VIA ELECTRONIC MAIL

November 4, 2024

Ms. Tara Rutland
Environmental Engineer, Div. of Environmental Remediation
New York State Department of Environmental Conservation
625 Broadway
Albany, New York 12233-7015

Subject: **Onsite Soil Gas Survey Work Plan**
Former TransTechnology Corporation Facility, Glen Head, New York

Dear Ms. Rutland,

WSP USA Inc., on behalf of our client, Breeze-Eastern LLC (Breeze-Eastern), is pleased to submit this *Onsite Soil Gas Survey* work plan for the former TransTechnology Corporation (TTC) facility in Glen Head, New York (Figure 1). The proposed work is in response to recommendations made by the New York State Departments of Environmental Conservation (NYSDEC) and Health (NYSDOH) during their review of the *Operable Unit No. 2 Groundwater Feasibility Study* (OU-2 FS), dated December 8, 2023. The OU-2 FS presented, among other items, data collected as part of an annual vapor intrusion monitoring program in two private residences that adjoin the facility. The program began in 2013 after an evaluation revealed chlorinated volatile organic compounds (VOCs), including tetrachloroethene (PCE) and trichloroethene (TCE), in the sub-slab soil gas and (to a lesser extent) the indoor air samples collected within the homes. The annual monitoring results outlined substantial chlorinated VOC concentration reductions in the sub-slab soil gas samples collected in the first few years of the program with the concentrations of chlorinated VOCs detected in the gas eventually decreasing to trace or nondetectable levels. These reduced concentrations, when combined with the indoor sampling results and compared to the decision matrices in the NYSDOH *Guidance for Evaluating Vapor Intrusion in the State of New York* (SVI Guidance[1]), yielded *no further action* recommendations for both homes over the past nine years. The decreases observed in the soil gas sample concentrations are concurrent with the excavation and offsite disposal of more than 8,000 tons of soil, much of which contained chlorinated VOCs, from the site between 2012 and 2020 (i.e., during the implementation of the Operable Unit No. 1 soil remedy and post-closure activities), and the ongoing attenuation of dissolved chlorinated VOCs in the groundwater to trace levels. The interpretation, as presented in the OU-2 FS, is that the mass reductions in the soil and groundwater have minimized the subsurface sources of chlorinated VOCs to the soil gas and reduced the current and future *potential* for vapor intrusion in both the homes that were monitored and for the surrounding study area.

The Departments, based on these results, recommended that Breeze-Eastern consider reassessing the onsite soil gas concentrations and evaluating the need for the vapor intrusion control measures detailed in the NYSDEC-approved 2022 *Interim Site Management Plan*. Those measures, which include the use of both passive vapor barriers and sub-slab depressurization (SSD) systems for any future buildings on the property (including the single and multi-family homes planned[2] for the redeveloped site), were developed based on the early investigation data and did not incorporate the mass reductions outlined in the OU-2 FS (i.e., they likely do not reflect the current soil gas conditions at the site). The post-remediation concentrations of chlorinated VOCs in

[1] *Guidance for Evaluating Vapor Intrusion in the State of New York* was published by the NYSDOH in October 2006, with updates in 2017 and 2024. The sub-slab soil soil gas data from the homes were compared to the 2006 guidance between 2012 (when the initial home evaluation was conducted) and 2016; and to the 2017 and 2024 updated decision matrices for the data collected between 2017 and 2024. See the OU-2 FS, dated December 18, 2023, for additional information.

[2] The site was remediated as part of the Operable Unit No. 1 activities to the *Restricted Residential* land use category intended for the property; however, a portion of the property, designated as Parcel A, was reclassified from *Restricted Residential* land use *to Residential* land use. The 2.75-acre Parcel A is provisionally zoned for single family home construction (i.e., designated as RI-7 by the Town of Oyster Bay), with the remainder of the site, designated as Parcel B, zoned for multi-family homes (designated RMF-16). The bounds of the parcels is depicted on Sheets 1. See the 2022 *Environmental Easement* for the site for additional information.

WSP USA
13th Floor
100 Summer Street
Boston, MA 02110

Tel.: +1 617 426-7330
Fax: +1 617 482-8487
wsp.com

soil gas may have been reduced to levels that no longer warrant the installation of SSDs, the integration of a vapor barrier in the basement of each structure, or both.

APPROACH

WSP is proposing to conduct a site-wide survey to evaluate the (post-remediation) nature and extent of chlorinated VOC-affected soil gas beneath the site, determine if exposure via vapor intrusion remains a concern at the site, and whether the planned vapor intrusion control measures are warranted. The soil gas sampling will be based on the grid established for the site-wide characterization work in 2014 and 2018, which divided the 7.75 acre site into 25 cells, each with an area of approximately[3] 13,500 square-feet (125-feet long and 108 feet wide; Sheet 1). The grid was adopted for this phase of work as an aid to visualize the design of the soil gas sampling program and ensure the number of samples collected is sufficient to characterize the site. The specific soil gas sample locations, designated as SG-100 through SG-125, will be positioned along north-south transects spaced approximately 40 feet apart splitting the grid cells into equal east-west segments. The soil gas survey borings will be installed near the center of the cell in an alternating pattern between the two transects. This will create a sawtooth pattern with sample points positioned to capture soil gas concentration data in each grid cell, including areas historically underlain by affected soil and groundwater. The distances for the proposed sample locations are generally consistent with the spacing used during previous onsite soil gas work and, given the distribution and overall number of sample locations, sufficiently characterize the soil gas over the entire property.

The samples will be collected using 6-inch-long stainless steel soil gas implants installed with a direct-push drill rig equipped with 1.5-inch inside diameter (ID) drilling rods fitted with an expendable point. The implants (with the appropriate tubing) will be positioned between 6 and 8 feet below ground surface (bgs) with each borehole backfilled with clean sand (around the screened section of the implant) and hydrated bentonite (to form a seal). Select[4] soil gas sample locations will be evaluated with helium (or equivalent tracer) to ensure the integrity of the seal. The implants and tubing will then be purged, and the soil gas sampled over a 1-hour-long period using laboratory-supplied evacuated canisters. The borings will be abandoned after the sampling is complete by removing the implant, backfilling the borehole, and patching the surface to match the surrounding grade. The specific sampling procedures are detailed below.

The soil gas survey work detailed below will be conducted following the procedures outlined in the NYSDOH's 2006 SVI Guidance, with updates in 2017 and 2024; NYSDEC's *Technical Guidance for Site Investigation and Remediation* (DER-10), dated May 2010; the approved 2011 *Residential Reclassification and Feasibility Study Work Plan* (this work plan details the methods used for the previous soil gas survey in 2011 and early 2012); the NYSDEC-approved *Interim Site Management Plan*[5]; the site-specific *Quality Assurance Project Plan* (QAPP); the updated site-specific *Health and Safety Plan*; and WSP's Standard Operating Procedures (SOPs). A copy of the referenced SOPs is provided in Enclosure A

It is important to note that this letter work plan is a follow-on to the OU-2 FS and, as such, is not intended to be comprehensive. Historical investigations, including the groundwater profiling conducted as part of the 2018 *OU-2 Remedial Investigation* and the 2023 *Supplemental Groundwater Investigation*; and the corresponding delineation of the plumes of affected groundwater, are presented, where appropriate, for context but are otherwise not detailed in this work plan. Likewise, information regarding the Operable Unit No. 1 soil remediation activities, the soil gas evaluation (part of the OU-2 activities, but reported separately), and the post-closure work (building demolition, subsurface drainage structure abandonment activities) at the site are not discussed in this document except to provide a setting for the analysis of the soil gas data.

SCOPE OF WORK

The soil gas sample borings will be installed using a direct-push drill rig to create temporary subsurface sampling probes in accordance with the NYSDOH's SVI Guidance and WSP's SOP 15 (Enclosure A). Boreholes for all 26 soil gas sample locations, SG-100 through SG-125, will be advanced from the ground surface to a depth of approximately 8 feet bgs using 1.25-inch-

[3] The sampling grid was established as part of the soil pre-characterization work performed in 2014 and, later after the building was demolished, in 2018. The divisions within the grid were designed to separate the site into cells with a volume of 1,000 cubic yards (125 feet long by 108 feet wide by 2 feet deep), based on the soil sampling recommendations presented in Table 5.4(e)10 of the *Technical Guidance for Site Investigation and Remediation*. Portions of the property southwest of Grid 2 and west of Grid 3, because of the site layout, did not fit evenly under the gridded sections (Sheet 1). These areas were combined to form an additional sampling grid cell, designated as 1A and 1B. See the *Pre-Development Site-wide Soil Characterization Report* (Phase 1), dated February 19, 2014, for additional information.

[4] The helium leak testing will be performed on approximately 25 percent of the sample locations selected at random during the sampling event. This approach was adopted to provide a representative assessment of the soil gas sample point construction and limit the equipment, consumables, and time requirements for the evaluation.

[5] The proposed soil gas survey locations are not included in the list of activities included *Excavation Work Plan* portion of the 2022 *Interim Site Management Plan* and, thus, the *Community Air Monitoring Plan* is not required. See the 2022 *Interim Site Management Plan* for additional information.

diameter drilling rods fitted with an expendable point (Sheet 1). The actual depth of installation may be adjusted in the field to avoid buried utilities or other subsurface obstacles. Teflon® or Teflon®-lined tubing will be connected to a 6-inch-long stainless steel screen implant (Geoprobe® AT6 soil gas sampler, or equivalent) 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 select representative soil gas sample points 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 evacuated 1-liter Entech® 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 both the pre an post-sampling canister pressures in the field notebook. 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 quality assurance and quality control (QA/QC) samples (outlined below and detailed in the QAPP), will be shipped under ambient conditions via overnight carrier to an Environmental Laboratory Accreditation Program-certified (ELAP-certified) analytical laboratory for analysis the site-specific chlorinated VOCs (PCE, TCE, *cis*- and *trans*-1,2-dichloroethene, and vinyl chloride) by US Environmental Protection Agency Method TO-15. The sample analysis will be conducted 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 sampling activities will include the collection and analysis of duplicate samples, matrix spike and matrix spike duplicates (MS/MSDs), and trip blanks. 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 trip blank will accompany the sample containers from the laboratory to the field and the samples from the field to the 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 (Enclosures A).

DECONTAMINATION PROCEDURES AND WASTE MANAGEMENT

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 cleaner or non-phosphate soap (followed by a potable water rinse), as appropriate, in accordance with WSP's SOP 6 (Enclosure A). A dedicated decontamination pad will be constructed at the site to contain decontamination rinsate and soil cuttings.

Investigation-derived waste generated during the drilling and sampling activities, including decontamination rinsate, residual soil cuttings[6], and other solid waste (e.g., poly sheeting, personal protective equipment, tubing, etc.) will be placed in Department of

[6] The soil implants will be installed using a direct-push drill rig equipped with an expendable point that prevents soil from entering the drill string. WSP, based on the drilling method, does not anticipate generating significant soil cuttings.

Transportation-compliant 55-gallon steel drums and managed during the investigation in accordance with the QAPP and WSP's SOP 5. The drums will be staged onsite after the field activities have been completed for later offsite disposal in accordance with state and federal regulations.

PROJECT SCHEDULE AND REPORTING

The planned soil gas survey field activities will be initiated approximately six weeks following the approval of this work plan, depending on weather and subcontractor availability. The soil gas implant installation and sampling activities are anticipated to require up to three days to complete. Analytical samples collected during the onsite activities will be analyzed on a standard two-week turnaround-time, with the final data anticipated within four weeks of completing the field work. All final analytical results will be evaluated and assessed for usability by an appropriate data validator. The validation will be completed within four weeks of receiving the results from the analytical laboratory.

The findings of the soil gas survey will be presented in a letter report submitted to the NYSDEC and NYSDOH within 30 days of receiving the final, validated data. The report will include a plot of the soil gas data, which will be used to determine the nature and extent of the affected soil gas (if any) and identify spatial relationships (e.g., high concentrations correlating to areas of previous soil or groundwater impacts); a comparison to previous onsite soil gas sampling to quantify any change in the chlorinated VOC concentrations; and a comprehensive review of the soil gas data with all the current soil, groundwater, and vapor intrusion monitoring data for the site (no specific guidance values are available for evaluating soil gas concentrations in New York). This approach will be used to determine if the soil gas data characterize the site and are reflective of the conditions within the study area, whether additional sampling is required, and to assess possible exposure routes and the potential for any residual concentrations to impact indoor air of the future structures at the site. These data will, in turn, inform the evaluation of the vapor intrusion controls specified in the 2022 *Interim Site Management Plan.*

Breeze-Eastern is committed to completing the soil gas survey in a timely manner. Please do not hesitate to contact me at (315) 374-8494 or John Simon at (202) 505-1906, if you have any questions or comments regarding this work plan.

Sincerely yours,

David P. Bouchard
Assistant Vice President

DPB:dpb

Clients\Breeze-Eastern\TransTechnology\Investigation & Remediation\Pre-Development Work\2024 Soil Gas Survey\Text\workplan.hw130101.2024-11-04.SG Survey.docx

Enclosures

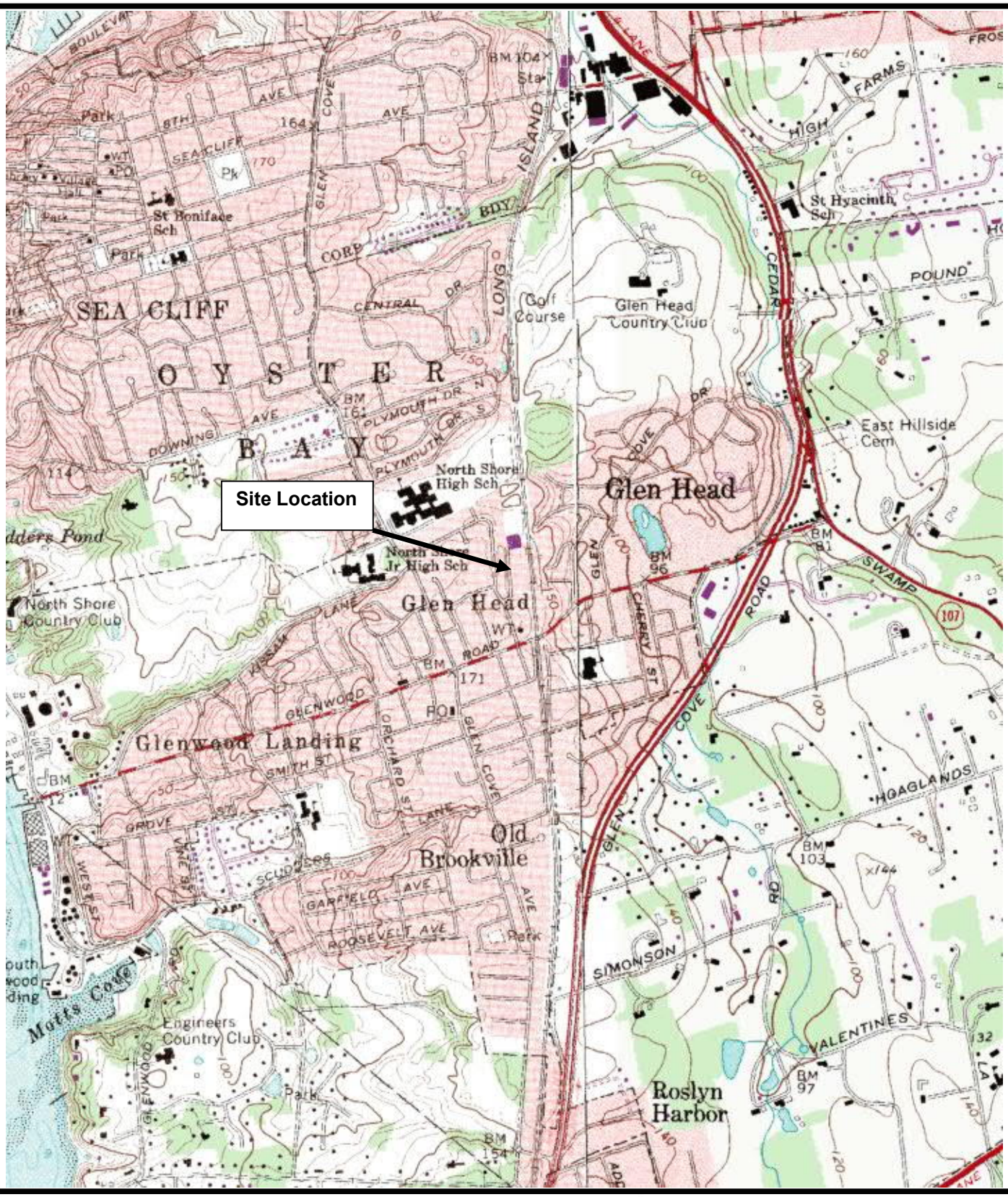
cc: Mr. Anthony C. Perretta, New York State Department of Health
Ms. Stephanie Selmer, New York State Department of Health
Mr. Carlos Pareja, Nassau County Department of Health
Mr. John A. Simon, Gnarus Advisors LLC

FIGURE

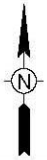
DWG Name:

Checked: Approved:

Drawn By: A



Reference
7.5 Minute Series Topographic Quadrangle
Sea Cliff, New York
Photorevised 1979; Scale 1:24,000



0 1000 2000 4000
SCALE, FEET

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

FIGURE 1

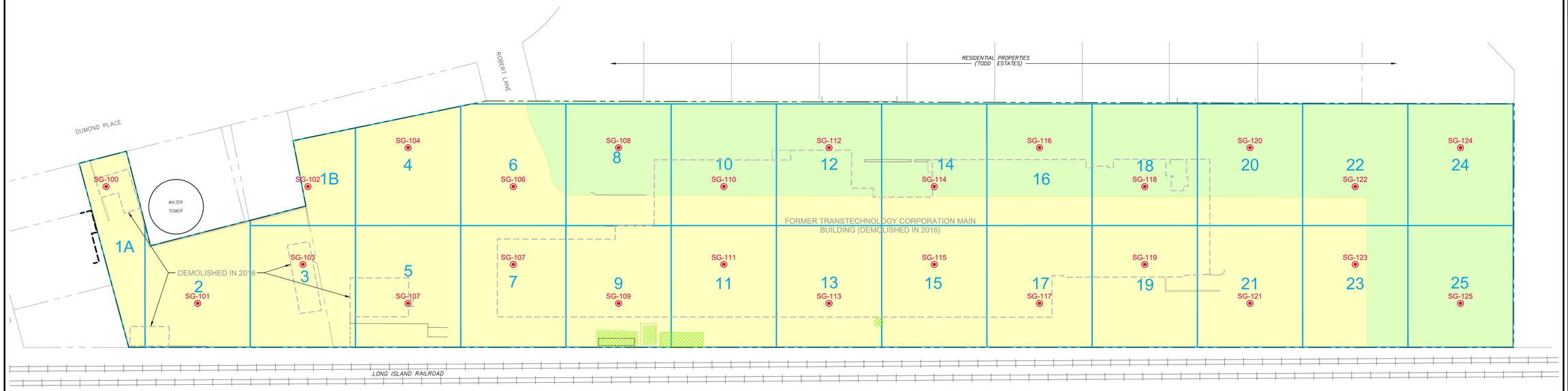
SITE LOCATION MAP

FORMER TRANSTECHNOLOGY CORPORATION
FACILITY — GLEN HEAD, NEW YORK

PREPARED FOR

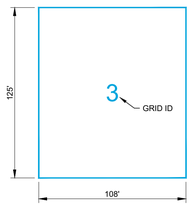
Breeze-Eastern LLC
Whippany, New Jersey

SHEET



LEGEND

- SG-100 — PROPOSED SOIL GAS SAMPLE
- PARCEL A (RI–7 ZONED FOR SINGLE FAMILY)
- PARCEL B (RMF–16 ZONED FOR MULTI–FAMILY)
- RESIDUAL IMPACTED SOIL OR SEDIMENT
- PROPERTY BOUNDARY
- FORMER BUILDING LOCATION

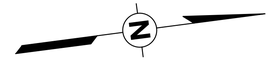


SAMPLE GRID

NOTES:

1. THE SAMPLING GRID, ESTABLISHED AS PART OF THE SOIL PRE–CHARACTERIZATION WORK PERFORMED IN 2014, WAS ADOPTED FOR THE SOIL GAS ACTIVITIES AS AN AID TO VISUALIZE THE DESIGN OF THE SAMPLING PROGRAM AND ENSURE THE NUMBER OF SAMPLES IS SUFFICIENT TO CHARACTERIZE THE SITE. SEE THE PRE–DEVELOPMENT SITE–WIDE SOIL CHARACTERIZATION REPORT (PHASE 1), DATED FEBRUARY 19, 2014, FOR ADDITIONAL INFORMATION ON THE DEVELOPMENT OF THE SAMPLING GRID.

2. THE SITE WAS REMEDIATED AS PART OF THE OPERABLE UNIT NO. 1 ACTIVITIES TO THE RESTRICTED RESIDENTIAL LAND USE CATEGORY; HOWEVER, A PORTION OF THE PROPERTY, DESIGNATED AS PARCEL A, WAS RECLASSIFIED FROM RESTRICTED RESIDENTIAL LAND USE TO RESIDENTIAL LAND USE. THE 2.75–ACRE PARCEL A, DEPICTED WITH GREEN SHADING ABOVE, IS PROVISIONALLY ZONED FOR SINGLE FAMILY HOME CONSTRUCTION (I.E., DESIGNATED AS RI–7 BY THE TOWN OF OYSTER BAY, NEW YORK), WITH THE REMAINDER OF THE SITE, DESIGNATED AS PARCEL B, ZONED FOR MULTI–FAMILY HOMES (DESIGNATED RMF–16; SHADED YELLOW ON THE DRAWING ABOVE). SEE TEXT FOR ADDITIONAL INFORMATION.



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

50 0 50 100

SCALE, FEET

SAMPLING LOCATIONS ARE APPROXIMATE

D

REFERENCE:

REMEDIAL INVESTIGATION REPORT, TRANSTECHNOLOGY CORPORATION, GLEN HEAD, NEW YORK SITE, SITE NUMBER I–30–101, PREPARED BY GEOMATRIX ENGINEERING, LLC, SEPTEMBER 2005.

REVISIONS

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

SEAL

DATE

DRAWN BY

CHECKED

APPROVED

NOTICE: THIS DRAWING HAS BEEN PREPARED UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER(S) OR LAND SURVEYOR(S). ALTERATIONS TO THIS DRAWING MADE BY ANY PARTY UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER OR LAND SURVEYOR OTHER THAN THE ENGINEER OR SURVEYOR WHO SIGNED OR SEALED IT IN ANY WAY, SHALL CAUSE THE ENGINEER OR SURVEYOR WHO SIGNED OR SEALED THE DRAWING TO BE RELIEVED OF RESPONSIBILITY FOR THE DRAWING.

PROPOSED SOIL GAS SAMPLING LOCATIONS

FORMER TRANSTECHNOLOGY CORPORATION FACILITY
GLEN HEAD, NEW YORK

PREPARED FOR
BREEZE–EASTERN LLC
WHIPPANY, NEW JERSEY

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

SHEET 1

Drawing Number
314P0522.000–D68

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 #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.