3M Company

Residential Vapor Intrusion Investigation Work Plan

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Wausau, Wisconsin

May 2022

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Wausau, Wisconsin

May 19, 2022

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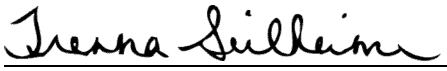

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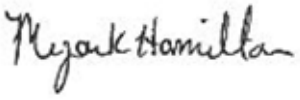

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1 Introduction

On behalf of 3M Company (3M), Arcadis U.S., Inc (Arcadis) has prepared this Residential Vapor Intrusion Investigation Work Plan (Work Plan) to evaluate the potential vapor intrusion (VI) pathway to four residential properties in Wausau, Marathon County, Wisconsin (**Figure 1**). The Work Plan was prepared to address the potential for VI associated with groundwater impacts discovered during the February 2022 VI investigation event.

The groundwater monitoring in February was part of an ongoing evaluation of trichloroethylene (TCE). TCE was used by the Wausau Motor Parts Company, formerly located at the corner of South 1st Avenue and West Thomas Street. 3M acquired the former Wausau Motor Parts property in 1957. When TCE was discovered on the property, 3M worked with the Wisconsin Department of Natural Resources (WDNR) to investigate and clean up the site. In April 2008, 3M received a “final case closure with conditions met” from WDNR. The former Wausau Motors site is currently used by 3M as a parking lot and rail car storage.

Based on a WDNR email request, a Vapor Intrusion Investigation Work Plan was submitted to the WDNR in November 2021. From February 7-10, 2022, Arcadis completed paired indoor air and sub-slab vapor sampling in the two adjacent buildings owned by Wauleco, Inc. (Wauleco) and a round of groundwater sampling from a subset of wells from the current Wauleco groundwater monitoring well network to assess the potential presence of residual TCE concentrations.

Groundwater analytical results from the February 2022 event exhibited TCE exceedances of the Natural Resources 140 Wisconsin Administrative Code Enforcement Standards (ES) in two wells, W25 and W40R. TCE concentrations in monitoring wells W25 and W40R were 5.8 micrograms per liter (µg/L) and 8.8 µg/L, respectively. To address the potential for vapor intrusion associated with impacted groundwater, additional vapor sampling is proposed. Monitoring well W25 is located on the Wauleco property and is therefore addressed under the existing Vapor Intrusion Investigation Work Plan dated November 23, 2021. To investigate the potential for a VI pathway associated with groundwater impacts detected at monitoring well W40R, Arcadis proposes a VI investigation at nearby residential properties. Per Figure 3a of the WDNR publication “Addressing Vapor Intrusion at Environmental Remediation and Redevelopment Sites in Wisconsin (RR-800)” and after discussions with WDNR on March 16, 2022, four residential properties have been identified for the investigation. At each property, the scope of work will include a building survey, ambient air sampling, and paired indoor air and sub-slab vapor sampling in one location within the basement.

This Work Plan describes the scope of work, including investigation activities, sampling methods, laboratory analysis, data evaluation, and reporting. The investigation activities will be completed in accordance with the WDNR Publication RR-800 and the Arcadis Technical Guidance Instructions (TGIs).

2 Residential Vapor Intrusion Investigation Scope of Work

Arcadis proposes to conduct a building survey, ambient air sampling, and paired indoor air and sub-slab vapor sampling at four residential properties to assess the potential VI pathway from residual TCE groundwater concentrations associated with the closed former Wausau Motors site. The four properties include:

1. 121 East Thomas Street, Wausau, WI 54401
2. 127 East Thomas Street, Wausau, WI 54401
3. 129 East Thomas Street, Wausau, WI 54401
4. 133 East Thomas Street, Wausau, WI 54401

Properties proposed for additional VI investigation, identified using the numbering above, are shown on **Figure 1**. Based on online records research, each property is believed to contain a residential structure with a full-height basement. Arcadis proposes collection of paired indoor air and sub-slab vapor samples from one location in each basement during three separate sampling events per the WDNR guidance. One duplicate indoor air sample will also be collected for quality assurance and quality control (QA/QC) purposes during each sampling event. Additionally, one outdoor ambient air sample will be collected each day during indoor air sampling activities for QA/QC purposes. The first sampling event will be conducted as soon as possible during spring conditions, the second event will be conducted during summer conditions, and the third sampling event will be conducted during winter worst-case conditions to assess potential seasonal variability.

Sampling at each property will take up to four days to complete. A building survey will be completed at each property prior to initiation of paired indoor air and sub-slab vapor sampling activities. The building survey will include a visual inspection of each property to document site information such as building construction, usage, and layout and identify and temporarily remove chemical products present in the building that could interfere with indoor air results. Removed chemical products will be stored outside in sealed totes where they will not impact sampling and will be returned to their original locations once sampling is completed. Additionally, a private utility locate will be completed with ground penetrating radar (GPR) at each proposed sub-slab port location prior to installation. Final sample locations will be subject to the utility clearance evaluation.

If chemical products must be removed from the residence, collection of indoor and ambient air samples will be initiated the following day. Once the 24-hour indoor air sample collection period is complete, the sub-slab vapor port will be installed in the basement, leak detection testing will be completed, and the sub-slab vapor port will be allowed to equilibrate. The following day, once the equilibration period is complete, the sub-slab vapor sample will be collected from the sample port.

3 Sampling Methods

Procedures for building surveying, indoor and ambient air sampling, and sub-slab vapor sampling are detailed in the Arcadis TGIs attached in **Appendix A**. The TGIs conform to the United States Environmental Protection Agency (USEPA) Office of Solid Waste and Emergency Response Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air and the WDNR Publication RR-800.

3M and Arcadis will work to gain access to the residential properties identified in this Work Plan.

3.1 Indoor and Ambient Air Sampling Methods

In the basement of each proposed residential property, one indoor air sample will be collected using a 6-liter polished stainless-steel SUMMA® canister with calibrated flow controller. SUMMA® canisters will be calibrated for a 24-hour sample collection and will be individually cleaned and certified by the laboratory Eurofins Air Toxics, LLC. During the collection process, the indoor air canister will be securely positioned in the breathing zone (approximately 3 to 5 feet above the floor). All indoor air samples will be collected under normal living conditions. One duplicate indoor air sample will be collected during each sampling event. The duplicate sample will be placed next to the parent indoor air sample and connected using a duplicate tee.

One ambient air sample will be collected during each day of indoor air sampling activities. The ambient air samples will be collected concurrently with the indoor air sample to evaluate potential outdoor background sources. Ambient air samples will be collected using a 6-liter SUMMA® canister calibrated for 24-hour sample collection and will be placed upwind of the residences being sampled at approximately 3 to 5 feet above the ground in the breathing zone.

Arcadis proposes to collect indoor air and ambient air samples for analysis utilizing USEPA method TO-15. Meteorological data (temperature, precipitation, humidity, barometric pressure, and wind speed/direction) will be collected before and during sampling activities.

3.2 Sub-Slab Vapor Port Installation and Sampling Methods

Prior to conducting sub-slab vapor port installation and sampling, utility locating activities using GPR will be completed to identify buried utilities in the vicinity of each proposed sub-slab vapor port. A One-Call public utility locate, and a visual inspection of the basement will also be completed as other lines of evidence for utility clearance. Final locations will be subject to the utility clearance evaluation.

Once indoor air sampling is complete, the sub-slab vapor ports will be installed in unobtrusive locations within the basements to minimize disturbance. The sub-slab vapor ports will be set flush to the upper surface of the concrete floor and will “float” in the slab to enable collection of vapors from the sub-slab material in direct contact with the slab. New stainless steel VAPOR PINs® will be utilized. The VAPOR PIN® will be preassembled for each location prior to drilling through the floor to minimize exposure time of the sub-slab soils to ambient conditions.

To install a sub-slab vapor port, a rotary hammer drill will be used to drill a 1.5-inch outer-diameter hole approximately 2 inches into the floor. The inside of the 1.5-inch outer-diameter hole will be cleaned with a damp towel and then a 0.625-inch outer-diameter hole will be drilled through the remainder of the concrete. Once through the concrete, the drill will be allowed to penetrate an additional 2 to 3 inches into the sub-slab material. The inner-diameter hole will be cleaned with a bottle brush and the outer-diameter hole will be cleaned once more with a damp towel. The VAPOR PIN® will be pressed into the concrete slab and sealed with the supplied non-volatile organic compound silicone sleeve. A protective cap will be placed on the end of the VAPOR PIN® and finished with a stainless-steel thread-on flush-mount cover.

Once the sub-slab vapor port is installed, it will be allowed to equilibrate for a minimum of 2 hours prior to sampling. After the equilibration period is complete, three volumes of dead air will be purged from the sample assembly at a rate of approximately 100 milliliters per minute (mL/min) using a 60mL syringe into a Tedlar® bag to not introduce potential vapors to the building interior. The sub-slab vapor ports will be sampled using a 1-liter

polished stainless-steel SUMMA® canister with a calibrated flow controller, calibrated for a maximum flow of 200 mL/min and batch cleaned and certified by the laboratory Eurofins Air Toxics, LLC. Sub-slab vapor samples from the sub-slab vapor ports will be analyzed utilizing USEPA method TO-15.

After sub-slab vapor samples are collected, a Landtec GEM™ 5000 Gas Analyzer or equivalent will be connected to the sub-slab port to screen sub-surface vapors for methane. If methane concentrations are detected greater than 5 percent by volume in the sub-slab vapor sample, the sample(s) will be shipped in an approved Department of Transportation secondary container via ground method. Meteorological data (temperature, precipitation, humidity, barometric pressure, and wind speed/direction) will be collected before and during sampling activities.

These sub-slab vapor ports will remain in place after the initial sampling for use in future sampling events. When the investigation is completed, the sub-slab vapor ports will be removed, the holes will be patched and returned to a similar surface (e.g., concrete or epoxy).

Leak Testing

Atmospheric dilution can occur in sub-slab vapor ports if drawn from the surface into the sub-slab port. To determine if atmospheric dilution is occurring, a leak test will be performed on each of the sub-slab sampling locations using the water dam method. Leak testing verifies the integrity of the sample collection system and demonstrates that representative samples are being collected.

Leak testing will be accomplished by connecting the sample tubing to the VAPOR PIN® and pouring enough distilled water into the sub-slab port annulus to immerse the base of the VAPOR PIN® and the tubing connection at the top of the VAPOR PIN®. Using a measuring tape to monitor the water level during purging, one to three volumes of air will be purged from the sub-slab port into a Tedlar bag. If water is lost to the sub-slab during purging, sampling will be stopped, the water will be removed from the annulus, and the Vapor Pin® will be repositioned to stop the leakage. The leak test will be performed again as described above. If water is not lost during the leak test, sample collection will be initiated.

A “leak down” test will also be performed to test the integrity of the valves and fittings for the sub-slab vapor port. After connecting the canister to the sample tubing, the canister will be opened and allowed to sit for one minute while the valve on the tubing is closed. The vacuum gauge will be monitored to determine if vacuum is lost.

3.3 Sampling Equipment Decontamination

Before collecting any samples for laboratory analyses, all reusable sampling equipment and tools or dedicated equipment will be thoroughly cleaned in accordance with the Arcadis TGIs attached in **Appendix A**.

4 Laboratory Analysis and Quality Assurance/Quality Control

Vapor samples will be analyzed for TCE and its breakdown compounds, cis-1,2-dichloroethene (cis-1,2 DCE), trans-1,2-dichloroethene (trans-1,2 DCE), and vinyl chloride (VC) using USEPA Method TO-15. All samples will be submitted to Eurofins Air Toxics, LLC located in Folsom, California, using proper QA/QC procedures and chain-of-custody protocols per Arcadis TGIs attached in **Appendix A**. Vapor analytical results will be reported in concentration units of micrograms per cubic meter. To minimize potential effects on the sample integrity, samples will be shipped within 48 hours following collection and the samples will not be chilled during storage. To improve

the confidence in measured concentrations, a duplicate indoor air sample will be collected and analyzed for the same parameters as the parent samples. The indoor air duplicate sample will be collected by connecting two canisters together with a tee, so they have the same intake port.

Eurofins Air Toxics, LLC will provide a full Level IV analytical data package for all analytical data. Analytical data packages will include an electronic data deliverable. Upon receipt of the laboratory analytical report and Level IV QA/QC package, the data reports will be validated, and a validation package will be generated.

5 Data Evaluation and Reporting

Per Table 2b of the WDNR Publication RR-800, the analytical results will be summarized in a letter and shared with the property owners and WDNR within 10 business days of receipt after each sampling event. Indoor air and sub-slab vapor data will be compared to the WDNR Vapor Action Levels and Vapor Risk Screening Levels for residential buildings in accordance with the Vapor Quick Look Up Table (RR-0136).

After the completion of the three sampling events, Arcadis will prepare one (1) letter report summarizing these results in the comprehensive Vapor Intrusion Investigation letter report being prepared for the Wauleco, Inc. investigation (Work Plan dated November 23, 2021). The letter report will be submitted to WDNR and include the following information:

- Documentation of activities completed
- Site figures
- Tabulated analytical results
- Analytical data reports

6 Schedule

The work is proposed to be completed during the Spring 2022, Summer 2022, and Winter 2022/2023 seasons, between May 2022 and March 2023. The final work schedule will be dependent on granted access to the proposed residential properties. 3M is prepared to proceed with the investigation as proposed in this Work Plan upon approval from the WDNR.

Figures

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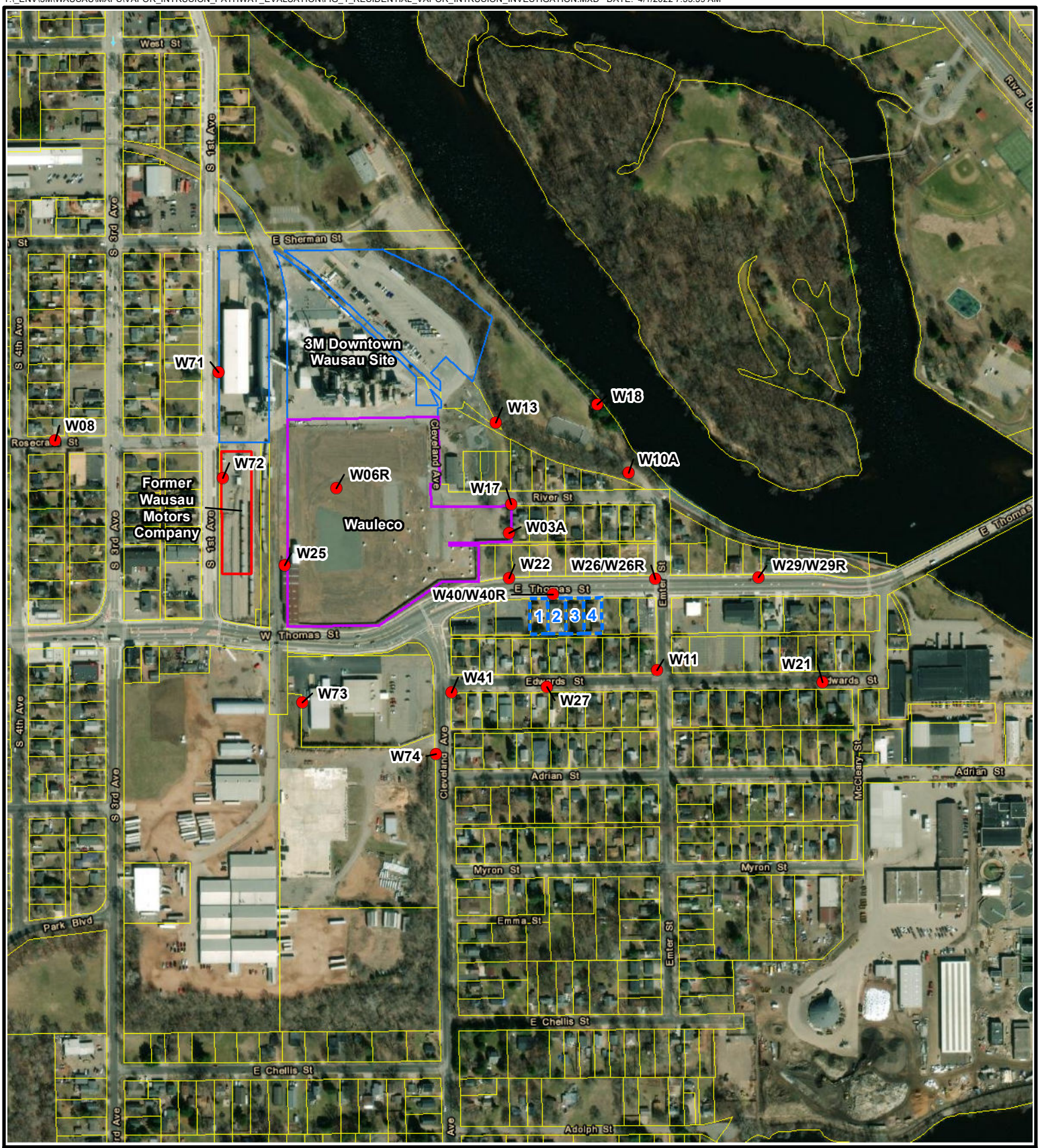

LEGEND:

- February 2022 Groundwater Sampling Monitoring Well Location
- Parcel Lines
- Wauleco, Inc. Parcel Boundary (BRRTS #02-37-000006)
- Area of the Cap for Former Wausau Motors Site (BRRTS # 02-37-000273)
- 3M Downtown Wausau Site Parcel Boundary
- Proposed Residential Properties for Paired Indoor Air/Sub-Slab Vapor Sampling

N

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SCALE IN FEET

3M COMPANY
WAUSAU, MARATHON COUNTY, WI

RESIDENTIAL VAPOR INTRUSION INVESTIGATION

ARCADIS

FIGURE 1

Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Appendix A

Vapor Intrusion Investigation Work Plan - TGIs

ARCADIS Design & Consultancy for natural and built assets

TGI - INDOOR OR AMBIENT AIR SAMPLING AND ANALYSIS VIA USEPA METHOD TO-15

Rev #: 1

Rev Date: August 19, 2016

SOP VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
1	8/19/2016	All	Updated Rev0	Mitch Wacksman

APPROVAL SIGNATURES

Prepared by: _____ Date: 8/19/2016

Margaret Bartee

Reviewed by: _____ Date: 8/19/2016

Mitch Wacksman

I. INTRODUCTION

This Technical Guidance Instruction (TGI) document describes the procedures to conduct a building survey prior to indoor air sampling.

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

II. SCOPE AND APPLICATION

This Technical Guidance Instruction (TGI) document describes the procedures to collect indoor air or ambient air samples in passivated stainless steel canisters (e.g., SUMMA®) for the analysis of volatile organic compounds (VOCs) using United States Environmental Protection Agency (USEPA) Method TO-15 (TO-15).

III. PERSONNEL QUALIFICATIONS

Arcadis field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, site-specific training, first aid, and cardiopulmonary resuscitation (CPR), as needed. Arcadis field sampling personnel will be competent in the relevant procedures and possess the required skills and experience necessary to successfully complete the

desired field work. Arcadis personnel responsible for directing indoor air and/or ambient air sample collection activities must have previous indoor air sampling experience and be able to complete the field work without direct supervision.

IV. EQUIPMENT LIST

The equipment required for indoor air sample collection is presented below:

- 6-liter, stainless steel passivated canisters (e.g., SUMMA®). Request one canister for each sampling location, plus duplicate canisters per project-specific requirements. If feasible, order extra canisters at a rate of 10 to 20% of the total number of sampling canisters (including duplicates).
- Flow controllers with in-line particulate filters and vacuum gauges. Flow controllers are pre-calibrated by the laboratory to the sampling duration [e.g., 8 hours] specified by the project team). Vacuum gauges are also generally supplied by the laboratory.
- Open-end wrench. Typical canister caps require 9/16-inch wrenches.
- Chain-of-custody (COC) form.
- Sample collection log (attached).
- Box, chair, tripod, or similar to hold canister above the ground surface at approximate breathing height (3-5 feet).
- Camera (optional, if photography is permitted at sampling locations).
- Hand-held weather meter (optional)

For abnormal situations (i.e., sumps, crawlspaces with no access, where canisters must be hidden, etc.), Teflon tubing may be used to collect an air sample. In these situations, ¼-inch Swagelok fittings (including nut, front sleeve, and back sleeve) or other methods may be appropriate to affix tubing to canister.

V. CAUTIONS

Care must be taken to minimize the potential for introducing interferences during the sampling event. As such, keep canisters away from heavy pedestrian traffic areas (e.g., main entranceways, walkways), if possible. Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens (sharpies), wear/apply fragrances, or smoke cigarettes before and/or during the sampling event.

Specify sample collection duration with the laboratory when ordering equipment, and confirm with the laboratory upon equipment receipt. Sample integrity can be compromised if sample collection is extended to the point that the canister reaches atmospheric pressure. Sample integrity is maintained if sample collection is terminated prior to the target sample duration and a measurable vacuum (e.g., 5 inches Hg) remains in the canister when sample collection is terminated.

VI. HEALTH AND SAFETY CONSIDERATIONS

All sampling personnel should review the appropriate health and safety plan (HASP) and job safety analysis (JSA) prior to beginning work to be aware of all potential hazards associated with the job site and the specific task.

VII. PROCEDURE

Preparation of Passivated Canister and Collection of Sample

1. Record the following information on the sampling form (use a hand-held weather meter, contact the local airport or other suitable information source [e.g., weatherunderground.com] to obtain the following information):
    - ambient temperature
    - barometric pressure
    - wind speed
    - relative humidity
    - significant recent precipitation
    - snow/ice cover
2. For indoor air sampling, note whether the heating, ventilation, and air conditioning (HVAC) system is operational and record settings.
3. Choose the sampling location in accordance with the project sampling plan. If a breathing zone sample is required, place the canister on a box, chair, tripod, or other similar stand to locate the canister orifice 3 to 5 feet above the ground or floor surface. The canister may be affixed to wall/ceiling support with nylon rope or placed on a stable surface. In general, areas near windows, doors, air supply vents, and/or other potential sources of “drafts” shall be avoided.
4. Record canister serial number and flow controller number on the sampling log and COC form. Assign sample identification (ID), and record on canister ID tag, sample collection log (Attachment A), and COC form.
5. Remove the brass dust cap from the canister with the wrench. Attach the flow controller and vacuum gauge to the canister with the wrench. Tighten with fingers first, then gently with the wrench (roughly a quarter turn). Use caution not to over tighten fittings.
6. Open the canister valve to initiate sample collection. Record the date and local time (24-hour basis) of valve opening on the sample collection log and COC form. Collection of duplicate samples will include collecting two samples side by side at the same time.
7. Check the initial canister pressure using the vacuum gauge. Record the initial pressure in the canister on the sample log and COC form. The initial pressure reading should be evaluated with respect to project-specific and jurisdictional requirements. If the initial pressure registers less

than -25 inches of Hg, then the canister is not appropriate for use, and another canister should be used.

8. Photograph the canister and surrounding area, if photography is permitted at sampling locations.
9. If feasible, check the canister approximately half-way through the sample duration and note progress on sample logs.

Termination of Sample Collection

1. Arrive at the sampling location at least 1 to 2 hours prior to the end of the sampling interval (e.g., 6 hours following sample initiation for an 8-hour sampling duration).
2. Stop collecting the sample by turning the valve on the canister when the canister pressure reaches approximately -5 inches of Hg or when the desired sample time has elapsed, whichever comes first. Leaving some vacuum in the canister provides a way to evaluate whether the canister leaks before it reaches the laboratory.
3. Record the final canister pressure. Record the date and local time (24-hour basis) of valve closing on the sample collection log and COC form.
4. Remove the flow controller from the canister, re-install brass cap on canister fitting, and tighten with the wrench.
5. Package the canister and flow controller in accordance with Department of Transportation regulations available on the Transportation Health and Safety's Team Site on the Source for return shipment to the laboratory. The canister does not require preservation with ice or refrigeration during shipment.
6. Complete the forms and sample labels provided by the laboratory as directed (e.g., affix card with string).
7. Complete COC form; copy, photograph, or scan a version for the project file (if possible); and place the form in the shipping container. Close the shipping container and affix the custody seal to the container closure. Transmit canisters via courier delivery service (e.g., Federal Express or UPS) to laboratory for analysis.

VIII. WASTE MANAGEMENT

No specific waste management procedures are required.

IX. DATA RECORDING AND MANAGEMENT

Notes will be recorded on the sampling log form (attached), with notations of project name, sample date, sample time, and sample location (e.g., description and GPS coordinates if available) sample start and finish times, canister serial number, flow controller number, initial vacuum reading, and final vacuum reading. Sampling logs and COC records will be transmitted to the Task Manager or Project Manager and stored in the project file consistent with client and project requirements.

X. QUALITY ASSURANCE

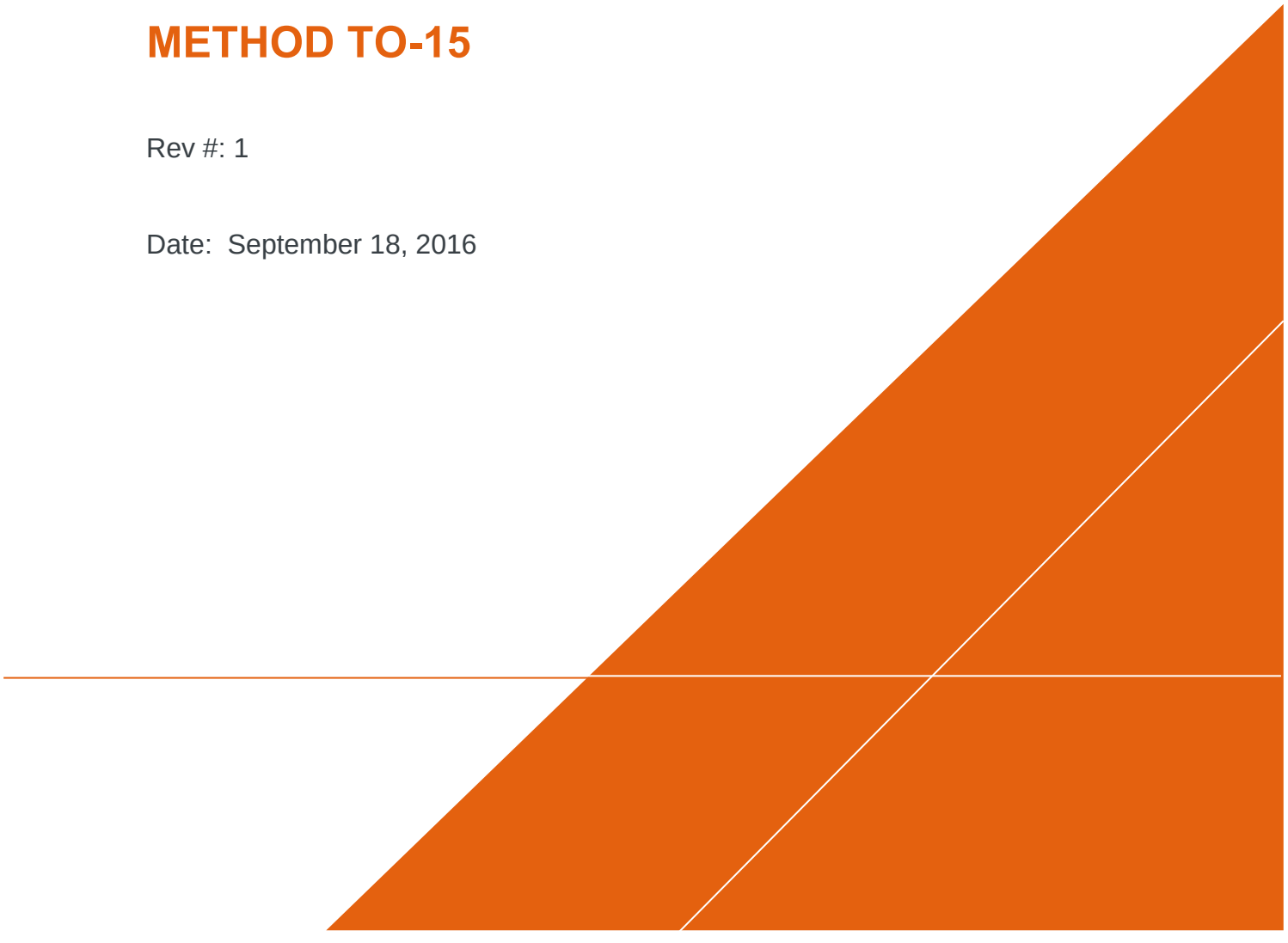
Conduct quality assurance as required by the project-specific work plan and/or Quality Assurance Project Plan (QAPP).

ARCADIS Design & Consultancy for natural and built assets

TGI - SUB-SLAB SOIL VAPOR OR SOIL VAPOR SAMPLING USING WHOLE AIR CANISTERS ANALYZED VIA USEPA METHOD TO-15

Rev #: 1

Date: September 18, 2016



SOP VERSION CONTROL

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1	9/18/2016	All	Updated Rev0	Mitch Wacksman

APPROVAL SIGNATURES

Prepared by:  Date: 9/18/2016

Eric Cathcart

Reviewed by:  Date: 9/18/2016

Mitch Wacksman (Technical Expert)

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II. SCOPE AND APPLICATION

This document describes the procedures for collecting exterior soil vapor or sub-slab soil vapor (herein referred to as "soil vapor") samples using whole air canisters for the analysis of volatile organic compounds (VOCs) by United States Environmental Protection Agency (USEPA) Method TO-15 (TO-15). This document assumes a sample port – either sub-slab or exterior soil vapor – has already been installed. This document covers the above ground assembly and sampling methods.

Method TO-15 uses a 1-liter 3-liter or 6-liter SUMMA® passivated stainless steel canister to collect a whole-air sample. The whole-air sample is then analyzed for VOCs using a quadrupole or ion-trap gas chromatograph/mass spectrometer (GS/MS) system to provide typical compound detection limits of 0.5 parts per billion volume (ppbv).

The following sections list the necessary equipment and detailed instructions for collecting soil vapor samples for VOC analysis.

III. PERSONNEL QUALIFICATIONS

Arcadis field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, site-specific training, first-aid, and cardiopulmonary resuscitation (CPR), as needed. Arcadis field sampling personnel will be well versed in the relevant technical guidance instructions (TGIs) and possess the required skills and experience necessary to successfully complete the desired field work. Arcadis personnel responsible for leading soil vapor sample collection activities must have previous soil vapor sampling experience.

IV. EQUIPMENT LIST

The equipment required for soil vapor sample collection is presented below:

- 1,3, or 6 – liter stainless steel SUMMA® canisters (order at least one extra, if feasible) (batch certified canisters or individual certified canisters as required by the project);
- Flow controllers with in-line particulate filters and vacuum gauges; flow controllers are pre-calibrated to specified sample duration (e.g.,5-, 10, or 30- minutes) or flow rate (e.g., < 200 milliliters per minute [mL/min]); confirm with the laboratory that the flow controller comes with an in-line particulate filter and pressure gauge (order at least one extra, if feasible);
- 1/4-inch OD tubing (Teflon®, or similar);
- Extra 1/4-inch Swagelok front and back compression sleeves
- Decontaminated stainless steel Swagelok or comparable “T” fitting and ball or needle valve for isolation of purge leg of sample train;
- Stainless steel duplicate “T” fitting provided by the laboratory (if collecting duplicate [i.e., split] samples);
- 60-mL syringe equipped with a three-way leur lock valve;
- Appropriate equipment and materials for quality assurance testing as laid out in the respective quality assurance TGIs (i.e., helium leak testing, water dam testing, methane testing);
- Appropriate-sized open-end wrench (typically 9/16-inch and ½”);
- Tedlar® bag to collect purge air for venting outside a structure if working inside;
- Portable weather meter, if appropriate;

- Chain-of-custody (COC) form;
- Sample collection log (attached);
- Nitrile gloves;
- Work gloves; and
- Field notebook

V. CAUTIONS

The following cautions and field tips should be reviewed and considered prior to installing or collecting a soil vapor sample.

- Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens (sharpies), wear/apply fragrances, or smoke cigarettes/cigars before and/or during the sampling event.
- Ensure that the flow controller is pre-calibrated to the proper sample collection duration (confirm with laboratory). Sample integrity can be compromised if sample collection is extended to the point that the canister reaches atmospheric pressure. Sample integrity is maintained if sample collection is terminated prior to the target duration and a measurable vacuum (e.g., 3 -7 – inches Hg) remains in the canister when sample collection is terminated.
- The integrity of the sample train will be tested in accordance with the project specific requirements. These procedures are contained in their own TGI documents and include helium leak testing, water dam testing, and methane screening.
- It is important to record the canister pressure, start and stop times, and sample identification on a proper field sampling form. You should observe and record the time/pressure at the start, and then again one or two hours after starting the sample collection. It is a good practice to lightly tap the pressure gauge with your finger before reading it to make sure it is not stuck. If the canister is running correctly for a 24-hour period, the vacuum will have decreased slightly after one or two hours (for example from 29 inches to 27 inches). Consult your project manager, risk assessor or air sampling expert by phone if the SUMMA canister does not appear to be working properly.
- Ensure that there is still measurable vacuum in the SUMMA® after sampling. Sometimes the gauges sent from labs have offset errors, or they stick.
- When sampling carefully consider elevation. If your site is over 2,000’ above sea level or the difference in elevation between your site and your lab is more than 2,000’ then pressure effects will be significant. If you take your samples at a high elevation they will contain less air for a given ending pressure reading. High elevation samples analyzed at low elevation

will result in more dilution at the lab, which could affect reporting limits. Conversely low elevation samples when received at high elevation may appear to not have much vacuum left in them. http://www.uigi.com/Atmos_pressure.html.

- If possible, have equipment shipped a two to three days before the scheduled start of the sampling event so that all materials can be checked. Order replacements if needed.

- Requesting extra canisters and flow controllers from the laboratory should also be considered to ensure that you have enough equipment on site in case of an equipment failure.

- Check the seal around the soil vapor sampling port by using a tracer gas (e.g., helium) or other method established in the appropriate guidance document. See TGI library and project specific instructions for appropriate TGIs.

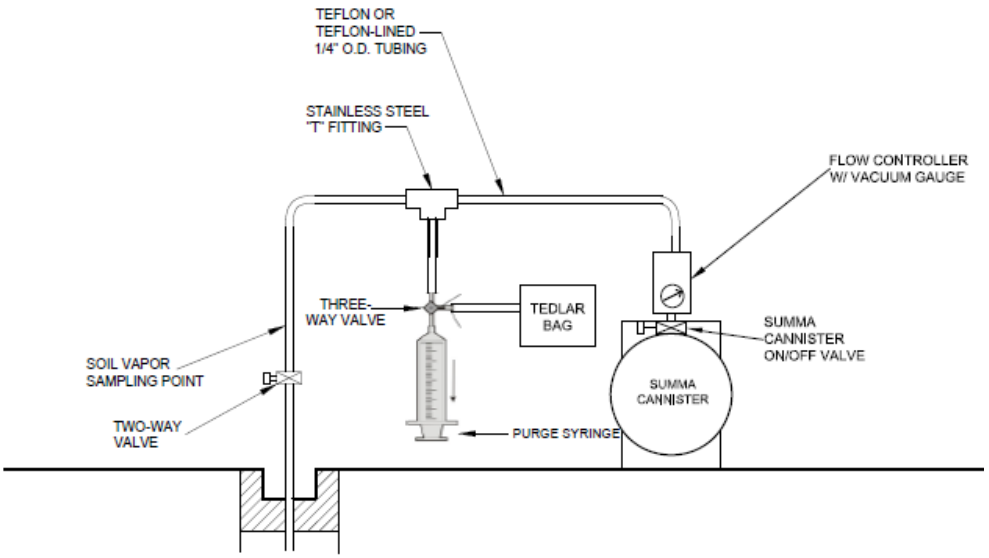
VI. HEALTH AND SAFETY CONSIDERATIONS

All sampling personnel should review the appropriate health and safety plan (HASP) and job safety analysis (JSA) prior to beginning work to be aware of all potential hazards associated with the job site and the specific task. Field sampling must be carefully performed to minimize the potential for injury and the spread of hazardous substances.

VII. SOIL VAPOR SAMPLE COLLECTION

Sample Train Assembly

The following procedures should be used to collect a soil vapor sample using a whole air canister (i.e., SUMMA canister). These methods can be used for both exterior soil vapor samples and interior sub-slab soil vapor samples collected from both permanent or temporary sample points installations. A schematic of the suggested sample train set up is included below



1. Assemble the sample train by removing the cap from the SUMMA canister and connecting the flow controller with in-line particulate filter and vacuum gauge. The flow controller attaches directly to the canister and dictates the sample duration. This piece will come preset from the laboratory.

2. Attach the canister and flow controller assembly to a stainless steel T-fitting using a short length of 1/4-inch OD Teflon tubing. This T-fitting adds a leg to the sample train that will be used to purge “dead” air from the sample train in order to collect a more representative sample.

3. Connect the purge syringe with three-way valve to one of the free ends of the T-fitting using a length of Teflon sample tubing, Swagelok compression fittings and silicon tubing.

4. Attach the Swagelok two-way valve to the remaining free end of the T-fitting using a short length of ¼-inch OD Teflon tubing. The two-way valve will be immediately adjacent to the sample point in the train assembly. This valve is used to isolate the sample train from the sample point prior to sampling in order to test the sample train’s integrity.

5. When collecting duplicate or other quality assurance/quality control (QA/QC) samples as required by applicable regulations and guidance, couple two SUMMA canisters using stainless steel Swagelok duplicate sample T-fitting supplied by the laboratory. Attach flow controller with in-line particulate filter and vacuum gauge to duplicate sample T-fitting provided by the laboratory.

6. Attach the terminal end of the two-way Swagelok valve to the sample port as appropriate. This may be done using the options below:

a. Use a section of silicon tube to connect the Teflon sample tubing to the barbed fitting of a Vapor Pin™ port.

b. Use Swagelok compression fittings to connect Teflon tubing to sampling port. Teflon tape should never be used on Swagelok compression fitting connections.

c. Wrap the Teflon tubing with Teflon tape to seal around the slab then use VOC free clay to further seal around the slab if using temporary points.

Sample Documentation

1. Record on the sample log and COC form the flow controller number with the appropriate SUMMA® canister number.

2. Record the following information on the sample log, if appropriate (contact the local airport or other suitable information source [e.g., site-specific measurements, weatherunderground.com] to obtain the information):

   a. wind speed and direction;

   b. ambient temperature;

   c. barometric pressure; and

   d. relative humidity.

3. Take a photograph of the SUMMA® canister and surrounding area.

Sample Collection

1. Perform a leak-down-test by closing the two-way valve to the sample port. Open the three-way valve to the syringe and pull a vacuum. Quickly close the three-way valve and record the pressure indicated on the gauge connected to the canister. If there are no leaks in the system this vacuum should be held. If vacuum holds proceed with sample collection; if not attempt to rectify the situation by tightening fittings.

2. Open the two-way valve and purge the soil vapor sampling port and tubing with the portable sampling pump. Purge approximately three volumes of air from the soil vapor sampling port and sampling line using a flow rate of 200 mL/min. Purge volume is calculated by the following equation “purge volume = 3 x Pi x inner radius of tubing^2 x length of tubing. Purge air will be collected into a Tedlar bag to provide that VOCs are not released into interior spaces. Perform quality control method tests concurrently, as appropriate

3. Close the three-way valve to the syringe in order to isolate this leg of the sample train.

4. Open the SUMMA® canister valve to initiate sample collection. Record on the sample log (attached) the time sampling began and the canister pressure.

   If the initial vacuum pressure registers less than -25 inches of Hg, then the SUMMA® canister is not appropriate for use and another canister should be used.

5. Check the SUMMA canister approximately half way through the sample duration and note progress on sample logs.

Termination of Sample Collection

1. Arrive at the SUMMA® canister prior to the end of sample collection.

2. Record the final vacuum pressure. Stop collecting the sample by closing the SUMMA® canister valves. The canister should have a minimum amount of vacuum (approximately 5 inches of Hg or slightly greater).

3. Record the date and local time (24-hour basis) of valve closing on the sample collection log and COC form.

4. Disconnect sample tubing from the sample port; replace any coverings or abandon as appropriate to mitigate tripping hazards.

5. Remove the particulate filter and flow controller from the SUMMA® canister, re-install the brass plug on the canister fitting, and tighten with the appropriate wrench.

6. Package the canister and flow controller per Department of Transportation regulations for return shipment to the laboratory. These regulations can be found at the Transportation Safety Program's Team Site on the Source. The SUMMA® canister does not require preservation with ice or refrigeration during shipment.

7. Complete the appropriate forms and sample labels as directed by the laboratory (e.g., affix card with a string).

8. Complete the COC form and place the requisite copies in a shipping container. Close the shipping container and affix a custody seal to the container closure. Ship the container to the laboratory via overnight carrier (e.g., Federal Express) for analysis.

VIII. WASTE MANAGEMENT

No specific waste management procedures are required.

IX. DATA RECORDING AND MANAGEMENT

Measurements will be recorded on the sample log at the time of measurement with notations of the project name, sample date, sample start and finish time, sample location (e.g., GPS

coordinates, distance from permanent structure [e.g., two walls, corner of room]), canister serial number, flow controller serial number, initial vacuum reading, and final pressure reading. Field sampling logs and COC records will be transmitted to the Project Manager.

X. QUALITY ASSURANCE

Duplicate samples should be collected in the field as a quality assurance step per project requirements. Generally, duplicates are taken from 10% of samples, but project specific requirements should take precedence.

XI. REFERENCES

DiGiulio et. al. 2003. Draft Standard Operating Procedure (SOP) for Installation of Sub-Slab Vapor Probes and Sampling Using EPA TO-15 to Support Vapor Intrusion Investigations. http://www.cdphe.state.co.us/hm/indoorair.pdf (Attachment C)

Di Giulio et. Al. 2006. Assessment of Vapor intrusion in Homes Near the Raymark Superfund Site Using Basement and Sub-Slab Air Samples. USEPA. EPA/600/R-05/147.

New York State Department of Health (NYSDOH). 2005. DRAFT “Guidance for Evaluating Soil Vapor Intrusion in the State of New York” February 23, 2005.

ARCADIS Design & Consultancy for natural and built assets

TGI - BUILDING SURVEYING PRIOR TO VAPOR INTRUSION INDOOR AIR SAMPLING

Rev. #: 1

Rev Date: August 16, 2016

SOP VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
1	8/19/2016	All	Update Rev 0	Margaret Bartee Mitch Wacksman

APPROVAL SIGNATURES

Prepared by: _____ Date: 8/19/2016

Margaret Bartee

Reviewed by: _____ Date: 8/19/2016

Mitch Wacksman

I. SCOPE AND APPLICATION

This Technical Guidance Instruction (TGI) document describes the procedures to conduct a building survey prior to indoor air sampling.

II. PERSONNEL QUALIFICATIONS

Arcadis field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, site-specific training, first aid, and cardiopulmonary resuscitation (CPR), as needed. Arcadis field sampling personnel will be competent in the relevant procedures and possess the required skills and experience necessary to successfully complete the desired field work. Arcadis personnel responsible for directing indoor air and/or ambient air sample collection activities must have previous indoor air sampling experience and be able to complete the field work without direct supervision.

III. EQUIPMENT LIST

The equipment required for conducting a building survey is presented below:

- Building survey form specific to jurisdiction, or using one of the attached forms. If the building survey form does not include sufficient space for documenting the chemical product inventory, bring additional pages (attached) to complete the chemical product inventory.
- Photoionization detector (PID) capable of readings in the parts per billion by volume (ppbv) range (e.g., ppbRae)
- Nitrile gloves

IV. HEALTH AND SAFETY CONSIDERATIONS

All survey personnel should review the appropriate health and safety plan (HASP) and job safety analysis (JSA) prior to beginning work to be aware of all potential hazards associated with the job site and the specific task.

V. PROCEDURE

Using the appropriate building survey form, document site information; building construction, usage, and layout; and chemical products present in the building prior to conducting indoor air sampling. The building survey form should be jurisdiction-specific, or use one of the generic Arcadis forms for either a commercial or residential building included in Attachment A.

- Complete the portions of the form provide site and property information. This information may be completed in advance of the building survey.
- If property contact is available, review building construction, layout, usage, and occupancy information with property contact. If no property contact is available, complete these portions of the form based on observations during the building survey.
- Document observed products or materials that may potentially produce or emit volatile organic compounds (VOCs) on the building survey form, or if sufficient space is unavailable, on separate pages. Record brand name, product name, and product identification number; take a reading with the PID to

evaluate potential off-gassing; and take a photograph of each product or material documented. Use nitrile gloves, as needed, to handle chemical products. If the building is owned and/or occupied by a commercial/industrial occupant, ask the property contact whether a copy of the chemical product inventory could be provided for confirmatory purposes.

- Items or materials that contain contaminants of concern and/or exhibit elevated PID readings shall be considered probable sources of VOCs. Request approval of the owner or occupant to have these items removed to a structure not attached to the target structure at least 48 hours prior to sampling, if possible.
- Note the buildings current condition, particularly the floor slab. Pay attention for any penetrations or perforations in the floor that could act as preferential pathways. These include floor cracks, floor drains, utility penetrations, and sumps.
- Set a date and time with the owner or occupant to return to conduct sampling.

VI. WASTE MANAGEMENT

No specific waste management procedures are required.

VII. DATA RECORDING AND MANAGEMENT

Notes taken during the initial building survey will be recorded on the building survey form. A copy of the building survey form will be transmitted to the Task Manager or Project Manager.

VIII. QUALITY ASSURANCE

Conduct quality assurance as required by the project-specific work plan and/or Quality Assurance Project Plan (QAPP).

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ATTACHMENT A

Generic Building Surveys

Building Survey and Product Inventory Form

Directions: This form must be completed for each building or area planned to be evaluated for the study.

Preparer's Name:_____

Date/Time Prepared: _____

Preparer's Affiliation:_____

Phone No.: _____

Purpose of Investigation: _____

1. OCCUPANT:

Interviewed: Y / N

Last Name:_____ First Name: _____

Address: _____

County: _____

Home Phone:_____Office Phone: _____

Number of Occupants/Persons at this Location:_____

Age of Occupants:_____

2. OWNER OR LANDLORD: (Check if Same as Occupant _)

Interviewed: Y / N

Last Name:_____ First Name: _____

Address: _____

County: _____

Home Phone:_____ Office Phone:_____

3. BUILDING CHARACTERISTICS:

Type of Building: (circle appropriate response)

Residential	School	Commercial/Multi-use
Industrial	Church	Other:_____

If the Property is Residential, Type? (circle appropriate response)

Ranch		2-Family 3-Family
Raised Ranch	Split Level	Colonial
Cape Cod	Contemporary	Mobile Home
Duplex	Apartment House	Townhouses/Condos
Modular	Log Home	Other:_____

If Multiple Units, How Many? _____

If the Property is Commercial, Type?

Business Type(s) _____

Does it include residences (i.e., multi-use)? Y / N If yes, how many? _____

Other Characteristics:

Number of Floors_____ Building Age_____

Is the Building Insulated? Y / N How Air-Tight? Tight / Average / Not Tight

4. AIRFLOW:

Use air current tubes or tracer smoke to evaluate airflow patterns and qualitatively describe:

Airflow Between Floors

_____

_____

_____

Airflow Near Source

Outdoor Air Infiltration

Infiltration Into Air Ducts

5. BASEMENT AND CONSTRUCTION CHARACTERISTICS: (circle all that apply)

a.	**Above grade construction:**	wood frame	concrete	stone brick	
b.	**Basement type:**	full	crawlspace	slab	other _____
c.	**Basement floor:**	concrete	dirt	stone	other _____
d.	**Basement floor:**	uncovered	covered	covered with _____	
e.	**Concrete floor:**	unsealed	sealed	sealed with _____	
f.	**Foundation walls:**	poured	block stone	other _____	
g.	**Foundation walls:**	unsealed	sealed	sealed with _____	
h.	**The basement is:**	wet	damp	dry	moldy
i.	**The basement is:**	finished	unfinished	partially finished	
j.	**Sump present?**	Y / N			
k.	**Water in sump?**	Y / N / NA			

Basement/lowest level depth below grade: _____ (feet)

Identify potential soil vapor entry points and approximate size (e.g., cracks, utility ports, drains)

_____

Are the basement walls or floor sealed with waterproof paint or epoxy coatings? Y / N

6. HEATING, VENTILATING, AND AIR CONDITIONING: (circle all that apply)

Type of heating system(s) used in this building: (circle all that apply – note primary)

Hot air circulation	Heat pump	Hot water baseboard
Space heaters	Stream radiation	Radiant floor
Electric baseboard	Wood stove	Outdoor wood boiler
Other _____		

The primary type of fuel used is:

Natural gas	Fuel oil	Kerosene
Electric	Propane	Solar
Wood coal		

Domestic hot water tank fueled by: _____

Boiler/furnace located in: Basement Outdoors Main Floor Other_____

Air conditioning: Central Air Window Units Open Windows None

Are there air distribution ducts present? Y / N

Describe the supply and cold air return ductwork, and its condition where visible, including whether there is a cold air return and the tightness of duct joints. Indicate the locations on the floor plan diagram.

_____

_____

_____

7. OCCUPANCY:

Is basement/lowest level occupied? Full-time Occasionally Seldom Almost Never

General Use of Each Floor (e.g., family room, bedroom, laundry, workshop, storage):

Basement_____

1st Floor _____

2nd Floor _____

3rd Floor_____

4th Floor _____

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY:

a. Is there an attached garage? Y / N

b. Does the garage have a separate heating unit? Y / N / NA

c. Are petroleum-powered machines or vehicles stored in the garage (e.g., lawnmower, ATV, car)?

Y / N / NA Please specify: _____

d. Has the building ever had a fire? Y / N When?_____

e. Is a kerosene or unvented gas space heater present? Y / N Where? _____

f. Is there a workshop or hobby/craft area? Y / N Where & Type? _____

g. Is there smoking in the building? Y / N How frequently? _____

h. Have cleaning products been used recently? Y / N When & Type? _____

i. Have cosmetic products been used recently? Y / N When & Type? _____

j. Has painting/staining been done in the last 6 months? Y / N Where & When? _____

k. **Is there new carpet, drapes or other textiles? Y / N Where & When?** _____

l. Have air fresheners been used recently? Y / N When & Type?_____

m. Is there a kitchen exhaust fan? Y / N If yes, where _____

n. Is there a bathroom exhaust fan? Y / N If yes, where vented?_____

o. Is there a clothes dryer? Y / N If yes, is it vented outside? Y / N

p. Has there been a pesticide application? Y / N When & Type?_____

q. Are there odors in the building? Y / N

If yes, please describe: _____

Do any of the building occupants use solvents (e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide application, cosmetologist) at work? Y / N

If yes, what types of solvents are used?_____

If yes, are their clothes washed at work? Y / N

Do any of the building occupants regularly use or work at a dry-cleaning service? (circle appropriate response)

Yes, use dry-cleaning regularly (weekly) No

Yes, use dry-cleaning infrequently (monthly or less) Unknown

Yes, work at a dry-cleaning service

Is there a radon mitigation system for the building/structure? Y / N

Date of Installation: _____

Is the system active or passive? Active/Passive

Are there any Outside Contaminant Sources? (circle appropriate responses)

Contaminated site with 1000-foot radius? Y / N Specify _____

Other stationary sources nearby (e.g., gas stations, emission stacks, etc.): _____

_____

Heavy vehicle traffic nearby (or other mobile sources): _____

9. WATER AND SEWAGE:

Water Supply: Public Water Drilled Well Driven Well Dug Well Other: _____

Sewage Disposal: Public Sewer Septic Tank Leach Field Dry Well Other: _____

10. RELOCATION INFORMATION: (for oil spill residential emergency)

a. Provide reasons why relocation is recommended: _____

_____

b. Residents choose to: remain in home relocate to friends/family relocate to hotel/motel

c. Responsibility for costs associated with reimbursement explained? Y / N

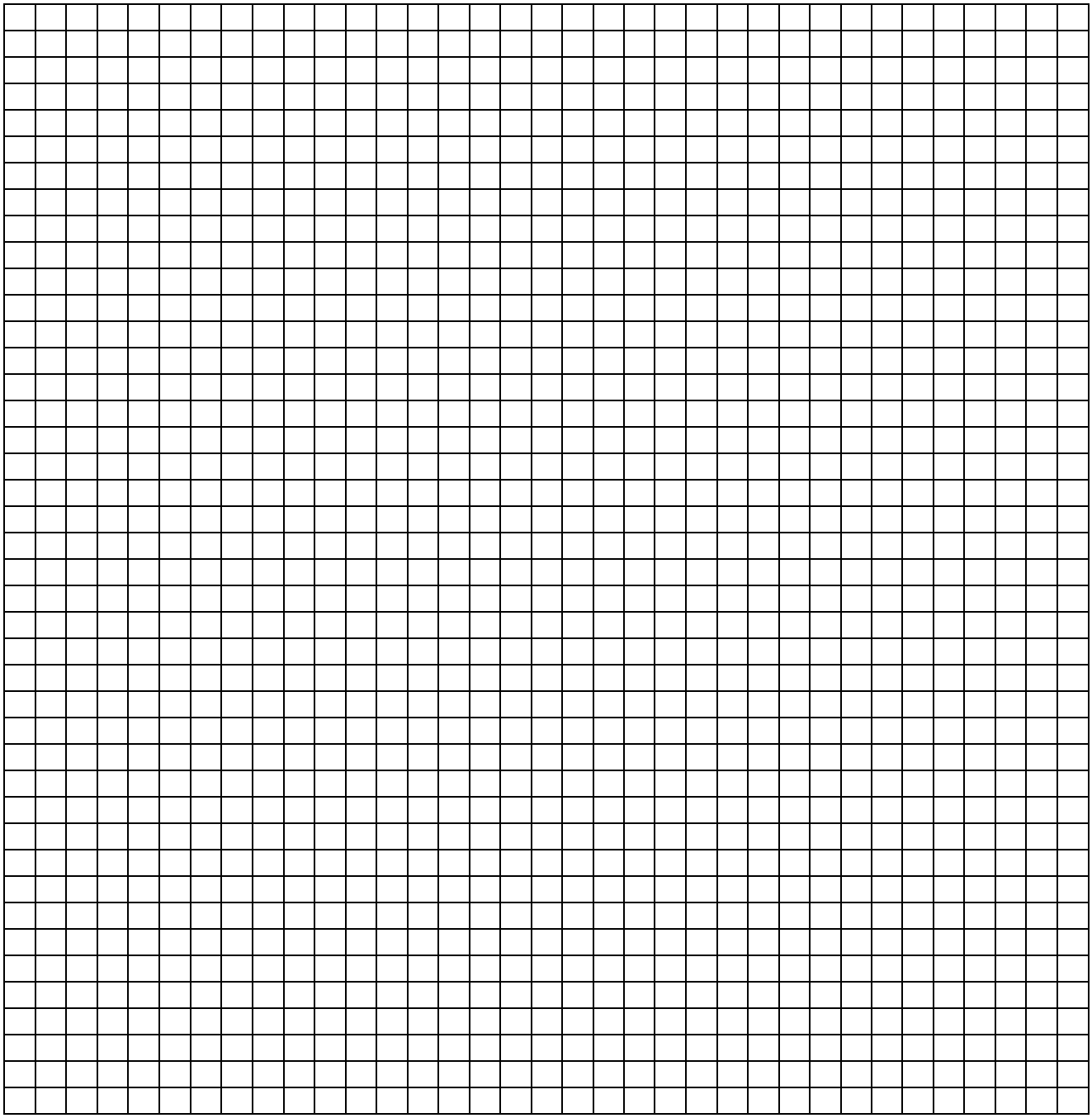
d. Relocation package provided and explained to residents? Y / N

11. FLOOR PLANS:

Draw a plan view sketch of the basement and first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

Basement:

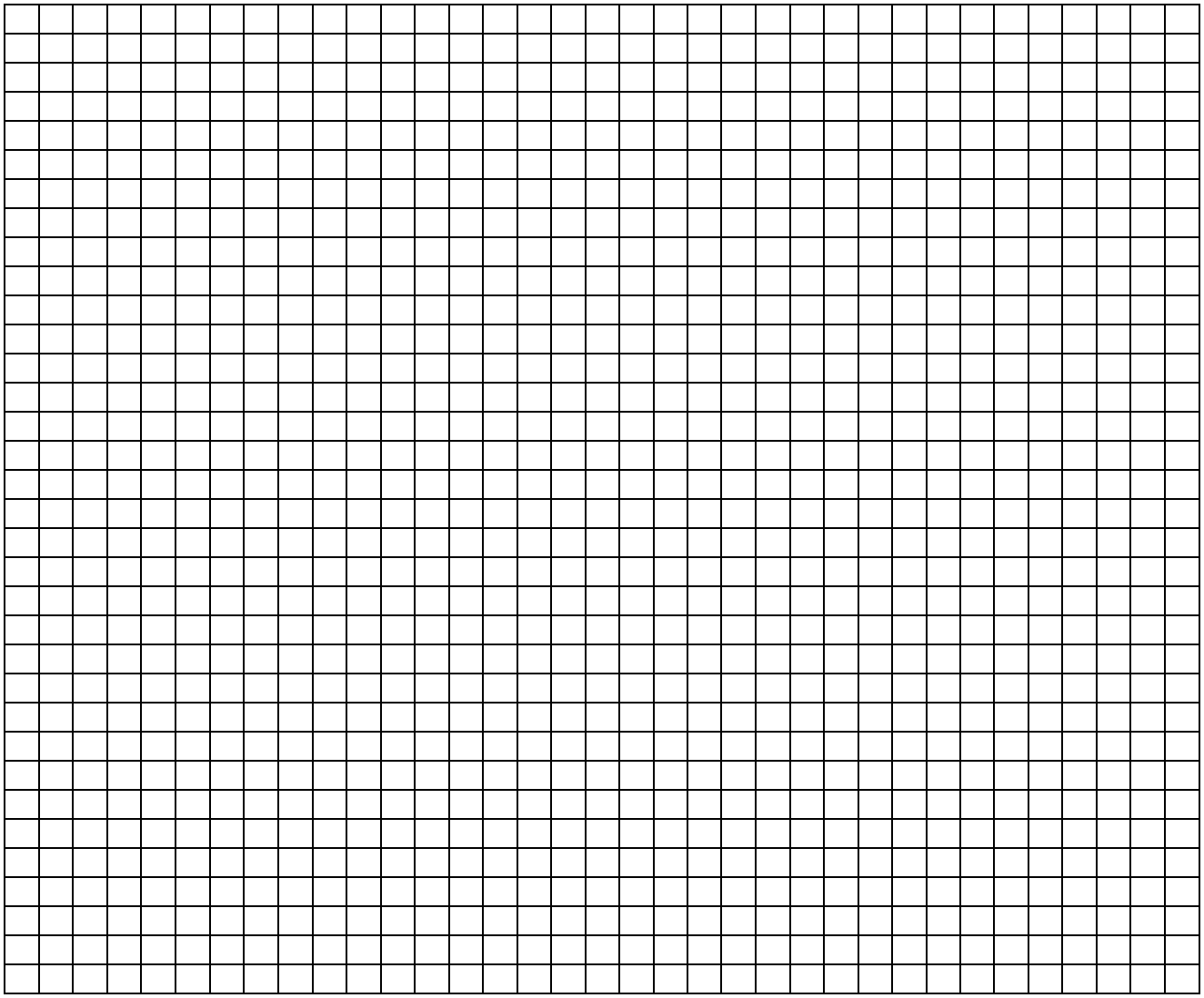
First Floor:



12. OUTDOOR PLOT:

Draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc.), outdoor air sampling location(s), and PID meter readings.

Also indicate compass direction, wind direction and speed during sampling, the locations of the well and septic system, if applicable, and a qualifying statement to help locate the site on a topographic map.



13. PRODUCT INVENTORY FORM:

Make and Model of field instrument used:_____

List specific products found in the residence or area that have the potential to affect indoor air quality (e.g., gasoline or kerosene storage cans, glues, paints, cleaning solvents/products, polishes/waxes, new furniture/ carpet, nail polish/hairspray/cologne).

Location	Product Description	Size (units)	Condition*	Chemical Ingredients	Field Instrument Reading (units)	Photo** Y/N

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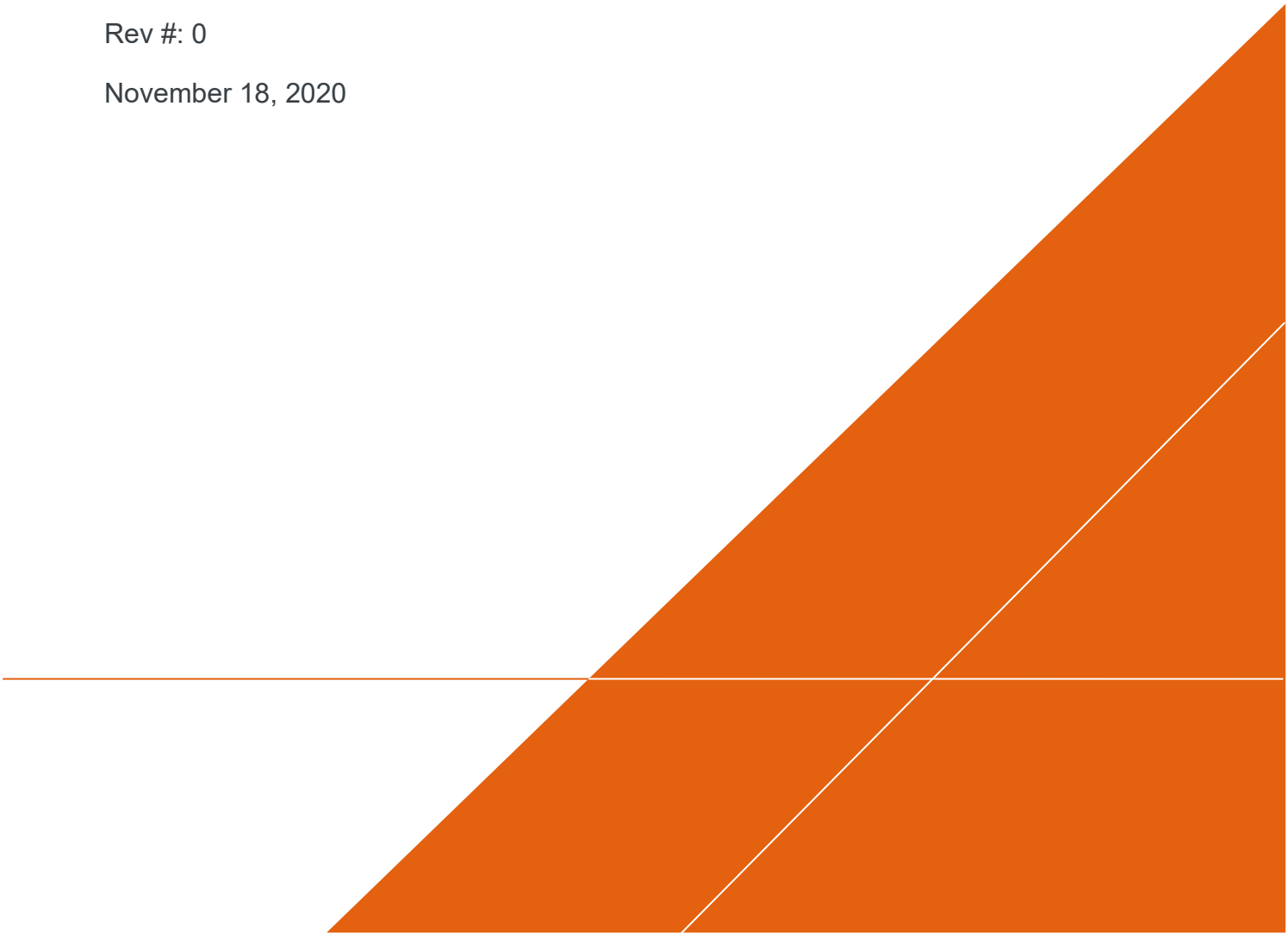
TGI – DECONTAMINATION OF COMPONENTS FOR VAPOR INTRUSION SAMPLING

Rev #: 0

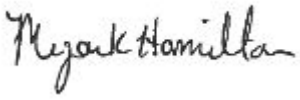
November 18, 2020



VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	11/13/2020	All	Development of TGI	Megan Hamilton

Approval Signatures

Prepared by:		11/13/2020
	Sarah Jonker	Date:
Technical Expert Reviewed by:		11/18/2020
	Megan Hamilton	Date:

1 Introduction

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 Scope and Application

This Technical Guidance Instruction (TGI) document describes the procedures to decontaminate components used during the installation and sampling of soil vapor monitoring locations (sub-slab and exterior soil gas probes).

3 Personnel Qualifications

Arcadis field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site-specific training, first aid, and cardiopulmonary resuscitation (CPR), as needed. Arcadis field sampling personnel will be competent in the relevant procedures and possess the required skills and experience necessary to successfully complete the desired decontamination procedures and field work.

4 Equipment List

Precautions regarding cross-contamination should be strongly considered. Laboratory reporting limits for soil vapor samples are in the parts-per billion (ppb) and equipment contamination could affect overall data quality. Only confirmed clean or new equipment should be used for decontamination.

Specific components required for decontamination may vary depending on project scope of work and objectives for the site. Relevant components to decontaminate are listed below.

Sampling Components	Installation Components
Stainless-steel valves, nuts, caps, ferrules	Hammer drill bits
Stainless-steel Vapor Pins including extensions	Hand auger
Stainless-steel vapor screens (exterior soil gas)	Drill rig tooling

Reusable drill rig tooling and equipment decontamination procedures are provided in other associated TGIs. Arcadis recommends following approved procedures for the decontamination of drilling subcontractor equipment.

The equipment required to complete decontamination of the above components is listed below:

- Stainless-Steel Bowl or Bucket for Drill Bits
- Personal Protective Equipment including Nitrile Gloves and Safety Glasses
- Paper Towels
- Brushes – bottle brush or toothbrush, wire brush
- Distilled Water
- Trisodium Phosphate (TSP), Alconox, Liquinox or equivalent (TSP preferred)

Sampling components should be decontaminated prior to mobilization to the site.

5 Cautions and Health and Safety Considerations

Take safety precautions as with handling any heavy-duty cleaner using nitrile gloves and safety glasses throughout the decontamination process.

6 Procedure

Decontamination procedures should be completed prior to arrival at the project site and will vary dependent upon the application as detailed below.

- Place supplies (valves, nuts, caps, ferrules, tees, vapor pins, vapor pin extensions, and/or vapor screens) into the stainless-steel bowl or plastic bucket for drill bits.
  - Used components need to be completely broken down (tubing and ferrules cannot be reused).
  - Valves should be in the open position.
- Pour a mixture of distilled water and TSP (or equivalent) into the bowl completely covering all components. Follow the TSP (or equivalent) mixing instructions.
- Mix applicable components and soapy mixture.
- Use the toothbrush or bottle brush to clean components.
- Drain the soapy mixture from the stainless-steel bowl into a bucket or sanitary sewer, leaving the components.

- Rinse components in distilled water and completely empty the rinsate into a bucket or sanitary sewer. Repeat the rinsing process two additional times or continue rinsing until soapy mixture is not visible.
- Shake water from components and place on clean, dry paper towels.
- Allow all components to completely dry by using paper towels, a fan, air dry, or a combination of these prior to assembly/use.

Hammer drill bits used during the installation of sub-slab ports need to be decontaminated prior to use at each new installation location in the field and is outlined below:

- Create a solution of TSP cleaner (or equivalent) and distilled water in a clean spray bottle.
- Prepare another spray bottle with clean distilled water for rinsing.
- Remove any soil clinging to hammer drill bits with a wire brush.
- Place the drill bit into a clean, new, 5-gallon bucket.
- Spray the drill bit with the cleaning solution over enough paper towels to absorb the water and capture the solution into the bucket.
- Thoroughly clean the drill bit with a scrub brush.
- Repeat process with cleaning solution.
- Rinse by spraying the drill bit with clean distilled water and capture the rinse water in the bucket.
- Wipe drill bit down with paper towels.
- Repeat rinsing process.
- Completely dry drill bits with clean paper towels.

7 Waste Management

Used cleaning solution water and rinsate water utilized for decontaminating sampling components can be disposed directly into the sanitary sewer. Used cleaning solution water and rinsate water utilized for decontaminating installation components should be containerized and disposed of in accordance with project specifications.

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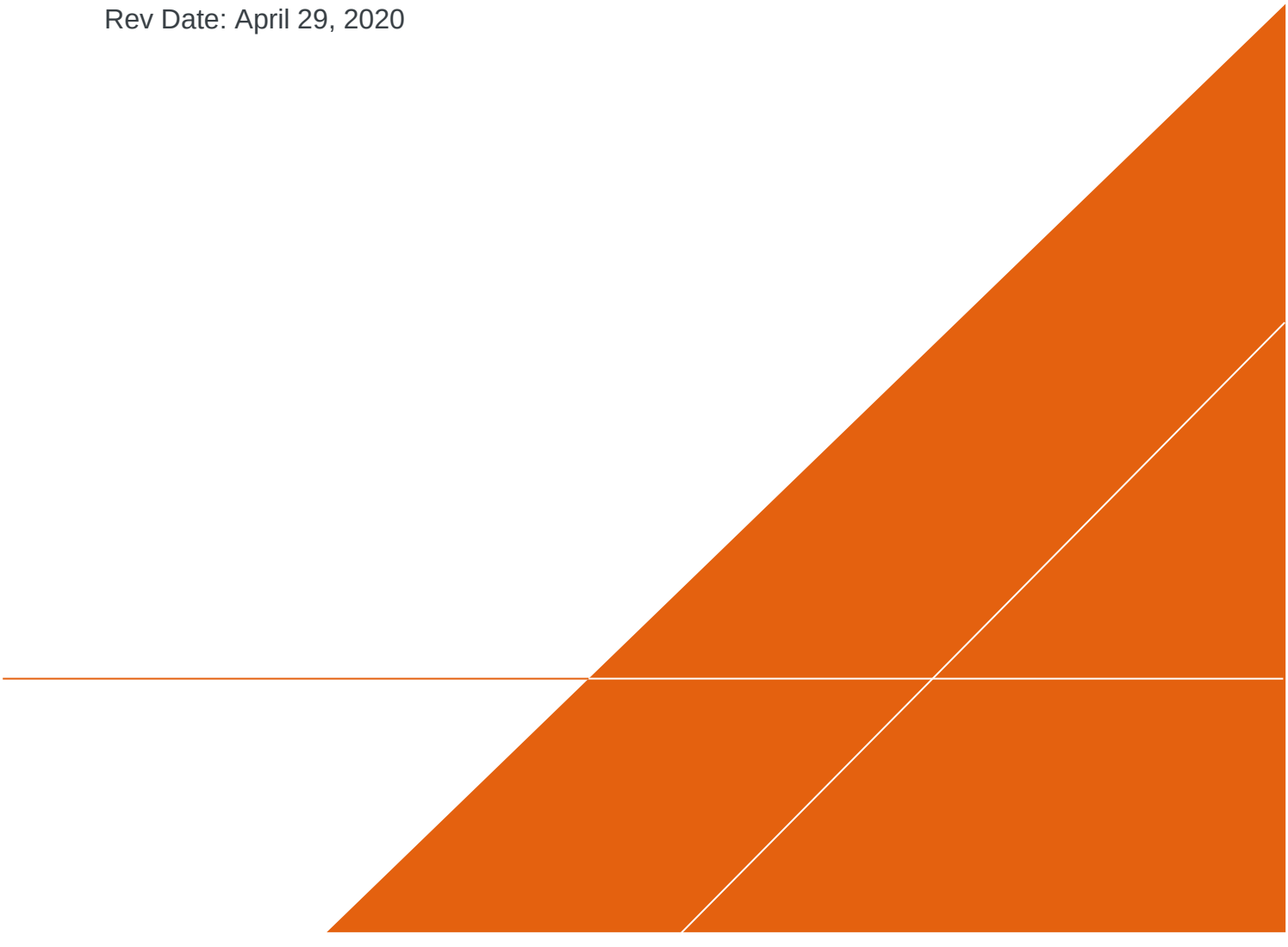
SOP - SAMPLE CHAIN OF CUSTODY

Rev: #2

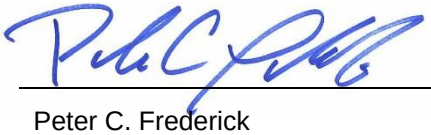
Rev Date: April 29, 2020



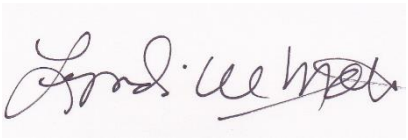
VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	April 19, 2017	All	Re-write to COC only	Richard Murphy
1	May 23, 2017	4	Add: Guidance on use of previous version of SOP.	Peter Frederick
		9	Add: Info on COCs for multiple shipping containers	
		7	Modify: Move letter i. to letter m. and change to “when appropriate”	
2	April 29, 2020	4	Remove obsolete link	Lyndi Mott
		11	Remove obsolete link	

APPROVAL SIGNATURES

Prepared by:  05/23/2017

Peter C. Frederick Date:

Technical Expert Reviewed by:  05/29/2020

Lyndi Mott (Technical Expert) Date:

1 INTRODUCTION

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2 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) describes the general Chain of Custody (COC) procedures and guidance instructions for samples collected from project sites that are relinquished from Arcadis' possession.

COC is defined as the maintenance of an unbroken record of possession of an item from the time of its collection through some analytical or testing procedure. COC is typically documented by a written record of the collection, possession, and handling of samples collected from a project location. Each sample will be tracked by a documented record that efficiently documents the individuals who were responsible for the sample during each successive transfer of that sample to various recipients beyond Arcadis' possession. This information can be used to legally establish the integrity of the samples and therefore the analytical results derived from the samples. This information can be used in addition to other records and documentation regarding the samples, such as field forms, field logs, and photographs.

A sample is considered under custody if:

- It is in your possession; or
- It is in your view, after being in your possession; or
- It was in your possession and then you then locked it up to prevent tampering; or
- It is in a designated secure area.

Continued use of previous version of SOP:

Although not recommended, Arcadis program-, project-, and client-teams may be able to use the previous version of this SOP provided that it meets all of the quality expectations of Arcadis and client, and meets applicable regulatory requirements. It is up to the program, project, and/or client-team leader to determine whether it is appropriate to adopt the current SOP or to continue using the previous version.

However, all new work not associated with the previous version of this SOP must be performed with the current version of the SOP.

When adopting this new SOP, users of the previous versions must be aware that specific handling, packing, and shipping procedures and guidance has been removed and that those should be addressed within program or project plans (e.g. QAPPs, Work Plans, SAPs, etc.) or in a more detailed SOP or TGI specific to that sampling activity, whether related to media, constituent/analyte, client, state, etc.

In addition, adopting this new SOP will require users to refer to the Arcadis DOT Safety Program for procedures and guidance on the determination and handling, packing, and shipping of samples that are or may be considered hazardous materials.

3 PERSONNEL QUALIFICATIONS

Arcadis personnel performing work under the purview of this SOP will have received appropriate training and have field experience regarding the collection of samples from project locations. Arcadis personnel will have all other applicable and appropriate training relevant to the sampling work and project site.

4 EQUIPMENT LIST

The following list provides materials that may be required for each COC. Project reporting and documentation requirements must be reviewed with the CPM prior to execution of work. Additional materials, tools, equipment, etc. may be required, and project staff are required to verify with the CPM and/or Technical Expert what specific equipment is required to complete the COC.

- Indelible ink pen (preferably either black or blue ink);
- COC form (**Appendix A**) from either Arcadis, laboratory receiving and analyzing the samples, or other applicable and appropriate entity for the work performed;
- When appropriate, such as for litigation or expert testimony work, custody seals or tape.

5 CAUTIONS

One way in which the law tries to ensure the integrity of evidence is by requiring proof of the chain of custody by the party who is seeking to introduce a particular piece of evidence.

A proper chain of custody requires three types of affirmations: (1) affirmation that a sample is what it purports to be (for example, soil collected from a specified location and depth); (2) affirmation of continuous possession by each individual who has had possession of the sample from the time it is collected until the time it is analyzed or held by a laboratory; and (3) affirmation by each person who has had possession that sample remained in substantially the same condition and not contaminated or affected by outside influences from the moment one person took possession until the moment that person released the evidence into the custody of another (for example, affirmation that the sample was stored in a secure location where no one but the person in custody had access to it).

Proving chain of custody is necessary to "lay a foundation" for the samples in question, by showing the absence of alteration, substitution, or change of condition.

Ensure that appropriate sample containers with applicable preservatives, coolers, and packing material are planned for and provided at the site at the time of sample collection.

Understand the offsite transfer requirements of the samples for the facility at which samples are collected.

If overnight courier service is required schedule pick-up or know where the drop-off service center is located and the hours of operation.

An Arcadis employee appropriately trained at the correct level of internal hazardous materials/DOT (Department of Transportation) shipping must complete an Arcadis shipping determination to address applicable DOT and IATA (International Air Transport Association) shipping requirements. Review the applicable Arcadis procedures and guidance instructions for sample packaging, and labeling. Prior to using air transportation, confirm air shipment is acceptable under DOT and IATA regulations.

The person relinquishing possession of the samples or other member of the project team should contact the final recipient of the samples to confirm receipt and review any special provisions on the COC or questions that they may have.

6 HEALTH AND SAFETY CONSIDERATIONS

Follow the health and safety procedures outlined in the project/site Health and Safety Plan (HASP) as well as other applicable H&S requirements, such as:

- Arcadis Hazardous Material/DOT handling, packaging, and shipping training
- Project site-specific H&S training
- Client-specific H&S training
- Constituent-specific H&S training
- Media-specific H&S training

7 PROCEDURE

Collected samples must be uniquely identified, and properly documented, containerized, labeled with unique identifier, possessed in a secure manner during remainder of sampling event, packaged, and shipped to recipient laboratory.

Sample Identification

The method of sample identification depends on the type of measurement or analyses performed. In some cases, in-situ measurements of existing conditions and/or sample location must be made during sample collection. These data will be recorded directly on field forms, logbooks, or other project record data sheets used to permanently retain this information for the project file. Examples of location identification information includes: latitude/longitudinal measurements, compass directions, well number, building number, floor number, room name, or proximity to a site feature unique to the site. Examples of in-situ measurements are pH, temperature, conductivity, flow measurement, or physical condition of the media being sampled. Physical samples collected are identified by a unique identifying number or code on a sample tag or label. These physical samples are removed from the sample location and transported to a laboratory for analyses.

In some cases, before samples are placed into individual containers and labeled as individual samples, samples may be separated into portions depending upon the analytical methods and required duplicate or triplicate analyses to be performed.

When completing a COC for samples, personnel must complete the following:

1. Written COCs must be completed with indelible ink (preferably either black or blue colored ink).
2. Written COCs must be completed using legible printed writing, and not cursive writing.
3. All entry fields on the COC form must be completed. If information is not applicable for a specific entry field, personnel will either put “N/A” or use a strike-out line or dash like “----------“ to indicate no applicable information is needed for that field.
4. Use of quotation marks or lines/down arrows to represent repetitive/duplicative text in similar fields.
5. Regardless of the type or specific COC form, the following pertinent information must be provided on the COC form:
    a. Arcadis project number
    b. Arcadis project name
    c. Project location, including street address, city, state, building number, providing as much detail as appropriate
    d. Recipient laboratory contact and sample receiving shipping location information
    e. Entities’/persons’ contact information for who will be receiving analytical results
    f. Name of sampler, i.e. person collecting sample and relinquishing possession of samples to the next entity in the chain of custody
    g. Date of sample collection

h. If appropriate for the sample media, contaminant/constituent of concern, or analytical method, document time of sample collection using standard military time

i. Sample analytical method(s)

j. Turnaround time required for analyses and/or reporting

k. Instructions to laboratory regarding handling, timing, analyses, etc. as applicable and appropriate

l. Printed name and signature of the individual person who collected the samples and relinquishing possession of the samples

m. If appropriate or when documentation of the specific sample collection method will influence how the laboratory handles, prepares, or analyzes the samples, document the sample collection methodology used for collecting the samples (e.g. ASTM D5755)

6. The following additional specific information will be entered on the COC form, regardless of what type of COC is being used:

   a. Unique Sample Identifier – The sample identifier (ID) must be unique to the individual sample it is applied to. The information in which the sample ID conveys is determined by the CPM, Technical Expert, and/or other project team members in advance of sample collection so that sample identification is consistently applied for the project. The sample nomenclature may be dictated by a specific client, program, or project database and require unique identification for each sample collected for the project. Consult with the CPM and/or Technical Expert for additional information regarding sample identification.

      The sample ID could convey specific information regarding the sample to aid personnel in recognizing what the sample represents, or they may be arbitrary so as to facilitate the anonymity of the sample location, media, constituent of concern, project site, etc.

      Examples of unique identifiers include:

      1. Well locations, grid points, or soil boring identification numbers (e.g., MW-3, X-20, SB-30). When the depth interval is included, the complete sample ID would be “SB-30 (0.5-1.0) where the depth interval is in feet. Please note it is very important that the use of hyphens in sample names and depth units (i.e., feet or inches) remain consistent for all samples entered on the chain of custody form. DO NOT use the apostrophe or quotes in the sample ID.

      2. Sample names may also use the abbreviations “FB,” “TB,” and “DUP” as prefixes or suffixes to indicate that the sample is a field blank, trip blank, or field duplicate, respectively.

   b. List the date of sample collection. All indicated dates must be formatted using either mm/dd/yy (e.g., 03/07/09) or mm/dd/yyyy (e.g. 03/07/2009).

   c. When appropriate for the analytical procedure used, list the local time that the sample was collected. The time value should be presented using military format. For example, 3:15 P.M. should be entered as 15:15.

d. Samples should be indicated to be either “Grab” or “Composite”. Grab samples are collected from only one unique location at one specific point in time.

e. Composite samples are a group of individual samples that are combined for analysis in their totality. Composite samples need to be documented if they are either collected from a number of different locations over a broader area to be representative of the entire area being sampled, or if they are representative of a single location over an extended period of time.

f. If used, preservatives for the individual sample will be noted.

g. The requested analytical method(s) that the samples are being analyzed for must be indicated. As much detail, as necessary, should be presented to allow the analytical laboratory to properly analyze the samples. For example, polychlorinated biphenyl (PCB) analyses may be represented by entering “EPA Method 8082 – PCBs” or “EPA PLM 600-R93-116.” In cases where multiple analytical methods and/or analytical parameters are required for an individual sample, each method should be indicated for the sample (e.g., EPA 8082/8260/8270 or EPA PLM/400-point count).

h. If there are project-specific sample analytes to be reported, they should be specifically listed for each individual sample (e.g., 40 CFR 264 Appendix IX).

i. The total number of containers for each analytical method requested should be documented. This information may be included under the parameter or as a total for the sample.

j. When necessary, note which samples should be used for site specific matrix spikes.

k. Indicate special project-specific requirements pertinent to the handling, shipping, or analyses. These requirements may be on a per sample basis such as “extract and hold sample until notified,” or may be used to inform the laboratory of special reporting requirements for the entire sample delivery group (SDG).

l. Indicate turnaround time (TAT) required for samples on COC. If individual samples have differing TATs, the different TATs for each sample or groups of samples must be clearly indicated.

m. Provide contact name and phone number in the event that problems are encountered when samples are received at the laboratory. The person relinquishing possession of the samples or other member of the project team should contact the final recipient of the samples to confirm receipt and review any special provisions on the COC or questions that they may have.

n. If available, attach the Laboratory Task Order or Work Authorization forms.

o. The “Relinquished By” field must contain the signature of the Arcadis person who relinquished custody of the samples to the next entity in the chain of custody, which may be another person, the shipping courier, or the analytical laboratory.

p. Dates and times must be indicated using the following format:

    1) Date: either mm/dd/yy e.g., 01/01/17 OR mm/dd/yyyy e.g., 01/01/2017

    2) Time: use military format, e.g. 9:30 a.m. is 0930 and 9:30 p.m. is 2130

q. The “Received By” section is signed by sample courier or laboratory representative who received the samples from the sampler or it is signed upon laboratory receipt from the overnight courier service.

4. When more than one page of the COC form is required to complete the total number of samples, use as many sheets as necessary to accurately and clearly document the samples and information. Some COCs may have a standard first page/cover page, and subsequent pages may not contain all the detailed fields as the first page/cover page. Ensure that any subsequent pages convey all of the necessary and pertinent information for each individual sample as required in this procedure document.
5. Pages of the COC must retain a page count of the total number of pages; e.g., Page 1 of 3, Page 2 of 3, Page 3 of 3.
6. Upon completing the COC forms, forward the original signed COC with the sample package. Ensure that the original COC form is secured with the sample package so that it remains with the physical samples for the duration of transport and handling to its final destination and ensure that the COC form will not be become damaged or rendered unreadable due to sample breakage/leakage if stored inside the sample shipping container or outside influences if COC is stored in an outside plastic pouch to the container.
7. If you’ve collected enough samples that would require more than one container to ship them all to the same laboratory or location, then each separate/individual container that contains any number of samples must have a separate COC representing only those samples contained within that specific container. For example, if you have 3 total shipping containers for all of your samples, you must have a total of 3 separate, individual COCs for each of the 3 containers representing only those samples in their representative container. Thus, every container holding samples must have its own, individual COC.
8. If electronic chain of custody (eCOC) forms are utilized, ensure that the requirements of this procedure and guidance instructions are followed to the extent possible. Verify that proper signature and COC procedures are maintained with the CPM and/or Technical Expert when using eCOC.

8 WASTE MANAGEMENT

Not Applicable.

9 DATA RECORDING AND MANAGEMENT

The original signed COC shall be submitted with the samples. Copies of COC records will be transmitted to the CPM or designee at the end of each day unless otherwise directed by the CPM. The sampling team leader retains copies of the chain of custody forms for filing in the project file. Record retention shall be in accordance with client- and project-specific requirements and Arcadis policies, the most stringent will apply.

10 QUALITY ASSURANCE

COC forms will be legibly completed in accordance with this procedure and guidance instruction document, as well as other applicable and appropriate project documents such as Sampling and Analysis Plan (SAP), Quality Assurance Project Plan (QAPP), Work Plan, or other project guidance documents.

COC records will be reviewed by the CPM or their appropriate designee for completeness and accuracy to the applicable requirements. Non-conformances will be noted and corrected in a timely manner on the copies retained by Arcadis as well as contacting the ultimate receiving entity for correction to the originally signed COC in their possession.

11 REFERENCES

Arcadis Client Document Retention Guide

Arcadis Transportation Safety Program requirements, procedures, and guidance instructions

EPA Samplers' Guide – Contract Laboratory Program Guidance for Field Samplers, EPA document EPA-540-R014-013 October 2014

EPA Region III – *Sample Submission Procedures for the Office of Analytical Services and Quality Assurance (OASQA) Laboratory Branch* revision 13.0 January 29, 2014

EPA Region I Office Environmental Measurement and Evaluation – *Standard Operating Procedures for Chain of Custody of Samples* revision 1 March 25, 2002

EPA Region IV Science and Ecosystem Support Division *Operating Procedure for Sample and Evidence Management* January 29, 2013

APPENDIX A
Chain of Custody Form

ARCADIS

ID#

CHAIN OF CUSTODY & LABORATORY ANALYSIS REQUEST FORM

Page ____ of ____

Lab Work Order #

Send Results to:

Contact & Company Name:

Telephone:

Address:

Fax:

City State Zip

E-mail Address:

Project Name/Location (City, State):

Project #:

Sampler's Printed Name:

Sampler's Signature

SAMPLE ID	Collection Date	Collection Time	Type (✓) Comp	Type (✓) Grab	Matrix	Preservative	Filtered (✓)	# of Containers	Container Information	PARAMETER ANALYSIS & METHOD	REMARKS

Keys

Preservation Key:
A. H_2SO_4
B. HCL
C. HNO_3
D. NaOH
E. None
F. Other: _____
G. Other: _____
H. Other: _____

Containment Information Key
1. 40 ml Vial
2. 1 L Amber
3. 250 ml Plastic
4. 500 ml Plastic
5. Encore
6. 2 oz. Glass
7. 4 oz. Glass
8. 8 oz. Glass
9. Other: _____
10. Other: _____

Matrix Key:
SO - Soil
W - Water
T - Tissue
SE - Sediment
SL - Sludge
A - Air
NL - NAPL/Oil
SW - Sample Wipe
Other: _____

Special Instructions/Comments

☐ Special QA/QC Instructions (✓)

Laboratory Information and Receipt		Relinquished By	Received By	Relinquished By	Laboratory Received By
Last Name:	Cooler Custody Seal (✓)	Printed Name:	Printed Name:	Printed Name:	Printed Name
☐ Cooler packed with ice (✓)	☐ Intact ☐ Not Intact	Signature:	Signature:	Signature:	Signature:
Specify Turnaround Requirements:	Sample Receipt	Firm:	Firm:	Firm:	Firm:
Shipping Tracking #:	Condition/Cooler Temp:_____	Date/Time:	Date/Time:	Date/Time:	Date/Time:

SOP – Sample Chain of Custody Rev1_May 23, 2017

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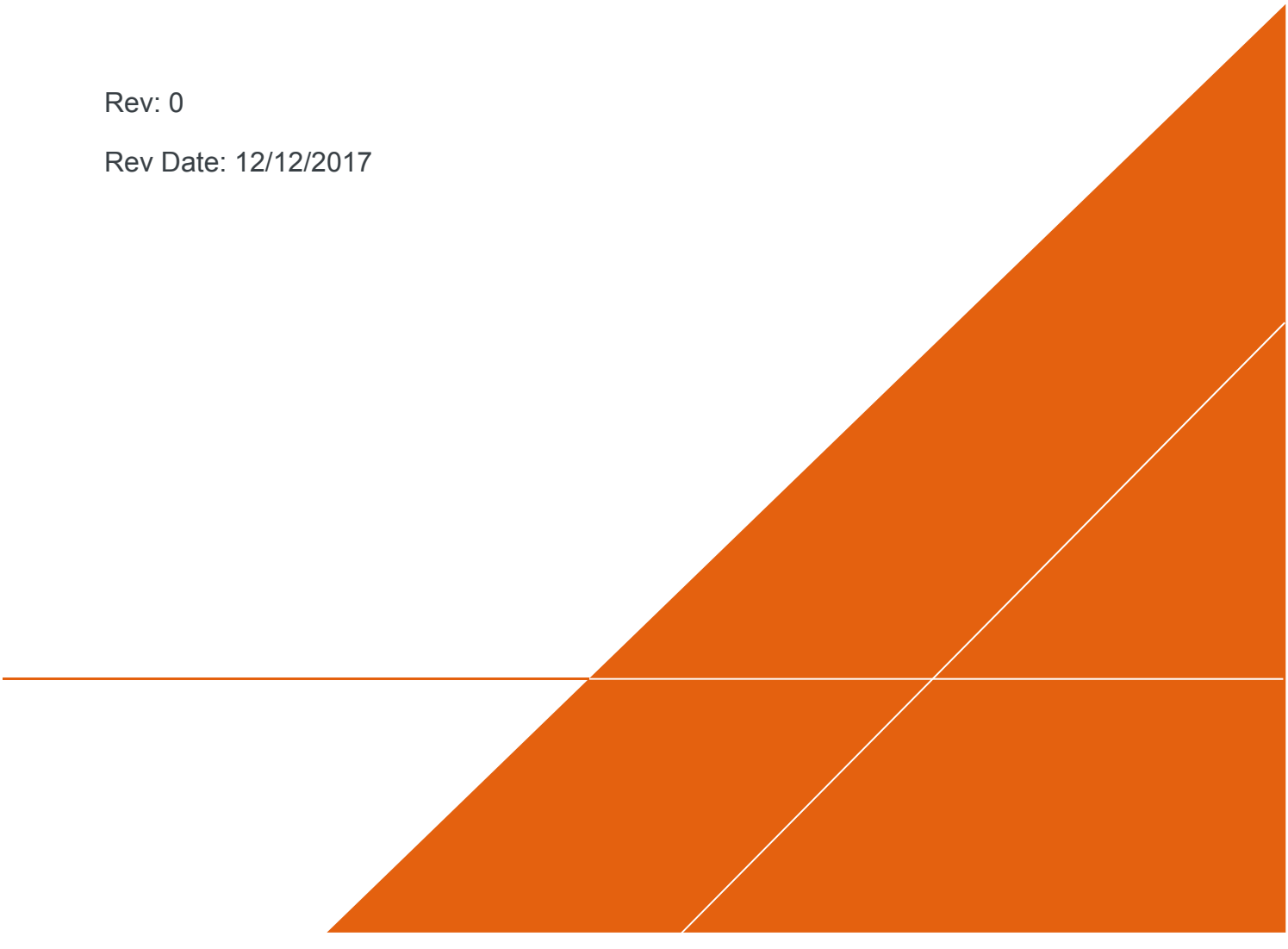
TECHNICAL GUIDANCE INSTRUCTIONS: INSTALLATION OF PERMANENT SOIL VAPOR PROBES

Rev: 0

Rev Date: 12/12/2017



VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	12/12/2017			Technical Expert Name Procedure Librarian Name

APPROVAL SIGNATURES

Prepared by:  12/12/2017

Eric Epple Date:

Technical Expert Reviewed by:  12/12/2017

Daniel Zuck, CPG Date:

Technical Expert Reviewed by:  12/12/2017

Mitch Wacksman Date:

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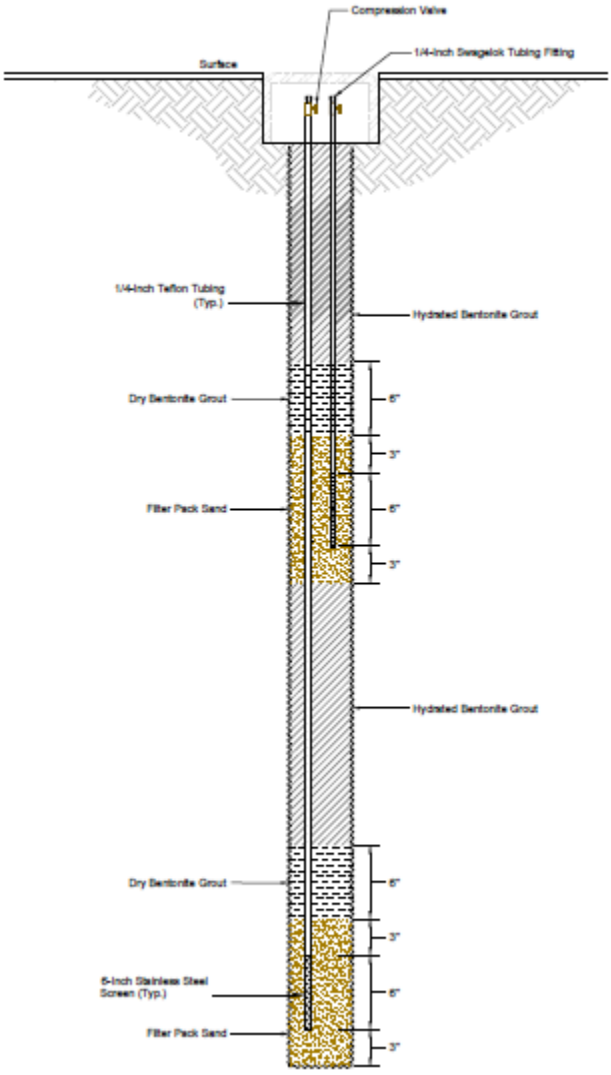
2 SCOPE AND APPLICATION

This technical guidance instructions (TGI) is recommended as a practical approach for the installation of permanent soil vapor sampling probes where the intent is to collect soil vapor samples over one or more sampling events. Nested sample soil vapor probes (i.e., multiple sample depths inside a single boring) can also be installed using these methods. Methods that can be used to advance the soil vapor probes installation include: hand auger, direct push, and auger. Rotary sonic drilling should be avoided. Soil vapor samples are often used during vapor intrusion investigations associated with subsurface impacts. Methods for soil vapor sample collection are described in Arcadis documents *TGI: Sub-Slab Soil Vapor or Soil Vapor Sampling Using Whole Air Canisters Analyzed Via USEPA Method TO-15* and *SOP: Soil-Gas Sampling and Analysis Using Sorbent Tubes*. The project team is responsible for ensuring this procedure meets all applicable guidance or regulations in the jurisdiction where work is performed. Receiving approval/concurrence from the leading regulatory agency for the project is suggested prior to implementation.

Water level gauging, geotechnical sampling, soil sampling, and soil logging are often executed during soil vapor sampling or as part of a vapor intrusion investigation. These activities are outside the scope of this TGI.

The depth of each soil vapor probe should be discussed and determined by the project team prior to beginning installation procedures. Under normal circumstances soil vapor probe should not be shallower than 5’ below ground surface. Soil vapor probe placement is project specific and based on site objectives, however as a general consideration soil vapor probe are often placed approximately 2.5’ above the highest known groundwater elevation.

An example of a finished soil vapor probe is presented in the schematic below.



3 PERSONNEL QUALIFICATIONS

Soil vapor probe installation activities will be performed by persons who have been trained in proper installation procedures. If geotechnical sampling, soil sampling, or soil logging are required as part of the scope of work it is critical that field personnel are appropriately trained for these additional tasks as described in the appropriate Standard Operating Procedures (SOPs) and/or Technical Guidance Instructions(TGI)s for those activities.

4 EQUIPMENT LIST

The following materials will be available during soil vapor probe installation and soil logging activities, as required:

- Site Plan figure presenting proposed soil boring/well locations
- Work Plan (or equivalent)
- Site-specific Health and Safety Plan (HASP) with task specific Job Safety Analysis (JSA(s))
- Personal protective equipment (PPE), as required by the HASP and JSA
- Traffic cones, delineators, caution tape, and/or fencing, as appropriate
- Probe tubing – new 1/4-inch or 3/8-inch outer diameter (OD) Teflon, Teflon-lined, or Nylon tubing
- Probe cap (to seal the tubing during equilibration) – Swagelok® part number SS-400-;
- Probe screen and anchor point – ½-inch OD stainless steel screen, such as the Geoprobe Systems® implant, or similar. Several screen lengths are available (1-inch, 6-inch, 14-inch, 21-inch), for discrete intervals required in Vapor Intrusion investigations, a 6-inch screen is typically recommended. Make sure the diameter of the tubing connection (i.e. barbed, Swagelok®) on the top side of the screen matches the diameter of the sample tubing used for the installation.
- Hand tools including appropriate-sized open-end wrenches (typically 9/16-inch, 1/2-inch, and 3/4-inch), tubing cutters, etc.
- Drum labels as required for investigation derived waste handling
- Labels for sample soil vapor probe tubing. Stamped metal tags affixed with zip ties are recommended
- MultiRae® four or five-gas meter for health and safety monitoring during drilling. A photoionization detector (PID) capable of parts per billion (ppb) readings (e.g., ppbRAE); and/or Landtec® GEM 2000 landfill gas meter (or equivalent) may be used instead of the five-gas meter when only VOC hazards exist
- Particulate Dust Meter (PDR-1000) as required by HASP
- Decontamination equipment (bucket, distilled or deionized water, cleansers (Alconox® or similar) appropriate for removing expected chemicals of concern, paper towels)
- Engineer's tape/measuring wheel
- Weighted tape
- Digital camera or phone with camera (confirm client approval)
- Field notebook or Personal Digital Assistant (PDA)
- Appropriate field forms

If soil sampling or soil logging is required by the project additional materials may be required per the appropriate TGIs for these tasks.

Prior to mobilizing to the site, Arcadis personnel will contact the drilling subcontractor to confirm that appropriate equipment will be provided. Specifications of the installation equipment are expected to vary by project, and so communication with the driller is necessary to ensure that the materials provided will meet the project objectives. It is strongly recommended that Arcadis personnel provide sample tubing and not drillers.

Equipment/materials typically provided by the driller could include:

- Disposable plastic liners (when drilling with direct-push equipment);
- Drums for investigation derived waste;
- Drilling decontamination materials;
- Decontamination pad materials, if required;
- Boring equipment: hand auger, air knife with vac-truck, and/or drill rig equipped with direct push or rotary auger capability;
- Clean filter silica sand (#2 or larger);
- Granular bentonite and bentonite powder;
- Hydraulic or non-shrink cement grout;
- Tremie pipe with funnel or manual grout pump (1-inch OD PVC Pipe);
- Applicable materials to install water tight protective casing (flush or stand-pipe) to be discussed with drilling contractor prior to mobilization.

5 PRECAUTIONS

Pre-installation considerations:

- Underground utilities in the vicinity of the drilling areas must be delineated by the drilling contractor or an independent underground utility locator service prior to soil vapor probe installation. See AUS Utility Clearance HS Standard and HASP for detail. An AUS Utility Clearance Checklist must be completed and discussed with the project manager and team. There should be a clear understanding of subsurface conditions at the site, with a minimum of 3 good lines of evidence used.
- A field mobilization memo, work plan or scope of work should be reviewed and discussed with team members (office, field, and subcontractors) prior to implementation to ensure that all field logistics (e.g., access issues, health and safety issues, communication network, schedules, etc.) and task objectives are clearly understood by all.
- Soil vapor probe installation should not be performed within 48 hours after a significant rain event (defined as >1 inch of rainfall), as saturated soils could present a false saturated soil interval which could lead to inaccurate screen settings.
- Field personnel should not handle substances that could contain VOCs and lead to cross-contamination. These include marking paint, fuels and solvents or oils prior to handling soil vapor construction materials. Clean nitrile gloves should be used when handling any probe components (this include the drilling contractor). Field personnel should not use sharpie markers during installation or note taking.

- Gravel or dense clay may make direct push installation impracticable. Site geology should be discussed with the project technical lead and drilling contractor prior to field work.
- Ensure all soil vapor sampling probes are decontaminated and compatible with sample tubing prior to field mobilization. A two-stage decontamination process is preferred consisting of a soap wash that consists of distilled water and a non-phosphate detergent (Alconox® or similar), then a final rinse with distilled water. The equipment should be allowed to air dry before use.

Installation Considerations:

- Depth to Groundwater – soil vapor samples must be collected in the vadose zone (and above the capillary fringe). The bottom of the soil vapor probe must be above the capillary fringe. Depths of perched water zones should also be considered.
- If using an air knife for utility clearing, soils should be removed via hand auger or direct push beginning a minimum of 1 foot above the top of the sampling interval.
- Vapor probes can be finished at the ground surface with a flush mount road box (preferred) or with a stand pipe protective casing, similar to groundwater monitoring wells.
- Soil permeability - It may not be feasible to collect soil vapor from finer-grained or tight soils with little pore volume, such as clays or dense dry silts; if there are known clay layers present in the subsurface, these intervals should be avoided when setting vapor probes. During the installation process, it is advisable to collect a soil core from the proposed sampling interval prior to installing the soil vapor probe to identify the exact depth of the capillary fringe and/or determine where the most permeable soil layers are located. For sampling in tighter soils, it is recommended that permanent soil vapor implants be installed with a wider borehole diameter.

6 HEALTH AND SAFETY CONSIDERATIONS

Field activities associated with soil vapor probe installation will be performed in accordance with a site-specific HASP and applicable JSA, a copy of which will be present on site during such activities.

7 PROCEDURE

All drilling equipment must be decontaminated prior to use. Handle and store decontaminated soil vapor probes in a manner that prevents contamination, such as in a Ziploc® bag prior to use.

Inspect vapor probe parts and drilling equipment for wear and faulty parts. Have the driller replace probe tips, o-rings, adapters, and probe rods as appropriate.

The procedures below allow the installation of a soil vapor probe similar to that presented in the figure below. If multiple depths are to be installed, steps 3-6 are repeated, starting with the deepest sample interval.

1. Hand clear boring location as specified in HASP. If an air knife is used, discontinue use 1-foot above the top of the sample interval and finish boring using a hand auger or drill rig.

2. Record in the field log the soil type and any PID readings that were collected from soil cuttings removed during installation. If saturated soils are encountered, plug the interval(s) with granulated bentonite up through the last dry interval.
3. After reaching the desired depth, install sample screen and tubing. Place the screen and tubing into the open borehole or have the driller place inside the direct push drill pipe along with the push tip.
4. Once in place, install the required amount of clean silica sand (as specified in Step 3 based on soil type). Add clean silica sand to create an appropriate sand pack. Typically, there are 3 inches of clean silica sand both above and below a 6-inch sample screen, along with the clean silica sand surrounding the screen, creating a 12 inches total sampling interval.
5. Withdraw the drill pipe 6-inches and place 6 inches of dry granulated bentonite on top of the clean sand layer.
6. Add hydrated bentonite to 12-inches below the ground surface, or bottom of next sample interval (for nested installations). Install appropriate surface finish (i.e., bolting water tight road box, stick-up). If nested ports are not installed and the depth is greater than 10-feet below grade, a bentonite slurry grout may be placed above the granulated bentonite to 1-foot below grade.
7. Fill the remaining annulus within the road box with non-shrink grout cement to approximately 0.5-foot below ground surface, or enough to seal the tubing to the protective casing. A small amount of sand may need to be placed on top of the cement to ensure that the tubing does not make contact with the cement during curing.
8. Cut sample tubing long enough to allow enough length to reach a sample container or sorbent tube in the future. For flush mounted casings, 2-3 feet of tubing is recommended. For stand-pipe casing, make sure there is at least 6-7-feet of tubing extending above grade. Terminate sample tubing using an air tight plug or valve. Swagelok® or similar stainless-steel fittings are recommended.
9. Clearly label sample probe and protective casing with ID and depth. Stamped metal tags affixed with stainless zip ties are recommended.
10. Allow at least 24-hours for soil vapor probe equilibration and cement curing prior to leak testing and sampling. See applicable TGIs for these procedures.

8 WASTE MANAGEMENT

Investigation-derived wastes (IDW), including soil cuttings, decontamination liquids, and disposable materials (material packages, PPE, etc.), will be placed in clearly labeled, appropriate containers, or managed as otherwise specified in the Work Plan (or equivalent), field sampling plan (FSP), and/or IDW management guidance document.

9 DATA RECORDING AND MANAGEMENT

Drilling activities should be documented on appropriate field/log forms (see Attachment A) as well as in a proper field notebook and/or PDA. Additionally, all documents (and photographs) should be scanned and electronically filed in the appropriate project directory for easy access. Pertinent information will include personnel present on site, times of arrival and departure, significant weather conditions, timing of installation activities, soil descriptions, construction specifications (backfill material and borehole diameter,

tubing length, screen details, seal type), and quantities of materials used. In addition, the locations of newly-installed soil vapor probes will be documented photographically or in a site sketch. If appropriate, a measuring wheel or engineer's tape will be used to determine approximate distances between important site features. The well location will be surveyed using the method specified in the site Work Plan (or equivalent).

10 QUALITY ASSURANCE

All drilling equipment and associated tools (including augers, drill rods, sampling equipment, wrenches, and any other equipment or tools) that may have come in contact with soil will be cleaned in accordance with the procedures outlined in the appropriate SOP. Soil vapor probe materials will also be cleaned prior to well installation.

11 REFERENCES

California Environmental Protection Agency (CalEPA) – Department of Toxic Substances Control (DTSC). 2012. Advisory – Active Soil Gas Investigations (https://www.dtsc.ca.gov/SiteCleanup/upload/VI_ActiveSoilGasAdvisory_FINAL_043012.pdf). April.

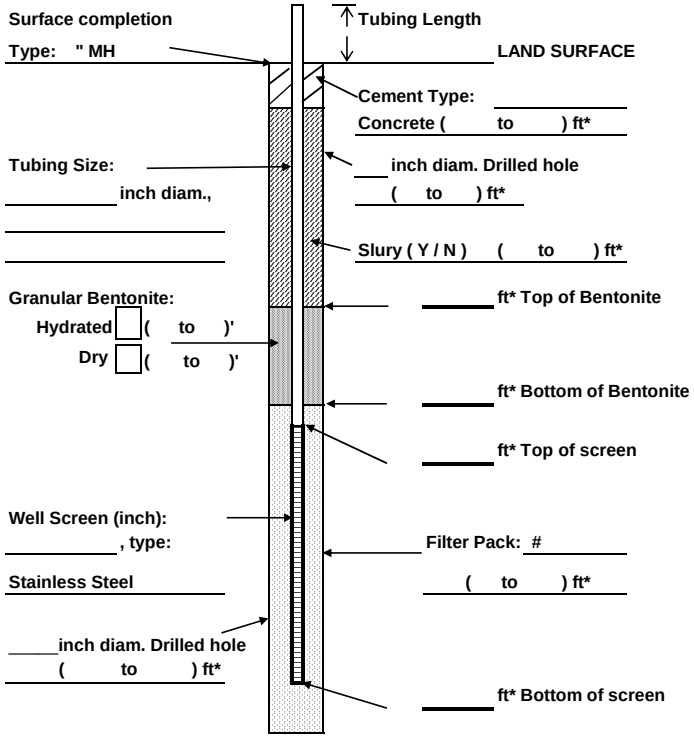
Interstate Technology Regulatory Council (ITRC). 2007. Technical and Regulatory Guidance. Vapor Intrusion Pathway: A Practical Guideline (http://www.itrcweb.org/documents/VI-1.pdf). January.

New Jersey Department of Environmental Protection (NJDEP) – Site Remediation and Waste Management Program. 2016. Vapor Intrusion Technical Guidance (http://www.nj.gov/dep/srp/guidance/vaporintrusion/vig_main.pdf?version_4). August.

United States Environmental Protection Agency (USEPA) – Office of Solid Waste and Emergency Response (OSWER). 2015. Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air (https://www.epa.gov/sites/production/files/2015-09/documents/oswer-vapor-intrusion-technical-guide-final.pdf). June.

Arcadis

Permanent Soil Vapor Probe Construction Log



Project Name and No.: _____

SV Probe ID: _____ **Address:** _____

Town/City: _____ **State:** _____

Land-Surface Elevation and Datum:

_____ **feet** ☐ **Surveyed** ☐ **Estimated**

Coordinates- Northing: _____ **Easting:** _____

Installation Date(s): _____

Drilling Contractor: _____
(Diller/Helper)

Installation Method: _____

Equipment Used: _____

_____

Groundwater Information:

Well ID: _____

Well Screen Setting: _____

Static Depth to Water: _____

SV Probe Purpose: _____

_____

Remarks: **Soils:** _____

_____

_____

****Measuring Point is Top of Well Casing Unless Otherwise Noted.**

Prepared by _____

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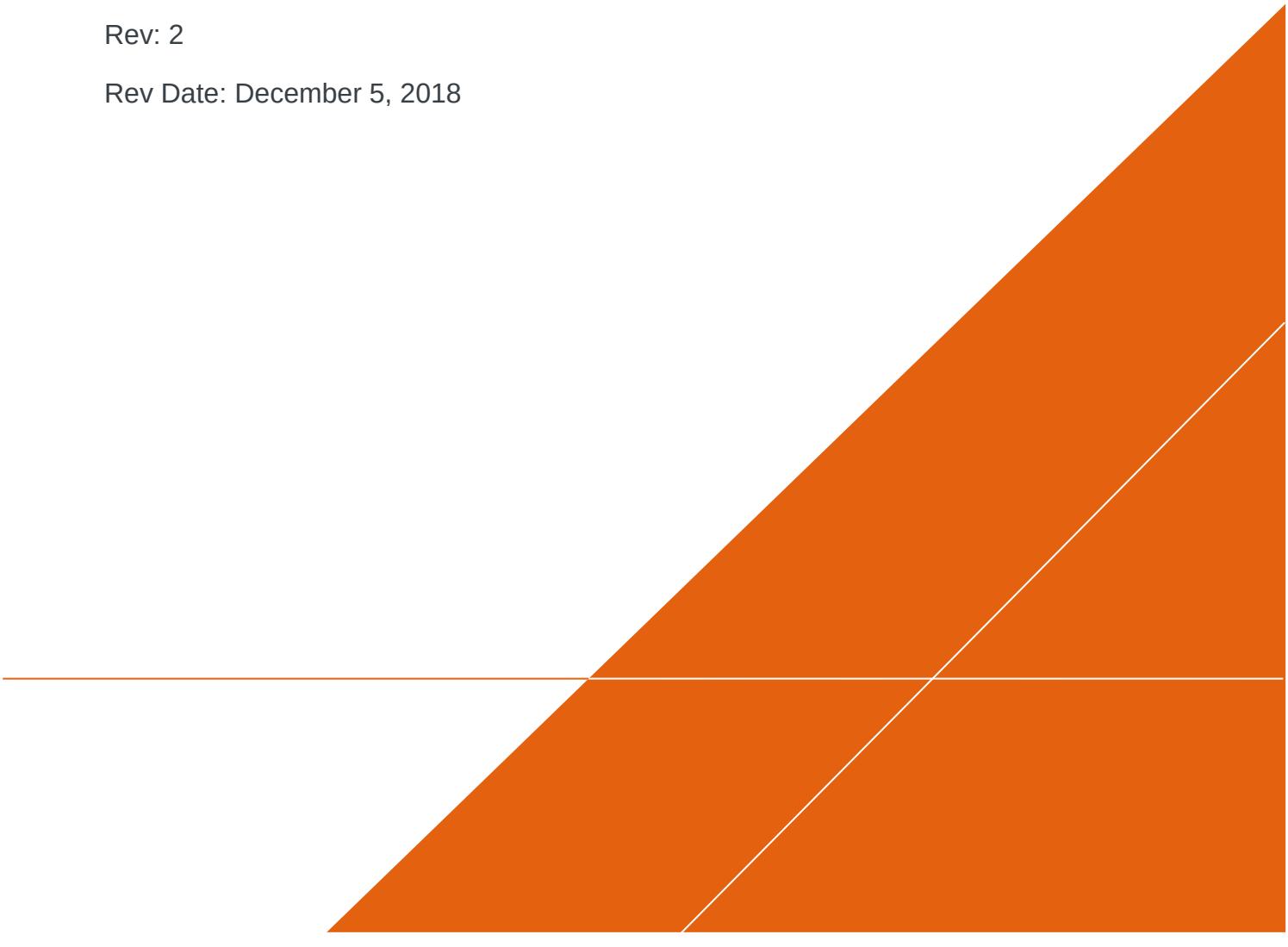
TGI - ADMINISTERING HELIUM TRACER GAS LEAK TEST

Rev: 2

Rev Date: December 5, 2018



VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
1	October 14, 2016			Mitch Wacksman
2	December 5, 2018		• Revised purge rate to be consistent with other vapor intrusion TGIs • Add Health and Safety Considerations section	Mitch Wacksman

APPROVAL SIGNATURES

Prepared by:		12/5/2018
	Eric Cathcart	Date:
Technical Expert Reviewed by:		12/5/2018
	Mitch Wacksman (Technical Expert)	Date:

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

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In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

When collecting subsurface vapor samples as part of a vapor intrusion evaluation, a tracer gas serves as a quality assurance/quality control method to verify the integrity of the vapor port seal and the numerous connections comprising the sample train. Without the use of a tracer, verification that a soil vapor sample has not been diluted by ambient or indoor air is difficult.

This Technical Guidance Instruction (TGI) focuses on using helium as a tracer gas. It should be noted that a field helium meter could register a false positive if methane is present in the subsurface. In this case an alternative method should be employed (i.e., water dam test), The protocol for using a tracer gas includes the following basic steps: (1) enrich the atmosphere in the immediate vicinity of the sample port where ambient air could enter the sampling train during sampling with the tracer gas; and (2) measure a vapor sample from the sample tubing for the presence of elevated concentrations (> 10%) of the tracer. A plastic pail, bucket, garbage can or even a plastic bag can serve as a shroud to keep the tracer gas in contact with the port during the testing.

There are two basic approaches to testing for the tracer gas:

1. Include the tracer gas in the list of target analytes reported by the laboratory; and/or
2. Use a portable monitoring device to analyze a sample of soil vapor for the tracer prior to sampling for the compounds of concern. (Note that tracer gas samples can be collected via syringe, Tedlar bag, etc. They need not be collected in SUMMA® canisters or minicans)

This TGI focuses on monitoring helium using a portable sampling device, although helium can also be analyzed by the laboratory along with other volatile organic compounds (VOCs). Real-time tracer sampling allows the investigator to confirm the integrity of the port seals prior to formal sample collection.

During the initial stages of a subsurface vapor sampling program, tracer gas samples should be collected at each of the sampling points. If the results of the initial samples indicate that the port seals are adequate, the Project Manager can consider reducing the number of locations at which tracer gas samples are used in future monitoring rounds. At a minimum, at least 10% of the subsequent samples should be supported with tracer gas analyses. When using permanent soil vapor points as part of a long-term monitoring program, the port should be tested prior to the first sampling event. Tracer gas testing of subsequent sampling events may often be reduced or eliminated unless conditions have changed at the site. Soil gas port integrity should certainly be rechecked with Tracer gas if land clearing/grading activities, freeze thaw cycles, or soil desiccation may have occurred. Points should also be rechecked if more than 2 years have elapsed since the last check of that port.

3 PERSONNEL QUALIFICATIONS

Arcadis field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, site-specific training, first aid, and cardiopulmonary resuscitation (CPR), as needed. Arcadis field sampling personnel will be competent in the relevant procedures and possess the required skills and experience necessary to successfully complete the desired field work. Arcadis personnel responsible for directing tracer gas testing must have previous experience conducting similar tests without direct supervision.

4 EQUIPMENT LIST

The equipment required to conduct a helium tracer gas test is presented below:

- Appropriate PPE for site (as required by the Health and Safety Plan)
- Helium (laboratory grade)
- Regulator for helium tank
- Shroud (plastic bucket, garbage can, plastic bag, etc.)
    - The size of the shroud should be sufficient to fit over the sample port. It is worth noting that using the smallest shroud possible will minimize the volume of helium needed; this may be important when projects require a large number of helium tracer tests.

  - The shroud will need to have three small holes in it. These holes will include one on the top (to accommodate the sample tubing), and two on the side (one for the helium detector probe, and one for the helium line).
  - The shroud should ideally enclose the sample port and as much as possible of the sampling train.
- Helium detector capable of measuring from 1 - 100% (Dielectric MGD-2002, Mark Model 9522, or equivalent)
- Tedlar bag
- Seal material for shroud (rubber gasket, VOC-free modeling clay, bentonite, etc.) to keep helium levels in shroud high in windy conditions. Although the sealing material is not in direct contact with the sample if leakage does not occur, sealing materials with high levels of VOC emissions should be avoided, since they could contaminate a sample if a leak occurs.
- Sample logs
- Field notebook

5 CAUTIONS

Helium is an asphyxiant! Be cautious with its use indoors! Never release large volumes of helium within a closed room!

Field sampling equipment must be carefully handled to minimize the potential for injury and the spread of hazardous substances. All sampling personnel should review the appropriate health and safety plan (HASP) and job safety analysis (JSA) prior to beginning work to be aware of all potential hazards associated with the job site and the specific task. Field staff should review the attachment on safely handling compressed gas cylinders prior to commencing field work.

Compressed gas cylinders should be handled with caution; see attachment on the use and storage of compressed gasses before beginning field work.

Care should be taken not to pressurize the shroud while introducing helium. If the shroud is completely air tight and the helium is introduced quickly, the shroud can be over-pressurized and helium can be pushed into the ground. Provide a relief valve or small gap where the helium can escape.

Because minor leakage around the port seal should not materially affect the usability of the soil vapor sampling results, the mere presence of the tracer gas in the sample should not be a cause for alarm. Consequently, portable field monitoring devices with detection limits in the low ppm range are more than adequate for screening samples for the tracer. If high concentrations (> 10%) of tracer gas are observed in a sample, the port seal should be enhanced and fittings within the sampling train should be checked and/or tightened to reduce the infiltration of ambient air and the tracer test readministered. If the problem cannot be rectified, a new sample point should be installed or an alternate sampling train used.

6 HEALTH AND SAFETY CONSIDERATIONS

All sampling personnel should review the appropriate health and safety plan (HASP) and job safety analysis (JSA) prior to beginning work to be aware of all potential hazards associated with the job site and the specific task. Field sampling must be carefully performed to minimize the potential for injury and the spread of hazardous substances.

Soil Vapor sampling is often done on the ground with workers on their knees. Knee pads or a large pad can be used under the entire sample area (i.e. a large folded box). This will protect the worker's knees and the sampling equipment from touching the potentially impacted ground (i.e. asphalt parking lot with car oil stains).

The metal on metal fittings often create small metal splinters, so always used gloves when handling the canisters, fittings, valves, etc. Do not blow the splinters off towards other workers

7 PROCEDURE

The helium tracer test can be conducted when using temporary or permanent sampling points and inside or outside a facility. A visual of an example helium tracer gas test equipment set up in included as Figure 1.

1. Attach Teflon or nylon (Nylaflow) sample tubing to the sample point. This can be accomplished utilizing a number of different methods depending on the sample install (i.e., Swage-Lok or comparable fittings).
2. Place the shroud over the sample point and tubing.
3. Pull the tubing through hole in top of shroud. Seal opening at top of shroud with VOC free modeling clay.
4. Place weight on top of shroud to help maintain a good seal with the ground.
5. Insert helium tubing and helium detector probe into side of shroud. Seal both with modeling clay to prevent leaks.
6. Fill shroud with helium. Fill shroud slowly, allowing atmospheric air to escape either by leaving a gap where the shroud meets the ground surface or by providing a release value on the side of the shroud. Do not pressurize the shroud!
7. Use the helium detector to monitor helium concentration within the shroud from the lowest hole drilled in the shroud (bottom of the shroud nearest where the sample tubing intersects the ground). Helium should be added until the environment inside the shroud has > 40% helium.
8. Purge the sample point through the sample tubing into a Tedlar bag using a syringe equipped with a three-way leur lock valve. The purge rate should at least match the sample collection rate but not exceed 200 ml/min. Test the air in the Tedlar bag for helium using portable helium detector. If the point is free of leaks there should be very low helium in the purge air from the soil. The natural concentration of helium in the atmosphere is 0.00052% by volume and there are few if any natural sources of helium to soil gas.

9. If > 10% of the amount of helium present in the shroud is noted in purge air, rectify issues with the seal at the sample port and repeat the testing procedure. If the seal cannot be fixed, reinstall sample point.
10. Monitor and record helium level in shroud before, during and after tracer test.
11. Monitor and record helium level in purge exhaust.
12. At successful completion of tracer test and sample point purging, the soil vapor sample can be collected (if the helium shroud must be removed prior to sample collection be mindful not disturb the sample tubing and any established seals.

8 WASTE MANAGEMENT

No specific waste management procedures are required.

9 DATA RECORDING AND MANAGEMENT

Measurements will be recorded on the sample logs at the time of measurement with notations of the project name, sample date, sample start and finish time, sample location, and the helium concentrations in both the shroud and the purge air before, during, and after tracer testing. Any problems encountered should also be recorded in the field notes.

10 QUALITY ASSURANCE

Conduct quality assurance as required by the project-specific work plan and/or Quality Assurance Project Plan (QAPP).

11 REFERENCES

New Jersey Department of Environmental Protection (NJDEP). 2018. Vapor Intrusion Technical Guidance. January.

New York Department of Health. 2006. Guidance for Evaluating Soil Vapor Intrusion in the State of New York. October.

United States Environmental Protection Agency (USEPA). 2015. OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air. June

ATTACHMENT

Compressed Gases – Use and Storage

In general, a compressed gas is any material contained under pressure that is dissolved or liquefied by compression or refrigeration. Compressed gas cylinders should be handled as high- energy sources and therefore as potential explosives and projectiles. Prudent safety practices should be followed when handling compressed gases since they expose workers to both chemical and physical hazards.

Handling

- Safety glasses with side shields (or safety goggles) and other appropriate personal protective equipment should be worn when working with compressed gases.
- Cylinders should be marked with a label that clearly identifies the contents.
- All cylinders should be checked for damage prior to use. Do not repair damaged cylinders or valves. Damaged or defective cylinders, valves, etc., should be taken out of use immediately and returned to the manufacturer/distributor for repair.
- All gas cylinders (full or empty) should be rigidly secured to a substantial structure at 2/3 height. Only two cylinders per restraint are allowed in the laboratory and only soldered link chains or belts with buckles are acceptable. Cylinder stands are also acceptable but not preferred.
- Handcarts shall be used when moving gas cylinders. Cylinders must be chained to the carts.
- All cylinders must be fitted with safety valve covers before they are moved.
- Only three-wheeled or four-wheeled carts should be used to move cylinders.
- A pressure-regulating device shall be used at all times to control the flow of gas from the cylinder.
- The main cylinder valve shall be the only means by which gas flow is to be shut off. The correct position for the main valve is all the way on or all the way off.
- Cylinder valves should never be lubricated, modified, forced, or tampered with.
- After connecting a cylinder, check for leaks at connections. Periodically check for leaks while the cylinder is in use.
- Regulators and valves should be tightened firmly with the proper size wrench. Do not use adjustable wrenches or pliers because they may damage the nuts.
- Cylinders should not be placed near heat or where they can become part of an electrical circuit.
- Cylinders should not be exposed to temperatures above 50 °C (122 °F). Some rupture devices on cylinders will release at about 65 °C (149 °F). Some small cylinders, such as lecture bottles, are not fitted with rupture devices and may explode if exposed to high temperatures.
- Rapid release of a compressed gas should be avoided because it will cause an unsecured gas hose to whip dangerously and also may build up enough static charge to ignite a flammable gas.

- Appropriate regulators should be used on each gas cylinder. Threads and the configuration of valve outlets are different for each family of gases to avoid improper use. Adaptors and homemade modifications are prohibited.
- Cylinders should never be bled completely empty. Leave a slight pressure to keep contaminants out.

Storage

- When not in use, cylinders should be stored with their main valve closed and the valve safety cap in place.
- Cylinders must be stored upright and not on their side. All cylinders should be secured.
- Cylinders awaiting use should be stored according to their hazard classes.
- Cylinders should not be located where objects may strike or fall on them.
- Cylinders should not be stored in damp areas or near salt, corrosive chemicals, chemical vapors, heat, or direct sunlight. Cylinders stored outside should be protected from the weather.

Special Precautions

Flammable Gases

- No more than two cylinders should be manifolded together; however, several instruments or outlets are permitted for a single cylinder.
- Valves on flammable gas cylinders should be shut off when the laboratory is unattended and no experimental process is in progress.
- Flames involving a highly flammable gas should not be extinguished until the source of the gas has been safely shut off; otherwise it can reignite causing an explosion.

Acetylene Gas Cylinders

- Acetylene cylinders must always be stored upright. They contain acetone, which can discharge instead of or along with acetylene. Do not use an acetylene cylinder that has been stored or handled in a nonupright position until it has remained in an upright position for at least 30 minutes.
- A flame arrestor must protect the outlet line of an acetylene cylinder.
- Compatible tubing should be used to transport gaseous acetylene. Some tubing like copper forms explosive acetylides.

Lecture Bottles

- All lecture bottles should be marked with a label that clearly identifies the contents.
- Lecture bottles should be stored according to their hazard classes.
- Lecture bottles that contain toxic gases should be stored in a ventilated cabinet.
- Lecture bottles should be stored in a secure place to eliminate them from rolling or falling.
- Lecture bottles should not be stored near corrosives, heat, direct sunlight, or in damp areas.

- To avoid costly disposal fees, lecture bottles should only be purchased from suppliers that will accept returned bottles (full or empty). Contact the supplier before purchasing lecture bottles to ensure that they have a return policy.
- Lecture bottles should be dated upon initial use. It is advised that bottles be sent back to the supplier after one year to avoid accumulation of old bottles.

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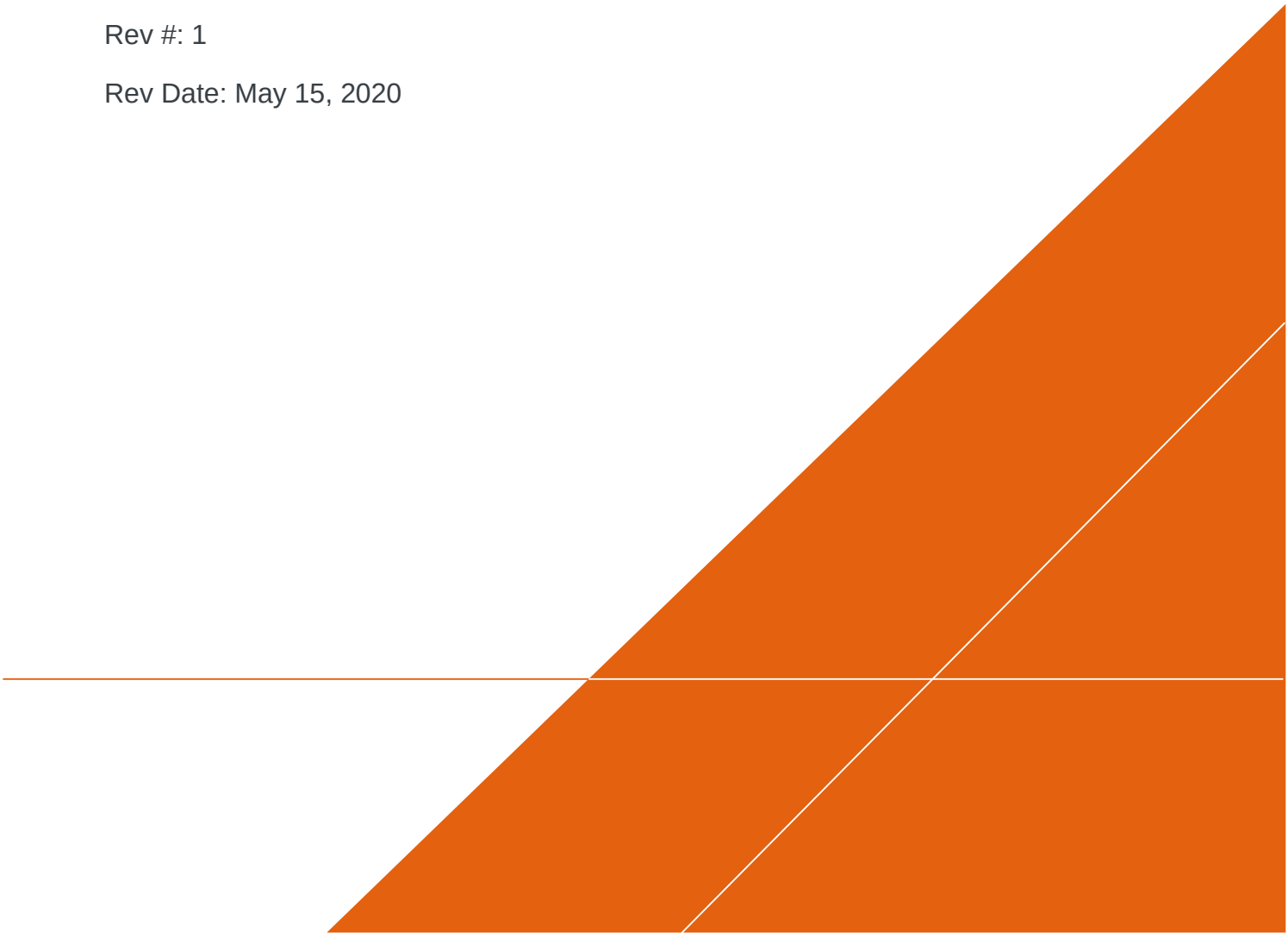
TGI - INVESTIGATION-DERIVED WASTE HANDLING AND STORAGE

Rev #: 1

Rev Date: May 15, 2020



VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	February 23, 2017	ALL	Conversion from SOP to TGI	Ryan Mattson / Peter Frederick
1	May 15, 2020	ALL	Updated to reflect regulatory changes	

APPROVAL SIGNATURES

Prepared by:		02/23/2017
	Derrick Maurer	Date:
Technical Expert Reviewed by:		05/15/2020
	Ryan Mattson (Technical Expert)	Date:

1 INTRODUCTION

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2 SCOPE AND APPLICATION

The objective of this Technical Guidance Instruction (TGI) is to describe the procedures to manage investigation-derived wastes (IDW), both hazardous and nonhazardous, generated during site activities, which may include, but are not limited to: drilling, trenching/excavation, construction, demolition, monitoring well sampling, soil sampling, decontamination and remediation. For the purposes of this TGI, IDW is considered to be discarded materials which are defined as solid waste by United States Environmental Protection Agency (EPA) standard 40 CFR § 261.2 (which may include liquids, solids, or sludges). IDW may include soil, groundwater, drilling fluids, decontamination liquids, as well as contaminated personal protective equipment (PPE), sorbent materials, construction and demolition debris, and disposable sampling materials. Hazardous or uncharacterized IDW will be collected and staged at the point of generation. Quantities small enough to be containerized in 55-gallon drums will be taken to a designated temporary onsite storage area (discussed in further detail under Drum Storage) pending characterization and disposal. IDW materials will be characterized using process knowledge and appropriate laboratory analyses to determine the waste classification and evaluate proper safe handling and disposal methods.

This TGI describes the necessary equipment, field procedures, materials, regulatory references, and documentation procedures necessary for proper handling and storage of IDW up to the time it is properly transported from the project site and disposed. The procedures included in this TGI for handling and temporary storage of IDW are based on the EPA's guidance document *Guide to Management of Investigation Derived Wastes* (USEPA, 1992). IDW is assumed to be contaminated with the site constituents of concern (COCs) until analytical evidence indicates otherwise. IDW will be managed to ensure the protection of human health and the environment and will comply with all applicable or relevant and appropriate requirements (ARAR). Although not comprehensive, the following laws and regulations on Hazardous Waste Management should be considered as potential ARAR. It is the Arcadis Certified Project Manager (CPM) and/or designated Technical Expert to determine which laws and regulations, at all levels of government, are applicable to each project site and activity falling under this TGI.

Federal Laws and Regulations

- Resource Conservation and Recovery Act (RCRA) 42 USC § 6901-6987.
- Federal Hazardous Waste Regulations 40 CFR § 260-265

Department of Transportation (DOT) Hazardous Materials Transportation 49 CFR

Occupational Safety and Health Administration (OSHA) Regulations 29 CFR

State Laws and Regulations

- To be determined based on location of site and location of treatment, storage, and/or disposal facility (TSDF) to be utilized.

Regional, County, Municipal, and Local Regulations

- To be determined based on location of site and location of treatment, storage, and/or disposal facility (TSDF) to be utilized.

Initial Storage

Pending characterization, IDW will be temporarily stored appropriately within each area of contamination (AOC). Under RCRA, "storage" is defined as the "holding of hazardous waste for a temporary period, at the end of which the hazardous waste is treated, disposed of, or stored elsewhere" (40 CFR § 260.10). The onsite waste staging area will be in a secure and controlled area. Uncharacterized wastes are considered potentially hazardous wastes and must be stored in DOT approved packaging. Liquid wastes must be stored in DOT approved closed head drums or other approved containers (e.g., portable tank containers) that are compatible with the type of material stored therein. Solid materials must be stored in DOT approved open head drums where practicable. Larger quantities of solid IDW can be containerized in bulk containers (such as in a roll-off box). Soil from large excavation projects may be managed in stockpiles with within the AOC and does not need to be containerized until exiting the AOC.

Characterization

Waste characterization can either be based on generator knowledge, such as using historical process knowledge and safety data sheets (SDS), or can be based upon characterization sampling analytical results. IDW typically is not characterized using SDS as it is a mixture of aged chemicals and environmental media. Historical process knowledge should be used to determine if the IDW is a listed hazardous waste (40 CFR § 261.31-33). If the IDW is not a listed hazardous waste, waste

characterization can be completed by laboratory analysis of representative samples of the IDW. The laboratory used for waste characterization analysis must have the appropriate state and federal accreditations and may be required to be pre-approved by the Client. IDW will be classified as RCRA hazardous or non-regulated under RCRA based on the waste characterization determination.

If IDW is characterized as RCRA hazardous waste, RCRA and DOT requirements must be followed for packaging, labeling, transporting, storing, and record keeping as described in 40 CFR § 262 and 49 CFR § 171-178. Waste material classified as RCRA nonhazardous may be handled and disposed of as nonhazardous waste in accordance with applicable federal, state, and local regulations.

Storage Time Limitations

Containerized hazardous wastes can be temporarily stored for a maximum of 90 calendar days from the accumulation start date for a large quantity generator or a maximum of 180 calendar days from the accumulation start date for a small quantity generator. Wastes classified as nonhazardous may be handled and disposed of as nonhazardous waste and are not subject to storage time limitations.

This is TGI may be modified by the CPM and/or Technical Expert for a specific project or client program, as required, dependent upon client requirements, site conditions, equipment limitations, or limitations imposed by the procedure. The resulting procedure employed to execute the work will be documented in the project work plans or reports. If changes to the sampling procedures are required due to unanticipated field conditions, the changes will be discussed with the CPM and/or Technical Expert as soon as practicable, and if approved to be performed, be documented.

3 PERSONNEL QUALIFICATIONS

Arcadis field sampling personnel will have current regulatory- and Arcadis-required health and safety training including 40-hour HAZWOPER training, site supervisor training, site-specific training, first aid, and cardiopulmonary resuscitation (CPR), as needed. Personnel handling and packaging hazardous waste and performing hazardous waste characterizations must have RCRA hazardous waste management training per 40 CFR § 264.16. Additional state-specific hazardous waste management training is required in certain states (i.e., California).

Although not common practice, in certain situations Arcadis personnel may sign waste profiles and/or waste manifests on a case by case basis for clients, provided the appropriate agreement is in place between Arcadis and the client documenting that Arcadis is not the generator, but is acting as an authorized representative of the generator. Arcadis personnel who sign waste profiles and/or waste manifests will have both current RCRA hazardous waste management training per 40 CFR § 264.16 and current DOT hazardous materials transportation training per 49 CFR § 172.704. Arcadis field personnel will also comply with client-specific training. In addition, Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and Technical Guidance Instructions (TGIs) and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. The project health and safety plan (HASP) and other documents will identify other training requirements or access control requirements.

4 EQUIPMENT LIST

The Following Materials, as required, will be available for IDW handling and Storage:

- Appropriate personal protective equipment as specified in the Site Health and Safety Plan (HASP)
- DOT approved containers
- Hammer
- Leather gloves
- Drum dolly
- Appropriate drum labels (outdoor waterproof self-adhesive)
- Portable tank container
- Appropriate labeling, packing, chain-of-custody forms, and shipping materials as determined by the CPM and/or Technical Expert.
- Indelible ink and/or permanent marking pens
- Plastic sheeting
- Appropriate sample containers, labels, and forms
- Stainless-steel bucket auger
- Stainless steel spatula or knife
- Stainless steel hand spade
- Stainless steel scoop
- Digital camera
- Field logbook

5 CAUTIONS

Filled drums can be very heavy, become unbalanced, or spill its contents. Therefore, use appropriate moving techniques and equipment for safe handling. Similar media (e.g. soils with other soils; or liquids with other liquids) will be stored in the same drums to aid in sample analysis and disposal. Drum lids must be secured to prevent rainwater from entering the drums and leakage during movement. Drums containing solid material may not contain any free liquids. Waste containers stored for extended periods of time may be subject to deterioration. Drum Over Packs may be used as secondary containment. All drums must be visually inspected for condition to ensure that they are in good condition without visible evidence of rusting, holes, breakage, etc., to prevent potential leakage and facilitate subsequent disposal. All drum lids must be verified as having a properly functioning secured lid prior to use.

6 HEALTH AND SAFETY CONSIDERATIONS

As determined by the site's known and suspected hazards, appropriate PPE must be worn by all field personnel within the designated work area. Exposure air monitoring may be required during certain field activities as required in the Site Health and Safety Plan. If soil excavation in areas with potentially hazardous contaminants is possible, contingency plans will be developed to address the potential for encountering gross contamination or non-aqueous phase liquids. All excavation activities shall be in compliance with OSHA standard 29 CFR 1926.651 Excavations, and any other applicable regulations.

Arcadis field personnel and subcontractors will be trained in and perform their work in compliance with all applicable federal, state, and local health and safety regulations as well as Arcadis' HASP and applicable Client health and safety requirements.

7 PROCEDURE

Specific waste temporary storage and handling procedures to be used are dependent upon the type of generated waste, including type of media (e.g. soils or free liquids) and constituents of concern. For this reason, IDW can be stored in a secure location onsite in separate 55-gallon storage drums, where solids can be stockpiled onsite (if nonhazardous) and purge water may be stored in portable tank containers. Waste materials such as broken sample bottles or equipment containers and wrappings will be stored in 55-gallon drums unless they were not in contact with sample media.

Management of IDW

Minimization of IDW should be considered by the project team during all phases of the project. Site managers may want to consider techniques such as replacing solvent based cleaners with aqueous-based cleaners for decontamination of equipment, reuse of equipment (where it can be properly decontaminated), limitation of traffic between exclusion and support zones, and drilling methods and sampling techniques that minimize the generation of waste. Alternative drilling and subsurface sampling methods may include the use of small diameter boreholes, as well as borehole testing methods such as a core penetrometer or direct push technique instead of coring.

Drum Storage

Drums containing hazardous waste will be stored in accordance with the requirements of 40 CFR 265 Subpart I (for containers) and 265 Subpart DD (for containment buildings). All 55-gallon drums will be stored at a secure, centralized onsite location that is readily accessible for vehicular pick-up. Drums confirmed as, or assumed to contain hazardous waste will be stored over an impervious surface provided with secondary spill containment. The storage location will, for drums containing liquid, have a containment system that can contain at least the larger of 10% of the aggregate volume of staged materials or 100% of the volume of the largest container. Drums will be closed during storage and be in good condition in accordance with the Guide to Management of Investigation-Derived Wastes (USEPA, 1992).

Hazardous Waste Determination

Waste material must be characterized to determine if it meets any of the federal definitions of hazardous waste as required by 40 CFR § 262.11. If the waste does not meet any of the federal definitions, it must then be established if any state-specific or local-specific hazardous waste criteria exist/apply.

Generator Status

Once hazardous waste determination has been made, the generator status will be determined. Large quantity generators (LQG) are generators who generate more than 1,000 kilograms of hazardous waste in a calendar month. Small quantity generators (SQG) of hazardous waste are generators who generate greater than 100 kilograms but less than 1,000 kilograms of hazardous waste in a calendar month. Very small quantity generators (VSQG) are generators who generate less than 100 kilograms of hazardous

waste per month. Please note that a generator status may change from month to month and that a notice of this change is usually required by the generator's state agency.

Accumulation Time for Hazardous Waste

A LQG may accumulate hazardous waste on site for 90 calendar days or less without a permit and without having interim status, provided that such accumulation is in compliance with requirements in 40 CFR § 262.17. A SQG may accumulate hazardous waste on site for 180 calendar days or less without a permit or without having interim status, subject to the requirements of 40 CFR § 262.16. VSQG requirements are found in 40 CFR § 262.14. NOTE: The federal VSQG and SQG provisions may not be recognized by some states (e.g., California and Rhode Island). State-specific and local-specific regulations must be reviewed and understood prior to the generation of hazardous waste.

Satellite Accumulation of Hazardous Waste Satellite accumulation (SAA) will mean the accumulation of as much as fifty-five (55) gallons of hazardous waste, or the accumulation of as much as one quart of acutely hazardous waste, in containers at or near any point of generation where the waste initially accumulates, which is under the control of the operator of the process generating the waste, without a permit or interim status and without complying with the requirements of 40 CFR § 262.15 and without any storage time limit, provided that the generator complies with 40 CFR § 262.15.

Once more than 55 gallons of hazardous waste accumulates in SAA, the generator has three days to move this waste into storage.

Storage recommendations for hazardous waste include:

- Ignitable or reactive hazardous wastes must be >50 feet from the property line per 40 CFR § 265.176 (LQG generators only).
- Hazardous waste should be stored on a concrete slab (asphalt is acceptable if there are no free liquids in the waste).
- Drainage must be directed away from the accumulation area.
- Area must be properly vented.
- Area must be secure.

Drum/Container Labeling

Drums will be labeled on both the side and lid of the drum using a permanent marking pen. Old drum labels must be removed to the extent possible, descriptions crossed out should any information remain, and new labels affixed on top of the old labels. Other containers used to store various types of waste (e.g., polyethylene tanks, roll-off boxes, end-dump trailers, etc.) will be labeled with an appropriate "Waste Container" or "Testing in Progress" label pending characterization. Drums and containers will be labeled as follows:

- Appropriate waste characterization label (Pending Analysis, Hazardous, or Nonhazardous)
- Waste generator's name (e.g., client name)
- Project Name
- Name and telephone number of Arcadis project manager
- Composition of contents (e.g., used oil, acetone 40%, toluene 60%)
- Media (e.g., solid, liquid)
- Accumulation start date

- Drum number of total drums as reconciled with the Drum Inventory maintained in the field log book.

IDW containers will remain closed except when adding or removing waste. Immediately upon beginning to place waste into the drum/container, a “Waste Container” or “Pending Analysis” label will be filled out to include the information specified above, and affixed to the container. Once the contents of the container are identified as either non-hazardous or hazardous, the following additional labels will be applied.

- Containers with waste determined to be non-hazardous will be labeled with a green and white "Nonhazardous Waste" label over the "Waste Container" label.
- Containers with waste determined to be hazardous will be stored in an onsite storage area and will be labeled with the "Hazardous Waste" label and affixed over the "Waste Container" label.

The ACCUMULATION DATE for the hazardous waste is the date the waste is first placed in the container and is the same date as the date on the "Waste Container" label. DOT hazardous class labels must be applied to all hazardous waste containers for shipment offsite to an approved disposal or recycling facility. In addition, a DOT proper shipping name will be included on the hazardous waste label. The transporter should be equipped with the appropriate DOT placards. However, placarding or offering placards to the initial transporter is the responsibility of the generator per 40 CFR § 262.33.

Inspections and Documentation

All IDW will be documented as generated on a Drum Inventory Log maintained in the field log book. The Drum Inventory will record the generation date, type, quantity, matrix and origin (e.g., Boring-1, Test Pit 3, etc.) of materials in every drum, as well as a unique identification number for each drum. The drum inventory will be used during drum pickup to assist with labeling of drums. The drum storage area and any other areas of temporarily staged waste, such as soil/debris piles, will be inspected weekly. The weekly inspections will be recorded in the field notebook or on a Weekly Inspection Log. Digital photographs will be taken upon the initial generation and drumming/staging of waste, and final labeling after characterization to document compliance with labeling and storage protocols, and condition of the container. Evidence of damage, tampering or other discrepancy should be documented photographically.

Emergency Response and Notifications

Specific procedures for responding to site emergencies will be detailed in the HASP. If the generator is designated as a LQG, a Contingency Plan will need to be prepared to include emergency response and notification procedures per 40 CFR § 265 Subpart D. In the event of a fire, explosion, or other release which could threaten human health outside of the site or when Client or Arcadis has knowledge of a spill that has reached surface water, Client or Arcadis must immediately notify the National Response Center (800-424-8802) in accordance with 40 CFR § 262.265. Other notifications to state and/or other local regulatory agencies may also be necessary.

Drilling Soil Cuttings and Muds

Soil cuttings are solid to semi-solid soils generated during trenching activities, subsurface soil sampling, or installation of monitoring wells. Depending on the drilling method, drilling fluids known as "muds" may be used to remove soil cuttings. Drilling fluids flushed from the borehole must be directed into a settling section of a mud pit. This allows reuse of the decanted fluids after removal of the settled sediments. Soil cuttings will be labeled and stored in 55-gallon drums with bolt-sealed lids.

Excavated Solids

Excavated solids may include, but are not limited to: soil, fill, and construction and demolition debris. Prior to permitted treatment or offsite disposal, potentially hazardous excavated solids may be temporarily stockpiled onsite as long as the stockpile remains in the same AOC from where it was excavated. Potentially hazardous excavated solids removed from the AOC must be immediately containerized in labeled drums or closable top roll-offs lined with 9-mil polyvinyl chloride (PVC) sheeting and are subject to LQG storage time limits. Nonhazardous excavated solids can be stockpiled either inside or outside of the AOC, do not have to be containerized and are not subject to hazardous waste regulations. Potentially hazardous excavated solids must not be mixed with nonhazardous excavated solids. All classes of excavated solid stockpiles should be maintained in a secure area onsite. At a minimum, the floor of the stockpile area will be covered with a 20-mil high density polyethylene liner that is supported by a foundation or at least a 60-mil high density polyethylene liner that is not supported by a foundation. The excavated material will not contain free liquids. The owner/operator will provide controls for windblown dispersion, run-on control, and precipitation runoff. The run-on control system will prevent flow onto the active portion of the pile during peak discharge from at least a 25-year storm and the run-off management system will collect and control at least the water volume resulting from a 24-hour, 25-year storm (USEPA, 1992). Additionally, the stockpile area will be inspected on a weekly basis and after storm events. Individual states may require that the stockpile be inspected/certified by a licensed professional engineer. Stockpiled material will be covered with a 6-mil polyvinyl chloride (PVC) liner or sprayed dust control product. The stockpile cover will be secured in place with appropriate material (concrete blocks, weights, etc.) to prevent the movement of the cover.

Decontamination Solutions

Decontamination solutions are generated during the decontamination of personal protective equipment and sampling equipment. Decontamination solutions may range from detergents, organic solvents and acids used to decontaminate small field sampling equipment to steam cleaning rinsate used to wash heavy field equipment. These solutions are to be labeled and stored in closed head drums compatible with the decontamination solution. Decontamination procedures, including personnel and field sampling equipment, must comply with applicable Arcadis procedural documents.

Disposable Equipment

Disposable equipment includes personal protective equipment (e.g., tyvek coveralls, gloves, booties and APR cartridges) and disposable sampling equipment such as trowels or disposable bailers. If the media sampled exhibits hazardous characteristics per results of waste characterization sampling, contaminated disposable equipment will also be disposed of as a hazardous waste. If compatible with the original IDW waste stream (i.e., the IDW is a solid and the disposal equipment is a solid), the disposable equipment can be combined with the IDW. If these materials are not compatible (i.e., the IDW is a liquid and the disposal equipment is a solid), the disposable equipment will be stored onsite in separate labeled 55-gallon drums. Uncontaminated or decontaminated disposable equipment can be considered nonhazardous waste.

Purge Water

Purge water includes groundwater generated during well development, groundwater sampling, or aquifer testing. The volume of groundwater generated will dictate the appropriate storage procedure. Monitoring

well development and groundwater sampling may generate three well volumes of groundwater or more. This volume will be stored in labeled 55-gallon drums. Aquifer tests may generate significantly greater volumes of groundwater depending on the well yield and the duration of the test. Therefore, large-volume portable polyethylene tanks will be considered for temporary storage pending groundwater-waste characterization.

Purged Water Storage Tank Decontamination and Removal

The following procedures will be used for inspection, cleaning, and offsite removal of storage tanks used for temporary storage of purge water. These procedures are intended to be used for rented portable tanks such as Baker Tanks or Rain for Rent containers. Storage tanks will be made of inert plastic materials. The major steps for preparing a rented tank for return to a vendor include characterizing the purge water, disposing of the purge water, decontaminating the tank, final tank inspection, and mobilization. Decontamination and inspection procedures are described in further detail below.

- Tank Cleaning: Most vendors require that tanks be free of any visible sediment and water before returning, a professional cleaning service may be required. Each specific vendor should be consulted concerning specific requirements for returning tanks.
- Tank Inspection: After emptying the tank, purged water storage tanks should be inspected for debris, chemical staining, and physical damage. The vendors require that tanks be returned in the original condition (i.e., free of sediment, staining and no physical damage).

8 WASTE MANAGEMENT

Soil/Solids Characterization

Waste characterization will be conducted in accordance with waste hauler, waste handling facility, and local/state/federal requirements. In general, RCRA hazardous wastes are those solid wastes determined by a Toxicity Characteristic Leaching Procedure (TCLP) test or to contain levels of certain toxic metals, pesticides, or other organic chemicals above specific applicable regulatory agency thresholds. If the one or more of 40 toxic compounds listed in Table I of 40 CFR § 261.24 are detected in the sample at levels above the maximum unregulated concentrations, the waste must be characterized as a toxic hazardous waste. Wastes can also be considered “listed” hazardous waste depending on site-specific processes.

Composite soil samples will be collected at a frequency of one sample per 250 cubic yard basis for stockpiled soil or one per 55-gallon drum per different waste stream for containerized. A four-point composite sample will be collected per 250 cubic yards of stockpiled material and for each drum waste stream. Sample and composite frequencies may be adjusted in accordance with the waste handling facility’s requirements and may be reduced for large volumes of waste with consistent properties. Waste characterization samples will be considered valid for consistent waste streams for a period of 1 year. Waste characterization samples may be analyzed for the TCLP volatile organic compounds (VOCs), TCLP semi-volatile organic compounds (SVOCs), TCLP RCRA metals, and polychlorinated biphenyls (PCBs), as well as reactivity and flammability (flashpoint). Additional samples may be collected and analyzed by the laboratory on a contingency basis. Site-specific constituents of concern including pesticides may require additional sampling. Please note that state- or local-specific regulations may require a different or additional sampling approaches.

Wastewater Characterization

Waste characterization will be conducted in accordance with the requirements of the waste hauler, waste handling facility, and local/state/federal governments. In general, purge water should be analyzed by methods appropriate for the known contaminants, if any, that have been historically detected in the monitoring wells. Samples will be collected and analyzed in accordance with the requirements of the waste disposal facility. Wastewater characterization samples may be analyzed for TCLP volatile organic compounds (VOCs), TCLP semi-volatile organic compounds (SVOCs), TCLP RCRA metals, and polychlorinated biphenyls, as well as corrosivity (pH), reactivity and flammability (flashpoint). Additional samples may be collected and analyzed by the laboratory on a contingency basis. Site-specific constituents of concern including pesticides may require additional sampling. Please note that state- and/or local-specific regulations may require different or additional sampling approaches.

Sample Handling and Shipping

All samples will be appropriately labeled, packed, and shipped, and the chain-of-custody will be filled out in accordance with current Arcadis sample chain of custody, handling, packing, and shipping procedures and guidance instructions.

It should be noted that additional training is required for packaging and shipping of hazardous and/or dangerous materials. Please refer to the current Arcadis training requirements related to handling and shipping of samples, shipping determinations, and hazardous materials.

Preparing Waste Shipment Documentation (Hazardous and Nonhazardous)

Waste profiles will be prepared by the Arcadis CPM and forwarded, along with laboratory analytical data to the Client for approval/signature. The Client will then return the profile to Arcadis who will then forward to the waste removal contractor for preparation of a manifest. The manifest will be reviewed by Arcadis prior to forwarding to the Client for approval. Upon approval of the manifest, the Client will return the original signed manifest directly to the waste contractor or to the Arcadis CPM for forwarding to the waste contractor. Arcadis personnel may sign waste profiles and/or waste manifests on a case by case basis for clients, provided the appropriate agreement is in place between Arcadis and the client documenting that Arcadis is not the generator, but is acting as an authorized representative of the generator.

Final drum labeling and pickup will be supervised by an Arcadis representative who is trained and experienced with applicable waste labeling procedures. The Arcadis representative will have a copy of the drum inventory maintained in the field book and will reconcile the drum inventory with the profile numbers on the labels and on the manifest. Different profile numbers will be generated for different matrices or materials in the drums. For example, the profile number for drill cuttings will be different than the profile number for purge water. When there are multiple profiles it is critical that the proper label, with the profile number appropriate to a specific material be affixed to the proper drums. A copy of the Arcadis drum inventory will be provided to the waste transporter during drum pickup and to the facility receiving the waste.

9 DATA RECORDING AND MANAGEMENT

Waste characterization sample handling, packing, and shipping procedures will be documented in accordance with relevant Arcadis procedures and guidance instructions as well as applicable client and/or project requirements, such as a Quality Assurance Project Plan or Sampling and Analysis Plan. Copies of the chain-of-custody forms will be maintained in the project file. Arcadis should photograph or maintain a copy of any hazardous waste manifest signed on behalf of Client in the corresponding office DOT record file.

10 QUALITY ASSURANCE

The CPM or APM will review all field documentation once per week for errors or omissions as compared to applicable project requirements including but not limited to: the proposal/scope of work, QAPP, SAP, HASP, etc. Deficiencies will be noted, tracked, and resolved. Upon correction, they will be noted for project documentation.

11 REFERENCES

United States Environmental Protection Agency (USEPA). 1992. Guide to Management of Investigation-Derived Wastes. Office of Remedial and Emergency Response. Hazardous Site Control Division. January 1992.

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