Infrastructure · Water · Environment · Buildings

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Mr. William Wu
Division of Environmental Remediation
New York State Department of Environmental Conservation
625 Broadway
Albany, New York 12233-7014

ENVIRONMENT

Subject:
National Fuel
Dunkirk Former MGP Site
Remedial Investigation Scope of Work

Date:
February 8, 2013

Contact:
Scott A. Powlin

Phone:
315 671 9456

Email:
Scott.Powlin@arcadis-us.com

Our ref:
B0023301

Dear Mr. Wu:

On behalf of National Fuel Gas Distribution Corporation (NFG), ARCADIS is pleased to present this proposed Remedial Investigation (RI) Scope of Work (SOW) for the former manufactured gas plant (MGP) site located at 31 West 2nd Street in Dunkirk, New York. The general elements of this RI SOW were discussed during the January 14, 2013 meeting between the New York State Department of Environmental Conservation (NYSDEC), NFG, and ARCADIS. The purpose of the meeting was to introduce Mr. William Wu (NYSDEC's new project manager) to the project and discuss a path forward for the site. The meeting call was attended by Ms. Tanya Alexander and Ms. Leigh Farrell of NFG, Mr. Gardiner Cross and Mr. William Wu of the NYSDEC, and Mr. Terry Young and Mr. Scott Powlin of ARCADIS.

During the meeting, NFG and the NYSDEC discussed and agreed that the RI SOW would consist of the following three general investigations:

- Soil Vapor Intrusion (SVI) evaluation of four buildings located in proximity to the dissolved-phase benzene plume in the northeast corner of the site

- Further delineation of the source of the benzene plume in the northeast corner of the site

- Downgradient delineation of the benzene plume (northeast corner of the site) and benzene, toluene, ethylbenzene, and toluene (BTEX) plume in the western portion of the site (downgradient from MW-3)

A detailed description of these investigations is provided in the attached table and proposed investigation locations are shown on Figures 1 and 2. Field protocols for completing the RI activities are discussed below, followed by a tentative schedule and reporting for implementing this RI SOW.

Imagine the result

**Field Methods and Analytical Protocol**

As discussed in the attached table, RI field activities will be conducted in accordance with the procedures detailed in the NYSDEC-approved Site Characterization (SC) Work Plan for the Dunkirk Former MGP Site (ARCADIS, 2009) and the following supporting appendices:

- Field Sampling Plan (FSP)
- Quality Assurance Sampling and Analysis Project Plan (QA/SAPP)
- Health and Safety Plan (HASP)
- DNAPL Contingency Plan (DCP)

A Community Air Monitoring Plan (CAMP) will also be implemented during subsurface drilling activities that disturb soil. The CAMP monitoring will be performed in accordance with the NYSDEC-approved CAMP that was submitted to the NYSDEC on March 6, 2012.

As described in the QAPP, analytical samples will be submitted for laboratory analysis using United States Environmental Protection Agency (USEPA) SW-846 Methods as referenced in the most recent edition of the NYSDEC Analytical Services Protocol (ASP), with Category B analytical laboratory reports. Data Usability Summary Reports (DUSRs) of the laboratory data packages will be prepared and the results of the DUSR will be incorporated into data tables prepared for the project.

It should be noted that the FSP included in the SC Work Plan did not provide Standard Operating Procedures (SOPs) for SVI evaluations. As such, appropriate SVI-related SOPs are attached to this RI SOW for your review/approval.

**Schedule and Reporting**

A tentative schedule for implementing this RI SOW is provided in the following table:

| Activity | Schedule |
|---|---|
| NYSDEC Approval of RI SOW | February 22, 2013 (or sooner) |
| NYSDEC Distributes Revised Fact Sheet | March 1, 2013 (or sooner) |
| Implement SVI Evaluation | Heating Season (by March 31, 2013) |
| Source and Downgradient Plume Delineation | April - June 2013 |
| Submit RI Data Summary Report | August 2013 |

The above schedule is contingent upon NFGs ability to obtain access to appropriate properties. NFG will contact the three off-site property owners in late February to early March to discuss the impending SVI sampling. NFG hopes to obtain access and complete the SVI sampling before the end of this heating season.

As detailed in the attached table, NFG anticipates the following reporting will be required to support the SVI evaluation:

- Updating the existing Fact Sheet for the site and delivering the Fact Sheet to property owners in the site area. The Fact Sheet will be important for notifying SVI-related property owners of the site status. The Fact Sheet will also be useful for updating other property owners in the site area. NFG requests that the NYSDEC update the Fact Sheet and allow NFG to review the Fact Sheet before submittal to the property owners.

- NFG will submit an e-mail to the NYSDEC after the initial building assessments are completed to notify the NYSDEC of the proposed SVI sampling approach for each property.

- Submitting unvalidated data to the NYSDEC/NYS Department of Health (NYSDOH) within 48 hours after receipt of the data from the laboratory.

- Submitting brief letter reports of the SVI sampling results to each property owner. Draft letters will be provided to NYSDEC/NYSDOH for review prior to submittal to property owners. NFG assumes each letter will be approximately two pages in length and will attach a table of analytical results with comparison to appropriate criteria

Consistent with the approach for submitting SC results to the NYSDEC, NFG also proposes to submit a data summary report of all RI results to the NYSDEC and follow up the submittal with a conference call to discuss the results. We anticipate the data summary will contain:

- Monitoring well completion logs for the new monitoring wells and logs for soil borings for the new soil borings

- Analytical data summary tables for temporary well and monitoring well groundwater sample results, soil sampling results, and SVI sampling results

- A site plan showing the locations of new and existing soil borings, temporary wells, monitoring wells, and SVI evaluation buildings

- A new water table elevation contour map including the hydraulic head information from the new monitoring wells

- Updated cross-sections, as appropriate
- Updated figure depicting dissolved-phase constituents in groundwater, if any
- Updated figure depicting soil analytical results

We look forward to your approval of this RI SOW. In the meantime, if you have any questions, please feel free to contact me at 315.671.9456 or Tanya Alexander of NFG at 716.857.7410.

Sincerely,

ARCADIS of New York, Inc.

Scott A. Powlin
Sr. Geologist

Attachment

Copies:
Tanya Alexander, CHMM, REM, National Fuel
Lee Hartz, National Fuel
Gardiner Cross, NYSDEC
Anthony Lopes, NYSDEC – Region 9
Nathan Freeman, NYSDOH
Terry Young, ARCADIS

ARCADIS

**Remedial Investigation Scope of Work**

# REMEDIAL INVESTIGATION SCOPE OF WORK

## NATIONAL FUEL
## DUNKIRK FORMER MGP SITE
## DUNKIRK, NEW YORK

| Location/Activity | Action | Rationale |
|---|---|---|
| **Soil Vapor Intrusion Evaluation (Four Properties) – First RI Activity (2013 Heating Season)** | | |
| **National Fuel Service Center Building**<br><br>**17 Second Street (owned by the City of Dunkirk)**<br><br>**24 Second Street (owned by John R Davis, Jr.)**<br><br>**28 Second Street (owned by Benito Rodriguez)** | A soil vapor intrusion (SVI) evaluation will be the first field activity conducted during the Remedial Investigation (RI). The SVI will be conducted at four properties. The first step in the SVI evaluation will be to evaluate the construction and usage of the buildings on each property. Building construction and usage will be used to determine the potential scope of the SVI evaluation for each building.<br><br>Once the building assessments are completed, National Fuel will transmit an e-mail to the NYSDEC/NYSDOH to confirm the sampling approach for each building. At a minimum, National Fuel anticipates that one indoor air, one sub-slab or soil vapor, and one ambient air sample will be collected during the SVI evaluation at each building; however, the final sampling approach will be determined based on the building assessments.<br><br>Each SVI evaluation will be conducted in conformance with the New York State Department of Health (NYSDOH) document entitled <u>Guidance for Evaluating Soil Vapor Intrusion in the State of New York, Final</u>, October 2006 (Guidance), and the attached Standard Operating Procedures (SOPs).<br><br>As detailed in the attached SOPs, each soil vapor, indoor air, and ambient outdoor air sample will be collected using a 6-liter SUMMA® canister with an attached, pre-set flow regulator. The laboratory will provide batch-certified-clean canisters with and initial vacuum of approximately 29 inches of mercury (in. of Hg) for sample collection. Flow regulators will be pre-set by the laboratory to provide uniform sample collection over the desired sampling duration. Sampling durations will be as follows:<br><br>• Residential properties – 24-hr sampling duration<br>• Businesses – 8 hr sampling duration<br><br>A tracer gas (helium) will be used while collecting soil vapor samples to evaluate the integrity of the seals around the soil vapor sampling apparatus. This will provide a means to evaluate whether the samples are diluted by surface air.<br>Samples will be submitted for laboratory analysis to an ELAP | The purpose of the SVI evaluation is to<br><br>• Determine the SVI sampling approach for each property.<br><br>• Determine whether site-related volatile organic compounds (VOCs) are present in sub-slab, soil vapor, and/or indoor air.<br><br>• If present in indoor air, evaluate if the VOCs are attributable to the site or other potential sources.<br><br>• If present in indoor air, evaluate if the VOCs levels warrant additional investigation. |

| Location/Activity | Action | Rationale |
|---|---|---|
| | certified laboratory in accordance with the United States Environmental Protection Agency (USEPA) Compendium Method TO-15, titled "Determination of VOCs in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)". Samples will be analyzed for the standard TO-15 Target Analyte List, including n-alkanes as presented in Table 1. Laboratory analysis will be performed on a standard turnaround for reporting of analytical results (i.e., three to four weeks following sample collection). Within 48 hours after receiving initial, unvalidated data from the laboratory, a preliminary analytical report and figure will be prepared and transmitted to the New York State Department of Environmental Conservation (NYSDEC) and NYSDOH.<br><br>National Fuel will prepare brief letter reports of the SVI sampling results for submittal to each property owner. Draft letters will be provided to NYSDEC/NYSDOH for review prior to submittal to property owners. We've assumed each letter will be approximately two pages in length and will attach a table of analytical results with comparison to appropriate criteria. | |
| **Sump Sampling** | If, during the building assessments, buildings are determined to have sub-grade foundations with groundwater seeping into the foundations or into sumps, a grab groundwater sample will be collected from basements for Target Compound List (TCL) VOCs analysis using USEPA Method 8260. | The analytical results of potential grab groundwater samples from basements will be evaluated to determine whether dissolved-phase benzene could be present in groundwater entering the basements. |

| Location/Activity | Action | Rationale |
|---|---|---|
| **Source Delineation Near MW-1 (Gas Holder No. 1) – Second RI Activity (Spring 2013)** | | |
| **Ground Penetrating Radar (GPR)/Electromagnetic (EM) Surveys** | GPR and EM-31 will be the first field activity conducted in connection with the Source Delineation program. GPR and EM-31 will be completed in a dense grid over the location of Former Holder No. 1 and former oil tank. GPR and EM-31 surveying will also be used at each drilling location to clear utilities prior to drilling. | GPR and EM-31will be used to:<br>• Fine tune the location of Former Holder No. 1.<br>• Attempt to locate remnants of the former oil tank foundation.<br>• Fine tune the locations of soil borings and monitoring wells to be installed during the RI.<br>• Locate underground utilities at each drilling location. |
| **Vacuum Excavator Utility Clearance and Former Foundation Confirmation** | A vacuum excavator will be used to clear each soil boring and monitoring well location to approximately 5 feet below grade.<br><br>The vacuum excavator will also be used to confirm the location of Former Holder No. 1 foundation and former oil tank foundation. The vacuum excavator confirmation borings will be positioned based on the results of the GPR and EM-31 geophysical survey. Vacuum excavator borings will be completed until the intact foundations are exposed. The soil borings targeted to be inside and outside of the holder ring (below) will be fine-tuned based on the results of the vacuum excavator borings. | The vacuum excavator will enable safe drilling by identifying potential utilities at each drilling location.<br><br>The vacuum excavator will also allow for visual confirmation of the intact Former Holder No. 1 foundation and potentially the former oil tank foundation. Both of these structures could be a potential source of the dissolved-phase benzene observed in the MW-1 area. |
| **Soil Borings SB-13 through SB-24** | Soil borings will be continuously-sampled using hollow stem auger (HSA) and/or direct-push drilling techniques. The drilling rig chosen for the program will have both capabilities. Soil samples will be collected using 2-inch diameter by 2- or 4-feet long macro-core samplers. Soil recovered from each 2- or 4-foot interval will be visually characterized for color, texture, and moisture content. The presence of visible discoloration, NAPL, and obvious odors encountered in the soil will be noted.<br><br>Each boring will be drilled to the bedrock surface, which is expected to be encountered at a depth of approximately 18 to 20 feet below grade. Drilling will not be performed through any subsurface structures (e.g., concrete or brick slabs) where significant quantities of NAPL are encountered, in an effort to limit the potential downward migration of NAPL. Drilling may continue to greater depths at such locations at an alternate boring located just outside the footprint of | The purpose of drilling these soil borings is to:<br>• Collect soil samples to help define the three-dimensional distribution of benzene impacts and potential MGP-related impacts in soil in the MW-1 area.<br>• Better define the source of elevated benzene concentrations.<br>• Evaluate whether Former Holder No. 1 was constructed with a floor.<br>• Assess the potential presence of MGP-related impacts within and/or beneath the floor of Former Holder No. 1 (if a floor is present). |

## REMEDIAL INVESTIGATION SCOPE OF WORK

## NATIONAL FUEL
## DUNKIRK FORMER MGP SITE
## DUNKIRK, NEW YORK

| Location/Activity | Action | Rationale |
|---|---|---|
| | the subsurface structure. This will be determined in the field based on field observations.<br><br>Up to two soil samples will be collected from each boring and submitted to an ELAP certified laboratory for analysis of TCL VOCs, TCL SVOCs, and total cyanide using United States Environmental Protection Agency (USEPA) methods. Samples will be collected from interval(s) based on visual/olfactory observations and photoionization detector (PID) screening results. Priority will be given to intervals containing potential MGP-related impacts. Samples will also be collected from apparently "clean" intervals to provide information to define the "bottom" extent of impacted areas. If no impacts are observed in a soil boring, one soil sample will be collected near the water table and the other will be collected from the bottom of the boring (above the bedrock surface). | • Assess whether the potential source of elevated benzene detected in the MW-1 area could be outside/upgradient of Former Holder No. 1 and whether MGP-related impacts are present outside of Former Holder No. 1.<br><br>• Gather data to support a potential remedial action for the MW-1/Former Holder No. 1 area. |
| **Temporary Wells (at SB-13 through SB-24)** | Temporary wells will be installed at each boring using 1-inch diameter PVC with 10-foot long screens. Temporary wells will be installed at each location by lowering the PVC well material to the bottom of the soil boring (assumed to be on the bedrock surface) prior to pulling the augers/direct-push tooling from the boring. Natural soils will be allowed to collapse around the well screen. Groundwater samples will be collected using a new, disposable polyethylene mini bailer to purging approximately one well volume prior to sampling. Groundwater samples will be submitted to an ELAP certified laboratory and analyzed for TCL VOCs using USEPA Method 8260. Borings will be abandoned after sampling by filling the temporary well with a loose grout mixture and allowing the grout to seep into the formation, then topping the temporary well will another slug of grout prior to pulling the PVC. | The overall purpose of the temporary well groundwater sampling is to collect data to help define the distribution of benzene impacts and other potential MGP-related impacts in groundwater in the Former Holder No.1/MW-1 area, and to better define the source of elevated benzene concentrations. |

# REMEDIAL INVESTIGATION SCOPE OF WORK

## NATIONAL FUEL
## DUNKIRK FORMER MGP SITE
## DUNKIRK, NEW YORK

<table>
<tr><th>Location/Activity</th><th>Action</th><th>Rationale</th></tr>
<tr><td colspan="3">Downgradient Plume Delineation (Downgradient from MW-3 and MW-7/MW-8) – Second RI Activity (Spring 2013)</td></tr>
<tr><td><u>Monitoring Wells</u><br><br><u>MW-9 through MW-12 (downgradient from MW-7 and MW-8)</u><br><br><u>MW-13 (downgradient from MW-3)</u></td><td>Install and sample groundwater from four monitoring wells located downgradient from MW-7 and MW-8 and one monitoring well downgradient from MW-3. Well borings will be drilled and sampled in the same manner as the soil borings (described above).<br><br>Monitoring wells will be constructed using two-inch diameter schedule 40 PVC material and 0.010-inch slotted, 10-foot long well screens. The monitoring well downgradient from MW-3 will be constructed similar to the construction of MW-3: a 10-ft screen from approximately 5 to 15 feet below grade. Monitoring wells downgradient from MW-7 and MW-8 will be installed similar to the construction of MW-7/MW-8, with the bottom of each well situated on the bedrock surface (assumed to be approximately 18 feet below grade).<br><br>Monitoring wells will be developed by surging/purging the saturated portion of the screened interval. An attempt will be made to remove a minimum of 10 well volumes from each well, depending on the yielding capacity of the well.<br><br>Two rounds of groundwater samples will be collected from the monitoring wells using low-flow sampling techniques and specific-capacity test data will be measured at the new monitoring wells as water is purged during sampling.<br><br>Both rounds of groundwater samples will be submitted to an ELAP certified laboratory and analyzed for TCL VOCs, TCL SVOCs, and total cyanide using USEPA methods. Field parameters measured during groundwater sampling will include pH, turbidity, temperature, conductivity, dissolved oxygen, and oxidation-reduction potential (ORP).</td><td>The overall purpose of monitoring wells MW-9 through MW-13 will be to define the downgradient extent of dissolved-phase site –related impacts and better define the groundwater flow direction. The specific purpose of each well is as follows:<br><br>• MW-9 through MW-12: define the extent of dissolved-phase benzene downgradient from MW-7 and MW-8.<br><br>• MW-13: define the extent of dissolved-phase BTEX compounds detected in MW-3.<br><br>Monitoring wells will be developed to promote the hydraulic connection between the well screen and the surrounding geologic formation and to help remove fine sediment from the borehole wall and sand pack.<br><br>Specific-capacity data will be used to estimate the hydraulic conductivity of the saturated material screened by the monitoring wells.</td></tr>
</table>

| Location/Activity | Action | Rationale |
|---|---|---|
| **Survey** | | |
| **Survey New Borings, Wells, and Vacuum Excavator Borings** | Determine location and elevation of new wells and soil borings using a licensed land surveyor. Information measured will include the horizontal location and vertical locations of the top of the protective casing, the top of the inner casing, and the ground surface adjacent to the wells and soil borings. | Provide the information necessary to determine groundwater elevations, location/elevation of subgrade soil horizons or encountered structures.<br><br>The survey of the vacuum excavator confirmation borings will be used to update the location of Former Holder No. 1 and possibly the former oil tank onto site mapping. |
| **Field Methods and Quality Assurance for Soil and Groundwater Sampling** | | |
| The field and sampling activities will be conducted in general accordance with the appendices included in the NYSDEC-approved *Site Characterization Work Plan,* dated August 2009. The appendices include the Field Sampling Plan (FSP), Quality Assurance Sampling and Analysis Project Plan (QASAPP), Health and Safety Plan (HASP), and DNAPL Contingency Plan (DCP). Community air monitoring will also be conducted in accordance with the NYSDOH-approved Community Air Monitoring Plan (CAMP), dated March 2012.<br><br>As described in the QAPP, soil and groundwater samples will be submitted for laboratory analysis using United States Environmental Protection Agency (USEPA) SW-846 Methods as referenced in the most recent edition of the NYSDEC Analytical Services Protocol (ASP), with Category B analytical laboratory reports. Soil and groundwater samples will be analyzed for TCL VOCs, TCL SVOCs, and/or total cyanide. The soil and groundwater sample(s) (including quality assurance/quality control [QA/QC] samples) will be collected, packaged, handled, and shipped in general accordance with the QA/QC protocols and the soil and groundwater sampling protocols presented in the FSP and QASAPP.<br><br>A Data Usability Summary Report (DUSR) of the laboratory data packages will be prepared and the results of the DUSR will be incorporated into data tables which will be provided in subsequent reports. | | |

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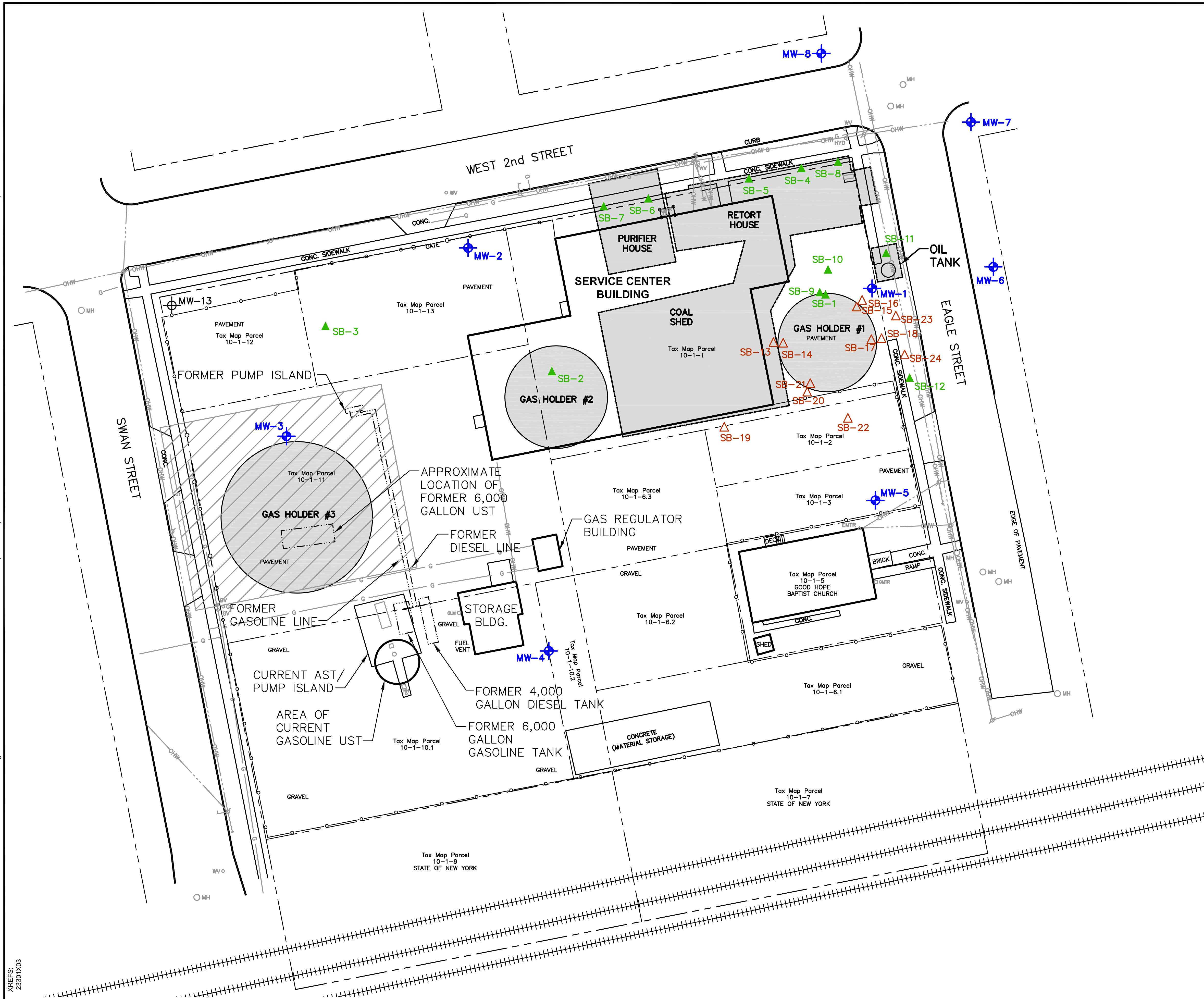
# Figures




**LEGEND:**

- PROPOSED MONITORING WELL
- PROPOSED SOIL BORING
- SOIL BORING
- MONITORING WELL
- FORMER MGP STRUCTURE
- FORMER PETROLEUM DISTRIBUTION STRUCTURES
- APPROXIMATE EXTENT OF PETROLEUM REMEDIATION AREA
- APPROXIMATE PROPERTY LINE
- RAILROAD
- EXISTING BUILDING
- CHAIN LINK FENCE
- GAS LINE
- OVERHEAD WIRE
- WATER LINE

**NOTES:**

1. ALL LOCATIONS APPROXIMATE.
2. BASEMAP FROM NYS GIS CLEARINGHOUSE WEBPAGE FOR ORTHOIMAGERY AND CT MALE SURVEY OBTAINED ON SEPTEMBER 14, 2010.
3. APPROXIMATE EXTENT OF PETROLEUM REMEDIATION AREA BASED ON A HAND SKETCH MAP PROVIDED BY NATIONAL FUEL ON JANUARY 26, 2009. DATE OF REMEDIATION NOT DEFINED ON THAT MAP.
4. LOCATIONS OF GAS HOLDERS 2 AND 3 DIGITIZED FROM A MAY 10, 1956 DRAWING PROVIDED BY NATIONAL FUEL. ALL OTHER MGP STRUCTURES DIGITIZED FROM 1893 AND 1904 SANBORN FIRE INSURANCE MAPS.
5. LOCATIONS OF FORMER USTs, PUMP ISLAND, AND ASSOCIATED DISTRIBUTION LINES FROM MESCH ENGINEERING, P.C. DRAWING ENTITLED "SITE PLAN", ORIGINAL DRAWING DATED 9/17/87.
6. MONITORING WELLS MW-5 AND MW-6, AND SOIL BORINGS SB-9 THROUGH SB-12 FROM SURVEY FILE PROVIDED BY C.T. MALE ASSOCIATES, DATED 10/7/11.

0 50' 100'

GRAPHIC SCALE

NATIONAL FUEL
DUNKIRK FORMER MGP SITE
DUNKIRK, NEW YORK
**SITE CHARACTERIZATION**

**ONSITE INVESTIGATION LOCATIONS**

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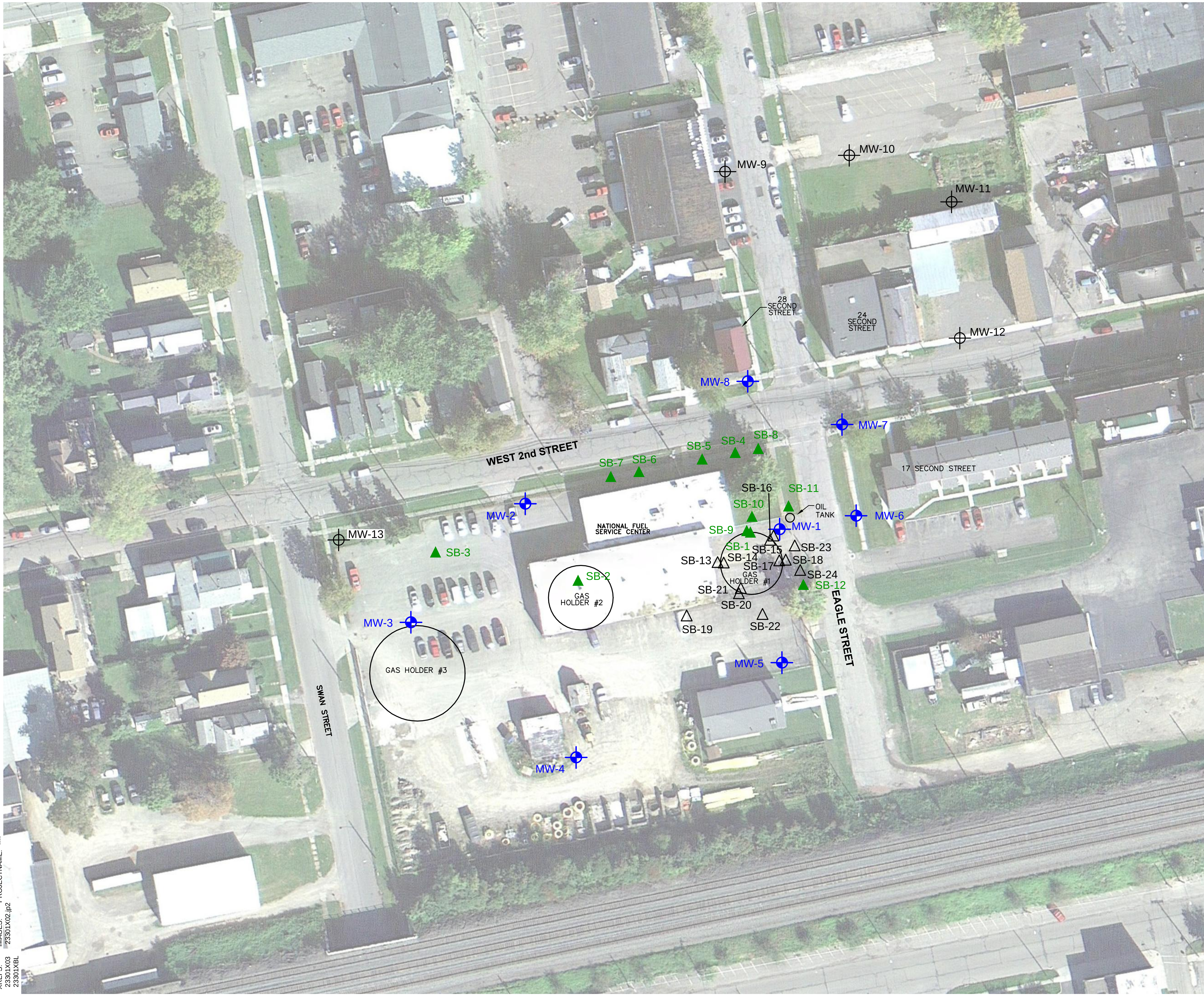
FIGURE 1




**LEGEND:**

- PROPOSED MONITORING WELL
- PROPOSED SOIL BORING
- MONITORING WELL
- SOIL BORING

**NOTES:**

1. ALL LOCATIONS APPROXIMATE.
2. LOCATIONS OF GAS HOLDERS 2 AND 3 DIGITIZED FROM A MAY 10, 1956 DRAWING PROVIDED BY NATIONAL FUEL. ALL OTHER MGP STRUCTURES DIGITIZED FROM 1893 AND 1904 SANBORN FIRE INSURANCE MAPS.
3. MONITORING WELLS MW–5 AND MW–6, AND SOIL BORINGS SB–9 THROUGH SB–12 FROM SURVEY FILE PROVIDED BY C.T. MALE ASSOCIATES, DATED 10/7/11. MONITORING WELLS MW–7 AND MW–8 FROM SURVEY FILE PROVIDED BY C.T. MALE ASSOCIATES, DATED 10/1/12.
4. AERIAL PHOTOGRAPH FROM GOOGLE EARTH PRO OBTAINED ON JANUARY 28, 2012 DATED OCTOBER 6, 2011.

0 80' 160'

GRAPHIC SCALE

NATIONAL FUEL
DUNKIRK FORMER MGP SITE
DUNKIRK, NEW YORK
**REMEDIAL INVESTIGATION**

**OFFSITE INVESTIGATION LOCATIONS**

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FIGURE
**2**

**Soil Vapor Intrusion Evaluation**
**Target Analyte List**

## TARGET ANALYTE LIST AND REPORTING LIMITS

### SVI EVALUATION
### NATIONAL FUEL
### DUNKIRK FORMER MGP SITE
### DUNKIRK, NEW YORK

| Analyte | CAS Number | Molecular Weight | Reporting Limit (ppbv) | Reporting Limit ($mg/m^3$) |
|---|---|---|---|---|
| Benzene | 71-43-2 | 78.11 | 0.20 | 0.64 |
| Benzyl chloride | 100-44-7 | 140.57 | 0.40 | 2.3 |
| Bromodichloromethane | 75-27-4 | 163.83 | 0.20 | 1.3 |
| Bromoform | 75-25-2 | 252.75 | 0.20 | 2.1 |
| Bromomethane (Methyl bromide) | 74-83-9 | 94.95 | 0.20 | 0.78 |
| 2-Butanone (Methyl ethyl ketone) | 78-93-3 | 72.11 | 1.0 | 2.9 |
| Carbon Tetrachloride | 56-23-5 | 153.84 | 0.20 | 1.3 |
| Chlorobenzene | 108-90-7 | 112.56 | 0.20 | 0.92 |
| Chloroethane | 75-00-3 | 64.52 | 0.20 | 0.53 |
| Chloroform | 67-66-3 | 119.39 | 0.20 | 0.98 |
| Chloromethane (Methyl chloride) | 74-87-3 | 50.49 | 0.50 | 1.0 |
| Cyclohexane | 110-82-7 | 84.16 | 0.50 | 1.7 |
| Dibromochloromethane | 124-48-1 | 208.29 | 0.20 | 1.7 |
| 1,2-Dibromoethane | 106-93-4 | 187.88 | 0.20 | 1.5 |
| 1,2-Dichlorobenzene | 95-50-1 | 147.01 | 0.20 | 1.2 |
| 1,3-Dichlorobenzene | 541-73-1 | 147.01 | 0.20 | 1.2 |
| 1,4-Dichlorobenzene | 106-46-7 | 147.01 | 0.20 | 1.2 |
| Dichlorodifluoromethane (Freon 12) | 75-71-8 | 120.92 | 0.20 | 0.99 |
| 1,1-Dichloroethane | 75-34-3 | 98.97 | 0.20 | 0.81 |
| 1,2-Dichloroethane | 107-06-2 | 98.96 | 0.20 | 0.81 |
| 1,1-Dichloroethene | 75-35-4 | 96.95 | 0.20 | 0.79 |
| 1,2-Dichloroethene (cis) | 156-59-2 | 96.95 | 0.20 | 0.79 |
| 1,2-Dichloroethene (trans) | 156-60-5 | 96.95 | 0.20 | 0.79 |
| 1,2-Dichloropropane | 78-87-5 | 112.99 | 0.20 | 0.92 |
| cis-1,3-Dichloropropene | 10061-01-5 | 110.98 | 0.20 | 0.91 |
| trans-1,3-Dichloropropene | 10061-02-6 | 110.98 | 0.20 | 0.91 |
| 1,2-Dichlorotetrafluoroethane (Freon 114) | 76-14-2 | 170.93 | 0.20 | 1.4 |
| 1,4-Dioxane | 123-91-1 | 88.11 | 0.50 | 1.8 |
| Ethanol * | 64-17-5 | 46.07 | 0.20 | 0.38 |
| Ethylbenzene | 100-41-4 | 106.16 | 0.20 | 0.87 |
| Hexachlorobutadiene | 87-68-3 | 260.76 | 1.0 | 10.7 |
| n-Hexane | 110-54-3 | 86.18 | 0.50 | 1.8 |
| Methylene Chloride | 75-09-2 | 84.94 | 0.50 | 1.7 |
| 4-Methyl-2-pentanone (MIBK) | 108-10-1 | 100.16 | 0.50 | 2.0 |
| MTBE (Methyl tert-butyl ether) | 1634-04-4 | 88.15 | 1.0 | 3.6 |
| Styrene | 100-42-5 | 104.14 | 0.20 | 0.85 |
| Tertiary Butyl Alcohol (TBA) | 76-65-0 | 74.12 | 2.0 | 6.1 |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | 167.86 | 0.20 | 1.4 |
| Tetrachloroethene (PCE) | 127-18-4 | 165.85 | 0.20 | 1.4 |
| Toluene | 108-88-3 | 92.13 | 0.20 | 0.75 |
| 1,2,4-Trichlorobenzene | 120-82-1 | 181.46 | 1.0 | 7.4 |
| 1,1,1-Trichloroethane | 71-55-6 | 133.42 | 0.20 | 1.1 |
| 1,1,2-Trichloroethane | 79-00-5 | 133.42 | 0.20 | 1.1 |
| 1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113) | 76-13-1 | 187.38 | 0.20 | 1.5 |
| Trichloroethene (TCE) | 79-01-6 | 131.40 | 0.20 | 1.1 |
| Trichlorofluoromethane (Freon 11) | 75-69-4 | 137.38 | 0.20 | 1.1 |
| 1,2,4-Trimethylbenzene | 95-63-6 | 120.19 | 0.20 | 0.98 |
| 1,3,5-Trimethylbenzene | 108-67-8 | 120.19 | 0.20 | 0.98 |
| 2,2,4-Trimethylpentane | 540-84-1 | 114.23 | 0.50 | 2.3 |

See Notes on Page 2.

## TARGET ANALYTE LIST AND REPORTING LIMITS

### SVI EVALUATION
### NATIONAL FUEL
### DUNKIRK FORMER MGP SITE
### DUNKIRK, NEW YORK

| Analyte | CAS Number | Molecular Weight | Reporting Limit | |
|---|---|---|---|---|
| | | | (ppbv) | ($mg/m^3$) |
| Vinyl Chloride | 75-01-4 | 62.50 | 0.20 | 0.51 |
| Xylenes (m&p) | 1330-20-7 | 106.16 | 0.20 | 0.9 |
| Xylenes (o) | 95-47-6 | 106.16 | 0.20 | 0.87 |
| Acetone (2-propanone) | 67-64-1 | 58.08 | 5.0 | 12 |
| Bromoethene | 593-60-2 | 106.96 | 0.20 | 0.87 |
| 1,3-Butadiene | 106-99-0 | 54.09 | 0.40 | 0.88 |
| Carbon Disulfide | 75-15-0 | 76.14 | 0.50 | 1.6 |
| 3-Chloropropene (allyl chloride) | 107-05-1 | 76.53 | 0.20 | 0.63 |
| 2-Chlorotoluene | 95-49-8 | 126.59 | 0.40 | 2.1 |
| 4-Ethyltoluene (p-ethyltoluene) | 622-96-8 | 120.20 | 0.40 | 2.0 |
| n-Heptane | 142-82-5 | 101.20 | 0.50 | 2.1 |
| Isopropyl Alcohol | 67-63-0 | 61.09 | 2.0 | 5.0 |
| Methyl Butyl Ketone | 591-78-6 | 100.16 | 0.50 | 2.0 |
| n-Butane | 106-97-8 | 58.12 | 0.40 | 1.0 |
| n-Decane | 124-18-5 | 142.29 | 1.0 | 5.8 |
| n-Dodecane | 112-40-3 | 170.34 | 1.0 | 7.0 |
| n-Nonane | 111-84-2 | 128.26 | 0.50 | 2.6 |
| n-Octane | 111-65-9 | 114.23 | 0.40 | 1.9 |
| n-Pentane | 109-66-0 | 72.15 | 1.0 | 3.0 |
| n-Undecane | 1120-21-4 | 156.31 | 1.0 | 6.4 |
| 1,2,3-Trimethylbenzene** | 80-62-6 | 120.19 | 0.20 | 1.0 |
| Naphthalene | 91-20-3 | 128.17 | 0.50 | 2.6 |
| 1-Methylnaphthalene** | 90-12-0 | 142.20 | 2.50 | 15 |
| 2-Methylnaphthalene** | 91-57-6 | 142.20 | 2.50 | 15 |
| Tetramethylbenzene* | 25619-60-7 | 134.21 | TBD | TBD |
| Indene** | 95-13-6 | 116.16 | 0.40 | 1.9 |
| Indane** | 496-11-7 | 118.18 | 0.20 | 1.0 |
| Thiophene** | 110-02-1 | 84.14 | 0.20 | 0.7 |

**Notes:**
1. Analyses to be performed using United States Environmental Protection Agency (USEPA) Compendium Method TO-15.
2. CAS = Chemical Abstract Services.
3. Molecular weights are presented in grams per mole.
4. ppbv = parts per billion volumetric basis.
5. $mg/m^3$ = micrograms per cubic meter.
6. TBD = To be determined; reporting limit not available.
7. * = Compound to be included in laboratory analysis as a tentatively identified compound (TIC).
8. ** = 1-point calibration.

**Soil Vapor Intrusion Evaluation**
**Standard Operating Procedures**

Infrastructure, environment, facilities

Imagine the result

# Soil-Gas Sampling and Analysis Using USEPA Method TO-17 and TO-15

SOP #112409

Rev. #: 1

Rev Date: July 9, 2010

## I. Scope and Application

This document describes the procedures to collect subsurface soil-gas samples from sub-slab sampling ports and soil vapor monitoring points for the analysis of volatile organic compounds (VOCs) including volatile polyaromatic hydrocarbons (PAHs) by United States Environmental Protection Agency (USEPA) Method TO-17 (TO-17) and USEPA Method TO-15.

The TO-17 method uses a glass or stainless steel tube packed with a sorbent material. Sorbents of increasing strength and composition are packed within the tube. The specific sorbent material packed within each tube is selected based on the target compounds and desired reporting limits. A measured volume of soil-gas is passed through the tube during sample collection.

The TO-15 method uses 1-liter 3-liter or 6-liter SUMMA® passivated stainless steel canister. An evacuated SUMMA canister (less than 28 inches of mercury [Hg]) will provide a recoverable whole-gas sample of approximately 5 liters when allowed to fill to a vacuum of approximately 6 inches of Hg. The whole-air sample is then analyzed for VOCs using a quadrupole or ion-trap gas chromatograph/mass spectrometer (GS/MS) system to provide compound detection limits of 0.5 parts per billion volume (ppbv). Optionally the canister sample can also be analyzed for fixed gasses such as Helium, Carbon dioxide and oxygen. .

Following sample collection the TO-17 tube and TO-15 canister is sent to the laboratory where the sampling media is analyzed for the target compounds.

The following sections list the necessary equipment and provide detailed instructions for the collection of soil-gas samples for analysis using TO-17 and TO-15.

Soil vapor samples can be collected from sub-slab sample probes or soil-vapor ports. Refer to the appropriate standard operating procedure (SOP) from the ARCADIS SOP library for a description of construction methods.

## 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 well versed in the relevant standard operating procedures (SOPs) and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS personnel responsible for leading soil-gas sample collection activities must have previous soil-gas sampling experience.

## III. Health and Safety Considerations

All sampling personnel should review the appropriate health and safety plan (HASP) and job loss analysis (JLA) prior to beginning work to be aware of all potential hazards associated with the job site and the specific task. Field sampling equipment must be carefully handled to minimize the potential for injury and the spread of hazardous substances. For sub-slab vapor probe installation, drilling with an electric concrete impact drill should be done only by personnel with prior experience using such a piece of equipment and with the appropriate health and safety measures in place as presented in the JLA

## IV Equipment List

The equipment required for collect soil-gas samples for analysis using method TO-15 and TO-17 is presented below:

- Appropriate personal protective equipment (PPE; as presented in the site specific HASP and the JLA)

- TO-17 tubes pre-packed by the laboratory with the desired sorbent. Specific sorbents will be recommended by the laboratory considering the target compound list and the necessary reporting limits;

- TO-17 sample flow rate calibration tubes (provided by the laboratory);

- Stainless steel SUMMA® canisters (1-liter, 3-liter, or 6-liter; order at least 5% 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., 30 minutes, 8 hours, 24 hours) 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 5% extra, if feasible). Flow rate should be selected based on expected soil type (see below).

- Two decontaminated Swagelok or stainless-steel or comparable two-way ball or needle valve (sized to match sample tubing).

- 1/4-inch outer diameter (OD) tubing (Teflon® or Teflon-lined polyethylene);

- Stainless steel or comparable Swagelok® or equivalent compression fittings for 1/4-inch OD tubing;

- Stainless steel “T” fitting (if sample train will be assembled with an inline vacuum gauge a four-way fitting will be needed);
- Three Stainless steel duplicate “T” fittings ;
- 2 Portable vacuum pumps capable of producing very low flow rates (e.g., 10 to 200 mL/min) with vacuum gauge;
- Vacuum gauge if monitoring vacuum reading during sample collection is necessary and portable vacuum pump is not equipped with a vacuum gauge;
- Rotameter or an electric flow sensor if vacuum pump does not have a flow gauge (Bios DryCal or equivalent);
- Tracer gas testing supplies (refer to Adminstering Tracer Gas SOP #41699);
- Photoionization Detector (PID) (with a lamp of 11.7 eV);
- Appropriate-sized open-end wrench (typically 9/16-inch, 1/2-inch , and 3/4-inch);
- 2 Tedlar bags;
- Portable weather meter, if appropriate;
- Chain-of-custody (COC) form;
- Sample collection log;
- Gel ice; and
- Field notebook.

## V. Cautions

The following cautions and field tips should be reviewed and considered prior to collecting soil-gas samples.

- 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.

- Care should be taken to ensure that the appropriate sorbent is used in the TO-17 tube preparation. Sorbent should be selected in consultation with the analytical laboratory and in consideration of the target compound list, the necessary reporting limits and the expected range of concentrations in field samples. The expected range of concentrations in field samples may be estimated from previous site data, release history and professional judgment informed by the conceptual site model.

- Flow rates for sample collection with TO-17 sorbent tubes should be determined well in advance of field work in consultation with the laboratory.

- A Shipping Determination must be performed, by DOT-trained personnel, for all environmental samples that are to be shipped, as well as some types of environmental equipment/supplies that are to be shipped.

- At the sampling location, keep the tubes in their storage and transportation container to equilibrate with ambient temperature prior to attaching to the sample train.

- Always use clean gloves when handling sampling tubes.

- Seal clean, blank sorbent tubes and sampled tubes using inert, Swagelok®-type fittings and PTFE ferrules. Wrap capped tubes individually in uncoated aluminum foil. Use clean, sealable glass jars or metal cans containing a small packet of activated charcoal or activated charcoal/silica gel for storage and transportation of multiple tubes. This activated charcoal is not analyzed, but serves as a protection for the analytical sorbent tube. Store the multi-tube storage container in a clean environment at 4ºC.

- Keep the sample tubes inside the storage container during transportation and only remove them at the monitoring location after the tubes have reached ambient temperature. Store sampled tubes in a refrigerator at 4ºC inside the multi-tube container until ready for analysis.

- The purge flow rate of 100 ml/min should be suitable for a variety of silt and sand conditions but will not be achievable in some clays without excessive vacuum. A low vacuum (<10” of mercury) should be maintained. Record the measured flow rate and vacuum pressure during sample collection.

The cutoff value for vacuum differs in the literature from 10” of water column (ITRC 2007) to 136” of water column or 10” of mercury (http://www.dtsc.ca.gov/lawsregspolicies/policies/SiteCleanup/upload/SMBR_ADV_activesoilgasinvst.pdf). A detailed discussion of the achievable flow rates in various permeability materials can be found in Nicholson 2007. Related issues of contaminant partitioning are summarized in ASTM D5314-92. Passive sampling approaches can be considered as an alternative for clay soils. However most passive sampling approaches are not currently capable of quantitative estimation of soil gas concentration.

- It is important to record the canister pressure, start and stop times and ID on a proper field sampling form. You should observe and record the time/pressure at a mid-point in the sample duration. It is a good practice to lightly tap the pressure gauge with your finger before reading it to make sure it isn’t stuck.

- Ensure that there is still measureable 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 or three days before the sampling date so that all materials can be checked. Order replacements if needed.

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

- Shallow exterior soil-gas sampling should not proceed within 5 days following a significant rain event (1/2-inch of rainfall or more).

## VI. Procedure

### Soil-Gas Sample Preparation

Selection of Sorbent and Sampling Volume (to be completed prior to sampling event)

1. Identify the necessary final reporting limit for the target compound(s) in accordance with the project quality assurance plan and/or in consultation with the data end user.

2. Identify the necessary method reporting limit(s). The laboratory will be helpful in providing this information as it is typically specific to the sensitivity of the instrumentation.

3. The minimum sampling volume is the volume of soil-gas sample that must be drawn through the sorbent in order to achieve the desired final reporting limit. Calculate the minimum sampling volume using the following equation:

$$Minimum\ Sampling\ Volume\ (L) = \frac{Final\ Reporting\ Limit\ (\mu g)}{Action\ Level\ (\mu g/m^3)} \times \frac{1{,}000\ L}{m^3}$$

Where:

L = liters

µg = microgram

m = meter

4. If a timed sample duration is specified in the work plan, calculate the minimum flow rate. The minimum flow rate is the flow rate necessary to achieve the minimum sampling volume using the following formula:

$$Minimum\ Flow\ Rate\ (L/min) = \frac{Minimum\ Sampling\ Volume\ (L)}{Sample\ Duration\ (min)}$$

Where:

min = minutes

Then compare the minimum flow rate calculated to the requirements for maximum soil gas sampling without excessive danger of short circuiting, normally stated as 0.2 liters/minute, although it can be lower in tight soils. Soil vapor sampling flow rates should not exceed 200 ml/min.

5. Compare the minimum sampling volume to the safe sampling volume (SSV) for the sorbents selected. SSV for specific sorbents can be provide by the manufacture or the laboratory, being used (Table 1 and Appendix 1 in Method TO-17). Ensure that the compound will not breakthrough when sampling the volume calculated above.

**Soil-Gas Sample Collection**

<u>Calibration of the sample pump prior to assembly of sampling train</u>

1. Attach the sample flow rate calibration tube provided by the laboratory to the inlet of the sample pump using a section of tubing. Attach the flow calibrator to the inlet of the sample flow rate calibration tube. The sample flow rate calibration tube should be clearly marked by the laboratory with an arrow indicating flow direction (or as otherwise specified by the laboratory).

2. Turn on the sample pump and adjust the flow rate on the sample pump to achieve the desired minimum flow rate (calculated above) as measured by the flow calibrator.

3. Repeat until each sampling pump has been properly calibrated to its appropriate flow rate.

Assembly of combined TO-17 and TO-15 sampling train

1. Record the following information in the field notebook, 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.

2. If samples are being collected from temporary or permanent soil vapor points simply remove the cap or plug and proceed to step 3. When collecting samples from a sub-slab port remove the cap or plug from the sampling port. Connect a short piece of Teflon or Teflon-lined tubing to the sampling port using a Swagelok or equivalent stainless-steel or comparable compression fitting.

3. Connect the Teflon or Teflon-lined tubing to a stainless steel T fitting using a Swagelok or equivalent stainless-steel or comparableompression fitting.

4. Remove the brass cap from the SUMMA® canister and connect the flow controller with in-line particulate filter and vacuum gauge to the SUMMA® canister. Do not open the valve on the SUMMA® canister. Record in the field notebook and COC form the flow controller number with the appropriate SUMMA® canister number.

5. Connect the flow controller to the stainless steel T fitting using a Swagelok or equivalent stainless-steel or comparable compression fitting. The TO-15 leg of the combined sampling train is now complete.

6. Attach a length of Teflon or Teflon-lined tubing to the free end of the stainless steel T fitting using a Swagelok or equivalent stainless-steel or comparble compression fitting.

7. Complete the remainder of the sampling train as depicted in Figure 1.

Purge Sampling Assembly and Sampling Point Prior to Sample Collection.

1. Ensure the two-way valve next to the flow rate calibration tube is open and the two way valve next to the TO-17 sampling tubes is closed. Purge three volumes of air from the vapor probe and sampling line using the portable pump. Measure organic vapor levels with the PID. Lower flow rates may be necessary in silt or clay to avoid excessive vacuum. Vacuum reading greater than 136 inches of water column are clearly excessive. Other available sources cite a cutoff of greater than 10 inches of water column.

2. Check the seal established around the soil vapor probe and the sampling train fittings by using a tracer gas (e.g., helium) or other method established in applicable regulatory guidance documents. [Note: Refer to ARCADIS SOP "Administering Tracer Gas," adapted from NYSDOH 2005, for procedures on tracer gas use.]

3. When three volumes of air have been purged from the vapor probe and sampling line stop the purge pump and close the valve next to the flow rate calibration tube.

TO-15 Sample Collection

1. 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 registered is not between -30 and -25 inches of Hg, then the SUMMA® canister is not appropriate for use and another canister should be used.

2. Take a photograph of the SUMMA® canister and surrounding area (unless photography is restricted by the property owner).

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

TO-15 Sample Termination

1. Arrive at the SUMMA® canister location at least 10 to 15 minutes prior to the end of the sampling interval.

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 6 inches of Hg or slightly greater).

3. Record the date and time of valve closing in the field notebook, sample collection log, and COC form.

TO-17 Sample Collection

1. Record in the field notebook and COC form the tube number on the TO-17 tube.

2. Open the two-way valve next to the TO-17 tubes

3. Turn on the sample pump to begin sample collection. Use a stopwatch to ensure accuracy in pumping time. Record in the field notebook and the field sample log the time sampling began and the flow rate from each of the sample pumps.

<u>Termination of Sample Collection</u>

1. Stop the sample pumps after the desired volume of soil-gas has passed through the sorbent, and close the two-way valves next to the TO-17 sample tubes.

2. Record the stop time.

3. Detach the Tedlar bag from each sample pump and measure the helium concentration in the soil-gas collected by the Tedlar bag. Record any detections in the field book and sample collection log.

4. Open the two-way valve to permit flow through the flow rate calibration tube. Reconnect each of the sampling pumps and measure the flow rate. Record the post-sampling flow rates in the field log book and the sample collection logs. The post-sampling flow rate should match within 10% of the pre-sample flow rate. Average the pre-sampling and post-sampling flow rate and record in the field log book, and the sample collection log.

5. Calculate the sample volume using the average of the pre-sample and post-sample flow rate. Record the sample volume in the field log book, the sample collection log, and on the COC.

6. Package the tubes according to laboratory protocol on gel ice and ship to the laboratory for analysis.

## VII. Waste Management

The waste materials generated during sampling activities should be minimal. PPE, such as gloves and other disposable equipment (i.e., tubing), will be collected by field personnel for proper disposal.

## VIII. Data Recording and Management

Measurements will be recorded in the field notebook 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), tube type and number and sample volume. Field sampling logs and COC records will be transmitted to the Project Manager.

## IX. Quality Assurance

Duplicate samples should be collected in the field as a quality assurance step. Generally, duplicates are taken of 10% of samples, but project specific requirements should take precedence. Duplicate soil gas samples should be collected via a split sample train, allowing the primary and duplicate sample to be collected from the soil-gas probe simultaneously.

Quality assurance planning for method TO-17 should take careful note of the method requirement for distributed volume pairs. Although in some circumstances this requirement may be waived, this does constitute a deviation from the method as written. It is wise to discuss this decision with clients and/or regulators before sampling.

Soil-gas sample analysis will be performed using USEPA TO-17 methodology for a site specific constituent list defined in the work plan. Constituent lists and reporting limits must be discussed with the laboratory prior to mobilizing for sampling. Quality assurance parameters should be confirmed with the laboratory prior to sampling. Field quality assurance parameters should be defined in the site-specific work plan. A trip blank sample should accompany each shipment of soil-gas samples to the laboratory for analysis. Trip blanks assess potential sample contamination resulting from the transportation and storing of samples. Soil-gas sample analysis will generally be performed using USEPA TO-15 methodology or a project specific constituent list. Method TO-15 uses a quadrupole or ion-trap GC/MS with a capillary column to provide optimum detection limits (typically 0.5-ppbv for most VOCs).

## X. References

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

AirToxics Ltd. “Sorbent & Solution Sampling Guide.”

CITY: PETALUMA, CA DIV/GROUP: ENV DB: J. HARRIS LD:--- PIC:--- PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
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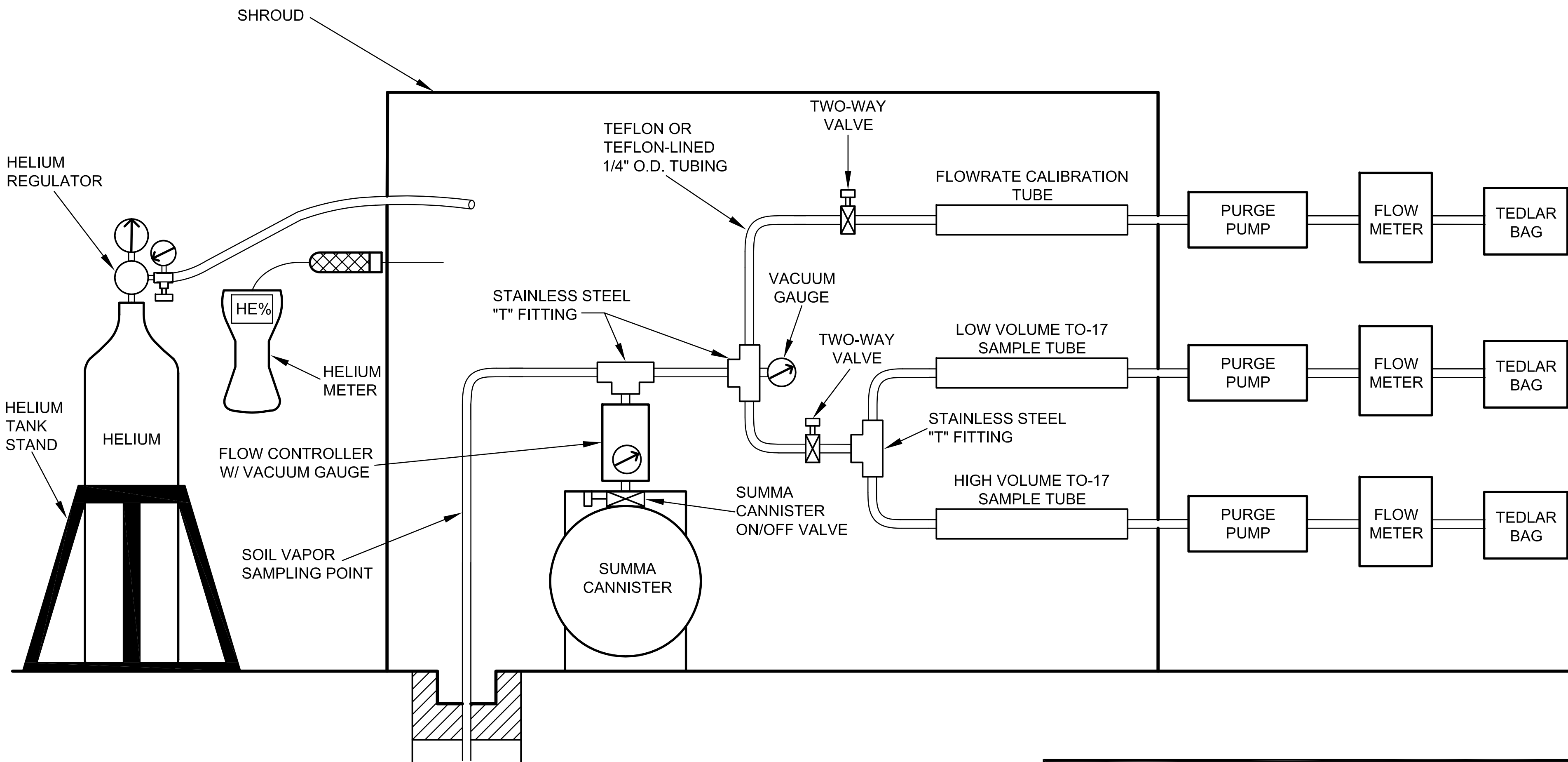


# SOIL VAPOR SAMPLING EQUIPMENT ARRANGEMENT

ARCADIS

FIGURE
1

Infrastructure, environment, facilities

Imagine the result

# Administering Helium Tracer Gas for Leak Checks of Soil Gas or Sub-slab Sampling Points

SOP #416199

Rev. #: 3

Rev Date: July 7, 2010

## I. 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 standard operating procedure (SOP) focuses on using helium as a tracer gas. However, depending on the nature of the contaminants of concern, other compounds can be used as a tracer including sulfur hexafluoride (SF6), butane and propane (or other gases). In all cases, the protocol for using a tracer gas is consistent and 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 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 SOP 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 is generally preferred as the results can be used 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 5% 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 dessication may have occurred. Points should also be rechecked if more than 2 years have elapsed since the last check of that port.

## 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 well versed in the relevant SOPs and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS personnel responsible for leading the tracer gas testing must have previous experience conducting similar tests.

## III. Health and Safety Considerations

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.

## IV. 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, 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 miminze 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 bags

- Seal material for shroud (rubber gasket, 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

## V. Cautions

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

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 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.

## VI. Procedure

The procedure used to conduct the helium tracer test should be specific to the shroud being used and the methods of vapor point installation. The helium tracer test can be conducted when using temporary or permanent sampling points and inside or outside a facility. When using the tracer gas within indoor areas you must provide adequate ventilation as helium is an asphyxiant.

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., most typically Swage-Lok brand compression fittings, but some quick release fittings could also be used etc.).

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 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.

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 > 60% helium.

8. Purge the sample point through the sample tubing into a Tedlar bag using a hand held sampling pump. The purge rate should at least match the sample collection rate but not exceed 100 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% helium is noted in purge air, add more clay or other material to the seal the sample port and repeat the testing procedure. If the seal cannot be fixed, re-install 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).

## VII. 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.

## 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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# Sub-Slab Soil-Gas Sampling Using Method TO-15 – Temporary Probe Approach

SOP # 427199

Rev. #: 4

Rev Date: July 8, 2010

## I. Scope and Application

This document describes the procedures for installing temporary sub-slab sampling probes and collect sub-slab soil gas samples for the analysis of volatile organic compounds (VOCs) by United States Environmental Protection Agency (USEPA) Method TO-15. Method TO-15 uses a 1-liter, 3-liter, or 6-liter SUMMA® passivated stainless steel canister. An evacuated 6-liter SUMMA canister (less than 28 inches of mercury [Hg]) will provide a recoverable whole-gas sample of approximately 5 liters when allowed to fill to a vacuum of 5 inches of Hg. The whole-air sample is then analyzed for VOCs using a quadrupole or ion-trap gas chromatograph/mass spectrometer (GC/MS) system to provide compound detection limits of 0.5 parts per billion volume (ppbv).

These procedures are not recommended if the probe is to be sampled more than once. Under those conditions refer to ARCADIS SOP for permanent sub-slab soil gas installations. The following sections list the necessary equipment and detailed instructions for installing temporary sub-slab soil gas probes and collecting soil-gas samples for VOC analysis.

## II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training. Site supervisor training, site-specific training, first-aid, and cardiopulmonary resuscitation (CPR) may be appropriate at some sites. ARCADIS field sampling personnel will be well versed in the relevant SOPs and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS personnel responsible for leading sub-slab soil-gas sample collection activities must have previous sub-slab soil-gas sampling experience.

## **III.** Health and Safety Considerations

All sampling personnel should review the appropriate health and safety plan (HASP) and job loss analysis (JLA) 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 conducted to minimize the potential for injury and the spread of hazardous substances. For sub-slab vapor probe installation, drilling with an electric concrete impact drill should be done only by personnel with prior experience using such a piece of equipment and with the appropriate health and safety measures in place as presented in the JLA. It is possible to encounter high concentrations of VOCs in sub-slab soil gas, so the amount of time the borehole remains open should be minimized. For the same reason, when installing sub-slab probes in spaces with minimal dilution potential, such as closets, it is advisable to provide local ventilation. Finally, sub-slab probe installation should be completed 24 hours in advance or after any indoor air sampling to avoid cross contamination of the indoor air samples.

## IV. Equipment List

The equipment required to install a temporary sub-slab vapor probe is presented below. Modifications to account for project- or regulatory-specific requirements should be noted in the accompanying work plan:

- Appropriate personal protective equipment (PPE; as required by the HASP and the JLA);
- Hammer drill (Hilti, Bosch Hammer, or equilivant);
- 1/2 inch-diameter concrete drill bit (drill bit length contingent on slab thickness);
- Hand tools including open-end wrench (typically 9/16-inch), pliers, channel lock pliers, etc;
- 1/4-inch OD tubing (Teflon, nylon, or Teflon-lined); Note that Nylaflow tubing has a somewhat higher background level of BTEX and much poorer recovery of tirchlorobenzene and naphthalene then Teflon, so should not be used on sites where these compounds are a concern (Hayes, 2006).
- Teflon® tape;
- Work gloves;
- Nitrle gloves;
- Hydrated bentonite, VOC-free modeling clay that complies with ASTM D4236 (McMaster Carr 6102T11 recommended) or wax to seal drill hole (see cautions section);
- Whisk broom and dust pan;
- Bottle brush;
- Ground fault circuit interrupter (GFCI);
- Extension cords rated for amperage required for hammer drill;
- Plastic sheeting; and

- Shop vacuum with clean fine-particle filter.

The equipment required for sub-slab soil gas 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., 30 minutes, 8 hours, 24 hours) 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);
- Extra 1/4-inch Swagelok front and back compression sleeves;
- Swage-Lok fittings;
- Decontaminated stainless steel Swagelok or comparable “T” fitting and needle valve for isolation of purge pump;
- Two 3-inch lengths of 1/4-inch OD Teflon tubing;
- Stainless steel duplicate “T” fitting provided by the laboratory (if collecting duplicate [i.e., split] samples);
- Portable vacuum pump capable of producing very low flow rates (e.g., 100 to 200 milliliters per minute [mL/min]); vacuum pump should also be equipped with a vacuum gauge;
- Rotameter or an electric flow sensor if vacuum pump does not have and accurate flow gauge;
- Tracer gas testing supplies if applicable (refer to SOP ”Adminstering Tracer Gas” #416199);
- Appropriate-sized open-end wrench (typically 9/16-inch and1/2”);

- Photo Ionization Detector (PID) with a lamp of 11.7 eV; detectable to ppb range (optional);

- Tedlar bag to collect purge air;

- Portable weather meter, if appropriate (temperature, barometric pressure, humidity, etc);

- Quick setting grout or sika flex to seal abandoned holes;

- Chain-of-custody (COC) form;

- Sample collection log (attached); and

- Field notebook.

## V. Cautions

The following cautions and field tips should be reviewed and considered prior to installing or collecting a sub-slab soil gas sample.

- When drilling sample collection holes be mindful of utilities that may be in the area. Always complete utility location, identification and marking before installing subslab ports as required by the ARCADIS Utility Location Policy and Procedure. Be aware that public utility locator organizations frequently do not provide location information within buildings so alternative lines of evidence must be used. If the driller is concerned about a particular location, consult the project manager about moving it to another location. Don’t be hesitant to use your Stop Work Authority, if something doesn’t seem right stop and remedy the situation.

- Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens, 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. Do not let sample canister reach atmospheric pressure (e.g., 0-inches Hg).

- Field personnel will properly seal the vapor probe at the slab surface to prevent leaks of atmosphere into the soil vapor probe during purging and sampling. Temporary points should be fit snug into the pre-drilled hole using Teflon® tape or modeling clay and sealed with hydrated bentonite, clay or wax at the surface. If this is not done properly, the integrity of the sample port may be compromised.

- Modeling clay or other materials used to seal the hole should only be obtained from an approved ARCADIS source and should not be purchased off the shelf from an unapproved retail source. Data indicate that some modeling clays may contain VOCs that can affect sample results.

- It is important to record the canister pressure, start and stop times and sample identification on a proper field sampling form. Often Summa canisters are collected over a 24 hour period. The time/pressure should be recorded at the start of sampling, and then again one or two hours later. It is a good practice to lightly tap the pressure gauge with your finger before reading it to make sure it isn't stuck. If the canister is running correctly for a 24 hour period then the vacuum will have decreased slightly after an hour or two (for example from 29" to 27"). Consult your project manager (PM), risk assessor or air sampling expert by phone if the Summa canister does not appear to be working properly.

- Ensure that there is still measureable vacuum in the Summa after sampling. Sometimes the gauges sent from the lab 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 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 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-gas sampling port by using a tracer gas (e.g., helium) or other method established in the appropriate guidance document.

## VI. Procedure

Temporary sub-slab soil vapor probes are installed using equipment and procedures that allows the point to be installed quickly and abandoned after an initial sample is collected. These procedures are not recommended if the probe is to be sampled more than once. Under those conditions refer to ARCADIS SOP for permanent sub-slab soil gas installations.

**Sub-slab Soil Gas Point Installation**

1. Complete the ARCADIS Utility Locate SOP prior to drilling activities.

2. Remove, only to the extent necessary, any covering on top of the slab (e.g., carpet).

3. Lay down plastic sheeting to keep the work area clean. Check to make sure shop vacuum is working properly and fine concrete particles will not pass through filter

4. Drill a 1/2-inch-diameter hole into the concrete slab using the electric drill. Do not fully penetrate the slab at this time. Stop drilling approximately 1 inch short of penetrating the slab.

5. Use the shop vacuum, bottle brush and dust broom to clean up the work area and material that may have fallen into and around the drill hole..

6. Advance the 1/2-inch drill bit the remaining thickness of the slab and approximately 3 inches into the sub-slab material to create an open cavity. Note (if possible) from the drill cuttings any evidence for the types of materials in the immediate sub-slab – i.e. moisture barriers, sand, gravel, shrinkage gap?

7. Use the bottle brush, whisk broom, and dust pan to quickly clean material around and within the hole. The hole should not be left open for any extended length of time to ensure that VOCs below the slab do not migrate into indoor air. Do not use the shop vacuum to clean up the drill hole after the full thickness of the slab has been penetrated.

8. Re-drill the 1/2 – inch hole to ensure it remains clear. This can also be accomplished using a piece of steel rod, sample tubing, or even a piece of heavy wire (coat hanger).

9. Wrap the tubing with Teflon® tape or modeling clay, to the extent necessary, for a snug fit of tubing and hole.

10. Insert the tubing approximately 2 to 3 inches into the slab; tubing should not contact material beneath the slab. Tubing should be capped with clay or other fitting so it does not provide a pathway for vapor movement.

11. Prepare a hydrated bentonite mixture and apply bentonite at slab surface around the tubing. Instead of hydrated bentonite, either VOC free modeling clay (McMaster-Carr #6102T11) or wax may be used for the temporary seal around the tubing where it enters the slab.

12. Proceed to soil gas sample collection after waiting a minimum of 1 hour for equilibration following probe installation.

**Sub-Slab Soil Gas Sample Collection**

Once the temporary sample probe is installed, the following procedure should be used to collect the sample in the Summa canister.

1. 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.

2. Assemble the sample train by removing the cap from the SUMMA canister and connecting the Swagelok T-fitting to the can using a short length of 1/4-inch OD Teflon tubing. The flow controller with in-line particulate filter and vacuum gauge is then attached to the T-fitting. The Swagelok (or similar) two-way valve is connected to the free end of the T-fitting using a short length of ¼-inch OD Teflon tubing.

3. 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.

4. Perform a leak-down-test by replacing the nut which secures sample tubing with the cap from the canister. This will create a closed system. Open the canister valve and quickly close it; the vacuum should increase approaching 30" Hg. 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.

5. Attach Teflon sample tubing from the temporary probe to the flow controller using Swagelok fittings.

6. Connect the two-way valve and the portable purge pump using a length of Teflon sample tubing.

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

8. If appropriate, the seal around the soil-gas sampling port and the numerous connections comprising the sampling train will be evaluated for leaks using helium as a tracer gas. The helium tracer gas will be administered according to the methods established in the appropriate guidance documents and SOP: Administering Helium Tracer Gas.

9. Open the two-way valve and purge the soil-gas sampling port and tubing with the portable sampling pump. Purge approximately three volumes of air from the soil-gas sampling port and sampling line using a flow rate of 200 mL/min or less. 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. Measure organic vapor levels and tracer gas within the Tedlar bag, as appropriate.

10. Close the two-way valve to isolate the purge pump.

11. 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.

Sampling flow rate should be 200 mL/min or less.

12. Take a photograph of the SUMMA® canister and surrounding area unless prohibited by the building owner.

13. 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 location at least 10 to 15 minutes prior to the end of the required sampling interval in order to have sufficient time to terminate the 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 (ideally 3-7 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. 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.

5. Package the canister and flow controller in the shipping container supplied by the laboratory for return shipment to the laboratory. The SUMMA® canister does not require preservation with ice or refrigeration during shipment.

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

7. 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.

8. A Shipping Determination must be performed, by DOT-trained personnel, for all environmental and geotechnical samples that are to be shipped, as well as some types of environmental equipment/supplies that are to be shipped.

9. Remove the tubing and grout the hole in the slab with quick-setting hydraulic cement powder, Sika-Flex, or other material similar to the slab. This step must be done carefully to ensure that the abandoned sampling point does not become a preferential flow pathway.

10. Replace the surface covering (e.g., carpet) to the extent practicable. Sample collection location should be returned to pre-sampling conditions/

## VII. Waste Management

The volume of waste materials generated by these activities should be minimal. Personal protective equipment, such as gloves and other disposable equipment (i.e., tubing) should be collected by field personnel for proper disposal.

## VIII. Data Recording and Management

Information collected in the field should be recorded in the field notebook as well as written on the field sampling log and COC, as appropriate. The field notebook and sampling log must include the project name, sample date, sample start and finish time, sample location (e.g., global positioning system [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 PM.

## IX. Quality Assurance

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

Soil-gas sample analysis will generally be performed using USEPA TO-15 methodology or a project specific constituent list. Method TO-15 uses a quadrupole or ion-trap GC/MS with a capillary column to provide optimum detection limits (typically 0.5-ppbv for most VOCs).

## X. References

ASTM – “Standard Guide for Soil Gas Monitoring in the Vadose Zone”, D5314-92.

Hayes, H. C., D.J. Benton and N. Khan "Impact of Sampling media on Soil Gas Measurements" Presented with short paper at AWMA Vapor Intrusion Conference January 2006, Philadelphia PA.

ITRC "Vapor Intrusion Pathway: A Practical Guide", January 2007, Appendix F: "regulators Checklist for Reviewing Soil Gas Data"

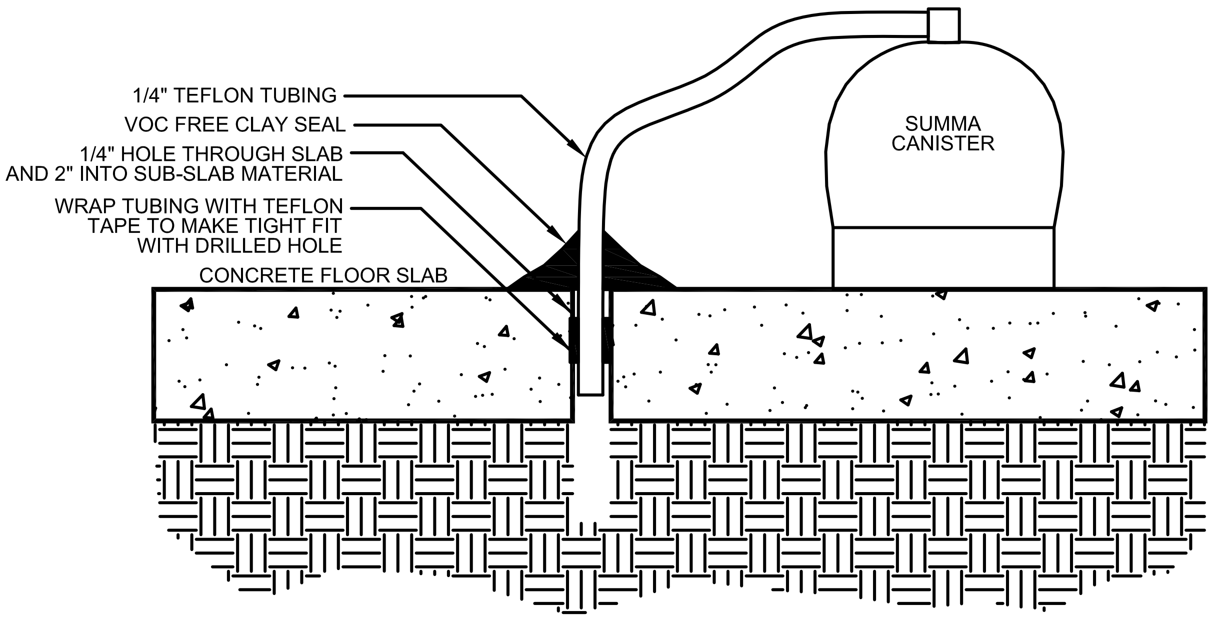


**DIAGRAM OF TEMPORARY SUB-SLAB SAMPLE POINT**

ARCADIS

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# Ambient Air Sampling and Analysis Using USEPA Method TO-15

Rev. #: 1

Rev Date: March 13, 2009

## I. Scope and Application

This standard operating procedure (SOP) describes the procedures to collect ambient air samples for the analysis of volatile organic compounds (VOCs) using United States Environmental Protection Agency (USEPA) Method TO-15 (TO-15). The TO-15 method uses a 6-liter SUMMA® passivated stainless steel canister. An evacuated SUMMA® canister (<28 inches of mercury [Hg]) will provide a recoverable whole-gas sample of approximately 5.5 liters when allowed to fill to a vacuum of 2-7 inches of Hg. The whole-air sample is then analyzed for VOCs using a quadrupole or ion-trap gas chromatograph/mass spectrometer (GS/MS) system to provide compound detection limits of 0.5 parts per billion volume (ppbv).

The following sections list the necessary equipment and detailed instructions for placing the sampling device and collecting ambient air samples for VOC analysis.

## 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 well versed in the relevant SOPs and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS personnel responsible for leading ambient air sample collection activities must have previous ambient air sampling experience.

## III. Equipment List

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

- 6-liter, stainless steel SUMMA® canisters (order at least one extra, if feasible);
- Flow controllers with in-line particulate filters and vacuum gauges (flow controllers are pre-calibrated by the laboratory to a specified sample duration [e.g., 8-hour]). Confirm with lab that flow controller comes with in-line particulate filter and pressure gauge (order an extra set for each extra SUMMA® canister, if feasible);
- Appropriate-sized open-end wrench (typically 9/16-inch);
- Chain-of-custody (COC) form;
- Field notebook;

- Sample collection log (attached);
- Camera;
- Lock and chain; and
- Ladder or similar to hold canister above the ground surface (optional).

## IV. Cautions

Care must be taken to minimize the potential for introducing interferences during the sampling event. As such, care must be taken to keep the canister away from public roadways to prevent collection of automobile source pollutants (unless this is the objective of the study). Care must also be taken to keep the canister away from heavy pedestrian traffic areas (e.g., main entranceways, walkways). If the canister is not to be overseen for the entire sample duration, precautions should be taken to maintain the security of the sample (e.g., do not place in areas regularly accessed by the public, fasten the sampling device to a secure object using lock and chain, label the canister to indicate it is part of a scientific project, place the canister in secure housing that does not disrupt the integrity/validity of the sampling event). Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens, wear/apply fragrances, or smoke cigarettes/cigars before and/or during the sampling event.

Care should also be taken to ensure that the flow controller is pre-calibrated to the proper sample collection time (confirm with laboratory). Sample integrity is maintained if the sampling event is shorter than the target duration, but sample integrity can be compromised if the event is extended to the point that the canister reaches atmospheric pressure.

A Shipping Determination must be performed, by DOT-trained personnel, for all environmental and geotechnical samples that are to be shipped, as well as some types of environmental equipment/supplies that are to be shipped.

## V. Health and Safety Considerations

Field sampling equipment must be carefully handled to minimize the potential for injury and the spread of hazardous substances.

## VI. Procedure

### Preparation of SUMMA®-Type Canister and Collection of Sample

1. Record the following information in the field notebook (contact the local airport or other suitable information source [e.g., weatherunderground.com] to obtain the following information):

   - ambient temperature;
   - barometric pressure; and
   - relative humidity.

2. Choose the sample location in accordance with the sampling plan. If a breathing zone sample is required, place the canister on a ladder, tripod, or other similar stand to locate the canister orifice 3 to 5 feet above ground. If the canister will not be overseen for the entire sampling period, secure the canister as appropriate (e.g., lock and chain).

3. Record SUMMA® canister serial number and flow controller number in the field notebook and COC form. Assign sample identification on canister ID tag and record in the field notebook, sample collection log (attached), and COC form.

4. Remove the brass dust cap from the SUMMA® canister. Attach the flow controller with in-line particulate filter and vacuum gauge (leave swage-lock cap on the vacuum gauge during this procedure) to the SUMMA® canister with the appropriate wrench. Tighten with fingers first, then gently with the wrench.

5. Open the SUMMA® canister valve to initiate sample collection. Record the date and local time (24-hour basis) of valve opening in the field notebook, sample collection log, and COC form.

6. Record the initial vacuum pressure in the SUMMA® canister in the field notebook and COC form. If the initial vacuum pressure does not register less than -28 inches of Hg, then the SUMMA® canister is not appropriate for use and another canister should be used.

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

**Termination of Sample Collection**

1. Arrive at the SUMMA® canister location at least 10 to 15 minutes prior to the end of the sampling interval (e.g., 8-hour).

2. Stop collecting the sample when the canister vacuum reaches approximately 2-7 inches of Hg (leaving some vacuum in the canister provides a way to verify if the canister leaks before it reaches the laboratory) or when the desired sample time has elapsed.

3. Record the final vacuum pressure. Stop collecting the sample by closing the SUMMA® canister valve. Record the date and local time (24-hour basis) of valve closing in the field notebook, sample collection log, and COC form.

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

5. Package the canister and flow controller in the shipping container supplied by the laboratory for return shipment to the laboratory. The SUMMA® canister does not require preservation with ice or refrigeration during shipment.

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

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

## VII. Waste Management

No specific waste management procedures are required.

## VIII. Data Recording and Management

Measurements will be recorded in the field notebook at the time of measurement, with notations of project name, sample date, sample start and finish times, sample location (e.g., GPS coordinates if available), canister serial number, flow controller number, initial vacuum reading, and final vacuum reading. Field sampling logs and COC records will be transmitted to the Project Manager.

## IX. Quality Assurance

Ambient air sample analysis will be performed using USEPA Method TO-15. This method uses a quadrupole or ion-trap GC/MS with a capillary column to provide optimum detection limits. The GC/MS system requires a 1-liter gas sample (which can easily be recovered from a 6-liter canister) to provide a 0.5 ppbv detection limit. The 6-liter canister also provides several additional 1-liter samples in case subsequent reanalyses or dilutions are required. This system also offers the advantage of the GC/MS detector, which confirms the identity of detected compounds by evaluating their mass spectra in either the SCAN or SIM mode.

## X. References

[Click here and enter Text]

| ARCADIS Infrastructure, environment, facilities | Indoor/Ambient Air Sample Collection Log | |
|---|---|---|
| | Sample ID: | |

| | | | |
|---|---|---|---|
| **Client:** | | **Outdoor/Indoor:** | |
| **Project:** | | **Sample Intake Height:** | |
| **Location:** | | **Miscellaneous Equipment:** | |
| **Project #:** | | **Time On/Off:** | |
| **Samplers:** | | **Subcontractor:** | |

**Instrument Readings:**

| Time | Canister Pressure (inches of HG) | Temperature (F or C) | Relative Humidity (%) | Air Speed (ft/min) | Pressure Differential (inches of H20) | PID (ppm or ppb) |
|---|---|---|---|---|---|---|
| | | | | | | |
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**SUMMA Canister Information:**

**Size (circle one): 1 L 6 L**

**Canister ID:**

**Flow Controller ID:** ____________________

**General Observations/Notes:**

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Please record current weather information including wind speed and direction, ambient temperature, barometric pressure, and relative humidity via suitable information source (e.g., weatherunderground.com).