the previous investigation and remediation, and the scope of work is presented in Section 4 below.

The HASP prepared for this site provides an overview of conditions at the property, describes the safety procedures associated with these planned activities, and presents the minimum requirements for all WSP employees and its subcontractors[2]. The HASP development considered current safety standards as defined by the U.S. Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), the American Conference of Governmental Industrial Hygienists (ACGIH), and the National Institute of Occupational Safety and Health (NIOSH). The document also includes information on health effects and standards for known contaminants and the procedures designed to account for the potential for exposure to unknown substances. Specifically, the following references have been consulted:

- 29 Code of Federal Regulations (CFR) 1910.120 and 40 CFR 311;
- OSHA/NIOSH/EPA Occupational Health and Safety Guidelines for Activities at Hazardous Waste Sites;
- NIOSH Pocket Guide to Chemical Hazards; and
- ACGIH Threshold Limit Values.

1.1 COMPLIANCE REQUIREMENTS

WSP project personnel performing field activities will be subject to the standards, procedures, and requirements specified in this HASP and will be required to certify their review and intended compliance with the document before conducting any activities. The certification for this HASP is provided in Section 14. The field personnel will be briefed on their specific

[1] The activities will also include supervision of the onsite waste containerization and onsite staging, and the decontamination of field equipment, both by the subcontractors used for the investigation materials. The methods for the proposed scope of work are detailed below.

[2] All subcontractors performing work at the site are required to implement their own corporate HASP, which may detail requirements that are more stringent than those specified by WSP.

task(s) and will be required to become familiar with all sections of this plan. All subcontractors that will be under WSP's direct supervision must maintain a separate HASP and, at a minimum, be familiar with the following sections of this plan:

- Emergency Procedures - Section 11;
- WSP Personnel Records - Appendix A;
- WSP's Field Standard Operating Procedures (SOPs) - Appendix B; and
- NIOSH Pocket Guide to Chemical Hazards - Appendix C.

This HASP may be modified if the provisions specified are not feasible or adequate to protect the health and safety of personnel, or if additional onsite activities are planned. Changes to this HASP will be documented by completing a HASP change form (Section 13), and changes should be reviewed by members of the HASP chain of command before implementation onsite. The form must document all the modifications to the plan and include an explanation of they may change potential exposure hazards to all subcontractor supervisors. A copy of completed HASP modification forms will be included in each copy of the HASP, maintained with the project records, and presented to all field personnel during the daily briefings.

2 ORGANIZATIONAL STRUCTURE

Every HASP that WSP prepares is organized to ensure that information regarding site conditions, potential exposure to hazards, and worker safety flows freely within the project team. The HASP also establishes a chain of command with lines of authority, responsibility, and communication, as required by the Occupational Safety and Health Administration (OSHA). Each project will have a General Supervisor (as designated by OSHA), a Task Manager, and a Site Health and Safety Coordinator (SHSC). The General Supervisor is typically the WSP client manager (or WSP project manager) who is ultimately responsible for the overall implementation of the project. The project director's role as the General Supervisor is to staff and support the work appropriately. This includes securing company funds for the personal protective equipment (PPE) and monitoring equipment recommended for the site in this HASP.

The designated Task Manager is responsible for the safe and proper implementation of the work plan activities detailed below. They have authority to expend company resources for PPE and other safety equipment. The Task Manager oversees all field work associated with the project and will communicate with the General Supervisor regarding implementation of the work. The SHSC is responsible for the implementation of this HASP. The SHSC will communicate any issues with changing site conditions, upgrades in PPE, decontamination procedures and needs for monitoring equipment with the Task Manager. The SHSC will confirm that other workers[3] assigned to the project are following the HASP.

It is expected that all other employees assigned to the project will follow the HASP and report all potential safety concerns to the SHSC.

2.1 PERSONNEL ASSIGNMENTS

The appropriate technical personnel will be organized into a project team to perform the site activities efficiently and safely. The project goals can only be accomplished through appropriate management techniques and personnel. WSP will oversee[4] and monitor environmental work on behalf of AIREF. The responsibilities of key technical personnel are described below along with the emergency contact information (Table 2).

Table 2.1 Project Personnel

Project Role	Name	Cell	Office	Email
General Supervisor	David Sarr	(571) 217-3628	(703) 318-3956	David.sarr@wsp.com
Task Manager	David Bouchard	(315) 374-8494	(360) 930-0301	David.Bouchard@wsp.com
Site Health and Safety Coordinator	Mark Goldberg	(475) 992-1708	(203) 610-4412	Mark.Goldberg@wsp.com
Field Team Leader	Michael Reiff	(914) 461-2967		michael.reiff@wsp.com
Field Team	TBD	-	-	-

Certificates documenting the training for field personnel are provided in Appendix A.

2.1.1 GENERAL SUPERVISIOR – DAVID SARR

The WSP client manager, Mr. David Sarr, is the General Supervisor for the site. He has primary responsibility for the completion of project activities, including the overall planning, scheduling, and cost control. Specifically, Mr. Sarr is responsible for maintaining communication with the client; providing strategic direction to the field team regarding client and contract requirements; maintaining compliance with the budget and schedule; and ensuring the overall work quality

[3] Other personnel required to conduct the proposed work will be assigned to the project and this HASP, as appropriate.

[4] Subcontractors will be responsible for conducting their work in a safe manner.

(including any deliverables). Mr. Sarr, as the General Supervisor, will oversee the Task Manager in planning, coordinating, and controlling technical aspects of the project.

2.1.2 TASK MANAGER – DAVID BOUCHARD

The Task Manager, Mr. David Bouchard, is responsible for ensuring compliance with all project programs and protocols; providing oversight; managing the document control process; and maintaining consistency in and reviewing all work products. Mr. Bouchard will prepare technical reports and other project documents and for ensuring adherence to the HASP. He will also be responsible for monitoring the quality of the technical and management aspects of the project, implementing tasks, and maintaining communication with the NYSDEC, as appropriate, to ensure that the objectives of the project are met.

The Task Manager will ensure that all necessary equipment and supplies are available to complete the proposed tasks and any necessary accident, incident, and near hit investigations are completed in a safe, thorough, and effective manner. The Task Manager must ensure that all field team leaders have the necessary training and equipment to implement their assigned tasks as well as the skills necessary to lead a field crew and manage WSP contractors.

2.1.3 SITE HEALTH AND SAFETY COORDINATOR AND FIELD SITE SAFETY COORDINATOR

The responsibilities of the SHSC, or if the SHSC is not onsite for the planned activities, the Field Site Safety Officer Coordinator (FSSC), will be assigned by the Task Manager before the beginning of every field task. The assignment will continue until the end of the field task or until the Task Manager re-assigns the responsibilities. Mr. Mark Goldberg is currently assigned as the SHSC for the planned activities.

The SHSC or FSSC will be responsible for the compliance of the field team with this HASP. Specifically, the SHSC or FSSC will:

- ensuring that decontamination procedures are followed;
- maintain onsite documentation of the medical clearances and emergency medical programs for each employee; and
- assist in onsite emergencies, if any, and modify the health and safety protocols or terminate field work when unsafe work conditions exist.

The SHSC or FSSC will familiarize personnel with health and safety protocols and observe that field personnel wear appropriate PPE. Data from direct reading instruments, hazards evaluation, and any occurrence of site injury or illness will be recorded by the SHSC or FSSC.

The SHSC or FSSC are also responsible for monitoring field team leaders and field personnel to determine if employees are safe and acting professionally. Unsuitable behavior or conditions for performing work at the site include, but are not limited to:

- fatigue
- evidence of lack of fitness for duty
- heat or cold stress
- irresponsible or inappropriate behavior
- harassment (physical threats or verbal abuse) of WSP or other site workers

WSP will also monitor the subcontractors mobilized to the field for the work. Unsafe or unprofessional acts (as defined by this HASP) conducted by the subcontractor personnel, if observed, will be reported to the subcontractor supervisor by the SHSC or FSSC. Subcontractors are responsible for correcting any unsafe conditions created by their activities or acts by their employees in compliance with their HASP and any applicable regulations. The SHSC or FSSC has the authority to stop work until corrective measures are implemented.

The SHSC or FSSC will determine if work practices or site conditions require changes in this HASP including, but not limited to, upgrades or downgrades in personal protection; changes in equipment or methodology to increase the safety level or monitoring; and implementation of engineering or administrative controls, if necessary. If unsafe conditions are encountered, if illness or injury occurs, or if the level of protection needs to be changed, the SSC or FSSC will consult in a timely manner with the Task Manager. The SHSC or FSSC will be responsible for implementing any approved changes to the HASP.

2.2 FIELD TEAM LEADER

The Field Team Leader will be assigned by the Task Manager before the beginning of every field task. The assignment will continue until the end of the field task or until the Project Manager re-assigns the responsibilities.

The Field Team Leaders are responsible for the proper implementation of each work task assigned to WSP and its subcontractors. Team leader responsibilities include:

- advance and onsite organization of field activities;
- ensuring subcontractors mobilize to the site as scheduled and are prepared to implement the scope of work;
- procuring the necessary field equipment and verifying it is operational and available for the field team;
- compliance with the provisions of the work plan;
- quality control, field documentation and record keeping; and
- communication with the WSP project manager, project engineer, or other on the project team, as appropriate

The Field Team Leaders must ensure that all field team members are properly trained to fulfill their assigned tasks, which includes implementation of both the HASP and work plan. The Field Team Leaders, in coordination with the SHSC or FSSC, will ensure that WSP[5] and subcontracted personnel conduct their tasks safely in accordance with the HASP, and the facilities health and safety requirements.

WSP Field Team Leaders will be responsible for the onsite implementation of the accident, incident, and near hit investigation process. The Field Team Leader will work under the direction of the SHSC or FSSC and the Task Manager to:

- investigate and determine the cause of accidents, incidents, and near hits;
- determine any preventive corrective actions that may be necessary; and
- implement the changes and track its efficacy once the onsite activities have resumed.

Section 12 contains detailed requirements for accident, incident, and near hit reporting, investigation, and corrective action.

2.2.1 WSP FIELD PERSONNEL

WSP field team members are responsible for safely implementing the approved scope of work (described below). The responsibilities, all performed under the supervision of the Field Team Leader, include:

- donning and doffing of the appropriate PPE;
- conducting assigned site (safety) monitoring;
- performing assigned tasks in support of the approved scope of work; and
- decontamination of field equipment and nondedicated PPE.

Field personnel will report all safety concerns, task-related problems and successes, and equipment deficiencies or malfunctions directly to their Field Team Leader. All activities performed by the field team will conform to this HASP.

[5] The Field Team Leader will also monitor the SHSC or FSSC onsite behavior (as defined above) to determine if they should be removed from the work site.

3 SITE BACKGROUND

The site is located at 175 Roger Avenue in Inwood, Nassau County (Long Island), New York (Figure 1). The 3.5-acre site formerly consisted of a 155,000 one and two-story warehouse and office complex (main building) built on a peninsula extending into the east side of Jamaica Bay. Development at the site, including the construction of the main building, began in 1954 with additional phases of construction occurring through 1967. The property was used by an unnamed sheet metal fabrication firm through the 1960s and, later, by Rockaway Metal Products (another sheet metal business). Rockaway's operations began in 1971 and included enamel painting sheet metal products, such as office cabinets and interior office partitions. Waste from the operations, such as spent solvents, recovered paint products, and waste oil were containerized and staged in an outside drum storage area and, later, transferred to a 5,000-gallon tanker trailer parked near the main building. The firm operated at the site for more than 15 years.

Rockaway declared bankruptcy in the mid-1980s and abandoned the property 1987 reportedly leaving behind hazardous waste material generated while they were in business. The EPA, at the behest of the NYSDEC, performed an inspection of the site in 1992. The inspection revealed 240 deteriorating drums; dry wells filled with sludge-like material; the 5,000-gallon tanker trailer; and USTs found to contain heating oil, xylene, and a paint solvent compound known by the trade name Solvesso. The EPA conducted an Emergency Removal Action in 1993 to address the identified hazardous conditions on the property. The drums, tanker trailer, and one 1,000-gallon UST containing heating oil were removed from the site for offsite disposal. The balance of the tanks, a 5,000-gallon heating oil UST, a 1,000-gallon xylene, and a 1,000-gallon containing the solvent Solvesso, all located in the UST area near the northern property line, were reportedly cleaned out and abandoned in-place.

The site was acquired by Nassau County after the removal action in 1995. The County leased the property to several tenants for use as a warehouse (Long Island Party Rental) or an automobile repair facility (Gunter Autor Shop) through 2004, after which the site was vacant. The main building, damaged by fire in 2011, was eventually demolished by Nassau County in 2019. The site remains vacant with no buildings on the property.

3.1 SURROUNDING PROPERTIES AND TOPOGRAPHY

The 175 Roger Avenue site is in a mixed-use commercial and residential area of Long Island (Figure 2). The property is bordered to the north by a warehouse and associated parking lot operated by Sony Pictures Entertainment Inc., and to the west by BM Cargo, Inc., a trucking company. The site is adjoined by Gates Avenue to the east and further east by Peninsula Recycling Inc., and D. Daniels Contracting Limited, refuse management and hauling companies; MGR Equipment Corporation, manufacturers of ice storage (dispensers and bins) and specialty refrigeration equipment, and an unnamed warehouse facility. The property is abutted by and private residences to the south along Bayview Avenue.

The topography of the site is relatively flat with the area on the peninsula extending into Jamaica Bay. The site is approximately 12 feet above mean sea level with the areas directly north, south, and west sloping to the nearby Motts Basin, an arm of Jamaica bay, the closest body of water to the site (Figures 1 and 2). The site is accessible by road via the gated entrances along Roger Avenue or, if necessary, by air.

3.2 PREVIOUS INVESTIGATION

Environmental investigation at the site was conducted in two separate phases following the departure of the building tenants in 2004. ATC Associates, Inc. of New York, NY, conducted the first phase of investigation beginning in 2005. Samples[6] collected from soil borings and monitoring wells installed by ATC during the preliminary site evaluation revealed dissolved concentrations of chlorinated volatile organic compounds (VOCs), including tetrachloroethene (PCE) and trichloroethene

[6] The monitoring well, soil boring and groundwater sample locations for the ATC Associates and the subsequent Fleming, Lee Shue investigations are shown on Sheet 1 for reference but are not otherwise discussed in this document.

(TCE); and petroleum compounds (aromatics) that were presumed to have been released from the UST area (Sheet 1). ATC also detected petroleum related VOCs and metals in the soil and sediment sampled from the dry wells at the site.

A follow-up remedial investigation (RI) performed by ATC in 2009 confirmed the preliminary findings and based on their distribution, provided evidence that the petroleum hydrocarbons were likely released from the USTs. Xylenes and the compound 1,2,4-trimethylbenzene were detected in soil samples at concentrations up to 740,000 and 870,000 milligrams per kilogram (mg/kg), respectively. These same two compounds were detected in groundwater samples at respective concentrations up to 94,000 and 107,000 micrograms per liter (µg/l). The highest concentrations of these compounds were found within and near the former UST area near the northern property line (Sheet 1).

The samples collected in 2009 were also used to further characterize the chlorinated VOCs. Only trace levels of TCE (up to 19 micrograms per kilogram [µg/kg]) were detected in the soil samples; however, groundwater samples contained significant dissolved concentrations of TCE (up to 6,100 µg/l) and PCE (up to 15,000 µg/l) and both compounds were detected in sub-slab vapor samples. Notably, the highest concentrations of dissolved chlorinated VOCs were detected in groundwater samples collected between 30 and 35 feet below ground surface (bgs). ATC's interpretation was that the chlorinated VOCs released at or near the surface migrated vertically through the water column before encountering a low permeability layer (i.e., an interval of clay and silt) around 35 feet bgs. The release occurred directly over an east-west groundwater high (i.e., a groundwater mound) directly beneath the UST area resulting in chlorinated VOC-affected flowing in multiple directions and impacting most of the property (Sheet 1). ATC's RI did not define the extent of chlorinated groundwater at the site.

The second phase of work, a *Supplemental Remedial Investigation* (SRI) was conducted by Fleming, Lee Shue (FLS) of New York, NY, in 2020. The SRI, conducted under the BCP, was intended to verify the earlier ATC findings, including the chlorinated VOCs detected below 30 feet bgs; and collect information necessary to design a remedy for the impacted media. The results generally confirmed ATC's findings that the highest concentrations of both chlorinated and non-chlorinated VOCs were detected in the soil associated with the USTs (i.e., within the UST area) and that the release occurred over a groundwater high (Sheet 1). Groundwater samples collected during the investigation revealed the presence of petroleum hydrocarbons[7] near the UST area and verified that chlorinated VOCs were present in the water column near the USTs and between 30 and 35 feet bgs but at comparatively lower concentrations that those detected by ATC. The maximum concentrations of dissolved PCE (up to 7,610 µg/l) detected by FLS were, for example, were reduced approximately 50-percent from the highest concentration detected in ATC's 2009 RI. Concurrent soil vapor samples revealed decreases in the concentrations of PCE (up to 548 micrograms per cubic meter [$\mu g/m^3$] and TCE (up to 55 $\mu g/m^3$), although the levels detected still represented a potential vapor intrusion concern for any future structures at the site.

3.2.1 REMEDIATION

Remediation at the site was implemented by previous owner as a *Volunteer* under the BCP guidelines between June and September 2022. The NYSDEC-approved remedy, detailed in a *Remedial Action Work Plan* (RAWP) prepared by FLS, included the following activities:

- excavation of 3,310 tons of impacted soil and sediment (from the 10 onsite dry wells) and 300 tons of stained or hazardous concrete (lining the former UST area) for offsite disposal;
- onsite treatment and disposal of 84,000 gallons of liquid waste (groundwater and rainwater) from the dewatering activities;
- the abandonment of all thirteen of the existing groundwater monitoring wells to limit vertical migration;
- the cleanout and removal of three previously closed in-place USTs, one 5,000-gallon petroleum tank and two 1,000-gallon solvent tanks; and
- the placement of approximately 13,000 pounds of powdered zero valent iron (ZVI)[8] in the open UST excavations and mixed with the upper 2 feet of saturated soil in the base of the pits (Sheet 1).

[7] Groundwater samples collected by FLS contained concentrations of ethylbenzene (9.4 to 7,920 µg/l); toluene (106 to 21,800 µg/l); total xylene (10 to 48,700 µg/l); 1,2,4-trimethylebenzene (105 to 4,850 µg/l), 1,3,5-trimehylbenzne (19.2 to 1,510 µg/l) and several other petroleum-related compounds (aromatics) at concentrations above the ambient water quality standards. These compounds, the highest concentration of which were detected in shallow groundwater samples near the former UST area, were limited in extent and are interpreted to have been reduced to residual levels by the 2022 remediation.

[8] The Ferox PRB-brand ZVI was manufactured by Hepure Technologies of Hillsborough, New Jersey.

These actions were designed the treat the identified affected media and remove the likely ongoing source (i.e., the affected soil and shallow groundwater in the UST area) of compounds to the underlying groundwater. Actions that were to be implemented after the sale of the property[9] as part of the site management plan (SMP) included:

- integration of a vapor barrier and (passive) sub-slab depressurization system for the planned warehouse; and
- the installation of eight co-located shallow and deep monitoring wells following the construction of the warehouse.

The remedy also included restrictions on the use of onsite groundwater, the construction and maintenance of a 2-foot-thick soil cover system, an *Environmental Easement* and, after the active remediation was completed and the SMP developed, implementation and periodic certification of the institutional and engineering controls associated with the site. Notably, the RAWP did not address the affected groundwater at the site beyond the former UST area (Sheet 1). No treatment was targeted at the chlorinated VOC-affected groundwater detected between 30 and 35 feet bgs during the 2009 RI and 2020 SRI.

The remediation was approved by the NYSDEC. The Department issued a *Certificate of Completion* for the remediation conducted under the BCP on April 25, 2023.

[9] The property has been sold to AIREF; however, the redevelopment activities have not been implemented at the time this HASP was prepared.

4 PROPOSED ONSITE ACTIVITIES

Supplemental investigations[10] performed by WSP in late 2023 and early 2024, determined that the remedy decreased the concentrations of the dissolved aromatics and chlorinated VOCs in the upper few feet of the water-bearing zone near the former UST area (Sheet 1). Those investigations also found that higher chlorinated VOC concentrations remain in the deeper water-bearing zone (i.e., the affected groundwater below about 20 feet bgs) with the bulk of the dissolved chlorinated mass detected between 27 and 33 feet bgs above a low permeability layer. The investigation results also confirmed earlier findings that the release from the USTs occurred over a groundwater divide. Chlorinated VOC-affected groundwater is present along the flow directions from the divide to the north along the northern property line (within and near the former UST excavation), and portions of the eastern and southern site boundaries. Chlorinated VOCs desorbing from the affected groundwater (or impacted soil, if present) have the potential, via vapor intrusion, to impact the indoor air quality for onsite buildings (a warehouse will be built during the site redevelopment).

WSP proposed pre-design investigations to collect data that will be necessary to address the identified chlorinated VOC-affected media at the site. The investigation data will be used to refine an *in situ* chemical reduction (ISCR) remedial action (the presumptive remedy, based on the October 2021 Decision Document[11]) that will be implemented to treat the affected groundwater, and design a SVE system to address affected soil gas, if warranted. The proposed investigation work to be conducted on site includes:

- the installation and subsequent gauging and sampling of four pre-design groundwater monitoring wells at select locations where ISCR injections may be conducted;
- the installation, gauging, and water quality sampling of eleven monitoring wells positioned near the northern and southern property lines;
- the design, deployment, and recovery of amended in situ microcosm (ISM) samplers in select pre-design monitoring wells;
- the installation and sampling of soil gas probes positioned throughout the site;
- the installation of a shallow vapor recovery test well and nearby vacuum monitoring points; and
- conducting a soil vapor extraction (SVE) pilot test using temporary vapor recovery and vacuum monitoring wells to evaluate the vacuum radius of influence (ROI) within the unsaturated zone.

The groundwater monitoring well samples will be used to characterize the water quality, and the geochemical and ecological conditions within the water bearing zone. Those data, in turn, will be used to inform the selection of appropriate ISCR remedial amendment formulations to treat the chlorinated VOCs. The efficacy of the identified amendments will be evaluated under the site conditions during the ISM evaluation performed after the groundwater sampling.

The soil vapor investigation includes the collection of soil gas samples over most of the site to assess the current distribution of VOCs in soil gas, evaluate the potential for offsite migration of soil gas, and determine if additional mitigation (beyond the approved sub-slab depressurization system for the future building) is warranted. Mitigation methods could include, depending on the data, the construction of an SVE system to both capture affected soil gas beneath future site building and limit potential offsite migration of the affected soil gas. The proposed investigation includes an SVE system pilot test to evaluate the effective vacuum ROI at the site. These data will be used to aid in the design of a full-scale SVE system, if necessary.

In addition to the pre-design investigation, WSP will also conduct a soil investigation to support the redevelopment of the property. The work will be presented in a separate work plan and will be designed to evaluate the soil cover in select areas of the site (i.e., the top 2 feet of soil) and assess whether regulated compounds are present in deeper soil intervals within and below planned sub-surface storm water management structures (these will be installed during the site redevelopment). The soil characterization will include both discrete and composite samples for the evaluation of target compound list (TCL)

[10] The onsite activities included the use of a drill rig equipped with membrane interface probe and hydraulic profiling tool (MiHPT) to characterize the subsurface stratigraphy and, later, a targeted *in situ* groundwater sampling program. The *in situ* samples were collected from areas of chlorinated affected groundwater identified by the MiHPT tool. See the *Investigation Results* letter report, dated March 22, 2024, for additional information.

[11] The October 2021 Decision Document identifies ISCR as the selected remedy to treat VOCs in groundwater at the site. The Decision Document further states that additional remedial action such as ISCR will occur to address any residual VOCs that remain in groundwater.

VOCs; TCL semivolatile organic compounds (SVOCs); target analyte list (TAL) metals; total organic carbon (TOC); polychlorinated biphenyls (PCBs); pesticides, PFAS and 1,4-Dioxane.

A summary of the planned[12] work, the utility clearance procedures, and the hazards associated with the activities are presented below. The location of the former UST area, the groundwater elevation contours, select previous sample locations are depicted on Sheet 1 for reference but are otherwise not discussed in this document. All work will be performed in accordance with WSP's SOPs and the NYSDEC's *Technical Guidance for Site Investigation and Remediation* (DER-10). Copies of the SOPs cited in the scope of work are presented in Appendix B.

4.1 UTILITY CLEARANCE

The proposed work at the 175 Roger Avenue site includes drilling boreholes for groundwater monitoring and soil vapor wells, implant installation for the soil gas sampling, and soil sampling for the pre-characterization activities. This intrusive work cannot begin at the site until **all buried and overhead utilities** in the public rights-of-way and on the site are located, marked, or cleared. WSPs preference, as indicated in our current request for proposal and contract language, is for the subcontractor (in this case, the drilling company) to be responsible for both notifying the public utility locating authority and for mobilizing a private utility locator in advance of the investigation activities. The specific procedures for utility clearance are detailed in WSP SOP 2 (Appendix B) and outlined below.

4.1.1 PUBLIC UTILITY CLEARANCE

The public utility locating authority (known as New York 811) is provided with information regarding the site location (including the nearest cross street and the local municipality or township), the planned work activity (e.g., drilling, excavation, etc.), and the scheduled start date. The locating service typically requires a minimum 48-hour notice in advance of the planned work.

The public utility authority will identify those providers that have utilities in the right-of-way near the site or, in some cases, beneath the site; and issue a utility clearance ticket that has the legal dig date (the date when it will be legal to perform the intrusive work, which is usually 48 to 72 hours after the call) and an expiration date (typically about 2 weeks from the call date; renewable with the ticket number). The time delay between the ticket call and the legal dig date allows those utility owners to either contact WSP (or its subcontractors) with an all clear or mobilize to the site and mark the buried utilities. The information provided must be recorded (by the contractor or the company) on the *Ground Disturbance Plan & Utility Locates Form* provided in the Forms Section of this document with a completed copy of this form maintained as part of the project file.

Onsite WSP personnel must visually verify that all the utility providers identified by the public utility authority have either issued an all clear or have been marked at the site and that there are no overhead utilities that may conflict with the proposed intrusive work.

4.1.2 PRIVATE UTILITY LOCATORS

The utility providers identified by the public utility locating authority will mark any buried lines in the right-of-way near the site but, in most cases, will not mark any buried lines on private property. The utilities on sites that are private property must be cleared by a private utility locating service. The private utility locator is a requirement and the responsibility of the subcontractor under the current contracting language.

A private utility locating service will use ground-penetrating radar, electromagnetic detectors, acoustic plastic pipe locator, trace wire, or other devices to locate and mark suspected buried lines both outside and beneath any onsite structures. The private utility locator should be directed to sweep the area around suspect buried lines (e.g., within a 20-foot radius around the proposed drilling location) to allow WSP and the drilling company to select alternate locations (a minimum of 5 feet for

[12] It is important to note that, while these activities are part of the proposed investigations, other similar activities may be conducted at the site following the procedures outlined in those sections of this plan. The document will be modified for any proposed activities that are not detailed below, as necessary.

drilling locations and 6 feet for trenching operations) to avoid contacting the utility. The safe working distances for all subsurface activities are presented in WSP SOP 2 (Appendix B). Drilling locations within the specified minimum must be advanced using hand digging or soft digging methods to a depth of at least 5 feet. Note that the use of hand digging, or soft digging methods does not replace the need for public and private utility locating services.

WSP personnel are also encouraged to identify a site contact (e.g., facility engineer, maintenance supervisor, or a plant manager) who may have specific knowledge about the utilities at the site. The contact may have direct knowledge of the plant layout or, in some cases, provide facility drawings outlining the location of buried utility lines. This information can be useful for facilities that are active and may have machinery, reinforced concrete floors, or other equipment that can interfere with the devices used by the private utility locator. The site contact is a valuable resource; however, the person and the facility drawings (or both) cannot replace the public and private utility locates. No intrusive work can be performed at the site before the legal dig date, all utilities on the list have been marked and visually verified, and the private utility locator has completed the sweep of the work area. It is not acceptable to rely solely on the site contact or facility drawings.

Any deviation from the public and private utility locates must be approved by the project manager and a District Business Leader with the further approval of the Chief Operating Officer, as detailed in WSP SOP 2 (Appendix B).

4.1.3 UTILITY STRIKES AND DAMAGE

Damage to an underground or overhead utility is possible even if following all the guidance provided in the HASP and WSP's SOP 2 (Appendix B). WSP personnel, in the event of a strike, should:

- turn off the drilling or excavating equipment, move the equipment from the damaged line (if possible and it can be done safely) or abandon the equipment;
- avoid contact with escaping liquids, live wires, and open flames, and do not handle or view the ends of a fiber optic cable (this can result in eye damage;
- evacuate the personnel from the area and establish a safe perimeter around the equipment and struck line; and
- notify the local emergency response number listed in in this HASP if the damaged utility has the potential to cause, or is causing, dangerous conditions.

WSP personnel should immediately notify the facility operator or site contact, and the utility operator (and the public utility authority) once onsite personnel are in a secure location. WSP personnel should also:

- send an alert or notification via the Integrated Safety Health, Environment, and Quality Management System (iSMS) and send an email to SafetyTeam@wsp.com;
- contact your immediate supervisor, human resources, and sector management in accordance with company policy.

Additional information about the utility clearance procedures is presented in WSP SOP 2 (Appendix B).

4.2 GROUNDWATER INVESTIGATION

The groundwater investigation will include the installation of 15 groundwater monitoring wells, designated MW-1P, MW-2P, MW-3S/3M/3PD, MW-4P, MW-5S/5M/5D, MW-6S/6M/6D, and MW-7S/7M/7D, positioned in areas of the site that will be in or near the likely ISCR injection zones or along the perimeter of the site (Sheet 2). Four locations will be installed as co-located sets of wells with one well screened in the previously identified shallow water-bearing zone (i.e., well identifiers with an *S* suffix), one well screened above the upper low permeability zone (identified with an M suffix) and the third screened in the deeper water-bearing zone (identified with a *D* suffix).

The wells will be gauged and sampled after they have been developed and allowed to stand undisturbed for a minimum of two weeks (to allow for equilibration with the surrounding formation). The depth-to-groundwater will be measured in advance[13] of collecting the analytical samples. Each well will be uncapped and allowed to stand for a minimum of 15 minutes

[13] The measurements will be collected from the wells in advance of the passive diffusion bag sampler removal to ensure that the measurements accurately reflect the water table elevation under ambient conditions.

and then gauged using an electronic water-level indicator. The depth-to-water measurements will be made to the nearest 0.01-foot using an electronic water level meter with the results recorded in the field notebook.

The groundwater monitoring will be performed using passive diffusion bags (PDBs); or, for select wells, using low flow sampling techniques in accordance EPA's *Low-flow (Minimal Drawdown) Groundwater Sampling Procedures* (EPA 1996) and WSP's SOP 11 (Appendix B). WSP anticipates that the PDBs will be the primary sampling methodology for the perimeter wells with low flow sampling used for the pre-design wells. The additional data collected during the low flow sampling will be used to characterize the groundwater geochemistry and evaluate the microbial ecology in advance of completing the remedial design. The sampling techniques and the analytical analyses (VOCs for both methods and, for the low flow sampling, monitored natural attenuation [MNA] parameters, dissolved gases, and advanced diagnostics including the microbial ecology) are detailed below.

4.2.1 MONITORING WELL INSTALLATION

The proposed monitoring wells will be installed at the site by a New York-licensed drilling company using a vehicle-mounted drill rig equipped with 4.25-inch inside diameter (ID) hollow-stem augers (HSAs). The boreholes for the shallow water-bearing zone wells will be advanced from the ground surface to a depth of approximately 16 feet bgs. The boreholes for the medium wells will be advanced to the upper low permeability layer at a depth of approximately 22 feet bgs. The boreholes for the deep water-bearing zone wells will be advanced to the site-wide low permeability layer at a depth of 33 feet bgs. Continuous soil samples will be collected ahead of the HSAs using a 2-inch ID split-spoon sampler (or equivalent) to allow for soil classification (in accordance with WSP's SOP 9; Appendix B), organic vapor screening (using a calibrated photoionization detector [PID] with a 10.6 electron volt [eV] lamp), and proper positioning of the well screens.

The boreholes will be converted to groundwater monitoring wells once the target depth has been achieved by installing 2-inch ID, flush-threaded 0.010-inch continuous-wrap polyvinyl chloride (PVC) screen fitted with enough 2-inch ID flush threaded blank PVC casing to reach the surface. The wells will be completed by installing an appropriately sized sand filter pack from the base of the borehole to a level approximately 2 feet above the top of the screened interval, which will be topped with a minimum of 2 feet of hydrated bentonite to form a seal. The remaining annular space will be backfilled with bentonite-cement grout with each well completed with an aboveground steel protective cover. The concrete pad for the wells will extend a minimum of 1-foot bgs and will be installed such that the concrete extends below (and inside) the protective cover skirt to form a robust surface seal.

The newly installed monitoring wells will be developed 24 hours or later after installation of the well seal. The water column will be surged using dedicated development pump and surge blocks, as appropriate, until the purge water is relatively free of sediments. Groundwater generated during the monitoring well development activities will be contained in appropriately labeled Department of Transportation-compliant (DOT-compliant) 55-gallon steel drums in accordance with WSP's SOP 5 (Appendix B). The drums will be staged onsite for later offsite disposal in accordance with state and federal regulations.

4.2.2 PASSIVE DIFFUSION BAG GROUNDWATER SAMPLING

Water quality samples will be collected from designated monitoring wells using PDB samplers. The PDBs consist of 24-inch long, 1.25-inch diameter, heat-sealed, low-density polyethylene bags that are pre-filled by the laboratory with 220 milliliters of laboratory-grade analyte-free, de-ionized water. The samplers will be suspended at the midpoint of the screened interval in each well a minimum of two weeks in advance of the sample recovery to allow equilibration with the surrounding formation water. Upon retrieval, each bag will be sliced open at one end using decontaminated field scissors, and the contents poured into the appropriate laboratory-supplied, pre-cleaned and preserved sample vials.

The groundwater samples, including those for quality assurance and quality control (QA/QC; in accordance with WSP SOP 4), will be labeled, packed on ice, and shipped to the analytical laboratory for analysis of VOCs by EPA Method 8260C. The samples will be handled and shipped in accordance with WSP SOP 3 (Appendix B).

4.2.3 LOW FLOW GROUNDWATER SAMPLING

The purge and subsequent groundwater sampling of the pre-design monitoring wells will be conducted using a QED Environmental Systems, Inc., (QED) MP-15 Controller® (to adjust the flow rates) and Sample Pro® portable bladder pump

equipped with disposable bladder and tubing (or equivalent). The bladder pump will be positioned at the midpoint of each monitoring well screen and purged at a rate between 0.2 and 0.5 liters per minute. The extracted groundwater will be monitored (during the purge) for temperature, specific conductance, dissolved oxygen (DO), pH, oxygen reduction potential (ORP), and turbidity using a calibrated Horiba U-52 water quality meter equipped with a flow-through cell (or equivalent). Purging will continue until water quality parameters stabilized (±10-percent for temperature, turbidity, DO, and ORP; ±0.1 unit for pH; ± 3-percent for specific conductance; and drawdown variance less than 0.3 feet). Groundwater analytical samples will be collected directly from the pump's discharge tubing once the purge parameters have stabilized, and the flow-through cell removed.

The analytical samples, including those for QA/QC, will be placed in the laboratory-supplied glassware, labeled, and packed in coolers with wet ice. The samples will be shipped via overnight express to an Environmental Laboratory Accreditation Program-certified (ELAP-certified) analytical laboratory for analysis of the following parameters:

- VOCs by EPA Method 8260
- alkalinity by Method SM2320B
- chloride by Method 4500-CLE
- sulfate by EPA Method 300.0
- SVOCs by EPA Method 8270
- sulfide by EPA Method 4500
- total organic carbon by Method 5310C
- dissolved organic carbon by Method 415.2 / 3510C
- total and dissolved metals by EPA Method 6010/7000 series

Samples collected for biological analysis will be placed in laboratory-supplied (unpreserved) glassware and shipped to an approved laboratory for quantitative polymerase chain reaction analysis of the following:

— total Eubacteria, methanogens, and the halorespiring microbes *Dehalobacter* spp., *Dehalococcoides* spp., and *Dehalogenimonas* spp; and

— dechlorination enzymes (i.e., the key functional genes) tceA reductase, BAV1 vinyl chloride reductase, and vinyl chloride reductase.

All the analytical samples[14] will be handled and shipped following the procedures[15] outlined in WSP's SOP 3 (Appendix B). The QA/QC sampling will be performed in accordance with WSP's SOP 4.

4.2.4 IN SITU MICROCOSM STUDY

The ISMs are specialized devices manufactured by Microbial Insights of Knoxville, Tennessee. The ISM is an assembly of smaller sampling devices, including a Bio-Trap® sampler, PDB sampler, volatile organic analysis vial sampler with nylon-screened caps (i.e., a grab sampler), all of which are contained within a 1.25-inch ID, 15-inch-long Schedule 40 slotted PVC housing. The individual sampling devices provide biological, chemical and geochemical data regarding the performance of the amendments under the prevailing conditions with the water-bearing zones. *In situ* microcosm samplers can also be used to evaluate potential groundwater treatments by including a slow-release source within the sampler that is spiked with the amendment (i.e., stimulant, augmentation, or a combination of the two). The deployment of the amendment within the ISM sampler allows the efficacy of that formulation to be tested within the water-bearing zone under the site-specific conditions.

The ISMs with the selected ISCR candidates will be deployed in well MW-1P to characterize the response of each amendment in the area directly beneath the historical source area (i.e., the former UST Area; Sheet 2). The determination of the specific amendments to evaluate, if any, will be made based on the characterization groundwater sampling conducted during the first phase of work. The control for the ISM evaluation will be deployed in well MW-3PD rather than in MW-1P to avoid any potential impact to the control from the amendment-containing samplers.

The ISMs will be deployed using a lift line to suspend the sampler within the screened interval of the well. The sampler will be secured in the well and allowed to stand undisturbed during incubation period (typically 60 to 90 days). The ISMs

[14] The list of analytical analyses may be modified to reduce or, in select cases, increase the number of sampling parameters. This plan will be updated to detail additional analyses that substantively change the associated job hazards.

[15] The preserved glassware and the collected groundwater samples are not, based on the previous investigation work, anticipated to be considered Department of Transportation hazardous materials. Any questions regarding the classification of the glassware or collected samples should consult with the Task Manager and a WSP compliance professional, as indicate in SOP 3.

recovered from the wells will be packed in coolers with wet ice and shipped via overnight express to Microbial Insights for analysis. All the samples will be handled and shipped in accordance with WSP's SOP 3 (Appendix B).

4.3 SOIL GAS SURVEY

The soil gas samples will be collected using a direct-push drill rig to install temporary subsurface sampling probes in accordance with the NYSDOH's *Guidance for Evaluating Soil Vapor Intrusion* (SVI Guidance), dated October 2006, with updates in 2017, and WSP's SOP 15 (Appendix B). Boreholes for all 23 soil gas sample locations, designated as SG-1P through SG-23P, will be advanced from the ground surface to a depth of between 5 and 6 feet bgs (depending on the depth to groundwater) using 1.25-inch-diameter drilling rods fitted with an expendable point (Sheet 2). Teflon® or Teflon®-lined tubing will be connected to a 6-inch-long stainless-steel screen implant that, once the target depth has been achieved, will be inserted through the hollow drill string, and screwed into the top of the expendable point. The drilling rods will then be retracted leaving the implant with the expendable point in the bottom of the borehole and tubing leading to the surface. A clean sand filter pack will be installed in the annular space around the screened interval to a minimum depth of approximately 6 inches above the top of the screen (i.e., 1-foot-deep total). The filter pack with be capped with bentonite slurry to form a seal between the implant and the surface.

The integrity of the sample probe will be verified using a tracer gas (helium) in accordance with the NYSDOH guidelines and WSP's SOP 15 before sampling (Appendix B). Each sample point will be covered with a laboratory-supplied 18-inch-diameter stainless-steel dome for the leak test. The dome will be charged with helium and the sample point monitored for a period of 2 minutes to verify that the system did not short-circuit to the helium atmosphere inside the dome. Samples will be collected following satisfactory seal tests.

4.3.1 SOIL GAS SAMPLING

The soil gas samples will be collected using evacuated 1-liter Entech® vacuum canisters fitted with a dedicated flow controller pre-set by the laboratory to collect the soil gas sample over a 1-hour period. WSP will record the canister pressures in the field notebook at the start and end of the 1-hour period. The sample canister and regulator will be disconnected from each location at the completion of the 1-hour period and labeled with the sample name, location, time, and date of collection. The sample regulator and canister number, and the analytical method will be recorded on the chain-of-custody and field notebook.

The canisters, including appropriate QA/QC samples (in accordance with WSP SOP 4; Appendix B), will be shipped under ambient conditions via overnight carrier to the same laboratory as used for the vapor intrusion investigation for analysis of the VOCs by EPA Method TO-15 with minimum detection limits of 1 microgram per cubic meter ($\mu g/m^3$) for all chlorinated VOCs. The shipping and handling of the samples will be performed in accordance with WSP's SOP 3 (Appendix B).

The soil gas probe tubing will be removed from the subsurface for each location once the sample collection has been completed. The boreholes will be backfilled with bentonite and capped with material to match the surrounding ground cover.

4.4 SOIL VAPOR EXTRACTION SYSTEM PILOT TEST

An SVE pilot test will be conducted to determine a representative vacuum response and ROI for the subsurface conditions at the site. This information, in combination with the soil gas sampling results, will determine if an SVE system is necessary, and if so, the locations and spacing of SVE wells. The SVE pilot test cell will include the temporary vapor extraction well, SVE-1, and four temporary vacuum observation wells, SVE-2 through SVE-5, arranged radially around SVE-1 at distances of 5, 10, 20, and 30 feet, respectively. The SVE well locations are shown in the work plan.

The vapor well installation, the pilot test procedures, and the post-test abandonment of the vapor wells is detailed below.

4.4.1 SVE PILOT TEST WELL INSTALLATION

The SVE pilot test wells will be installed using a vehicle-mounted drill rig equipped with 4.25-inch or 6.25-inch ID (SVE-1 only) HSAs for the vapor monitoring and extraction wells, respectively. The vapor well boreholes will be advanced from the ground surface to a minimum depth of 5 feet bgs (the depth may be adjusted in the field depending on the depth to groundwater, as determined by the onsite geologist). Continuous soil samples will be collected ahead of the HSAs using a 2-inch ID split-spoon sampler (or equivalent) to allow for soil classification and organic vapor screening in accordance with WSP's SOP 9 (Appendix B), and proper positioning of the screen above the water table.

The boreholes will be converted to the vapor wells once the target depth has been achieved by installing approximately 2 feet of 4-inch ID (extraction well) or 1-inch ID (vapor monitoring wells), flush-threaded 0.020-inch slotted PVC casing fitted with enough flush threaded blank PVC casing to reach the surface. The wells will be completed by installing an appropriately sized sand filter pack from the base of the borehole to a level approximately 1 foot above the top of the screened interval, which will be topped with hydrated bentonite to form a seal (the bentonite will be installed level with the surrounding grade). The vapor wells will be equipped with a lockable well cap with ports to allow for vacuum, flow and PID readings during the pilot test.

The vapor extraction and monitoring wells will be allowed to stand undisturbed for a minimum of 12 hours to allow the bentonite to cure and reduce the potential for short-circuiting during the pilot test.

4.4.2 PILOT TEST AND VAPOR WELL ABANDONMENT

The SVE pilot test will be performed using a three-horsepower regenerative blower (Rotron Model DR656, 230V single phase, or equivalent) to generate a subsurface vacuum. The test will be performed using at a minimum of two vacuum levels to allow for comparison of vapor flow rates and the corresponding measurements at each of the observation wells. The applied vacuum in each step will be applied at a constant level for at least 20 minutes prior to collecting vacuum and PID measurements to allow for stabilization in the vapor flow regime below the surface. Emissions from the blower will be plumbed through a 50-pound vapor-phase granular activated carbon (GAC) vessel for treatment before discharge to the atmosphere. The influent and effluent of the GAC vessel will be monitored with a PID to document VOC concentrations in the vapor stream and ensure that they are addressed by the GAC vessel.

The pilot test cell will be deconstructed once the evaluation is complete. The blower, GAC vessel, and other components of the pilot test cell (pipes, fittings, gauges) will be removed from the site and the vapor wells decommissioned. The well abandonment will follow the procedures outlined in the NYSDEC's *Groundwater Monitoring Well Decommissioning Policy* (CP-43), dated on November 3, 2009. Well materials removed from the ground, including the well casings, will be placed in DOT-compliant 55-gallon steel drums in accordance with WSP's SOP 5 (Appendix B). The drums will be staged onsite for later offsite disposal in accordance with state and federal regulations.

4.5 SOIL CHARACTERIZATION

The soil characterization samples will be collected from multiple soil borings using a vehicle-mounted direct-push drill rig equipped with a 2-foot-long macro-core sampler fitted with a disposable (and PFAS-free) plastic liner . The sampler will be advanced from the surface to a depth of 2 feet bgs at all locations and deeper , for the targeted soil evaluations, up to 9 feet bgs, depending on the location. Continuous soil samples will be collected to allow for soil classification, organic vapor screening, and proper positioning of sample depth interval above the water table. Information on the soil sample locations and depths are provided in the project work plan.

The composite soil characterization samples will be composited from the multiple locations within an area designated in the work plan. Aliquots of soil from a 2-foot-long depth interval recovered from each boring will be combined in a dedicated stainless steel bowl and composited using dedicated stainless steel implements in accordance with WSP SOP 9 (Appendix B). The samples will be placed in the appropriate laboratory-supplied glassware, labeled, and packed in coolers with wet ice for later shipment to the laboratory (see below).

The soil evaluation associated with the planned storm water management structures will include both discrete and composite samples. Discrete samples will be collected from the selected depth interval (i.e., 0 to 2 feet bgs; 2 to 4 feet bgs; or the

interval directly above the groundwater) by evaluating the headspace in the recovered soil core (using a PID), visual or olfactory observations, or, if no impact to the soil is detected, from the midpoint of the 2-foot-long sample interval. The remaining soil in each of the discrete sample intervals (i.e., the soil not collected for the discrete samples) within a borehole will be combined in a dedicated stainless steel bowl and composited using dedicated stainless steel implements in accordance with WSP SOP 9 (Appendix B).

The soil cover characterization and storm water feature evaluation samples, including those for QA/QC (collected in accordance with WSP SOP4; Appendix B), will be shipped via overnight express to the analytical laboratory for analysis. The PFAS and 1,4-dioxane samples will be handled separate from the other soil samples collected at the site and transported to the laboratory using dedicated laboratory-supplied containers (coolers).

The soil characterization samples will be shipped to the laboratory and analyzed by one or more of the following methods::

- TCL VOCs plus tentatively identified compounds (TICs) by EPA Method 8260D and 8260C, respectively (discrete samples only);
- TCL SVOCs plus TICs by EPA Method 8270E and 8270D, respectively;
- TAL metals by EPA Method 6010/7000 series;
- TOC by EPA Method 9030; and
- PCBs and pesticides by EPA Method 8280A.
- PFAS by EPA Method 1633; and
- 1,4-dioxane by EPA Method 8270D

All the samples will be handled and shipped in accordance with WSP's SOP 3 (Appendix B). The boreholes will be backfilled using hydrated bentonite once the sampling activities have been completed.

4.6 DECONTAMINATION AND INVESTIGATION-DERIVED WASTE

All downhole and non-dedicated equipment used for the investigation will be decontaminated before work begins, between each borehole, and at the end of site activities using a steam jenny or non-phosphate soap and deionized water, as appropriate. Investigation-derived waste generated during the drilling and sampling activities, including purge water, decontamination rinsate, residual soil cuttings, and other solid waste (e.g., poly sheeting, personal protective equipment, etc.) will be placed in DOT-compliant 55-gallon steel drums in accordance with SOP 5 (Appendix B). The drums will be staged onsite after the field activities have been completed for later offsite disposal in accordance with state and federal regulations.

5 JOB HAZARD ANALYSIS

WSP has completed a Job Hazard Analysis (JHA) for each task detailed in the *Planned Onsite Activities* Section (Section 4) above. The JHA is an evaluation of the risks associated with the proposed work. The analysis considers the impacted media likely to be encountered during the work and the associated physical, chemical, and environmental hazards; and the severity and the likelihood that the identified hazards will impact WSP personnel (i.e., the baseline risk). The JHA also includes task-specific measures and procedures (i.e., control measures) that are designed to mitigate or eliminate the identified hazards. These measures range from recommendations to use the proper lifting technique when handling heavy items to guidance on the use of personal protective equipment to minimize chemical or physical hazards.

National Institute for Occupational Safety and Health (NIOSH) pocket guide pages for the constituents of concern (COCs) identified at the site (detailed below). The generalized hazardous associated with each task in the proposed activities is presented below. The analysis incorporates the hazards presented by the constituents of concern identified at the site, which are presented in Appendix C. The risk evaluation for each task, including the *Baseline Risk Score* and the *Controlled Risk Score*, is presented in a JHA form in Appendix D.

5.1 CONSITUTENTS OF CONCERN

The primary[16] COCs at the 175 Roger Avenue site are the chlorinated VOCs including PCE, TCE, and, to a lesser degree, dechlorination daughter products *cis*-1,2-dichloroethene (*cis*-1,2-DCE) and vinyl chloride. The compounds were generally not present (above trace levels) in the soil samples collected from the former UST (and surrounding) area but were detected in groundwater and soil gas samples collected from the site in both the 2009 ATC and 2020 FLS investigations (Sheet 1). Concentrations of PCE, which were detected as high as 15,000 µg/l in 2009, were reported at lower levels (up to about 7,600 µg/l) during the 2020 evaluation. Likewise, the amounts of TCE, detected as high as 6,100 µg/l in 2009, was reduced to a maximum concentration of approximately 5,440 µg/l. The maximum concentrations of these two compounds were in groundwater samples collected by the investigators below 30 feet bgs with relatively minor concentrations (less than 109 µg/l) detected in the water column above this depth.

The samples collected by FLS in 2020 also revealed evidence of some natural dechlorination with concentrations of *cis*-1,2-DCE (up to 3,510 µg/l) and vinyl chloride (up to 107 µg/l) detected in samples collected below 30 feet bgs. Notably, the remedy conducted in 2022 was restricted to the shallow groundwater and likely did not treat any affected groundwater (including the dissolved chlorinated VOCs) at depths beyond 20 feet bgs. NIOSH *Pocket Guide to Chemical Hazards* datasheets for the COCs are presented in Appendix C.

Soil and groundwater samples collected by ATC and FLS also revealed concentrations of non-chlorinated constituents in the soil within and the groundwater beneath the former UST area (Sheet 1). The including xylenes (up to 354,000 µg/kg in soil and 48,700 µg/l in groundwater), 1,3,5-trimetylbenzene (up to 37,500 µg/kg in soil and 1,510 µg/l in groundwater), toluene (up to 6,150 µg/kg in soil and 21,800 µg/l in groundwater), ethyl benzene (up to 72,000 µg/kg in soil and 9,470 µg/l in groundwater), and n-propylbenzene (up to 34,100 µg/kg in soil and 1,340 µg/l in groundwater). The compound 1,2,4-trimethylbenze was not detected in 2020 by FLS but was present in the soil (within the UST area) and groundwater samples collected by ATC in 2009. The soil contained concentrations of the compound as high as 870,000 µg/kg with the groundwater samples containing dissolved concentrations as high as 107,000 µg/l. All the maximum concentrations were detected in soil and groundwater samples collected in and around the former UST area: the dissolved levels of all the non-chlorinated compounds decreased rapidly with distance from this area. WSP's analysis is that the 2022 remedy addressed the affected soil and groundwater within the UST area.

[16] The investigations also detected metals, including arsenic, lead, chromium, nickel, and zinc. The metals were detected at relatively low levels in the soil and sediment collected from the onsite drywells, the former UST and manufacturing building, and at trace levels in the groundwater. The dissolved concentrations were generally at or near the ambient water quality standards and are consistent with levels detected in samples from the Magothy Aquifer in a nearby (unaffected) groundwater well owned by the U.S. Geological Survey. The dissolved concentrations of metals are not considered a significant constituent of concern at the site.

Investigation data collected by ATC and FLS did not reveal substantive detections of SVOCs or metals in the groundwater at the site. WSP does not consider these compounds as COCs for this plan.

The 17 soil gas samples collected by FLS in 2020 revealed seven compounds, including chlorinated VOCs, with concentrations above the detection limit. The highest concentrations were PCE (up to 548 µg/m^3) and TCE (up to 55.4 µg/m^3). The balance of the compounds, methylene chloride (up to 21 µg/m^3), acetone (up to 375 µg/m^3) and 2-butanone (up to 10 µg/m^3) were generally detected at low or modest concentrations. Fleming, Lee Shue performed a statistical analysis of the data that showed the acetone and 2-butanone were strongly associated with the chlorinated VOCs. These compounds are known metabolic intermediates of dechlorination and support the data indicating some level of chlorinated VOC breakdown is occurring under ambient conditions. The concentrations of these compounds are relatively low and not considered to be representative of a widespread release at the site nor are they included as COCs for this HASP.

Potential exposures to the COCs (i.e., direct contact or via inhalation) outlined above will be reduced by establishing and implementing health and safety procedures, including using work zones (i.e., exclusion, contaminant reduction, and support zones), PPE, and implementing procedures for personnel and equipment decontamination, as presented in Sections 6 and 7. NIOSH *Pocket Guide to Chemical Hazards* datasheets for the COCs are presented in Appendix C.

5.2 HAZARD EVALUATIONS

WSP identified the following (generalized) hazards and risks associated with proposed work outlined above. A specific analysis of the risks is presented in the JHA form for each task (Appendix D).

Table 5.1.1 Impacted Media

Impacted Media ("X" indicates chemical hazard)		Tasks
X	Soil	Well install and soil sampling
	Sediment	None
X	Groundwater	Groundwater investigation and soil sampling
	Surface Water	None
X	Air/Vapor	Well install, groundwater, soil gas, and soil sampling
	Building Materials (e.g., concrete, paint)	None
	Non-aqueous Phase Liquid	None
X	Waste	Well install, groundwater and soil sampling

Table 5.1.2 Chemical Hazards

Chemical Hazards ("X" indicates chemical hazard)		Tasks
X	Volatile (boiling point less than 250 degrees Celsius [°C])	Well install, groundwater soil gas and soil sampling
	Corrosive (e.g., acids, bases, cement)	None (except use[17] as sample preservative)
	Flammable (flash point less than 37.8 °C)	None
	Combustible (flash point at or above 37.8 °C and below 93.3 °C)	None
	Toxic	Well install, groundwater and soil sampling
	Reactive (e.g., explosives, oxidizers, reducers, acid sensitive, air sensitive, unstable)	None
	Radioactive	None

[17] WSP does anticipate that select groundwater sample containers will contain sample preservatives (e.g., hydrochloric, and nitric acids) that could potentially pose absorption, inhalation, or ingestion hazards during the handling of the sample containers; however, the volume used in these containers is low and the risk associated with the sampling is negligible.

PHYSICAL HAZARDS

- Electrical (fire): Use of electrical power that results in electrical overheating or arcing to the point of combustion or ignition of flammables, or electrical component damage.
- Electrical (shock/short circuit): Contact with exposed conductors or a device that is incorrectly or inadvertently grounded.
- Ergonomics (strain): Damage of tissue due to overexertion such as strain and sprains, or repetitive motion.
- Fall (slip, trip): Conditions that result in falls (impacts) from height or traditional walking surfaces.
- Fire/Heat: Temperatures that can cause burns to the skin or damage other organs. Fire requires a heat source, fuel, and oxygen.
- Mechanical failure: Typically occurs when devices exceed designed capacity or are inadequately maintained.
- Mechanical: Skin, muscle, or body part exposed to crushing, caught-between, cutting, tearing, shearing items or equipment.
- Mechanical/vibration (chaffing/fatigue): Vibration that can cause damage to nerve endings, or material fatigue that results in a safety-critical failure.
- Noise: Noise levels (> 85 decibels [dBA] 8-hour time weighted averages [TWA]) that results in hearing damage or inability to communicate safety-critical information.
- Stuck by (mass acceleration): Accelerated mass that strikes the body causing injury or death.
- Struck against: Injury to a body part resulting from contact with a surface in which action was initiated by the person.

ENVIRONMENTAL HAZARDS

- Visibility: Lack of lighting or obstructed vision that results in hazards.
- Radiation (non-ionizing): Ultraviolet, visible light, infrared, and microwaves that can cause injury to tissue by thermal or photochemical means.
- Weather phenomena: rain and thunderstorms, wind, ice, and snow; extreme temperatures (hot and cold).
- Biological hazards: Direct contact with poisonous plants or insects (e.g., poison ivy, biting or venomous ants, chiggers [mite larvae], bees, wasps, yellow jackets, ticks, potentially venomous spiders, and potentially venomous snakes), or, in work within residences or residential areas, encounters with uncontrolled pets.

5.3 HAZARD CONTROLS

Normal operating conditions (e.g., truck and other motorized vehicle traffic), inclement weather, and third party subcontractors working during the proposed investigation activities pose physical hazards for the field team, visitors, facility workers (if present at an active facility), and others who may be present at the site. Eliminating all the risks and hazards is not feasible; however, heightened awareness and the implementation and control of the work area during the investigation activities can mitigate the hazards and prevent injury. Steps such as establishing an overall work zone, marking onsite mobilization pathways, and securing loads can limit the possibility of unauthorized access to the work area, being struck by a moving vehicle or the accidental release of supplies or equipment. Likewise, identifying work zones with inherent risk (e.g., near excavators or loaders, drill rigs, electrically power pumps, diesel powered generators, power tools, etc.) and controlling access to these zones can aid in limiting the physical hazards to onsite personnel. Onsite hazards can also be minimized by ensuring that the WSP personnel perform the scope of work in accordance with the WSP SOPs (referenced in the work plan) and that the subcontractors store and operate their machinery in a professional manner that prevents accidents via inadvertent contact with moving parts or falling equipment.

WSP personnel who are part of the field team are encouraged to maintain line-of-sight connections with the balance of the team and subcontractors (when possible) and to carry mobile phones. The latter will ensure communication with other WSP team members, the subcontractors, and, if necessary, provide a means for contacting emergency services. WSP personnel should also conduct daily health and safety briefings (i.e., the tailgate meeting) with the field team members and subcontractor employees. The meetings provide an opportunity to:

- outline the planned activities for the day, including the deployment of specific equipment and personnel; and

- organize the onsite work such that a minimum of two workers (WSP and subcontractors) are onsite during the planned activities.

The meetings will aid in a general awareness of the balance of the team and the location of the equipment used for the work.

The balance of the hazard controls listed below are designed to minimize the chemical exposure and select physical and environmental hazards identified for the site.

5.3.1 CHEMICAL HAZARDS

The hazard evaluation identified exposure to volatiles, including chlorinated compounds, that may be toxic. WSP has established the guidelines for the appropriate PPE (outlined in Section 6 below). The PPE includes the weather-appropriate clothing; protective shoes, eyewear, and headgear; hearing protection, and the use of disposable (nitrile) gloves. WSP has also established a monitoring regime (outlined in Section 7) that will be implemented while onsite and an upgrade pathway for the PPE.

Field personnel will also minimize potential chemical hazards by:

- limiting direct contact with soil or groundwater during the investigation activities;
- conducting frequent air monitoring (as detailed below) to determine the necessary level of PPE (i.e., to limit inhalation exposures); and
- avoiding ingestion or inhalation of dust or aerosolized groundwater generated during the drilling work.

WSP personnel will also refrain from eating, drinking, or smoking (allowed away from the active work areas). No smoking will be allowed at the site.

5.3.2 FALL (SLIP, TRIP) AND VISIBILITY

Uneven, wet, or slick surfaces, or poorly lit areas of the site present an increased risk of injury. Recognizing these hazards onsite and taking steps to address the concern (e.g., removing tools, piping, cables, and other potential tripping hazards; using sand or other material to reduce slips on wet surfaces; clearly marking depressions or holes within the work area, etc.) will minimize the potential for injury due to a fall. WSP should also employ supplemental lighting at the site to increase visibility when conditions warrant (e.g., working at or near dusk).

5.3.3 ERGONOMICS (STRAIN)

Improper lifting and carrying equipment, sampling supplies, or other material mobilized to the site for the investigation often results in (ergonomic) strain or injury. This risk can be minimized by using the following lifting techniques:

- maintain a neutral and straight spine alignment (bend at knees, not the waist) when lifting the object;
- place materials to be manually lifted about mid-thigh to mid-chest where you have greatest lift capacity;
- keep the lifted object or materials close to your body to reduce the strain on your back;
- use the proper handholds for the object; and
- avoid twisting while carrying.

Strain can also be avoided by using lifting aids such as pallet jacks or hand trucks to move heavy or awkward items (e.g., 55-gallon drums).

5.3.4 ELECTRICAL, FIRE/HEAT, MECHANICAL, NOISE, STRUCK BY AND STRUCK AGAINST

The proposed field activities include the likely use of heavy equipment (drill rigs, front-end loader), vehicles and trailers, electrical generators, steam cleaners, and pumps, all of which are potential physical hazards. Working near the drill rigs or the excavator, for instance, presents a risk of injury due to being struck or crushed by moving machine parts, exposure to

excessive noise[18] (during the drilling operations), or being stuck while moving between drilling locations. WSP personnel can also be inadvertently hit by trucks or other vehicles moving on or around the site, exposed to electrical shocks associated with the generator, and suffer burns, lacerations or eye injury resulting from contact with (or improper use of) the steam cleaners[19]. These hazards can be minimized by establishing work zones and mobilization pathways (i.e., limiting the avenues for driving on the site); ensuring that all onsite equipment is fitted with the machine guarding and safety apparatus (e.g., shrouds, guards, backup warnings, emergency kill switches, etc.) and is properly grounded (i.e., fitted with ground fault protection); and increasing the situational awareness of WSP personnel and the subcontractor employees (i.e., keeping track of the location of working heavy equipment and vehicles). Other appropriate precautions include the following:

- the use of the appropriate PPE (e.g., hardhats, safety glasses or goggles, and safety boots) as detailed in Section 6 below;
- minimizing loose clothing that may catch in moving parts of the drill rig or other equipment;
- wearing hearing protection during drilling activities; and
- use of DOT-compliant high visibility reflective clothing or vests (a required part of the PPE for the site; see below).

5.3.5 RADIATION (NON-IONIZING)

Ultraviolet (UV) rays are a part of sunlight that can penetrate and change the structure of skin cells. There are three types of UV rays: UVA, UVB, and UVC. The most abundant of the three types of rays, UVA, penetrates beyond the top layer of human skin and may cause damage to connective tissue and increase a person's risk for developing skin cancer. Solar radiation that contains UVB does not penetrate as deep into the skin (as UVA); however, the radiation can still cause some forms of skin cancer. Natural UVC rays are absorbed by the upper atmosphere and, thus, do not pose a risk to workers.

Workers should follow these recommendations to protect themselves from UV damage:

- use sunscreen with a minimum Sun Protection Factor (SPF[20]) of 15;
- apply sunscreen liberally to exposed skin, including ears, scalp, lips, neck, and the backs of hands;
- reapply frequently following the directions of the manufacturer increasing the applications if used in tandem with an insect repellant (insecticides can reduce the efficacy of the sunscreen);
- wear appropriate clothing (including high SPF garments) that covers skin in areas prone to sunburn; and
- use wide-brimmed hats and sunglasses, if appropriate for the specific activity.

WSP personnel should also remember that sunlight exposure is highest during the summer and between 10:00 a.m. and 4:00 p.m. and that UV radiation is a concern even on cloudy days. It is also important to note that many prescribed or over-the-counter medicines, such as thiazides, diuretics, tetracycline, doxycycline, sulfa antibiotics, and even ibuprofen may increase sensitivity to sunlight and the risk of a sunburn. Use of these medicinal drugs at the site may require additional protective clothing or more frequent use of sunscreen.

5.3.6 WEATHER

Weather at the 175 Roger Avenue site can be a concern for WSP personnel conducting the proposed investigation activities. The forecast for the day should be discussed during the daily health and safety meeting and a determination made as to

[18] All WSP employees are entered in a Hearing Conservation Program and will don hearing protection when noise is expected above the OSHA action level of 85 dBA. Hearing protection should be worn when any the noise is loud enough to make conversation difficult at 3 feet. Foam ear plugs or protective over-the-ear muffs capable of providing a 33 dBA noise reduction rating are considered minimum protection.

[19] A steam cleaner other high-pressure washers may be employed for purposes of decontamination of equipment and vehicles (these are typically operated by the subcontractor). Steam-cleaning spray wands discharge hot water and steam at pressures exceeding 1,000 pounds per square inch. The steam can severely lacerate and burn exposed skin, and hurl soil and rocks at high velocity. WSP personnel should avoid handling the steam cleaner devices and maintain a safe distance during its operation.

[20] Sun Protection SPF refers to the amount of time that persons will be protected from a burn. An SPF of 15 will allow a person to stay out in the sun approximately 15 times longer than they normally would be able to stay without burning. The SPF rating applies to skin reddening and protection against UVB exposure (and, for select formulations that contain Mexoryl, Parsol 1789, titanium dioxide, zinc oxide, or avobenzone, UVA radiation). Sunscreens have a limited lifetime (1 to 2 years, on average) and their performance is affected by humidity, perspiration, and wind.

whether the ambient conditions pose a potential risk for heat or cold stress. Weather-appropriate clothing, proper hydration, and continuous monitoring of team members will help reduce the risk. The briefing should also discuss the possibility of thunderstorms in the area while the team is onsite. No work should be conducted during a thunderstorm. All field personnel will cease their onsite work if thunder is heard and either move indoors or to an onsite vehicle. Field personnel will stay indoors (or sheltering in onsite vehicles) for at least 30 minutes after hearing the last sound of thunder.

5.3.7 BIOLOGICAL HAZARDS

The 175 Roger Avenue site is in a developed portion of Long Island (Figures 1 and 2). WSP does not anticipate any large fauna (e.g., bears or coyote) or contact with venomous snakes. The team is more likely to encounter poisonous plants (e.g., poison ivy or poison oak) or nuisance insects, such as mosquitos, tics, bees, and arachnids (spiders). Poison ivy or oak, if present on the vacant site, will likely be found around the margins of the site where is borders other commercial properties. WSP personnel should avoid these areas, if possible, and minimize any contact with unknown vegetation. Insect bites can cause skin irritation, transmit disease, or, in some cases, result in an allergic response. Medical information (i.e., allergies and current medications of field personnel) will be requested before site activities are initiated. Insect repellent containing DEET should be used to prevent tick and mosquito bites. The repellant should be applied to exposed skin and around the ankles and beltline (to prevent tics). Field personnel should also be mindful of the potential presence of arachnids and bees when working outside, opening well vaults, or other enclosures that may harbor a bee nest.

6 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment will be used to reduce employee exposure to chemical, physical, and environmental hazards that cannot be abated through engineering or administrative controls. The WSP PPE Program was prepared to provide information regarding personnel training; hazard assessments; PPE selection, use, efficacy, maintenance, replacement, and storage; the limitation of the equipment; and the proper disposal of used PPE. The program complies with the requirements of the OSHA standards (29 CFR 1910 Subpart I).

6.1 LEVEL OF PROTECTION

All WSP personnel and WSP subcontractors[21] are required to have successfully completed a 40-hour health and safety training course fulfilling the initial and refresher instruction requirements specified in 29 CFR 1910.120 for activities on a hazardous waste site. Subcontractors, before mobilizing to the site, are required to supply documentation of 40-hour training, 8-hour refresher training, participation in a medical monitoring program, and fit-test results for the use of tight-fitting respirators for each site worker (the *Respirator Fit Test Results* documentation is included in the Forms Section of this document). Those workers must understand the hazards detailed in this HASP and maintain a site-specific HASP that their employer has prepared. WSP subcontractors are also responsible for providing the appropriate PPE for their employees and conducting training on the use of that equipment before any onsite activities begin.

Levels of protection should be selected based on the following:

- type and concentration of the chemical substance in the ambient atmosphere and its toxicity;
- potential for exposure to substances in air, liquids, solids, or other materials personnel may encounter during the proposed work; and
- an understanding of the chemical properties such as toxicity, route of exposure, and contaminant matrix

WSP anticipates that most work at the 175 Roger Avenue site will be conducted in modified Level D PPE, as detailed in Table 6.1.1 below.

Table 6.1.1 Personal Protective Equipment – Modified Level D

Type	PPE (list all required PPE)
Respiratory	Level D, upgrade to full-face APR with organic vapor cartridges (i.e., Level C), as necessary;
Clothing	Weather-appropriate work clothes (e.g., long pants, shirt with sleeves); **high-visibility vests** (required for all field activities)
Gloves	Work (cotton, canvas, or leather); nitrile (when collecting analytical samples or in potential contact with affected media at the 175 Roger Avenue site)
Boots	Safety boots (e.g., steel toe)[22]
Hearing protection	Ear plug or muff (hammer drill and work near direct-push drill rig)
Other PPE	Safety glasses[23] and hard hat

[21] The 40-hour training requirement specified in 29 CFR 1910.120 for activities on a hazardous waste site does not apply to surveyors or support subcontractors who do not conduct intrusive activities and are not responsible for the management of investigation-derived waste.

[22] Safety boots must meet one of the following test standards: ASTM F-2412-2005 *Standard Test Methods for Foot Protection* and ASTM F 2413 2005 *Standard Specification for Performance Requirements for Protective Footwear*; ANSI Z41-1999 *American National Standard for Personal Protection -- Protective Footwear*; or ANSI Z41-1991 *American National Standard for Personal Protection -- Protective Footwear*.

[23] Protective eye and face protection devices must comply with any of the following: ANSI Z87.1-2003 *American National Standard Practice for Occupational and Educational Eye and Face Protection*; ANSI Z87.1-1989 (R-1998) *American National Standard Practice for Occupational and*

The current PPE assessment was based on the anticipated physical and environmental hazards outlined above, and the known COCs at the site (derived from previous investigation at the property). Modifications to this level of PPE are permitted with review and permission by the Task Manager or the SHSC, which will then be communicated to other members of the project team. WSP personnel shall be prepared to upgrade to Level C respiratory PPE, if necessary (see the *Monitoring Procedures* in Section 7 below). Respiratory protection and hearing protection training are included in the 40-hour health and safety training course (no separate training is required).

6.1.1 LEVEL C PERSONAL PROTECTIVE EQUIPMENT

Level C PPE will consist of the same items listed for the modified Level D and include a NIOSH-approved full face-piece air-purifying respirator (APR) equipped with organic vapor cartridges (NIOSH-approved), and chemical-resistant coveralls, gloves, and safety boots. The level of PPE (e.g., Level D or Level C) may be upgraded or downgraded by the Field Team Leader based on changes in conditions (e.g., the start of a new task or phase of work, weather changes, or encountering higher-than-expected COC concentrations) or monitoring information (see below). No changes to the specified level of protection shall be made without the approval of the SHSC or the General Supervisor.

The PPE for both Levels C and D will be constantly inspected for damage via the buddy system and by individual employees. Proper inspection depends on the specific articles of PPE and the frequency of use. The different levels of PPE evaluation are as follows:

- inspection and operational testing of equipment as it is received from the manufacturer or distributor, or after it has been stored;
- inspection of equipment as it is issued to field team members;
- a visual assessment of the equipment before it is donned;
- a follow-up evaluation conducted after the use and decontamination of the equipment; and
- a reevaluation of the appropriateness of the selected PPE when conditions change or there is an equipment problem elsewhere on the site.

The primary inspection of PPE will occur before use and will be conducted by the user. This ensures that the device is serviceable and aids in familiarizing the personnel with its use. Damaged PPE will be discarded and replaced immediately.

Educational Eye and Face Protection; or ANSI Z87.1-1989 *American National Standard Practice for Occupational and Educational Eye and Face Protection*.

7 MONITORING PROCEDURES

WSP interpretation of the investigation and remedial data is that the primary COCs at the 175 Roger Avenue site are the dissolved chlorinated VOCs. Most of the chlorinated mass, based on the previous investigation data, is PCE and TCE; however, there are detectable concentrations of the degradation daughter products *cis*-1,2-DCE and vinyl chloride. Vinyl chloride has the lowest exposure limit and is the basis for establishing the first tier of the action levels at the site. The second tier action level (if vinyl chloride is not detected using colorimetric tubes) is the compound with the penultimate exposure limit, TCE. The specific monitoring procedures and action levels are presented below.

The non-chlorinated compounds were included in the development of the monitoring procedures. Those compounds (e.g., xylene, toluene, 1,2,4-trimethylbenze, 1,3,5-triumethylbenzene, etc.) were, based on the investigations, limited in extent and concentrations in and beneath the former UST area (Sheet 1). Those compounds that were detected in soil were removed from the site and the underlying dissolved mass reduced[24] as part of the remedial excavation and local groundwater treatment. WSP included these compounds in the assessment as part of a conservative approach (the full extent of the mass removal and treatment is unknown); however, the thresholds and resulting action levels are substantially higher than those calculated for vinyl chloride or TCE and, thus, are not included in monitoring procedures.

7.1 MONITORING AND ACTION LEVELS

The work at the site will begin in modified Level D PPE, as specified in Section 6 above, with the option to upgrade to Level C, if necessary. The breathing zone for the site and the specific work area will be monitored for organic vapors using a PID equipped with a **10.6 eV lamp**. The PID and lamp value were selected based on the exposure limits (threshold limit values [TLVs]) and the ionization potentials (IPs) for the compounds detected onsite (all the identified COCs at the site, including the non-chlorinated compounds[25], have an IPs of less than 10 eV). The TLVs and IPs for the primary COCs are listed in Table 7.1.1 below.

Table 7.1.1 Exposure Limits and Ionization Potentials for Constituents of Concern

Compound	TLV (PPM)	Ionization Potential (eV)
PCE	25	9.32
TCE	10	9.47
cis-1,2-DCE	200	9.65
vinyl chloride	1	9.99

Table Notes: PPM = parts per million.

The monitoring of the breathing zone will be conducted by SHSC, or their designated representative, before and during all proposed activities with a PID equipped with the appropriate lamp that has undergone a battery check and is calibrated as per the manufacturer's recommendations.

The action levels for the site are based on the exposure limits for vinyl chloride (Tier 1) and TCE (Tier 2). The specific action levels (based on the organic vapor monitoring performed with the PID) are:

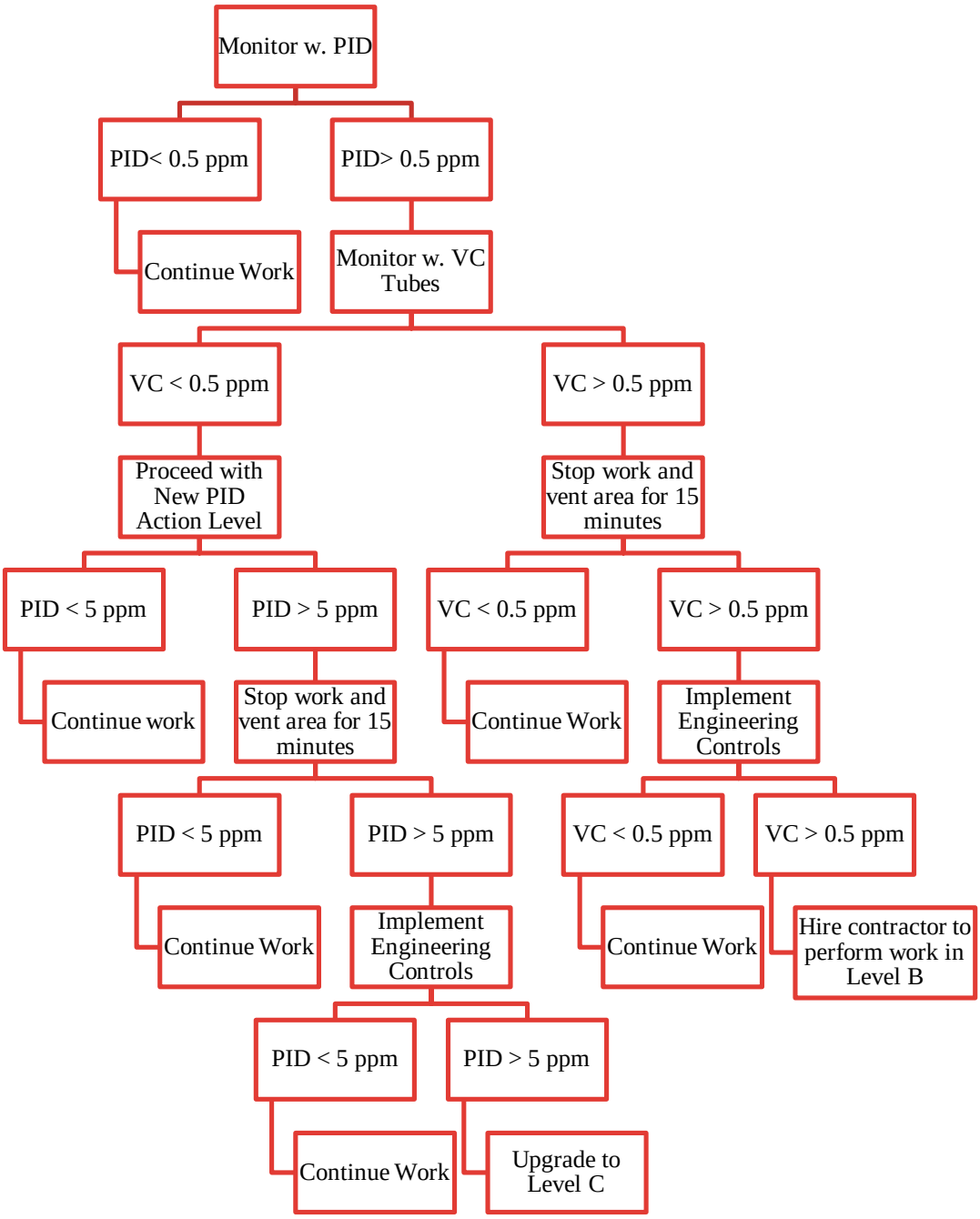
- **0.5 parts per million (ppm),** based on half the TLV for **vinyl chloride** (1 ppm);
- **5 ppm**, based on half the TLV for TCE (10 ppm), the VOC with the next most stringent TLV.

[24] The remedial excavation in the former UST area was advanced 7 feet below the water table allowing the removal of impacted soil both above and below the water table, the extraction of affected groundwater (for the dewatering activities), and, through the emplacement of ZVI in the open excavation, localized treatment of the dissolved compounds. These actions likely reduced the amount of non-chlorinated compounds at the site; however, the efficacy is unknown. The work was not followed by a post-treatment performance monitoring program.

[25] The non-chlorinated compounds detected at the site during the 2009 and 2020 investigations have the following IPs: xylenes, 8.52 eV; 1,2,4-trimethylbenzene, 8.27 eV; 1,3,5-trimethylbenze, 8.39 eV; toluene, 8.80 eV; ethyl benzene, 8.75 eV; and n-propylbenzene, 8.77 eV.

Compound-specific monitoring will be performed for **vinyl chloride** with colorimetric tubes (or similar) if the action level is exceeded (and periodically thereafter). The following tiered monitoring approach (Diagram 1) will be implemented:

Diagram 1 – Vinyl Cloride and Trichloroethene Tiered Monitoring Approach



The maximum use concentration (MUC) for a full-face APR, calculated as the assigned protection factor (50) multiplied by the TLV for TCE (10 ppm), is 500 ppm.

8 CONTROLS AND DECONTAMINATION

Site controls, as detailed below, are an essential component of the health and safety program. Those controls, at a minimum, should include:

- using the buddy system;
- conducting a health and safety briefing (i.e., tailgate) before beginning site activities each day and record in field book.
- avoiding sitting or kneeling in contaminated areas or laying equipment on the ground where contaminated groundwater or soil may be present;
- not eating, drinking, or using tobacco products outside the designated support zone(s);
- avoiding the use contact lenses while onsite;
- washing hands and face before eating or drinking (offsite);
- maintaining copies of the HASP at the site;
- replacing damaged or worn PPE as soon as possible; and
- ensuring that all subcontractors have a site-specific HASP.

Specific controls for the site, including those associated with decontamination, are presented below.

8.1 WORKING ALONE

Employees should not be sent out to work alone (i.e., lone working) in the field whenever possible. This must be considered during the proposal phase of the project. Should lone working be required, the following must be adhered to:

- field personnel and their home office should be made prior to departure, during the work (for tasks lasting longer than half a day), and upon completion of the task whether returning to the office or going to another location;
- working alone only be conducted when WSP subcontractors are onsite (for the planned activities). Other onsite work (beyond that with the planned subcontractors) may require the support of additional personnel should the task not be deemed acceptable as a risk for lone working.
- Task Managers must consider the level of competence of the individual being sent to perform the work. Under no circumstances shall interns be sent out to work alone.

By signing the HASP, the Task Manager acknowledges that the appropriate staff is selected for all work especially for lone working conditions.

8.2 HEALTH AND SAFETY BRIEFING

The SHSC, or an appropriate designee, will review activities scheduled for each day before any work starts. The meeting will include the hazards associated with the planned activities for WSP personnel, the onsite workers (if present at an active facility) or any others that are authorized to be onsite. The briefing will also include a discussion of the weather forecast and any additional weather-appropriate clothing that may be necessary for the work that day. The SCSH or other designee will document the daily health and safety briefing in the field logbook.

8.3 ESTABLISHING WORK ZONES

All WSP employees are responsible for onsite control. During work activities, the following zones will be established:

Work/Exclusion Zone – No unauthorized personnel will be permitted within 20 feet of any sampling, staging, or treatment area;

Contamination Reduction Zone – The contaminant reduction zone will be located outside the exclusion zone as designated by WSP personnel; all decontamination procedures will be conducted within this zone; and,

Support Zone – All areas outside of the work/exclusion zones will be treated as a support zone; no work or contaminated materials will be removed from the work area or taken into the support zone.

The prevailing wind conditions are not known and will be determined onsite (cardinal direction). No contamination reduction zone or support zone will be established downwind of a work/exclusion zone.

8.4 CONFINED SPACE ENTRY

No WSP employee may conduct **ANY TYPE** of confined space entries. All non-permit required confined space entries **MUST BE** approved by the Direct of Environment or their designee before any entry attempt is made. Therefore, no attempt will be made to enter any type of confined space without approval.

8.5 DECONTAMINATION

Decontamination is the process of removing or neutralizing contaminants that have accumulated on personnel and equipment. It is critical to health and safety at sites where the potential for exposure to hazardous chemicals is present. Decontamination:

- addresses hazardous substances that may contaminate and eventually permeate the protective clothing, respiratory equipment, tools, vehicles, and other equipment used on site;
- protects site personnel by minimizing the transfer of harmful materials into clean areas;
- prevents contact of incompatible chemicals; and
- it protects the community by preventing uncontrolled release of contaminants from the site.

Detergent and water will be used as the decontamination solution unless otherwise specified. Decontamination procedures will include the following (describe onsite decontamination procedures for PPE and personnel; for example [e.g., boot wash]):

- Segregated equipment drops, outer boot and glove wash, outer boot and glove rinse, outer boot and glove removal, coverall removal, inner glove removal, field wash.
- Gloves will be used when contact with potentially contaminated groundwater and soils are anticipated. Glove removal will ensure that contaminated surfaces are not in contact with skin.

Gross decontamination of non-disposable equipment (e.g., clothing) should take place onsite using rags or brushes to remove dust or soil. Any clothing that has been saturated or soiled by potentially contaminated environmental media should be segregated and laundered separately, being mindful of contact contamination at home or at the hotel room.

All non-dedicated sampling equipment will be decontaminated before each use and before leaving the site, in accordance with the following procedures: wash equipment thoroughly with laboratory detergent and hot water using a brush to remove any particulates, rinse equipment with tap water, allow equipment to air dry, rinse equipment with analyte-free water, allow equipment to air dry, and wrap equipment in aluminum foil during storage or transport in the field.

Equipment decontamination procedures will be conducted in accordance with WSP's SOP 6.

9 TRAINING PROGRAM

Several levels of health and safety training are required for personnel participating in the implementation of field activities. All WSP employees must have current training documentation for the following before field activities commence:

- 40-hour OSHA training;
- current 8-hour refresher certificates; and
- first-aid, cardiopulmonary resuscitation (CPR) and automatic external defibrillator (AED) training.

The HAZWOPER training must include[26] the proper use of respiratory and hearing protection. Documentation of this training will be maintained by WSP for all personnel who have access to or work at the site and is provided in Appendix A.

WSP employees are also required to have completed the *Health and Safety Field Safety Orientation* training and a *Defensive Driving* course before mobilizing to the field. These training courses are required by WSP who will be conducting field work and driving as part of their work activities. These training courses listed on the *Energy and Environment Health and Safety – Training Resources* SharePoint at the following address:

(https://wsponlinenam.sharepoint.com/sites/US-USEEHealthandSafety/SitePages/E&E-HSE-Training-Resources.aspx).

Completion of the required courses is documented within My Learning Portal (MyLP; https://mylp.synlms.com/).

9.1 HAZARDOUS WASTE OPERATIONS AND EMERGENCY RESPONSE TRAINING AND REFRESHER

Personnel participating in field activities at the site who may be exposed to hazardous materials will receive 40 hours of initial Hazardous Waste Operations and Emergency Response (HAZWOPER) training. The training program, which must comply with the requirements of 29 CFR 1910.120, should include:

- names of personnel and alternates responsible for site safety and health;
- safety, health, and other hazards present on the site;
- use of PPE, including respiratory and hearing protection;
- work practices designed to minimize risks from hazards;
- safe use of engineering controls and equipment on the site;
- medical surveillance requirements including recognition of symptoms and signs which might indicate over exposure to hazards; and
- elements of a HASP.

The employees, once certified, must complete an 8-hour refresher course on an annual basis (certificates documenting the refresher training are required for work at the 175 Roger Avenue site).

9.2 FIRST AID

All WSP personnel who perform fieldwork are required to have current American Red Cross or American Heart Association Heartsaver® certifications in first aid, CPR, and use of an AED. Training and certification are provided by WSP at no charge to the employees. WSP's Area Managers are responsible for ensuring that initial and required refresher training is provided to staff as necessary and for maintaining documentation of the training provided.

The Task Manager should designate an individual to render first aid in the event of an emergency if the response time from the local fire and rescue squad is expected to exceed 4 minutes. The SHSC (and Task Manager) should also ensure that a

[26] Respiratory protection and hearing protection training are included in the 40-hour health and safety training course.

standard first aid kit is available at the site. The kits will contain, as a minimum, the items specified in Appendix A of 29 CFR 1910.151, which are as follows:

- gauze roller bandages, 1 inch and 2 inches;
- gauze compress bandages, 4 inches;
- adhesive bandages, 1 inch;
- triangular bandages, 40 inches;
- ammonia inhalants and ampoules;
- antiseptic applicators or swabs;
- burn dressing;
- eye dressing;
- wire or thin board splints; and
- forceps and tourniquet.

The designated first aid provider is responsible for checking the kits prior to bringing them to the site to ensure they are fully stocked. The kits will be contained in weatherproof containers with individual sealed packages for each type of item. A means to flush the eyes or body should also be provided on sites where there is a potential for the eyes or body to be exposed to injurious corrosive materials. A plumbed-in-place eye wash fountain or shower will be replaced by a portable, gravity feed eye wash fountain (to be added to the standard first aid kit, as necessary).

The location of the nearest medical facility, the directions from the site to the facility, and the telephone number of the facility and the local first responders is provided in Section 11.

9.3 VISITOR TRAINING

All visitors to the active work areas will be briefed by the SHSC or their designee on health and safety procedures to be followed. The visitors will be provided the HASP to review and, depending on the locations to be visited, will sign a certification that the plan has been provided, reviewed, and understood before visitors enter an active work area.

The Task Leader or his designee will control visitor entry to the active work areas. No visitor will enter these areas without previously notifying the Task Leader or their designee of the visit and providing documentation of training outlined in Section 9.1. The SHSC or their designee will ensure that all visitors have the proper level of PPE for downrange activities and training in the use of the equipment; visitors who do not have the appropriate training will not be permitted in areas where the use of PPE is required.

10 MEDICAL SURVEILLANCE

All employees, regardless of the exposure involved, are required to participate in the medical monitoring program established by WSP. OSHA regulations state that employees involved in certain activities that may expose them to hazardous materials at or above permissible exposure limits (PELs) or above the published exposure limit for greater than 30 days per year, or all employees who wear a respirator are required to participate in the monitoring program.

The purposes of the medical monitoring program are to identify any illness or condition that might be aggravated by exposure to hazardous materials or work conditions; to certify that each employee can use negative-pressure respirators as required by OSHA and withstand heat or cold stress; to ensure that employees are able to physically perform their assigned tasks and to establish and maintain a medical record to monitor for abnormalities that may be related to work exposure that could increase injury risk for the employee. WSP's medical monitoring program includes the following:

- a baseline physical examination;
- annual physical examination;
- a medical determination of fitness for duty, including work restrictions after any injury or illness that may affect employee safety; and
- a review of potential exposures to determine the need for specific biological and medical monitoring.

10.1 BASELINE, ANNUAL, AND EXIT PHYSICAL EXAMINATIONS

A baseline physical examination will be performed on each employee engaged in hazardous site activities as outlined above before any assignment with the potential for exposure to hazardous chemicals. The purposes of this examination are to identify any illness or condition that might be aggravated by exposure to hazardous materials or work conditions; to certify the safe use of negative-pressure respirators (29 CFR 1910.134); and to develop a medical record for the assessment of exposure-related risk. Variable data, such as age, sex, race, smoking, previous employment, and exposure history, that may have a bearing on future examinations after employment begins will be gathered.

An examination and updated occupational history will be performed annually during the anniversary month of the baseline physical examination. This annual examination serves to recertify that the employee can conduct work activities at hazardous waste and similar sites. The content of the examination may vary based on the nature of the work and potential exposure since the previous exam.

The baseline and follow-up annual physical examinations will include written questionnaire of the employees medical and occupational history; and a complete physical examination stressing the central and peripheral nervous system; cardiopulmonary system, spine and other musculoskeletal system, abdomen, rectum, and genitourinary system. Specifically, the physical for the baseline and annual exams will include:

- height, weight, temperature, pulse, respiration rate, and blood pressure;
- an examination of the head, nose, neck, and throat;
- a chest exam (heart and lungs);
- a resting 12-lead electrocardiogram;
- a chest X-ray (posterior-anterior view);
- a pulmonary function test;
- an otoscopic examination and an audiogram at 500, 1,000, 2,000, 3,000, 4,000, and 6,000 hertz pure tone in an approved booth, administered by a qualified technician, and the results read by a qualified physician;
- a multiple chemistry blood panel (e.g., Chem 24), including kidney and liver function tests, complete blood count (CBC) with differential, and urinalysis with microscopic examination of centrifuged sediment;
- a red blood cell cholinesterase; and
- visual acuity testing.

The physical examination may include any follow-on tests that are deemed necessary by the physician due to symptoms, medical history, or, depending on the occupational history, exposure (e.g., to lead or other heavy metals, polychlorinated biphenyls, asbestos[27], etc.). WSP employees should obtain a complete medical and work history to expedite the physical examination process. Specifically, the employee should identify the following:

- any history of respiratory disease;
- previous occupations;
- problems associated with breathing during normal work activities;
- past problems with respirator use;
- psychological problems or symptoms including claustrophobia;
- any known physical deformities or abnormalities including those that may interfere with respirator use;
- past and current use of medication; and
- tolerance to increased heart rate, which can be produced by extra weight, increased workload, and heat stress associated with wearing respirators and protective clothing.

Any job-related illness or injury will be followed by a medical examination to determine fitness for duty or possible job restrictions based on the physical findings of the medical examiner. A similar physical examination will also be conducted following employee termination (i.e., an exit physical examination).

10.2 OTHER EXAMINATIONS

Medical examinations in addition to those described above may be required by the WSP Health and Safety Leader. Additional examinations could be required before or after a project of long duration or after work at a site with exposure concerns. An employee may also request a medical examination at their discretion based on potential exposure history, potential illness, or any condition which may produce a potential health hazard during work activities.

10.3 MEDICAL RECORDS

All medical records will be maintained by the examining physician, as well as the WSP medical monitoring provider. Copies of these records are typically transmitted directly to employees shortly after their annual physicals are completed. WSP's medical monitoring program administrator will maintain the certification of fitness provided by the physician, and the exposure records. Employee medical and exposure records will only be made available on written request by the employee or an authorized representative of the employee. OSHA compliance officers do not need to write a request for records that are required for them to evaluate compliance. When records are requested, they will be furnished within 15 days of the request. If OSHA requests records in writing, the written request will be posted in a visible location for at least 15 days (29 CFR 1910.20). Medical records will be kept on file for at least 30 years. If WSP ceases to do business without a successor, then OSHA will be notified and may require transfer of the records.

[27] All employees who are or will be exposed to airborne concentrations of asbestos fibers, the physical examination will also include completion of a respiratory disease standardized questionnaire per 29 CFR 1910.1001 Appendix D.

11 EMERGENCY PROCEDURES

Emergency response procedures for WSP and the authorized subcontractors will be outlined daily by the SHSC during the daily site briefings (this should be noted in the field logbook). Reviewing the standard procedures (as outlined below) procedures and evacuation routes will ensure that all site personnel know what to do in case of an onsite emergency related to the planned scope of work, the operation of the onsite facility (if active) and, the activities on other adjoining properties.

The SHSC shall be responsible for ensuring that the appropriate procedures are followed.

11.1 PERSONNEL ROLES AND LINES OF AUTHORITY

Field team leaders and WSP subcontractor supervisors have primary responsibility for responding to and correcting emergency situations affecting project personnel. Possible actions may involve evacuation of personnel from the work zones or from the entire site. The SHSC is responsible for the proper implementation of this HASP and all its requirements. Both the field team leaders and the SHSC will work with the Task Manager to ensure the safe and effective implementation of the proposed work.

WSP subcontractors are responsible for addressing any emergencies resulting from their work, establishing the proper incident command structure, and implementing response actions, as necessary. This includes informing WSP employees of the potential hazards related to the operation of their equipment and plans for evacuation if there is an emergency related to the operation or storage of their equipment.

11.2 EVACUATION ROUTES AND PROCEDURES

An emergency at the site, should it arise, could necessitate evacuation of all WSP personnel and subcontractors from the onsite work zone. A series of three extended horn blasts will be used by any onsite personnel to signal the emergency and communicate that all personnel should move immediately to the designated meeting location[28] (established, along with a secondary meeting location, at the beginning of the project). Electronic communication (e.g., mobile phone) will be used to alert workers beyond the range of the horns.

All available vehicles outside the work area will be used in the evacuation of a WSP work zone, if necessary. Personnel exiting the area should be upwind of smoke, vapors, or spill location(s) and meet at one of the designated rendezvous points. The Field Team Leader or their designee will conduct a head count to ensure all personnel have been evacuated safely 9the field book will provide a record of all onsite personnel). If someone is missing, The Field Team Leader or their designee will alert the appropriate emergency response personnel if someone is missing.

11.3 EMERGENCY CONTACT AND NOTIFICATION SYSTEM

WSP personnel shall initiate first aid and **call 911** in the event of an onsite emergency. Field personnel should also notify their respective Field Team Leader, who will notify the Task Manager and General Supervisor. The General Supervisor shall be responsible for contacting the client (AIREF), WSP Management, WSP Human Resources and the Health and Safety Team, and field personnel's emergency contact (as necessary).

Employees who suffer non-emergency or non-life threatening injuries are required to contact **TriageNow** (877-311-0038) in advance of seeking care. The health representative at TriageNow will gather pertinent information regarding the type of injury (including photographs of the injury mailed to nurse@injurypics.net), guide the employee to an appropriate nearby

[28] The Task Manager or SHSC will establish a meeting location and a secondary rendezvous point (selected in case the primary location is inappropriate due to wind direction, the severity, or type of emergency incident) at the beginning of the project. The meeting locations should be mentioned to the field team each day during the tailgate meeting.

health provider (e.g., Urgent Care), contacts that medical facility, and sends an incident report regarding the injury to WSP. The employee is required to enter the injury into iSMS following the completion of injury treatment.

The following telephone numbers, addresses, and directions for the nearest medical treatment facilities will be posted in each project vehicle for use during an onsite emergency:

Table 11.3.1 Emergency Contacts

Agency	Name	Address	Phone Number
TriageNow	TriageNow	NA	(877) 311-0038
Ambulance Service	First Response Ambulance of Inwood	455 Bayview Avenue Inwood, NY 11096	(516) 239-5666 (non-emergency)
Hospital	St. John's Episcopal Hospital/Emergency Room	327 Beach 19th Street Far Rockaway, NY 11691	911 or (718) 869-7755 (non-emergency)
Urgent Care	Urgent Care Lawrence (for non-emergency care; requires advance contact of TriageNow)	625 Rockaway Turnpike Lawrence, NY 11569	911 or (516) 750-0252 (non-emergency)
Police	Nassau County Police Department – 4th Precinct	1699 Broadway Hewlett, NY 11557	911 or (516) 573-6400 (non-emergency)
Fire Department	Inwood Fire Department	188 Doughty Blvd. Inwood, NY 11096	911 or (516) 239-4324 (non-emergency)
Poison Control	New York City Regional Poison Control Center	455 First Avenue, Rm. 123 New York, NY 10016	911 or 1-800-222-1222

11.3.1 DIRECTIONS TO HOSPITAL

The closest hospital is St. John's Episcopal Hospital located at 327 Beach 19th Street in Far Rockaway, NY.

Directions to Hospital:

- Head south on Cerro Street towards Bayview Avenue — 157 feet
- Turn left at the 1st cross street onto Bayview Avenue — 0.3 miles
- Turn right onto Sheridan Blvd. — 0.3 miles
- Continue onto Beach Channel Drive — 0.4 miles
- Turn left onto Mott Avenue — 0.1 miles
- Turn right onto Beach 20th Street — 0.4 miles
- Turn left onto Elk Drive — 135 feet

Total Estimated Time: 11 minutes Total Estimated Distance: 1.5 miles

A map showing the route to the hospital is provided in Appendix E.

11.4 EMERGENCY MEDICAL TREATMENT PROCEDURES

The primary concern in an emergency is to prevent the loss of life or severe injury to personnel. The Task Manager shall be notified of any emergencies and will be responsible for ensuring that the appropriate procedures are followed (detailed below). These procedures shall be rehearsed regularly as part of the overall safety program for the project.

Minor injuries: full decontamination should be completed, and first aid administered by onsite personnel before the injured is transported to hospital.

Major injuries: Serious injuries warrant an immediate call to 911 from a mobile phone. Partial decontamination may be completed, but only under the supervision of trained medical professionals. First aid may be administered while awaiting an ambulance or paramedics. The choice of hospital shall be made by the ambulance personnel.

Any person transported to a clinic or hospital for treatment should take a copy of this HASP because it provides information of the chemical or chemicals to which the person may have been exposed.

11.5 MEDICAL EMERGENCIES

Five medical emergencies have been identified as requiring implementation of emergency procedures. These emergencies include:

- cardio-pulmonary emergencies;
- physical injuries;
- heat or cold-related injuries;
- chemical exposures; and
- snake or spider bite.

The procedures for each of the five identified medical emergencies are detailed below.

11.5.1 CARDIO-PULMONARY EMERGENCIES

Cardio-pulmonary emergencies are life-threatening situations requiring immediate response of trained individuals to prevent death. These emergencies include heart attack, cardiac arrest, or respiratory arrest. Response and emergency treatment will be rendered without regard to protective equipment or decontamination procedures. As a precaution, and if necessary, a representative from the field team will accompany the worker to the hospital to advise on matters of decontamination.

Cardio-pulmonary emergencies will at no time be considered less than life-threatening.

11.5.2 PHYSICAL INJURIES

Physical injuries can range from minor sprains to an open compound fracture or even internal injuries. The injury may require onsite first aid or, if severe enough, an emergency medical response. The injured employee should be moved to the edge of the work area (on a stretcher, if needed) where contaminated clothing can be removed, additional emergency first aid administered, and transportation to a local emergency medical facility can be arranged.

Treatment may be delayed for decontamination procedures to be performed, depending on the injury, and should be supervised by a trained medical professional when injury is severe (as determined by the Task Manager). Outside garments can be removed (depending on the weather) if they do not cause delays, interfere with treatment, or aggravate the injury. Respiratory masks and chemically resistant clothing should be removed from the injured person. If the outer contaminated garments cannot be safely removed, the individual should be wrapped in blankets to help prevent contaminating the inside of the ambulance or medical personnel. The only exception to this procedure would be in the case of contamination with an extremely toxic or corrosive material, which could cause severe injury or loss of life.

11.5.3 CHEMICAL EXPOSURE

Exposure to chemicals can be divided into two categories:

- injuries from direct contact, such as acid burns or inhalation of toxic chemicals
- potential injury due to gross contamination on clothing or equipment

Chemical exposure that involves substances on the skin or in the eyes require immediate measures to counteract any deleterious effect. First aid treatment usually is flooding the affected area with clean water, although this may not be advised depending on the chemical (some compounds react with water and may result in additional harm to the individual; see the COCs for the site as listed in Section 5.1 and Appendix C). Treatment for inhaled contaminants should be addressed by qualified physicians only.

Gross contamination of protective clothing or equipment may result in injuries to the individual wearing the PPE or, if other injuries are involved, the personnel providing first aid. The protective clothing should be washed off as rapidly as possible and carefully removed (unless severe medical problems have occurred simultaneously with splashes). Portable eye washes may be available to provide a means of flushing and washing contamination from the eyes.

The following first aid procedures should be used if the splash or uncontrolled release results in a worker injury:

- Eye Exposure - Wash eyes immediately at an emergency eyewash station (if available) using large amounts of running or flowing water. Obtain medical attention immediately.
- Skin Exposure – Promptly wash skin contaminated with solids or liquids using soap or mild detergent and water. Obtain medical attention immediately.
- Breathing – Move anyone who breathes in large amounts of contaminants to a source of fresh air at once. Artificial respiration may be required if the breathing has stopped. Keep the affected person warm, at rest, and seek medical attention as soon as possible.
- Swallowing - Obtain information from any individual who inadvertently swallows contaminated solids or liquids (if conscious) to aid in identifying the substance. Contact the poison control center immediately. The poison control center may direct a responder to administer milk or water to dilute the compound or, in some cases, the responder may be directed to induce vomiting. Do not induce vomiting if the person is unconscious or semiconscious, convulsing, or if strong corrosive acids, alkalis, or petroleum products are suspected. Vomiting is best induced by administering one tablespoon of Syrup of Ipecac (if available onsite). Transport the person to the hospital and monitor the airway constantly.

11.5.4 SNAKE OR SPIDER BITE

There are several species of snake native to southern New York. Most of these snakes (e.g., garter, milk, ribbon, hognose, etc.) are nonvenomous and generally harmless. The exceptions are the Timber Rattlesnake and Copperhead, both of which are native to the eastern U.S. and are poisonous. Although this includes some portions of southern New York, venomous snakes are generally not found on Long Island. Spiders that may be encountered include sac spiders, which are mildly venomous to humans. They create itchy or painful ulcerations around the bite that are uncomfortable and often are slow to heal.

11.6 FIRE OR EXPLOSION

A fire or explosion at the site should be immediately followed (if possible) by the emergency signal of three extended horn blasts and all personnel moving to the designated meeting location, as detailed in the *Emergency Procedures* (Section 11) above. The fire department (via 911) should be contacted as soon as everyone has moved to a safe distance from the emergency area. Site personnel and the public in the vicinity should be evacuated if toxic gases are released. WSP employees will follow the *Evacuation Routes and Procedures* outlined in Section 11.2 above. Only personnel trained in firefighting and outfitted with proper protective equipment will be allowed in the immediate fire area.

11.7 PERSONAL PROTECTIVE EQUIPMENT FAILURE

If any worker experiences a failure or alteration of protective equipment that affects the protection factor, that person and his buddy shall immediately leave the work zone. Re-entry shall not be permitted until the equipment has been repaired or replaced.

12 ACCIDENT AND INCIDENT INVESTIGATION AND REPORTING

All accidents and incidents related to the work that WSP and WSP's subcontractors conduct on the site will be investigated, the root cause determined, and corrective actions implemented. Field personnel will report accidents and incidents to their respective field team leader who will report to the SHSC, Task Manager and General Supervisor. The General Supervisor will report all incidents to the host facility or client and, subsequently, to applicable regulatory agencies within the necessary timeframe to meet regulatory requirements. All accidents/incidents will be reported within 24 hours to the WSP iSMS (https://zeroharm.onepb.net/fieldforms). An incident report should be filed using iSMS for the following:

- occupational injury or illness;
- vehicular accidents;
- near hits/misses[29];
- environmental events;
- quality incidents;
- service or utility strikes;
- notifications of legal action;
- visits by regulatory authorities;
- complaints;
- office or job-site security issues; and
- loss, theft, or damage.

Observation reports can be filed using iSMS for a potential safety hazard that has not created a near hit/miss or incident or a good safety practice that should be recognized.

In accordance with OSHA requirements (29 CFR 1904 and 29 CFR 1910.20), all reportable injuries or illnesses should be recorded on the OSHA Form 300 and either the OSHA 301 or equivalent state worker's compensation form within 6 days of the injury.

[29] Near hits (or misses) describe 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 could have occurred.

13 AUTHORIZED CHANGES TO THE HEALTH AND SAFETY PLAN

All changes to this HASP are to be documented by completing a *Modification of Site Health and Safety Plan* form (Form 1; copied below). This completed form must be signed by the General Supervisor for the project. A copy of all completed and executed change forms will be included with each copy of the HASP and maintained in the project files.

13.1 HEALTH AND SAFETY MODIFICATION FORM

FORM 1 - MODIFICATION OF THE HEALTH AND SAFETY PLAN
175 Roger Avenue
Inwood, New York

Client: AIREF JFK IC LLC (AIREF)

Location: 175 Roger Avenue site in Inwood, New York

Change No.: Revision 2

Date: April 18, 2025

Section(s) of Health and Safety Plan Affected:

The *Planned Onsite Activities* Section (Sections 4.2 through 4.5) and the figures and sheets included in this document were modified to reflect changes to the scope of work in the work plans for the investigations. In some cases, details were removed and the reader is referred to the work plans.

Modification: The plan was modified to incorprate changes to the scope that have been or are being incorporated into the work plans for the investigations.

Approved:



Signature — Site Health and Safety Coordinator

Signature — Project Manager

Signature — Client Manager

14 CERTIFICATION

The HASP satisfies the requirements of OSHA 1910.120, WSP safety policies, and procedures.

By their signature below, these and all site personnel certify that they have read the HASP and are familiar with the document and will comply with its provisions.

NAME	SIGNATURE	EMPLOYER

15 ACRONYM LIST

ACGIH	American Conference of Governmental Industrial Hygienists
AED	automatic external defibrillator
APR	air-purifying respirator
ATC	ATC Associates, Inc.
BCP	Brownfield Cleanup Program
bgs	below ground surface
°C	degrees Celsius
CFR	Code of Federal Regulations
cis-1,2-DCE	*cis*-1,2-dichloroethene
COC	constituents of concern
CPR	cardiopulmonary resuscitation
dBA	decibels
DO	dissolved oxygen
DOT	Department of Transportation
ELAP	Environmental Laboratory Accreditation Program
EPA	U.S. Environmental Protection Agency
eV	electron volts
FLS	Fleming, Lee Shue
FSSC	Field Site Safety Officer Coordinator
GAC	granular activated carbon
HASP	health and safety plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
ID	inside diameter
ISCR	*in situ* chemical reduction
ISM	*in situ* microcosm
iSMS	Integrated Safety Health, Environment, and Quality Management System
IP	ionization potential
JHA	job hazard analysis
MiHPT	membrane interface probe/hydraulic profiling tool
mg/kg	milligrams per kilogram
MNA	monitored natural attenuation
MUC	maximum use concentration
NIOSH	National Institute for Occupational Safety and Health
NYSDEC	New York State Department of Environmental Conservation

NYSDOH	New York State Department of Health
ORP	oxygen-reduction potential
OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PDB	passive diffusion bag
PEL	permissible exposure limit
PFAS	per- and polyfluoroalkyl substances
PID	photoionization detector
PPE	personal protective equipment
ppm	parts per million
PVC	polyvinyl chloride
QA/QC	quality assurance and quality control
RAWP	remedial action work plan
RI	remedial investigation
ROI	radius of influence
SHSC	site health and safety coordinator
SMP	site management plan
SOP	standard operating procedure
SPF	sun protection factor
SRI	supplemental remedial investigation
SVE	soil vapor extraction
SVI	Guidance for Evaluating Soil Vapor Intrusion
SVOC	semivolatile organic compound
TAL	target analyte list
TCL	target compound list
TCE	trichloroethene
TICs	tentatively identified compounds
TLV	threshold limit value
µg/kg	micrograms per kilogram
µg/l	micrograms per liter
µg/m^3	micrograms per cubic meter
UST	underground storage tank
UV	ultraviolet
VOC	volatile organic compound
ZVI	zero-valent iron

FORMS

Ground Disturbance Plan (GDP)/Utility Locates Form

This form is for all intrusive work, regardless of who is responsible for the public and/or private locates
HS-EE&EG-PRO-SA 313 Overhead and Underground Utilities

Completion Checklist:

☐ Collect/review Site data for potential utilities
☐ Public underground utility locates (complete below)
☐ Private underground utility locates (complete below)
☐ Complete Site Plan (proposed boring locations, identified utilities)
☐ Conduct site reconciliation
☐ Deviation approval (as needed) (documented below)
☐ Identify overhead utilities (hazard assessment below)
☐ Communicate Emergency Procedures to onsite workers

Project Information			
Project Name and Number		**Client**	**Site Location**
Project Manager	**Site Supervisor**	**Subcontractor (s)**	**Date(s) of Work**
Description of ground disturbance activities (including who will be conducting the activities (WSP? Sub?))			
Project Manager Notified of any conflicts, changes to boring locations, issues, etc.? Describe			

Emergency Response	
Stop Work and follow the project Emergency Response Plan. -Take measures to protect the health and safety of others. -If risk to life, health, or property, Notify emergency responders and 811 -Notify the Project Manager and facility owner -Do not resume work until authorized -Enter incident in iSMS	**Additional Instructions:**

Ground Disturbance Plan (GDP)/Utility Locates Form

This form is for all intrusive work, regardless of who is responsible for the public and/or private locates
HS-EE&EG-PRO-SA 313 Overhead and Underground Utilities

Underground Utilities

Public Utility One - Call

Service name/contact info		Notification Made By (Name, Title and Company)		Date & Time of Call/Web Notification
Ticket No.	Legal Dig Date	Ticket Expiration Date		Ticket Renewal Date
Utilities Notified	Responded?	Utilities Present?	Emergency Number	Tolerance Zone Distance/other special instructions (e.g., daylighting required)

Private Utility Locator Information

Locator Company/Contact info	Contracted by	Date of service	Type of locate conducted (EM-Tracing, High-Resolution GPR)
Utilities Identified	Tolerance Zone	Other special instructions (e.g., daylighting required)	

Notes

Underground Utilities Verification

Ground Disturbance Plan (GDP)/Utility Locates Form

This form is for all intrusive work, regardless of who is responsible for the public and/or private locates
HS-EE&EG-PRO-SA 313 Overhead and Underground Utilities

Onsite Visual Confirmation of Utilities			
Marking Color	**Utility Type and Potential Visual Clues**	**Cleared/ marked?**	**No markings - comments**
Blue	Potable water: fire hydrant, manholes; water meter, AST, interior connections, hose bib, valve box		
Yellow	Gas, oil steam, petroleum: gas meter, manholes; yellow bollards, interior connections, valve box		
Red	Electric power lines, lighting cables, parking lot lights, overhead lines (telephone poles), conduits: interior connections, underground vaults, manholes, transformers/switchgear, conduit on buildings		
Green	Sewer and drain lines: underground vaults, manholes, drain grates, leach field, sand mound, no evidence of sanitary sewer (for septic system)		
Orange	Communication, alarm or signal lines, cables or conduits: red/orange bollards, telephone poles, interior connections; manholes; conduit on buildings		
Purple	Reclaimed water, irrigation, and slurry lines: sprinkler heads, hose bibs		
Pink	Survey markings		
White/ Black	Proposed locations for excavation and drilling (black can be used for snow conditions)		

Deviation	
If any activities deviate from this procedure, obtain approval from the Project Manager and District Business Leader (or designee) before the work commences. Deviations may include, but not limited to: - When working with subcontractors, the company assumes subcontractor's (or Client's) utility clearance responsibilities established in the agreement -Not conducting public and/or private locates -Not conducting daylighting when required or there are unresolved inconsistencies	**Describe any deviations:**
Deviation Approval:	**Date:**

Verification	
Ground Disturbance Plan verified by:	**Date:**

Overhead Utilities

Ground Disturbance Plan (GDP)/Utility Locates Form

This form is for all intrusive work, regardless of who is responsible for the public and/or private locates

HS-EE&EG-PRO-SA 313 Overhead and Underground Utilities

Survey your work area and identify any overhead utilities within 20ft (50ft for transmission lines)

Overhead Utilities Identified (type/voltage)	**Location**	**Required clearance distance (varies for type of equipment operated)**	**Controls** (e.g., move/change the activity, isolate, use barrier protection (insulated sleeves), use a competent line spotter/safety watch, have the utility de-energize or move power line, use warning lines with flags/post warning sign, use non-conductive tools)

Notes

RESPIRATOR FIT TEST FORM

Employee Name _____ Date of test _____

Home Office _____ Business Line _____

Examiners Name _____

Respirator Fit Test Data

Respirator Description				Type		Fit Test Protocol		Fit Test Results
Make/Model	Mfg.	Size	Full or Half Face	APR	SAR	Quantitative (QNFT)	Qualitative (QLFT) list challenge agent (e.g., smoke, isoamyl acetate*, bitrex, other)	(Pass/Fail) (Overall fit factor-QNFT only)
Additional Information:								

*Particulate respirators must be equipped with an organic vapor filter if using isoamyl acetate as the challenge agent

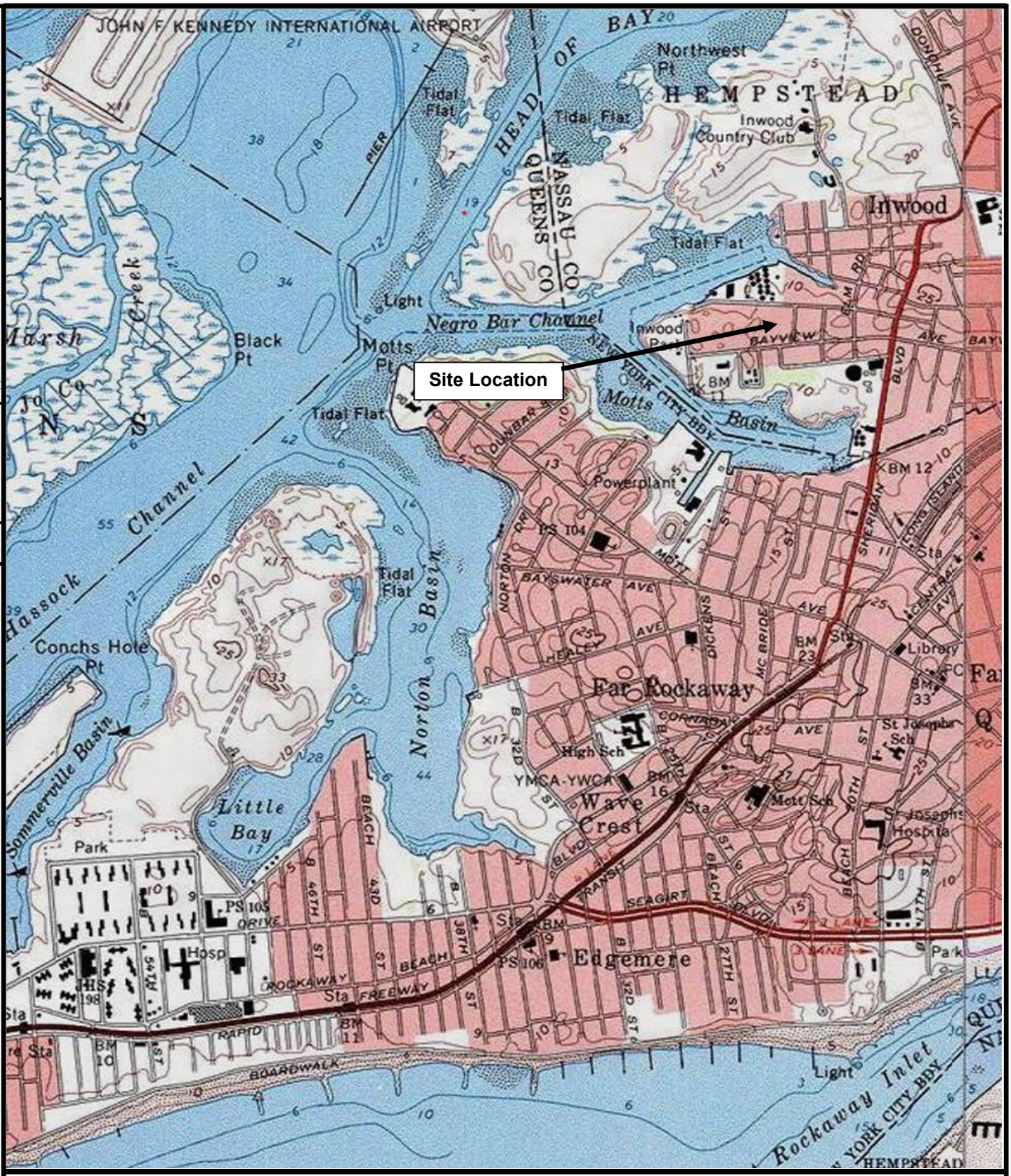
Fit Test Exercises (conduct for 1 minute unless otherwise indicated)

Conduct sensitivity screening (QLFT only)	☐	Bend over or jog in place	☐
Conduct positive and negative seal check (wait 5 minutes)	☐	Read Rainbow Passage*	☐
Breathe normally then deeply	☐	Grimace by smiling or frowning (15 seconds) (QNFT only)	☐
Move head side to side and up and down	☐	Mirror available for use by subject	☐

***Rainbow Passage:**
When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond his reach, his friends say he is looking for the pot of gold at the end of the rainbow".

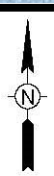
Document retention:
Upload fit test record to Oracle Horizon under your training records

FIGURES



Reference
7.5 Minute Series Topographic Quadrangle
Far Rockaway, New York (2019)
Scale 1:24,000





0 1000 2000 4000
SCALE, FEET

DWG Name:
Checked:
Approved:
Drawn By:
A

WSP USA Inc.
100 SUMMER STREET, 13TH FLOOR
BOSTON, MASSACHUSETTS 02116
TEL: +1 617.426.7330

FIGURE 1

SITE LOCATION MAP

175 ROGER AVENUE — INWOOD, NEW YORK

PREPARED FOR
AIREF JFK IC LLC
Rutherford, New Jersey



B

REFERENCE:
GOOGLE EARTH AERIAL PHOTOGRAPH.

0 100 200
SCALE, FEET

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Drawn By: RZ 04/12/2022
Checked: JM 04/12/2022
Approved:
Dwg No.: 314P4181.000-B01

175 ROGER AVENUE
INWOOD, NEW YORK

PREPARED FOR
AIREF AQUISITIONS LLC
DENVER, COLORADO

FIGURE 2

VICINITY MAP

WSP USA Inc.
100 SUMMER STREET
13th FLOOR
BOSTON, MA 02110
TEL: +1 617.426.7330

R:\Shared_GISCAD\SharedCAD\Acad_CLIENTS\AIREF Aquisitions LLC\NY_Inwood\CAD\314P4181.000-B01.dwg 4/14/2022 10:01 AM USRZ01165

SHEETS

LEGEND

- IS-12 — IN-SITU GROUNDWATER SAMPLE (2024)
- MP-2 — MEMBRANE INTERFACE PROBE/HYDRAULIC PROFILING TOOL SAMPLE (2023)
- MW-14 — FORMER MONITORING WELL (ABANDONED 2022)
- TMP-6/SB-6 — TEMPORARY MONITORING WELL (2020)
- SSB-4 — SHALLOW SOIL SAMPLE (2020)
- DW-5 — FORMER DRYWELL
- UTILITY POLE
- SEWER MANHOLE
- OHE — OVERHEAD ELECTRIC LINE
- FORMER BUILDING (DEMOLISHED 2019)
- SITE PROPERTY LINE
- OFFSITE PROPERTY LINE
- 4.3 — INTERPOLATED GROUNDWATER ELEVATION CONTOUR IN FEET ABOVE MEAN SEA LEVEL

NOTE:

DEPTH–TO–GROUNDWATER MEASUREMENTS AND THE CORRESPONDING GROUNDWATER ELEVATIONS WERE OBTAINED FROM THE REMEDIAL INVESTIGATION REPORT, DATED JULY 8, 2009, PREPARED BY ATC ASSOCIATES, INC., OF NEW YORK, NEW YORK.

ROGER AVENUE

GATES AVENUE

CERRO STREET

BAYVIEW AVENUE

FORMER MAIN BUILDING (DEMOLISHED FEBRUARY 2019)

FORMER UST EXCAVATION AREA (APPROXIMATE)

ONE STORY MASONRY DWELLING

SHED

ONE STORY FRAME GARAGE

ONE STORY MASONRY BUILDING

ONE STORY FRAME GARAGE

RESIDENTIAL AREA

RESIDENTIAL AREA

MW-13, MW-14, MW-15, MW-17, MW-18, MW-8, MW-9, MW-3, MW-6, MW-2, MW-20, MW-22, MW-1, BW-6

MP-1, MP-2, MP-3, MP-4, MP-5, MP-6, MP-7, MP-8, MP-9, MP-10, MP-11, MP-12, MP-13, MP-14

IS-1, IS-2, IS-3, IS-4, IS-5, IS-6, IS-7, IS-8, IS-9, IS-10, IS-11, IS-12, IS-13

DW-1, DW-2, DW-3, DW-4, DW-5, DW-6, DW-7, DW-8, DW-9

SSB-1, SSB-2, SSB-3, SSB-4, SSB-5

TMP-1/SB-1, TMP-2/SB-2, TMP-3/SB-3, TMP-4/SB-4, TMP-5/SB-5, TMP-6/SB-6, TMP-7/SB-7, TMP-8/SB-8, TMP-9/SB-9, TMP-10/SB-10, TMP-11/SB-11, TMP-12/SB-12, TMP-13/SB-13, TMP-14/SB-14

HA-1, HA-2, HA-3, HA-4, HA-5, HA-6, HA-7, HA-8, HA-9, HA-10, HA-11, HA-12, HA-13

4.0, 4.1, 4.2, 4.3, 4.4, 4.5

SCALE, FEET: 25 0 25 50

REFERENCES:

FLEMING, LEE SHUE ENVIRONMENTAL MANAGEMENT & CONSULTING DRAWINGS TITLED, "GROUNDWATER FLOW DIRECTION", FIGURE 4, "SOIL RESULTS ABOVE SOIL CLEANUP OBJECTIVES", FIGURE 5, AND "GROUNDWATER RESULTS (µg/l) ABOVE TOGS GA AWQS", FIGURE 6, DATED JULY 2020, PROJECT NUMBER 10188–017.

THE ORIGINAL VERSION OF THIS DRAWING IS IN COLOR. BLACK & WHITE REPRODUCTION MAY NOT ACCURATELY DEPICT CERTAIN INFORMATION.

D

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REVISIONS

REV	DESCRIPTION	Chkd:	Appr.:
1	Revised	Chkd:	Appr.:
2	Revised	Chkd:	Appr.:
3	Revised	Chkd:	Appr.:

SEAL

DATE

DRAWN BY: KAC 10/25/2024

CHECKED: AW 10/25/2024

APPROVED: SB 10/25/2024

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SITE LAYOUT WITH HISTORICAL SAMPLE LOCATIONS

175 ROGER AVENUE
INWOOD, NEW YORK

PREPARED FOR
AIREF ACQUISITIONS LLC
DENVER, COLORADO

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100 SUMMER STREET, 13th FLOOR
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TEL: +1 617.426.7330

SHEET 1

Drawing Number
314P7196.000–D22

LEGEND

- SG-2P — PRE-DESIGN SOIL GAS SAMPLE
- MW-2M — GROUNDWATER MONITORING WELL
- UTILITY POLE
- SEWER MANHOLE
- OHE — OVERHEAD ELECTRIC LINE
- FORMER BUILDING (DEMOLISHED 2019)
- SITE PROPERTY LINE
- OFFSITE PROPERTY LINE
- 4.3 — INTERPOLATED GROUNDWATER ELEVATION CONTOUR IN FEET ABOVE MEAN SEA LEVEL

NOTE:

1. CO-LOCATED WELL PAIRS, DESIGNATED BY THE SUFFIX "S" (SHALLOW) AND "D" (DEEP), WILL BE INSTALLED TO SELECT DEPTHS BASED ON THE RESULTS OF PREVIOUS GROUNDWATER INVESTIGATIONS AT THE SITE. SEE TEXT FOR EXPLANATION.

2. DEPTH-TO-WATER MEASUREMENTS AND THE CORRESPONDING GROUNDWATER ELEVATIONS WERE OBTAINED FROM THE REMEDIAL INVESTIGATION REPORT, DATED JULY 8, 2009, PREPARED BY ATC ASSOCIATES, INC., OF NEW YORK, NEW YORK.

REFERENCES:

FLEMING, LEE SHUE ENVIRONMENTAL MANAGEMENT & CONSULTING DRAWINGS TITLED, "GROUNDWATER FLOW DIRECTION", FIGURE 4, "SOIL RESULTS ABOVE SOIL CLEANUP OBJECTIVES", FIGURE 5, AND "GROUNDWATER RESULTS (µg/l) ABOVE TOGS GA AWQS", FIGURE 6, DATED JULY 2020, PROJECT NUMBER 10188-017.

ROGER AVENUE

GATES AVENUE

CERRO STREET

BAYVIEW AVENUE

SG-1P, MW-5S, MW-5D, MW-5M, SG-2P, SG-3P, MW-6S, MW-6D, MW-6M, SG-4P, SG-5P, MW-1P, SG-6P, SG-7P, SG-8P, FORMER UST EXCAVATION AREA (APPROXIMATE), SG-9P, SG-10P, SG-11P, SG-12P, SG-13P, MW-2P, SG-14P, FORMER MAIN BUILDING (DEMOLISHED FEBRUARY 2019), MW-4P, SG-15P, SG-16P, SG-20P, SG-21P, ONE STORY MASONRY DWELLING, SHED, SG-22P, MW-3M, MW-3S, MW-3PD, SG-23P, SG-17P, SG-18P, MW-7S, MW-7D, MW-7M, SG-19P, [ND], ONE STORY FRAME GARAGE, ONE STORY MASONRY BUILDING, ONE STORY FRAME GARAGE, RESIDENTIAL AREA, RESIDENTIAL AREA

N

SCALE, FEET: 25 0 25 50

THE ORIGINAL VERSION OF THIS DRAWING IS IN COLOR. BLACK & WHITE REPRODUCTION MAY NOT ACCURATELY DEPICT CERTAIN INFORMATION.

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REVISIONS

REV	DESCRIPTION	Appr.
1	Revised	Chkd.
2	Revised	Chkd.
3	Revised	Chkd.

SEAL

DATE

DRAWN BY: KK 04/15/25
CHECKED: JM 04/15/25
APPROVED: SS 04/15/25

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PROPOSED PRE-DESIGN SOIL GAS SAMPLE LOCATIONS AND MONITORING WELLS

175 ROGER AVENUE
INWOOD, NEW YORK

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SHEET 2

Drawing Number
314P7196.000-D32

APPENDIX

A WSP PERSONNEL RECORDS

APPENDIX

A-1 HAZWOPER CERTIFICATES

VectorSolutions™

Training Certificate of Achievement

Hereby Acknowledges that

David Paul Bouchard

has completed the in-service training on **August 18 2024** for

8-Hour HAZWOPER Refresher

Congratulations on your completion of this **8** hour online course.

Michael Schreiner, VP of Content

As an IACET Accredited Provider, Vector Solutions offers CEUs for its programs that qualify under the ANSI/IACET Standard.

ACCREDITED IACET PROVIDER

Vector Solutions | Two Urban Centre | 4890 West Kennedy Boulevard | Suite 300, Tampa, FL 33609 | 866.546.1212

APPENDIX

A-2 FIRST AID CERTIFICATES

APPENDIX

A-3 *FIT TESTING FORMS*

APPENDIX

B FIELD STANDARD OPERATING PROCEDURES

FIELD STANDARD OPERATING PROCEDURE #2

UTILITY LOCATING PROCEDURE

The purpose of this procedure is to ensure that all required and appropriate procedures are followed to locate and mark subsurface utilities (e.g., electrical lines, natural gas lines, communication lines) before initiating any intrusive field activities (e.g., drilling, test pits, trenching, excavation). The company's preference, as indicated in our subcontractor agreement templates, is for our contractors to be responsible for both public and private utility mark-outs; this includes contacting the public authority and obtaining a subcontractor for private utility locating services, if needed. Guidance for contractors to follow to conduct a utility clearance is provided in our request for proposal (RFP) template and must be included in all RFP's for intrusive field activities.

In rare circumstances, the company may choose to accept responsibility for clearing utilities, which will require a change to the language of our subcontractor agreement. This assumption of increased liability by the company requires written rationale and approval from the cognizant District Business Leader, with written concurrence from the Chief Operating Officer. The written approvals **MUST** be obtained prior to submitting the Request for Subcontract to Contract Administration.

Compliance with this procedure for projects where the company will be responsible for clearing utilities is mandatory. **ALL** deviations from this standard operating procedure (SOP) **MUST** be approved by the project manager and a District Business Leader, with confirmation from the Chief Operating Officer **BEFORE** beginning intrusive work.

Field personnel have the authority and responsibility to postpone intrusive activities if a contractor has not completed utility clearances to the company's satisfaction; if sufficient information, as stipulated in this SOP, is not available; or, if onsite reconnaissance identifies inconsistencies in the findings of utility locators. In these instances, field personnel must notify the project manager or the health and safety officer, or their designee, before proceeding with the proposed work; approval from a District Business Leader, with confirmation from the Chief Operating Officer, is required before the work commences.

The user is advised to read the entire SOP and review the site health and safety plan (HASP) and/or project safety plan (PSP) before beginning any onsite activities.

2.1 ACRONYMS AND ABBREVIATIONS

HASP	health and safety plan
PSP	project safety plan
RFP	request for proposal
SOP	standard operating procedure

2.2 MATERIALS

- Utility Locating Form (Attachment 1)
- Field book
- Wood stakes
- Spray paint
- Flagging tape
- As-built drawings for sub-grade utilities (if available)
- Hand auger or post-hole digger

2.3 PRECONDITIONS AND BACKGROUND

This SOP has been prepared as part of the company's Environmental Quality Management Plan and is designed to provide detailed procedures for common field practices. Compliance with the methods presented in this document is mandatory for all field personnel

and will ensure that the tasks are performed in a safe and consistent manner, are in accordance with federal and state guidance, and are technically defensible.

This SOP is written for the sole use of company employees and will be revised periodically to reflect updates to company policies, work practices, and the applicable state and/or federal guidance. Employees must verify that this document is the most recent version of the company SOPs. Employees are also strongly advised to review relevant state and/or federal guidance, which may stipulate program-specific procedures, in advance of task implementation.

WSP requires that all personnel performing specific project assignments be appropriately qualified, including having required certifications or licenses; and, are properly trained in accordance with the requirements of their assignment, the Environmental Service Line's field SOPs, and the Quality Management System.

This procedure is intended to allow the work to proceed safely and minimize the potential for damaging underground and aboveground utilities. Intrusive work includes all activities that require the company's employees or its subcontractors to penetrate the ground surface. Examples of intrusive work include, but are not limited to, hand augering, probing, drilling, injections, test pit excavations, trenching, and remedial excavations.

This SOP assumes the user is familiar with basic field procedures, such as recording field notes (SOP 1).

2.4 PRE-FIELD MOBILIZATION PROCEDURES

Public rights-of-way and private property must be cleared of buried utilities and overhead utilities must be identified before any intrusive work can begin regardless of who is responsible for completing these activities (company or a contractor). The first step in this process is notifying the state public utility locating service of the planned work. These services provide a link between the entities performing the work and the various utility operators (e.g., the water company, the electric company, etc.). All the public utility locating service call centers in the United States have been streamlined under a single "Call Before You Dig" phone number: 811. However, the appropriate state or provincial call center (http://call811.com/811-your-state) will need to be contacted[1].

When the appropriate call center is contacted, information regarding the site (e.g., location, nearest cross street, township, etc.) and work activity (e.g., drilling, excavation) will need to be provided to the operator to aid in locating the likely utilities at the work site. The information provided on the Utility Locating Form (Attachment 1) must be recorded (by the contractor or the company) and a completed copy of this form must be maintained as part of the project file. Be aware that several states, including California, require that the proposed drilling locations be marked with white spray paint before contacting the locating services.

The following information must always accompany the field team during the field project:

- The utility clearance ticket number
- The ticket's legal dig date
- The ticket's expiration date
- Utility providers that were contacted

The ticket number serves as a point of reference for both the utility service providers and for the company or contractor should follow up (e.g., renewing the ticket) with the locating service be required. The legal dig and expiration dates reflect the times when it will be legal to perform the proposed work. Recognize that the legal dig date reflects the lead time necessary, typically between 48 and 72 hours after you call, for the utility service providers to mark the utilities in you work area. Be sure to include this delay when scheduling your work. Most utility clearance tickets expire about 2 weeks after the legal dig date. If your work is delayed beyond the expiration date, the 811 utility locating service will need to be called again and the ticket renewed. The renewed ticket will have a new legal dig date that incorporates the same lead-time (48 to 72 hours) as the original ticket.

[1] Some state or provincial laws require that the person who will be conducting the intrusive work must be the person who places the call to the public utility locating service. This means that the company cannot make this call on the contractor's behalf; the contractor must place the call in those states where required. If there is any doubt about the requirements for the state where a project is located, the relevant state authority must be contacted (http://call811.com/811-your-state).

The locating service will also provide the caller with a list of utility companies that will be notified. Compare this list with utilities generally expected at all sites (e.g., sewer, water, gas, communication, and electric). Some utilities (e.g., sewer, water, cable television) may not be included. If any expected utilities are absent from the contact list, the utilities **MUST** be contacted directly for clearance before the start of intrusive activities. All contacts should be recorded on the Utility Locating Form.

2.4.1 PRIVATE UTILITY LOCATORS AND OTHER SOURCES

Public utility service providers will generally mark their underground lines within the public right-of-way up to the private property boundary. A public utility locating service must be contacted prior to any intrusive work, regardless of whether the intrusive work is located on public or private property. However, be aware that most public utility locating services will not locate utilities on private property. If your work is to be conducted on private property, a private utility locating service **MUST** be used to clear the work area. These companies typically use a variety of methods (e.g., electromagnetic detectors, ground-penetrating radar, acoustic plastic pipe locator, trace wire) to locate utilities in the work area, including those that may be buried beneath onsite buildings. Pseudoscientific methods (e.g., dowsing, divining, witching) are not acceptable utility locating methods.

For all operating facilities and to the extent possible for closed facilities, identify a site contact familiar with the utilities on the property (e.g., plant manager, facility engineer, maintenance supervisor), and provide this individual with a site plan showing the proposed locations of all soil borings, monitoring wells, test pits, and other areas where intrusive activities will be conducted. These individuals often have knowledge of buried structures or process-specific utilities that may not be identified by the private utility locator. This is particularly important for work performed inside industrial buildings where reinforced concrete and other metallic components of the structure may interfere with the scanning devices used by the private utility locator. Ask the site contact for all drawings concerning underground utilities in the proposed work areas for future reference.

Keep in mind that no intrusive work may be done before the legal dig date provided by the state utility locating service and no digging, drilling, or other ground-breaking activities may be begin until all utilities on the list have been marked and visually verified in the work area (see below). It is **NOT ACCEPTABLE** to rely solely on as-built drawings or verbal utility clearances from the site contact (these should be used as guides only). A private locator may not be necessary in rare instances; however, nonconformity with the private locate requirement must be approved by the project manager **AND** a District Business Leader, with confirmation from the Chief Operating Officer.

2.5 SITE MOBILIZATION PROCEDURES

Upon arrival, the first step in determining if you are clear of buried and overhead utilities is to locate all the proposed drilling and trenching locations and mark them with (white) spray paint, stakes, or other appropriate markers. This will help you judge distances from marked drilling and trenching locations to underground and overhead utilities and minimizes any potential misunderstandings regarding the locations between you, the subcontractors (drillers, excavators, private utility locator), and the site contact.

Once you have the proposed work areas marked, verify that ALL utility companies listed by the state public utility locating service, and any contacted directly by the company or the contractor, have either marked the underground lines in the specified work areas or have responded (via telephone, facsimile, or e-mail) with “no conflict.” Document on the Utility Locating Form (Attachment 1) and in the field book as each utility mark is visually confirmed. When receiving verbal clearances by telephone from utility companies, or their subcontractors, it is imperative that you verify the utilities that are being cleared, particularly when dealing with subcontractors that may be marking more than one utility.

Review all available as-built utility diagrams and plans for your general work area and conduct a site walk to identify potential areas where underground lines may be present; include the site contact in these activities. It is a good idea to survey your surroundings during the walk to identify any features that may indicate the presence of underground utilities, such as linear depressions in the ground, cuts in concrete or asphalt, old road cuts, catch basins, or manholes. Keep in mind that many sewer lines can be offset from catch basins. The presence of aboveground utilities, such as parking lot lights or pad-mounted transformers, is also a good indicator of

buried electrical lines. Check these items against the Utility Locating Form checklist and discuss the locations with the private utility locating service.

2.5.1 SAFE WORKING DISTANCES AND HAND CLEARING

A minimum of 5-feet clearance must exist between utilities and proposed drilling locations, and a minimum of 6-feet between utilities and proposed trenching locations. Be aware that some clients, states and localities (e.g., New York City, Long Island) may require greater minimum working distances, depending on the utility (e.g., for high pressure gas mains). A minimum distance of 15 feet must be maintained by heavy equipment (e.g., excavator buckets, drill rig towers and rods) from overhead power lines and a safe distance of 25 feet must be maintained from high-tension overhead power lines. If work must be conducted within 25 feet of high-tension wires, the lines must be wrapped and insulated by the local utilities. Increase these minimum distances whenever possible to offer additional assurance that buried or overhead utilities will not be encountered.

If a utility conflict is identified within the minimum safe clearance distance, adjust the proposed location(s) using the criteria given above. It is recommended to have the private utility locator sweep a relatively large area (e.g., a 20-foot circle around a proposed drilling location) to provide room for adjustment should the proposed drilling or excavation area need to be moved to avoid a buried utility. Subsurface work within five feet of a confirmed or suspected utility or other subsurface structure must be done by nondestructive clearing techniques to the point where either the utility/structure is visually located and exposed, or in the case of soil borings, where the bottom depth of the structure is surpassed and drilling may begin.

Uncertainty may exist in some circumstances (e.g., inside a building) even after the area has been swept for utilities. In these cases, advance the first few feet of a soil boring (or probe the area for excavation) using a hand auger or post-hole digger. If hand digging is unable to penetrate the subsurface soils, soft dig or air knife equipment service providers may be retained to clear the location. This equipment applies high pressure air to penetrate, loosen, and extract subsurface soils in the borehole, thereby safely exposing any utilities. If using either hand digging or soft digging, the probe hole should be advanced a minimum of 5 feet below ground surface at each proposed drilling or excavation location. Complete a sufficient number of probe holes so that the area is cleared for the proposed intrusive activity (i.e., use several holes for a proposed excavation). The use of hand digging or soft digging methods **does not** replace the need for state and private utility locating services.

Protect and preserve the markings of approximate locations of facilities until the work activities are completed. If the markings of utility locations are destroyed or removed before excavation commences or is completed, stop work. Notify the utility company, utility protection service, or the utility locating service to inform them that the markings have been destroyed. Do not continue work until the utilities have been re-marked.

2.5.2 EXPANDED WORK AREAS AND TICKET RENEWAL

Many projects begin with well-defined work areas only to expand quickly as the investigation or remediation progresses. If the scope of intrusion expands or includes new onsite or offsite area(s), you will need to review the existing ticket and work performed by the private utility locator to determine whether work can progress into the new area safely. It may be necessary, depending on the scope, to contact (or for the Contractor to contact) the state locating service and request another clearance for the new area(s) of investigation and retain a private locating service. Remember, the new request will provide a new legal dig date before which NO INTRUSIVE WORK CAN BEGIN. Additionally, if a clearance ticket will expire while the work is ongoing (typically after 2 weeks), a new clearance must be requested before the first ticket expires so that work can continue uninterrupted. Refer to the Utility Locating Form (Attachment 1) for the legal dig date time frame required by the state locating service.

2.5.3 UTILITY DAMAGE

It is possible, even if you followed all the procedures outlined in this SOP, to damage an underground or overhead utility. Assuming it can be done safely, quickly turn off the drilling or excavating equipment, or move the equipment from the damaged line. Avoid contact with escaping liquids, live wires, and open flames. Abandon the equipment, evacuate the personnel from the area, and

maintain a safe perimeter if there are any concerns about safety. If a fiber optic cable is damaged, do not handle the cable or look into the end of the cable as serious eye damage may occur. Once personnel are in a secure location, immediately notify the facility operator or site contact and 811; additionally, send an immediate alert or notification via iSMS and send an email to SafetyTeam@wsp.com. You should also, as applicable, contact your immediate supervisor, human resources and sector management in accordance with company policy. If the damaged utility has the potential to cause, or is causing, dangerous conditions, immediately notify the local emergency response number listed in your HASP or PSP.

** This form is mandatory for all intrusive work, regardless of who is responsible for the public and/or private locate.

Utility Locating Form

Project Name	Project No. and Task	Work being done for (Company or Individual Name)		Project Manager
Office Address	**Office Phone**	**Field Contact**		**Field Contact Phone**
Project Location: Street Address		**City/Township**	**County**	**State**
Nearest Intersecting Street				
Description of Work Area (street working on, which side of street, how far in which direction from nearest intersecting street; etc.)				
Type of Work	**Explosives (Y/N)**	**Directional Borings (Y/N)**	**Dig Locations Marked (Y/N)**	**Mark Type (e.g., stake)**
Scheduled Work Start (Date & Time)	**Estimated Work Stop Date**	**One-call Phone Number/Website Address**		**One-call Service Name**
Call/Web Notification Made By (Name, Title and Company)		**Date & Time of Call/Web Notification**		**Operator Name**
Ticket No.	**Legal Dig Date**	**Ticket Expiration Date**		**Ticket Renewal Date**

Utilities Notified		Complete After Receiving Notification (e.g., e-mail, facsimile) from Utilities or Subcontractor		
		Utilities Present (Y/N)	**Onsite Meeting (Y/N; if "Y" Date & Time)**	**Contact Name and Phone**
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Form Completed By (Signature)	
	(e-mail completed page 1 to Project Manager)

** This form is mandatory for all intrusive work, regardless of who is responsible for the public and/or private locate.

Utility Locating Form

Private Utility Locator Information			
Company	**Contact Name**	**Phone**	**E-mail**
Who Contracted Locator?		**Scheduled Start (Date & Time)**	**Contract Executed (Y/N/NA)**

Onsite Visual Confirmation of Utilities			
Marking Color	**Utility Type and Visual Clues**	**Cleared or Marked (Y/N)**	**No Markings - Comments**
Blue	Potable water: fire hydrant, manholes; water meter, ASTs, interior connections, hose bib, valve box		
Yellow	Gas, oil steam, petroleum: gas meter, manholes; yellow bollards, interior connections, valve box		
Red	Electric power lines, lighting cables, parking lot lights, overhead lines (telephone poles), conduits: interior connections, underground vaults, manholes, transformers/switchgear, conduit on buildings		
Green	Sewer and drain lines: underground vaults, manholes, drain grates, leach field, sand mound, no evidence of sanitary sewer (for septic system)		
Orange	Communication, alarm or signal lines, cables or conduits: red/orange bollards, telephone poles, interior connections; manholes; conduit on buildings		
Purple	Reclaimed water, irrigation, and slurry lines: sprinkler heads, hose bibs		
Pink	Survey markings		
White	Proposed locations for excavation and drilling		

Project Manager Notified of any Conflicts? (Y/N)

Notes:

Marks Verified By (Signature)	
	(scan and save to client file)

FIELD STANDARD OPERATING PROCEDURE #3

SAMPLE PACKAGING AND SHIPMENT PROCEDURE

Shipping samples is a basic but important component of field work. The majority of field activities include the collection of environmental samples. Proper packing and preservation of those samples is critical to ensuring the integrity of our work product. The user is advised to read the entire standard operating procedure (SOP) and review the site health and safety plan (HASP) and/or project safety plan (PSP) before beginning any onsite activities. In accordance with the HASP or PSP, proper personal protective equipment (PPE) must be selected and used appropriately.

3.1 ACRONYMS AND ABBREVIATIONS

CFR	Code of Federal Regulations
DOT	U.S. Department of Transportation
IATA	International Air Transport Association
HASP	Health and safety plan
PPE	Personal protective equipment
PSP	Project safety plan
SOP	Standard operating procedure

3.2 MATERIALS

- Suitable shipping container (e.g., plastic cooler)
- Chain-of-custody forms
- Custody seals
- Sample container custody seals (as necessary)
- Mailing address labels (as necessary)
- Shipping form (with account number, as necessary)
- Tape (e.g., strapping, clear packing)
- Permanent marker
- PPE
- Bubble wrap or other packing material

Temperature-preserved samples:

- Large plastic garbage bag
- Wet ice
- Heavy-duty zipper-style plastic bags
- Universal sorbent materials

Note: Some materials will be supplied by the laboratory, while others are must be supplied by the sampler. Confirm supplier of materials prior to mobilizing to the field.

3.3 PRECONDITIONS AND BACKGROUND

This SOP has been prepared as part of the company's Environmental Quality Management Plan and is designed to provide detailed procedures for common field practices. Compliance with the methods presented in this document is mandatory for all field personnel

and will ensure that the tasks are performed in a safe and consistent manner, are in accordance with federal and state guidance, and are technically defensible.

This SOP is written for the sole use of company employees and will be revised periodically to reflect updates to company policies, work practices, and the applicable state and/or federal guidance. Employees must verify that this document is the most recent version of the company SOPs. Employees are also strongly advised to review relevant state and/or federal guidance, which may stipulate program-specific procedures, in advance of task implementation.

WSP requires that all personnel performing specific project assignments be appropriately qualified, including having required certifications or licenses, and properly trained in accordance with the requirements of their assignment, the Environmental Service Line's field standard operating procedures, and the Quality Management System.

This SOP is designed to provide the user with a general outline for shipping samples and assumes the user is familiar with basic field procedures, such as recording field notes (SOP 1), sample collection and quality assurance procedures (SOP 4), and investigation derived waste management procedures (SOP 5).

Most environmental samples are classified non-hazardous materials due to unknown characteristics and hazardous classes, however environmental samples can meet the definition of U.S. Department of Transportation (DOT) hazardous materials when shipped by air, ground, or rail from a project site to the laboratory (e.g., free product, samples preserved with a hazardous material [TerraCore® samplers]). As such, field staff must work with their assigned company compliance professional to determine whether the sample shipment is subject to any specific requirements (e.g., packaging, marking, labeling, and documentation) under the DOT hazardous materials regulations.

3.4 SAMPLE SHIPMENT PROCEDURES

The two major concerns in shipping samples are incidental breakage during shipment and complying with applicable DOT and courier requirements for hazardous materials shipments.

> **NOTE: Many couriers, including Federal Express and United Parcel Service, have requirements that the company register with them before shipping hazard materials. In most cases, it is the sampling location, not the company office address, which needs to be registered. Therefore, each project will likely have unique requirements. Please contact your company compliance professional to determine whether or not you will be required to register for your shipment.**

Protecting the samples from incidental breakage can be achieved using "common sense." Pack all samples in a manner that will prevent them from moving freely about in the cooler or shipping container. Do not allow glass surfaces to contact each other. When possible, repack the sample containers in the same materials that they were originally received in from the laboratory. Cushion each sample container with plastic bubble wrap, styrofoam, or other nonreactive cushioning material. A more detailed procedure for packing environmental samples is presented below.

3.4.1 NON-HAZARDOUS MATERIAL ENVIRONMENTAL SAMPLES

The first step in preparing your samples for shipment is securing an appropriate shipping container. In most cases, the analytical laboratory will supply the appropriate container for bottle shipment, which can be used to return samples once they have been collected. Be sure that the container is large enough to contain the samples plus a sufficient amount of packing materials, and if applicable, enough wet ice to maintain the samples at the preservation temperature (usually 4 degrees Celsius). Use additional shipping containers as needed so that sample containers are protected from breakage due to overcrowding. Do not use lunch-box sized coolers or soft sided coolers, which do not offer sufficient insulation or protection from damage.

3.4.1.1 TEMPERATURE-PRESERVED SAMPLE CONTAINER PREPARATION

Temperature-preserved samples should be shipped to the laboratory in an insulated container (e.g., cooler). If using a plastic cooler with a drain, securely tape the inside of the drain plug with duct tape or other material to ensure that no water leaks from the cooler during shipment. Place universal sorbent materials (e.g., sorbent pads) in the bottom of the insulated container. The amount of sorbent material must be sufficient to absorb any condensation from the wet ice and a reasonable volume of water from melted wet ice (if a bag were to rupture) or a damaged (aqueous) sample container.

The next step is to line the insulated container with a large, heavy-duty plastic garbage bag. If shipping breakable sample containers (e.g., glass), place bubble wrap or other packing materials on the bottom of the container. Place the samples, including a temperature blank, on the packing materials with sufficient space to allow for the addition of more bubble wrap or other packing material between the sample containers. Place large or heavy sample containers on the bottom of the cooler with lighter samples placed on top to minimize the potential for breakage. Place all sample containers in the shipping container right-side up. Do not overfill the cooler with samples; room must be left for a sufficient volume of wet ice. Wet ice must be double-bagged in heavy-duty zipper-style plastic bags (1 gallon-sized, or less); properly seal both bags before placing in the insulated container. Place the bags of ice on top of or between the samples. Place as much ice as possible into the cooler to ensure the samples arrive at the lab at the required preservation temperature, even if the shipment is delayed. Fill any remaining space in the container with bubble wrap or other packing material to limit the airspace and minimize the shifting of the sample containers and in-transit melting of ice. Securely close the top of the heavy-duty plastic bag and knot or seal with tape.

3.4.1.2 NON-TEMPERATURE-PRESERVED SAMPLE CONTAINER PREPARATION

Non-temperature-preserved samples should be shipped to the laboratory in a durable package (e.g., hard plastic container or cardboard box). If shipping breakable sample containers (e.g., glass), place bubble wrap or other packing materials on the bottom of the container. Place the samples on the packing materials with sufficient space to allow for the addition of more bubble wrap or other packing material between and on top of the sample containers. Place large or heavy sample containers on the bottom of the container with lighter samples placed on top to minimize the potential for breakage. Place all sample containers within the shipping container right-side up. Fill any remaining space in the container with bubble wrap or other packing material to limit the airspace and minimize the shifting of the sample containers and in-transit melting of ice.

3.4.1.3 CONTAINER SHIPMENT

Samples in the container should be cross-checked against the chain-of-custory before signing off on the form and sealing the cooler. Place the original chain-of-custody form (i.e., laboratory copy) into a heavy-duty zipper-style plastic bag, affix/tape the bag to the shipping container's inside lid, and then close the shipping container; as required, include return shipping labels for the laboratory to return company-owned coolers. Only one chain-of-custody form is required to accompany one of the shipping containers per sample shipment; the other coolers in the shipment do not need to include chain-of-custody forms, unless required by the project. At this point, sample shipment preparations are complete if using a laboratory courier.

Once the shipping container is sealed, shake test the shipping container to make sure that there are no loose sample containers. If loose sample containers are detected, open the shipping container, repack the contents, and reseal the shipping container. If sending the sample shipment through a commercial shipping vendor, place two signed and dated chain-of-custody seals on alternate sides of the shipping container lid so that it cannot be opened without breaking the seals. Securely fasten the top of the shipping container shut with clear packing tape; carefully tape over the custody seals to prevent damage during shipping.

Affix a mailing label with the ship to and return to addresses to the top of the shipping container using clear shipping tape. Use the pre-printed return mailing label from the laboratory, if provided, or complete a new mailing label from the shipping carrier. Ship environmental samples to the contracted analytical laboratory using an appropriate delivery schedule. **Note: Samples can be shipped for Saturday delivery once the lab has been verified to be open and receiving samples on the weekend.**

Verify whether the shipment cost should be billed to the sender or recipient, and ensure the internal billing reference section on the mailing label includes either the laboratory's billing reference number, if the shipment is billed to the laboratory, or the project billable number, if the shipment is billed to WSP.

Declare the value of samples on the shipping form for insurance purposes, if applicable. When shipping samples to a lab, identify a declared value equal to the carrier's default value ($100); additional fees will be charged based on a higher value declared. Our preferred carrier, Federal Express, will only reimburse for the actual value of the cooler and its contents if a sample shipment is lost; they will not reimburse for the cost of having to re-collect the samples. [Please note: if you are shipping something other than samples, such as field equipment, declare the replacement value of the contents.]

Record the tracking numbers from the shipping company forms (i.e., the airbill number) in the field book and retain a copy of the shipping airbill. On the expected delivery date, confirm sample receipt by contacting the laboratory or tracking the package using the tracking number; provide this confirmation information to the project manager.

> **NOTE: Most shipping carriers adhere to transit schedules with final pickup times each day; these schedules are subject to change and vary by service location. If shipping containers are dropped off at a service location after the final pickup time, transit to the laboratory will not be initiated until the following day, and samples may not be properly preserved. Therefore, confirm transit schedules in advance of each sampling event, and ensure samples are delivered to the carrier before the final pickup time of the day.**

3.4.2 HAZARDOUS MATERIALS SAMPLES

Employees rarely ship hazardous materials due to DOT shipping requirements. If you find that your samples could be considered a DOT hazardous material, first coordinate with the assigned company compliance professional and project manager to make a hazardous material classification and, if necessary, establish the necessary protocols and to receive the appropriate training/certification.

> **NOTE: Employees shipping samples regulated as hazardous materials or exempt hazardous materials by air must have International Air Transport Association (IATA) training. IATA training is a separate training required in addition to DOT hazardous materials training for such shipments. Most of our employees do not have IATA training and therefore, anyone who needs to ship by air MUST consult with a company IATA-trained compliance professional.**

FIELD STANDARD OPERATING PROCEDURE #4

SAMPLE COLLECTION AND QUALITY ASSURANCE PROCEDURE

The purpose of this procedure is to assure that sample volumes and preservatives are sufficient for analytical services required under U.S. Environmental Protection Agency (EPA) or other agency approved protocols. This operating procedure describes sample identification procedures, sampling order for select analytes, quality control and quality assurance (QA/QC) sampling procedures, and custody documentation. The user is advised to read the entire standard operating procedure (SOP) and review the site health and safety plan (HASP) and/or project safety plan (PSP) before beginning any onsite activities. In accordance with the HASP, proper personal protective equipment (PPE) must be selected and used appropriately.

4.1 ACRONYMS AND ABBREVIATIONS

ºC	degrees Celsius
COC	chain-of–custody [form]
DI	laboratory-grade, analyte-free deionized water
DOT	US Department of Transportation
EDD	electronic data deliverable
EPA	US Environmental Protection Agency
HASP	health and safety plan
ID	identification [number]
MS/MSD	matrix spike and matrix spike duplicate
MSA	master services agreement
PPE	personal protective equipment
PSP	project safety plan
QA	quality assurance
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
SOP	standard operating procedure
VOCs	volatile organic compounds

4.2 MATERIALS

- Field book
- Indelible (waterproof) markers or pens
- PPE
- Sampling containers and labeling/shipping supplies

- Deionized (DI) water
- Cleaned or dedicated sampling equipment

4.3 PRECONDITIONS AND BACKGROUND

This SOP has been prepared as part of the company's Environmental Quality Management Plan and is designed to provide detailed procedures for common field practices. Compliance with the methods presented in this document is mandatory for all field personnel and will ensure that the tasks are performed in a safe and consistent manner, are in accordance with federal and state guidance, and are technically defensible.

This SOP is written for the sole use of employees and will be revised periodically to reflect updates to company policies, work practices, and the applicable state and/or federal guidance. Employees must verify that this document is the most recent version of the company's SOPs. Employees are also strongly advised to review relevant state and federal guidance, which may stipulate program-specific procedures, in advance of task implementation.

WSP requires that all personnel performing specific project assignments be appropriately qualified, including having required certifications or licenses, and properly trained in accordance with the requirements of their assignment, the Environmental Service Line's field SOPs, and the Quality Management System.

This SOP is designed to provide the user with a general outline for collecting environmental and quality assurance samples and assumes the user is familiar with basic field procedures, such as recording field notes (SOP 1), sample shipment procedures (SOP 3), investigation derived waste management procedures (SOP 5), and equipment decontamination (SOP 6). This SOP does not cover investigation planning, nor does it cover the analysis of the analytical results. These topics are more appropriately addressed in a site-specific work plan or a dedicated quality assurance project plan (QAPP). This SOP does not include an special handling requirements for specific parameters such as low-level mercury or per- and polyfluoroalkyl substances. These requirements should be included in the QAPP.

4.4 SAMPLE IDENTIFICATION PROCEDURES

All sample containers (e.g., glass bottles, plastic jars, foil bags, plungers, etc.) should be identified by an affixed sample label. Unless otherwise approved by your project manager or specified in your site-specific work plan/QAPP, information on the sample container labels must include the site/project name, project/task number, unique alpha-numeric sample identification (ID) number, sample collection date, time of collection using the military or 24-hour clock system (i.e., 0000 to 2400 hours), analytical parameters, preservative, and the initials of the sampling personnel. Employees are advised to use pre-printed waterproof mailing labels (e.g., Avery® 5xxx-series Waterproof Address Labels) for all sample identification. Electronic label templates are available.

The sample identification (ID) number must, unless otherwise approved by your project manager or specified in your site-specific work plan/QAPP, follow the company's naming protocol. This protocol was developed to aid in determining the type of sample collected (e.g., soil, groundwater, vapor, etc.), the sample location, and, where appropriate, the sample depth. This protocol was also designed to ensure consistency across the company.

Construct sample IDs in the following format:

SB-10A (4-6)

Where, in this example:

- SB = the first two or three characters will define the sample type (see list of approved prefixes below); in this case, a soil boring
- 10A = the next two or three alpha-numeric digits (separated by a dash from the sample type identifier) indicate the location of the boring on the site; in this case, boring number 10A
- (4-6) = the depth the sample was collected, with the first number (including decimals, if necessary) indicating the top of the sample interval (in feet) and the second number indicating the bottom of the sample interval (in feet); not all sample types will include depth information.

Additional label information may be added after the last character of the sample ID number (e.g., sample date, underground storage tank number, area of concern number, "Area" number, client identifier, etc.). Separate any additional information from the required portion of the sample name by dash(es).

Sample Prefix	Permitted Use
AA	Ambient outdoor air sample
CC	Concrete core/chip sample
CS	Confirmation/verification soil sample collected from an excavation
HA	Soil sample collected with a hand auger
IAB	Indoor air sample – basement
IAC	Indoor air sample – crawl space
IAF	Indoor air sample – first floor
MW	Soil sample collected from a monitoring well borehole or a groundwater sample collected from a monitoring well
PZ	Groundwater sample collected from a piezometer
SB	Soil sample collected from boreholes that will not be converted to monitoring wells
SED	Sediment sample
SG	Soil gas sample other than a sub-slab sample (e.g., sample collected from a temporary or permanent polyvinyl chloride sample point or stainless steel screen implant)
SL	Sludge sample
SS	Surface soil sample collected using hand tools (e.g., trowel, spoon, etc.) and typically at depths less than 2 feet below ground surface
SSV	Sub-slab vapor sample
SW	Surface water sample
TC	Tree core sample
TP	Soil sample collected from a test pit
WC	Waste characterization sample
WP	Wipe sample
WW	Wastewater

4.5 SAMPLE CONTAINERS, PRESERVATIVES, AND HOLDING TIMES

The first step in sample collection is to verify that the correct number and type of sample containers were provided, and that each contains the appropriate preservatives for the proposed project (i.e., check against the sampling plan requirements outlined in the site-specific QAPP or, for those projects without a site-specific QAPP, the laboratory Task Order). Inspect all containers and lids for flaws (cracks, chips, etc.) before use. Do not use any container with visible defects or discoloration. Report non-receipt and any discrepancies of specific types of sample containers to the team leader or project manager immediately. Make arrangements to have missing or additional sampling containers provided on an expedited basis.

Precautions must be taken to prevent cross-contamination and contamination of the environment when collecting samples. Wear a clean pair of new, disposable gloves each time a different sample is collected and don the gloves immediately prior to collection. This limits the possibility of cross-contamination from accidental contact with gloves soiled during collection of the previous sample. The gloves must not contact the medium being sampled and must be changed any time during sample collection when their cleanliness is compromised. ***In no case should gloved hands be used as a sampling device: always use the appropriate sampler to move the sample from the sampling device to the laboratory-supplied containers.***

Sample collection must follow all appropriate SOPs, state and federal regulations, or guidance, for the collection of environmental samples; the recommended order of sample collection is:

- Geochemical measurements (e.g., temperature, pH, specific conductance)
- Volatile organic compounds (VOCs)
- Extractable organics, petroleum hydrocarbons, aggregate organics, and oil and grease
- Per- and Polyfluoroalkyl substances
- Total metals
- Dissolved metals
- Inorganic non-metallic and physical and aggregate properties
- Microbiological samples
- Radionuclides

Fill the sample bottles to the appropriate level for the parameter analyzed including eliminating head space, as appropriate. Collected samples that require thermal preservation must be immediately (within 15 minutes) placed in a cooler with wet ice and maintained at a preservation temperature of 4° Celsius (ºC).

4.6 FIELD QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

Field quality assurance/quality control (QA/QC) samples may include equipment blanks, trip blanks, temperature blanks, duplicates, matrix spike and matrix spike duplicate samples, field blanks, and split samples. The project manager or QAPP must specify the type and frequency of QA/QC sample collection. The QA/QC sample identification number must, unless otherwise approved by your project manager or specified in your site-specific work plan, follow the company's naming protocol as discussed in the sections below. QA/QC samples must be clearly identified on our copy of the chain-of-custody (COC) form (described below) and in the field book. Failure to properly collect and submit required QA/QC samples can result in invalidation of an entire sampling event.

Several blanks, discussed below, require laboratory-grade analyte-free, deionized water (DI) be used. Only if all options to obtain laboratory-grade DI have been exhausted should store-grade distilled water be used to prepare blanks. If store-grade distilled water is used, be sure to record the source and lot number in the field book.

Collect, preserve, transport and document split samples using the same protocols as the related samples.

4.6.1 EQUIPMENT BLANKS

Equipment blanks, or rinsate blanks, are used to document contamination attributable to using non-dedicated equipment (i.e., equipment that must be decontaminated after each use). Collect equipment blanks in the field at a rate of one per type of sampling equipment per day, unless otherwise specified. If the site-specific work plan or QAPP indicates that an equipment blank is to be collected from dedicated sampling equipment, collect the equipment blank in the field before sampling begins. If field decontamination of sampling equipment is required, prepare the equipment blanks after the equipment has been used and field-decontaminated at least once.

Prepare equipment blanks by filling or rinsing the pre-cleaned equipment with DI and collecting the rinsate in the appropriate sample containers. Record the type of sampling equipment used to prepare the blank and how the equipment blank was generated in the field book. Decontamination of the equipment following equipment blank procurement is not required.

The samples must be labeled, preserved, and filtered (if required) in the same manner as the environmental samples. Have the equipment blanks analyzed for all the analytes for which the environmental samples are being analyzed, unless otherwise specified. Designate equipment blanks using "EB", followed by the date, and in the order of equipment blanks collected that day. For example, the first equipment blank collected on July 4, 2015, would be designated EB070415-1.

4.6.2 TRIP BLANKS

Trip blanks are used to document VOC contamination attributable to shipping and field handling procedures. Trip blanks are only required when analyzing samples for VOCs. The blanks are prepared by the analytical laboratory and shipped along with the empty sample containers. These pre-filled blanks should accompany the environmental sample containers wherever they are stored onsite (i.e., keep the trip blank sample bottles in the same shipping container used to ship and store VOC sample bottles during the sampling event). Never open the laboratory-supplied trip blank sample bottles. Only as a last resort, store-grade distilled water, can be poured into empty VOC sample bottles to generate event-specific trip blanks (or augment the laboratory-supplied ones, if they are provided in insufficient numbers).

The trip blanks, even those provided by the analytical laboratory, should be labeled in the field like other environmental samples collected during the investigation activities. Identify trip blanks using the prefix "TB", followed by the date. For example, the trip blank shipped with a cooler of samples on July 4, 2019, would be designated TB070419-1. If a second trip blank is needed on that same day, the designation would be TB070419-2. A minimum of one trip blank should accompany each shipping container of VOC samples, unless more stringent project requirements are in place. The number of trip blanks needed per shipment can be minimized by shipping all the VOC samples in the same shipping container (if possible).

4.6.3 FIELD BLANKS

The field blank is analogous to the trip blank in that it is designed to assess and document any contamination to the environmental samples that can be attributable to the (ambient) field conditions. Not all projects require the use of field blanks. Their use, if required, and the frequency of collection (often 1 blank per 10 or 20 environmental samples collected) is detailed in the QAPP and the site-specific work plan. The sample is collected by pouring DI water into empty glassware at the site during the sampling event. The intent is to expose the field blank to the same conditions in the atmosphere as those present when the environmental samples were collected.

Identify field blanks using the prefix "FB", followed by the date. For example, the field blank shipped collected on August 22, 2019, would be designated FB082219. If a second field blank is needed on that same day, the designation would be FB082219-2. At least one field blank should be collected for each analytical parameter identified in the sampling event.

4.6.4 TEMPERATURE BLANKS

Temperature blanks are used to determine if the samples are at the appropriate temperature for preservation at the time the sample container (cooler) is received by the analytical laboratory. The temperature is determined by measuring the temperature blank, which provides a proxy for the temperature of the sample container upon arrival at the laboratory. These temperature blanks are typically provided by the laboratory and should be included in each sample cooler used to ship and store the sample bottles during the sampling event. If laboratory-provided temperature blanks are not available, fill a clean, unpreserved sample bottle with potable, DI, or store-grade distilled water and identify the bottle as a temperature blank.

4.6.5 DUPLICATES

Duplicate samples, which are used for measuring the variability and documenting the precision of the sampling process, should be collected at a rate of at least 1 duplicate per 20 environmental samples collected, unless specific project requirements (as detailed in a QAPP) are in place. Be sure that the location selected for duplication has sufficient sample volume and is within the area of contamination, if known. Under no circumstances can equipment or trip blanks be used as duplicates.

Collect each duplicate sample at the same time, from the same sample aliquot, and in the same sampling order (i.e., volatile organic compounds, then semivolatile organic compounds, then inorganics, etc.) as the corresponding environmental sample. Sample bottle aqueous duplicate samples, for example, should be alternately filled with the environmental sample bottles (i.e., the actual sample bottle and the bottle to be used for the duplicate) from the same sampling device. If the sampling device does not hold enough volume to fill the sample containers, fill the first container with equal portions of the sample, and pour the remaining sample into the next

sample containers. Obtain additional sample volume and pour the first portion into the last sample container, and pour the remaining portions into the first containers. Continue with these steps until all containers have been filled.

Duplicate samples will be assigned arbitrary sample ID and a false collection time so that they are not identified as duplicates by the laboratory (i.e., submit the duplicates samples as *blind* to the lab). The blind duplicate sample "location designation" will be left up to the project manager; however, in no case will "Dup" be allowed to appear in the sample name. The duplicate samples should be analyzed for the same analytes as the original environmental sample. Be sure to record the sampling method, duplicate sample ID, the false time, and the actual time of collection in the field notebook. The duplicate should also be indicated in separate documentation, such as on our carbon copy of the chain-of-custody (i.e., the yellow copy), and not on the original chain-of-custody that accompanies the samples to the laboratory.

4.6.5 MATRIX SPIKE AND MATRIX SPIKE DUPLICATES

Matrix spike and matrix spike duplicate samples (i.e., MS/MSD samples) are used to determine the bias (accuracy) and precision of an analytical method for a specific sample matrix. Many of the company's projects require the collection of MS/MSD samples; however, laboratory generated MS/MSD samples are sufficient for some projects (as detailed in the QAPP or site-specific work plan). Collect MS/MSD samples at a rate of 1 MS and 1 MSD (i.e., 2 samples) for every 20 environmental samples, unless more stringent project requirements (as detailed in a QAPP) are in place. Clearly convey the MS/MSD identity to the laboratory by adding "MS" or "MSD" after the sample name (e.g., MW-01MS) and/or in the comments section of the chain-of-custody on the same line as the parent sample. Under no circumstances can equipment or trip blanks be used as MS/MSD samples.

4.6.6 SPLIT SAMPLES

Split samples may be collected as a means of determining compliance or as an added measure of quality control. Split samples measure the variability between laboratories and not the variability of sample collection and laboratory procedures (i.e., they are not equivalent to duplicate samples). The split samples must be subsamples of the same parent material used for the environmental sample: soil should be collected from the same in-place material (for VOCs) or, for non-discrete samples, the same mixing vessel after homogenization. Collect aqueous split samples using the same alternating bottle approach detailed in the duplicate sample description above. These procedures will ensure that the split samples are valid and are representative of the environmental sample collected as part of the investigation.

Collecting split samples of soil, sediment, waste, and sludge is not recommended because the homogenization necessary for a true split sample in these matrices is not possible and the resulting laboratory results would not be comparable.

Spilt samples should have the same sample location designation (e.g., MW-01, SB-03 (4-6), but are differentiated from each other by inserting the laboratory analyzing or the agency/consultant collecting the sample after the sample location (e.g., MW-01-WSP and MW-01-EPA).

4.7 CUSTODY DOCUMENTATION

Sample custody protocols are used to demonstrate that the samples and sample containers were handled and transferred in such a manner as to prevent tampering. Legal COC begins when the pre-cleaned sample containers are dispatched to the field from the laboratory and continues through sample analysis and eventual disposal of the sample and sample containers. Maintaining custody requires that samples must be in the actual possession or view of a person who is authorized to handle the samples (e.g., sample collector, laboratory technician, etc.), secured by the same person to prevent tampering, or stored in a designated secure area.

It is a good idea to limit, to the extent possible, the number of individuals who physically handle the samples. Samples must be placed in locked storage (e.g., locked vehicle, locked storeroom, etc.) when not in the possession or view of authorized personnel. Do not leave samples in unoccupied motel or hotel rooms or other areas where access cannot be controlled by the person(s) responsible for custody without first securing samples and shipping or storage containers with tamper indications in place (i.e., custody seals).

The COC form is used to trace sample possession from the time of collection to receipt at the analytical laboratory. It is recommended that the company's COC be used rather than the laboratory-supplied COC form to ensure that all necessary data are recorded. Submit one COC form per sample shipment, unless more stringent project requirements are in place (as detailed in the QAPP or site-specific work plan). The COC needs to have a unique COC number (pre-printed on the form), accompany all the samples, and include all appropriate project-specific information, such as:

- Project number, name, and location
- Sampler's printed name(s) and signature(s)
- Sample identification number
- Date and time (using the 24-hour clock) of collection
- Sample matrix (e.g., soil, aqueous, solid, etc.)
- Total number of containers per sample
- Parameters requested for analysis including number of containers per analyte.
- Remarks (e.g., irreducible headspace, field filtered sample, expected concentration range, specific turn-around time requested, etc.)
- Signatures of all persons involved in the chain of possession in chronological order
- Requested turn-around-time
- Name and location of analytical laboratory
- Custody seal numbers
- Shipping courier name and tracking information
- Internal temperature of shipping container upon shipment to laboratory, as needed
- Internal temperature of shipping container upon delivery to laboratory
- Employee contact information

Affix custody seals to all storage and shipping container closures when transferring or shipping sample container kits or samples to an off-property party. Place the seal so that the closure cannot be opened without breaking the seal. In the field book, record the time, date and signatures of responsible personnel affixing and breaking all seals for each sample container and shipping container. Affix new custody seals every time a seal is broken until continuation of evidentiary custody is no longer required.

FIELD STANDARD OPERATING PROCEDURE #5

INVESTIGATION DERIVED WASTE MANAGEMENT PROCEDURE

The purpose of this standard operating procedure (SOP) is to provide instructions for handling, storing, and managing investigation derived waste (IDW) pending disposal. All IDW, which includes (but is not limited to) soil cuttings, development water, purge water, drilling fluids, decontamination fluids, personal protective equipment (PPE), and sampling equipment, must be managed in compliance with applicable or relevant and appropriate requirements. The user is advised to read the entire SOP and review the site health and safety plan (HASP) and/or project safety plan (PSP) before beginning any onsite activities. In accordance with the HASP or PSP, proper PPE must be selected and used appropriately.

5.1 ACRONYMS AND ABBREVIATIONS

DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
HASP	health and safety plan
IDW	investigation derived waste
PCB	polychlorinated biphenyl
PPE	personal protective equipment
PSP	project safety plan
RCRA	Resource Conservation and Recovery Act
SOP	standard operating procedure
TSCA	Toxic Substances Control Act

5.2 MATERIALS

- Pre-printed weatherproof waste labels (e.g., non-hazardous waste, hazardous waste, polychlorinated biphenyls [PCBs], etc.)
- IDW log (Figure 1)
- Permanent ink marking pen, paint, stick/pen
- Sampling equipment (refer to sampling SOPs)
- Impermeable covers (tarps), as needed
- Duct tape, rope, or other material to secure tarp
- Copy of the waste manifest or bill of lading

5.3 PRECONDITIONS AND BACKGROUND

This SOP has been prepared as part of the company's Environmental Quality Management Plan and is designed to provide detailed procedures for common field practices. Compliance with the methods presented in this document is mandatory for all field personnel and will ensure that the tasks are performed in a safe and consistent manner, are in accordance with federal and state guidance, and are technically defensible.

This SOP is written for the sole use of company employees and will be revised periodically to reflect updates to company policies, work practices, and the applicable state and/or federal guidance. Employees must verify that this document is the most recent version

of the company SOPs. Employees are also strongly advised to review relevant state and/or federal guidance, which may stipulate program-specific procedures, in advance of task implementation.

WSP requires that all personnel performing specific project assignments be appropriately qualified, including having required certifications or licenses, and properly trained in accordance with the requirements of their assignment, the Environmental Service Line's field standard operating procedures, and the Quality Management System.

This SOP is designed to provide the user with a general outline for handling, storing, and managing IDW pending disposal and assumes the user has received current U.S. Department of Transportation (DOT) training, Hazardous Waste Operations and Emergency Response training, and Resource Conservation and Recovery Act (RCRA) training (if required) and is familiar with basic field procedures, such as recording field notes (SOP 1), sample shipment procedures (SOP 3), sample collection and quality assurance procedures (SOP 4), and equipment decontamination (SOP 6). The SOP does not cover investigation planning; DOT, RCRA, and Toxic Substances Control Act (TSCA) regulations; nor does it cover the evaluation of the analytical results. **Consult and involve the company's compliance professionals during all phases of IDW management and disposal.**

It is important to note that information contained in this SOP is based on federal regulations and interpretive guidance provided by the U.S. Environmental Protection Agency (EPA) and other federal regulatory sources; therefore, information provided in this SOP may be superseded by state or local-specific statutes or regulations. Field personnel must plan for and discuss the handling procedures with the project manager and assigned company compliance professional before mobilizing to the field.

5.4 IDW GENERAL PROCEDURES

Nearly all intrusive field activities will generate solid or liquid wastes. Examples include:

Solid Waste

- Soil cuttings
- Drilling mud
- Plastic sheeting
- Spent carbon or filters
- PPE (e.g., Tyvek coveralls, gloves, respirator cartridges)
- Disposable or dedicated sampling equipment (e.g., bailers, hoses, clamps, buckets, cartridge filters)
- Field analytical waste (e.g., HACH kits, Chlor-n-Soil kits, Gastech tubes)
- Compressed gas cylinders (e.g., isopropylene, helium)
-
- Disposable cleaning materials (e.g., wipes or rags)

Liquid Waste

- Decontamination water
- Development water
- Drilling fluids
- Purge water
- Soap or wash solutions
- Reagents (e.g., hexane, nitric acid, methanol)

The specific procedures for dealing with these materials after the field activities have been completed will vary depending on whether the materials are considered to be non-hazardous, RCRA hazardous (characteristic or listed wastes), TSCA-regulated PCB waste, and/or DOT hazardous materials. The characterization of the wastes to be generated should be determined in conjunction with a company compliance professional before the field event occurs, based on previously generated data; however, in some cases, particularly for new sites, the status of the wastes may not be known. In these cases, handle IDW as hazardous waste until the status can be verified. Field personnel must consult their assigned company compliance professionals for assistance in proper waste characterization and to determine waste management requirements applicable to the site.

5.4.1 WASTE MINIMIZATION

As possible, select investigation methods and techniques that will minimize the amount of wastes generated during field activities, particularly if the IDW is hazardous. Examples include using direct-push methods instead of hollow stem augers (to minimize soil cuttings) during a soil investigation, if appropriate, eliminating the use of solvents or solvent-based cleaners for decontamination, if

possible, and limiting contact with the materials to reduce the amount of PPE required. Minimizing the amount of waste generated will reduce handling requirements and overall project costs, and is consistent with the company's corporate goals for sustainability.

5.5 ONSITE IDW MANAGEMENT PROCEDURES

Onsite handling procedures typically involve containerization of the IDW for offsite disposal at a regulated facility or, in the case of certain non-hazardous wastes, onsite disposal. Should more than one waste stream be present onsite, segregate the IDW containers by waste stream to facilitate the future waste disposal. The procedures for each type of waste are presented below.

5.5.1 NON-HAZARDOUS WASTE MANAGEMENT

If the IDW is classified as non-hazardous waste, the following procedures must be implemented only if approved by the applicable regulatory agency and after being discussed and approved by the project manager, project compliance professional, client, and facility personnel:

- Soil can be either:
  - spread around the borehole or other onsite location
  - placed back in the boring or excavated test pit
  - containerized and disposed of offsite
- Groundwater and decontamination fluids can be either:
  - poured onto the ground next to the well to allow infiltration
  - discharged to either the publically-owned treatment works or storm sewer
  - discharged to the onsite wastewater treatment plant
  - containerized and disposed of offsite
- After rendering the IDW unusable (e.g., cutting or tearing material), PPE, plastic sheeting, disposable cleaning materials, and spent bag filters can be double bagged and disposed of as general trash or containerized and disposed of offsite.
- Compressed gas cylinders should be depressurized and disposed of as general trash, recycled as scrap metal, or containerized and disposed of offsite.
- Field analytical waste (e.g., HACH® kits, Chlor-n-Soil® kits) can be disposed of in accordance with the manufacturer's instructions provided the disposal method is approved by the company's project manager and compliance professional.
- Minimize the volume of reagents as much as possible. Consult a company compliance professional to determine the proper disposal of any quantity of unused reagents. Empty reagent containers may be disposed of as general trash after removing all chemical name and warning labels, or may be containerized and disposed of offsite.
- Spent water treatment media (e.g., carbon, resin) should be containerized and disposed of offsite.
- Exploration and production exempt waste derived from material that was downhole at an oil and gas production site.

If the IDW is containerized and is classified as non-hazardous, the following procedures will apply:

- Place the non-hazardous IDW in DOT-compliant containers (e.g., 55-gallon drum, roll-off container, or temporary storage tank). Before placing IDW in the containers, ensure that the containers are in good condition and will not leak.
- Drums used as containers must remain closed except when adding, sampling, or inspecting the waste. The drums cannot be used as a work surface once waste is put in the container.
- Mark the container with the appropriate waterproof, self-adhesive non-hazardous waste label. The label must include a description of the contents of the container (e.g., soil cuttings, purge water) and the generator name (the client or the facility, never the company). **Field personnel must consult the project compliance professional for help in properly completing the labels.**
- Complete the IDW Log (Figure 1) before leaving the site. Present one copy of the log to the site contact and the original to the project manager.
- The IDW containers must be properly closed, wiped clean, and stored in a secure onsite location.

5.5.2 HAZARDOUS WASTE MANAGEMENT

If site data or generator knowledge indicates that the IDW is RCRA hazardous, the following procedures will apply:

- Place IDW in DOT-compliant containers (e.g., 55-gallon drum, roll-off container, or temporary storage tank). Before placing IDW in the containers, ensure that the containers are appropriate for the type of IDW generated (e.g., solid in containers authorized for transport of solids), in good condition and will not leak.

- Containers must remain closed except when adding, sampling, or inspecting the material. The containers cannot be used as a work surface once waste is put in the container.
- Mark the container with an appropriate waterproof, self-adhesive hazardous or radiological waste label. The label must include the accumulation start date, a description of the contents of the container (e.g., soil cuttings, purge water), the EPA identification number, the generator name (the client or the facility, never the company), and the hazardous waste codes, if known. **Field personnel must consult the project compliance professional for help in properly completing the labels.**
- The IDW containers must be properly closed, wiped clean, and stored in a secure onsite location (i.e., a designated facility hazardous waste storage area) to limit access. At a minimum, place the drums on an impermeable surface (if available) in an area of limited access. If stored outside, cover the containers with a secured tarp at the end of each field day until the containers are picked up for disposal.
- Complete the IDW Log (Figure 1) before leaving the site. Present one copy of the log to the site contact and the original to the project manager.
- If applicable, ensure that weekly inspections are conducted, and the proper inspection forms for documentation are completed during the entire time the waste is stored onsite. **Field personnel must consult the project compliance professional for help to determine if weekly inspections are required.**

If the IDW is presumed to be hazardous and sampling is required to confirm its classification, it must be labeled "Hazardous Waste-Pending Analysis" and sampled for the parameters specified by the project compliance professional or project manager before leaving the site. Any waste confirmation samples must be collected in accordance with the company's SOPs. Treatment, storage, and disposal facilities will usually specify the required analysis for waste profiles.

5.5.3 PCB WASTE MANAGEMENT

If information exists to classify PCB-containing IDW as TSCA-regulated IDW (i.e., PCBs greater than 50 milligrams per kilogram), the following procedures must be implemented:

- Place the PCB-containing IDW in DOT-compliant containers (e.g., 55-gallon drum, roll-off container, or temporary storage tank). Before placing IDW in the containers, ensure that the containers are in good condition and will not leak.
- Containers must remain closed except when adding, sampling, or inspecting the material. The containers cannot be used as a work surface once waste is put in the container.
- Mark the container with an appropriate waterproof, self-adhesive yellow label with the words "Caution Contains PCBs", the "removed from service" date (the accumulation start date), and a description of the contents of the container (e.g., soil cuttings). Complete the label with the name and phone number of the company personnel to contact in the event of an accident or spill. **Field personnel must consult the project compliance professional for help in properly completing the labels.**
- The IDW containers must be properly closed, wiped clean, and stored in a secure PCB storage area onsite. If a PCB storage area is not available, construct a temporary PCB storage area. Cover the containers with a secured tarp at the end of each field day until the drums are picked up for disposal. Place one yellow 6" x 6" "Caution Contains PCBs" label on the outside of the tarp, and note the "Removed from service date" on the label.
- Complete the IDW Log (Figure 1) before leaving the site. Present one copy of the log to the site contact and the original to the project manager.
- If applicable, inspect the area and the containers for leaks once every 30 days in accordance with TSCA requirements during the entire period the waste is stored onsite. **Field personnel must consult the project compliance professional for help to determine if weekly inspections are also required.**

5.6 POST-FIELD IDW MANAGEMENT ACTIVITIES

Field personnel must follow up on the management of the IDW after returning from the field. RCRA hazardous and TSCA-regulated PCB-containing wastes have storage time limits and periodic inspection requirements to remain in compliance with federal, state, or local regulations. Arrangements for proper disposal of wastes must be made within the required time limits and must be consistent with all applicable regulatory requirements, as well as the company's contracting procedures and policies for waste disposal. Copies of waste disposal documentation (e.g., bill of lading, waste manifest, land disposal restriction form, etc.) should be provided to the project manager and saved with the project files.

INVESTIGATION DERIVED WASTE LOG

Date/Time:_____

Site Information:
Site Name: _____ Site EPA ID #: _____
Site Contact: _____ Site Address: _____
Site Contact Telephone No: _____

Origin of Material: _____
Type of Waste Generated:
- ☐ Soil Cuttings ☐ PPE ☐ Decontamination Water
- ☐ Groundwater ☐ Storm Water ☐ Drilling Fluids
- ☐ Other (Describe): _____

Field Activities that Generated the Waste:
- ☐ Soil Borings ☐ Well Sampling ☐ Well Installation
- ☐ Decontamination ☐ Excavation ☐ Pumping Tests
- ☐ Other (Describe): _____

Generation Date: _____ ***90/180/270-Day Deadline(for hazardous waste)***: _____
Quantity of Waste Generated and Container Type: _____
_____
Storage Location: _____
Waste Identification:
- ☐ Non-hazardous Waste (pending analysis)
- ☐ Non-hazardous Waste (based on site information or generator knowledge)
- ☐ Hazardous Waste (pending analysis)
- ☐ Hazardous Waste (based on site information or generator knowledge)
- ☐ PCB-containing Waste
- ☐ Radiological Waste

If generator knowledge or site information was used for identification, explain: _____
_____
_____
Type of Label Applied to Container: ☐ Non-hazardous ☐ Hazardous ☐ PCB ☐ Radiological
WSP Information (Note: One copy to site contact - the original copy to project manager)
Personnel/Contact: _____ Project No.:_____
Telephone: _____

Date Removed: _____ Signature: _____

FIELD STANDARD OPERATING PROCEDURE #6

DECONTAMINATION PROCEDURE

The decontamination procedures outlined in this standard operating procedure (SOP) are designed to ensure that all sampling equipment is free from the analytes that could potentially interfere with sample results. The user is advised to read the entire SOP and review the site health and safety plan (HASP) and/or project safety plan (PSP) before beginning any onsite activities. In accordance with the HASP or PSP, proper personal protective equipment (PPE) must be selected and used appropriately.

6.1 ACRONYMS AND ABBREVIATIONS

DI	deionized water
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
HASP	health and safety plan
PPE	personal protective equipment
PSP	project safety plan
QAPP	quality assurance project plan
SOP	standard operating procedure

6.2 MATERIALS

- Field book
- PPE
- Polyethylene sheeting and/or garbage bags
- Laboratory-grade non-phosphate detergent[1] (e.g., Luminox® or Liquinox®)
- Cleaning reagents, as needed (e.g., isopropyl alcohol, methanol, hexane, nitric acid)
- Potable water
- Deionized (DI) water
- Containers (e.g., plastic buckets)
- Bristle brushes
- Aluminum foil
- Spray bottles
- Paper towels
- Pressurized steam cleaner (e.g., steam jenny), as needed
- Waste collection containers (e.g., drums), as needed
- Decontamination pad, as needed

6.3 PRECONDITIONS AND BACKGROUND

This SOP has been prepared as part of the company's Environmental Quality Management Plan and is designed to provide detailed procedures for common field practices. Compliance with the methods presented in this document is mandatory for all field personnel

[1] Not all laboratory-grade detergents are phosphate free. Be sure to verify the detergent's phosphate content before use.

and will ensure that the tasks are performed in a safe and consistent manner, are in accordance with federal and state guidance, and are technically defensible.

This SOP is written for the sole use of company employees and will be revised periodically to reflect updates to company policies, work practices, and the applicable state and/or federal guidance. Employees must verify that this document is the most recent version of the company's SOPs. Employees are also strongly advised to review relevant state and/or federal guidance, which may stipulate program-specific procedures, in advance of task implementation.

WSP requires that all personnel performing specific project assignments be appropriately qualified, including having required certifications or licenses, and properly trained in accordance with the requirements of their assignment, the Environmental Service Line's field SOPs, and the Quality Management System.

This SOP is designed to provide the user with a general outline for decontamination and assumes the user is familiar with basic field procedures, such as recording field notes (SOP 1), sample shipment procedures (SOP 3), sample collection and quality assurance procedures (SOP 4), and investigation-derived waste management procedures (SOP 5). All decontamination references must be available for consultation in the field, including:

- Company's SOPs
- Applicable state and federal guidelines or procedures
- Manufacturer's manuals
- Project-specific work plan, PSP and/or HASP, and QAPP

6.4 GENERAL PROCEDURES

The cleaning and decontamination procedures described below are designed to ensure that the equipment used for sample collection is free of analytes that could potentially alter the analytical results. These procedures are primarily targeted at preventing the incidence of cross-contamination (i.e., compounds of interest being transferred on the sampling equipment from one sample to another) in order to produce high quality, representative sample results. As with all analytical sampling, the effectiveness of the cleaning procedures must be demonstrated with the collection of equipment blanks; equipment blank sample collection procedures and frequency are discussed in SOP 4.

6.4.1 EQUIPMENT AND REAGENT SELECTION

It is important for employees to evaluate the expected types of contamination before mobilization to a site. State programs (or the U.S. Environmental Protection Agency [EPA], depending on the site) may require more stringent decontamination procedures than those listed in this SOP, specify the types and grades of various cleaning detergents and reagents (e.g., acids and solvents), or allow the use of phosphate-containing detergents, such as Liquinox® liquid detergent (preferred[2]) or the powdered Alconox®. Decontamination equipment (e.g., spray bottles, brushes, etc.) should be constructed of non-reactive, non-leachable materials (e.g., metal, glass, Teflon®-coated, polyethylene, etc.) which are compatible with the reagents and solvents being used for decontamination.

Many of the cleaning reagents (e.g., nitric acid, hexane, methanol) are U.S. Department of Transportation (DOT) hazardous materials and must be shipped using a ground delivery service. The Safety Data Sheets (SDSs) for any hazardous cleaning reagents to be used onsite must be reviewed before the commencement of work, and the potential hazards and protective measures to be employed must be addressed in the HASP. Do not use decontamination liquids that have been improperly stored (e.g., unsealed containers).

In specific cases, it may be necessary to steam clean the field equipment before proceeding with the decontamination steps presented in Section 6.5 (e.g., hollow stem augers). Generally, the company's subcontractors are responsible for bringing or building a decontamination pad, if necessary, to contain the spray from a steam jenny. As possible, decontamination pads should be constructed on a level, paved surface in an area known or believed to be free of surface contamination, and should be of sufficient size to contain the decontamination water. Equipment that is steam cleaned should be placed on racks or saw horses and not on the floor of the

[2] Liquinox® liquid detergent, manufactured by Alconox, Inc., is phosphate-free and does not contribute to nutrient loading or algae blooms in the environment.

decontamination pad. Decontamination water should be removed from the decontamination pad frequently to minimize the potential for leaks or overflow.

Consult and involve the company's compliance professionals for storage procedures and disposal requirements of cleaning reagents, detergents, wastes, and other decontamination-related materials.

6.4.2 OTHER CONSIDERATIONS

In preparing for decontamination, you should perform the following activities (with all observations and measurements noted in the field book):

- Perform a quick reconnaissance of the site to identify a decontamination (pad) area and evaluate the accessibility to and safety of the location.
- If working in a hazardous waste exclusion area, the decontamination area should be located in the contaminant reduction zone.
- Record a description of the decontamination (pad) area.

Survey the breathing zone around the decontamination area with the appropriate air quality meter(s), as necessary (see HASP), to ensure that the level of PPE is appropriate. When decontaminating equipment, it is important to find a suitable location away from any sources of cross-contamination that could compromise the integrity of the decontamination. As possible, position the decontamination area away from fuel-powered equipment, such as drill rigs or excavators, and upwind of other site activities (e.g., purging, sampling).

6.5 DECONTAMINATION PROCEDURES

The decontamination procedures described below are a four- to nine-step process, depending on the the applicable federal or state guidelines, the project-specific work plan, or the QAPP. Sampling activities must be initiated with clean, decontaminated equipment. Decontaminate all non-dedicated equipment that contacts the sample directly (e.g., spoons, trowels, pumps), before and between each sample location and sampling interval. record decontamination procedures in the field book. Disposable, single use items, such as bailers or tubing, do not require decontamination.

The decontamination process includes the following four basic steps:

1. Physical removal of soil or debris
2. Wash with non-phosphate detergent, such as Liquinox®, and nylon brush
3. Potable water rinse
4. Laboratory-supplied deionized (DI), analyte-free water rinse (distilled water can be used as a substitute, if necessary)

The first step is to remove as much soil or other debris from the sampling device as possible near the sampling area to limit the spread of potentially-contaminated materials into clean areas of the site. Containerize all soil or debris in DOT-compliant containers in accordance with SOP 5 or the project-specific work plan. Dispose of all wastes in conformance with the project-specific work plan and applicable regulations.

Cleaning and decontamination should occur at a designated area(s) (i.e., decontamination pad) on the site. If gross contamination or an oily film or residue is observed on the equipment, use a steam jenny or wash by hand, using a brush, to remove the particulate matter or surface film. Heavy oils or grease may be initially removed with paper towels soaked with isopropyl alcohol.

The physical removal of debris process is followed by soaking (a simple dunk of the equipment is insufficient) and hand scrubbing the equipment with a solution of potable water and non-phosphate detergent (mixed to the manufacturer's instructions) followed by a potable water rinse. If not using a decontamination pad, the most common set-up uses multiple 5-gallon plastic buckets (or equivalent) for washing and rinsing. The decontamination containers should be labeled as to their contents and pertinent information from original source, such as the date opened or transferred, and the expiration date (as well as any applicable hazardous labels), placed on polyethylene sheeting (to contain drips of decontamination fluids during the decontamination process), and sealed when not in use to prevent accidental release of the fluids. If decontaminating sealed submersible pumps, pump both the non-phosphate detergent wash

fluid and the potable water rinse through the pump body itself (usually done in separate buckets) to ensure that the internal components are thoroughly cleaned. Replace the detergent solution and rinse water at least daily or when it becomes oily or silty.

Next, place the DI water for the rinse in a small spray bottle or pour over the equipment after the potable water rinse.

Typically, this level of decontamination (i.e., steps 1 through 4) is sufficient.

Following Steps 1 through 4, additional decontamination (steps 5 through 9) may be required by the applicable federal or state guidelines, the project-specific work plan, or the QAPP. Typically, these decontamination steps are performed when sampling for inorganics or oil-related substances using non-motorized equipment. These steps include:

5 10% nitric acid rinse (if metals are part of the analyses)
6 Laboratory-supplied DI water rinse
7 Pesticide-grade solvent rinse (e.g., acetone [preferred], hexane, or isopropyl alcohol)
8 Air dry (solvent must evaporate)
9 Laboratory-supplied DI water rinse

Isopropyl alcohol is the recommended solvent for organic contaminants because it is readily available and is not a DOT hazardous material; where possible, lab-grade isopropyl alcohol should be used . However, other solvents (e.g., hexane and methanol) may be more effective in removing certain contaminants, such as oils or polychlorinated biphenyls, but any waste generated using these solvents must be managed accordingly. Solvents are never used for decontamination if sampling for volatiles organic compounds.

Handle the solvents and acid with care and store unused chemicals in their original, labeled, protective containers when not in use. It is a good idea to transfer small quantities of each solution into labeled, laboratory-grade spray bottles, which offer a convenient and controllable way to rinse the equipment. The equipment can then be rinsed over a 5-gallon plastic bucket or other suitable container placed on plastic sheeting as with the first part of the cleaning process. Nitric acid rinses must be used only on non-carbon steel sampling devices. Do not spray acid or solvent into pumps.

Decontamination steps used at sites where radioactive materials are contaminants of concern are similar with a few special considerations. Radiation contamination monitoring is used to help locate contamination and guide the success of the decontamination process. The liberal use of water and fluids as a decontamination agents are minimized, where practicable, because of the expense that can be incurred with disposing of radioactively contaminated decontamination water. Containerized decontamination wastes must be evaluated for radioactive content and disposed of appropriately depending on their content.

6.6 HANDLING DECONTAMINATED EQUIPMENT

Handle any decontaminated equipment using clean gloves to prevent re-contamination. Place the equipment away (preferably upwind) from the decontamination area once the process has been completed on clean plastic sheeting to allow it to air-dry. Once the equipment is dry, protect it from re-contamination by securely wrapping and sealing with aluminum foil (shiny side out) or clean, disposable plastic bags (inorganics only). Plastic bags may be wrapped directly around wet or dry equipment except when the expected contaminants include volatile and extractable organics; under those circumstances, allow the equipment to completely dry or wrap it in aluminum foil.

All sampling equipment must be decontaminated at the end of the investigation (i.e., prior to departure from the site). Label each piece of equipment with the date of decontamination, the initials of personnel performing the decontamination, and the type of decontamination solution(s) used. Containerize all decontamination fluids, and other disposable decontamination materials in DOT-compliant containers in accordance with SOP 5 or the project-specific work plan. Dispose of all wastes, including open and unused solvents or acids, in conformance with the project-specific work plan and applicable regulations.

FIELD STANDARD OPERATING PROCEDURE #9

SOIL SAMPLING PROCEDURE

The soil sampling procedures outlined in this standard operating procedure (SOP) are designed to ensure that collected soil samples are representative of current site conditions. Soil samples can be collected for onsite screening or for laboratory analysis. The user is advised to read the entire SOP and review the site health and safety plan (HASP) and/or project safety plan (PSP) before beginning any onsite activities. In accordance with the HASP, proper personal protective equipment (PPE) must be selected and used appropriately.

9.1 ACRONYMS AND ABBREVIATIONS

ºF	degrees Fahrenheit
HASP	health and safety plan
IDW	investigation derived waste
PID	photoionization detector
PPE	personal protective equipment
PSP	project safety plan
QAPP	quality assurance project plan
QA/QC	quality assurance/quality control
SOP	standard operating procedure
USCS	Unified Soil Classification System

9.2 MATERIALS

- Field book
- PPE
- Air quality monitoring equipment, (e.g., photoionization detector [PID]), as needed
- Field test kits, as needed
- Sampling containers and labeling/shipping supplies
- Ruler or tape measure
- Zipper-style plastic bags, as needed
- Plastic sheeting
- Soil sampling method specific materials, as needed:
- Stainless steel trowels, probes, or shovels
- Stainless steel spatulas or spoons
- Bucket augers, auger extension rods, auger handle, pipe wrenches
- Split-spoon samplers, pipe wrenches
- Direct-push acetate liners, including catchers and opening tools, as needed
- Shelby tube samplers, plastic or wax caps
- Mixing tray or bowl
- Munsell color chart
- Decontamination supplies

9.3 PRECONDITIONS AND BACKGROUND

This SOP has been prepared as part of the company's Environmental Quality Management Plan and is designed to provide detailed procedures for common field practices. Compliance with the methods presented in this document is mandatory for all field personnel and will ensure that the tasks are performed in a safe and consistent manner, are in accordance with federal and state guidance, and are technically defensible.

This SOP is written for the sole use of company employees and will be revised periodically to reflect updates to company policies, work practices, and the applicable state and/or federal guidance. Employees must verify that this document is the most recent version of the company SOPs. Employees are also strongly advised to review relevant state and/or federal guidance, which may stipulate program-specific procedures, in advance of task implementation.

WSP requires that all personnel performing specific project assignments be appropriately qualified, including having required certifications or licenses, and properly trained in accordance with the requirements of their assignment, the Environmental Service Line's field SOPs, and the Quality Management System.

This SOP is designed to provide the user with a general outline for conducting soil sampling and assumes the user is familiar with basic field procedures, such as recording field notes (SOP 1), utility location (SOP 2), sample shipment procedures (SOP 3), sample collection and quality assurance procedures (SOP 4), investigation-derived waste (IDW) management procedures (SOP 5), equipment decontamination (SOP 6), and use and calibration of sampling and monitoring equipment (SOPs 7 and 8). This SOP does not cover investigation planning, nor does it cover the evaluation of the analytical results. These topics are more appropriately addressed in a project-specific work plan. Before soil sampling, be sure to review the project-specific work plan or Quality Assurance Project Plan (QAPP) and any applicable state and federal guidelines or sampling procedures.

Consult and involve your assigned compliance professional during all phases of soil sampling. Do not ship hazardous waste samples without first consulting a company compliance professional.

All sampling and monitoring references must be available for consultation in the field, including:

- Company's SOPs
- Applicable state and federal guidelines or sampling procedures
- Manufacturer's manuals
- Project-specific work plan, PSP and/or HASP, and QAPP

9.4 GENERAL PROCEDURES

Soil samples are collected using a variety of techniques and equipment, depending on the type (e.g., surface, subsurface) and purpose (e.g., lithological logging, headspace evaluation, laboratory analysis) of the sampling, and most sampling events employ more than one equipment type or methodology. Subsurface soil sampling, for example, often includes sample collection from split-spoon, macro-core, or other dedicated sampling devices advanced into the subsurface. Recovered cores are often logged (using a Munsell color chart and other logging aids), screened for volatile organic compounds (VOCs) using a PID, and sampled for laboratory analysis using disposable stainless steel spoons or other discrete sampling devices.

Each sampling configuration is associated with a unique set of sampling equipment requirements and techniques. The selected procedures and equipment are project-specific and should be discussed by the project team before arriving onsite. All types of soil sampling, regardless of the equipment used, share common handling and management procedures that are designed to ensure the integrity of the samples collected. These procedures include:

- The use of new, disposable or decontaminated sampling equipment
- The use and rotation of the appropriate PPE
- Selection of a suitable sampling location and staging area

Wear a clean pair of new, disposable gloves each time a different sample is collected and don the gloves immediately prior to collection. This limits the possibility of cross-contamination from accidental contact with gloves soiled during collection of the

previous sample. The gloves must not come in contact with the medium being sampled and must be changed any time during sample collection when their cleanliness is compromised. ***Gloved hands should not be used as a sampling device; always use the appropriate equipment to move the sample from the sampling device to the laboratory-supplied containers.*** If the soil cannot be transferred directly from the sampling device to the laboratory-supplied containers, use a stainless steel spoon or spatula to transfer the soil from the sampling device to the laboratory-supplied containers.

9.4.1 EQUIPMENT SELECTION

Collect all samples using either new, disposable equipment, such as polyethylene liners or single-use stainless steel spoons; or properly decontaminated sampling equipment, such as hand augers, split-spoon samplers, or trowels. Soil sampling equipment should be selected based on the analytical requirements of the project and the project-specific conditions likely to be encountered. The equipment should be constructed of non-reactive, non-leachable materials (e.g., stainless steel, Teflon®, Teflon®-coated steel, polyethylene, polypropylene) which are compatible with the chemical constituents at the site. When choosing sampling equipment, give consideration to:

- the types of soil or fill present
- the required depth of the sample
- the volume of sample required
- the analytes of interest

Select the types of equipment and decontamination procedures based on the types of sampling to be performed. Decontamination may require multiple steps or differing cleaning methods, depending on the sampling goals (see SOP 6 for decontamination procedures). In no case should disposable, single use materials (e.g., acetate liners, soil baskets) be used to collect more than one sample.

9.4.2 SAMPLING CONSIDERATIONS

In preparing for sampling, you should perform the following activities (with all observations and measurements noted in the field book):

- Perform a quick reconnaissance of the site to identify sampling locations and evaluate the accessibility (physical obstructions, slope, overhead and underground utilities) to the sampling location.
- Record the approximate ambient air temperature, precipitation, wind (direction and speed), tide, and other field conditions in the field book. In addition, any site-specific conditions or situations that could potentially affect the samples should be recorded.
- Record a description of the sampling location and the approximate distance to and direction from at least one permanent feature.
- Should any sample location require a vertical or horizontal offset from the proposed location, indicate the reason and record the actual sample location in the field book.

Survey the breathing zone around the sampling location with the appropriate air quality meter(s), as necessary (see HASP), to ensure that the level of PPE is appropriate. When sampling soil, it is important to find a suitable sampling location away from any sources of cross-contamination that could compromise the integrity of the samples. Consider the following:

- Position the sample collection area away from fuel-powered equipment, such as drill rigs or excavators, and upwind of other site activities (e.g., purging, sampling, decontamination) that could influence the sample. This is particularly important when screening samples in the field for VOCs with a PID, but should not be limited to the active sample collection.
- Store samples already collected from the field for laboratory analysis in clean containers in an ice-filled cooler (as required) and securely stage, if possible, in an uncontaminated area of the site.

9.5 SOIL SAMPLE COLLECTION

Soil samples can be collected from surface or subsurface depths, depending on the project requirements. Surface soils are generally those collected at depths less than 2 feet below ground surface (bgs) and can be collected using trowels, soil probes, shovels, or hand augers. Be aware that some states have specific definitions of what constitutes a surface soil sample. Subsurface soils are generally

deeper and require specialized equipment to recover the samples. In most cases, subsurface soils will be collected using a drill rig or excavator to prevent the soil from being mixed with soils from a shallower interval.

Push or drive the method-specific sampling equipment (e.g., trowel, hand auger, hollow corers, split-spoon, direct push sampler, rotosonic core barrel sampler, excavator bucket) into the soil to the desired sampling depth using decontaminated equipment. Record in the field book the depth interval through which the sampler was advanced and, when using a drilling rig and split-spoon sampler, the number of blows needed to drive the sampler 6 inches. If additional soil is needed to provide sufficient sample volume, repeat this step taking care to ensure that the same depth interval is collected during the resample. Use core catchers on the leading end of the sampler (if available) for soils that lack cohesiveness and are subject to falling out of the sampler (i.e., poor recovery).

Withdraw the sampling equipment from the interval, open the sampler (as appropriate), and collect the sample in a safe location (e.g., avoid entering an excavation by collecting the sample from an excavator bucket at ground surface). When collecting a sample from an excavator bucket, the sampler should watch the bucket as the excavated material is retrieved and collect the sample from the desired sampling material.

Recovered soils should be placed on plastic sheeting in a consistent manner such that the orientation of the sample (i.e., which end is "up") and the depth interval is readily apparent to the sampling personnel. Measure the length of the material recovered relative to the interval the sampler was advanced in percent notation (e.g., 75%) or as a fraction of the total length of the sample interval (i.e., [3/4] indicating 3 out of 4 feet) and record this information in the field book. If field screening for organic vapors is required, break or cut the soil core every 3 to 4 inches and quickly scan the breaks in the core material with the appropriate air quality monitoring equipment (e.g., PID) and record the readings and approximate depth in the field book. These measurements can be used to select appropriate soil samples for VOC or headspace analysis, if required (see procedures below).

9.5.1 UNDISTURBED SAMPLE COLLECTION

Undisturbed soil samples collected for geotechnical parameters (e.g., porosity, permeability) generally require the use of specialized undisturbed sampling equipment (e.g., Shelby tube or sealed Geoprobe® liner) and collection procedures. The sampling device, once retrieved, is typically capped or sealed (to maintain the sample in its relatively undisturbed state), labeled with the sample name, orientation of the sample (i.e., top and bottom), depth interval, and shipped to the appropriate geotechnical laboratory. Follow sample labeling, preparation, and shipping procedures in SOPs 3 and 4.

9.5.2 VOLATILE ORGANIC COMPOUND SAMPLING

Analytical soil samples for VOC analysis should be collected immediately after screening with the PID to avoid loss of constituents to the atmosphere. Transfer the soil from the portion of the soil core to be sampled (usually the area where the highest PID readings were observed) directly into the sample containers; do not homogenize soils for VOC analysis. Place the soil in the sampling container such that no headspace is present above the soil when the cover is placed on the jar. If U.S. Environmental Protection Agency Method 5035 (e.g., Encore® samplers) is required, follow manufacturer's specifications and company recommended shipping procedures. Collect quality assurance/quality control (QA/QC) samples, if appropriate, in accordance with SOP 4, the project-specific work plan, and the QAPP.

9.5.3 SOIL HEADSPACE ANALYSIS

Collect soil samples for field-based headspace analysis, if required as part of the project-specific work plan, after collecting the VOC sample. First, examine the soil and remove coarse gravel, organic material (e.g., roots, grass, and woody material) and any other debris. Transfer the soil from the portion of the soil core to be sampled and place in a heavy-duty zipper-style plastic bag and seal the bag. Label the sample indicating the sampling location, depth, and date. Shake the sample vigorously for approximately 15 seconds to disaggregate the sample and expose as much surface area of the soil as possible (to release the VOCs to the atmosphere within the bag). If necessary, warm the sample to room temperature (70º Fahrenheit, [ºF]) by placing the bag in a heated room or vehicle. This step is critical when the ambient temperature is below 32ºF.

The VOCs, if present, will volatilize into the sealed bag. Allow the bag to stand (to achieve equilibrium) for approximately 15 minutes. Carefully open the bag slightly and place the tip of the PID into the opening. Do not insert the tip of the probe into the soil material and avoid the uptake of water droplets. Allow the PID to equilibrate and record the highest PID measurement noted. Erratic PID responses may result from high organic vapor concentrations or elevated headspace moisture. If these conditions exist, qualify the headspace data in the field book. It is also important to record the ambient temperature, humidity, and whether moisture was present in plastic bag. Duplicate 10% of the headspace samples by collecting two samples from the same location. Generally, duplicate sample values should be consistent to ±20%. Samples collected for headspace screening cannot be retained for laboratory analysis.

9.5.4 SEMI- AND NON-VOLATILE ANALYTICAL SAMPLE COLLECTION

For metal sulfide analysis, sediment should be maintained in anoxic conditions to limit exposure to oxygen. Samples should be collected immediately and stored with zero headspace.

Collect remaining organic samples then inorganic samples in the following order of volatilization sensitivity:

- Extractable organics, petroleum hydrocarbons, aggregate organics, and oil and grease
- Metals
- Inorganic non-metallic and physical and aggregate properties
- Microbiological samples
- Radionuclides

If homogenization is required, mix the soils (using stainless steel bowls and spoons, or other appropriate equipment) to a homogeneous particle size and texture. Transfer the soils from the sampler or mixing bowl to the sample container using a decontaminated or dedicated stainless steel spoon or spatula. Collect QA/QC samples in accordance with SOP 4, the project-specific work plan, and the QAPP.

If approved by the appropriate regulatory agency and specified in the project-specific work plan, composite soil samples can be collected to minimize the total number of analytical samples. Composite samples consist of equal aliquots (same sample size) of soil from each location being sampled (e.g., from each borehole or from multiple areas of a soil pile), by mixing the soil to a homogeneous particle size and texture using new or decontaminated stainless steel bowls and a stainless steel spoon or trowel. Transfer the contents to the appropriate laboratory supplied sample container using a stainless steel spoon. Collect QA/QC samples in accordance with SOP 4, the project-specific work plan, and the QAPP, if required.

If necessary, conduct field tests or screening on soils in accordance with the project-specific work plan and manufacturer's specifications for field testing equipment.

9.5.5 SAMPLE LABELING AND PREPARATION FOR SHIPMENT

Once collected, prepare the soil samples for offsite laboratory analysis:

1. Clean the outside of the sample container with paper towels or appropriate materials, if necessary
2. Affix a sample tag or label to each sample container and complete all required information (sample number, date, time, depth interval, sampler's initials, analysis, preservatives, place of collection)
3. Place clear tape over the tag or label (if non-waterproof labels are used)
4. Preserve samples immediately after collection by placing them into an insulated cooler filled with bagged wet ice to maintain a temperature of approximately 4°Celcius (if required by analytical method)
5. Record the sample designation, date, time, depth interval, number of sampling containers, analytical methods, and the sampler's name in the field book and on the chain-of-custody form
6. Complete the chain-of-custody forms with appropriate sampling information, including:
   - Location
   - Sample name
   - Sample collection date and time

- Number of sample containers
- Analytical method

7 Complete sample packing and ship in accordance with proper procedures

Do not ship hazardous waste samples without first consulting a company compliance professional.

9.6 SOIL CLASSIFICATION

Soil classification should be performed whenever soil samples are being collected to provide context for the analysis. Unless required to follow a different soil classification (e.g., US Department of Agriculture), follow the Unified Soil Classification System (USCS) logging procedures as described in ATSM D2488[1] . The emphasis of soil classification in the field must be on describing the soils using ALL of the required descriptors; categorization of the USCS group name or symbol alone may not provide details about the soils that could later prove useful. Avoid geologic interpretation or the use of local formation names, which are often difficult to determine in the field without the regional framework. Record ALL of the following information for each sample interval/soil type in the field book:

- Depth interval
- USCS group name (e.g., lean clay, elastic silt, well-graded gravel)
- USCS group symbol (e.g., cl, mh, gw)
- Color, using Munsell chart (in moist condition)
- Percent of cobbles, boulders, gravel, sand, and fines (approximate; by volume). Use the following standard descriptors for the textural percentages:
- Trace: <5%[2]
- Few: 5-10%
- Little: 15-25%
- Some: 30-45%
- Mostly: 50-100%
- Particle-size range:
- Gravel—fine (0.2-inch to 0.75-inch), medium, coarse (0.75-inch to 3 inch)
- Sand—fine (0.003-inch to 0.02-inch), medium (0.02-inch to 0.08-inch), coarse (0.08-inch to 0.2-inch)
- Fines – clay or silt
- For gravel and sand:
- Particle angularity: angular, subangular, subrounded, rounded
- Particle shape: (if appropriate) flat, elongated, flat and elongated
- Maximum particle size or dimension
- Hardness (under hammer blow) of coarse sand and larger particles
- For fine-grained soil (i.e., clay and silt):
- Plasticity: non-plastic, low, medium, high
- Dry strength: none, low, medium, high, very high
- Dilatancy: none, slow, rapid
- Toughness: low, medium, high
- Odor (mention only if organic or unusual; factual descriptions only, no interpretations)
- Moisture: dry, moist, wet
- Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

For intact samples also include:

- Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
- Structure: stratified, laminated, fissured, lensed, homogeneous

[1] Note that certain states/regulatory programs may require soil classification under a secondary system (e.g., US Department of Agriculture) or the use of hydrochloric acid to test the reaction with soil (none, weak, strong).

[2] The use of "Trace" for describing the fraction of clay soils is inappropriate for field-based logs as clay contents of less than 20% in fine-grained soils cannot be reliably determined in the field.

- Cementation: weak, moderate, strong

Example descriptions, using the information listed above, would read as follows:

- 8-10' – Well Graded Sand, SW (5YR 2/6) fine- to medium-grained sand, trace medium sub-angular rounded gravel (less than 0.5-inch diameter); medium dense to dense; wet; moderate petroleum-like odor between 9 feet bgs and 10 feet bgs.
- 10-12' – Lean Clay with Gravel, CL (5YR 2/6) some fine- to coarse-grained angular to subangular gravels (less than 0.25-inch diameter), trace fine- to medium-grained rounded sands; very stiff; low plasticity; low dry strength; no dilatancy; moist; no odors.

9.7 CLOSING NOTES

Once sampling is completed, restore and mark all sample locations with spray paint, stakes, or other appropriate marker for future reference or survey, including collecting Global Positioning System coordinates and photographs, or survey in accordance with the project-specific work plan. Decontaminate all equipment prior to departure and properly manage all PPE and IDW in conformance with SOP 6, the project-specific work plan, and applicable regulations.

FIELD STANDARD OPERATING PROCEDURE #11

GROUNDWATER SAMPLING PROCEDURE

Groundwater sampling procedures outlined in this Standard Operating Procedure (SOP) are designed to ensure that collected samples are representative of current site conditions. These procedures can be applied to permanently or temporarily installed monitoring wells, direct-push sample points, water supply wells with installed plumbing, extraction wells for remedial groundwater treatment systems, and excavations where groundwater is present. The user is advised to read the entire SOP and review the site health and safety plan (HASP) and/or project safety plan (PSP) before beginning any onsite activities. In accordance with the HASP, proper personal protective equipment (PPE) must be selected and used appropriately.

11.1 ACRONYMS AND ABBREVIATIONS

ID	inside diameter
DI	deionized
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
DTW	depth-to-water
HASP	health and safety plan
IDW	investigation-derived waste
l/min	liters per minute
LNAPL	light non-aqueous phase liquid
mg/l	milligrams per liter
mV	millivolts
NAPL	non-aqueous phase liquid
NTU	nephelometric turbidity unit
ORP	oxygen reduction potential
PID	photoionization detector
PPE	personal protective equipment
PSP	project safety plan
QAPP	quality assurance project plan
SOP	standard operating procedure
SU	standard units
TD	total depth
TOC	top-of-casing
VOCs	volatile organic compounds

11.2 MATERIALS

- Field book
- PPE
- Air quality monitoring equipment (e.g., photoionization detector [PID]) with calibration reagents and standards, as needed
- Electronic water level indicator or interface probe
- Water quality meter(s) with a flow-through cell, and calibration reagents and standards, as needed
- Field test kits, as needed
- Adjustable wrench or manhole wrench, as needed
- Well key(s), as needed
- Power supply, as needed
- Sampling containers and labeling/shipping supplies
- Deionized (DI) water
- Container(s) for water storage (e.g., bucket, drum)
- Pump or bailers, tubing, and associated lanyard materials
- Filters, as needed
- Decontamination supplies

11.3 PRECONDITIONS AND BACKGROUND

This SOP has been prepared as part of the company's Environmental Quality Management Plan and is designed to provide detailed procedures for common field practices. Compliance with the methods presented in this document is mandatory for all field personnel and will ensure that the tasks are performed in a safe, consistent manner; are in accordance with federal and state guidance; and are technically defensible.

This SOP is written for the sole use of company employees and will be revised periodically to reflect updates to company policies, work practices, and the applicable state and/or federal guidance. Employees must verify that this document is the most recent version of the company SOPs. Employees are also strongly advised to review relevant state and/or federal guidance, which may stipulate program-specific procedures, in advance of task implementation.

WSP requires that all personnel performing specific project assignments be appropriately qualified, including having required certifications or licenses, and properly trained in accordance with the requirements of their assignment, the Environmental Service Line's field SOPs, and the Quality Management System.

This SOP is designed to provide the user with a general outline for conducting groundwater sampling and assumes the user is familiar with basic field procedures, such as recording field notes (SOP 1), utility location (SOP 2), sample shipment procedures (SOP 3), sample collection and quality assurance procedures (SOP 4), investigation derived waste (IDW) management procedures (SOP 5), equipment decontamination (SOP 6), and use and calibration of all sampling and monitoring equipment (SOPs 7 and 8). This SOP does not cover investigation planning, nor does it cover the analysis of the analytical results. These topics are more appropriately addressed in a project-specific work plan. Before groundwater sampling, be sure to review the project-specific work plan or quality assurance project plan (QAPP) and any applicable state and federal guidelines or sampling procedures. All sampling and monitoring references must be available for consultation in the field, including:

- Company SOPs
- Applicable state and federal guidelines or sampling procedures
- Manufacturer's manuals
- Project-specific work plan, PSP and/or HASP, and QAPP

11.4 GENERAL PROCEDURES

Although the techniques used to sample groundwater are varied, most sampling events can be broken down into a three-step sequence:

1. Gauging: The measurement of the water column height (i.e., total well depth less depth-to-water) within the well.

2 Purging: The removal of stagnant water from the well bore to ensure that samples collected are representative of groundwater conditions in the water-bearing zone surrounding the well.
3 Sample Collection: After purging, the collection of aliquots of groundwater in method-specific, preserved (as needed) containers.

The procedures and equipment that are used to accomplish these steps are project-specific and should be discussed by the project team before arriving onsite. All types of groundwater sampling, however, regardless of the equipment used, share common handling and management procedures that are designed to ensure the integrity of the samples collected. These procedures include:

- The use of new, disposable, decontaminated, or dedicated sampling equipment
- The use and rotation of the appropriate PPE
- Selection of a suitable sampling location and staging area

Wear a clean pair of new, disposable gloves each time a different sample is collected and don the gloves immediately prior to collection. This limits the possibility of cross-contamination from accidental contact with gloves soiled during collection of the previous sample. The gloves must not contact the medium being sampled and must be changed any time during sample collection when their cleanliness is compromised. ***Gloved hands should not be used as a sampling device; always use the appropriate equipment to move the sample from the sampling device to the laboratory-supplied containers.***

11.5 EQUIPMENT SELECTION

Collect all samples using either new, disposable equipment or properly decontaminated sampling equipment. Groundwater purging and sampling equipment should be selected based on the analytical requirements of the project and the project-specific conditions (e.g., well diameter, depth to water, dissolved constituents, etc.) likely to be encountered. The equipment should be constructed of non-reactive, non-leachable materials (e.g., stainless steel, Teflon®, Teflon®-coated steel, polyethylene, polypropylene, etc.) that are compatible with the chemical constituents at the site. Note that project or regulatory guidance may limit the type of equipment for groundwater sampling.

Consider the following when choosing groundwater purging and sampling equipment:

- the diameter and depth of the well
- the depth to groundwater
- the volume of water to be withdrawn
- the sampling and purging technique
- the volume of sample required
- the analytes of interest

Select the decontamination procedures based on the types of sampling to be performed and media encountered; decontamination may require multiple steps or differing cleaning methods (see SOP 6 for decontamination procedures). In no case, should disposable, single-use materials be used to collect more than one sample.

11.6 PRE-SAMPLING CONSIDERATIONS

You should perform the following activities in preparing for sampling with all observations and measurements noted in the field book and on the project-specific groundwater monitoring log, if appropriate:

- Perform a quick reconnaissance of the site to identify sampling locations and evaluate the accessibility to the sampling location.
- Record the approximate ambient air temperature, precipitation, wind (direction and speed), tide, and other field conditions. In addition, any site-specific conditions or situations that could potentially affect the samples at the sample locations should be recorded.
- Record temporary sampling locations with respect to approximate distance to and direction from at least one permanent feature.
- Survey the breathing zone around the sampling location with the appropriate air quality meter(s), as necessary (see HASP), to ensure that the level of PPE is appropriate.
- Install the pump, tubing, passive sampler or other appropriate sampling equipment to the depth prescribed in the project-specific work plan or QAPP.

- Containerize and manage purge water in accordance with the project-specific work plan.

It is important to minimize any sources of cross-contamination that could compromise the integrity of the groundwater samples. Consider the following:

- Position fuel-powered equipment away from the sample collection area, such as drill rigs or excavators, and upwind of other site activities (e.g., purging, sampling, decontamination) that could influence the sample. This is particularly important when screening samples in the field for volatile organic compounds with a PID but should not be limited to the active sample collection.
- Establish a secure sample staging area in an uncontaminated area of the site.

11.7 GAUGING PROCEDURES

All wells should be opened to the atmosphere in advance of sampling to allow any pressure differentials, which could artificially raise or depress the water column in the well, to dissipate. The wells should be inspected to ensure that the protective casing is intact and has not been damaged. Remove the well covers and all standing water around the top of the well casing (for flush mounted-protective covers), as necessary, before opening the inner well cap or plug. Unlock and carefully remove well cap and allow the well to stand undisturbed for a minimum of 15 minutes, or as required by the project-specific work plan, before conducting any down-hole testing or measurements. If required by the HASP, survey the open well casing and the breathing zone around the wellhead with a PID to ensure that the level of PPE is appropriate.

11.7.1 GROUNDWATER LEVEL AND TOTAL DEPTH MEASUREMENT PROCEDURES

Depth to water (DTW) and total depth (TD) measurements are collected prior to sampling and are used to determine the volume water to be purged from the well (if using techniques other than no-purge or low flow sampling). The DTW measurements are also used after the field event to establish the groundwater elevation, flow direction, and gradient. Unless otherwise directed, do not place any objects inside the casing of private water wells; accordingly, DTW and TD measurements should not be collected at private water wells. Measurements of TD are not required for low flow and no-purge sampling applications and should not be measured before sampling the well.

Water level measurements must be collected within the shortest interval possible from all the wells to be gauged during the event before beginning any purge and sampling procedures at the site. This will ensure a nearly instantaneous snapshot of the water levels before the formations are disturbed by pumping or acted upon by other outside influences, such as tides, precipitation, barometric pressure, river stage, or intermittent pumping of production, irrigation, or supply wells.

Record the following observations and measurements (and the time when they were collected) in the field book:

- Measure the casing inside diameter (ID) and record in inches
- Measure the DTW with an electronic water level indicator (or an interface meter, if non-aqueous phase liquid [NAPL] is potentially present – see procedures below) from the top-of-casing (TOC) at the surveyor's mark, if present, and record the depth (to the nearest 0.01 foot) in feet below TOC
- If no mark is present, measure from the north side of the casing and mark the measuring point with a knife, metal file (if the inner casing is metal) or indelible marker for future reference
- Measure the TD from TOC at the surveyor's mark or north side of the casing, as appropriate.

Measuring the depth of deep wells with long water columns can be problematic due to tape buoyancy and weight effects or sediment in the bottom of the well casing. Care must be taken, and proper equipment selection must be used in these situations to ensure accurate measurements. Multiple TD measurements in silt-laden wells can provide a more precise assessment of the bottom depth.

11.7.2 GAUGING WELLS WITH NON-AQUEOUS PHASE LIQUID

If NAPL is potentially present at the site, the DTW and NAPL thickness measurements are collected using an interface meter capable of distinguishing between the NAPL and the groundwater, or a weighted tape coated with the appropriate reactive indicator paste for the suspected NAPL. Measuring NAPL thicknesses must be done with care to avoid agitating the liquids and generating an emulsion. This is particularly the case for light NAPL (LNAPL; those having a density less than water), which are typically viscous oils that

cling to the probe. Oil coating the probe can result in thickness measurements that are biased high (i.e., overestimate the thickness of the NAPL).

Conduct the following procedures to ensure an accurate measurement of the NAPL thickness:

- For LNAPL, slowly lower the electronic interface probe in the well casing until the electronic tone indicates the probe is at the top of the LNAPL layer; measure the depth below the TOC to the nearest 0.01 foot.
- To gauge the NAPL thickness, advance the probe slowly through the layer until the electronic tone indicates top of the water column and then slowly bring the probe back up to the bottom of the LNAPL. Repeat this process several times to ensure an accurate measurement of the bottom of the LNAPL layer (which can include bubbles and an emulsion layer).
- For dense NAPL (DNAPL), advance the probe through the water column until the tone indicates the top of the DNAPL layer; record the depth below TOC.
- To gauge the DNAPL thickness, advance the probe through the layer to the bottom of the well.

11.8 GROUNDWATER PURGING PROCEDURES

Purging is a process whereby potentially stagnant water is removed allowing the collection of samples that are representative of groundwater conditions in the water-bearing zone. The water in a well bore that has not been purged may be different than the surrounding formation due to exposure to ambient air. There are several purging (and no-purge) methods that may be used, depending on specific conditions encountered (e.g., DTW, hydraulic conductivity of the formation, etc.) and the sampling requirements. The purge/no purge options are described below.

- *Multiple Volume Purge:* Traditional well purging technique that relies on the withdrawal of the volume of the well bore and the surrounding filter pack (if present); three to five well volumes are typically removed using pumps or bailers. This methodology relies on equipment that is easy to obtain and use and is generally accepted in most states as an appropriate purging method.
- *Temporary Well Purge:* A variation of the multiple volume purge technique that often uses inertia lift pumps, peristaltic pumps, or bailers to remove water from a temporary well or discrete groundwater sampler (e.g., a groundwater profiler or direct-push screen point sampler). This is a less stringent technique that is typically done to minimize the turbidity of the samples, which can be high due to the lack of a well filter pack.
- *Private Water Well or In-Place Plumbing Purge:* A variation on the multiple volume purge technique whereby a tap or faucet is opened on a fixed water supply pipe and is allowed to remain open until the potentially stagnant water within the well casing and other components of the system (e.g., fixed piping, pressure tanks, etc.) has been removed and groundwater representative of the water-bearing zone is discharged at the tap.
- *Low Flow (Minimal Drawdown/Low Stress) Purge (and Sampling):* A modified purging technique that establishes an isolated, discrete, horizontal flow zone directly adjacent to the pump intake; this method requires the pump to be placed within a screened-interval or open borehole. Pumping rates are typically 0.1 to 0.5 liters per minute (l/min) or less to minimize the stress on the surrounding formation and reduce the geochemical alteration of the groundwater caused by pumping.
- *No-Purge/Passive Sampling Techniques:* These techniques use specialized equipment, such as trap-style samplers or permeable diffusion bags, to sample the undisturbed water column within a screened interval or open borehole. This methodology assumes that the water in the well is representative of the surrounding formation. This approach is well suited for some volatile organic compounds (VOCs), metals, and hydrophobic compounds, depending on the sampling device used.

11.8.1 CALCULATING ONE PURGE VOLUME

Multiple volume purging techniques require that a ***minimum*** of three well volumes of water must be removed before sample collection. The actual amount of water removed may be greater than the three volumes, depending on geochemical parameter stabilization (the field measurement of these parameters is discussed below).

Calculate the volume of water in a well or boring using the following equation:

$$\textbf{Volume (gallons)} = (\textbf{TD} - \textbf{DTW}) \times \textbf{ID}^2 \times \textbf{0.041}$$

where:

TD = total depth (feet)

DTW = depth to water (feet)

ID = inner diameter (inches)

Alternately, the volume of water in a well or boring may also be calculated by multiplying the water column height by the gallons per foot of water for the appropriate well or boring diameter:

ID	Gallons per foot of water	Gallons per three water columns
1-inch	0.04	0.12
2-inch	0.16	0.48
3-inch	0.37	1.11
4-inch	0.65	1.98

Calculate the total volume of the pump, associated tubing and container for in situ measurements (flow-through cell), using the following equation:

Volume (in gallons) = P + ((0.0041)*D2*L) + fc

where:

P = volume of pump (gallons)
D = tubing diameter (inches)
L = length of tubing (feet)
fc = volume of flow-through cell (gallons)

11.8.2 MULTIPLE VOLUME PURGE PROCEDURES

Begin purging at a rate that will not cause excessive turbulence and drawdown in the well; commonly less than 1 gallon per minute for a typical 2-inch diameter monitoring well. You may need to observe the water elevation after the pump is started and adjust the flow rate to minimize the amount of drawdown in the well casing. The objective is to remove the stagnant water in the casing and surrounding filter pack or open borehole allowing water from the surrounding water-bearing zone to enter the well for sampling with as little disturbance as possible. Excessive pump rates or well dewatering can result in higher turbidity, potential volatilization, and geochemical alteration of dissolved parameters.

Typically collect geochemical parameters (i.e., pH, specific conductance, dissolved oxygen [DO], oxygen-reduction potential [ORP], and temperature) at a minimum frequency of once for every well volume of water removed during the purge process. Record the measurements in the field book along with any other pertinent details, such as the visual quality of the water (e.g., color, odor, and presence of suspended particulates) and the approximate withdrawal rate (this can be estimated using a calibrated container and stopwatch). Review the geochemical measurements to ensure that readings have stabilized (after the minimum purge volume has been achieved). This is a proxy for determining that you are purging formation water rather than potentially stagnant water in the casing. Stabilization occurs when at least three consecutive measurements are within the following tolerances:

Multiple Volume Purge Stabilization Parameters	
pH	± 0.1 standard units (SU)
Specific Conductance	± 3%
Temperature	± 3%
Dissolved Oxygen (DO)	± 0.2 milligrams per liter (mg/l) or 10% (flow-through cell only)
Turbidity	± 10% for values greater than 10 nephelometric turbidity units (NTU)
Oxygen Reduction Potential (ORP)	± 10 millivolts (mV; flow-through cell only)

Parameter stabilization that does not occur within five well volumes may require you consult your project manager to decide whether to collect a sample or to continue purging. Wells with extremely slow recharge may also be problematic. Purging these wells, in some cases, may result in dewatering the well before the minimum purge can be completed. Allow wells or borings purged dry to recharge to a level of approximately 90% of the static (pre-purge) water elevation and proceed immediately to sample collection. If recovery exceeds 2 hours, sample as soon as sufficient sample volume is available, in accordance with applicable regulations.

11.8.3 LOW FLOW PURGE PROCEDURES

Low flow purging and sampling is used to obtain representative groundwater samples without removing all the water within the well. The protocol uses relatively low pumping rates (i.e., less than 0.5 l/min) to establish an isolated zone around the inlet of the pump where flow is horizontal (i.e., from the water bearing zone) rather than from the stagnant water in the well casing above and below the pump. Selection of an appropriate pump is critical to establishing the flow zone: it must be well suited for both low pumping rates and the analytes being sampled. Bailers are not appropriate for low flow sampling.

The set-up for low flow sampling includes positioning the pump at the appropriate depth within the casing such that the pump inlet is within the screened section of the well. Slowly lower the pump, where appropriate, and tubing into the water column to avoid agitating the water column; use of a lanyard is recommended (i.e., do not use the extraction tubing to lift or lower the pump). Secure the pump and/or tubing at the wellhead once the specified sampling depth has been achieved and record the depth in the field book. Avoid contacting the bottom of the well by using pre-cut tubing at the appropriate length or by lowering the pump/tubing simultaneously with an electronic water level indicator. Once the pump/tubing has been inserted and secured, allow the water levels to return to static conditions before initiating the purge.

The discharge tubing must be connected to an in-line flow-through cell equipped with a multi-parameter real-time water quality meter. The flow-through cell minimizes the exposure of the groundwater to ambient air, which can influence DO and ORP measurements.

Start the pump and maintain a steady flow rate that results in a stabilized water level (less than 0.3 feet of drawdown or as specified in the project-specific work plan). The pumping rate may need to be adjusted depending on the response of the water levels in the well. Record each adjustment made to the pumping rate and the water level measured immediately after each adjustment. Purging should not exceed 0.5 l/min.

During purging, monitor and record the flow rate and geochemical parameters at 30 seconds to 5-minute intervals (depending on the hydraulic conductivity of the aquifer, diameter of the well, and pumping rate). Stabilization occurs once the following criteria have been met over three successive measurements made at least three minutes apart:

Low Flow Purge Stabilization Parameters	
Water Level Drawdown	<0.3 feet
pH	± 0.1 SU
Specific Conductance	± 3%
Temperature	± 3%
DO	± 0.2 mg/l or 10% (flow-through cell only)
Turbidity	± 10% for values greater than 10 NTU
ORP	± 10 mV (flow-through cell only)

Record any other notable observations in the field book (e.g., groundwater color).

11.8.4 NO-PURGE SAMPLING TECHNIQUES

Several alternate sampling devices are available, such as equilibrated grab samplers, passive diffusion samplers, and other in situ sampling devices, that will allow sample collection without purging the well. These devices may be particularly useful for sampling low permeability geologic materials, assuming the device is made of materials compatible with the analytical parameters, meets data quality objectives, and has been properly evaluated.

No-purge grab or trap samplers are placed in the well before sampling and typically remain closed (i.e., no water is allowed into the sampler during insertion) until the sampler is activated. This allows the sampler device to equilibrate with the surrounding groundwater (to prevent adsorption to the sampler materials) and for the groundwater to recover and re-establish the natural flow after the disturbance caused by the sampler insertion into the well. Typical equilibration times depend on the well recovery rates and the type of sampler used. Samples recovered using the no-purge devices are either transferred to containers at the well head or the sampler itself is shipped to the laboratory for analysis. Examples of equilibrated grab samplers include HydraSleeve™, Snap Sampler™, and Kemmerer samplers.

Equilibration time for diffusion samplers are generally dictated by the diffusion rate through the permeable membrane and, thus, are less sensitive to changes induced within the well during deployment. Most diffusion bag samplers have a minimum equilibration time of 14 days prior to sample collection. The samplers may be deployed for an extended period (e.g., three months or longer), although the continuous exchange between the sampler and the well water means that the sampler will likely reflect only the conditions in the few days preceding the sample collection.

11.8.5 TEMPORARY WELL PURGE PROCEDURES

Procedures used to purge temporary groundwater monitoring wells differ from permanent wells because temporary wells are installed for immediate sample acquisition. Wells of this type may include open bedrock boreholes, standard polyvinyl chloride well screen and riser placed in open boreholes, or drilling rod-based sampling devices (e.g., Wellpoint®, Geoprobe® screen point or Hydropunch® samplers). Purging temporary wells of this type may not be necessary because stagnant water is typically not present. However, if water is used in the drilling process, purging would be necessary. Purging can minimize the turbidity in the sample, which can be significant due to the disturbance caused by the sampler installation and to rinse the sampling system with groundwater. The exception is for groundwater profiling applications (e.g., using a Waterloo Profiler®) where a more rigorous purge is used (using the multiple volume purge techniques described above) to limit the potential for cross-contamination between sample intervals.

11.8.6 PRIVATE WATER WELL OR IN-PLACE PLUMBING PURGE PROCEDURES

The configuration and construction of private water wells varies widely and access points for obtaining groundwater samples may be limited. WSP personnel should coordinate with the property owner or site representative to access functioning ports and valves to avoid causing any inadvertent damage.

Collect the groundwater sample as close to the well as possible (e.g., from a sample port at the well head) to ensure the sample is representative. Ideally, the sample should be collected upstream of the piping and treatment equipment (e.g., particulate filter, water softener, carbon filters, ultra-violet lights), heating unit, or storage tanks. The following potential sampling locations are presented in order of preference:

- Sampling port or spigot near the well head or piping system prior to entry into the storage tank
- Sampling port or spigot at storage tank
- Sampling port or spigot downstream of the pressure tank or holding tank but upstream of any water treatment equipment
- Tap or faucet

If purging from a tap or faucet, try to remove any aerators, filters, or other devices from the tap before purging and work with the property owner or site representative to bypass any water treatment systems. Document where the sample was collected and any steps that were taken to minimize the potential alteration of the water sample in the field book.

Purge the system by opening the tap or spigot and allowing the water to run for several minutes. Observe and record the purge rate for the system. The minimum purge volume must be more than the combined volume of the pump, tanks, piping, etc. Review the geochemical measurements (after the minimum purge volume has been removed) to ensure that readings have stabilized using the same procedures as those used for the multiple volume purge detailed above. Purge the system for a minimum of 15 minutes if the minimum volume is unknown. Sample only after the geochemistry parameters have stabilized and no there are no suspended particles (e.g., iron or rust) visible. Record the final purge volume in the field book and any water quality observations.

11.9 GROUNDWATER SAMPLE COLLECTION PROCEDURES

Collect groundwater samples as soon as possible after the geochemical parameters indicate representative groundwater is present. As practically possible, reduce the pump flow rate, but maintain a flow rate high enough to deliver a smooth stream of water without splashing or undue agitation. Collect samples directly from the tubing as it exits the well bore; do not sample on the downstream side of flow-through cells or any other instrumentation. If using a bailer for sample collection, lower and raise the bailer slowly and smoothly to minimize the disturbance to the water within the well.

Collect groundwater samples in order of volatilization sensitivity with organic compounds sampled first followed by inorganic compounds:

- VOCs
- Extractable organics, petroleum hydrocarbons, aggregate organics, and oil and grease
- Per- and Polyfluoroalkyl substances
- Total metals
- Dissolved metals (see filtering procedures below)
- Inorganic non-metallic and physical and aggregate properties
- Microbiological samples
- Radionuclides

Collect quality assurance/quality control samples in accordance with SOP 4 and the project-specific work plan or QAPP.

As necessary, conduct field tests or screening in accordance with the project-specific work plan and manufacturer's specifications for field testing equipment. Field samples must be directly transferred from the sampling equipment to the container that has been specifically prepared for that given parameter; intermediate containers should be avoided. If field chemical preservation is required, check the pH preservation by pouring a small portion of sample onto a pH test strip Adjust pH with additional preservative, if necessary.

Record the sample depth interval, if applicable, in the field book. Note the volume, phases, odor, and color of the groundwater.

11.9.1 GROUNDWATER FILTRATION PROCEDURES

Filtered groundwater samples are sometimes used for field kit analyses and should only be collected for laboratory analysis after approval from the appropriate regulatory agency or project manager. The filtered samples can be collected by attaching the in-line filter directly to the outlet tubing for a pressurized bailer, a submersible pump or a peristaltic pump. Intermediate containers can be used with a peristaltic pump if the well is too deep to use the pump to recover the sample directly. The intermediate container should be unpreserved laboratory-supplied glassware to avoid any cross-contamination during the filtering process.

Filtered samples using pumps should use the following procedures:

- Use a variable speed peristaltic pump with the in-line filter fitted on the outlet end of the tubing and the pump inlet tubing into the intermediate container holding the unpreserved groundwater sample; or,
- If a submersible pump is used to collect the groundwater sample, attached the in-line filter to the outlet end of the tubing (do not allow the groundwater to pass through flow-through cells or any other instrumentation while sampling)

Once the filter is connected:

- Turn on the pump and maintain a flow rate high enough to deliver a smooth stream of water without splashing or undue agitation. Hold the filter upright with the inlet and outlet in the vertical position and pump groundwater through the filter until all atmospheric oxygen has been removed and the minimum volume of water has been flushed through the filter, in accordance with the manufacturer's specifications
- Collect the filtered samples by placing the filtered output directly into the sample container
- If sediment is visible in the sample container after filtration, filter break-through has occurred and the sampling and filtering process should be repeated
- Discard the tubing and filter appropriately

Record sample filtration in the field book.

11.9.2 NON-AQUEOUS PHASE LIQUID SAMPLING PROCEDURES

Non-aqueous phase liquid is typically sampled to identify the compound, usually through an analytical "fingerprint" analysis. If samples are to be collected, the sampling options and techniques should be discussed with the assigned WSP compliance professional and project manager to ensure that the NAPL is either not considered to be a hazardous material for shipping to the laboratory or is properly shipped by qualified personnel using appropriate shipping containers (SOP 3). Samples of NAPL should be collected using the same procedures as above and placed in the appropriate laboratory-supplied containers, packed on ice, and shipped to the analytical laboratory using procedures outlined in SOP 3.

11.9.3 SAMPLE LABELING AND PREPARATION FOR SHIPMENT

Groundwater samples for offsite laboratory analysis should be prepared as follows:

1. Clean the outside of the sample container, if necessary
2. Affix a sample tag or label to each sample container and complete all required information (sample number, date, time, sampler's initials, analysis, preservatives, place of collection)
3. Place clear tape over the tag or label (if non-waterproof labels are used), as needed
4. If needed, preserve samples immediately after collection by placing them into an insulated cooler filled with bagged wet ice to maintain a temperature of approximately 4°Celcius
5. Record the sample designation, date, time, and the sampler's initials in the field book and on a sample tracking form, if appropriate
6. Complete the chain-of-custody forms with appropriate sampling information, including:
   - location
   - sample name
   - sample collection date and time
   - number of sample containers

- analytical method
- field filtration status

7 Secure the sample packing and shipping in accordance with proper procedures

Do not ship hazardous waste samples without first consulting a WSP compliance professional.

11.10 CLOSING NOTES

Secure and restore the site once sampling is completed. This may include locking permanent monitoring wells, staging the IDW, and disposing of (in conformance with applicable regulations) sampling expendables, such as plastic sheeting, tubing, and PPE. All locations where temporary wells or other sampling devices (e.g., profilers or direct-push equipment) should be marked with spray paint, stakes, or other appropriate method for future reference or survey, including collecting Global Positioning System coordinates and photographs, in accordance with the project-specific work plan. Decontaminate all equipment prior to departure and properly manage all PPE and investigation-derived wastes in conformance with SOP 6, the project-specific work plan, and applicable regulations.

FIELD STANDARD OPERATING PROCEDURE #15

SOIL VAPOR SAMPLING PROCEDURES

Soil vapor sampling involves the collection of samples from the vadose zone and may be conducted within or outside a building footprint. The procedures outlined in this Standard Operating Procedure (SOP) are designed to ensure that soil vapor samples are representative and have not been altered or contaminated by the sampling and handling methods. Soil vapor sampling is generally conducted to assess the presence of volatile organic compounds (VOCs) in the vadose zone, but, in special cases, may also include semivolatile organic compounds, such as naphthalene, elemental metals, such as mercury, or other organic compounds, such as polychlorinated biphenyls. The user is advised to read the entire SOP and review the site health and safety plan (HASP) and/or project safety plan (PSP) before beginning any onsite activities. In accordance with the HASP or PSP, proper personal protective equipment (PPE) must be selected and used appropriately.

15.1 ACRONYMS AND ABBREVIATIONS

IDW	investigation derived waste
HASP	health and safety plan
PID	photoionization detector
PPE	personal protective equipment
PSP	project safety plan
QAPP	quality assurance project plan
SOP	standard operating procedure
VI	vapor intrusion
VOCs	volatile organic compounds

15.2 MATERIALS

- Field book
- PPE
- Air quality monitoring equipment (e.g., photoionization detector [PID]) with calibration reagents and standards, as needed
- Camera
- Portable weather station, as needed
- Sampling containers and labeling/shipping supplies
- Sample point installation materials:
  - Soil vapor point assembly
  - Teflon®, Teflon®-lined, or stainless steel tubing
  - Tube fittings (e.g. Swagelok®, Qwik-Lok®)
  - Sand pack material as specified in the project-specific work plan or regulatory guidance
  - Non-volatile sealant material (e.g., hydrated bentonite chips, granular bentonite, or bentonite slurry)
  - Permanent cover assembly, if necessary
  - Potable water
- Leak testing materials, as needed:
  - Tracer compound detector (e.g., helium gas detector)
  - Tracer compound gas (e.g., helium)
  - Shroud (e.g., 5-gallon bucket or stainless steel dome)

  - Shroud sealant material (e.g., bentonite pellets or modeling clay)
  - Tedlar® bags (to capture purged soil gas), as required
- Tubing (e.g., Teflon®, Tygon®)
- Air purging pump or vapor syringe, as needed
- Adjustable wrenches, as needed
- Air sampling pump, as needed
- Inline flow meter , as needed

15.3 PRECONDITIONS AND BACKGROUND

This SOP has been prepared as part of the company's Environmental Quality Management Plan and is designed to provide detailed procedures for common field practices. Compliance with the methods presented in this document is mandatory for all field personnel and will ensure that the tasks are performed in a safe and consistent manner, are in accordance with federal and state guidance, and are technically defensible.

This SOP is written for the sole use of company employees and will be revised periodically to reflect updates to company policies, work practices, and the applicable state and/or federal guidance. Employees must verify that this document is the most recent version of the company's SOP. Employees are also strongly advised to review relevant state and/or federal guidance, which may stipulate program-specific procedures, in advance of task implementation.

WSP requires that all personnel performing specific project assignments be appropriately qualified, including having required certifications or licenses, and properly trained in accordance with the requirements of their assignment, the Environmental Service Line's field SOPs, and the Quality Management System.

This SOP is designed to provide the user with a general outline for conducting soil vapor sampling activities and assumes the user is familiar with basic field procedures, such as recording field notes (SOP 1), utility location (SOP 2), sample shipment procedures (SOP 3), sample collection and quality assurance procedures (SOP 4), investigation derived waste (IDW) management procedures (SOP 5), equipment decontamination (SOP 6), and the use and calibration of soil vapor sampling and monitoring equipment (SOP 7). This SOP does not cover other air or vapor sampling activities, such as air sampling (SOP 13) or sub-slab vapor sampling (SOP 14). Additionally, this SOP does not cover investigation planning, nor does it cover the analysis of the analytical results. These topics require a significant amount of planning and are more appropriately addressed in a project-specific work plan. Before implementing the soil vapor sampling, be sure to review the project-specific work plan or Quality Assurance Project Plan (QAPP) and any applicable state and federal guidelines or sampling procedures.

All sampling and monitoring references must be available for consultation in the field, including:

- Company SOPs
- Applicable state and federal guidelines or sampling procedures
- Manufacturer's manuals
- Project-specific work plan, PSP and/or HASP, and QAPP

15.4 GENERAL PROCEDURES

Soil vapor can be affected by temporal, structural, and meteorological factors. The user should also be aware that a number of regulatory agencies have specific guidelines as to timing or the sequence of the sampling activities, particularly if performed as part of a vapor intrusion (VI) investigation.

Although the specific procedures used to sample soil vapor vary between investigations, most sampling can be broken down into a five-step sequence:

1. Inspection (if sampling is performed within a building footprint): a detailed survey of the subject building, including an evaluation of all materials used or stored in the structure that could potentially interfere with the sample collection
2. Sample Point Installation: installing the soil vapor point in the vadose zone.

3 Leak Testing: testing the integrity of the soil vapor sample point (if required).
4 Purging: removing any non-representative vapor from the soil vapor sample point.
5 Sample Collection: collecting samples over a specified period (typically grab, 1-hour, or 8-hour), using a laboratory-supplied container, such as an evacuated sample canister with the appropriate regulator, or a Tedlar® bag with an air sampling pump.

Information regarding weather conditions, including temperature, barometric pressure, wind speed and direction, and precipitation, should be noted and recorded in the field notebook during all steps. A portable weather station is often required for documenting the weather conditions. Consult the project-specific work plan and applicable regulatory guidance to determine if fixed weather monitoring during the sample collection is required.

The project team should discuss the project-specific sampling procedures and equipment in advance of site mobilization. While the investigation is underway, the project team should avoid other environmental activities which may release volatile vapors into the investigation area, including soil sampling, excavation, and groundwater monitoring.

To ensure the integrity of the samples collected, the following common procedures shall be employed:

- The use of new, disposable or decontaminated sampling equipment
- The use, changing, and disposal of the appropriate PPE
- Selection of a suitable sampling location and staging area

Wear a clean pair of new, disposable gloves each time a different sample is collected and don the gloves immediately prior to collection. This limits the possibility of cross-contamination from accidental contact with gloves soiled during collection of the previous sample. The gloves must not contact the medium being sampled and must be changed any time during sample collection when their cleanliness is compromised.

15.4.1 PRE-SAMPLING CONSIDERATIONS

In preparing for sampling, you should perform the following activities (with all observations and measurements noted in the field book):

- Perform a quick reconnaissance of the site to identify sampling locations.
- Record the approximate ambient air temperature, precipitation, wind (direction and speed), tide, and other field conditions in the field book. Any site-specific conditions or situations that could potentially affect the samples at the sample locations should also be recorded.
- Record sampling locations with respect to approximate distance to and direction from at least one permanent feature. Survey the breathing zone around the sampling location with a PID, as necessary (see HASP), to ensure that the level of PPE is appropriate.
- Establish a secure sample staging area in an uncontaminated area of the site. All construction materials must be selected in accordance with the project-specific work plan and relevant regulatory guidance.

15.5 BUILDING INSPECTION AND MATERIALS SURVEY

If soil vapor sampling is performed within a building footprint, a building inspection and materials inventory may be required as a prerequisite activity. The scope of this activity, including completion of an inspection questionnaire (with a building representative, if possible), shall be performed in accordance with the project-specific work plan and applicable regulatory guidance. Before embarking on the inspection, confirm that there are no access limitations for the inspection, sampling activities, or photography.

Components of a typical building walkthrough and survey include:

- Identification of potential background sources of volatile compounds, such as vapor releases from neighboring properties, or materials stored within the building, such as paint, fuels, solvents, cleaners, etc. Some states may require scanning of the potential background sources with an appropriately-sensitive PID.
- Review of current and historical building operations and chemical use.
- Assessment of the building construction and condition (e.g., whether or not a basement is present, poured or block foundation, concrete slab present, air flow, etc.).
- Identifying areas of potential VI into a building (e.g., cracks in the concrete slab or walls, pipe penetrations, sumps, etc.).

- Inspection and photographic documentation, if necessary, of proposed sample locations.
- Identification of building pressure/ventilation system location and specifications.

At the conclusion of the building inspection and survey, discuss the sampling procedures with building occupants and prepare the structure for the soil vapor sampling in accordance with the project-specific work plan. Building preparations typically include requesting that the building occupants close windows, and remove sources of background VOCs (e.g., paint, fuels, solvents, household cleaners, beauty items), and that they refrain from smoking in the investigation area during sampling activities.

15.6 SOIL VAPOR POINT INSTALLATION

Ensure each proposed soil vapor boring location is clear of potential hazards, including utilities prior to breaking the ground surface (see SOP 2). Advance the soil vapor boring from the ground surface to the target depth using decontaminated drilling equipment; typically a direct-push drill rig such as a Geoprobe®, or equivalent, equipped with 1.25-inch inside diameter drilling rods and an expendable point is used to install the soil vapor boring. Record the actual depth interval in the field book once the drilling has been completed. Insert the soil vapor sampling point, which typically consists of Teflon® or Teflon®-lined tubing attached to a polyethylene or stainless steel soil gas implant, through the hollow drill string and screwed into the top of the expendable point. Retract the rods, leaving the implant with the expendable point in the bottom of the borehole and tubing leading to the surface. As detailed in the project-specific work plan, install a clean sand filter pack in the annular space around the screened interval to a minimum depth of approximately 6 inches above the top of the screen (i.e., 1-foot deep total) and place a hydrated bentonite seal (e.g., bentonite chips, granular bentonite, or bentonite slurry) to the ground surface. Attach the appropriate fittings (e.g., a 3-way valve) and additional tubing, if appropriate. Ensure that the tubing is clamped or otherwise closed off to avoid discharging vapor to the air.

Soil vapor sampling must not be performed until the subsurface equilibrium has been re-established and, if sampling indoors as part of a VI investigation, any vapors that have escaped from the subsurface during the implant installation have had a chance to dissipate. Equilibrium is typically re-established approximately 24 hours following sample point installation, or as otherwise specified in the project-specific work plan or regulatory guidance.

15.7 LEAK TESTING PROCEDURES

If required by the project-specific work plan or regulatory guidance, verify the integrity of the seal between the ground surface (or finished floor, if the sampling is within a building) and sample point assembly using a tracer gas such as helium. This type of leak testing is typically performed before sampling and involves creating an enclosure above the sample point, which is then charged with the tracer gas. A meter capable of detecting the tracer is then connected to the sampling tube and monitored to ensure that the gas (an analog for ambient air) is not passing through the seal and being introduced into the sample train.

The user should verify the leak testing procedures in the project-specific work plan and/or relevant regulatory guidance.

Typical leak testing procedures are:

1. Select a container to serve as the shroud (e.g., 5-gallon bucket or stainless steel dome). This device should be of sufficient size to cover the soil vapor sample point. Dedicated testing shrouds with fittings and sample ports are available from some laboratories or can be purchased/constructed.
2. Fit the shroud with two hose barbs or quick-lock connectors, one sized appropriately to connect to the sample tubing and the other sized appropriately for tubing from the tracer gas. These fittings allow the tracer gas to be introduced to the enclosure and the soil vapor sample point tubing to be connected to the detector outside of the shroud.
3. Connect the sample tubing to the appropriate connector inside the shroud and then place it over the sample point and aboveground tubing and fittings. The shroud should be sealed to the ground surface or floor using modeling clay, bentonite, or other appropriate material.
4. Connect the detector to the shroud via a short length of tubing and start the detector. The detector's pump rate should be adjusted to not exceed a maximum of 200 milliliters per minute.

5 Charge the shroud with a tracer gas through the second hose barb or quick-lock connector. A target concentration of 10% to 20% is generally recommended for within the shroud, or as otherwise specified in the project-specific work plan and relevant regulatory guidance.
6 Monitor the tracer compound concentrations by alternatingly connecting the gas detector to the first and second quick-lock connectors.
7 Monitor the soil vapor sample point over a period of at least 2 minutes, or as otherwise specified in the site-specific work plan and/or regulatory guidance. A leak is occurring if the tracer gas is detected within the sample train above background concentrations, or as otherwise specified in the project-specific work plan and relevant regulatory guidance. If a leak is detected, the seal around the soil vapor sample point must be repaired or augmented and the process repeated until the results indicate the seal is competent.
8 Record the leak detection procedures and observations in the field book.
9 Disassemble the shroud

15.8 SOIL VAPOR POINT PURGING PROCEDURES

Before collecting a soil vapor sample, the sample point and sample train (tubing, connectors, valves, etc.) must be purged to remove ambient air. Purging can be accomplished by connecting a hand-powered air pump or vapor syringe to the soil vapor discharge tubing. A "low-flow" purge rate (typically a maximum of 200 milliliters per minute) is required by many regulatory agencies to avoid potential short-circuiting or desorbing of volatile compounds from soil particles; a calibrated sampling pump or inline flow meter may be used to ensure the flow rate is maintained. Purge a minimum of 3 tubing/point volumes from the soil vapor sampling assembly prior to sample collection. The volume is calculated as follows:

Purge Volume = (3* π *r2*h)point + (3* π *r2*h)tubing

Where:

r = the inner radius of the point and connecting tubing
h = the height of the point and the connected tubing

Purged vapor from the soil vapor point should be contained in Tedlar® bags to prevent the release of soil vapor into the air (if the sampling is being conducted inside a building as part of a VI investigation). As required by the project-specific work plan or regulatory guidance, collect air quality readings from the purged air (e.g., PID).

15.9 SOIL VAPOR SAMPLE COLLECTION

Soil vapor samples are collected using clean, evacuated stainless steel canisters (e.g., Entech-style or SUMMA®-equivalent), or active (requires a pump) equipment, such as a Tedlar® bag and hand-powered pump. The canister sampling equipment typically includes a canister under vacuum, a flow regulator with an in-line vacuum gauge, and in-line particulate filters. The flow regulator is pre-set by the laboratory to collect a sample over the collection period specified in the project-specific work plan and the laboratory task order. Instructions for connecting the sample canister to the flow regulator are typically provided by the laboratory. Tedlar® bag sampling is only appropriate for "grab" samples.

At each sampling location, record the initial conditions at the sample location in accordance with the project-specific work plan or regulatory guidance, often including the weather conditions (e.g., precipitation, barometric pressure, and indoor and outdoor temperature), PID readings, and any observations. Record sample locations with respect to a permanent feature and record a description of the sampling location.

Collect quality assurance/quality control samples in accordance with SOP 4 and the project-specific work plan. Duplicate samples may be collected by using a "T" fitting attached to the sample tubing.

15.9.1 CANISTER SAMPLING

1. Connect the sample canister to its dedicated[1], pre-set flow controller with an inline vacuum gauge. If using a SUMMA®-equivalent canister, tighten (hand-tight) the fitting with adjustable wrenches. Do not over tighten. If using an Entech-style canister, connect the canister to the flow controller by sliding back the collar on the female end of the regulator's fitting and inserting it into the male end of the canister's fitting.
2. Ensure that the canister is in a stable position and will not fall or be relocated during the sampling process. Place physical and visual barriers around the canisters, as necessary, so they are not disturbed during sample collection.
3. Open the appropriate valve port on the soil vapor discharge tubing to allow vapor flow from the soil vapor point to the sample canister.
4. Open the canister's intake valve, record initial vacuum, and begin sample collection. Do not use canisters that show unacceptable (as detailed in the laboratory instructions or project-specific work plan) initial vacuum readings.
5. Attach a label to the sample container and enter information (sample number, start date, start time, sampler's initials, analysis, initial vacuum readings, and place of collection).
6. Check the canister vacuum gauge reading at least once during the sample collection period to ensure the canister's pressure is changing at the appropriate rate. If the canister's pressure is not changing at the appropriate rate, contact your project manager.
7. Once the sample collection period is completed, record the final vacuum, close the canister's intake valve, close the valve port connected to the soil vapor discharge tubing, disconnect the sample canister's intake port to the tubing from the soil vapor point, and disconnect the pre-set flow controller from the canister. Residual vacuum should be measurable after the collection period is completed; recommended residual vacuum is typically between -2 and -5 inches of mercury. The sample results may be subject to rejection during validation if vacuum was not maintained during the entire sample collection period. If vacuum readings are outside of the recommended range, inform your project manager as soon as possible. Enter the remaining information on the sample label and field book (stop date, stop time, and final vacuum reading).
8. Record the final conditions at the sample location in accordance with the project-specific work plan or regulatory guidance, often including the weather conditions (e.g., precipitation, barometric pressure, and air temperature), PID readings, and any observations (e.g., odor, staining, or spills).

15.9.2 TEDLAR® BAG SAMPLING

1. Attach a new, appropriately-sized section of Teflon® or Teflon®-lined tubing to the air sampling pump.
2. Purge the tubing by operating the pump in accordance with the manufacturer's specifications (this will remove whatever air was present in the tube and pump mechanism allowing the air to be sampled to enter the sampling assembly).
3. Connect the pump's intake to the soil vapor discharge tubing, and the pump's discharge to the Tedlar® bag sample port.
4. Open Tedlar® bag valve and the appropriate valve port for the soil vapor discharge tubing to allow air flow from the soil vapor point to the Tedlar® bag.
5. Turn on the air sampling pump (or use the hand-powered pump) and begin filling the Tedlar® bag. Ensure the air sampling pump's flow rate meets any requirements in the project-specific work plan or regulatory guidance, using a calibrated air sampling pump or inline flow meter.
6. Once the Tedlar® bag is approximately two-thirds full, close the valve on the Tedlar® bag and the valve on the soil vapor discharge tubing.
7. Discontinue the pump operation and disconnect the air sampling pump from the Tedlar® bag.
8. Attach a label to each bag and enter information (sample number, date, start/stop time, sampler's initials, analysis, and place of collection).

[1] [1] Some laboratories match and pre-test specific flow controller and canister assemblies at the laboratory prior to shipment to the field for sample collection; be sure to assemble the equipment in the field using the matched components.

9 Record the final conditions at the sample location in accordance with the project-specific work plan or regulatory guidance, often including the weather conditions (e.g., precipitation, barometric pressure, and air temperature), PID readings, and any observations (e.g., odor, staining, or spills).

15.10 SAMPLE LABELING AND PREPARATION FOR SHIPMENT

Once sample collection is complete, prepare the sample canisters for offsite laboratory analysis:

1 Clean the outside of the sample container, if necessary.
2 Ensure all required information is completed on each sample label (see above).
3 Record sample designation, date, time, and the sampler's initials in the field book.
4 Complete chain-of-custody forms with appropriate sampling information, including:
   - Location
   - Sample name
   - Sample collection start and end date and times
   - Initial vacuum measurement, if applicable
   - Ending vacuum measurement, if applicable
   - Sample regulator number, if applicable
   - Sample canister number, if applicable
   - Analytical method
5 Complete sample packing and ship in accordance with proper procedures.

Note that air samples are typically shipped under ambient temperatures.

15.11 CLOSING NOTES

Once sampling is completed, secure the sample port or abandon the location boreholes/locations in accordance with the project-specific project work plan. Mark all sample locations with spray paint, stakes, or other appropriate marker for future reference, as needed, or survey, including collecting Global Positioning System coordinates and photographs, in accordance with the project-specific work plan. Decontaminate all equipment prior to departure and properly manage all PPE and IDW in conformance with SOP 6, the project-specific work plan, and applicable regulations.

APPENDIX

C NIOSH POCKET GUIDE TO CHEMICAL HAZARDS

Tetrachloroethylene

SYNONYMS & TRADE NAMES

Perchlorethylene, Perchloroethylene, Perk, Tetrachlorethylene

CAS NO.	RTECS NO.	DOT ID & GUIDE
127-18-4	KX3850000	1897 160

FORMULA	CONVERSION	IDLH
$Cl_2C=CCl_2$	1 ppm = 6.78 mg/m^3	Ca [150 ppm] See: 127184

EXPOSURE LIMITS

NIOSH REL
Ca Minimize workplace exposure concentrations. See Appendix A
OSHA PEL
TWA 100 ppm
C 200 ppm (for 5 minutes in any 3-hour period), with a maximum peak of 300 ppm
See Appendix G

MEASUREMENT METHODS

NIOSH 1003;
OSHA 1001
See: NMAM or OSHA Methods

PHYSICAL DESCRIPTION

Colorless liquid with a mild, chloroform-like odor.

MOLECULAR WEIGHT	BOILING POINT	FREEZING POINT	SOLUBILITY	VAPOR PRESSURE	IONIZATION POTENTIAL
165.8	250°F	-2°F	0.02%	14 mmHg	9.32 eV

SPECIFIC GRAVITY	FLASH POINT	UPPER EXPLOSIVE LIMIT	LOWER EXPLOSIVE LIMIT		
1.62	NA	NA	NA		

Noncombustible Liquid, but decomposes in a fire to hydrogen chloride and phosgene.

INCOMPATIBILITIES & REACTIVITIES

Strong oxidizers; chemically-active metals such as lithium, beryllium & barium; caustic soda; sodium hydroxide; potash

EXPOSURE ROUTES

inhalation, skin absorption, ingestion, skin and/or eye contact

SYMPTOMS

irritation eyes, skin, nose, throat, respiratory system; nausea; flush face, neck; dizziness, incoordination; headache, drowsiness; skin erythema (skin redness); liver damage; [potential occupational carcinogen]

TARGET ORGANS

Eyes, skin, respiratory system, liver, kidneys, central nervous system

CANCER SITE

[in animals: liver tumors]

PERSONAL PROTECTION/SANITATION

(See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet or contaminated
Change: No recommendation
Provide: Eyewash, Quick drench

FIRST AID

(See procedures)
Eye: Irrigate immediately
Skin: Soap wash promptly
Breathing: Respiratory support
Swallow: Medical attention immediately

RESPIRATOR RECOMMENDATIONS

NIOSH

At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection

SEE ALSO

INTRODUCTION ICSC CARD: 0076 MEDICAL TESTS: 0179

Page last reviewed: October 30, 2019

The National Institute for Occupational Safety and Health (NIOSH)

Promoting productive workplaces through safety and health research NIOSH

Trichloroethylene

SYNONYMS & TRADE NAMES

Ethylene trichloride, TCE, Trichloroethene, Trilene

CAS NO.	RTECS NO.	DOT ID & GUIDE
79-01-6	KX4550000	1710 160

FORMULA	CONVERSION	IDLH
$ClCH{=}CCl_2$	1 ppm = 5.37 mg/m^3	Ca [1000 ppm] See: 79016

EXPOSURE LIMITS

NIOSH REL
Ca See Appendix A See Appendix C
OSHA PEL
TWA 100 ppm C 200 ppm 300 ppm (5-minute maximum peak in any 2 hours) See Appendix G

MEASUREMENT METHODS

NIOSH 1022 , 3800;
OSHA 1001
See: NMAM or OSHA Methods

PHYSICAL DESCRIPTION

Colorless liquid (unless dyed blue) with a chloroform-like odor.

MOLECULAR WEIGHT	BOILING POINT	FREEZING POINT	SOLUBILITY	VAPOR PRESSURE	IONIZATION POTENTIAL
131.4	189°F	-99°F	0.1%	58 mmHg	9.45 eV

SPECIFIC GRAVITY	FLASH POINT	UPPER EXPLOSIVE LIMIT	LOWER EXPLOSIVE LIMIT		
1.46	?	(77°F): 10.5%	(77°F): 8%		

Combustible Liquid, but burns with difficulty.

INCOMPATIBILITIES & REACTIVITIES

Strong caustics & alkalis; chemically-active metals (such as barium, lithium, sodium, magnesium, titanium & beryllium)

EXPOSURE ROUTES

inhalation, skin absorption, ingestion, skin and/or eye contact

SYMPTOMS

irritation eyes, skin; headache, visual disturbance, lassitude (weakness, exhaustion), dizziness, tremor, drowsiness, nausea, vomiting; dermatitis; cardiac arrhythmias, paresthesia; liver injury; [potential occupational carcinogen]

TARGET ORGANS

Eyes, skin, respiratory system, heart, liver, kidneys, central nervous system

CANCER SITE

[in animals: liver & kidney cancer]

PERSONAL PROTECTION/SANITATION

(See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet or contaminated
Change: No recommendation
Provide: Eyewash, Quick drench

FIRST AID

(See procedures)
Eye: Irrigate immediately
Skin: Soap wash promptly
Breathing: Respiratory support
Swallow: Medical attention immediately

RESPIRATOR RECOMMENDATIONS

NIOSH

At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection

SEE ALSO

INTRODUCTION ICSC CARD: 0081 MEDICAL TESTS: 0236

Page last reviewed: October 30, 2019

1,2-Dichloroethylene

SYNONYMS & TRADE NAMES

Acetylene dichloride, cis-Acetylene dichloride, trans-Acetylene dichloride, sym-Dichloroethylene

CAS NO.	RTECS NO.	DOT ID & GUIDE
540-59-0	KV9360000	1150 130P

FORMULA	CONVERSION	IDLH
ClCH=CHCl	1 ppm = 3.97 mg/m^3	1000 ppm See: 540590

EXPOSURE LIMITS

NIOSH REL
TWA 200 ppm (790 mg/m^3)
OSHA PEL
TWA 200 ppm (790 mg/m^3)

MEASUREMENT METHODS

NIOSH 1003;
OSHA 7
See: NMAM or OSHA Methods

PHYSICAL DESCRIPTION

Colorless liquid (usually a mixture of the cis & trans isomers) with a slightly acrid, chloroform-like odor.

MOLECULAR WEIGHT	BOILING POINT	FREEZING POINT	SOLUBILITY	VAPOR PRESSURE	IONIZATION POTENTIAL
97.0	118-140°F	-57 to -115°F	0.4%	180-265 mmHg	9.65 eV

SPECIFIC GRAVITY	FLASH POINT	UPPER EXPLOSIVE LIMIT	LOWER EXPLOSIVE LIMIT		
(77°F): 1.27	36-39°F	12.8%	5.6%		

Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F.

INCOMPATIBILITIES & REACTIVITIES

Strong oxidizers, strong alkalis, potassium hydroxide, copper [Note: Usually contains inhibitors to prevent polymerization.]

EXPOSURE ROUTES

inhalation, ingestion, skin and/or eye contact

SYMPTOMS

irritation eyes, respiratory system; central nervous system depression

TARGET ORGANS

Eyes, respiratory system, central nervous system

PERSONAL PROTECTION/SANITATION

(See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet (flammable)
Change: No recommendation

FIRST AID

(See procedures)
Eye: Irrigate immediately
Skin: Soap wash promptly
Breathing: Respiratory support
Swallow: Medical attention immediately

RESPIRATOR RECOMMENDATIONS

NIOSH/OSHA

Up to 1000 ppm:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode[£]
(APF = 25) Any powered, air-purifying respirator with organic vapor cartridge(s)[£]
(APF = 50) Any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection

SEE ALSO

Page last reviewed: October 30, 2019

Vinyl chloride

SYNONYMS & TRADE NAMES

Chloroethene, Chloroethylene, Ethylene monochloride, Monochloroethene, Monochloroethylene, VC, VCM, Vinyl chloride monomer (VCM)

CAS NO.	RTECS NO.	DOT ID & GUIDE
75-01-4	KU9625000	1086 116P(inhibited)

FORMULA	CONVERSION	IDLH
CH_2=CHCl	1 ppm = 2.56 mg/m^3	Ca [N.D.] See: IDLH INDEX

EXPOSURE LIMITS

NIOSH REL
Ca See Appendix A
OSHA PEL
[1910.1017] TWA 1 ppm C 5 ppm [15-minute]

MEASUREMENT METHODS

NIOSH 1007;
OSHA 4 , 75
See: NMAM or OSHA Methods

PHYSICAL DESCRIPTION

Colorless gas or liquid (below 7°F) with a pleasant odor at high concentrations. [Note: Shipped as a liquefied compressed gas.]

MOLECULAR WEIGHT	BOILING POINT	FREEZING POINT	SOLUBILITY	VAPOR PRESSURE	IONIZATION POTENTIAL
62.5	7°F	-256°F	(77°F): 0.1%	3.3 atm	9.99 eV

	FLASH POINT	UPPER EXPLOSIVE LIMIT	LOWER EXPLOSIVE LIMIT	RELATIVE GAS DENSITY	
	NA (Gas)	33.0%	3.6%	2.21	

Flammable Gas

INCOMPATIBILITIES & REACTIVITIES

Copper, oxidizers, aluminum, peroxides, iron, steel [Note: Polymerizes in air, sunlight, or heat unless stabilized by inhibitors such as phenol. Attacks iron & steel in presence of moisture.]

EXPOSURE ROUTES

inhalation, skin and/or eye contact (liquid)

SYMPTOMS

lassitude (weakness, exhaustion); abdominal pain, gastrointestinal bleeding; enlarged liver; pallor or cyanosis of extremities; liquid: frostbite; [potential occupational carcinogen]

TARGET ORGANS

Liver, central nervous system, blood, respiratory system, lymphatic system

CANCER SITE

[liver cancer]

PERSONAL PROTECTION/SANITATION

(See protection codes)
Skin: Frostbite
Eyes: Frostbite
Wash skin: No recommendation
Remove: When wet (flammable)
Change: No recommendation
Provide: Frostbite wash

FIRST AID

(See procedures)
Eye: Frostbite
Skin: Frostbite
Breathing: Respiratory support

RESPIRATOR RECOMMENDATIONS

(See Appendix E)

NIOSH

At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection

SEE ALSO

Page last reviewed: October 30, 2019

1,2,4-Trimethylbenzene

SYNONYMS & TRADE NAMES

Asymmetrical trimethylbenzene, psi-Cumene, Hemimellitene [1,2,4-Trimethylbenzene], Pseudocumene [Note: Hemimellitene is a mixture of the 1,2,3-isomer with up to 10% of related aromatics such as the 1,2,4-isomer.]

CAS NO.

95-63-6

RTECS NO.

DC3325000

DOT ID & GUIDE

FORMULA

$C_6H_3(CH_3)_3$

CONVERSION

1 ppm = 4.92 mg/m^3

IDLH

N.D.
See: IDLH INDEX

EXPOSURE LIMITS

NIOSH REL
TWA 25 ppm (125 mg/m^3)
OSHA PEL
none See Appendix G

MEASUREMENT METHODS

OSHA PV2091
See: NMAM or OSHA Methods

PHYSICAL DESCRIPTION

Clear, colorless liquid with a distinctive, aromatic odor.

MOLECULAR WEIGHT	BOILING POINT	FREEZING POINT	SOLUBILITY	VAPOR PRESSURE	IONIZATION POTENTIAL
120.2	337°F	-77°F	0.006%	(56°F): 1 mmHg	8.27 eV

SPECIFIC GRAVITY	FLASH POINT	UPPER EXPLOSIVE LIMIT	LOWER EXPLOSIVE LIMIT
0.88	112°F	6.4%	0.9%

Class II Flammable Liquid

INCOMPATIBILITIES & REACTIVITIES

Oxidizers, nitric acid

EXPOSURE ROUTES

inhalation, ingestion, skin and/or eye contact

SYMPTOMS

irritation eyes, skin, nose, throat, respiratory system; bronchitis; hypochromic anemia; headache, drowsiness, lassitude (weakness, exhaustion), dizziness, nausea, incoordination; vomiting, confusion; chemical pneumonitis (aspiration liquid)

TARGET ORGANS

Eyes, skin, respiratory system, central nervous system, blood

PERSONAL PROTECTION/SANITATION

(See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet or contaminated
Change: No recommendation

FIRST AID

(See procedures)
Eye: Irrigate immediately
Skin: Soap wash
Breathing: Respiratory support
Swallow: Medical attention immediately

RESPIRATOR RECOMMENDATIONS

Not available.

Important additional information about respirator selection

SEE ALSO

INTRODUCTION ICSC CARD: 1433

Page last reviewed: October 30, 2019

1,3,5-Trimethylbenzene

SYNONYMS & TRADE NAMES

Mesitylene, Symmetrical trimethylbenzene, sym-Trimethylbenzene

CAS NO.	RTECS NO.	DOT ID & GUIDE
108-67-8	OX6825000	2325 129

FORMULA	CONVERSION	IDLH
$C_6H_3(CH_3)_3$	1 ppm = 4.92 mg/m^3	N.D. See: IDLH INDEX

EXPOSURE LIMITS

NIOSH REL
TWA 25 ppm (125 mg/m^3)
OSHA PEL
none See Appendix G

MEASUREMENT METHODS

OSHA PV2091
See: NMAM or OSHA Methods

PHYSICAL DESCRIPTION

Clear, colorless liquid with a distinctive, aromatic odor.

MOLECULAR WEIGHT	BOILING POINT	FREEZING POINT	SOLUBILITY	VAPOR PRESSURE	IONIZATION POTENTIAL
120.2	329°F	-49°F	0.002%	2 mmHg	8.39 eV

SPECIFIC GRAVITY	FLASH POINT	UPPER EXPLOSIVE LIMIT	LOWER EXPLOSIVE LIMIT		
0.86	122°F	?	?		

Class II Flammable Liquid

INCOMPATIBILITIES & REACTIVITIES

Oxidizers, nitric acid

EXPOSURE ROUTES

inhalation, ingestion, skin and/or eye contact

SYMPTOMS

irritation eyes, skin, nose, throat, respiratory system; bronchitis; hypochromic anemia; headache, drowsiness, lassitude (weakness, exhaustion), dizziness, nausea, incoordination; vomiting, confusion; chemical pneumonitis (aspiration liquid)

TARGET ORGANS

Eyes, skin, respiratory system, central nervous system, blood

PERSONAL PROTECTION/SANITATION

(See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet or contaminated
Change: No recommendation

FIRST AID

(See procedures)
Eye: Irrigate immediately
Skin: Soap wash
Breathing: Respiratory support
Swallow: Medical attention immediately

RESPIRATOR RECOMMENDATIONS

Not available.

Important additional information about respirator selection

SEE ALSO

INTRODUCTION ICSC CARD: 1155

Page last reviewed: October 30, 2019

The National Institute for Occupational Safety and Health (NIOSH)

Promoting productive workplaces through safety and health research NIOSH

Cumene

SYNONYMS & TRADE NAMES

Cumol, Isopropyl benzene, 2-Phenyl propane

CAS NO.	RTECS NO.	DOT ID & GUIDE
98-82-8	GR8575000	1918 130

FORMULA	CONVERSION	IDLH
$C_6H_5CH(CH_3)_2$	1 ppm = 4.92 mg/m^3	900 ppm [10%LEL] See: 98828

EXPOSURE LIMITS

NIOSH REL
TWA 50 ppm (245 mg/m^3) [skin]
OSHA PEL
TWA 50 ppm (245 mg/m^3) [skin]

MEASUREMENT METHODS

NIOSH 1501
See: NMAM or OSHA Methods

PHYSICAL DESCRIPTION

Colorless liquid with a sharp, penetrating, aromatic odor.

MOLECULAR WEIGHT	BOILING POINT	FREEZING POINT	SOLUBILITY	VAPOR PRESSURE	IONIZATION POTENTIAL
120.2	306°F	-141°F	Insoluble	8 mmHg	8.75 eV

SPECIFIC GRAVITY	FLASH POINT	UPPER EXPLOSIVE LIMIT	LOWER EXPLOSIVE LIMIT		
0.86	96°F	6.5%	0.9%		

Class IC Flammable Liquid: Fl.P. at or above 73°F and below 100°F.

INCOMPATIBILITIES & REACTIVITIES

Oxidizers, nitric acid, sulfur acid [Note: Forms cumene hydroperoxide upon long exposure to air.]

EXPOSURE ROUTES

inhalation, skin absorption, ingestion, skin and/or eye contact

SYMPTOMS

irritation eyes, skin, mucous membrane; dermatitis; headache, narcosis, coma

TARGET ORGANS

Eyes, skin, respiratory system, central nervous system

PERSONAL PROTECTION/SANITATION

(See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet (flammable)
Change: No recommendation

FIRST AID

(See procedures)
Eye: Irrigate immediately
Skin: Water flush promptly
Breathing: Respiratory support
Swallow: Medical attention immediately

RESPIRATOR RECOMMENDATIONS

NIOSH/OSHA

Up to 500 ppm:
(APF = 10) Any chemical cartridge respirator with organic vapor cartridge(s)*
(APF = 10) Any supplied-air respirator*

Up to 900 ppm:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode*
(APF = 25) Any powered, air-purifying respirator with organic vapor cartridge(s)*
(APF = 50) Any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection

SEE ALSO

INTRODUCTION ICSC CARD: 0170 MEDICAL TESTS: 0060

Page last reviewed: October 30, 2019

Ethyl benzene

SYNONYMS & TRADE NAMES

Ethylbenzol, Phenylethane

CAS NO.	RTECS NO.	DOT ID & GUIDE
100-41-4	DA0700000	1175 130

FORMULA	CONVERSION	IDLH
$CH_3CH_2C_6H_5$	1 ppm = 4.34 mg/m^3	800 ppm [10%LEL] See: 100414

EXPOSURE LIMITS

NIOSH REL
TWA 100 ppm (435 mg/m^3) ST 125 ppm (545 mg/m^3)
OSHA PEL
TWA 100 ppm (435 mg/m^3) See Appendix G

MEASUREMENT METHODS

NIOSH 1501;
OSHA 7 , 1002
See: NMAM or OSHA Methods

PHYSICAL DESCRIPTION

Colorless liquid with an aromatic odor.

MOLECULAR WEIGHT	BOILING POINT	FREEZING POINT	SOLUBILITY	VAPOR PRESSURE	IONIZATION POTENTIAL
106.2	277°F	-139°F	0.01%	7 mmHg	8.76 eV

SPECIFIC GRAVITY	FLASH POINT	UPPER EXPLOSIVE LIMIT	LOWER EXPLOSIVE LIMIT		
0.87	55°F	6.7%	0.8%		

Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F.

INCOMPATIBILITIES & REACTIVITIES

Strong oxidizers

EXPOSURE ROUTES

inhalation, ingestion, skin and/or eye contact

SYMPTOMS

irritation eyes, skin, mucous membrane; headache; dermatitis; narcosis, coma

TARGET ORGANS

Eyes, skin, respiratory system, central nervous system

PERSONAL PROTECTION/SANITATION

(See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet (flammable)
Change: No recommendation

FIRST AID

(See procedures)
Eye: Irrigate immediately
Skin: Water flush promptly
Breathing: Respiratory support
Swallow: Medical attention immediately

RESPIRATOR RECOMMENDATIONS

NIOSH/OSHA

Up to 800 ppm:
(APF = 10) Any chemical cartridge respirator with organic vapor cartridge(s)*
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
(APF = 25) Any powered, air-purifying respirator with organic vapor cartridge(s)*
(APF = 10) Any supplied-air respirator*
(APF = 50) Any self-contained breathing apparatus with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection

SEE ALSO

INTRODUCTION ICSC CARD: 0268 MEDICAL TESTS: 0098

Page last reviewed: October 30, 2019

m-Xylene

SYNONYMS & TRADE NAMES

1,3-Dimethylbenzene, meta-Xylene, m-Xylol

CAS NO.	RTECS NO.	DOT ID & GUIDE
108-38-3	ZE2275000	1307 130

FORMULA	CONVERSION	IDLH
$C_6H_4(CH_3)_2$	1 ppm = 4.34 mg/m^3	900 ppm See: 95476

EXPOSURE LIMITS

NIOSH REL
TWA 100 ppm (435 mg/m^3) ST 150 ppm (655 mg/m^3)
OSHA PEL
TWA 100 ppm (435 mg/m^3) See Appendix G

MEASUREMENT METHODS

NIOSH 1501 , 3800;
OSHA 1002
See: NMAM or OSHA Methods

PHYSICAL DESCRIPTION

Colorless liquid with an aromatic odor.

MOLECULAR WEIGHT	BOILING POINT	FREEZING POINT	SOLUBILITY	VAPOR PRESSURE	IONIZATION POTENTIAL
106.2	282°F	-54°F	Slight	9 mmHg	8.56 eV

SPECIFIC GRAVITY	FLASH POINT	UPPER EXPLOSIVE LIMIT	LOWER EXPLOSIVE LIMIT		
0.86	82°F	7.0%	1.1%		

Class IC Flammable Liquid: Fl.P. at or above 73°F and below 100°F.

INCOMPATIBILITIES & REACTIVITIES

Strong oxidizers, strong acids

EXPOSURE ROUTES

inhalation, skin absorption, ingestion, skin and/or eye contact

SYMPTOMS

irritation eyes, skin, nose, throat; dizziness, excitement, drowsiness, incoordination, staggering gait; corneal vacuolization; anorexia, nausea, vomiting, abdominal pain; dermatitis

TARGET ORGANS

Eyes, skin, respiratory system, central nervous system, gastrointestinal tract, blood, liver, kidneys

PERSONAL PROTECTION/SANITATION

(See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet (flammable)
Change: No recommendation

FIRST AID

(See procedures)
Eye: Irrigate immediately
Skin: Soap wash promptly
Breathing: Respiratory support
Swallow: Medical attention immediately

RESPIRATOR RECOMMENDATIONS

NIOSH/OSHA

Up to 900 ppm:
(APF = 10) Any chemical cartridge respirator with organic vapor cartridge(s)*
(APF = 25) Any powered, air-purifying respirator with organic vapor cartridge(s)*
(APF = 10) Any supplied-air respirator*
(APF = 50) Any self-contained breathing apparatus with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection

SEE ALSO

INTRODUCTION ICSC CARD: 0085

Page last reviewed: October 30, 2019

o-Xylene

SYNONYMS & TRADE NAMES

1,2-Dimethylbenzene, ortho-Xylene, o-Xylol

CAS NO.	RTECS NO.	DOT ID & GUIDE
95-47-6	ZE2450000	1307 130

FORMULA	CONVERSION	IDLH
$C_6H_4(CH_3)_2$	1 ppm = 4.34 mg/m^3	900 ppm See: 95476

EXPOSURE LIMITS

NIOSH REL
TWA 100 ppm (435 mg/m^3) ST 150 ppm (655 mg/m^3)
OSHA PEL
TWA 100 ppm (435 mg/m^3) See Appendix G

MEASUREMENT METHODS

NIOSH 1501 , 3800;
OSHA 1002
See: NMAM or OSHA Methods

PHYSICAL DESCRIPTION

Colorless liquid with an aromatic odor.

MOLECULAR WEIGHT	BOILING POINT	FREEZING POINT	SOLUBILITY	VAPOR PRESSURE	IONIZATION POTENTIAL
106.2	292°F	-13°F	0.02%	7 mmHg	8.56 eV

SPECIFIC GRAVITY	FLASH POINT	UPPER EXPLOSIVE LIMIT	LOWER EXPLOSIVE LIMIT		
0.88	90°F	6.7%	0.9%		

Class IC Flammable Liquid: Fl.P. at or above 73°F and below 100°F.

INCOMPATIBILITIES & REACTIVITIES

Strong oxidizers, strong acids

EXPOSURE ROUTES

inhalation, skin absorption, ingestion, skin and/or eye contact

SYMPTOMS

irritation eyes, skin, nose, throat; dizziness, excitement, drowsiness, incoordination, staggering gait; corneal vacuolization; anorexia, nausea, vomiting, abdominal pain; dermatitis

TARGET ORGANS

Eyes, skin, respiratory system, central nervous system, gastrointestinal tract, blood, liver, kidneys

PERSONAL PROTECTION/SANITATION

(See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet (flammable)
Change: No recommendation

FIRST AID

(See procedures)
Eye: Irrigate immediately
Skin: Soap wash promptly
Breathing: Respiratory support
Swallow: Medical attention immediately

RESPIRATOR RECOMMENDATIONS

NIOSH/OSHA

Up to 900 ppm:
(APF = 10) Any chemical cartridge respirator with organic vapor cartridge(s)*
(APF = 25) Any powered, air-purifying respirator with organic vapor cartridge(s)*
(APF = 10) Any supplied-air respirator*
(APF = 50) Any self-contained breathing apparatus with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection

SEE ALSO

INTRODUCTION ICSC CARD: 0084

Page last reviewed: October 30, 2019

p-Xylene

SYNONYMS & TRADE NAMES

1,4-Dimethylbenzene, para-Xylene, p-Xylol

CAS NO.	RTECS NO.	DOT ID & GUIDE
106-42-3	ZE2625000	1307 130

FORMULA	CONVERSION	IDLH
$C_6H_4(CH_3)_2$	1 ppm = 4.41 mg/m^3	900 ppm See: 95476

EXPOSURE LIMITS

NIOSH REL
TWA 100 ppm (435 mg/m^3) ST 150 ppm (655 mg/m^3)
OSHA PEL
TWA 100 ppm (435 mg/m^3) See Appendix G

MEASUREMENT METHODS

NIOSH 1501 , 3800;
OSHA 1002
See: NMAM or OSHA Methods

PHYSICAL DESCRIPTION

Colorless liquid with an aromatic odor. [Note: A solid below 56°F.]

MOLECULAR WEIGHT	BOILING POINT	FREEZING POINT	SOLUBILITY	VAPOR PRESSURE	IONIZATION POTENTIAL
106.2	281°F	56°F	0.02%	9 mmHg	8.44 eV

SPECIFIC GRAVITY	FLASH POINT	UPPER EXPLOSIVE LIMIT	LOWER EXPLOSIVE LIMIT		
0.86	81°F	7.0%	1.1%		

Class IC Flammable Liquid: Fl.P. at or above 73°F and below 100°F.

INCOMPATIBILITIES & REACTIVITIES

Strong oxidizers, strong acids

EXPOSURE ROUTES

inhalation, skin absorption, ingestion, skin and/or eye contact

SYMPTOMS

irritation eyes, skin, nose, throat; dizziness, excitement, drowsiness, incoordination, staggering gait; corneal vacuolization; anorexia, nausea, vomiting, abdominal pain; dermatitis

TARGET ORGANS

Eyes, skin, respiratory system, central nervous system, gastrointestinal tract, blood, liver, kidneys

PERSONAL PROTECTION/SANITATION

(See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet (flammable)
Change: No recommendation

FIRST AID

(See procedures)
Eye: Irrigate immediately
Skin: Soap wash promptly
Breathing: Respiratory support
Swallow: Medical attention immediately

RESPIRATOR RECOMMENDATIONS

NIOSH/OSHA

Up to 900 ppm:
(APF = 10) Any chemical cartridge respirator with organic vapor cartridge(s)*
(APF = 25) Any powered, air-purifying respirator with organic vapor cartridge(s)*
(APF = 10) Any supplied-air respirator*
(APF = 50) Any self-contained breathing apparatus with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection

SEE ALSO

INTRODUCTION ICSC CARD: 0086

Page last reviewed: October 30, 2019

Toluene

SYNONYMS & TRADE NAMES

Methyl benzene, Methyl benzol, Phenyl methane, Toluol

CAS NO.	RTECS NO.	DOT ID & GUIDE
108-88-3	XS5250000	1294 130

FORMULA	CONVERSION	IDLH
$C_6H_5CH_3$	1 ppm = 3.77 mg/m^3	500 ppm See: 108883

EXPOSURE LIMITS

NIOSH REL
TWA 100 ppm (375 mg/m^3) ST 150 ppm (560 mg/m^3)
OSHA PEL
TWA 200 ppm C 300 ppm 500 ppm (10-minute maximum peak) See Appendix G

MEASUREMENT METHODS

NIOSH 1500 , 1501 , 3800 , 4000;
OSHA 111
See: NMAM or OSHA Methods

PHYSICAL DESCRIPTION

Colorless liquid with a sweet, pungent, benzene-like odor.

MOLECULAR WEIGHT	BOILING POINT	FREEZING POINT	SOLUBILITY	VAPOR PRESSURE	IONIZATION POTENTIAL
92.1	232°F	-139°F	(74°F): 0.07%	21 mmHg	8.82 eV

SPECIFIC GRAVITY	FLASH POINT	UPPER EXPLOSIVE LIMIT	LOWER EXPLOSIVE LIMIT		
0.87	40°F	7.1%	1.1%		

Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F.

INCOMPATIBILITIES & REACTIVITIES

Strong oxidizers

EXPOSURE ROUTES

inhalation, skin absorption, ingestion, skin and/or eye contact

SYMPTOMS

irritation eyes, nose; lassitude (weakness, exhaustion), confusion, euphoria, dizziness, headache; dilated pupils, lacrimation (discharge of tears); anxiety, muscle fatigue, insomnia; paresthesia; dermatitis; liver, kidney damage

TARGET ORGANS

Eyes, skin, respiratory system, central nervous system, liver, kidneys

PERSONAL PROTECTION/SANITATION

(See protection codes)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet (flammable)
Change: No recommendation

FIRST AID

(See procedures)
Eye: Irrigate immediately
Skin: Soap wash promptly
Breathing: Respiratory support
Swallow: Medical attention immediately

RESPIRATOR RECOMMENDATIONS

NIOSH

Up to 500 ppm:
(APF = 10) Any chemical cartridge respirator with organic vapor cartridge(s)*
(APF = 25) Any powered, air-purifying respirator with organic vapor cartridge(s)*
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
(APF = 10) Any supplied-air respirator*
(APF = 50) Any self-contained breathing apparatus with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
Any appropriate escape-type, self-contained breathing apparatus

Important additional information about respirator selection

SEE ALSO

Page last reviewed: October 30, 2019

APPENDIX

D JOB HAZARD ANALYSIS

Prepared By:	Prepared Date:
Dave Bouchard	2/18/2025
Approved By:	**Approved Date:**

JOB HAZARD ANALYSIS
WATER & ENVIRONMENT

Project Name:	Project No:	Project Location:	Project/Task Description:	Project/Task Equipment:
175 Roger Avenue	31404181.01	175 Roger Avenue Inwood, NY	**Groundwater and Soil Vapor Well Installation**	Vehicle-mounted drill rig equipped with hollow-stem augers and soil sampler.

Chemicals of Concern:	Site-Specific Hazards:	Action Levels:
Tetrachloroethene (PCE) and degradation products (trichloroethene, *cis*- 1,2-dichloroethene, and vinyl chloride).	Vacant property	1.) Vinyl chloride - 0.5 ppm; and, 2.) Trichloroethene - 5 ppm (see action level flow chart)
Level D PPE: Weather appropriate clothing, steel-toed safety shoes, work gloves, nitrile gloves, safety glasses/googles, high-visibility vest (required for all field-based activities).	**PPE Upgrades:** Level C PPE: Full face air purifying respirator, organic vapor cartridges, hooded Tyvek coveralls, chemical resistant gloves and boot covers.	**Health & Safety Equipment:** Vinyl chloride colorimetric tubes, photoionization detector (PID) equipped with 10.6 eV lamp, first aid kit, sunscreen, and insect repellent.

Basic Job Step	Potential Hazards (From HASP)																											Baseline Risk Score			Hazard Controls Protection Measures	Controlled Risk Score			Persons Affected
	Explosion (Chemical Reaction)	Explosion (Over Pressurization)	Electrical (Shock/Short Circuit)	Electrical (Fire)	Electrical (Static)	Electrical (Loss of Power)	Ergonomics (Strain)	Ergonomics (Human Error)	Excavation (Collapse)	Fall (Slip, Trip)	Fire/Heat	Mechanical/Vibration (Chafing/Fatigue)	Mechanical Failure	Mechanical	Noise	Struck By (Mass Acceleration)	Struck Against	Chemical (Toxic)	Chemical (Ignitable)	Chemical (Corrosive)	Chemical (Volatile)	Radiation (Ionizing)	Radiation (Non-Ionizing)	Temperature Extreme (Heat/Cold)	Visibility	Weather Phenomena (Snow/Rain/Wind/Ice)	Biological Hazards (Venomous/Disease-Carrying Animals/Insects, Poisonous Plants)	Severity	Likelihood	Risk Score	Color Key: §No shading indicates acceptable risk - no action needed. §Green shading indicates low risk - review the operation/activity and take any steps necessary to reduce & control the risks. §Yellow shading indicates medium risk - inform H&S management & seek further advice before proceeding any further with the operation/activity. §Red shading indicates high risk - HALT the activity immediately, review and reduce the risks identified.	Severity	Likelihood	Risk Score	
Mobilize/Demobilize								X		X	X	X	X	X		X								X	X	X		6	3	18	Inspect vehicle for unsafe conditions; stay alert and be aware of other traffic; obey traffic laws; do not drive when tired; reduce speed in inclement weather or poor road conditions; do not drive through standing water; park WSP vehicle outside of work zone.	6	2	12	WSP
Load/Unload equipment							X			X						X								X	X	X	X	X	3	2	6	Use proper lifting techniques; stay alert; park in designated parking/loading area; wear appropriate Level D clothing and gear (work gloves and steel toe boots, high visibility vest etc.); wear weather-appropriate clothing and use sun protection factor (SPF) 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET.	3	1	3	WSP
Tailgate meeting (daily)										X														X	X		X	X	3	1	3	Wear steel toe boots; wear appropriate Level D clothing and gear; use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET.	3	1	3	WSP
Confirm drilling locations (marked by surveyor in advance of mobilization)										X														X	X	X	X	X	3	2	6	Wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, high-visibility vest, etc.); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; stay alert while moving about the site.	3	1	3	WSP and subcontractor
Verify utility clearance in proposed drilling areas							X			X			X	X		X								X	X	X	X	X	3	2	6	Wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, high-visibility vest, etc.); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; stay alert while moving about the site; conduct utility clearance in accordance with WSP's standard operating procedures (SOPs).	3	1	3	WSP and subcontractor
Position drill rig		X	X	X		X	X			X	X	X	X	X	X	X	X				X			X	X	X	X	X	6	2	12	Verify that drilling location is free of buried utilities (see above); wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, hearing protection, high-visibility vest, hard hat, etc.); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; stay alert while moving about the site and the drill rig.	6	1	6	WSP and subcontractor
Hollow-stem auger drilling				X			X			X	X		X	X	X	X	X				X			X	X	X	X	X	4	3	12	Stay alert and maintain distance from the drill rig and rotating parts; wear appropriate Level D clothing and gear (steel toe boots, hearing protection, safety glasses, high-visibility vest, etc.); perform air monitoring as per the Health and Safety Plan (HASP); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET.	3	1	3	WSP and subcontractor

Prepared By:	Prepared Date:
Dave Bouchard	2/18/2025
Approved By:	**Approved Date:**

JOB HAZARD ANALYSIS
WATER & ENVIRONMENT

Project Name:	Project No:	Project Location:	Project/Task Description:	Project/Task Equipment:
175 Roger Avenue	31404181.01	175 Roger Avenue Inwood, NY	**Groundwater and Soil Vapor Well Installation**	Vehicle-mounted drill rig equipped with hollow-stem augers and soil sampler.

Chemicals of Concern:	Site-Specific Hazards:	Action Levels:
Tetrachloroethene (PCE) and degradation products (trichloroethene, *cis*- 1,2-dichloroethene, and vinyl chloride).	Vacant property	1.) Vinyl chloride - 0.5 ppm; and, 2.) Trichloroethene - 5 ppm (see action level flow chart)
Level D PPE: Weather appropriate clothing, steel-toed safety shoes, work gloves, nitrile gloves, safety glasses/googles, high-visibility vest (required for all field-based activities).	**PPE Upgrades:** Level C PPE: Full face air purifying respirator, organic vapor cartridges, hooded Tyvek coveralls, chemical resistant gloves and boot covers.	**Health & Safety Equipment:** Vinyl chloride colorimetric tubes, photoionization detector (PID) equipped with 10.6 eV lamp, first aid kit, sunscreen, and insect repellent.

Basic Job Step	Potential Hazards (From HASP)																											Baseline Risk Score			Hazard Controls Protection Measures	Controlled Risk Score			Persons Affected
	Explosion (Chemical Reaction)	Explosion (Over Pressurization)	Electrical (Shock/Short Circuit)	Electrical (Fire)	Electrical (Static)	Electrical (Loss of Power)	Ergonomics (Strain)	Ergonomics (Human Error)	Excavation (Collapse)	Fall (Slip, Trip)	Fire/Heat	Mechanical/Vibration (Chafing/Fatigue)	Mechanical Failure	Mechanical	Noise	Struck By (Mass Acceleration)	Struck Against	Chemical (Toxic)	Chemical (Ignitable)	Chemical (Corrosive)	Chemical (Volatile)	Radiation (Ionizing)	Radiation (Non-Ionizing)	Temperature Extreme (Heat/Cold)	Visibility	Weather Phenomena (Snow/Rain/Wind/Ice)	Biological Hazards (Venomous/Disease-Carrying Animals/Insects, Poisonous Plants)	Severity	Likelihood	Risk Score	Color Key: §No shading indicates acceptable risk - no action needed. §Green shading indicates low risk - review the operation/activity and take any steps necessary to reduce & control the risks. §Yellow shading indicates medium risk - inform H&S management & seek further advice before proceeding any further with the operation/activity. §Red shading indicates high risk - HALT the activity immediately, review and reduce the risks identified.	Severity	Likelihood	Risk Score	
Continuous soil samples (borehole logging)							X			X											X		X	X	X	X	X	2	2	4	Follow SOPs for well installation and continuous soil sampling; stay alert; wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, high-visibility vest, etc.); perform air monitoring as per HASP; wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET.	2	1	2	WSP and subcontractor
Well construction							X			X				X			X				X		X	X	X	X	X	3	3	9	Wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, high-visibility vest, etc.); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; stay alert while moving near the drill rig, open borehole or during backfill operations (including grout preparation and emplacement).	3	1	3	WSP and subcontractor
Monitoring well development (groundwater wells only)							X			X							X				X		X	X	X	X	X	3	2	6	Follow SOPs; stay alert; wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, high-visibility vest, etc.); perform air monitoring as per HASP; wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; use caution when opening drums used for waste containment; development and purge water are not anticipated to be Department of Transportation hazardous materials.	3	1	3	WSP
Decontamination (hollow-stem augers, soil samplers, and other drilling equipment)										X											X		X	X	X	X	X	3	1	3	Follow SOPs and allow subcontractor to decontaminate equipment; stay alert; wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, high-visibility vest, etc.); perform air monitoring as per HASP; wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET.	3	1	3	WSP and subcontractor
Waste management							X	X		X	X	X	X	X		X	X				X		X	X	X	X	X	5	3	15	Follow SOPs; direct subcontractors to handle wastes at site, when possible (including moving full drums to staging area); use proper lifting techniques; stay alert; wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, high-visibility vest, etc.); perform air monitoring as per HASP; wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET.	4	1	4	WSP and subcontractor

Prepared By:	Prepared Date:
David Bouchard	2/18/2025
Approved By:	**Approved Date:**

JOB HAZARD ANALYSIS
WATER & ENVIRONMENT

Project Name:	Project No:	Project Location:	Project/Task Description:	Project/Task Equipment:
175 Roger Avenue	31404181.01	175 Roger Avenue Inwood, New York	**Soil Characterization Sampling (with direct-push drill rig)**	Direct-push drill rig fitted with soil gas implant and expendable drilling point.

Chemicals of Concern:	Site-Specific Hazards:	Action Levels:
Tetrachloroethene (PCE) and degradation products (trichloroethene, *cis*- 1,2-dichloroethene, and vinyl chloride).	Vacant property	1.) Vinyl chloride - 0.5 ppm; and, 2.) Trichloroethene - 5 ppm (see action level flow chart)
Level D PPE: Weather appropriate clothing, steel-toed safety shoes, work gloves, nitrile gloves, safety glasses/googles, high-visibility vest (required for all field-based activities).	**PPE Upgrades:** Level C PPE: Full face air purifying respirator, organic vapor cartridges, hooded Tyvek coveralls, chemical resistant gloves and boot covers.	**Health & Safety Equipment:** Vinyl chloride colorimetric tubes, photoionization detector (PID), first aid kit, sunscreen, and insect repellent.

Basic Job Step	Potential Hazards (From HASP)																									Baseline Risk Score			Hazard Controls Protection Measures	Controlled Risk Score			Persons Affected
	Explosion (Chemical Reaction)	Explosion (Over Pressurization)	Electrical (Shock/Short Circuit)	Electrical (Fire)	Electrical (Static)	Electrical (Loss of Power)	Ergonomics (Strain)	Ergonomics (Human Error)	Excavation (Collapse)	Fall (Slip, Trip)	Fire/Heat	Mechanical/Vibration (Chafing/Fatigue)	Mechanical Failure	Mechanical	Noise	Struck By (Mass Acceleration)	Struck Against	Chemical (Toxic)	Chemical (Ignitable)	Chemical (Corrosive)	Chemical (Volatile)	Radiation (Ionizing)	Radiation (Non-Ionizing)	Temperature Extreme (Heat/Cold)	Visibility	Weather Phenomena (Snow/Rain/Wind/Ice)	Biological Hazards (Venomous/Disease-Carrying Animals/Insects, Poisonous Plants)	Severity	Likelihood	Risk Score	Color Key: §No shading indicates acceptable risk - no action needed. §Green shading indicates low risk - review the operation/activity and take any steps necessary to reduce & control the risks. §Yellow shading indicates medium risk - inform H&S management & seek further advice before proceeding any further with the operation/activity. §Red shading indicates high risk - HALT the activity immediately, review and reduce the risks identified.	Severity	Likelihood	Risk Score	
Mobilize/Demobilize								X		X	X	X	X	X		X	X						X	X	X	X		6	3	18	Inspect vehicle for unsafe conditions; stay alert; be aware of other traffic; obey traffic laws; do not drive when tired; reduce speed in inclement weather or poor road conditions; do not drive through standing water; park WSP vehicle outside of work zone.	6	2	12	WSP
Load/Unload equipment							X			X			X	X		X	X						X	X	X	X	X	5	2	10	Use proper lifting techniques; stay alert; park in designated parking/loading area; wear appropriate Level D clothing and gear (steel toe boots, hearing protection, safety glasses, high-visibility vest, nitrile gloves, etc.); work during daylight hours; use SPF 15 or higher sunscreen; use insect repellant containing DEET.	3	1	3	WSP and subcontractor
Tailgate meeting (daily)										X													X	X	X	X	X	3	1	3	Wear appropriate Level D clothing and gear (steel toe boots, hearing protection, safety glasses, high-visibility vest, nitrile gloves, etc.); conduct indoors during inclement weather or after dark; use SPF 15 or higher sunscreen; use insect repellant containing DEET.	3	1	3	WSP and Subcontractor
Confirm drilling locations (marked by surveyor in advance of mobilization)										X													X	X	X	X	X	3	2	6	Wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, high-visibility vest, etc.); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; stay alert while moving about the site.	3	1	3	WSP and subcontractor
Verify utility clearance in proposed drilling areas							X			X			X	X			X						X	X	X	X	X	3	2	6	Wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, high-visibility vest, etc.); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; stay alert while moving about the site; conduct utility clearance in accordance with WSP's standard operating procedures (SOPs).	3	1	3	WSP and subcontractor
Position direct-push drill rig and install soil gas implants										X				X	X		X				X		X	X	X	X	X	3	3	9	Wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, high-visibility vest, etc.); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; stay alert while moving near the drill rig, open borehole or during implant installation (including grout preparation and emplacement).	3	1	3	WSP and subcontractor

Prepared By:	Prepared Date:
David Bouchard	2/18/2025
Approved By:	**Approved Date:**

JOB HAZARD ANALYSIS
WATER & ENVIRONMENT

Project Name:	Project No:	Project Location:	Project/Task Description:	Project/Task Equipment:
175 Roger Avenue	31404181.01	175 Roger Avenue Inwood, New York	**Soil Characterization Sampling (with direct-push drill rig)**	Direct-push drill rig fitted with soil gas implant and expendable drilling point.

Chemicals of Concern:	Site-Specific Hazards:	Action Levels:
Tetrachloroethene (PCE) and degradation products (trichloroethene, *cis*- 1,2-dichloroethene, and vinyl chloride).	Vacant property	1.) Vinyl chloride - 0.5 ppm; and, 2.) Trichloroethene - 5 ppm (see action level flow chart)
Level D PPE: Weather appropriate clothing, steel-toed safety shoes, work gloves, nitrile gloves, safety glasses/googles, high-visibility vest (required for all field-based activities).	**PPE Upgrades:** Level C PPE: Full face air purifying respirator, organic vapor cartridges, hooded Tyvek coveralls, chemical resistant gloves and boot covers.	**Health & Safety Equipment:** Vinyl chloride colorimetric tubes, photoionization detector (PID), first aid kit, sunscreen, and insect repellent.

Basic Job Step	Potential Hazards (From HASP)																											Baseline Risk Score			Hazard Controls Protection Measures	Controlled Risk Score			Persons Affected
	Explosion (Chemical Reaction)	Explosion (Over Pressurization)	Electrical (Shock/Short Circuit)	Electrical (Fire)	Electrical (Static)	Electrical (Loss of Power)	Ergonomics (Strain)	Ergonomics (Human Error)	Excavation (Collapse)	Fall (Slip, Trip)	Fire/Heat	Mechanical/Vibration (Chafing/Fatigue)	Mechanical Failure	Mechanical	Noise	Struck By (Mass Acceleration)	Struck Against	Chemical (Toxic)	Chemical (Ignitable)	Chemical (Corrosive)	Chemical (Volatile)	Radiation (Ionizing)	Radiation (Non-Ionizing)	Temperature Extreme (Heat/Cold)	Visibility	Weather Phenomena (Snow/Rain/Wind/Ice)	Biological Hazards (Venomous/Disease-Carrying Animals/Insects, Poisonous Plants)	Severity	Likelihood	Risk Score		Severity	Likelihood	Risk Score	
Implant leak testing																		X			X				X			2	2	4	Follow SOPs and New York State Department of Health guidance; stay alert; use proper lifting techniques for helium cylinder and other leak testing equipment; wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, high-visibility vest, etc.); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; perform air monitoring as per HASP; wear weather-appropriate clothing.	2	1	2	WSP and subcontractor
Collect soil gas samples and abandon implant borings							X			X			X	X		X	X				X		X	X	X	X	X	3	2	6	Follow SOPs and New York State Department of Health guidance on soil gas sampling; wear appropriate Level D clothing and gear (steel toe boots, hearing protection, safety glasses, high-visibility vest, nitrile gloves, etc.); perform air monitoring as per HASP; wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; stay alert when near the borehole during backfill operations (including grout preparation and emplacement); allow subcontractor to abandon the borehole; use caution when containerizing used tubing and other wastes.	3	1	3	WSP and subcontractor
Pack and ship soil gas samples							X			X							X				X		X	X	X	X	X	3	1	3	Follow SOPs for shipping and handling analytical samples; use proper lifting techniques for shipping containers; wear appropriate Level D clothing and gear (steel toe boots, hearing protection, safety glasses, high-visibility vest, nitrile gloves, etc.); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; soil gas samples and canisters are not anticipated to be Department of Transportation hazardous materials.	3	1	3	WSP
Waste management (minimal waste generation; no containerization anticipated)							X	X		X													X	X	X	X	X	2	2	4	Follow SOPs; direct subcontractors to handle any containerized wastes at site; use proper lifting techniques; stay alert; wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, high-visibility vest, etc.); perform air monitoring as per HASP; wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET.	2	1	2	WSP and subcontractor

Color Key:
§No shading indicates acceptable risk - no action needed.
§Green shading indicates low risk - review the operation/activity and take any steps necessary to reduce & control the risks.
§Yellow shading indicates medium risk - inform H&S management & seek further advice before proceeding any further with the operation/activity.
§Red shading indicates high risk - HALT the activity immediately, review and reduce the risks identified.

JOB HAZARD ANALYSIS
WATER & ENVIRONMENT

Prepared By:	Prepared Date:
David Bouchard	2/18/2025
Approved By:	**Approved Date:**

Project Name:	Project No:	Project Location:	Project/Task Description:	Project/Task Equipment:
175 Roger Avenue	31404181.01	175 Roger Avenue Inwood, New York	**Soil Characterization Sampling (with direct-push drill rig)**	Direct-push drill rig fitted with soil gas implant and expendable drilling point.

Chemicals of Concern:	Site-Specific Hazards:	Action Levels:
Tetrachloroethene (PCE) and degradation products (trichloroethene, *cis*- 1,2-dichloroethene, and vinyl chloride).	Vacant property	1.) Vinyl chloride - 0.5 ppm; and, 2.) Trichloroethene - 5 ppm (see action level flow chart)
Level D PPE:	**PPE Upgrades:**	**Health & Safety Equipment:**
Weather appropriate clothing, steel-toed safety shoes, work gloves, nitrile gloves, safety glasses/googles, high-visibility vest (required for all field-based activities).	Level C PPE: Full face air purifying respirator, organic vapor cartridges, hooded Tyvek coveralls, chemical resistant gloves and boot covers.	Vinyl chloride colorimetric tubes, photoionization detector (PID), first aid kit, sunscreen, and insect repellent.

Basic Job Step	Potential Hazards (From HASP)																									Baseline Risk Score			Hazard Controls Protection Measures	Controlled Risk Score			Persons Affected
	Explosion (Chemical Reaction)	Explosion (Over Pressurization)	Electrical (Shock/Short Circuit)	Electrical (Fire)	Electrical (Static)	Electrical (Loss of Power)	Ergonomics (Strain)	Ergonomics (Human Error)	Excavation (Collapse)	Fall (Slip, Trip)	Fire/Heat	Mechanical/Vibration (Chafing/Fatigue)	Mechanical Failure	Mechanical	Noise	Struck By (Mass Acceleration)	Struck Against	Chemical (Toxic)	Chemical (Ignitable)	Chemical (Corrosive)	Chemical (Volatile)	Radiation (Ionizing)	Radiation (Non-Ionizing)	Temperature Extreme (Heat/Cold)	Visibility	Weather Phenomena (Snow/Rain/Wind/Ice)	Biological Hazards (Venomous/Disease-Carrying Animals/Insects, Poisonous Plants)	Severity	Likelihood	Risk Score		Severity	Likelihood	Risk Score	
																													Color Key: §No shading indicates acceptable risk - no action needed. §Green shading indicates low risk - review the operation/activity and take any steps necessary to reduce & control the risks. §Yellow shading indicates medium risk - inform H&S management & seek further advice before proceeding any further with the operation/activity. §Red shading indicates high risk - HALT the activity immediately, review and reduce the risks identified.				

Prepared By:	Prepared Date:
Dave Bouchard	2/18/2025
Approved By:	**Approved Date:**

JOB HAZARD ANALYSIS
WATER & ENVIRONMENT

Project Name:	Project No:	Project Location:	Project/Task Description:	Project/Task Equipment:
175 Roger Avenue	31404181.01	175 Roger Avenue Inwood, New York	**Groundwater Monitoring (Passive Diffusion Bags and Low Flow Sampling)**	

Chemicals of Concern:	Site-Specific Hazards:	Action Levels:
Tetrachloroethene (PCE) and degradation products (trichloroethene, *cis*- 1,2-dichloroethene, and vinyl chloride).	Vacant property	1.) Vinyl chloride - 0.5 ppm; and, 2.) Trichloroethene - 5 ppm (see action level flow chart)
Level D PPE: Weather appropriate clothing, steel-toed safety shoes, work gloves, nitrile gloves, safety glasses/googles, high-visibility vest (required for all field-based activities).	**PPE Upgrades:** Level C PPE: Full face air purifying respirator, organic vapor cartridges, hooded Tyvek coveralls, chemical resistant gloves and boot covers.	**Health & Safety Equipment:** Vinyl chloride colorimetric tubes, photoionization detector (PID), first aid kit, sunscreen, and insect repellent.

Basic Job Step	Potential Hazards (From HASP)																										Baseline Risk Score			Hazard Controls Protection Measures	Controlled Risk Score			Persons Affected
	Explosion (Chemical Reaction)	Explosion (Over Pressurization)	Electrical (Shock/Short Circuit)	Electrical (Fire)	Electrical (Static)	Electrical (Loss of Power)	Ergonomics (Strain)	Ergonomics (Human Error)	Excavation (Collapse)	Fall (Slip, Trip)	Fire/Heat	Mechanical/Vibration (Chafing/Fatigue)	Mechanical Failure	Mechanical	Noise	Struck By (Mass Acceleration)	Struck Against	Chemical (Toxic)	Chemical (Ignitable)	Chemical (Corrosive)	Chemical (Volatile)	Radiation (Ionizing)	Radiation (Non-Ionizing)	Temperature Extreme (Heat/Cold)	Visibility	Weather Phenomena (Snow/Rain/Wind/Ice)	Biological Hazards (Venomous/Disease-Carrying Animals/Insects, Poisonous Plants)	Severity	Likelihood	Risk Score		Severity	Likelihood	Risk Score	
Mobilize/Demobilize								X		X	X	X	X	X		X								X	X	X		6	3	18	Inspect vehicle for unsafe conditions; stay alert and be aware of other traffic; obey traffic laws; do not drive when tired; reduce speed in inclement weather or poor road conditions; do not drive through standing water; park WSP vehicle outside of work zone.	6	2	12	WSP
Load/Unload equipment							X			X						X							X	X	X	X	X	3	2	6	Use proper lifting techniques; stay alert; park in designated parking/loading area; wear appropriate Level D clothing and gear (steel toe boots, hearing protection, safety glasses, high-visibility vest, etc.); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; inspect and properly secure compressed gas cylinders (used to drive bladder pumps).	3	1	3	WSP
Tailgate meeting (daily)										X														X	X		X	X	3	1	3	wear appropriate Level D clothing and gear (steel toe boots, hearing protection, safety glasses, high-visibility vest, etc.) and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET.	3	1	3	WSP
Advance deployment of passive diffusion bag samplers (select wells) or *in situ* microcosm samplers								X		X											X			X	X	X	X	X	3	2	6	Conducted in advance of groundwater sampling for select wells; follow standard operating procedures (SOPs); stay alert; wear appropriate Level D clothing and gear (steel toe boots, hearing protection, safety glasses, high-visibility vest, nitrile gloves, etc.); perform air monitoring as per the Health and Safety Plan (HASP); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET.	3	1	3	WSP

Color Key:
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JOB HAZARD ANALYSIS
WATER & ENVIRONMENT

Project Name:	Project No:	Project Location:	Project/Task Description:	Project/Task Equipment:
175 Roger Avenue	31404181.01	175 Roger Avenue Inwood, New York	**Groundwater Monitoring (Passive Diffusion Bags and Low Flow Sampling)**	

Chemicals of Concern:	Site-Specific Hazards:	Action Levels:
Tetrachloroethene (PCE) and degradation products (trichloroethene, *cis*- 1,2-dichloroethene, and vinyl chloride).	Vacant property	1.) Vinyl chloride - 0.5 ppm; and, 2.) Trichloroethene - 5 ppm (see action level flow chart)
Level D PPE: Weather appropriate clothing, steel-toed safety shoes, work gloves, nitrile gloves, safety glasses/googles, high-visibility vest (required for all field-based activities).	**PPE Upgrades:** Level C PPE: Full face air purifying respirator, organic vapor cartridges, hooded Tyvek coveralls, chemical resistant gloves and boot covers.	**Health & Safety Equipment:** Vinyl chloride colorimetric tubes, photoionization detector (PID), first aid kit, sunscreen, and insect repellent.

Basic Job Step	Potential Hazards (From HASP)																													Baseline Risk Score			Hazard Controls Protection Measures	Controlled Risk Score			Persons Affected
	Explosion (Chemical Reaction)	Explosion (Over Pressurization)	Electrical (Shock/Short Circuit)	Electrical (Fire)	Electrical (Static)	Electrical (Loss of Power)	Ergonomics (Strain)	Ergonomics (Human Error)	Excavation (Collapse)	Fall (Slip, Trip)	Fire/Heat	Mechanical/Vibration (Chafing/Fatigue)	Mechanical Failure	Mechanical	Noise	Struck By (Mass Acceleration)	Struck Against	Chemical (Toxic)	Chemical (Ignitable)	Chemical (Corrosive)	Chemical (Volatile)	Radiation (Ionizing)	Radiation (Non-Ionizing)	Temperature Extreme (Heat/Cold)	Visibility	Weather Phenomena (Snow/Rain/Wind/Ice)	Biological Hazards (Venomous/Disease-Carrying Animals/Insects, Poisonous Plants)	Severity	Likelihood	Risk Score		Severity	Likelihood	Risk Score	
Collect groundwater sample (passive diffusion bag recovery and low flow sampling) or *in situ* microcosm samplers							X			X			X	X		X	X				X		X	X	X	X	X	3	2	6	Follow SOPs for groundwater sampling; use proper lifting technique for recovery of passve diffusion bags, bladder pumps, or *in situ* microcosm samplers from wells; wear appropriate Level D clothing and gear (steel toe boots, hearing protection, safety glasses, high-visibility vest, nitrile gloves, etc.); perform air monitoring as per HASP; wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; minimize contact with groundwater during low flow purge or pasive diffusion bag sampler; use caution when containerizing purge water or other wastes.	3	1	3	WSP
Decontamination (bladder pumps only)										X											X		X	X	X	X	X	3	1	3	Follow SOPs for decontamination; use proper lifting techniques when recovering bladder pumps from wells; stay alert; wear appropriate Level D clothing and gear (steel toe boots, hearing protection, safety glasses, high-visibility vest, nitrile gloves, etc.); perform air monitoring as per HASP; wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; use caution when containerizing decontamination fluid and other wastes.	3	1	3	WSP
Pack and ship groundwater samples or *in situ* microcosm samplers							X			X							X				X		X	X	X	X	X	3	1	3	Follow SOPs for shipping and handling analytical samples; use proper lifting techniques for shipping containers; wear appropriate Level D clothing and gear (steel toe boots, hearing protection, safety glasses, high-visibility vest, nitrile gloves, etc.); perform air monitoring as per HASP; perform air monitoring as per HASP; wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; groundwater samples (and the preserved containers) and the *in situ* microcosm samplers are not anticipated to be Department of Transportation hazardous materials.	3	1	3	WSP
Waste management							X	X		X	X	X	X	X		X	X				X		X	X	X	X	X	5	3	15	Follow SOPs; use proper lifting techniques; avoid moving drums that contain wastes; stay alert; wear appropriate Level D clothing and gear (steel toe boots, hearing protection, safety glasses, high-visibility vest, nitrile gloves, etc.); perform air monitoring as per HASP; perform air monitoring as per HASP; wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET.	4	1	4	WSP

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Dave Bouchard	2/18/2025
Approved By:	**Approved Date:**

JOB HAZARD ANALYSIS
WATER & ENVIRONMENT

Project Name:	Project No:	Project Location:	Project/Task Description:	Project/Task Equipment:
175 Roger Avenue	31404181.01	175 Roger Avenue Inwood, New York	**Soil Vapor Extraction Pilot Test and Vapor Well Abandonment**	Portable blower, granular activated carbon vessel, polyvinyl chloride pipes (plumbing); drill rig for well abandonment.

Chemicals of Concern:	Site-Specific Hazards:	Action Levels:
Tetrachloroethene (PCE) and degradation products (trichloroethene, *cis*- 1,2-dichloroethene, and vinyl chloride).	Vacant property	1.) Vinyl chloride - 0.5 ppm; and, 2.) Trichloroethene - 5 ppm (see action level flow chart)
Level D PPE: Weather appropriate clothing, steel-toed safety shoes, work gloves, nitrile gloves, safety glasses/googles, high-visibility vest (required for all field-based activities).	**PPE Upgrades:** Level C PPE: Full face air purifying respirator, organic vapor cartridges, hooded Tyvek coveralls, chemical resistant gloves and boot covers.	**Health & Safety Equipment:** Vinyl chloride colorimetric tubes, photoionization detector (PID), first aid kit, sunscreen, and insect repellent.

Basic Job Step	Potential Hazards (From HASP)																										Baseline Risk Score			Hazard Controls Protection Measures	Controlled Risk Score			Persons Affected
	Explosion (Chemical Reaction)	Explosion (Over Pressurization)	Electrical (Shock/Short Circuit)	Electrical (Fire)	Electrical (Static)	Electrical (Loss of Power)	Ergonomics (Strain)	Ergonomics (Human Error)	Excavation (Collapse)	Fall (Slip, Trip)	Fire/Heat	Mechanical/Vibration (Chafing/Fatigue)	Mechanical Failure	Mechanical	Noise	Struck By (Mass Acceleration)	Struck Against	Chemical (Toxic)	Chemical (Ignitable)	Chemical (Corrosive)	Chemical (Volatile)	Radiation (Ionizing)	Radiation (Non-Ionizing)	Temperature Extreme (Heat/Cold)	Visibility	Weather Phenomena (Snow/Rain/Wind/Ice)	Biological Hazards (Venomous/Disease-Carrying Animals/Insects, Poisonous Plants)	Severity	Likelihood	Risk Score	Color Key: §No shading indicates acceptable risk - no action needed. §Green shading indicates low risk - review the operation/activity and take any steps necessary to reduce & control the risks. §Yellow shading indicates medium risk - inform H&S management & seek further advice before proceeding any further with the operation/activity. §Red shading indicates high risk - HALT the activity immediately, review and reduce the risks identified.	Severity	Likelihood	Risk Score	
Mobilize/Demobilize								X		X	X	X	X	X		X								X	X	X		6	3	18	Inspect vehicle for unsafe conditions; stay alert and be aware of other traffic; obey traffic laws; do not drive when tired; reduce speed in inclement weather or poor road conditions; do not drive through standing water; park WSP vehicle outside of work zone.	6	2	12	WSP
Load/Unload equipment							X			X						X								X	X	X	X	X	3	2	6	Use proper lifting techniques; stay alert; park in designated parking/loading area; wear appropriate Level D clothing and gear (steel toe boots, hearing protection, safety glasses, high-visibility vest, etc.); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET.	3	1	3	WSP and subcontractor
Tailgate meeting (daily)										X														X	X		X	X	3	1	3	wear appropriate Level D clothing and gear (steel toe boots, hearing protection, safety glasses, high-visibility vest, etc.) and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET.	3	1	3	WSP and subcontractor
Soil vapor extraction pilot test set-up (blower and granular activated carbon vessel deployment; plumbing)			X				X			X			X	X	X						X		X	X	X	X	X	3	2	6	Conducted in advance of pilot test operation and includes connecting blower and granular activated carbon vessel for recovered soil gas, and deployment of electrical generator; follow standard operating procedures (SOPs); stay alert; wear appropriate Level D clothing and gear (steel toe boots, hearing protection, safety glasses, high-visibility vest, nitrile gloves, etc.); perform air monitoring as per the Health and Safety Plan (HASP); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; allow subcontractor to move and deploy blower, plumb system.	3	1	3	WSP and subcontractor

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JOB HAZARD ANALYSIS
WATER & ENVIRONMENT

Project Name:	Project No:	Project Location:	Project/Task Description:	Project/Task Equipment:
175 Roger Avenue	31404181.01	175 Roger Avenue Inwood, New York	**Soil Vapor Extraction Pilot Test and Vapor Well Abandonment**	Portable blower, granular activated carbon vessel, polyvinyl chloride pipes (plumbing); drill rig for well abandonment.

Chemicals of Concern:	Site-Specific Hazards:	Action Levels:
Tetrachloroethene (PCE) and degradation products (trichloroethene, *cis*- 1,2-dichloroethene, and vinyl chloride).	Vacant property	1.) Vinyl chloride - 0.5 ppm; and, 2.) Trichloroethene - 5 ppm (see action level flow chart)
Level D PPE: Weather appropriate clothing, steel-toed safety shoes, work gloves, nitrile gloves, safety glasses/googles, high-visibility vest (required for all field-based activities).	**PPE Upgrades:** Level C PPE: Full face air purifying respirator, organic vapor cartridges, hooded Tyvek coveralls, chemical resistant gloves and boot covers.	**Health & Safety Equipment:** Vinyl chloride colorimetric tubes, photoionization detector (PID), first aid kit, sunscreen, and insect repellent.

Basic Job Step	Potential Hazards (From HASP)																											Baseline Risk Score			Hazard Controls Protection Measures	Controlled Risk Score			Persons Affected
	Explosion (Chemical Reaction)	Explosion (Over Pressurization)	Electrical (Shock/Short Circuit)	Electrical (Fire)	Electrical (Static)	Electrical (Loss of Power)	Ergonomics (Strain)	Ergonomics (Human Error)	Excavation (Collapse)	Fall (Slip, Trip)	Fire/Heat	Mechanical/Vibration (Chafing/Fatigue)	Mechanical Failure	Mechanical	Noise	Struck By (Mass Acceleration)	Struck Against	Chemical (Toxic)	Chemical (Ignitable)	Chemical (Corrosive)	Chemical (Volatile)	Radiation (Ionizing)	Radiation (Non-Ionizing)	Temperature Extreme (Heat/Cold)	Visibility	Weather Phenomena (Snow/Rain/Wind/Ice)	Biological Hazards (Venomous/Disease-Carrying Animals/Insects, Poisonous Plants)	Severity	Likelihood	Risk Score	Color Key: §No shading indicates acceptable risk - no action needed. §Green shading indicates low risk - review the operation/activity and take any steps necessary to reduce & control the risks. §Yellow shading indicates medium risk - inform H&S management & seek further advice before proceeding any further with the operation/activity. §Red shading indicates high risk - HALT the activity immediately, review and reduce the risks identified.	Severity	Likelihood	Risk Score	
Soil vapor extraction pilot test operation and monitoring			X				X			X			X	X	X						X		X	X	X	X	X	3	2	6	Follow SOPs; wear appropriate Level D clothing and gear (steel toe boots, hearing protection, safety glasses, high-visibility vest, nitrile gloves, etc.); perform air monitoring as per HASP; wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; minimize contact with blower during operation; use caution when collecting vacuum and flow measurements from extraction well and vapor monitoring wells or when evaluating the vapor stream (using a photoionization detector) near the inlet or outlet of the granular activated carbon vessel.	3	1	3	WSP and subcontractor
Soil vapor extraction pilot test breakdown (blower and granular activated carbon vessel and plumbing)			X				X			X			X	X	X						X		X	X	X	X	X	3	2	6	Conducted following the pilot test operation and includes disconnecting blower, granular activated carbon vessel and electrical generator; follow standard operating procedures (SOPs); stay alert; wear appropriate Level D clothing and gear (steel toe boots, hearing protection, safety glasses, high-visibility vest, nitrile gloves, etc.); perform air monitoring as per the Health and Safety Plan (HASP); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; allow subcontractor to disconnect plumbing, disassemble the pilot test equipment, and load equipment following test.	3	1	3	WSP and subcontractor
Vapor extraction and monitoring well abandonment (post-test)							X			X				X			X				X		X	X	X	X	X	3	3	9	Wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, high-visibility vest, etc.); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; stay alert while moving near the drill rig, open boreholes (if casing is removed from he ground) or during backfill operations (including grout preparation and emplacement within decommissioned wells); follow WSP SOPs and New York State Department of Environmental Conservation guidance (CP-43) for well abandonment.	3	1	3	WSP and subcontractor
Waste management							X	X		X	X	X	X	X		X	X				X		X	X	X	X	X	5	3	15	Follow SOPs; use proper lifting techniques; avoid moving drums that contain wastes (pilot test pipes, fittings and other material used to plumb the vapor system); stay alert; wear appropriate Level D clothing and gear (steel toe boots, hearing protection, safety glasses, high-visibility vest, nitrile gloves, etc.); perform air monitoring as per HASP; wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; allow subcontractor to move and stage containerized wastes.	4	1	4	WSP and subcontractor

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Approved By:	**Approved Date:**

JOB HAZARD ANALYSIS
WATER & ENVIRONMENT

Project Name:	Project No:	Project Location:	Project/Task Description:	Project/Task Equipment:
175 Roger Avenue	31404181.01	175 Roger Avenue Inwood, New York	**Soil Characterization Sampling (with direct-push drill rig)**	Direct-push drill rig, disposable acetate soil sampling sleeves

Chemicals of Concern:	Site-Specific Hazards:	Action Levels:
Tetrachloroethene (PCE) and degradation products (trichloroethene, *cis*- 1,2-dichloroethene, and vinyl chloride).	Vacant property	1.) Vinyl chloride - 0.5 ppm; and, 2.) Trichloroethene - 5 ppm (see action level flow chart)
Level D PPE: Weather appropriate clothing, steel-toed safety shoes, work gloves, nitrile gloves, safety glasses/googles, high-visibility vest (required for all field-based activities).	**PPE Upgrades:** Level C PPE: Full face air purifying respirator, organic vapor cartridges, hooded Tyvek coveralls, chemical resistant gloves and boot covers.	**Health & Safety Equipment:** Vinyl chloride colorimetric tubes, photoionization detector (PID), first aid kit, sunscreen, and insect repellent.

Basic Job Step	Potential Hazards (From HASP)																										Baseline Risk Score			Hazard Controls Protection Measures	Controlled Risk Score			Persons Affected
	Explosion (Chemical Reaction)	Explosion (Over Pressurization)	Electrical (Shock/Short Circuit)	Electrical (Fire)	Electrical (Static)	Electrical (Loss of Power)	Ergonomics (Strain)	Ergonomics (Human Error)	Excavation (Collapse)	Fall (Slip, Trip)	Fire/Heat	Mechanical/Vibration (Chafing/Fatigue)	Mechanical Failure	Mechanical	Noise	Struck By (Mass Acceleration)	Struck Against	Chemical (Toxic)	Chemical (Ignitable)	Chemical (Corrosive)	Chemical (Volatile)	Radiation (Ionizing)	Radiation (Non-Ionizing)	Temperature Extreme (Heat/Cold)	Visibility	Weather Phenomena (Snow/Rain/Wind/Ice)	Biological Hazards (Venomous/Disease-Carrying Animals/Insects, Poisonous Plants)	Severity	Likelihood	Risk Score		Severity	Likelihood	Risk Score	
Mobilize/Demobilize								X		X	X	X	X	X		X								X	X	X		6	3	18	Inspect vehicle for unsafe conditions; stay alert and be aware of other traffic; obey traffic laws; do not drive when tired; reduce speed in inclement weather or poor road conditions; do not drive through standing water; park WSP vehicle outside of work zone.	6	2	12	WSP
Load/Unload equipment							X			X						X								X	X	X	X	X	3	2	6	Use proper lifting techniques; stay alert; park in designated parking/loading area; wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, high-visibility vest, etc.); wear weather-appropriate clothing and use sun protection factor (SPF 15) or higher sunscreen; work during daylight hours; use insect repellant containing DEET.	3	1	3	WSP
Tailgate meeting (daily)										X														X	X		X	X	3	1	3	Wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, high-visibility vest, etc.); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET.	3	1	3	WSP and subcontractor
Confirm drilling locations (marked by surveyor in advance of mobilization)										X														X	X	X	X	X	3	2	6	Wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, high-visibility vest, etc.); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; stay alert while moving about the site.	3	1	3	WSP and subcontractor
Verify utility clearance in proposed drilling areas							X			X			X	X		X								X	X	X	X	X	3	2	6	Wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, high-visibility vest, etc.); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; stay alert while moving about the site; conduct utility clearance in accordance with WSP's standard operating procedures (SOPs).	3	1	3	WSP and subcontractor
Position direct-push rig and begin drilling		X	X	X		X	X			X	X	X	X	X	X	X	X				X			X	X	X	X	X	6	2	12	Stay alert and maintain distance from the drill rig and rotating parts; wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, hearing protection, high-visibility vest, hard hat, etc.); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; stay alert while moving about the site and the drill rig; conduct utility clearance in accordance with WSP's SOPs.	6	1	6	WSP and subcontractor

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Dave Bouchard	2/18/2025
Approved By:	**Approved Date:**

JOB HAZARD ANALYSIS
WATER & ENVIRONMENT

Project Name:	Project No:	Project Location:	Project/Task Description:	Project/Task Equipment:
175 Roger Avenue	31404181.01	175 Roger Avenue Inwood, New York	**Soil Characterization Sampling (with direct-push drill rig)**	Direct-push drill rig, disposable acetate soil sampling sleeves

Chemicals of Concern:	Site-Specific Hazards:	Action Levels:
Tetrachloroethene (PCE) and degradation products (trichloroethene, *cis*- 1,2-dichloroethene, and vinyl chloride).	Vacant property	1.) Vinyl chloride - 0.5 ppm; and, 2.) Trichloroethene - 5 ppm (see action level flow chart)
Level D PPE: Weather appropriate clothing, steel-toed safety shoes, work gloves, nitrile gloves, safety glasses/googles, high-visibility vest (required for all field-based activities).	**PPE Upgrades:** Level C PPE: Full face air purifying respirator, organic vapor cartridges, hooded Tyvek coveralls, chemical resistant gloves and boot covers.	**Health & Safety Equipment:** Vinyl chloride colorimetric tubes, photoionization detector (PID), first aid kit, sunscreen, and insect repellent.

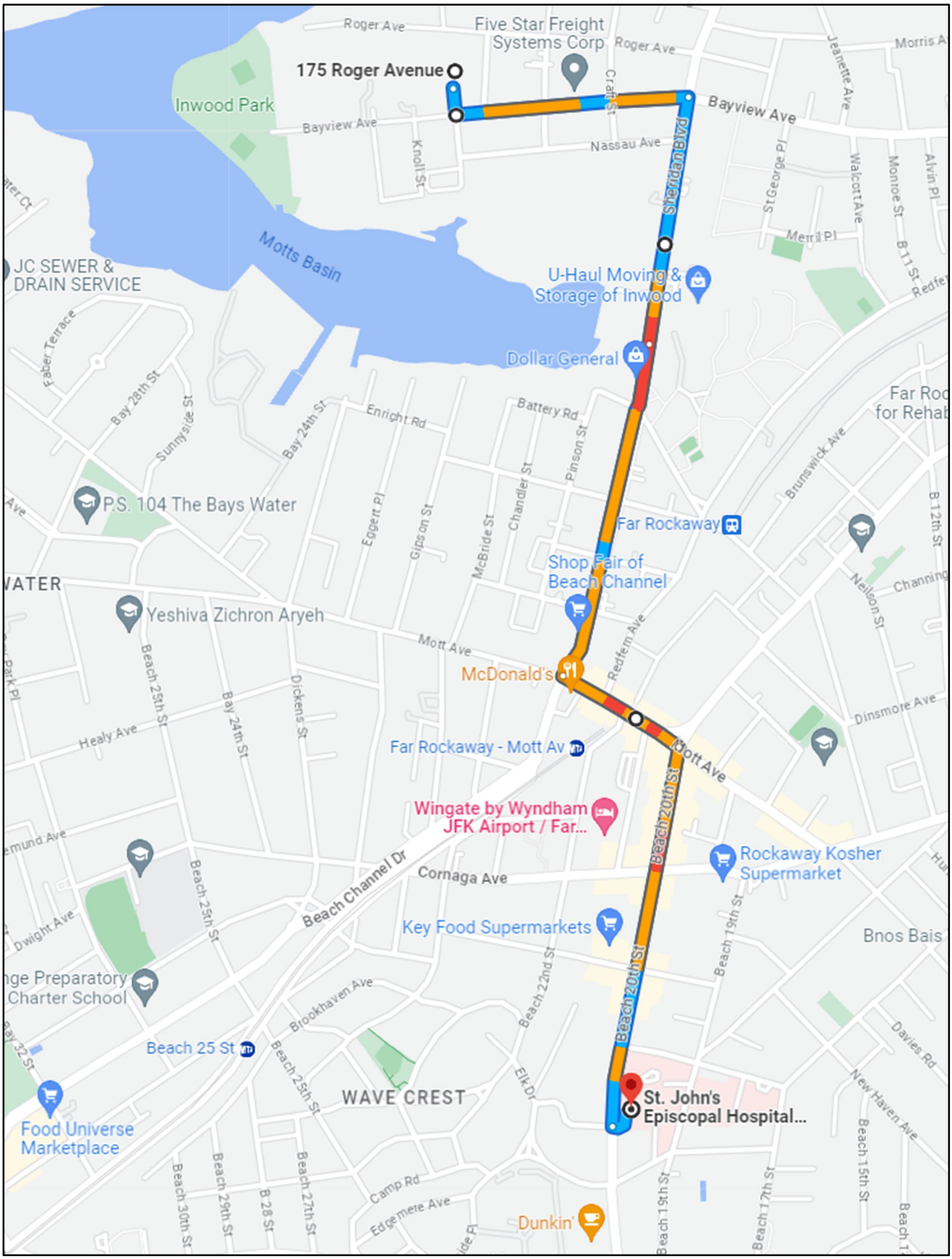
Basic Job Step	Potential Hazards (From HASP)																											Baseline Risk Score			Hazard Controls Protection Measures	Controlled Risk Score			Persons Affected
	Explosion (Chemical Reaction)	Explosion (Over Pressurization)	Electrical (Shock/Short Circuit)	Electrical (Fire)	Electrical (Static)	Electrical (Loss of Power)	Ergonomics (Strain)	Ergonomics (Human Error)	Excavation (Collapse)	Fall (Slip, Trip)	Fire/Heat	Mechanical/Vibration (Chafing/Fatigue)	Mechanical Failure	Mechanical	Noise	Struck By (Mass Acceleration)	Struck Against	Chemical (Toxic)	Chemical (Ignitable)	Chemical (Corrosive)	Chemical (Volatile)	Radiation (Ionizing)	Radiation (Non-Ionizing)	Temperature Extreme (Heat/Cold)	Visibility	Weather Phenomena (Snow/Rain/Wind/Ice)	Biological Hazards (Venomous/Disease-Carrying Animals/Insects, Poisonous Plants)	Severity	Likelihood	Risk Score		Severity	Likelihood	Risk Score	
Soil logging and analytical sample collection							X			X											X		X	X		X	X	3	2	6	Follow borehole logging procedures and soil sampling SOPs; stay alert; wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, high-visibility vest, etc.); perform air monitoring as per the Health and Safety Plan (HASP); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; allow subcontractor to extract and open the acetate sleeve within the soil sampler.	3	1	3	WSP and subcontractor
Abandon and backfill soil borings; restoration							X							X		X					X		X	X	X	X	X	3	3	9	Wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, high-visibility vest, etc.); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; stay alert while moving near the drill rig, open borehole or during backfill operations (including grout preparation and emplacement); allow subcontractor to abandon the borehole.	3	1	3	WSP and subcontractor
Decontamination (dedicated, single-use sampling equipment only)										X											X		X	X	X	X	X	3	1	3	Follow SOPs and allow subcontractor to decontaminate drilling equipment; use proper lifting techniques; stay alert; wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, high-visibility vest, etc.); perform air monitoring as per HASP; wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET.	3	1	3	WSP
Pack and ship soil samples for analysis							X			X							X				X		X	X	X	X	X	3	1	3	Follow SOPs; use proper lifting techniques; stay alert; wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, high-visibility vest, etc.); wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET; soil samples and the (unpreserved) containers are not anticipated to be Department of Transportation hazardous materials.	3	1	3	WSP
Waste management (minimal waste generation; no containerization anticipated)							X	X		X							X				X		X	X	X	X	X	2	2	4	Follow SOPs; direct subcontractors to handle wastes at site, when possible; use proper lifting techniques; stay alert; wear appropriate Level D clothing and gear (nitrile gloves, steel toe boots, safety glasses, high-visibility vest, etc.); perform air monitoring as per HASP; wear weather-appropriate clothing and use SPF 15 or higher sunscreen; work during daylight hours; use insect repellant containing DEET.	2	1	2	WSP and subcontractor

Color Key:
§No shading indicates acceptable risk - no action needed.
§Green shading indicates low risk - review the operation/activity and take any steps necessary to reduce & control the risks.
§Yellow shading indicates medium risk - inform H&S management & seek further advice before proceeding any further with the operation/activity.
§Red shading indicates high risk - HALT the activity immediately, review and reduce the risks identified.

APPENDIX

E ROUTE TO NEAREST EMERGENCY MEDICAL CARE

APPENDIX


175 Roger Avenue
Five Star Freight Systems Corp
Roger Ave
Inwood Park
Bayview Ave
Nassau Ave
Knoll St
Craft St
Sheridan Blvd
Motts Basin
JC SEWER & DRAIN SERVICE
U-Haul Moving & Storage of Inwood
Dollar General
Faber Terrace
Bay 28th St
Sunnyside St
Bay 24th St
Enright Rd
Battery Rd
Pinson St
Chandler St
McBride St
Gipson St
Eggert Pl
P.S. 104 The Bays Water
Far Rockaway
Shop Fair of Beach Channel
Brunswick Ave
Neilson St
Channing
Yeshiva Zichron Aryeh
Mott Ave
McDonald's
Redfern Ave
Far Rockaway - Mott Av
Dinsmore Ave
Healy Ave
Beach 25th St
Bay 24th St
Dickens St
Beach 20th St
Wingate by Wyndham JFK Airport / Far...
Rockaway Kosher Supermarket
Cornaga Ave
Beach Channel Dr
Key Food Supermarkets
Beach 19th St
Bnos Bais
Dwight Ave
Brookhaven Ave
Beach 22nd St
Beach 25 St
WAVE CREST
Elk Dr
St. John's Episcopal Hospital...
Food Universe Marketplace
Davies Rd
New Haven Ave
Beach 15th St
Beach 17th St
Beach 19th St
Camp Rd
Edgemere Ave
Beach 30th St
Beach 29th St
Beach 28 St
Beach 27th St
Dunkin'