ROUX

Interim Remedial Measure Work Plan

12 Franklin Street
Brooklyn, New York 11222

January 25, 2024

Prepared for:

Franklin Point LLC
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1. Introduction

Roux Environmental Engineering and Geology, D.P.C. (Roux) has prepared this Interim Remedial Measures (IRM) Work Plan (IRMWP) on behalf of Franklin Point LLC / Franklin Point Holding LLC (referred to herein as the "Volunteer") for the property located at 12 Franklin Street (Tax Block 2614, Lot 3) in the Greenpoint section of the Borough of Brooklyn in the City and State of New York (Site). The Site location map is provided as Figure 1. This IRMWP will be implemented in accordance with the New York State Department of Environmental Conservation (NYSDEC) Brownfield Cleanup Program (BCP), and the Brownfield Cleanup Agreement (BCA) dated March 28, 2019 and the associated BCA Amendment No. 1 dated September 21, 2023, which added the Volunteer to the BCA. The Volunteer has purchased the Site, and a second BCA Amendment was executed on January 8, 2024 to reflect this change of ownership. This revision of the IRMWP has been issued in response to NYSDEC and NYSDOH's conditional acceptance of the IRMWP, as documented in letter correspondence dated November 30, 2023.

The Site is improved with three structures as described below:

- One-story slab-on-grade vacant building, which was most recently used as a bar/restaurant/brewery and warehouse;
- Two-story slab-on-grade vacant building, which was most recently used as a bar/restaurant, and one-story building that was most recently used as a plumbing hardware store; and
- One-story building with a partial cellar that was most recently used as a music studio.

As part of the interim use for the Site prior to redevelopment, the existing structures will be renovated for a commercial/industrial mixed-use building (manufacturing/retail/office). While residential reuse possibilities may be contemplated in the future, they are not under consideration at this time. Any such consideration would be in tandem with future building demolition and additional remediation efforts. The building is currently unoccupied, and an interior build-out will occur prior to tenant occupancy.

This IRMWP is being proposed to meet the following objectives:

1) Install an active sub-slab depressurization system (SSDS) beneath portions of the existing building to address potential soil vapor intrusion of chlorinated volatile organic compounds (CVOCs) documented to be present in soil vapor beneath portions of the on-Site building that exceed NYSDOH's 2006 (as revised in 2017) Guidance for Evaluating Soil Vapor Intrusion in the State of New York (NYSDOH Vapor Guidance) decision matrices for mitigation. No on-Site source area of chlorinated solvents has been identified to date, but this IRM is being implemented to make the Site safe for the planned interim commercial/industrial use building occupants.
2) Investigate the potential presence of underground storage tanks (USTs) at the Site and properly close any USTs that may be encountered.

This IRMWP has been prepared in accordance with NYSDEC procedures set forth in the guidance document titled DER-10 Technical Guidance for Site Investigation and Remediation, dated May 2010 (DER-10), and the NYSDOH Vapor Guidance, dated October 2006 and updated May 2017 (NYSDOH Guidance), and complies with all applicable Federal, State and local laws, regulations and requirements. Additionally, all interior invasive work will be completed in accordance with the health and safety plan (HASP) provided as Appendix A. A Community Air Monitoring Plan (CAMP) is not required because all work will be performed inside the vacant building.

1.1 Objectives and Scope of the IRMWP

The proposed IRM will retrofit portions of the existing building at the Site with an SSDS capable of creating negative pressure under the building. This SSDS will prevent potentially contaminated vapor from entering the building indoor air by creating a preferential pathway for the discharge of such vapor to the outdoor air at a specific required height above the roof of the Site building. As expanded on in the remaining portions of this IRMWP, an SSDS pilot study was completed at the Site and was used to confirm the design of the SSDS provided herein as Drawing 1, which is provided as Appendix B. In addition to the SSDS installation, the suspected USTs at the Site (if encountered) will also be removed, and endpoint samples will be taken. This IRM is a component of the overall investigation and remediation of the Site, which will address the currently known soil vapor intrusion issues and allow for the interim reuse of the existing building for commercial and industrial tenants.

The remainder of this IRMWP is organized as follows:

- Section 2: Site Overview and Background
- Section 3: IRM Scope of Work
- Section 4: Soils/Materials Management Plan
- Section 5: Reporting
- Section 6: IRM Implementation Schedule

1.2 Certification

I, David Kaiser, P.E., certify that I am currently a registered professional engineer in the State of New York as defined in 6 NYCRR Part 375 and that this IRMWP was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER-10.

I certify that all information and statements in this certification are true. I understand that a false statement made herein is punishable as a Class "A" misdemeanor, pursuant to Section 210.45 of the Penal Law.

STATE OF NEW YORK
DAVID ERIC KAISER
097317
LICENSED PROFESSIONAL ENGINEER

David Kaiser, P.E.	January 25, 2024	
NYS Professional Engineer # 097317	Date	Signature

It is a violation of Article 130 of New York State Education Law for any person to alter this document in any way without the express written verification of adoption by any New York State licensed engineer in accordance with Section 7209(2), Article 145, New York State Education Law.

2. Site Overview and Background

This section provides relevant Site background information.

2.1 Site Location and Description

The Site address is 12 Franklin Street in the Borough of Brooklyn, City and State of New York (Figure 1). Additional information regarding the Site is provided in the tables below:

Property Location	
Property Name:	12 Franklin Street
Property Address:	12 Franklin Street
Property Town, County, State:	Brooklyn, Kings County, New York
Property Tax Identification:	Tax Block 2614, Lot 3
Property Topographic Quadrangle:	USGS; Brooklyn (2019) 7.5 Minute Topographic Quadrangle
Nearest Intersections:	(Northwest) Franklin Street and Meserole Avenue (Southwest) Franklin Street and N 15th Street (Southeast) Gem Street and N 15th Street (Northeast) Gem Street and Meserole Avenue
Area Description:	The Site is located in an urban and developed area. The surrounding properties are currently used as commercial or industrial properties.

Property Information	
Acreage:	0.66 acres
Shape:	Trapezoidal
Number of Buildings:	One
Number of Stories:	One with partial second story in northwest corner
Cellar/Slab-on-Grade:	Partial cellar in northeast corner
Property Use:	The Site is improved with three structures as described below: • One-story slab-on-grade vacant building was most recently used as a bar/restaurant/brewery and warehouse. • Two-story slab-on-grade vacant building that was most recently used as a bar/restaurant and one-story building that was most recently used as a plumbing hardware store. • One-story building with a partial cellar that was most recently used as a music studio. During the reconnaissance, the Subject Property was not identified to have any active tenants.

2.1.1 Historic Land Uses

According to available sources, the Site was developed with the current one-story building by 1951. The Site was occupied by multiple commercial entities including Ace Cellophane & Polyethylene Corp, Polycraft, Synerjol Co, Hardchrome Electro Processing Corp, ACME Finishing Co Inc, and Linaire Corp from 1960 to 2017.

2.2 Summary of Environmental Investigations

In December 2015, AECOM prepared a Phase I Environmental Site Assessment (ESA) (2015 AECOM Phase I ESA) for the Site on behalf of the previous property owner, original Volunteer, 12 Franklin Property Co LLC, and in their assessment identified the following in connection with the Site.

1. AECOM identified that there was no removal documentation provided for a 2,000-gallon #2 fuel oil UST that was located within the western portion of the Site within the former brewery space (Dirck the Norseman). AECOM indicated that residual petroleum contamination may be present in connection with this UST.
2. AECOM indicated that the 1942 and 1951 Sanborn Maps identified three gasoline USTs at the Site. AECOM indicated that there is potential for USTs beneath the former Dirck the Norseman brewery space.
3. AECOM indicated that during the inspection a vent pipe was identified near 8 Meserole Avenue, which corresponded to a 1,080-gallon #2 fuel oil UST according to Fire Department of New York (FDNY) records.
4. The former operations associated with historical operators (Superior Bearing Bronze Company and Hard Chrome Electro Processing Corporation) generated wastes associated with electroplating including spent cyanide plating bath solutions, spent stripping chemicals, corrosive wastes and cleaning bath solutions. AECOM indicated that these operations may have discharged these wastes to the subsurface and adversely impacted upon the environmental quality of the Subject Property.
5. AECOM also indicated that the New York City Department of Environmental Protection (NYCDEP) fueling facility located approximately 150-feet to the south of the Site had three 1,000-gallon gasoline USTs removed in 1984 and currently has three active 1,000-gallon gasoline USTs. The NYSDEC closed the files on the removed USTs in 1998. However, due to the lack of available information regarding the removal of the USTs or the current operations of the active USTs, as well as the proximity of this site, AECOM determined that the former and current USTs at this site are considered a recognized environmental condition.
6. AECOM indicated that the W.H. Christian & Sons at 22-28 Franklin Street is a uniform rental, laundry and dry cleaning facility located approximately 130-feet to the north-northwest of the Site. Operations were noted to be ongoing from approximately 1939 to 1992. AECOM indicated that the potential for dry cleaning related contamination could not be ruled out.

In October 2018, Langan Environmental Engineering, Environmental, Surveying, Landscape Architecture and Geology, D.P.C. (Langan) completed a limited subsurface investigation at the Site on behalf of 12 Franklin Property Co LLC. A summary of the soil, groundwater and sub-slab vapor sampling results is discussed below.

1. **Soil Data** - Soil samples were compared to NYSDEC Unrestricted Use Soil Cleanup Objectives (UUSCOs) and Restricted Commercial Use SCOs (RCSCOs). RCSCO exceedances were identified for semivolatile organic compounds (SVOCs) characterized as polycyclic aromatic hydrocarbons (PAHs). UUSCO exceedances were identified for two pesticides. The metals arsenic and copper were identified at concentrations exceeding RCSCOs.
2. **Groundwater Data** - Groundwater samples were compared to NYSDEC Technical and Operational Guidance Series (TOGS). The volatile organic compounds (VOCs) 1,2,4,5-tetramethylbenzene,

chloroethane, n-propylbenzene and naphthalene were identified to exceed their respective TOGS values. The SVOCs benzo(a)anthracene, chrysene and naphthalene were identified to exceed their respective TOGS values. Several dissolved metals including iron, manganese and sodium were identified to exceed their respective TOGS values.

3. **Sub-Slab Vapor Data** - Sub-slab vapor detections of considerable note included 1,1,1-trichloroethane (max. 4,220 micrograms per cubic meter [µg/m^3]), carbon tetrachloride (max. 150 µg/m^3), tetrachloroethene (max 187 µg/m^3) and trichloroethene (max. 6.72 µg/m^3). When compared to the NYSDOH Guidance Matrix Tables, Langan indicated that all of the compounds mentioned above required mitigation efforts.

In March 2019, the Site was accepted into the BCP and BCA Agreement Index No. C224286-03-19 was executed. In April 2021, Langan completed a Remedial Investigation in accordance with the NYSDEC-approved Remedial Investigation Work Plan (RIWP) for the Site. The results of the Remedial Investigation are provided in the Remedial Investigation Report (RIR), and a summary of the soil, groundwater and sub-slab vapor sampling results is discussed below.

1. **Soil Data** - Soil sample results were reviewed and generally contained SVOC and metal exceedances of RCSCOs (mostly PAHs, arsenic, barium and lead), which appears to be related to historical Subject Property operations. Several VOCs and pesticides were detected at concentrations exceeding their respective UUSCOs.

2. **Groundwater Data** - Groundwater sample results indicated the presence of both petroleum related and CVOCs in groundwater at concentrations exceeding TOGS values. SVOCs and metals were also detected throughout the monitoring wells at concentrations exceeding TOGS values. Groundwater samples were also analyzed for 1,4-dioxane and PFAS compounds. Three emerging contaminants were detected in three groundwater samples above their respective NYSDEC AWQSGVs, as summarized in the following table (number of detections above criteria in parentheses):

Analyte	Min. Concentration above NYSDEC Values (µg/L)	Max. Concentration above NYSDEC Guidance Values (µg/L)	NYSDEC AWQSGVs (µg/L)
1,4-Dioxane	1.47 (MW11)	17.2 (MW05 duplicate)	0.35
Perfluorooctanesulfonic Acid (PFOS)	0.066 (MW05 duplicate)	0.406 (MW11)	0.0027
Perfluorooctanoic Acid (PFOA)	0.0655 (MW11)	0.0794 (MW05)	0.0067

3. **Soil Vapor Data** - Soil vapor data consisted of the collection of sub-slab and soil vapor data. Concentrations of total VOCs ranged between 20.6 µg/m^3 and 780,000 µg/m^3. The highest concentrations were identified in SV06 which was collected from the northern portion of the building in the former Superior Bearing Bronze Co Magnesium Casting Cleaning/ Metal Finishing space that was historically operating at the Subject Property. The highest concentrations were generally identified as chlorinated solvent related compounds including 1,1,1-trichloroethane, 1,1-dichloroethene, carbon tetrachloride, cis-1,2,-dichloroethene, tetrachloroethene, trichloroethene and vinyl chloride.

On September 21, 2023, the Volunteer was officially added as a volunteer to the Site's BCA via BCA Amendment No. 1. Once the Volunteer acquires the Site, they will now be substituted as the sole Volunteer for the current Site owner and will be the sole remedial party for the BCP Site.

2.3 SSDS Pilot Study

Roux subcontracted EnviroTrac Ltd of Yaphank, NY to perform an SSDS pilot study at the Site to confirm the design details of the full-scale SSDS. This SSDS pilot study was performed in accordance with the November 8, 2023 SSDS Pilot Study Work Plan that was approved by the NYSDEC and NYSDOH on December 1, 2023. The SSDS pilot study occurred on December 1 and 4, 2023. The SSDS pilot study demonstrated that a full-scale SSDS can serve as an effective means of mitigation for the existing site building. The results of this study Recommended Design Parameters for each extraction well:

- Target Radius of Influence (ROI): 25 feet
- Applied Vacuum: 8.0 inches of water
- Applied Flow Rate: 13.1 cubic feet per minute (CFM)

It should be noted that at Test Point SSDS PIT 12 yielded anomalously high results (e.g., requirement of 35.7 inches of water at a flow of 20.1 CFM). However, in EnviroTrac's report, it is noted that "that at the time of testing, the underlying soil below the slab directly below underside of the concrete was found to be saturated in water. This water is presumed to be a result of the leaking roof in the area, which may have artificially created this saturated condition. As such, it is recommended that the results of the testing completed at SSDS PIT 12 not be used for the overall evaluation of the testing results." If Roux observes that there is an ongoing flooding issue during the installation of SSDS PIT 12, we may need to shift this pit's location. Any field modifications to the SSDS design will be documented to NYSDEC within the daily reports. The SSDS Pilot Study Report is provided as Appendix C.

3. IRM Scope of Work

The scope of work for the IRM consists of the following tasks:

1. Mobilization and Site Preparation for IRM ;
2. Suspected UST Investigation and Removal;
3. SSDS Installation;
4. Waste Disposal (assumed to be minimal); and
5. Documentation.

Although limited generation of waste is anticipated, implementation of the IRM will be performed in accordance with the Soils/Materials Management Plan (SoMP) included in Section 4 of this IRMWP.

3.1 Mobilization and Site Preparation for IRM

A seven-day notice will be provided prior to conducting a project kick-off call or meeting involving NYSDEC, the Volunteer, Roux, and the selected Contractor, if requested by NYSDEC. This meeting will precede the initiation of any ground-intrusive activities related to the IRM described in this IRMWP. The Contractor will be responsible for supplying the necessary labor (HAZWOPER Certified in accordance with OSHA 1910.120) and materials to execute the scope of work for the IRM. Additionally, all required permits, insurance, bonds, and licenses necessary for the completion of the work will be obtained, and associated fees will be paid. Mobilization and site preparation activities will involve mobilization of equipment to the work area, conducting a geophysical survey to identify underground obstructions and utilities, and establishing work area delineation zones.

3.2 Suspected UST Investigation and Removal

Based on documented petroleum bulk storage records, two USTs were historically located on the Site. One 2,000-gallon UST was reportedly closed in place in 1996 (PBS No. 2-364159). There was also a 1,080-gallon UST identified by FDNY documents. During the 2019 Remedial Investigation, these USTs were tentatively located using geophysical survey methods, and their suspected positions are shown on Figure 2. During the 2019 Remedial Investigation by Langan, petroleum-like impacts were observed in borings, and petroleum-related VOCs were detected during soil, sub-slab vapor, and groundwater samples, which suggests these two USTs have leaked.

As part of this IRM, Roux will confirm the UST locations via test pits, and if the USTs are encountered, they will be removed. The proposed removal of the suspected USTs will entail the following steps as detailed below. All work will be conducted in accordance with NYSDEC DER-10 guidance.

A UST removal notification will be provided to NYSDEC 30 days in advance of the UST removal.

An excavation/SOE permit will be obtained from the New York City Department of Buildings (NYCDOB).

Roux will provide NYSDEC with ten calendar days' notice prior to the fieldwork.

The UST will be uncovered by an excavator or hand tools, depending on Site accessibility. Care will be taken to avoid damaging and/or puncturing the UST.

A licensed UST removal contractor will perform the following:

- Any fluids currently in the UST will be extracted using a vacuum truck.
- The interior of the UST will be rendered inert by degassing.
- The UST will either be excavated and removed from its current location and placed on plastic and then cut/cleaned, or it will be cut open and cleaned in the location it was found, whichever makes more sense logistically.
- The UST will be cut into pieces (as necessary) and transported off-Site as scrap metal.
- Roux's oversight personnel will inspect the area beneath and around the UST after it is removed, screen the soil with a photoionization detector [PID] and assess for any evidence of a release from the UST (i.e., odors, visible staining and/or significant total VOC readings on the PID).
- Any oil or cleaning fluids will be disposed of off-Site at an appropriate licensed and permitted facility.

Any grossly contaminated soil as determined by Roux's oversight personnel will be excavated and contained in drums for removal from the Site.

The one unregistered tank will be registered with the NYSDEC Petroleum Bulk Storage (PBS) Unit and then the registration will be closed.

After removal, an affidavit will be submitted by the contractor to the New York City Fire Department and confirming its removal by a licensed contractor and a tank closure report will be provided to the NYSDEC as an appendix to the Construction Completion Report (CCR) after the UST endpoint sampling and any required source removal described in the next section.

3.2.1 UST Endpoint Sampling

Following the completion of UST and grossly contaminated soil removal, Roux will collect sidewall and bottom endpoint samples from each excavation and analyze each sample for VOCs and SVOCs listed on Table 2 and/or Table 3 of NYSDEC's CP-51 Soil Cleanup Guidance. The Quality Assurance Project Plan/Field Sampling Plan (QAPP/FSP) is attached as Appendix D and describes in detail the field sampling and quality assurance/quality control (QA/QC) methods to be used.

Endpoint samples will be collected from the northern, eastern, southern, and western sidewalls, as well as the bottom of each excavation. Each sample will be inspected for visual evidence of contamination (i.e., staining, presence of petroleum or odors) and field screened for VOCs using a PID. Soil samples to be submitted for analysis will be placed in a laboratory sample jar, placed in an iced cooler, and transported to the laboratory. A total of ten samples will be taken from the two UST removal excavations (assuming the USTs are encountered in the test pits).

The laboratory will report analytical results for endpoint samples in Analytical Services Program (ASP) Category B deliverable packages. An electronic data deliverable (EDD) in the required NYSDEC format will also be provided by the laboratory.

All end-point sample data generated for the IRM will be logged in a database and organized to facilitate data review and evaluation. The electronic dataset will include the data flags provided in accordance with United States Environmental Protection Agency (USEPA) Laboratory Data Validation Functional Guidelines for Evaluating Organic Analysis and Inorganic Analyses, as well as additional comments of the data review for ASP analyses. The data flags include such items as: 1) concentration below required detection limit;

2) estimated concentration due to poor recovery below required detection limit; 3) estimated concentration due to poor spike recovery; and 4) concentration of chemical also found in laboratory blank.

3.2.2 Groundwater Contingency

If USTs are identified within the saturated zone, additional sampling will be collected in accordance with DER-10. As noted in DER-10, if the contents of the UST being evaluated have ever had a density less than water, a soil sample will be collected from one foot above to one foot below the current water table surface. If the contents of the UST being evaluated have ever had a density greater than water, a soil sample will be collected from zero to two feet below the bottom of the tank. A groundwater sample will also be collected at the appropriate depth. To verify tank contents for out-of-service tanks, one sample will be taken of any product or residue remaining in the tank and analyzed using an appropriate fingerprinting or other analytical method.

3.3 SSDS Installation

Sub-slab soil vapor samples collected during the previous investigations detected elevated concentrations of CVOCs on-Site; therefore, an active SSDS is proposed to be installed beneath the portions of the Site building shown on Drawing 1 to address potential exposure pathways. The proposed active SSDS will include shallow polyvinyl chloride (PVC) suction points to be retrofitted into the existing building foundation while maintaining the structural integrity of the foundation. The testing of the SSDS will be completed following installation.

3.3.1 SSDS Installation Procedures

The active SSDS for the Site, when complete, will consist of a network of shallow suction pits creating a vacuum influence beneath the building slab shown on Drawing 1 (Appendix B). The design using twelve low vacuum vapor suction pits was deemed the most suitable. The suction pits will be connected to in-line fans placed on the roof, which will create a low-vacuum influence beneath the slab while avoiding extraction of water that would prevent system functionality. The SSDS floor plan design and piping details are provided in Appendix B. The SSDS component specifications are included in Appendix E. A description of the proposed active SSDS is provided below:

- All existing interior utility and slab penetrations will be sealed with silicone caulking, to the extent feasible.
- Twelve shallow suction pits will be installed to create a vacuum influence below the building slab in areas of high sub slab vapor concentrations. Each suction point will consist of a 4-foot by 4-foot pit extended 8-inches below the existing cellar slab lined with non-woven geotextile. All suction pits will consist of 4-inch perforated PVC piping below grade, 4-inch steel or iron piping above grade in accordance with NYCDOB building codes and regulations.
- All SSDS piping will be pitched towards suction pits in a manner that allows for any moisture build up to drain back into the pits.
- Each suction pit will have a shut off valve, vacuum indicator alarm and vacuum/sampling port.
- The piping from the suction pits will be brought to the roof along the interior/exterior of the building. A RadonAway HS5500 in-line fan (or approved equal) will be provided for each suction pit located throughout the building. The fans and piping risers will be located on the roof, as to not interfere with the existing Site use.
- Any interior piping will be routed around existing heating, ventilation, and air conditioning (HVAC) ducts and utility pipes and supported, as needed. Exterior piping will be supported appropriately.

- The discharge stacks will extend above the parapet wall or a minimum of 4 feet above the roof line or 10 feet above any occupiable roof decks and will be supported as necessary. The discharge points will be located a minimum of 10 feet from any HVAC air inlets and the building edge.
- Seven sub-slab sampling points (MP-1 through MP-7) will be used, as appropriate, to monitor the performance of the SSDS.

Any cracks in the floor slab will be patched and repaired.

3.3.2 SSDS Startup and Testing

Performance monitoring will be performed on the SSDS as part of the SSDS start-up to verify that the system is operating properly and will consist of the following:

- Confirm operation of the local alarm warning light;
- Confirm operation of in-line fans;
- Confirm acceptable negative pressure readings from the SSDS and suction pits by inspection of vacuum indicator alarms and monitoring of sample port;
- Collection of vacuum measurements from the soil vapor monitoring points and non-operating suction points;
- Collection of PID readings; and
- Collection of confirmation effluent air samples.

Vacuum measurements will be collected from the soil vapor monitoring points shown on Drawing 1 of Appendix B and non-operating suction pits (when testing the system during startup some suction pits will be turned off to evaluate vacuum response). The vacuum measurements will be collected using a micro-manometer capable of monitoring a minimum of 0.001 inches of water column. If adequate depressurization (e.g., vacuum influence) is not occurring, the cause for the lack of depressurization will be investigated and repaired, and measurements will be collected again.

In order to evaluate potential impacts of the SSDS emissions to neighboring structures or other sensitive receptors, the performance monitoring of the SSDS will include monitoring the system effluent VOC concentrations using a PID. In addition, during start-up of the SSDS, an effluent air sample will be collected from the discharge of the effluent stack using a Summa canister and analysed using USEPA Method TO-15 to verify that vapor treatment is not needed. The effluent air sample results will be compared in accordance with the NYSDEC's "Guidance on Air Emissions of VOCs at DER Remediation Sites." If the sample results indicate that treatment is required, appropriate treatment options will be implemented and evaluated periodically.

Additionally, 30-days following initial start-up of the SSDS and before building occupancy, indoor air samples will be collected from representative building areas (i.e., breathing zone in occupied areas) in each building. These indoor air samples will be collected in the breathing zone near each of the seven soil vapor monitoring points shown on Plate 1 in Appendix B of the IRMWP using Summa canisters and analysed using USEPA Method TO-15 to verify that the SSDS is effectively reducing CVOC vapor intrusion into the building. All samples will be collected in accordance with the Site's Quality Assurance Project Plan, which is included as Appendix D.

The system testing described above (excluding effluent air sampling) will be conducted if, in the course of the SSDS lifetime, significant changes are made to the SSDS, or if the system is shut down for an extended period for any reason, and the system must be restarted.

3.3.3 SSDS Operation, Maintenance and Monitoring (O, M & M)

O, M & M procedures for the SSDS will be included in the Site Management Plan (SMP) for the Site. However, these procedures are outlined herein for the interim period before the SMP is approved for the Site.

3.3.3.1 System Operation: Routine Operation Procedures

Routine operation procedures will consist of monitoring the operation/vacuum of the in-line fans and verifying there is flow at the effluent stack.

3.3.3.2 System Operation: Routine Equipment Maintenance

The routine maintenance activities include visual inspections, operating data collection and general maintenance. As part of routine SSDS operation, the SSDS will be inspected on a monthly basis (at a minimum) to evaluate if it is operating properly and generating vacuum below the building. Visual inspection is the routine part of the SSDS operator's activities. The system operator will note any conditions that present a potential hazard or could cause future system shutdown. In the field, special attention will be paid to the condition of the fans and appurtenances, and the above slab discharge piping and supports. Special attention will also be given to any unusual or excessive noise or vibrations from the piping and fans. The piping and valves will be inspected for leaks.

All equipment maintenance and inspections will be performed in accordance with manufacturer's instructions. Specific routine maintenance tasks are outlined below:

- Inspect fans and accessible piping to confirm operation and appropriate valve settings; and
- Inspect vacuum/pressure gauges for proper operation.

In the event that a condition warranting system component maintenance is identified, the appropriate reporting and maintenance should be conducted immediately. Manufacturer's recommendations for system component maintenance will be followed. Any maintenance completed for the SSDS should be documented in the Maintenance Log included in Appendix F.

3.3.3.3 System Operation: Non-Routine Equipment Maintenance

Non-routine equipment maintenance consists of maintenance activities that will be performed with less frequency than the routine maintenance (i.e., semi-annually) on several system components. Specific non-routine maintenance tasks are outlined below:

- Replacement of vacuum indicator alarms/valves; and
- Replacement of any faulty fan components.

Damage to any SSDS components will be noted during the routine and detailed system inspections and remedied upon identification. Any maintenance completed for the SSDS should be documented in the SSDS Log included in Appendix F.

3.4 Waste Disposal

All wastes generated during the installation of the SSDS and UST removal will be handled, transported and disposed of in a manner consistent with Federal, State and local laws and regulations. A limited amount of soil is anticipated to be generated during SSDS installation since the majority of the SSDS piping will be installed above the cellar concrete slab/floor. However, based on results of soil samples collected during previous investigation activities, soil containing elevated concentrations of CVOCs is not anticipated to be encountered during SSDS installation. A limited amount of soil is also anticipated to be generated during the suspected UST removal, which will be properly disposed.

3.5 Documentation

Detailed information regarding the IRM (e.g., as-built drawings, waste disposal documentation, backfill documentation, photographs, laboratory analytical reports, etc.) will be included in the CCR described in Section 7.

4. Soil/Materials Management Plan

Although the amount of earthwork is expected to be very limited, the following sections provide the SoMP to be implemented during the IRM, as necessary.

4.1 Soil Screening Methods

Visual, olfactory and PID soil screening and assessment will be performed during SSDS installation activities under the supervision of Roux personnel.

4.2 Containerization of Waste

All soil generated during SSDS installation and UST removal will be containerized in labeled, New York State Department of Transportation (NYSDOT) rated 55-gallon drums or roll-off containers, which will be fitted with tight fitting covers. If waste is determined to be hazardous, it will be disposed of within 90 days of generation at an approved hazardous waste disposal facility.

4.3 Characterization of Excavated Materials

Soil/fill or other excavated media that will be transported off-Site for disposal will be sampled in a manner required by the receiving facility, and in compliance with applicable laws and regulations.

4.4 Materials Excavation and Load Out

Roux will oversee all invasive work and the excavation and load-out of all excavated material. The quantity of waste is expected to be very limited during the SSDS installation, and it will be containerized in drums for disposal. Loadout and trucking of bulk waste is not expected during this task.

The quantity of waste excavated and disposed with depend on if a release is found beneath the suspected USTs. Any loadout and trucking of bulk waste during this task will be completed in accordance with regulatory requirements.

All work will be completed in accordance with the HASP (Appendix A). Support of excavation, though unlikely due to the nature of the work, will be provided, if necessary, based upon Site conditions and local regulations.

4.5 Materials Transport Off-Site

All transport of materials (i.e., drummed soil/fill/solid waste) will be performed by licensed haulers in accordance with appropriate local, State, and Federal regulations, including 6 NYCRR Part 364. Haulers will be appropriately licensed and trucks properly placarded.

4.6 Materials Disposal Off-Site

All soil/fill/solid waste excavated and removed from the Site will be disposed of in accordance with regulatory requirements based on the levels of contamination found to be present in waste characterization samples collected.

The following documentation will be obtained and reported for each disposal location used in this project to demonstrate and document that the disposal of material derived from the Site conforms with all applicable laws: (1) a letter or facility-specific waste profile/application from Roux or the Volunteer to the receiving facility describing the material to be disposed and requesting formal written acceptance of the material. This letter/profile/application will state that material to be disposed of is contaminated material (if applicable) generated at an environmental remediation Site in New York State. The letter will provide the project identity and the name and phone number of Roux or the Volunteer. The letter will include as an attachment a summary of all chemical data for the material being transported (including Site characterization data) and (2) a letter from all receiving facilities stating it is in receipt of the correspondence (above) and is approved to accept the material. These documents will be included in the CCR.

The CCR will include an accounting of the destination of all material removed from the Site during this IRM. This information will also be presented in a tabular form in the CCR.

A Bill of Lading system or equivalent will be used for off-Site movement of non-hazardous wastes and contaminated soils. This information will be reported in the CCR.

Hazardous and non-hazardous wastes derived from on-Site will be stored, transported, and disposed of in compliance with applicable local, State, and Federal regulations.

Appropriately licensed haulers will be used for material removed from this Site and will be in compliance with all applicable local, State and Federal regulations.

Waste characterization will be performed for off-Site disposal in a manner suitable to the receiving facility and in conformance with applicable permits. All data available for soil/material to be disposed at a given facility must be submitted to the disposal facility with suitable explanation prior to shipment and receipt.

4.7 Materials Reuse On-Site

Soil reuse is not anticipated as part of the IRM.

4.8 Fluids Management

Liquids (if any) to be removed from the Site will be handled, transported and disposed of in accordance with applicable laws and regulations. Liquid waste manifests will be reported to NYSDEC in the CCR.

Characterization of fluids for off-Site disposal will be performed in a manner suitable to the receiving facility and in conformance with applicable permits.

4.9 Backfill from Off-Site Sources

All materials proposed for import onto the Site will be approved by Roux and will be in compliance with provisions in this IRM prior to receipt at the Site. Materials anticipated to be imported to the Site during implementation of this IRMWP include ¾” gravel (round stone) to be used as backfill for SSDS pits.

Material from industrial sites, spill sites, other environmental remediation sites or other potentially contaminated sites will not be imported to the Site. Solid waste will not be imported onto the Site.

All imported soils will meet NYSDEC approved backfill or cover soil quality objectives for this Site. These NYSDEC approved backfill or cover soil quality objectives are the lower of the protection of groundwater or the protection of public health soil cleanup objectives for Commercial or higher use as set forth in Table 375-

6.8(b) of 6 NYCRR Part 375. Non-compliant soils will not be imported onto the Site without prior approval by NYSDEC. Nothing in the approved IRMWP or its approval by NYSDEC should be construed as an approval for this purpose.

Soils that meet 'exempt' fill requirements under 6 NYCRR Part 360, but do not meet backfill or cover soil objectives for this Site, will not be imported onto the Site without prior approval by NYSDEC. Nothing in this IRMWP should be construed as an approval for this purpose.

In accordance with DER-10, the following material may be imported, without chemical testing, to be used as backfill beneath pavement, buildings or as part of the final Site cover, provided that it contains less than 10% by weight material which would pass through a size 80 sieve and consists of:

- Gravel, rock or stone, consisting of virgin material from a NYSDEC permitted mine or quarry; or
- Recycled concrete or brick from a NYSDEC registered construction and demolition debris processing facility if the material conforms to the requirements of Section 304 of the New York State Department of Transportation *Standard Specifications Construction and Materials Volume 1* (2002).

Trucks entering the Site with imported soils will be securely covered with tight fitting covers.

4.10 Stormwater Pollution Prevention

While it is anticipated that soil disturbance outside the building footprint will not be included in the scope of work, if any changes to the project's scope necessitate such disturbance, we will ensure that all relevant laws and regulations concerning stormwater pollution prevention are adhered to. If necessary, erosion and sediment control measures (silt fences and/or barriers, and/or hay bale checks) will be installed, as appropriate, around the entire perimeter of the remedial construction area and inspected once a week and after every storm event to ensure that they are operating appropriately. Discharge locations will be inspected to determine whether erosion control measures are effective in preventing significant impacts to receptors. Results of inspections will be recorded in a logbook and maintained at the Site and available for inspection by NYSDEC. All necessary repairs to erosion and sediment controls shall be made immediately. Accumulated sediments will be removed as required to keep the barrier and hay bale check functional. Undercutting or erosion of the silt fence anchor will be repaired immediately with appropriate backfill materials. Manufacturer's recommendations will be followed for replacing silt fencing damaged due to weathering.

4.11 Contingency Plan

This contingency plan is developed for the remedial construction to address the discovery of unknown structures or contaminated media during implementation of the IRM. Due to the nature of the proposed work, discovery of previously unknown USTs is extremely unlikely.

If previously unidentified contaminant sources are found during implementation of the IRM, sampling will be performed on potentially contaminated source material and surrounding soils and reported to NYSDEC. Chemical analytical work will include full suite of parameters (target compound list [TCL] VOCs, TCL SVOCs, target analyte list [TAL] metals, TCL polychlorinated biphenyls [PCBs], pesticides and herbicides and TCL PFAS).

Identification of unknown or unexpected contaminated media identified by screening during invasive Site work will be promptly communicated by phone to NYSDEC's Project Manager. These findings will also be included in daily and periodic electronic reports.

4.12 Odor, Dust and Nuisance Control Plan

The CCR will include the following certification by the certifying professional engineer: "I certify that all invasive work during the remediation and all invasive development work were conducted in accordance with dust and odor suppression methodology defined in the IRMWP."

4.12.1 Odor Control Plan

In addition to the health and safety monitoring described in the HASP (Appendix A), Roux will closely monitor the presence of odors emanating from the work area within the building. Compliance with this odor control plan is capable of controlling emissions of nuisance odors on-Site. Due to the nature of the project, with all intrusive work occurring in the existing building, nuisance odor will not be generated at the sidewalk level surrounding the Site. The HASP will contain specific measures to address potential worker exposure to airborne contaminants during the IRM implementation. Specific odor control methods to be used on a routine basis will include limiting open excavation areas, keeping excavations covered, and covering excavated soil (i.e., in covered drums). If nuisance odors are identified, work will be halted, and the source of odors will be identified and corrected. Work will not resume until all nuisance odors have been abated. NYSDEC and NYSDOH will be notified of all odor events and of all other complaints about the project. Implementation of all odor controls, including the halt of work, will be the responsibility of Roux, who is responsible for certifying the CCR and its subcontractors.

Odor controls will be employed to prevent on- and off-Site odor nuisances. At a minimum, procedures will include: (a) limiting the area of open excavations; (b) shrouding open excavations with tarps and other covers; and (c) use of odor suppressants to cover exposed odorous soils.

4.12.2 Dust Control Plan

Due to the nature of the project, with excavation occurring in the cellar of the existing building, generation of nuisance dust at the sidewalk level surrounding the Site will not occur. The HASP will contain specific measures to address potential worker exposure to airborne particulates during the IRM implementation. A dust suppression plan that addresses dust management during invasive on-Site work, will include, at a minimum, the items listed below:

Dust suppression will be achieved through the use of water for wetting excavation areas. Water will be available on-Site at suitable supply and pressure for use in dust control.

4.12.3 Other Nuisances

Noise control will be exercised during the remedial program.

5. Reporting

5.1 Reporting During Site Activities

Daily reports to NYSDEC and NYSDOH will be submitted during the days when IRM activities take place. Daily reports will include an update of progress made during the reporting period; locations of work and quantities of material imported and exported from the Site; a summary of any and all complaints with relevant details (names, phone numbers); and an explanation of notable Site conditions, etc. If any issues arise, NYSDOH and NYSDEC will be notified within 24 hours.

Monthly reports will be submitted to NYSDEC and NYSDOH Project Managers by the 10th of the month following the end of the month of the reporting period and will include:

- Activities relative to the Site during the previous reporting period and those anticipated for the next reporting period, including a quantitative presentation of work performed (i.e., tons of material exported and imported, etc.);
- Description of approved activity modifications, including changes of work scope and/or schedule;
- Sampling results received following internal data review and validation, as applicable; and
- An update of the remedial schedule including the percentage of project completion, unresolved delays encountered or anticipated that may affect the future schedule, and efforts made to mitigate such delays.

5.2 Construction Completion Report (CCR)

Detailed information regarding the IRM (e.g., general description of the construction activities, as-built of the SSDS, waste disposal documentation, sample analysis results, UST removal documentation, backfill documentation, photographs, etc.) will be included in the CCR.

6. IRM Implementation Schedule

This IRM is anticipated to begin in the first and second quarter of 2024 and will require approximately three to four weeks to complete. It is anticipated that the actual on-Site duration of major remedial construction tasks will be completed as follows (time frames are not necessarily consecutive):

- Site Mobilization and Preparation .... one day
- Geophysical Survey for USTs...………………………………………………….. one day
- Removal of USTs ………………………………………………………………. one week
- UST Endpoint Soil Sampling ………………………………………………….. one day
- SSDS Installation .... two to three weeks
- SSDS Startup and Testing.. two days
- Transportation and Off-Site Disposal .... one day
- Site Restoration and Demobilization .... one day
- Submittal of CCR After Startup and Testing Completed............................. to Be Determined

FIGURES

QUADRANGLE LOCATION

N

0 2000'

SOURCE:
USGS, 2013, Brooklyn, NY
7.5 Minute Topographic Quadrangle

Title:

SITE LOCATION MAP

12 FRANKLIN STREET
BROOKLYN, NEW YORK 11222

Prepared for:

FRANKLIN POINT LLC

ROUX

Compiled by: J.R.	Date: 30MAY23	FIGURE	
Prepared by: B.H.C.	Scale: AS SHOWN		
Project Mgr: R.H.	Project: 4170.0001Y000	1	
File: 4170.0001Y101.03.DWG			

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LEGEND

SITE BOUNDARY

POTENTIAL UNDERGROUND STORAGE TANK (UST) LOCATION

20' 0 20'

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Title:

POTENTIAL UST LOCATIONS

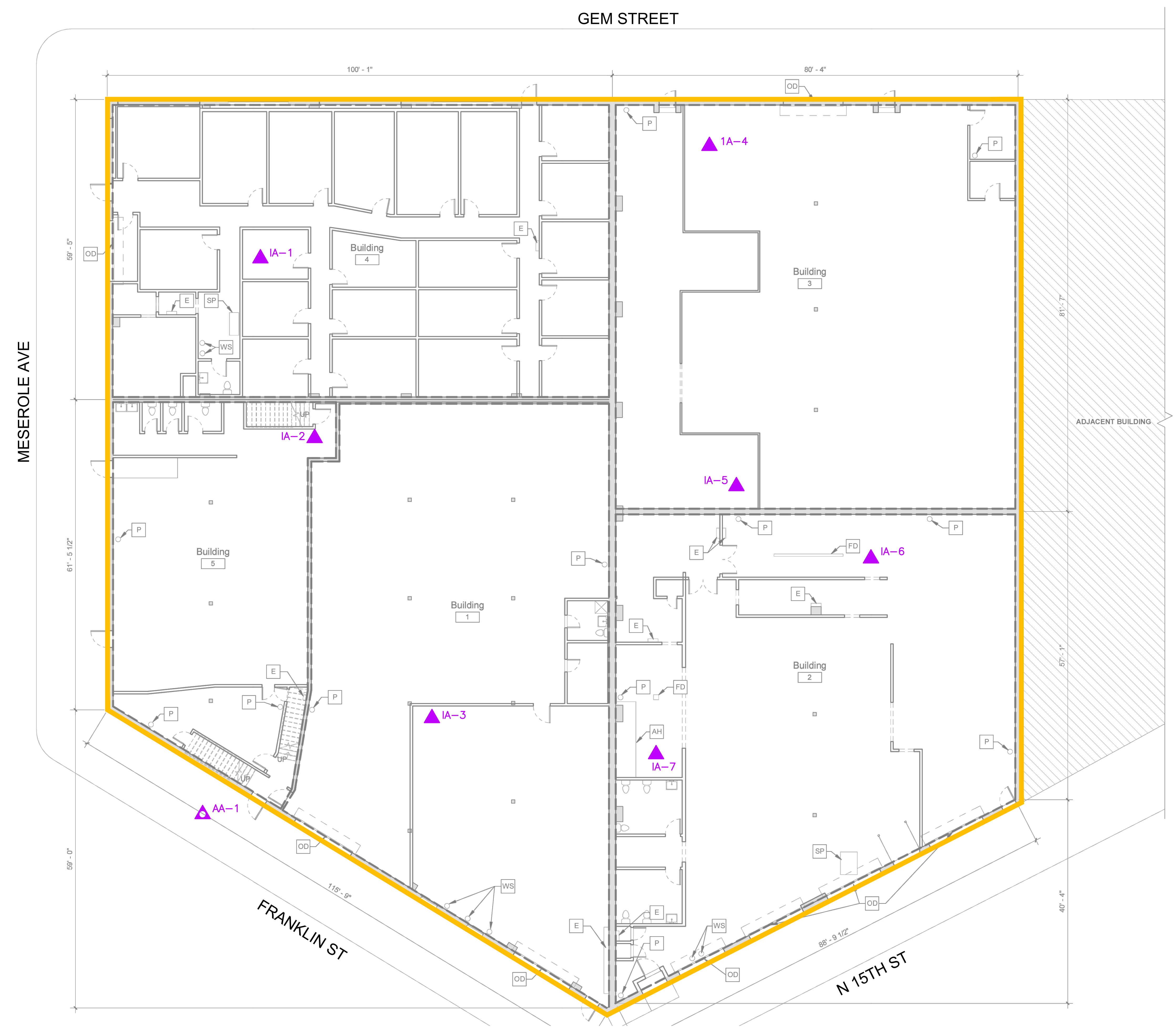
12 FRANKLIN STREET
BROOKLYN, NY 11222

Prepared for:

FRANKLIN POINT LLC

ROUX

Compiled by: J.R.	Date: 1/22/2024	FIGURE
Prepared by: B.H.C.	Scale: AS SHOWN	2
Project Mgr: R.H.	Project: 4170.0001Y000	
File: 4170.0001Y101.02.DWG		



LEGEND

SITE BOUNDARY

IA = INDOOR AIR SAMPLE LOCATION

AA = AMBIENT AIR SAMPLE LOCATION

20' 0 20'

Title:

INDOOR AND AMBIENT AIR SAMPLING LOCATIONS

12 FRANKLIN STREET
BROOKLYN, NY 11222

Prepared for:

FRANKLIN POINT LLC

ROUX

Compiled by: J.R.	Date: 1/25/2024	FIGURE
Prepared by: B.H.C.	Scale: AS SHOWN	3
Project Mgr: R.H.	Project: 4170.0001Y000	
File: 4170.0001Y109.02.DWG		

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APPENDICES

A. Health and Safety Plan

B. Conceptual Sub-Slab Depressurization System Design Drawing

C. SSDS Pilot Study Report

D. Field Sampling Plan/Quality Assurance Project Plan

E. Sub-Slab Depressurization System Component Specifications

F. Sub-Slab Depressurization System Operations and Maintenance Form

APPENDIX A

Health and Safety Plan

Site-specific Health and Safety Plan

12 Franklin Street
Brooklyn, New York 11222

January 25, 2024

Prepared for:

Franklin Point LLC
Franklin Point Holding LLC
175 Great Neck Road, Suite #407
Great Neck, New York 11021

Prepared by:

Roux Environmental Engineering and Geology, D.P.C.
209 Shafter Street
Islandia, New York 11749

4170.0001Y102/CV

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Site-Specific Emergency Information

Emergency Phone Numbers

Most emergency services can be obtained by calling **911**. Where 911 service is not available, use the telephone numbers provided in the below table. The following is a master emergency phone list for use by the project management personnel. A more condensed version of the emergency numbers listed below will be posted throughout project work areas. Emergencies encountered on the site will be responded to by a combination of off-site emergency services and site personnel.

Emergency Contact Information			
Site Personnel			
Title	**Contact**		**Telephone**
Project Manager (PM)	Rachel Henke		(631) 630-2334
Project Principal (PP)	Robert Kovacs		(631) 630-2320
Site Supervisor (SS)	TBD		
Site Health and Site Safety Officer (SHSO)	TBD		
Office Health and Safety Manager (OHSM)	Nevin Pahlad		631-630-2426
Corporate Health and Safety Manager (CHSM)	Brian Hobbs		(631) 630-2419
Client Emergency Contact	TBD		
Outside Assistance			
Agency	**Contact**	**Telephone**	**Address/Location**
Ambulance/emergency medical services (EMS)	FDNY EMS Station 35	(718) 384-7039 / 911	332 Metropolitan Avenue Brooklyn, NY 11211
Police	94th Precinct	(718) 383-3879 / 911	100 Meserole Avenue Brooklyn, NY 11222
Fire	New York City Fire Department	(718) 965 8229 / 911	75 Richardson Street Brooklyn, NY 11211
Site Address	12 Franklin Street, Brooklyn, NY 11222		

Route to NYU Medical Center:

403 E 34th Street, New York, NY

- Head north on Franklin Street toward Meserole Avenue
- Turn right onto Cayler Street
- Continue on McGuinness Boulevard over Pulaski Bridge
- Take Queens Midtown tunnel to E 35th Street in Manhattan
- Take the exit toward downtown from I-495W
- Drive to E 34th Street

Route to CityMD Greenpoint Urgent Care:

795 Manhattan Ave, Brooklyn, New York

- Head north on Franklin Street toward Meserole Avenue
- Turn right onto Cayler Street
- Turn right onto Manhattan Avenue

1. Introduction

This Site-specific Health and Safety Plan (HASP) has been prepared by Roux Environmental Engineering and Geology, D.P.C. (Roux) for use during the implementation of the Interim Remedial Measure Work Plan (IRMWP) and the Supplemental Remedial Investigation Work Plan (SRIWP) at the 12 Franklin Street site ("the Site"), located at 12 Franklin Street, Brooklyn, NY 11222 (see **Figure 1**). These activities fall within the scope of operations covered by the Occupational Safety and Health Administration (OSHA) standards promulgated at 29 CFR 1910.120 and 29 CFR 1926.65, both commonly referred to as the Hazardous Waste Operations and Emergency Response (HAZWOPER) Standard. In accordance with the HAZWOPER Standard, this Site-specific HASP was prepared to address the safety and health hazards associated with the oversight being performed at the Site by Roux and to provide requirements and procedures for the protection of Roux employees, subcontractor personnel, government oversight personnel, Site personnel, and the general public. It also addresses client- and Site-specific requirements for health and safety.

Implementation of this HASP is the joint responsibility of the Project Manager (PM), the Site Health and Safety Officer (SHSO), and all field staff, with assistance from the Project Principal (PP), Office Health and Safety Manager (OHSM), and Corporate Health and Safety Manager (CHSM). The PM for this project is Rachel Henke. The Site Supervisor (SS) and Site Health and Safety Officer (SHSO) will be determined with the onset of field work.

This HASP will be introduced to, reviewed, and signed off on by all Roux personnel through a formal training session prior to commencing work. A copy of the HASP will be kept at the Site at all times. The Roux SHSO or PM will be responsible for posting any changes, amendments, memos, etc. to the HASP. Any revisions to this HASP will be signed by appropriate personnel, which can include Roux's PP, CHSM, and SS. Any changes will be announced to all workers at the next safety meeting.

1.1 Roles and Responsibilities

Overall Roles and Responsibilities (R&Rs) of Roux personnel are provided in Roux's Policies and Procedures Manual. Only those R&Rs specific to HASP requirements are listed below.

Project Manager (PM)

The PM has responsibility and authority to direct all work operations. The PM coordinates safety and health functions with the Site Health and Safety Officer (SHSO), has the authority to oversee and monitor the performance of the SHSO, and bears ultimate responsibility for the proper implementation of this HASP. The specific duties of the PM are:

- preparing and coordinating the Site work plan;
- providing Site supervisor(s) with work assignments and overseeing their performance; Coordinating safety and health efforts with the SSHO;
- ensuring effective emergency response through coordination with the Emergency Response Coordinator (ERC); and
- serving as primary Site liaison with public agencies and officials and Site contractors.

Site Health and Safety Officer (SHSO)

The SHSO has full responsibility and authority to develop and implement this HASP and to verify compliance. The SHSO reports to the Project Manager. The SHSO is on Site or readily accessible to the Site during all work operations and has the authority to halt Site work if unsafe conditions are detected. The specific responsibilities of the SHSO include:

- managing the safety and health functions on this Site;
- serving as the Site's point of contact for safety and health matters;
- ensuring Site monitoring, worker training, and effective selection and use of PPE;
- assessing Site conditions for unsafe acts and conditions and providing corrective action;
- assisting the preparation and review of this HASP;
- maintaining effective safety and health records as described in this HASP; and
- coordinating with the Site Supervisor(s) and others as necessary for safety and health efforts.

Site Supervisor

The Site Supervisor is responsible for field operations and reports to the Project Manager (PM). The Site Supervisor ensures the implementation of the HASP requirements and procedures in the field. The specific responsibilities of the Site Supervisor include:

- executing the work plan and schedule as detailed by the PM;
- coordination with the SHSO on safety and health; and
- ensuring Site work compliance with the requirements of this HASP.

Employees

All Roux employees are responsible for reading and following all provisions of the Corporate Health and Safety Manual, including this HASP. Employees report to the SS at the project Site. Each employee is also responsible for the following:

- wearing all appropriate PPE as outlined within this HASP;
- attending all safety meetings;
- inspecting tools and equipment prior to use, and taking any defective tools or equipment out of service;
- appropriately documenting field events as they occur within a logbook or equivalent;
- properly operating machinery and/or equipment only if trained to do so;
- stopping work operations if unsafe conditions exist;
- identifying and mitigating hazards when observed;
- reporting all incidents and near misses to the Roux SHSO and SS immediately; and
- knowing where emergency equipment is located (e.g. first aid kit, fire extinguisher).

Subcontractors and Visitors

Subcontractors and visitors are responsible for complying with the same health and safety requirements. It is the responsibility of all to make sure subcontractors and visitors comply and uphold the HASP. Subcontractors and visitors have the following additional responsibilities:

- designating a qualified safety representative for the project that can make the necessary changes in work practices, as necessary;
- attending all safety meetings while participating in Roux Site work activities;
- reporting all incidents and near misses to Roux SHSO and SS immediately;
- conducting initial and periodic equipment inspections in accordance with manufacturer and regulatory guidelines; and
- providing copies of all Safety Data Sheets (SDS) to Roux SHSO for materials brought to the Site.

2. Background

Relevant background information is provided below, including a general description of the Site; a brief review of the Site's history with respect to hazardous material use, handling, and/or storage; and a review of known and potential releases of hazardous substances at the Site.

2.1 Site Description

The Site is located on the east side of Franklin Street, between Meserole Avenue to the north and N 15th Street to the south, in the borough of Brooklyn, New York. The borough of Brooklyn is situated in the southeast portion of New York City. The vicinity of the Subject Property consists of commercial, industrial, warehouses and factories. The ground surfaces in the vicinity of the Site consist of asphalt and concrete. The Site is located in an urban setting, so it is important that all personnel on site are aware of hazards that may arise in a densely populated setting, such as traffic hazards.

The properties situated adjacent to the Site include the unidentified one-story warehouses/industrial facilities to the north, an adjoining unmarked warehouse/industrial facility to the south, a smoke fish processing facility to the east, and a one story warehouse and undeveloped land, beyond which is the Bushwick inlet to the west.

2.2 Site History

According to available sources, the Site was developed as the current one-story building by 1951. The Site was occupied by multiple commercial entities including Ace Cellophane & Polyethylene Corp, Polycraft, Synerjol Co, Hardchrome Electro Processing Corp, ACME Finishing Co Inc, and Linaire Corp from 1960 to 2017. Soil quality was generally impacted with SVOCs characterized as PAHs and metals with some detections for pesticides and VOCs. Minor detections of chlorinated solvents were detected in soil suggesting a source may be present. Groundwater was generally impacted with both petroleum related and chlorinated VOCs, SVOCs and metals at concentrations exceeding NYSDEC standards as well as 1,4-dioxane (max 17,200 µg/L) and total PFAS with a maximum concentration of 847 µg/L. Soil vapor was also significantly impacted with chlorinated solvents, with concentrations of total VOCs ranging up to a total of 780,000 µg/m^3. These potential constituents should be considered when performing activities on site.

2.3 Known and Potential Releases of Hazardous Substances at the Site

The Site was identified to be associated with open NYSDEC SPILLS case #1806488 which occurred on September 17, 2018 which showed petroleum related VOCs and SVOCs in the soil and groundwater. The final memo indicated that the spill case would be remediated during the BCP remedial construction phase, and this spill case is still open.

3. Scope of Work

In general, the scope of work includes the following tasks:

- Mobilizing to the Site and Site preparation.
- Installing the SSDS components.
- Starting the SSDS and confirming its performance.
- Test pitting to confirm the presence of suspected underground storage tanks (USTs).
- Removing suspected USTs and excavating contaminated soil as needed.
- Collecting endpoint samples around the removed USTs.
- Collecting soil samples for emerging contaminant sampling.
- Investigation of groundwater elevations.
- Managing waste, which is assumed to be minimal.

4. Site Control

This Site control program is designed to reduce the spread of hazardous substances from contaminated areas to clean areas, to identify and isolate contaminated areas of the Site, to facilitate emergency evacuation and medical care, to prevent unauthorized entry to the Site, and to deter vandalism and theft.

4.1 Site Map

A map of this Site, showing Site boundaries, designated work zones, and points of entry and exit is provided in **Figure 2**.

4.2 Site Access

Access to the Site is restricted to reduce the potential for exposure to its safety and health hazards. During hours of Site operation, Site entry and exit is authorized only at the points identified in **Figure 2**. Entry and exit at these points is controlled by the following: closed front door, construction warning signs. When the Site is not operating, access to the Site is controlled by the following: Locked door, security camera, and alarm system.

4.3 Buddy System

This section is not applicable for all components of the SOW described in Section 3.0. Some Site inspections and oversight activities are completed by a single Roux employee. However, when completing these tasks, the single Roux employee is accompanied either by Roux subcontractors or the Site caretaker/other representatives from Franklin Point LLC / Franklin Point Holding LLC. Any time Roux is on-site, Franklin Point LLC / Franklin Point Holding is made aware and communications with Franklin Point LLC / Franklin Point Holding LLC and the Roux PM is maintained via cellular phone.

While working in the Exclusion Zone, Site workers use the buddy system. The buddy system means that personnel work in pairs and stay in close visual contact to be able to observe one another and summon rapid assistance in case of an emergency. The responsibilities of workers using the buddy system include:

- Remaining in close visual contact with partner;
- Providing partner with assistance as needed or requested;
- Observing partner for signs of heat stress or other difficulties;
- Periodically checking the integrity of partner's PPE; and
- Notifying the Site manager or other Site personnel if emergency assistance is needed.

4.4 Site Communications

The following communication equipment is used to support on-site communication: cell phones and hand signals.

As applicable, hand signals will be used according to the following:

Hand Signals

SIGNAL	MEANING
Hand gripping throat	Out of air, can't breathe
Grip partner's wrist	Leave area immediately
Hands on top of head	Need assistance
Thumbs up	I'm alright, okay
Thumbs down	No, negative

A current list of emergency contact numbers is presented on Page 1 of this HASP.

4.5 Site Work Zones

The SOW does not require the implementation of work zones; however, should the need arise, this section provides details for the proper execution of work zones at this Site.

This Site is divided into three (3) major zones, described below. These zones are characterized by the presence or absence of biological, chemical, or physical hazards and the activities performed within them. Zone boundaries are clearly marked at all times and the flow of personnel among the zones is controlled. The Site is monitored for changing conditions that may warrant adjustment of zone boundaries. Zone boundaries are adjusted as necessary to protect personnel and clean areas. Whenever boundaries are adjusted, zone markings are also changed and workers are immediately notified of the change.

Exclusion Zone

The area where contamination exists is the Exclusion Zone (EZ). All areas where excavation and handling of contaminated materials take place are considered the EZ. This zone will be delineated by orange high visibility fencing. Safety tape may be used as a secondary delineation within the EZ. The zone delineation markings may be opened in areas for varying lengths of time to accommodate equipment operation or specific construction activities. The SHSO may establish more than one EZ where different levels of protection may be employed or where different hazards exist. Personnel are not allowed in the EZ without:

- A buddy (co-worker)
- Required minimum level PPE
- Medical Authorization
- Training certification
- Requirement to be in the zone

Contamination Reduction Zone

A Contamination Reduction Zone (CRZ) is established between the exclusion zone and the support zone. The CRZ contains the Contamination Reduction Corridor (CRC) and provides an area for decontamination of personnel and equipment. The CRZ will be used for general Site entry and egress in addition to access for heavy equipment and emergency support services. Personnel are not allowed in the CRZ without:

- A buddy (co-worker)
- Appropriate PPE
- Medical authorization
- Training certification
- Requirement to be in the zone

Support Zone

The Support Zone (SZ) is an uncontaminated area that will be the field support area for the Site operations. The SZ will provide for field team communications and staging for emergency response. Appropriate sanitary facilities and safety equipment will be located in this zone. Potentially contaminated personnel or materials are not allowed in this zone. The only exception will be appropriately packaged/decontaminated and labeled samples.

5. Job Hazard Evaluation

Roux's work at the Site is expected to entail a variety of physical, chemical, and biological hazards, all of which must be sufficiently managed to allow the work to be performed safely. Some of the hazards are Site-specific, i.e., they are associated with the nature, physical characteristics, and/or routine operation of the Site itself, while others are activity-specific, i.e., they are associated with (or arise from) the particular activity being performed. The various hazards can be grouped into the following categories:

Caught/Crushed – the potential to become caught in, under, between, or by an object or parts of an object, such as equipment with parts that open and close or move up and down ("pinch points") or equipment that rotates, and the accompanying potential to have body parts cut, mangled, or crushed thereby.

Contact – the potential to be struck by or against moving or stationary objects that can cause physical injury, such as heavy machinery, overhead piping, moving vehicles, falling objects, and equipment (including tools and hand-held equipment) or infrastructure with the ability to cut or impale.

Energy Sources – the potential for bodily harm associated with energy sources, most notably electricity, but also including latent energy sources such as compressed air and equipment under tension (which when released could cause injurious contact or a fall).

Ergonomics – the potential for musculoskeletal injury associated with lifting/carrying, pushing/pulling, bending, reaching, and other physical activity attributable to poor body position/mechanics, repetitive motion, and/or vibration.

Exposure – the potential for injury/illness due to physical, chemical, or biological exposures in the work environment, including but not limited to temperature extremes, solar radiation, and noise (physical), chemical splashes and hazardous atmospheres (chemical), and animal/insect bites and poisonous plants (biological).

Falls – the potential to slip or trip and thus fall or drop a load, resulting in bodily injury to oneself or others.

The foregoing is intended to provide Roux employees with a general awareness of the hazards involved with Site work. A more detailed review of the potential hazards associated with each specific activity planned for the Site (or ongoing activity, as the case may be) is provided in the activity-specific Job Safety Analysis (JSA) forms in **Appendix A**. As can be seen in the JSA forms, the hazards are identified by category per the above, and specific measures designed to mitigate/manage those hazards are also identified. In preparing the JSA forms, all categories of hazards were considered, and all anticipated potential hazards were identified to the extent possible based on the experience of the personnel preparing and reviewing the JSA forms. However, there is always the possibility for an unanticipated hazard to arise, potentially as condition change over the course of the workday. Roux personnel must maintain a continual awareness of potential hazards in the work zone, regardless of whether the hazard is identified in the JSA form. Particular attention should be paid to hazards associated with exposure to hazardous substances (see Table 1 for a listing of the hazardous substances most likely to be encountered in environmental media at the Site) and to Site personnel being located "in the line of fire" with respect to moving equipment, pinch points, and latent energy, e.g., being located or having body parts located within the swing radius of an excavator, between two sections of pipe being connected, below a piece of suspended equipment, or adjacent to a compressed air line.

5.1 Hazard Communication and Overall Site Information Program

The information in the JSAs and safety data sheets is made available to all employees and subcontractors who could be affected by it prior to the time they begin their work activities. Modifications to JSAs are communicated during routine pre-work briefings.

The information in the JSAs and Safety Data Sheets (SDSs) is made available to all employees and subcontractors who could be affected by an exposure to the hazards covered in them prior to the time they begin their work activities. Modifications to JSAs are communicated during routine pre-work briefings, and periodically updated as needed in the HASP. SDSs will be maintained by the SHSO/SS for new chemicals brought on-site as needed. Copies of SDSs can be found in **Appendix B**.

6. Emergency Response Plan

This emergency response plan details actions to be taken in the event of Site emergencies. The PM and SHSO is responsible for the implementation of emergency response procedures onsite. The SHSO/PM provides specific direction for emergency action based upon information available regarding the incident and response capabilities and initiates emergency procedures and notification of appropriate authorities. In the event of an emergency, Site personnel are evacuated and do not participate in emergency response activities, response is facilitated through external emergency services.

6.1 Emergency Response

The SHSO, after investigating the incident and relevant information, shall determine the level of response required for containment, rescue and medical care. Limited on-site emergency response activities could occur therefore the SHSO is responsible for notifying external emergency response agencies. The SHSO provides relevant information to the responding organizations, including but not limited to the hazards associated with the emergency incident, potential containment problems, and missing Site personnel.

6.2 Emergency Alerting and Evacuation

If evacuation notice is given, Site workers leave the worksite, if possible, by way of the nearest exit. Appropriate primary and alternate evacuation routes and assembly areas have been identified and are shown on the Site Plan with Emergency Muster Area **Figure 2**. The routes and assembly area will be determined by conditions at the time of the evacuation based on wind direction, the location of the hazard source, and other factors as determined by SHSO/PM.

Personnel exiting the Site gather at a designated assembly point. To determine that everyone has successfully exited the Site, personnel will be accounted for at the assembly Site. If any worker cannot be accounted for, notification is given to so that appropriate action can be initiated. Subcontractors on this Site have coordinated their emergency response plans to ensure that these plans are compatible and potential emergencies are recognized, alarm systems are clearly understood, and evacuation routes are accessible to all personnel relying upon them.

6.3 Emergency Medical Treatment and First Aid

In the event of a work-related injury or illness, employees are required to follow the procedures outlined below. All work-place injury and illness situations require Roux's Project and Corporate Management Team to be notified when an injury/illness incident occurs, and communication with the contracted Occupational Health Care Management Provider, AllOne Health (AOH), is initiated. The Injury/Illness Notification Flowchart is provided below and within Roux's Incident Investigation and Reporting program included within Roux's Corporate Health and Safety Manual.

If on-site personnel require any medical treatment, the following steps will be taken:

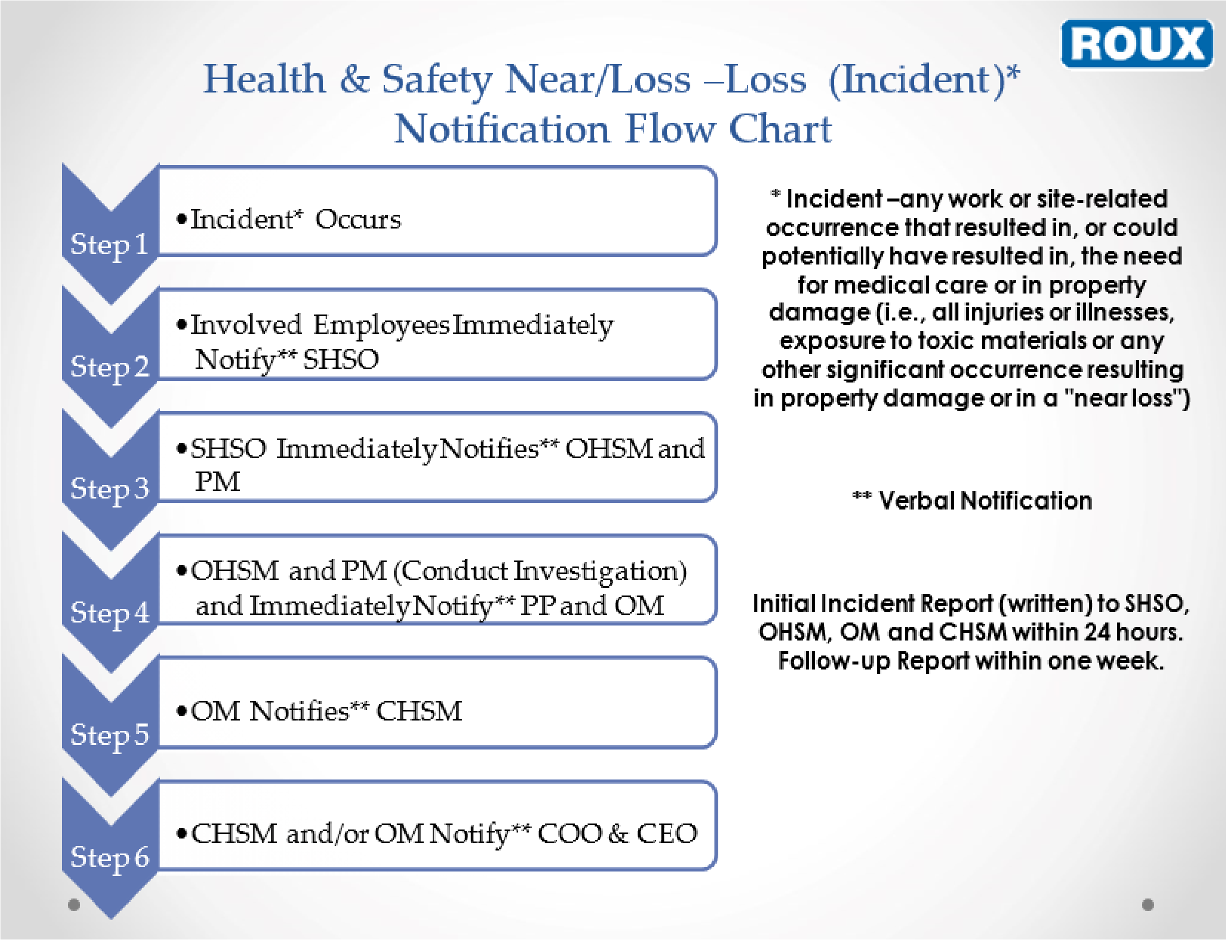
a. Notify Roux's Project and Corporate Management Team for any work-related injury and/or illness occurrence, and communicate with the contracted Occupational Health Care Management Provider, AOH, immediately following the notifications provided above.

b. Based on discussions with the Project Team, Corporate Management and the AOH evaluation, if medical attention beyond onsite First Aid is warranted, transport the injured / ill person (IP) to the Urgent Care Center, or notify the Fire Department or Ambulance Emergency service and request an ambulance or transport the victim to the hospital, and continue communications with Corporate Management Team. An Urgent Care/Hospital Route map with location to NYU Medical Center is included as **Figure 3**.

c. Decontaminate to the extent possible prior to administration of first aid or movement to medical or emergency facilities.

d. First aid medical support will be provided by onsite personnel trained and certified in First Aid, Cardio Pulmonary Resuscitation (CPR), Automatic External Defibrillation (AED), and Blood-Borne Pathogens (BBP) Awareness, until relieved by emergency medical services (EMS).

e. The SHSO and Project Manager will perform a Loss Investigation (LI) and the Project Team will complete the final Loss Report. If a Roux employee is involved in a vehicular incident, the employee must also complete the Acord Automobile Loss Notice.



6.4 Adverse Weather Conditions

In the event of adverse weather conditions, the SHSO or project principal will determine if work can continue without sacrificing the health and safety of all field workers. Some of the items to be considered prior to determining if work should continue are:

- Potential for heat stress and heat-related injuries.
- Potential for cold stress and cold-related injuries.
- Treacherous weather-related conditions.

- Limited visibility.
- Electrical storm potential.

Site activities will be limited to daylight hours and acceptable weather conditions. Inclement working conditions include heavy rain, fog, high winds, and lightning. Observe daily weather reports and evacuate if necessary in case of inclement weather conditions.

6.5 Electrical Storm Guidelines

In the event that lightning and/or thunder are observed while working onsite, all onsite activities shall stop and personnel shall seek proper shelter (e.g., substantial building, enclosed vehicle, etc.). Work shall not resume until the threat of lighting has subsided and no lightning or thunder has been observed for 30 minutes. If the possibility of lightning is forecast for the day, advise the onsite personnel on the risks and proper procedure at the pre-work safety briefing. Continuously monitor for changing weather conditions and allow enough time to properly stop work if lightning is forecast.

7. Safety Procedures

This section of the HASP presents the specific safety procedures to be implemented during Roux's activities at the Site in order to protect the health and safety of various on-site personnel. Minimum OSHA-mandated procedures are presented first, followed by client- and Site-specific procedures. Lastly, activity-specific procedures are discussed. These Site and activity-specific procedures supplement the general safety procedures included in Roux's Corporate Health and Safety Manual, which also must be followed in their entirely.

7.1 Training

At a minimum, Site personnel who will perform work in areas where there exists the potential for toxic exposure will be health and safety-trained prior to performing work onsite per OSHA 29 CFR 1910.120(e) and 29 CFR 1926.65(e). More specifically, all Roux, subcontractor, and other personnel engaged in sampling and remedial activities at the Site and who are exposed or potentially exposed to hazardous substances, health hazards, or safety hazards must have received at a minimum the 40 hour initial HAZWOPER training consistent with the requirements of 29CFR 1910.120(e)(3)(i) training and a minimum of 3 days' actual field experience under the direct supervision of a trained experienced supervisor, plus 8 hours of refresher training on an annual basis. Depending on tasks performed, less training may be permitted. Evidence of such training must be maintained at the Site at all times. Furthermore, all onsite management and supervisory personnel directly responsible for or who supervise the employees engaged in Site remedial operations, must have received an additional 8 hours of specialized training at the time of job assignment on topics including, but not limited to, the employer's safety and health program and the associated employee training program, personal protective equipment program, spill containment program, and health hazard monitoring procedure and techniques, plus 8 hours of refresher training on an annual basis.

Roux personnel training records are maintained in a corporate database with records available upon request from either the OHSM/SHSO/CHSM or Human Resources Department.

7.2 Site-Specific Safety Briefings for Visitors

A site-specific briefing is provided to all site visitors who enter this site beyond the site entry point. For visitors, the site-specific briefing provides information about site hazards, the site lay-out including work zones and places of refuge, the emergency alarm system and emergency evacuation procedures, and other pertinent safety and health requirements as appropriate.

7.3 HASP Information and Site-Specific Briefings for Workers

Site personnel review this HASP and are provided a site-specific tailgate briefing prior to the commencement of work to ensure that employees are familiar with this HASP and the information and requirements it contains as well as relevant JSAs. Additional briefings are provided as necessary to notify employees of any changes to this HASP as a result of information gathered during ongoing site characterization and analysis. Conditions for which we schedule additional briefings include but are not limited to: changes in site conditions, changes in the work schedule/plan, newly discovered hazards, and incidents occurring during site work.

7.4 Medical Surveillance

The medical surveillance section of the Health and Safety Plan describes how worker health status is monitored at this site. Medical surveillance is used when there is the potential for worker exposure to hazardous substance at levels above OSHA permissible exposure limits or other published limits. The purpose of a medical surveillance program is to medically monitor worker health to ensure that personnel are not adversely affected by site hazards. The provisions for medical surveillance at this site are based on the site characterization and job hazard analysis found in Section 4 of this HASP and are consistent with OSHA requirements in 29 CFR 1910.120(f) as applicable.

7.4.1 Site Medical Surveillance Program

Medical surveillance requirements are based on a worker's potential for exposure as determined by the site characterization and job hazard analysis documented in Section 4 and JSAs within **Appendix A** of this HASP and in compliance with the requirements of 29 CFR 1910.120(f)(2). Based on site information and use of direct reading instruments, limited use of respirators (less than 30 days per year), and the absence of an employee-staffed HAZMAT team, a limited medical surveillance program is required and implemented at this site. The medical surveillance program provides that:

1. Workers assigned to tasks requiring the use of respirators receive medical examinations in accordance with 29 CFR 1910.134(e) to ensure they are physically capable to perform the work and use the equipment, and
2. If a worker is injured, becomes ill, or develops signs or symptoms of possible over-exposure to hazardous substance or health hazards, medical examinations are provided to that worker as soon as possible after the occurrence and as required by the attending physician.
3. These medical examinations and procedures are performed by or under the supervision of a licensed physician and are provided to workers free of cost, without loss of pay, and at a reasonable time and place. In addition, the need to implement a more comprehensive medical surveillance program will be re-evaluated after any apparent over-exposure.

7.4.2 Medical Recordkeeping Procedures

Medical recordkeeping procedures are consistent with the requirements of 29 CFR 1910.1020 and are described in the company's overall safety and health program. A copy of that program is available at our Islandia, NY office.

The following items are maintained in worker medical records:

- Respirator fit test and selection
- Physician's medical opinion of fitness for duty (pre-placement, periodic, termination)
- Physician's medical opinion of fitness for respirator protection (pre-placement, periodic)
- Exposure monitoring results

7.4.3 Program Review

The medical program is reviewed to ensure its effectiveness. The Corporate Health and Safety Manager in coordination with the Human Resources Director is responsible for this review. At minimum, this review consists of:

- Review of accident and injury records and medical records to determine whether the causes of accidents and illness were promptly investigated and whether corrective measures were taken wherever possible;
- Evaluation of the appropriateness of required medical tests based on site exposures; and
- Review of emergency treatment procedures and emergency contacts list to ensure they were site-specific, effective, and current.

7.5 Personnel Protection

Site safety and health hazards are eliminated or reduced to the greatest extent possible through engineering controls and work practices. Where hazards are still present, a combination of engineering controls, work practices and PPE are used to protect employees. Appropriate personal protective equipment (PPE) shall be worn by Site personnel when there is a potential exposure to chemical hazards or physical hazards (e.g., falling objects, flying particles, sharp edges, electricity and noise), as determined by the SHSO. The level of personal protection, type and kind of equipment selected will depend on the hazardous conditions and in some cases cost, availability, compatibility with other equipment, and performance. An accurate assessment of all these factors will be made before work can be safely executed.

Roux maintains a comprehensive written PPE program that addresses proper PPE selection, use, maintenance, storage, fit and inspection. Roux's PPE program can be found within **Appendix C**. PPE to be used at the Site will meet the appropriate American National Standards Institute (ANSI) standards and the following OSHA (General/Construction Industry) standards for minimum PPE requirements.

The minimum level of PPE for entry onto the Site is Level D. The following equipment shall be worn:

- Work uniform (long pants, sleeved shirt)
- Hard hat
- Steel or composite toe work boots
- Safety Glasses (must comply with one of the following ANSI/ISEA Z87.1-2010, ANSI Z87.1-2003, ANSI Z87.1-2003)
- Boot Covers (as needed)
- Hearing Protection (as needed)
- High visibility clothing (shirt/vest)
- Hand Protection (e.g., minimum cut resistance meeting ANSI 105-2000 Level 2)

Note that jewelry shall be removed or appropriately secured to prevent it from becoming caught in rotating equipment or unexpectedly snagged on a fixed object. (e.g., wrist watches bracelets, rings, chains and necklaces, open earrings). Do not wear loose clothing and all shoulder length hair should be tied back.

Site specific PPE ensembles and materials are identified within task specific JSAs located within **Appendix A**, and any upgrades or downgrades of the level of protection (i.e., not specified in the JSA) must be approved by the PP and immediately communicated to all Roux personnel and subcontractors as applicable. PPE is used in accordance with manufacturer's recommendations.

7.5.1 Hearing Conservation

Hearing protection is made available when noise exposures equal or exceed an 8-hour time-weighted average sound level of 85 dBA. Hearing protection is required when the 8-hour time weighted average sound level $\geq$ 90 dBA. Where noise exposure meets or exceeds this level, noise is listed as a physical hazard in the JSA for the tasks/operation, and hearing protection is included as one of the control measures (PPE).

7.6 Monitoring

An air monitoring program is important to the safety of on- and off-Site personnel, and the surrounding area. A preliminary survey, to establish background conditions in the immediate sampling area, may be made prior to the initiation of Site work including, but not limited to, monitoring wind direction (e.g. wind socks) and approximate temperature during all invasive Site activities. This survey will be conducted with the appropriate pre-calibrated air monitoring instrument(s), as warranted by the field activity. Once this survey has been complete, any changes in the type of PPE will be determined and relayed to those working on-Site.

Work zone air monitoring will be performed to verify that the proper level of PPE is used, and to determine if increased protection or work stoppage is required. The following equipment shall be used to monitor conditions:

- A Photoionization Detector (PID) with a lamp energy of 10.6 eV will be used to provide direct readings of organic vapor concentrations during intrusive activities to determine that personnel protection is adequate. Concentrations shall be recorded during intrusive activities with the potential to encounter contaminant vapors.
- Colorimetric detection tubes shall be used based on PID action levels, to qualitatively identify possible contaminants as applicable.
- A pre-calibrated multi-gas meter with combustible Lower Explosive Limit (LEL), oxygen (O_2), carbon monoxide (CO), and hydrogen sulfide (H_2S) sensors shall be used to monitor the potential for oxygen-deficient atmospheres, explosive concentrations of organic vapors, and toxic gases during intrusive operations. Monitoring will be performed according to the action levels for oxygen and combustible gases provided in this section. The calibration for this device will be performed using a known gas composition calibration mixture.

Personal exposure monitoring utilizing activated charcoal tubes may be considered based on whether or not the area sample results are at or above half of the PEL. The decision to perform the monitoring will be made by, and under the control of, the CHSM.

Below are monitoring action levels for Site-specific chemicals of concern. In the event that PID readings above the thresholds identified below are sustained for 5 minutes in the breathing zone, worker protection will require upgrading following notification to the OHSM and applicable parties (e.g., client, board of health, regulators, etc.).

7.6.1 Action Levels for Air Monitoring

PPE can remain at Level D if breathing zone VOC concentrations are less than 5 ppm and benzene is non-detect. Personnel are required to evacuate the Site when breathing zone VOC readings exceed 25 ppm.

The following tables include summaries of the air monitoring, work practices, and action levels for the expected contaminants. The action levels to initiate testing with colorimetric tubes for airborne volatiles is 1 ppm (PID reading) and is based on the Permissible Exposure Limit (PEL) for benzene (1 ppm). The colorimetric tubes are used to confirm the presence or absence of specific constituents, and they do not provide a measured concentration.

Air Monitoring Summary and Action Levels Organic Vapors	
PID Reading in Breathing Zone (ppm)[1]	**Action**
0-1 ppm above background[2]	Continue monitoring
1-5 ppm sustained 60 seconds	Continue monitoring, if applicable initiate additional collection of benzene using colorimetric tubes.
<5 ppm and no presence of benzene	Continue Monitoring, ventilate space
$\geq$ 5 ppm - $\leq$ 25 ppm and no presence of benzene	Ventilate space until PID reads < 5 ppm. If < 25 ppm cannot be achieved, upgrade to Level C[3].
$\geq$ 25 ppm	Ventilate space and evacuate area.

1 Based on relative response/sensitivity of PID to benzene.

2 Background concentrations should be established at the beginning of each work day. It may be necessary to re-establish background concentrations and ambient conditions vary through the day.

3 Measured air concentrations of known organic vapors will be reduced by the respirator to one half of the PEL or lower, and the individual and combined compound concentrations shall be within the service limit of the respirator cartridge.

Air Monitoring Summary and Action Levels Oxygen	
O_2 Reading in Breathing Zone (%)[1]	**Action**
20.9% O_2	Oxygen level normal
< 19.5% O_2	Oxygen deficient Interrupt task/Evacuate area
>23.5% O_2	Oxygen enriched Interrupt task/Evacuate area

1. Action levels based on USEPA Standard Operating Safety Guides; Table 5-1, Atmospheric Hazard Action Guidelines may be further restricted based on the CHSM's professional judgment and experience.

Air Monitoring Summary and Action Levels Carbon Monoxide	
CO Reading in Breathing Zone (ppm)[1]	**Action**
<25 ppm	Inspect exhaust system for leaks or other sources of CO. Monitor initially and every 15 minutes during use of CO-generating equipment
25-50 ppm	Ventilate area. Monitor continuously and record measurements. Contact PM.
>50 ppm	Cease Field Operations. Ventilate area.

1. Based upon the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) of 25 ppm as an 8-hour time weighted average (TWA) and OSHA's Permissible Exposure Limit (PEL) of 50 ppm as an 8-hour TWA concentration.

Air Monitoring Summary and Action Levels Combustible Gases	
Lower Explosive Limit (LEL) Reading	**Action**
< 4% LEL (<2,000 ppm)	Site activities will continue with normal monitoring
4% – 20% LEL (2,000 – 10,000 ppm)	Stop work until levels dissipate to <4% LEL
> 20% LEL (>10,000 ppm)	Potential explosion hazard. Halt all site activities, research source of release, aerate work area, suppress source

Air Monitoring Summary and Action Levels Hydrogen Sulfide	
Hydrogen Sulfide (H_2S) Reading	**Action**
<10 ppm	Site activities will continue with normal monitoring
>10 ppm	Stop work until levels dissipate to <10 ppm; use mechanical ventilation if possible
Cannot use air purifying respirators for H_2S because of olfactory fatigue	

7.6.2 Air Monitoring Equipment and Calibration

A PID calibrated to an appropriate calibration mixture will be used to detect organic vapors in and around the work areas. Monitoring will be conducted in and around all work areas and at the workers breathing zone before activities commence to establish a background level, then at 15-minute intervals throughout the day. All equipment will be calibrated according to the manufacturer's recommendation. A calibration log will be maintained and will include the name of the person who performed the calibration, the date and time calibrated, and the instrument reading at the time of calibration. A manual bellows pump or equivalent with colorimetric tubes for formaldehyde will be utilized to determine the course of action related to upgrading or downgrading the level of respiratory protection, as applicable.

If air monitoring data indicate safe levels of potentially harmful constituents at consistent intervals (5-minute intervals), then monitoring can be conducted less frequently (every 30 minutes). This determination will be made by the onsite SHSO. Monitoring data, including background readings and calibration records, will be documented. Work to be performed on-Site will conform to Roux Associates' Standard Operating Procedures (SOPs). Conformance with these guidelines as well as the guidelines described in this HASP will aid in mitigating the physical and chemical hazards mentioned throughout this HASP.

7.7 Tailgate Safety Meetings

A designated Site worker will provide daily safety briefings (e.g., tailgate meetings) including, but not limited to, the following scenarios:

- When new operations are to be conducted;

- Whenever changes in work practices must be implemented; and
- When new conditions are identified and/or information becomes available.

Daily safety briefings shall be recorded on the Roux Daily Tailgate Health and Safety Meeting Log/Daily Site Safety Checklist, and all completed forms will become a part of the project file.

7.8 Spill Containment

Spill containment equipment and procedures should, at a minimum, meet the requirements of the facility's Spill Prevention, Control and Countermeasure Plan, if applicable. Otherwise, spill containment equipment and procedures must be considered depending on the task including, but no limited to, chemical/product transfer points and handling.

7.8.1 Initial Spill Notification and Response

Any worker who discovers a hazardous substance spill will immediately notify the Project Manager. The worker will, to his/her best ability, report the hazardous substance involved, the location of the spill, the estimated quantity of material spilled, the direction/flow of the spill material, related fire/explosion incidents, and any associated injuries without compromising their own safety.

7.8.2 Spill Evaluation and Response

The Project Manager is responsible for evaluating spills and determining the appropriate response. When this evaluation is being made, the spill area will be isolated and demarcated to the extent possible. If necessary, to protect nearby community members, notification of the appropriate authorities is made by the PM as appropriate. On-site response is limited to small spills (e.g., <10 gallons), large spills require external emergency responders who will be contacted by the SHSO.

7.9 Decontamination

The decontamination section of the HASP describes how personnel and equipment are decontaminated when they leave the Exclusion Zone. This section also describes how residual waste from decontamination processes is disposed. The site decontamination procedures are designed to achieve an orderly, controlled removal or neutralization of contaminants that may accumulate on personnel or equipment. These procedures minimize worker contact with contaminants and protect against the transfer of contaminants to clean areas of the site and off-site. They also extend the useful life of PPE by reducing the amount of time that contaminants contact and can permeate PPE surfaces. Decontamination is facilitated within the contamination reduction zone at this site.

7.9.1 Decontamination Procedures for Personnel and PPE

The following are general decontamination procedures established and implemented at this site.

1. Decontamination is required for all workers exiting a contaminated area. Personnel may re-enter the Support Zone only after undergoing the decontamination procedures described below in the next section.
2. Protective clothing is decontaminated, cleaned, laundered, maintained and/or replaced as needed to ensure its effectiveness.
3. PPE used at this site that requires maintenance or parts replacement is decontaminated prior to repairs or

4. PPE used at this site is decontaminated or prepared for disposal on the premises. Personnel who handle contaminated equipment have been trained in the proper means to do so to avoid hazardous exposure.
5. This site uses an off-site laundry for decontamination of PPE. The site has informed that facility of the hazards associated with contaminated PPE from this site.
6. The site requires and trains workers that if their permeable clothing is splashed or becomes wetted with a hazardous substance, they will immediately exit the work zone, perform applicable decontamination procedures, shower, and change into uncontaminated clothing.
7. Procedures for disposal of decontamination waste meet applicable local, State, and Federal regulations.

7.9.2 Decontamination Procedures for Equipment

All tools, equipment, and machinery from the Exclusion Zone or CRZ are decontaminated in the CRZ prior to removal to the Support Zone. Equipment decontamination procedures are designed to minimize the potential for hazardous skin or inhalation exposure and to avoid cross-contamination and chemical incompatibilities.

General Equipment Decontamination Procedures:

1. Decontamination is required for all equipment exiting a contaminated area. Equipment may re-enter the Support Zone only after undergoing the equipment decontamination procedures.
2. Vehicles that travel regularly between the contaminated and clean areas of the site are carefully decontaminated each time they exit the Exclusion Zone and the effectiveness of that decontamination is monitored to reduce the likelihood that contamination will be spread to other parts of the site.
3. Particular attention is given to decontaminating tires, scoops, and other parts of heavy equipment that are directly exposed to contaminants and contaminated soil.

The following items may be used to decontaminate equipment:

- Fresh water rinse;
- Non-phosphorus detergent wash;
- Distilled water rinse;
- Acetone rinse;
- Distilled water rinse; and
- A steam cleaner or pressure washer (heavy equipment only).

7.9.3 Monitoring the Effectiveness of Decontamination Procedures

Visual examination and sampling are used to evaluate the effectiveness of decontamination procedures. Visual examination is used to ensure that procedures are implemented as described and that they appear to control the spread of contaminants under changing site conditions. Visual examination is also used to inspect for signs of residual contamination or for contaminant permeation of PPE.

Personnel who work in contaminated areas of the site, either the Contamination Reduction Zone (CRZ) or the Exclusion Zone, are trained in the principles and practices of decontamination described in this section of the HASP and in related SOPs. If site procedures are changed as a result of inspection and monitoring, all affected employees are notified of these changes.

7.10 Confined Space Entry

Confined space entry is not in the scope of work for Roux employees during the activities of this project, however the guidelines for such activities are outlined below, should the need arise.

The following is a list of the safety requirements for confined space entry at the Site:

- **ROUX PERSONNEL ARE NOT AUTHORIZED TO ENTER AN OSHA PERMIT REQUIRED CONFINED SPACE;**
- Currently the scope of work **DOES NOT** require personnel to enter permitted confined space for this project; and
- Any changes to the field activities that may necessitate confined space entry will be reported to the Project Principal and OHSM.

Confined space is defined as any space, depression, or enclosure that:

- Has limited opening for entry and egress;
- Is large enough for and employee to enter and perform assigned work; and
- Is not intended for continuous occupancy.

A permit required confined space is one that meets the definition of a confined space and has one or more of the following characteristics:

- May contain or produce life-threatening atmospheres due to oxygen deficiency the presence of toxic, flammable, or corrosive contaminants;
- Contains a material that has the potential for engulfment;
- Has an internal configuration that may cause an entrant to be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross-section; and
- Contains any other serious safety or health hazards.

Although Roux personnel will not perform confined space entry, it is expected that subcontractors performing cleaning and mitigation and/or remedial measures activities may be required to enter structures that are considered to be a permit required confined space. Permitting of the confined space as well as hazard mitigation for entry will be completed by the subcontractor in accordance with 1910.146.

7.11 Client and Site-Specific

In addition to the OSHA-specific procedures discussed above, there may be client and site-specific safety procedures that must be adhered to during the performance of remedial activities at the Site.

7.12 Unusual or Significant Risks

Field activities that appear to have unusual or significant risks that cannot be adequately managed with existing risk tools such as LPS, HASPs, traffic safety plans, work permits, design and O&M practices, equipment HAZOPS or other safety tools must be referred to the CHSM to help with the assessment and management of the associated potential safety risks. Examples include the use of explosives for demolition, use of firearms to control wildlife, rappelling, demolition over water, etc.

7.13 Activity-Specific

In addition to the general hazards discussed above, there are activity-specific hazards associated with each work activity planned for the Site. An activity-specific JSA has been completed for each of the activities planned for the Site. JSAs are provided in **Appendix A**. In the event that new work activities or tasks are planned, JSAs will be developed and implemented prior to performing the new activities. In the absence of a JSA, the personnel performing work must prepare a field JSA and receive clearance from a designated competent safety official prior to performing any task with significant risk. In emergency situations where time is critical SPSAs will be utilized to identify the task, associated hazards and mitigative actions to take. For lower risk activities (as deemed by the discretion of a Competent Person) where a JSA is determined to not be needed, the individual(s) conducting the activities must perform SPSAs prior to and during the work.

7.13.1 Electrical and Other Utility Assessment and Accommodations

Roux shall perform a site walk to identify any potential overhead electrical or utility lines. All applicable guidelines will be followed in the vicinity of overhead power and utility lines (see Section 7.13.3 below).

Roux has also reviewed all available Site maps showing buried utility lines to identify potential hazards, which revealed that no underground hazards are known to exist in the vicinity of the areas of the Site pertinent to this HASP.

7.13.2 Subsurface Work

Subsurface work activities will require adherence to Roux's Corporate Subsurface Utility Clearance Management program found within **Appendix D**.

7.13.2.1 Excavations and Trenching

All trenching and excavation work activities contracted by Roux shall comply with 29 CFR 1926.651-652 Subpart P. Additionally, for trenches greater than 4 feet deep, where employees will enter, the trench needs to have a stairway or ladder or other safe means of egress. Where employees will enter trenches greater than 5 feet deep, the trench must have some type of protective system or sloped appropriately to prevent cave-ins.

The SHSO will be present on-Site during all Roux contracted excavation and backfill operations and will supplement health and safety monitoring conducted by Subcontractor air quality screening to ensure that appropriate levels of protection and safety procedures are utilized. The proximity of chemical, water, sewer, and electrical lines will be identified by Roux and/or their subcontractor before any subsurface activity or sampling is attempted.

The following safe work practices will be implemented during this task.

- The proximity of chemical, water, sewer, and electrical lines will be identified by a facility representative prior to beginning any subsurface activity.
- While earthmoving, stay out of the excavator's delineated heavy equipment exclusion zone and away from the excavation sides, where there is potential for cave in (within excavations that are 6 feet or more in depth, a delineated perimeter 6 feet away from the excavated edge is required).

Maximum Allowable Slopes

Soil or Rock Type	Maximum Allowable Slopes (H:V)[1] for Excavations Less Than 20 Feet Deep[3]	
Stable Rock	Vertical	(90°)
Type A[2]	$^3/_4$: 1	(53°)
Type B	1 : 1	(45°)
Type C	1 $^1/_2$: 1	(34°)

OSHA (29 CFR 1926.652, Subpart P, Appendices A and B)

Notes:

1 Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.

2 A short-term maximum allowable slope of $^1/_2$H : 1V (63°) is allowed in excavations in Type A soil that are 12 feet (3.67 meters) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 meters) in depth shall be $^3/_4$H : 1V (53°).

3 Sloping or benching for excavations greater than 20 feet deep shall be designed and stamped by a registered professional engineer.

Proper stockpiling (i.e., 2 feet minimum distance from the excavation edge), containment, transport, storage, and disposal practices will be utilized and is dependent upon the potential type and amount of waste generated during operations. The location of safety equipment and evacuation procedures will be established prior to initiation of operations according to this HASP.

7.13.3 Heavy Equipment

Use of heavy equipment at the Site will require adherence to Roux's Corporate Heavy Equipment Exclusion Zone Management Program found within **Appendix E**. Additionally, operation of the drill rig/other heavy equipment will maintain clearances from overhead power lines in accordance with OSHA 29 CFR1926.1408 Table A Minimum Clearance Distances provided below.

Minimum Required Clearances for Energized Overhead Power Lines

Nominal System Voltage of Power Line (K V)	Minimum Required Clearance (feet)
0-50	10
51-100	12
101-200	15
201-300	20
301-500	25
501-750	35
751-1000	45

1 kilovolt (KV) = 1,000 volts

7.14 Heat Stress

The National Oceanic and Atmospheric Administration records average minimum/maximum temperatures of [25/87] degrees Fahrenheit during the year in Brooklyn, New York.

7.14.1 Heat Stress

Heat stress is a significant potential hazard and can be associated with heavy physical activity and/or the use of personal protective equipment in hot weather environments. Heat cramps are brought on by prolonged exposure to heat. As an individual sweats, water and salts are lost by the body resulting in painful muscle cramps. The signs and symptoms of heat stress are as follows:

- Severe muscle cramps, usually in the legs and abdomen;
- Exhaustion, often to the point of collapse; and
- Dizziness or periods of faintness.

First aid treatment includes, but is not limited to, shade, rest, and fluid replacement. Typically, the individual should recover within one-half hour while being monitored constantly. If the individual has not improved substantially within 30 minutes and the body temperature has not decreased, the individual should be transported to a hospital for medical attention.

7.14.2 Heat Exhaustion

Heat exhaustion may occur in a healthy individual who has been exposed to excessive heat while working or exercising. The circulatory system of the individual fails as blood collects near the skin to rid the body of excess heat through transference. The signs and symptoms of heat exhaustion are as follows:

- Rapid and shallow breathing;
- Weak pulse;
- Cold and clammy skin with heavy perspiration;
- Skin appears pale;
- Fatigue and weakness;
- Dizziness; and
- Elevated body temperature.

First aid treatment includes, but is not limited to, cooling the victim, elevating the feet, and replacing fluids.

If the individual is not substantially improved within 30 minutes and the body temperature has not decreased, the individual should be transported to the hospital for medical attention.

7.14.3 Heat Stroke

Heat stroke occurs when an individual is exposed to excessive heat and stops sweating. This condition is classified as a MEDICAL EMERGENCY requiring immediate cooling of the victim and transport to a medical facility. The signs and symptoms of heat stroke are as follows:

- Dry, hot red skin;
- Body temperature approaching or above 105 degrees F;
- Confusion, altered mental state, slurred speech;
- Seizures;
- Large (dilated) pupils; and
- Loss of consciousness – the individual may go into a coma.

First aid treatment requires immediate cooling and transportation to a medical facility. Heat stress is a significant hazard if any type of protective equipment (semi-permeable or impermeable) that prevents evaporative cooling is worn in hot weather environments.

7.15 Cold Stress

Cold stress is a danger at low temperatures and when the wind-chill factor is low. Prevention of cold-related illnesses is a function of whole-body protection. Adequate insulating clothing must be used when the air temperature is below 60°F. A work/rest regimen will be initiated when ambient temperatures and protective clothing cause a stressful situation. In addition, reduced work periods followed by rest in a warm area may be necessary in extreme conditions. The signs and symptoms of cold stress include the following:

- Severe shivering;
- Abnormal behavior;
- Slowing;
- Weakness;
- Stumbling or repeated falling;
- Inability to walk;
- Collapse; and/or
- Unconsciousness.

First aid requires removing the victim from the cold environment and seeking medical attention immediately. Also, prevent further body heat loss by covering the victim lightly with blankets. <u>Do not cover the victim's face</u>. If the victim is still conscious, administer hot drinks and encourage activity such as walking, wrapped in a blanket.

8. Field Team Review

Each person performing work at or visiting this site shall sign this section after site-specific training is completed and before being permitted to access the CRZ or Exclusion Zone.

I have read and understand this Site-Specific Health and Safety Plan. I will comply with the provision contained therein.

Site/Project: 12 Franklin Street, Brooklyn, NY 11222

Name & Company	Signature	Date

9. Approvals

By their signature, the undersigned certify that this HASP is approved and will be utilized at the Franklin Point LLC / Franklin Point Holding LLC.

TBD – Site Health and Safety Officer	Date
Nevin Pahlad - Office Health and Safety Manager	Date
Rachel Henke – Senior Project Manager	Date
Robert Kovacs – Project Principal	Date

TABLES

1. Toxicological Properties of Hazardous Substances Present at the Site

Table 1. Toxicological, Physical, and Chemical Properties of Compounds Potentially Present at the Site.

Compound	CAS #	ACGIH TLV	NIOSH REL	OSHA PEL	IDLH	Routes of Exposure	Toxic Properties	Target Organs	Physical/Chemical Properties
ORGANOCHLORINE PESTICIDES (OCP)									
DDT	50-29-3	TWA 1 mg/m3	TWA 0.5 mg/m3	TWA 1 mg/m3	500 mg/m3	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin; paresthesia tongue, lips, face; tremor; anxiety, dizziness, confusion, malaise (vague feeling of discomfort), headache, lassitude (weakness, exhaustion); convulsions; paresis hands; vomiting; [potential occupational carcinogen]	Eyes, skin, central nervous system, kidneys, liver, peripheral nervous system	White, odorless and tasteless, very stable, water-insoluble, synthetic BP: 260°F Fl.Pt. = 162-171°F LEL: NA UEL: NA
Aldrin	309-00-2	TWA 0.1 mg/m3	TWA 0.25 mg/m3	TWA 0.25 mg/m3	25 mg/m3	Inhalation, ingestion, skin and/or eye contact	headache, dizziness; nausea, vomiting, malaise (vague feeling of discomfort); myoclonic jerks of limbs; clonic, tonic convulsions; coma; hematuria (blood in the urine), azotemia; [potential occupational carcinogen]	Developmemntal, Endocrine, Liver, Immune System, Nervous System,	Colorless to dark-brown crystalline solid with a mild chemical odor. BP: 293°F Fl.Pt. = 150°F LEL: NA UEL: NA
Lindane (gamma-BHC)	58-89-9	TWA 0.5 mg/m3	TWA 0.5 mg/m3	TWA 0.5 mg/m3	50 mg/m3	Inhalation, ingestion, skin and/or eye contact	irritation eyes, skin, nose, throat; headache; nausea; clonic convulsions; resp difficulty; cyanosis; aplastic anemia; muscle spasm; In Animals: liver, kidney damage	Eyes, skin, respiratory system, central nervous system, blood, liver, kidneys	White to yellow, crystalline powder with a slight, musty odor. BP: 614°F Fl.Pt. = 150°F LEL: NA UEL: NA
Dieldrin	860-57-1	TWA 0.1 mg/m3	TWA 0.25 mg/m3	TWA 0.25 mg/m3	25 mg/m3	Inhalation, ingestion, skin and/or eye contact	headache, dizziness; nausea, vomiting, malaise (vague feeling of discomfort), sweating; myoclonic limb jerks; clonic, tonic convulsions; coma; ; In Animals: liver, kidney damage [potential occupational carcinogen]	Developmemntal, Endocrine, Liver, Immune System, Nervous System,	Colorless to light-tan crystals with a mild, chemical odor. BP: NA (Decomposes) Fl.Pt. = NA LEL: NA UEL: NA
VOLATILE ORGANIC COMPOUNDS (VOCs)									
1,1,1-Trichloroethane	71-55-6	TWA 350 ppm STEL 450 ppm	C 350 ppm (1900 mg/m^3) [15-minute]	TWA 350 ppm (1900 mg/m^3)	700 ppm	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin; headache, lassitude (weakness, exhaustion), central nervous system depression, poor equilibrium; dermatitis; cardiac arrhythmias; liver damage	Eyes, skin, central nervous system, cardiovascular system, liver	Colorless liquid with a mild, chloroform-like odor. BP: 165°F Fl.Pt. = NA LEL: 7.5% UEL: 12.5% Combustible Liquid, but burns with difficulty
1,1,2,2-Tetrachloroethane	79-34-5	TWA 1 ppm [skin]	Ca TWA 1 ppm (7 mg/m^3) [skin]	TWA 5 ppm (35 mg/m^3) [skin]	Ca [100 ppm]	Inhalation, skin absorption, ingestion, skin and/or eye contact	Nausea, vomiting, abdominal pain; tremor fingers; jaundice, hepatitis, liver tenderness; dermatitis; leukocytosis (increased blood leukocytes); kidney damage; [potential occupational carcinogen]	Skin, liver, kidneys, central nervous system, gastrointestinal tract	Colorless to pale-yellow liquid with a pungent, chloroform-like odor BP: 296°F Fl.Pt. = NA LEL: NA UEL: NA Noncombustible Liquid
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	TWA 1000 ppm STEL 1250 ppm	TWA 1000 ppm (7600 mg/m3) ST 1250 ppm (9500 mg/m3)	TWA 1000 ppm (7600 mg/m3)	2000 ppm	Inhalation, ingestion, skin and/or eye contact	Irritation skin, throat, drowsiness, dermatitis; central nervous system depression; In Animals: cardiac arrhythmias, narcosis	Skin, heart, central nervous system, cardiovascular system	Colorless to water-white liquid with an odor like carbon tetrachloride at high concentrations. [Note: A gas above 118°F.] BP: 118°F Fl.Pt. = NA LEL: NA UEL: NA
1,1,2-Trichloroethane	79-00-5	TWA 10 ppm [skin]	Ca TWA 10 ppm (45 mg/m3) [skin]	TWA 10 ppm (45 mg/m3) [skin]	Ca [100 ppm]	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, nose; central nervous system depression; liver, kidney damage; dermatitis; [potential occupational carcinogen]	Eyes, respiratory system, central nervous system, liver, kidneys	Colorless liquid with a sweet, chloroform-like odor BP: 237°F Fl.Pt. = NA LEL: 6% UEL: 15.5% Combustible Liquid, forms dense soot
1,1-Dichloroethane	75-34-3	TWA 100 ppm	TWA 100 ppm (400 mg/m^3)	TWA 100 ppm (400 mg/m^3)	3,000 ppm	Inhalation, ingestion, skin and/or eye contact	Irritation skin; central nervous system depression; liver, kidney, lung damage	Skin, liver, kidneys, lungs, central nervous system	Colorless, oily liquid with a chloroform-like odor. BP: 135°F Fl.Pt. = 2°F LEL: 5.4% UEL: 11.4% Class IB Flammable Liquid Fl.P. below 73°F and BP at or above 100°F.
1,1-Dichloroethene	75-35-4	TWA 5 ppm	Ca	None	Ca	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin, throat; dizziness, headache, nausea, dyspnea (breathing difficulty); liver, kidney disturbance; pneumonitis; [potential occupational carcinogen]	Eyes, skin, respiratory system, central nervous system, liver, kidneys	Colorless liquid or gas (above 89°F) with a mild, sweet, chloroform-like odor BP: 89°F Fl.Pt. = -2°F LEL: 6.5% UEL: 15.5% Class IA Flammable Liquid: Fl.P. below 73°F and BP below 100°F

Table 1. Toxicological, Physical, and Chemical Properties of Compounds Potentially Present at the Site.

Compound	CAS #	ACGIH TLV	NIOSH REL	OSHA PEL	IDLH	Routes of Exposure	Toxic Properties	Target Organs	Physical/Chemical Properties
1,2,3-Trichlorobenzene	87-61-6	Cameo Chemicals Source https://cameochemicals.noaa.gov/chemical/10051	NA	NA	NA	Inhalation, skin absorption, ingestion, skin and/or eye contact	Inhalation may cause irritation of respiratory tract. Irritating to the eyes. May redden skin on contact. Ingestion may cause liver damage.	Skin, eyes, respiratory tract, liver	A white solid with a sharp chlorobenzene odor. Insoluble in water and denser than water. Hence sinks in water Fl.Pt. = 234.9°F
1,2,4-Trichlorobenzene	120-82-1	C 5 ppm	C 5 ppm (40 mg/m3)	None	N.D.	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation eyes, skin, mucous membrane; In Animals: liver, kidney damage; possible teratogenic effects	Eyes, skin, respiratory system, liver, reproductive system	Colorless liquid or crystalline solid (below 63°F) with an aromatic odor BP: 416°F Fl.Pt. = 222°F LEL (302°F): 2.5% UEL (302°F): 6.6% Class IIIB Combustible Liquid: Fl.P. at or above 200°F. Combustible Solid
1,2-Dibromo-3-chloropropane	96-12-8	NA	Ca	TWA 0.001 ppm	Ca	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin, nose, throat; drowsiness; nausea, vomiting; pulmonary edema; liver, kidney injury; sterility; [potential occupational carcinogen]	Eyes, skin, respiratory system, central nervous system, liver, kidneys, spleen, reproductive system, digestive system	Dense yellow or amber liquid with a pungent odor at high concentrations. [pesticide] [Note: A solid below 43°F.] BP: 384°F Fl.Pt. = (oc) 170°F LEL: NA UEL: NA Class IIIA Combustible Liquid: Fl.P. at or above 140°F and below 200°F.
1,2-Dibromoethane	106-93-4	None listed Skin	Ca TWA 0.045 ppm C 0.13 ppm [15-minute]	TWA 20 ppm C 30 ppm 50 ppm [5-minute maximum peak]	Ca [100 ppm]	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin, respiratory system; dermatitis with vesiculation; liver, heart, spleen, kidney damage; reproductive effects; [potential occupational carcinogen]	Eyes, skin, respiratory system, liver, kidneys, reproductive system	Colorless liquid or solid (below 50°F) with a sweet odor. [fumigant] BP: 268°F Fl.Pt. = 50°F LEL: NA UEL: NA Noncombustible Liquid
1,2-Dichlorobenzene	95-50-1	TWA 25 ppm STEL 50 ppm	C 50 ppm (300 mg/m3)	C 50 ppm (300 mg/m3)	200 ppm	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, nose; liver, kidney damage; skin blisters	Eyes, skin, respiratory system, liver, kidneys	Colorless to pale-yellow liquid with a pleasant, aromatic odor. [herbicide] BP: 357°F Fl.Pt. = 1°F LEL: 2.2% UEL: 9.2% Class IIIA Combustible Liquid: Fl.P. at or above 140°F and below 200°F.
1,2-Dichloroethane	107-06-2	TWA 10 ppm	Ca TWA 1 ppm (4 mg/m3) ST 2 ppm (8 mg/m3)	TWA 50 ppm C 100 ppm 200 ppm [5-minute maximum peak in any 3 hours]	Ca [50 ppm]	Inhalation, ingestion, skin absorption, skin and/or eye contact	Irritation eyes, corneal opacity; central nervous system depression; nausea, vomiting; dermatitis; liver, kidney, cardiovascular system damage; [potential occupational carcinogen]	Eyes, skin, kidneys, liver, central nervous system, cardiovascular system	Colorless liquid with a pleasant, chloroform-like odor. [Note: Decomposes slowly, becomes acidic & darkens in color.] BP: 182°F Fl.Pt. = 56°F LEL: 6.2% UEL: 16% Class IB Flammable Liquid Fl.P. below 73°F and BP at or above 100°F.
1,2-Dichloropropane	78-87-5	TWA 10 ppm Dermal Sensitizer (DSEN)	Ca	TWA 75 ppm (350 mg/m3)	Ca [400 ppm]	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin, respiratory system; drowsiness, dizziness; liver, kidney damage; In Animals: central nervous system depression; [potential occupational carcinogen]	Eyes, skin, respiratory system, liver, kidneys, central nervous system	Colorless liquid with a chloroform-like odor. [pesticide] BP: 206°F Fl.Pt. = 60°F LEL: 3.4% UEL: 14.5% Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F.
1,3-Dichlorobenzene	541-73-1	https://cameochemicals.noaa.gov/chemical/8514				Inhalation, skin absorption, ingestion, skin and/or eye contact	INHALATION: Causes headache, drousiness, unsteadiness. Irritating to mucous membranes. EYES: Severe irritation. SKIN: Severe irritation. INGESTION: Irritation of gastric mucosa, nausea, vomiting, diarrhea, abdominal cramps and cyanosis.		Colorless liquid. Sinks in water. BP: 343°F Fl.Pt. = 146°F LEL: 2.02% UEL: 9.2%
1,4-Dichlorobenzene	106-46-7	TWA 10 ppm	Ca	TWA 75 ppm (450 mg/m3)	Ca [150 ppm]	Inhalation, skin absorption, ingestion, skin and/or eye contact	Eye irritation, swelling periorbital (situated around the eye); profuse rhinitis; headache, anorexia, nausea, vomiting; weight loss, jaundice, cirrhosis; In Animals: liver, kidney injury; [potential occupational carcinogen]	Liver, respiratory system, eyes, kidneys, skin	Colorless or white crystalline solid with a mothball-like odor. [insecticide] BP: 345°F Fl.Pt. = 150°F LEL: 2.5% UEL: NA Combustible Solid, but may take some effort to ignite.
1,4-Dioxane	123-91-1	TWA 20 ppm [skin]	Ca C 1 ppm (3.6 mg/m3) [30-minute]	TWA 100 ppm (360 mg/m3) [skin]	Ca [500 ppm]	Inhalation, skin absorption, ingestion, skin and/or eye contact	irritation eyes, skin, nose, throat; drowsiness, headache; nausea, vomiting; liver damage; kidney failure; [potential occupational carcinogen]	Eyes, skin, respiratory system, liver, kidneys	Colorless liquid or solid (below 53°F) with a mild, ether-like odor. BP: 214°F Fl.Pt. = 55°F LEL: 2.0% UEL: 22% Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F
2-Butanone	78-93-3	TWA 200 ppm STEL 300 ppm	TWA 200 ppm (590 mg/m3) ST 300 ppm (885 mg/m3)	TWA 200 ppm (590 mg/m3)	3000 ppm	inhalation, ingestion, skin and/or eye contact	irritation eyes, skin, nose; headache; dizziness; vomiting; dermatitis	Eyes, skin, respiratory system, central nervous system	Colorless liquid with a moderately sharp, fragrant, mint- or acetone-like odor BP: 175°F Fl.Pt. = 16°F LEL (200°F): 1.4% UEL (200°F): 11.4% Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F

Table 1. Toxicological, Physical, and Chemical Properties of Compounds Potentially Present at the Site.

Compound	CAS #	ACGIH TLV	NIOSH REL	OSHA PEL	IDLH	Routes of Exposure	Toxic Properties	Target Organs	Physical/Chemical Properties
2-Hexanone	591-78-6	TWA 5 ppm STEL 10 ppm [skin]	TWA 1 ppm (4 mg/m3)	TWA 100 ppm (410 mg/m3)	1600 ppm	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, nose; peripheral neuropathy: lassitude (weakness, exhaustion), paresthesia; dermatitis; headache, drowsiness	Eyes, skin, respiratory system, central nervous system, peripheral nervous system	Colorless liquid with an acetone-like odor BP: 262°F Fl.Pt. = 77°F LEL: NA UEL: 8.0% Class IC Flammable Liquid: Fl.P. at or above 73°F and below 100°F
4-Methyl-2-pentanone	108-10-1	TWA 20 ppm STEL 75 ppm	TWA 50 ppm (205 mg/m3) ST 75 ppm (300 mg/m3)	TWA 100 ppm (410 mg/m3)	500 ppm	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin, mucous membrane; headache, narcosis, coma; dermatitis; In Animals: liver, kidney damage	Eyes, skin, respiratory system, central nervous system, liver, kidneys	Colorless liquid with a pleasant odor BP: 242°F Fl.Pt. = 64°F LEL (200°F): 1.2% UEL (200°F): 8.0% Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F
Acetone	67-64-1	TWA 250 ppm STEL 500 ppm	TWA 250 ppm (590 mg/m^3)	TWA 1000 ppm (2400 mg/m^3)	2500 ppm [10% LEL]	Inhalation, ingestion, skin and/or eye contact	irritation eyes, nose, throat; headache, dizziness, central nervous system depression; dermatitis	Eyes, skin, respiratory system, central nervous system	Colorless liquid with a fragrant, mint-like odor BP: 133°F Fl.Pt. = 0°F LEL: 12.8% UEL: 2.5% Class IB Flammable liquid: Fl.P. below 73°F and BP at or above 100°F.
Benzene	71-43-2	TWA 0.5 ppm STEL 2.5 ppm	Ca TWA 0.1 ppm ST 1 ppm	TWA 1 ppm ST 5 ppm	Ca [500 ppm]	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin, nose, respiratory system; dizziness; headache, nausea, staggered gait; anorexia, lassitude (weakness, exhaustion); dermatitis; bone marrow depression; [potential occupational carcinogen]	Eyes, skin, respiratory system, blood, central nervous system, bone marrow	Colorless to light yellow liquid with an aromatic odor [Note: Solid below 42 °F] BP: 176°F Fl.Pt. = 12°F LEL: 1.2% UEL: 7.8% Class IB Flammable liquid. Fl.P. below 73°F and BP at or above 100°F.
Bromochloromethane	74-97-5	TWA 200 ppm	TWA 200 ppm (1050 mg/m3)	TWA 200 ppm (1050 mg/m3)	2000 ppm	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin, throat; confusion, dizziness, central nervous system depression; pulmonary edema	Eyes, skin, respiratory system, liver, kidneys, central nervous system	Colorless to pale-yellow liquid with a chloroform-like odor. [Note: May be used as a fire extinguishing agent.] BP: 155°F Fl.Pt. = NA LEL: NA UEL: NA Noncombustible Liquid
Bromodichloromethane	75-27-4	https://cameochemicals.noaa.gov/chemical/16064				Inhalation, ingestion, skin and/or eye contact	Symptoms of exposure to this compound may include irritation of the skin, eyes, mucous membranes and respiratory tract. It may also cause narcosis. Other symptoms may include nausea, dizziness and headache.	Liver and kidney damage. Central nervous system effects may also occur.	Clear colorless liquid BP: 189°F Fl.Pt. = NA LEL: NA UEL: NA
Bromoform	75-25-2	TWA 0.5 ppm	TWA 0.5 ppm (5 mg/m3) [skin]	TWA 0.5 ppm (5 mg/m3) [skin]	850 ppm	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin, respiratory system; central nervous system depression; liver, kidney damage	Eyes, skin, respiratory system, central nervous system, liver, kidneys	Colorless to yellow liquid with a chloroform-like odor. [Note: A solid below 47°F.] BP: 301°F Fl.Pt. = NA LEL: NA UEL: NA Noncombustible Liquid
Bromomethane	74-83-9	TWA 1 ppm [skin]	Ca	C 20 ppm (80 mg/m3) [skin]	Ca [250 ppm]	Inhalation, skin absorption (liquid), skin and/or eye contact (liquid)	Irritation eyes, skin, respiratory system; muscle weak, incoordination, visual disturbance, dizziness; nausea, vomiting, headache; malaise (vague feeling of discomfort); hand tremor; convulsions; dyspnea (breathing difficulty); skin vesiculation; liquid: frostbite; [potential occupational carcinogen]	Eyes, skin, respiratory system, central nervous system	Colorless gas with a chloroform-like odor at high concentrations. [Note: A liquid below 38°F. Shipped as a liquefied compressed gas.] BP: 38°F Fl.Pt. = NA (Gas) LEL: 10% UEL: 16.0% Flammable Gas, but only in presence of a high energy ignition source.
Carbon disulfide	75-15-0	TWA 1 ppm [skin]	TWA 1 ppm (3 mg/m3) ST 10 ppm (30 mg/m3) [skin]	TWA 20 ppm C 30 ppm 100 ppm (30-minute maximum peak)	500 ppm	Inhalation, skin absorption, ingestion, skin and/or eye contact	Dizziness, headache, poor sleep, lassitude (weakness, exhaustion), anxiety, anorexia, weight loss; psychosis; polyneuropathy; Parkinson-like syndrome; ocular changes; coronary heart disease; gastritis; kidney, liver injury; eye, skin burns; dermatitis; reproductive effects	Central nervous system, peripheral nervous system, cardiovascular system, eyes, kidneys, liver, skin, reproductive system	Colorless to faint-yellow liquid with a sweet ether-like odor. [Note: Reagent grades are foul smelling.] BP: 116°F Fl.Pt. = -22°F LEL: 1.3% UEL: 50.0% Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F.
Carbon tetrachloride	56-23-5	TWA 5 ppm STEL 10 ppm [skin]	Ca ST 2 ppm (12.6 mg/m3) [60-minute]	TWA 10 ppm C 25 ppm 200 ppm (5-minute maximum peak in any 4 hours)	Ca [200 ppm]	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin; central nervous system depression; nausea, vomiting; liver, kidney injury; drowsiness, dizziness, incoordination; [potential occupational carcinogen]	Central nervous system, eyes, lungs, liver, kidneys, skin	Colorless liquid with a characteristic ether-like odor BP: 170°F Fl.Pt. = NA LEL: NA UEL: NA Noncombustible Liquid
Chlorobenzene	108-90-7	TWA 10 ppm	NA	TWA 75 ppm (350 mg/m3)	1000 ppm	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin, nose; drowsiness, incoordination; central nervous system depression; In Animals: liver, lung, kidney injury	Eyes, skin, respiratory system, central nervous system, liver	Colorless liquid with an almond-like odor BP: 270°F Fl.Pt. = 82°F LEL: 1.3% UEL: 9.6% Class IC Flammable Liquid: Fl.P. at or above 73°F and below 100°F.

Table 1. Toxicological, Physical, and Chemical Properties of Compounds Potentially Present at the Site.

Compound	CAS #	ACGIH TLV	NIOSH REL	OSHA PEL	IDLH	Routes of Exposure	Toxic Properties	Target Organs	Physical/Chemical Properties
Chloroethane	75-00-3	TWA 100 ppm [skin]	Handle with caution in the workplace	TWA 1000 ppm (2600 mg/m3)	3800 ppm [10%LEL]	Inhalation, skin absorption (liquid), ingestion (liquid), skin and/or eye contact	Incoordination, inebriation; abdominal cramps; cardiac arrhythmias, cardiac arrest; liver, kidney damage	Liver, kidneys, respiratory system, cardiovascular system, central nervous system	Colorless gas or liquid (below 54°F) with a pungent, ether-like odor. [Note: Shipped as a liquefied compressed gas.] BP: 54°F Fl.Pt. = NA (gas), -58°F (liquid) LEL: 3.8% UEL: 15.4% Flammable Gas
Chloroform	67-66-3	TWA 10 ppm	Ca ST 2 ppm (9.78 mg/m3) [60-minute]	C 50 ppm (240 mg/m3)	Ca [500 ppm]	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin; dizziness, mental dullness, nausea, confusion; headache, lassitude (weakness, exhaustion); anesthesia; enlarged liver; [potential occupational carcinogen]	Liver, kidneys, heart, eyes, skin, central nervous system	Colorless liquid with a pleasant odor BP: 143°F Fl.Pt. = -82°F LEL: NA UEL: NA Noncombustible Liquid
Chloromethane	74-87-3	TWA 50 ppm STEL 100 ppm	Ca	TWA 100 ppm C 200 ppm 300 ppm (5-minute maximum peak in any 3 hours)	Ca [2000 ppm]	Inhalation, skin and/or eye contact (liquid)	Dizziness, nausea, vomiting; visual disturbance, stagger, slurred speech, convulsions, coma; liver, kidney damage; liquid: frostbite; reproductive, teratogenic effects; [potential occupational carcinogen]	Central nervous system, liver, kidneys, reproductive system	Colorless gas with a faint, sweet odor which is not noticeable at dangerous concentrations. [Note: Shipped as a liquefied compressed gas.] BP: -12°F Fl.Pt. = NA (Gas) LEL: 8.1% UEL: 17.4% Flammable Gas
cis-1,2-Dichloroethene	156-59-2	TWA 200 ppm (All isomers)	TWA 200 ppm (790 mg/m3)	TWA 200 ppm (790 mg/m3)	1000 ppm	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, respiratory system; central nervous system depression	Eyes, respiratory system, central nervous system	Colorless liquid (usually a mixture of the cis & trans isomers) with a slightly acrid, chloroform-like odor. BP: 118-140°F Fl.Pt. = 36-39°F LEL: 5.6% UEL: 12.8% Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F
cis-1,3-Dichloropropene	10061-01-5	https://cameochemicals.noaa.gov/chemical/20168				Inhalation, ingestion, skin and/or eye contact	Symptoms of exposure to this compound may include local irritation of the eyes skin and respiratory tract; dermatitis, gasping, coughing, substernal pain, extreme respiratory distress, lacrimation, central nervous system depression, skin irritation, acute gastrointestinal distress with pulmonary congestion and edema. It also may cause injury to the liver, kidneys and heart.	Skin, eyes, mucous membranes, liver, kidney, heart	Colorless to amber liquid with a sweetish odor. BP: 219.7°F Fl.Pt. = NA LEL: NA UEL: NA
Cyclohexane	110-82-7	TWA 100 ppm	TWA 300 ppm (1050 mg/m3)	TWA 300 ppm (1050 mg/m3)	1300 ppm [10%LEL]	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin, respiratory system; drowsiness; dermatitis; narcosis, coma	Eyes, skin, respiratory system, central nervous system	Colorless liquid with a sweet, chloroform-like odor. [Note: A solid below 44°F.] BP: 177°F Fl.Pt. = 0°F LEL: 1.3% UEL: 8.0% Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F.
Dibromochloromethane	124-48-1	https://cameochemicals.noaa.gov/chemical/16183				Inhalation, ingestion, skin and/or eye contact	Symptoms of exposure to this compound may include irritation of the skin, eyes, mucous membranes and upper respiratory tract. It may also cause fatigue. Other symptoms may include central nervous system effects, lung and cornea irritation and liver and kidney damage. Prolonged exposure can cause nausea, dizziness, headache and narcosis.	Skin, eyes, mucous membranes, upper respiratory tract	Clear colorless to yellow-orange liquid BP: 246-248°F Fl.Pt. = Greater than 200°F LEL: NA UEL: NA
Dichlorodifluoromethane	75-71-8	TWA 1000 ppm	TWA 1000 ppm (4950 mg/m3)	TWA 1000 ppm (4950 mg/m3)	15,000 ppm	Inhalation, skin and/or eye contact (liquid)	Dizziness, tremor, asphyxia, unconsciousness, cardiac arrhythmias, cardiac arrest; liquid: frostbite	Cardiovascular system, peripheral nervous system	Colorless gas with an ether-like odor at extremely high concentrations. [Note: Shipped as a liquefied compressed gas.] BP: -22°F Fl.Pt. = NA LEL: NA UEL: NA Nonflammable Gas
Ethyl benzene	100-41-4	TWA 20 ppm	TWA 100 ppm (435 mg/m^3) ST 125 ppm (545 mg/m^3)	TWA 100 ppm (435 mg/m^3)	800 ppm [10%LEL]	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin, mucous membrane; headache; dermatitis; narcosis, coma	Eyes, skin, respiratory system, central nervous system	Colorless liquid with an aromatic odor. BP: 277°F Fl.Pt. = 55°F LEL: 0.8% UEL: 6.7% Class IB Flammable Liquid below 73°F and BP at or above 100°F
Isopropyl benzene	98-82-8	TWA 5 ppm	TWA 50 ppm (245 mg/m3) [skin]	TWA 50 ppm (245 mg/m3) [skin]	900 ppm [10%LEL]	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin, mucous membrane; dermatitis; headache, narcosis, coma	Eyes, skin, respiratory system, central nervous system	Colorless liquid with a sharp, penetrating, aromatic odor BP: 306°F Fl.Pt. = 96°F LEL: 0.9% UEL: 6.5% Class IC Flammable Liquid: Fl.P. at or above 73°F and below 100°F
Methyl Acetate	79-20-9	TWA 200 ppm STEL 250 ppm	TWA 200 ppm (610 mg/m3) ST 250 ppm (760 mg/m3)	TWA 200 ppm (610 mg/m3)	3100 ppm [10%LEL]	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin, nose, throat; headache, drowsiness; optic nerve atrophy; chest tightness; In Animals: narcosis	Eyes, skin, respiratory system, central nervous system	Colorless liquid with a fragrant, fruity odor BP: 135°F Fl.Pt. = 14°F LEL: 3.1% UEL: 16% Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F.

Table 1. Toxicological, Physical, and Chemical Properties of Compounds Potentially Present at the Site.

Compound	CAS #	ACGIH TLV	NIOSH REL	OSHA PEL	IDLH	Routes of Exposure	Toxic Properties	Target Organs	Physical/Chemical Properties
Methylcyclohexane	108-87-2	TWA 400 ppm	TWA 400 ppm (1600 mg/m3)	TWA 500 ppm (2000 mg/m3)	1200 ppm [LEL]	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin, nose, throat; dizziness, drowsiness; In Animals: narcosis	Eyes, skin, respiratory system, central nervous system	Colorless liquid with a faint, benzene-like odor BP: 214°F Fl.Pt. = 25°F LEL: 1.2% UEL: 6.7% Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F.
Methylene chloride	75-09-2	TWA 50 ppm [skin] STEL 100 ppm	Ca	[1910.1052] TWA 25 ppm ST 125 ppm	Ca [2300 ppm]	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin; lassitude (weakness, exhaustion), drowsiness, dizziness; numb, tingle limbs; nausea; [potential occupational carcinogen]	Eyes, skin, cardiovascular system, central nervous system	Colorless liquid with a chloroform-like odor. [Note: A gas above 104°F.] BP: 104°F Fl.Pt. = NA LEL: 13% UEL: 23% Combustible Liquid
Methyl-t-butyl ether	1634-04-4	TWA 50 ppm	NA	NA	NA	Inhalation, skin absorption, ingestion, skin and/or eye contact	May cause dizziness or suffocation. Contact may irritate or burn eyes or skin. May be harmful if swallowed.	Eyes, skin	A colorless liquid with a distinctive anesthetic like odor. BP: 131°F Fl.Pt. = -14°F LEL: NA UEL: NA
o-Xylene	95-47-6	TWA 20 ppm (All isomers)	TWA 100 ppm (435 mg/m3) ST 150 ppm (655 mg/m3)	TWA 100 ppm (435 mg/m3)	900 ppm	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin, nose, throat; dizziness, excitement, drowsiness, incoordination, staggering gait; corneal vacuolization; anorexia, nausea, vomiting, abdominal pain; dermatitis	Eyes, skin, respiratory system, central nervous system, gastrointestinal tract, blood, liver, kidneys	Colorless liquid with an aromatic odor BP: 292°F Fl.Pt. = 90°F LEL: 0.9% UEL: 6.7% Class IC Flammable Liquid: Fl.P. at or above 73°F and below 100°F
Styrene	100-42-5	TWA 10 ppm STEL 20 ppm OTO (ototoxicant)	TWA 50 ppm (215 mg/m3) ST 100 ppm (425 mg/m3)	TWA 100 ppm C 200 ppm 600 ppm (5-minute maximum peak in any 3 hours)	700 ppm	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, nose, respiratory system; headache, lassitude (weakness, exhaustion), dizziness, confusion, malaise (vague feeling of discomfort), drowsiness, unsteady gait; narcosis; defatting dermatitis; possible liver injury; reproductive effects	Eyes, skin, respiratory system, central nervous system, liver, reproductive system	Colorless to yellow, oily liquid with a sweet, floral odor BP: 293°F Fl.Pt. = 88°F LEL: 0.9% UEL: 6.8% Class IC Flammable Liquid: Fl.P. at or above 73°F and below 100°F
Tetrachloroethene	127-18-4	TWA 25 ppm STEL 100 ppm	Ca Minimize workplace exposure concentrations	TWA 100 ppm C 200 ppm (for 5 minutes in any 3-hour period), with a maximum peak of 300 ppm	Ca [150 ppm]	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin, nose, throat, respiratory system; nausea; flush face, neck; dizziness, incoordination; headache, drowsiness; skin erythema (skin redness); liver damage; [potential occupational carcinogen]	Eyes, skin, respiratory system, liver, kidneys, central nervous system	Colorless liquid with a mild, chloroform-like odor BP: 250°F Fl.Pt. = NA LEL: NA UEL: NA Noncombustible Liquid, but decomposes in a fire to hydrogen chloride and phosgene
Sodium Hydroxide	1310-73-2	Ceiling 2 mg/m^3	C 2 mg/m^3	TWA 2 mg/m^3	10 mg/m^3	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin, mucous membrane; pneumonitis; eye, skin burns; temporary loss of hair	Eyes, skin, respiratory system	Colorless to white, odorless solid (flakes, beads, granular form). BP: 2534°F Fl.Pt. = NA LEL: NA UEL: NA Noncombustible Solid, but when in contact with water may generate sufficient heat to ignite combustible materials.
Sulfuric Acid	7664-93-9	TWA 0.2 mg/m^3 (as thoracic particulate mass)	TWA 1 mg/m^3	TWA 1 mg/m^3	15 mg/m^3	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin, nose, throat; pulmonary edema, bronchitis; emphysema; conjunctivitis; stomatis; dental erosion; eye, skin burns; dermatitis	Eyes, skin, respiratory system, teeth	Colorless to dark-brown, oily, odorless liquid.[Note: Pure compound is a solid below 51°F. Often used in an aqueous solution.] BP = 554°F Fl.Pt. = NA LEL = NA UEL = NA Noncombustible Liquid, but capable of igniting finely divided combustible materials.
trans-1,2-Dichloroethene	156-60-5	200 ppm (All isomers)	TWA 200 ppm (790 mg/m3)	TWA 200 ppm (790 mg/m3)	1000 ppm	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, respiratory system; central nervous system depression	Eyes, respiratory system, central nervous system	Colorless liquid (usually a mixture of the cis & trans isomers) with a slightly acrid, chloroform-like odor. BP: 118-140°F Fl.P: 36-39°F LEL: 5.6% UEL: 12.8% Class IB Flammable Liquid Fl.P. below 73°F and BP at or above 100°F.
trans-1,3-Dichloropropene	10061-02-6	https://cameochemicals.noaa.gov/chemical/18110				Inhalation, ingestion, skin and/or eye contact	Symptoms of exposure to this compound may include local irritation of the eyes skin and respiratory tract, dermatitis, gasping, coughing, substernal pain, extreme respiratory distress, lacrimation, central nervous system depression, acute gastrointestinal distress with pulmonary congestion and edema. It may also cause injury to the liver, kidneys and heart	Skin, eyes, mucous membranes, liver, kidney, heart	A clear colorless liquid with chloroform odor BP: 234°F Fl.P: NA LEL: NA UEL: NA

Table 1. Toxicological, Physical, and Chemical Properties of Compounds Potentially Present at the Site.

Compound	CAS #	ACGIH TLV	NIOSH REL	OSHA PEL	IDLH	Routes of Exposure	Toxic Properties	Target Organs	Physical/Chemical Properties
Toluene	108-88-3	TWA 20 ppm (ototoxicant)	TWA 100 ppm (375 mg/m^3) ST 150 ppm (560 mg/m^3)	TWA 200 ppm C 300 ppm 500 ppm (10-minute maximum peak)	500 ppm	Inhalation, skin absorption, ingestion, skin and/or eye contact	irritation eyes, nose; lassitude (weakness, exhaustion), confusion, euphoria, dizziness, headache; dilated pupils, lacrimation (discharge of tears); anxiety, muscle fatigue, insomnia; paresthesia; dermatitis; liver, kidney damage	Eyes, skin, respiratory system, central nervous system, liver, kidneys	Colorless liquid with a sweet, pungent, benzene-like odor. BP: 232°F Fl.P: 40°F LEL: 1.1% UEL: 7.1% Class IB Flammable Liquid Fl.P. below 73°F and BP at or above 100°F.
Trichloroethene (TCE)	79-01-6	TWA 10 ppm STEL 25 ppm	Ca	TWA 100 ppm C 200 ppm 300 ppm (5-minute maximum peak in any 2 hours)	Ca [1000 ppm]	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin; headache, visual disturbance, lassitude (weakness, exhaustion), dizziness, tremor, drowsiness, nausea, vomiting; dermatitis; cardiac arrhythmias, paresthesia; liver injury; [potential occupational carcinogen]	Eyes, skin, respiratory system, heart, liver, kidneys, central nervous system	Colorless liquid (unless dyed blue) with a chloroform-like odor. BP: 189°F Fl.Pt. = NA LEL(77°F): 8.0% UEL(77°F): 10.5% Combustible Liquid, but burns with difficulty.
Trichlorofluoromethane	75-69-4	STEL C 1000 ppm	C 1000 ppm (5600 mg/m3)	TWA 1000 ppm (5600 mg/m3)	2000 ppm	Inhalation, ingestion, skin and/or eye contact	Incoordination, tremor; dermatitis; cardiac arrhythmias, cardiac arrest; asphyxia; liquid: frostbite	Skin, respiratory system, cardiovascular system	Colorless to water-white, nearly odorless liquid or gas (above 75°F) BP: 75°F Fl.P: NA LEL: NA UEL: NA Noncombustible Liquid Nonflammable Gas
Vinyl Chloride (chloroethylene)	75-01-4	TWA 1 ppm	Ca	TWA 1 ppm C 5 ppm [15-minute]	Ca (ND)	Inhalation, skin and/or eye contact (liquid)	Lassitude (weakness, exhaustion); abdominal pain, gastrointestinal bleeding; enlarged liver; pallor or cyanosis of extremities; liquid: frostbite; [potential occupational carcinogen]	Liver, central nervous system, blood, respiratory system, lymphatic system	Colorless gas or liquid (below 7°F) with a pleasant odor at high concentrations.[Note: Shipped as a liquefied compressed gas.] BP: 7°F Fl.Pt. = NA (Gas) LEL: 3.6% UEL: 33.0% Flammable Gas
Xylene (m, o & p isomers)	108-38-3, 95-47-6, 106-42-3	TWA 20 ppm	NA	NA	NA	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin, nose, throat; dizziness, excitement, drowsiness, incoordination, staggering gait; corneal vacuolization; anorexia, nausea, vomiting, abdominal pain; dermatitis	Eyes, skin, respiratory system, central nervous system, gastrointestinal tract, blood, liver, kidneys	Colorless liquid with an aromatic odor BP: 282°F, 292°F, 281°F Fl. Pt. 82°F, 90°F, 81°F LEL: 1.1%, 0.9%, 1.1% UEL: 7.0%, 6.7%, 7.0% Class IC Flammable Liquid at or above 73°F and below 100°F.
Zinc Oxide (dust)	7440-66-6	TWA 2 mg/m3 (repsirable) STEL 10 mg/m^3 (respirable)	TWA 5 mg/m^3 C 15 mg/m^3	TWA 15 mg/m^3 (total dust) TWA 5 mg/m^3 (resp dust) TWA 5 mg/m^3 (fume)	500 mg/m^3	Inhalation	Metal fume fever: chills, muscle ache, nausea, fever, dry throat, cough; lassitude (weakness, exhaustion); metallic taste; headache; blurred vision; low back pain; vomiting; malaise (vague feeling of discomfort); chest tightness; dyspnea (breathing difficulty), rales, decreased pulmonary function	Respiratory system	White, odorless solid. BP: NA Fl.Pt. = NA LEL: NA UEL: NA Noncombustible Solid
SEMI-VOLATILE ORGANIC COMPOUNDS (SVOCs)									
2-Chloronaphthalene	91-58-7	https://cameochemicals.noaa.gov/chemical/16185				Inhalation, ingestion, skin and/or eye contact	Chloracne, cysts, headache, fatigue, vertigo, anorexia and jaundice		Monoclinic plates or off-white crystalline powder BP: NA Fl.Pt. = NA LEL: NA UEL: NA
2-Methylnaphthalene	91-57-6	TWA 0.5 ppm TLV-SL 3 mg/100 cm2 [skin]	https://cameochemicals.noaa.gov/chemical/20668			Inhalation, ingestion, skin and/or eye contact	Headaches, nausea, vomiting, diarrhea, anemia, jaundice, euphoria, dermatitis, visual disturbances, convulsions and comatose	Skin, eyes, mucous membranes and upper respiratory tract	White crystalline solid Combustible solid BP: 466-468 ° F Fl.Pt. = 208 ° F LEL: NA UEL: NA
Acenaphthene	83-32-9	https://cameochemicals.noaa.gov/chemical/10358				Inhalation, ingestion, skin and/or eye contact	Irritation of the skin, eyes, mucous membranes and upper respiratory tract, vomiting	Skin, eyes, mucous membranes and upper respiratory tract	White needles BP: 534 ° F Fl.Pt. = NA LEL: 0.6% UEL: NA
Acenaphthylene	208-96-8	https://cameochemicals.noaa.gov/chemical/16157				Inhalation, ingestion, skin and/or eye contact			Colorless crystalline solid BP: 509 to 527 ° F at 760 mm Hg Fl.Pt. = NA LEL: NA UEL: NA
Anthracene (as coal tar pitch volatiles)	120-12-7	TWA 0.2 mg/m3 (as Benzene solubles)	Ca TWA 0.1 mg/m3 (cyclohexane-extractable fraction)	TWA 0.2 mg/m3 (benzene-soluble fraction) [1910.1002]	Ca [80 mg/m3]	Inhalation, skin and/or eye contact	Dermatitis, bronchitis, [potential occupational carcinogen]	Respiratory system, skin, bladder, kidneys	Black or dark-brown amorphous residue BP: NA Fl.Pt. = NA LEL: NA UEL: NA Combustible Solids
Benzo[a]anthracene	56-55-3	https://cameochemicals.noaa.gov/chemical/16171				Inhalation, injestion, skin and/or eye contact			Colorless leaflets or plates or coarse gold powder with a greenish-yellow fluorescence. May reasonably be expected to be a carcinogen. BP: 815° F at 760 mm Hg Fl.Pt. = NA LEL: NA UEL: NA

Table 1. Toxicological, Physical, and Chemical Properties of Compounds Potentially Present at the Site.

Compound	CAS #	ACGIH TLV	NIOSH REL	OSHA PEL	IDLH	Routes of Exposure	Toxic Properties	Target Organs	Physical/Chemical Properties
Benzo[a]pyrene (as coal tar pitch volatiles)	50-32-8	TWA 0.2 mg/m3 (as Benzene solubles)	Ca TWA 0.1 mg/m3 (cyclohexane-extractable fraction)	TWA 0.2 mg/m3 (benzene-soluble fraction) [1910.1002]	Ca [80 mg/m3]	Inhalation, skin and/or eye contact	Dermatitis, bronchitis, [potential occupational carcinogen]	Respiratory system, skin, bladder, kidneys	Black or dark-brown amorphous residue BP: NA Fl.Pt. = NA LEL: NA UEL: NA Combustible Solids
Benzo[b]fluoranthene	205-99-2	None listed	https://cameochemicals.noaa.gov/chemical/16172			Inhalation, injestion, skin and/or eye contact			Needles or yellow fluffy powder BP: NA Fl.Pt. = NA LEL: NA UEL: NA
Benzo[g,h,i]perylene	191-24-2	https://cameochemicals.noaa.gov/chemical/16174				Inhalation, injestion, skin and/or eye contact	Inhalation of material may be harmful. Contact may cause burns to skin and eyes. Inhalation of Asbestos dust may have a damaging effect on the lungs. Fire may produce irritating, corrosive and/or toxic gases. Some liquids produce vapors that may cause dizziness or suffocation. Runoff from fire control may cause pollution.	Lungs, skin, eyes	Colorless to white crystalline solid. Water insoluble. BP: NA Fl.Pt. = NA LEL: NA UEL: NA
Benzo[k]fluoranthene	207-08-9	https://cameochemicals.noaa.gov/chemical/16173				Inhalation, injestion, skin and/or eye contact	When heated to decomposition this compound emits acrid smoke and irritating fumes.		Pale yellow needles or yellow crystalline solid BP: 896° F Fl.Pt. = NA LEL: NA UEL: NA
Chrysene (as coal tar pitch volatiles	218-01-9	TWA 0.2 mg/m3 (as Benzene solubles)	Ca TWA 0.1 mg/m3 (cyclohexane-extractable fraction)	TWA 0.2 mg/m3 (benzene-soluble fraction) [1910.1002]	Ca [80 mg/m3]	Inhalation, skin and/or eye contact	Dermatitis, bronchitis, [potential occupational carcinogen]	Respiratory system, skin, bladder, kidneys	Black or dark-brown amorphous residue BP: NA Fl.Pt. = NA LEL: NA UEL: NA Combustible Solids
Dibenzo(a,h)anthracene	53-70-3	https://cameochemicals.noaa.gov/chemical/16192				Inhalation, injestion, skin and/or eye contact	Symptoms of exposure to this compound may include irritation. This compound is harmful if swallowed or inhaled. It may cause irritation. When heated to decomposition it emits acrid smoke, irritating fumes and toxic fumes of carbon monoxide and carbon dioxide.	Lungs	White crystals or pale yellow solid. Sublimes BP: 975° F Fl.Pt. = NA LEL: NA UEL: NA
Fluoranthene	206-44-0	https://cameochemicals.noaa.gov/chemical/16213				Inhalation, injestion, skin and/or eye contact	When heated to decomposition this compound emits acrid smoke and fumes.		Light yellow fine crystals BP: 482° F Fl.Pt. = NA LEL: NA UEL: NA
Fluorene	86-73-7	https://cameochemicals.noaa.gov/chemical/16214				Inhalation, injestion, skin and/or eye contact			White leaflets. Sublimes easily under a vacuum. Fluorescent when impure. BP: 563° F Fl.Pt. = NA LEL: NA UEL: NA
Indeno[1,2,3-cd]pyrene	193-39-5	https://cameochemicals.noaa.gov/chemical/16218				Inhalation, injestion, skin and/or eye contact			Yellow crystals BP: 997° F Fl.Pt. = NA LEL: NA UEL: NA
Naphthalene	91-20-3	TWA 10 ppm [skin]	TWA 10 ppm (50 mg/m3) ST 15 ppm (75 mg/m3)	TWA 10 ppm (50 mg/m3)	250 ppm	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes; headache, confusion, excitement, malaise (vague feeling of discomfort); nausea, vomiting, abdominal pain; irritation bladder; profuse sweating; jaundice; hematuria (blood in the urine), renal shutdown; dermatitis, optical neuritis, corneal damage	Eyes, skin, blood, liver, kidneys, central nervous system	Colorless to brown solid with an odor of mothballs. [Note: Shipped as a molten solid.] BP: 424°F Fl.P: 174°F LEL: 0.9% UEL: 5.9% Combustible Solid, but will take some effort to ignite
Phenanthrene	85-01-8	https://cameochemicals.noaa.gov/chemical/16236				Inhalation, injestion, skin and/or eye contact	Symptoms following exposure to this compound may include skin sensitization, dermatitis, bronchitis, cough, dyspnea, respiratory neoplasm, kidney neoplasm, skin irritation, and respiratory irritation.	Skin, respiratory tract	Colorless monoclinic crystals with a faint aromatic odor. Solutions exhibit a blue fluorescence. BP: 642° F Fl.Pt. = 340° F LEL: NA UEL: NA
Pyrene (see coal tar pitch volatiles)	129-00-0	TWA 0.2 mg/m3 (as Benzene solubles)	Ca TWA 0.1 mg/m3 (cyclohexane-extractable fraction)	TWA 0.2 mg/m3 (benzene-soluble fraction) [1910.1002]	Ca [80 mg/m3]	Inhalation, skin and/or eye contact	Dermatitis, bronchitis, [potential occupational carcinogen]	Respiratory system, skin, bladder, kidneys	Black or dark-brown amorphous residue BP: NA Fl.Pt. = NA LEL: NA UEL: NA Combustible Solids
METALS									
Aluminum	7429-90-5	TWA 1 mg/m3	TWA 10 mg/m^3 (total) TWA 5 mg/m^3 (resp)	TWA 15 mg/m^3 (total) TWA 5 mg/m^3 (resp)	N.D.	Inhalation, skin and/or eye contact	Irritation eyes, skin, respiratory system	Eyes, skin, respiratory system	Silvery-white, malleable, ductile, odorless metal BP: 4221°F Fl.Pt. = NA LEL: NA UEL: NA Combustible Solid, finely divided dust is easily ignited; may cause explosions.

Table 1. Toxicological, Physical, and Chemical Properties of Compounds Potentially Present at the Site.

Compound	CAS #	ACGIH TLV	NIOSH REL	OSHA PEL	IDLH	Routes of Exposure	Toxic Properties	Target Organs	Physical/Chemical Properties
Antimony	7440-36-0	TWA 0.5 mg/m3 (as Sb)	TWA 0.5 mg/m3 [*Note: The REL also applies to other antimony compounds (as Sb).]	TWA 0.5 mg/m3 [*Note: The PEL also applies to other antimony compounds (as Sb).]	50 mg/m3 (as Sb)	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin, nose, throat, mouth; cough; dizziness; headache; nausea, vomiting, diarrhea; stomach cramps; insomnia; anorexia; unable to smell properly	Eyes, skin, respiratory system, cardiovascular system	Silver-white, lustrous, hard, brittle solid; scale-like crystals; or a dark-gray, lustrous powder BP: 2975°F Fl.Pt. = NA LEL: NA UEL: NA Noncombustible Solid in bulk form, but a moderate explosion hazard in the form of dust when exposed to flame.
Arsenic	7440-38-2	TWA 0.01 mg/m3	Ca C 0.002 mg/m3 [15-minute]	[1910.1018] TWA 0.010 mg/m3	Ca [5 mg/m3 (as As)]	Inhalation, skin absorption, skin and/or eye contact, ingestion	Ulceration of nasal septum, dermatitis, gastrointestinal disturbances, peripheral neuropathy, resp irritation, hyperpigmentation of skin, [potential occupational carcinogen]	Liver, kidneys, skin, lungs, lymphatic system	Metal: Silver-gray or tin-white, brittle, odorless solid BP: Sublimes Fl.Pt. = NA LEL: NA UEL: NA Metal: Noncombustible Solid in bulk form, but a slight explosion hazard in the form of dust when exposed to flame
Barium	7440-39-3	TWA 0.5 mg/m3	0.5 mg Ba/m3 TWA	0.5 mg Ba/m3 TWA	50 mg Ba/m3	Inhalation, ingestion, skin and/or eye contact	Inhalation or contact with vapors, substance or decomposition products may cause severe injury or death. Contact may cause burns to skin, eyes, and mucous membranes. May be toxic by ingestion, inhalation and skin absorption. Used to make other chemicals.	Lungs, skin, eyes, and mucous membrane	A silver to white metallic solid BP: 1337°F Fl.Pt. = NA LEL: NA UEL: NA
Beryllium	7440-41-7	TWA 0.00005 mg/m^3	Ca C 0.0005 mg/m^3	TWA 0.002 mg/m^3 C 0.005 mg/m^3 0.025 mg/m3 [30-minute maximum peak]	Ca [4 mg/m^3 (as Be)]	Inhalation, skin and/or eye contact	Berylliosis (chronic exposure): anorexia, weight loss, lassitude (weakness, exhaustion), chest pain, cough, clubbing of fingers, cyanosis, pulmonary insufficiency; irritation eyes; dermatitis; [potential occupational carcinogen]	Eyes, skin, respiratory system	Hard, brittle, gray-white solid BP: 4532°F Fl.Pt. = NA LEL: NA UEL: NA Noncombustible Solid in bulk form, but a slight explosion hazard in the form of a powder or dust.
Cadmium	7440-43-9	TWA 0.01 mg/m^3 total dust TWA 0.002 mg/m^3 (as Cd) respirable fraction	Ca	TWA 0.005 mg/m^3	Ca [9 mg/m3 (as Cd)]	Inhalation, ingestion	Pulmonary edema, dyspnea (breathing difficulty), cough, chest tightness, substernal (occurring beneath the sternum) pain; headache; chills, muscle aches; nausea, vomiting, diarrhea; anosmia (loss of the sense of smell), emphysema, proteinuria, mild anemia; [potential occupational carcinogen]	Respiratory system, kidneys, prostate, blood	Silver-white/blue tinged lustrous, odorless solid. BP: 1409°F Fl.Pt. = NA LEL: NA UEL: NA Noncombustible - will burn in powder form
Calcium	7440-70-2	https://cameochemicals.noaa.gov/chemical/309				Inhalation, ingestion, skin and/or eye contact	Contact with eyes or skin produces caustic burns.	Eyes, skin	A silvery, soft metal that turns grayish white on exposure to air. BP: 2714°F Fl.Pt. = NA LEL: NA UEL: NA
Chromium	7440-47-3	TWA 0.5 mg/m^3 (metal) TWA 0.003 mg/m^3 (water-soluble Cr III compounds) TWA 0.0002 mg/m^3 (water-soluble Cr VI compounds) STEL 0.0005 mg/m3 (water-soluble Cr VI compounds)	TWA 0.5 mg/m^3	TWA 1 mg/m^3	250 mg/m^3 (as Cr)	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin; lung fibrosis (histologic)	Eyes, skin, respiratory system	Blue-white to steel-gray, lustrous, brittle, hard, odorless solid. BP: 4788°F Fl.Pt. = NA LEL: NA UEL: NA Noncombustible - will burn in dust form if heated in a flame
Cobalt	7440-48-4	TWA 0.02 mg/m3 [DSEN] [RSEN]	TWA 0.05 mg/m3	TWA 0.1 mg/m3	20 mg/m3 (as Co)	Inhalation, ingestion, skin and/or eye contact	Cough, dyspnea (breathing difficulty), wheezing, decreased pulmonary function; weight loss; dermatitis; diffuse nodular fibrosis; resp hypersensitivity, asthma	Skin, respiratory system	Odorless, silver-gray to black solid BP: 5612°F Fl.Pt. = NA LEL: NA UEL: NA Noncombustible Solid in bulk form, but finely divided dust will burn at high temperatures.
Copper	7440-50-8	TWA 0.2 mg/m^3 (fume) TWA 1 mg/m3 (dusts and mists)	TWA 1 mg/m^3	TWA 1 mg/m^3	100 mg/m^3 (as Cu)	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, nose, pharynx; nasal septum perforation; metallic taste; dermatitis; In Animals: lung, liver, kidney damage; anemia	Eyes, skin, respiratory system, liver, kidneys (increased risk with Wilson's disease)	Reddish, lustrous, malleable, odorless solid. BP: 4703°F Fl.Pt. = NA LEL: NA UEL: NA Noncombustible - powdered form may ignite
Iron (as iron oxide)	7439-89-6	TWA 5 mg/m3 (respirable particulate mass)	TWA 1 mg/m^3	NA	NA	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin, mucous membrane; abdominal pain, diarrhea, vomiting; possible liver damage	Eyes, skin, respiratory system, liver, gastrointestinal tract	Appearance and odor vary depending upon the specific soluble iron salt. BP: NA Fl.Pt. = NA LEL: NA UEL: NA Noncombustible Solids
Lead	7439-92-1	TWA 0.05 mg/m3	TWA (8-hour) 0.050 mg/m3	[1910.1025] TWA 0.050 mg/m3	100 mg/m3 (as Pb)	Inhalation, ingestion, skin and/or eye contact	Lassitude (weakness, exhaustion), insomnia; facial pallor; anorexia, weight loss, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremor; paralysis wrist, ankles; encephalopathy; kidney disease; irritation eyes; hypertension	Eyes, gastrointestinal tract, central nervous system, kidneys, blood, gingival tissue	A heavy, ductile, soft, gray solid BP: 3164°F Fl.Pt. = NA LEL: NA UEL: NA Noncombustible Solid in bulk form

Table 1. Toxicological, Physical, and Chemical Properties of Compounds Potentially Present at the Site.

Compound	CAS #	ACGIH TLV	NIOSH REL	OSHA PEL	IDLH	Routes of Exposure	Toxic Properties	Target Organs	Physical/Chemical Properties
Magnesium	7439-95-4	https://cameochemicals.noaa.gov/chemical/6949				Eye and/or skin contact	Dust irritates eyes in same way as any foreign material. Penetration of skin by fragments of metal is likely to produce local irritation, blisters, and ulcers which may become infected.	Eyes	A light silvery metal BP: 1202°F Fl.Pt. = NA LEL: NA UEL: NA
Manganese	7439-96-5	TWA 0.02 mg/m3 [R] TWA 0.1 mg/m3 [I]	TWA 1 mg/m3 ST 3 mg/m3	C 5 mg/m3	500 mg/m3 (as Mn)	inhalation, ingestion	Manganism; asthenia, insomnia, mental confusion; metal fume fever: dry throat, cough, chest tightness, dyspnea (breathing difficulty), rales, flu-like fever; low-back pain; vomiting; malaise (vague feeling of discomfort); lassitude (weakness, exhaustion); kidney damage	respiratory system, central nervous system, blood, kidneys	A lustrous, brittle, silvery solid BP: 3564°F Fl.Pt. = NA LEL: NA UEL: NA Metal: Combustible Solid
Mercury	7439-97-6	TWA 0.1 mg/m3, as Hg Aryl compounds TWA 0.025 mg/m3 as Hg, inorganic forms including metallic mercury	Hg Vapor: TWA 0.05 mg/m3 [skin] Other: C 0.1 mg/m3 [skin]	TWA 0.1 mg/m3	10 mg/m3 (as Hg)	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin; cough, chest pain, dyspnea (breathing difficulty), bronchitis, pneumonitis; tremor, insomnia, irritability, indecision, headache, lassitude (weakness, exhaustion); stomatitis, salivation; gastrointestinal disturbance, anorexia, weight loss; proteinuria	Eyes, skin, respiratory system, central nervous system, kidneys	Metal: Silver-white, heavy, odorless liquid. [Note: "Other" Hg compounds include all inorganic & aryl Hg compounds except (organo) alkyls.] BP: 674°F Fl.Pt. = NA LEL: NA UEL: NA Metal: Noncombustible Liquid
Nickel	7440-02-0	TWA 1.5 mg/m^3 [elemental] TWA 0.1 mg/m^3 [soluble inorganic compound] TWA 0.2 mg/m^3 [insoluble inorganic compound] TWA 0.1 mg/m^3 [Nickel subsulfide]	Ca TWA 0.015 mg/m^3	TWA 1 mg/m^3	Ca [10 mg/m3 (as Ni)]	Inhalation, ingestion, skin and/or eye contact	Sensitization dermatitis, allergic asthma, pneumonitis; [potential occupational carcinogen]	Nasal cavities, lungs, skin	Lustrous, silvery, odorless solid. BP: 5139°F Fl.Pt. = NA LEL: NA UEL: NA Combustible Solid; nickel sponge catalyst may ignite spontaneously in air.
Potassium	9/7/7440	https://cameochemicals.noaa.gov/chemical/4289				Eye and/or skin contact	Will burn skin and eyes	Skin, eyes	Potassium is a soft silvery metal though normally grayish white due to oxidation BP: 1425°F Fl.Pt. = NA LEL: NA UEL: NA
Selenium	7782-49-2	TWA 0.2 mg/m3	TWA 0.2 mg/m3	TWA 0.2 mg/m3	1 mg/m3 (as Se)	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin, nose, throat; visual disturbance; headache; chills, fever; dyspnea (breathing difficulty), bronchitis; metallic taste, garlic breath, gastrointestinal disturbance; dermatitis; eye, skin burns; In Animals: anemia; liver necrosis, cirrhosis; kidney, spleen damage	Eyes, skin, respiratory system, liver, kidneys, blood, spleen	Amorphous or crystalline, red to gray solid. [Note: Occurs as an impurity in most sulfide ores.] BP: 1265°F Fl.Pt. = NA LEL: NA UEL: NA Combustible Solid
Silver	7440-22-4	TWA 0.1 mg/m3 [Metal, dust, and fume] TWA 0.01 mg/m3 [Soluble compounds, as Ag]	TWA 0.01 mg/m3	TWA 0.01 mg/m3	10 mg/m3 (as Ag)	Inhalation, ingestion, skin and/or eye contact	Blue-gray eyes, nasal septum, throat, skin; irritation, ulceration skin; gastrointestinal disturbance	Nasal septum, skin, eyes	Metal: White, lustrous solid BP: 3632°F Fl.Pt. = NA LEL: NA UEL: NA Metal: Noncombustible Solid, but flammable in form of dust or powder
Sodium	7440-23-5	https://cameochemicals.noaa.gov/chemical/7794				Skin contact	Severe burns caused by burning metal or by caustic soda formed by reaction with moisture on skin	Skin	A silvery soft metal that becomes grayish white upon exposure to air BP: 1621°F Fl.Pt. = NA LEL: NA UEL: NA
Thallium	7440-28-0	0.02 mg/m3 inhallable particulate matter	TWA 0.1 mg/m3 [skin]	TWA 0.1 mg/m3 [skin]	15 mg/m3 (as Tl)	Inhalation, skin absorption, ingestion, skin and/or eye contact	Nausea, diarrhea, abdominal pain, vomiting; ptosis, strabismus; peri neuritis, tremor; retrosternal (occurring behind the sternum) tightness, chest pain, pulmonary edema; convulsions, chorea, psychosis; liver, kidney damage; alopecia; paresthesia legs	Eyes, respiratory system, central nervous system, liver, kidneys, gastrointestinal tract, body hair	Appearance and odor vary depending upon the specific soluble thallium compound BP: NA Fl.Pt. = NA LEL: NA UEL: NA
Vanadium	7440-62-2	https://cameochemicals.noaa.gov/chemical/16147				Inhalation, skin absorption, ingestion, skin and/or eye contact	Highly toxic, may be fatal if inhaled, swallowed or absorbed through skin. Avoid any skin contact. Effects of contact or inhalation may be delayed. Fire may produce irritating, corrosive and/or toxic gases. Runoff from fire control or dilution water may be corrosive and/or toxic and cause pollution	Skin	Silvery-whitish powder BP: NA Fl.Pt. = NA LEL: NA UEL: NA
Zinc	7440-66-6	https://cameochemicals.noaa.gov/chemical/4814				Inhalation, skin absorption, ingestion, skin and/or eye contact	Inhalation or contact with vapors, substance or decomposition products may cause severe injury or death. May produce corrosive solutions on contact with water. Fire will produce irritating, corrosive and/or toxic gases. Runoff from fire control may cause pollution	Lungs	A grayish powder BP: NA Fl.Pt. = NA LEL: NA UEL: NA
PCBs									
PCBs (total)	11097-69-1, 53469-21-9	TWA 0.5 mg/m3 [skin] TWA 1 mg/m3 [skin]	Ca TWA 0.001 mg/m3 Ca TWA 0.001 mg/m3	TWA 0.5 mg/m3 [skin] TWA 1 mg/m3 [skin]	Ca [5 mg/m3] Ca [5 mg/m3]	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, chloracne; liver damage; reproductive effects; [potential occupational carcinogen]	Skin, eyes, liver, reproductive system	Colorless to pale-yellow, viscous liquid or solid (below 50°F) with a mild, hydrocarbon odor BP: 689-734°F, 617-691°F Fl.Pt. = NA, NA LEL: NA UEL: NA Nonflammable Liquid, but exposure in a fire results in the formation of a black soot containing PCBs, polychlorinated dibenzofurans, and chlorinated dibenzo-p-dioxins.

Table 1. Toxicological, Physical, and Chemical Properties of Compounds Potentially Present at the Site.

Compound	CAS #	ACGIH TLV	NIOSH REL	OSHA PEL	IDLH	Routes of Exposure	Toxic Properties	Target Organs	Physical/Chemical Properties
Petroleum Hydrocarbons									
Gasoline	86290-81-5	TWA 300 ppm STEL 500 ppm	Ca	None	Ca [N.D.]	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin, mucous membrane; dermatitis; headache, lassitude (weakness, exhaustion), blurred vision, dizziness, slurred speech, confusion, convulsions; chemical pneumonitis (aspiration liquid); possible liver, kidney damage; [potential occupational carcinogen]	Eyes, skin, respiratory system, central nervous system, liver, kidneys	Clear liquid with a characteristic odor BP: 102°F Fl.Pt. = -45°F LEL: 1.4% UEL: 7.6%

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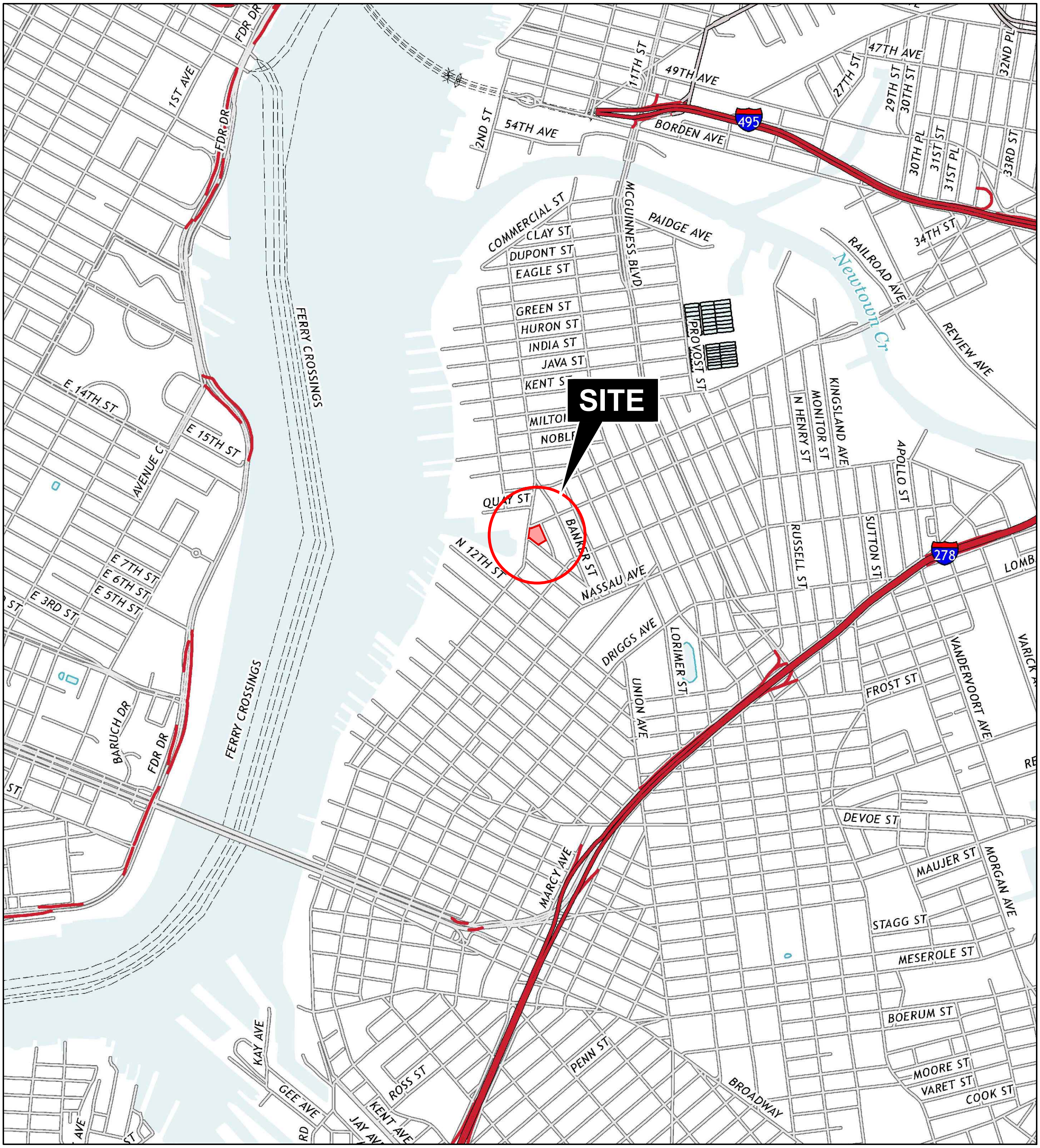
Proctor, N.H., J.P. Hughes and M.L. Fischman, 1989. *Chemical Hazards of the Workplace* . Van Nostrand Reinhold. New York.
Sax, N.I. and R.J. Lewis, 1989. *Dangerous Properties of Industrial Materials, 7th Edition.* Van Nostrand Reinhold. New York.

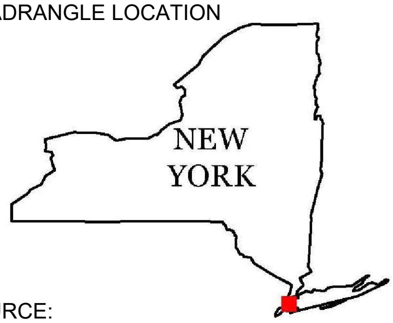
Abbreviations:

ACGIH – American Conference of Governmental Industrial Hygienists.
BP – boiling point at 1 atmosphere, °F
C – Ceiling, is a concentration that should not be exceeded during and part of the working exposure.
Ca – Carcinogenic.
CAS# - Chemical Abstracts Service registry number which is unique for each chemical.
DSEN - Dermal Sensitization
Ft Pt. – Flash point
IDLH - Immediately Dangerous to Life and Health concentrations represent the maximum concentration from which, in the event of respirator failure, one could escape within 30 minutes without a respirator and without experiencing any escape-impairing or irreversible health effects.
LEL – Lower explosive (flammable) limit in air, % by volume (at room temperature)
mg/m^3 – Milligrams of substance per cubic meter of air
NIOSH - National Institute for Occupational Safety and Health.
OSHA – Occupational Safety and Health Administration
OTO - Ototoxicant
PEL - OSHA Permissible Exposure Limit (usually) a time weighted average concentration that must not be exceeded during any 8 hour work shift of a 40 hr work week.
ppm – parts per million
REL – NIOSH Recommended Limit indicated a time weighted average concentration that must not be exceeded during any 10 hour work shift of a 40 hr work week
RSEN - Respiratory Sensitization
SG - Specific Gravity
STEL – ACGIH Short-term exposure limit (ST)
TLV - ACGIH Threshold Limit Values (usually 8 hour time weighted average concentrations).
TWA – 8-hour, time-weighted average
UEL – Upper explosive (flammable) limit in air, % by volume (at room temperature)
VP - Vapor Pressure

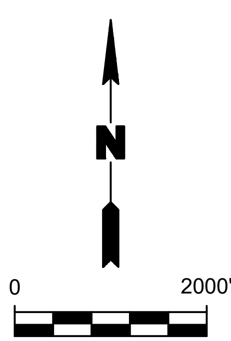
FIGURES



QUADRANGLE LOCATION



SOURCE:
USGS, 2013, Brooklyn, NY
7.5 Minute Topographic Quadrangle



Title:

SITE LOCATION MAP

12 FRANKLIN STREET
BROOKLYN, NEW YORK 11222

Prepared for:

FRANKLIN POINT LLC

ROUX

Compiled by: J.R.	Date: 15MAY23
Prepared by: G.M.	Scale: AS SHOWN
Project Mgr: J.R.	Project: 4170.0001Y000
File: 4170.0001Y102.01.DWG	

FIGURE
1

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LEGEND

SITE ENTRANCES AND EXITS

MUSTER AREA

SITE BOUNDARY

N

40' 0 40'

Title:

SITE PLAN WITH MUSTER AREA

12 FRANKLIN STREET
BROOKLYN, NEW YORK 11222

Prepared for:

FRANKLINE POINT LLC

ROUX

Compiled by: J.R.	Date: 15MAY23	FIGURE
Prepared by: G.M.	Scale: AS SHOWN	2
Project Mgr: J.R.	Project: 4170.0001Y000	
File: 4170.0001Y102.01.DWG		

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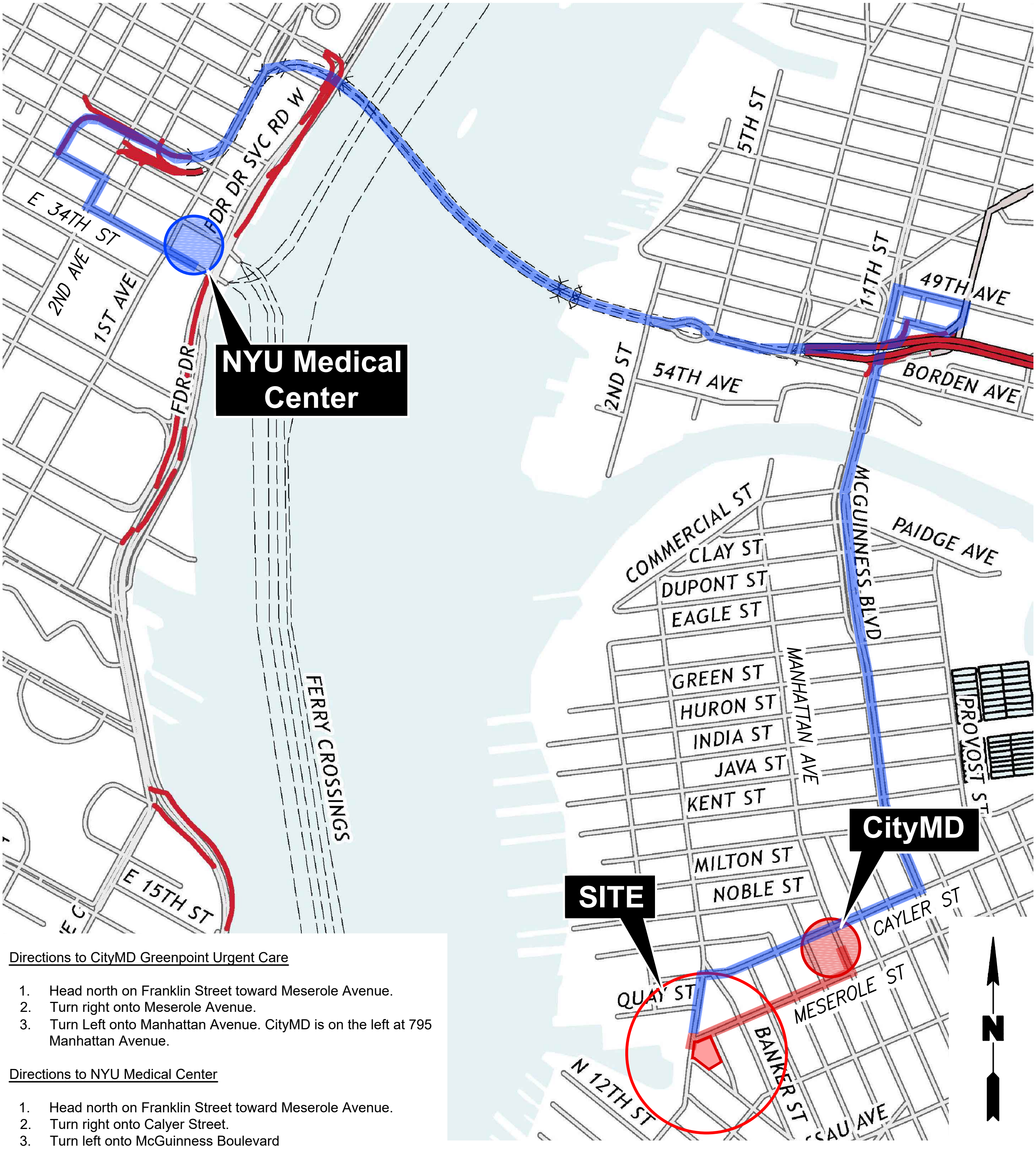

Directions to CityMD Greenpoint Urgent Care

1. Head north on Franklin Street toward Meserole Avenue.
2. Turn right onto Meserole Avenue.
3. Turn Left onto Manhattan Avenue. CityMD is on the left at 795 Manhattan Avenue.

Directions to NYU Medical Center

1. Head north on Franklin Street toward Meserole Avenue.
2. Turn right onto Calyer Street.
3. Turn left onto McGuinness Boulevard
4. Keep left to continue on Pulaski Bridge.
5. Slight right toward 49th Avenue. Turn right onto 49th Avenue
6. Turn right onto 11th Place. Turn right onto 50th Avenue.
7. Turn left onto the I-495 West ramp.
8. Keep left, follow signs for I-495 West and merge onto onto I-495 West. Continue onto Queens Midtown Tunnel.
9. Continue onto I-495 W/Queens Midtown Tunnel.
10. Take the 35th Street exit on the left toward Downtown/34th Street/2nd Avenue. Turn left onto E 35th Street.
11. Turn right at the first cross street onto 2nd Avenue.
12. Turn left at the first cross street onto E 34th Street. NYU Medical Center in on the left at 403 E 34th Street.

0 1200'

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Title:

ROUTES TO URGENT CARE AND HOSPITAL

12 FRANKLIN STREET
BROOKLYN, NEW YORK 11222

Prepared for:

FRANKLIN POINT LLC

ROUX

Compiled by: J.R.	Date: 15MAY23	FIGURE
Prepared by: G.M.	Scale: AS SHOWN	3
Project Mgr: J.R.	Project: 4170.0001Y000	
File: 4170.0001Y102.01.DWG		

APPENDICES

A. Job Safety Analysis (JSA) Forms

B. Safety Data Sheets (SDSs) for Chemicals Used

C. Personal Protective Equipment (PPE) Management Program

D. Subsurface Utility Clearance Management Program

E. Heavy Equipment Exclusion Zone Policy

APPENDIX A

Job Safety Analysis (JSA) Forms

JOB SAFETY ANALYSIS	Cntrl. No.	DATE:	☒ NEW ☐ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY **GENERIC**	WORK TYPE	WORK ACTIVITY (Description)	
DEVELOPMENT TEAM	**POSITION / TITLE**	**REVIEWED BY:**	**POSITION / TITLE**

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST ☐ HARD HAT ☐ LIFELINE / BODY HARNESS ☐ SAFETY GLASSES	☐ GOGGLES ☐ FACE SHIELD ☐ HEARING PROTECTION ☐ SAFETY SHOES	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☐ PPE CLOTHING:	☐ GLOVES: ☐ OTHER

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Required Equipment:

Commitment to LPS – All personnel onsite will actively participate in SPSA performance by verbalizing SPSAs throughout the day.

EXCLUSION ZONE: A _ foot exclusion zone will be maintained around (indicate equipment).

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. [INSERT JOB STEP]	**1a. CONTACT:** [INSERT HAZARD]	1a.
	1b. CAUGHT: [INSERT HAZARD]	1b.
	1c. FALL: [INSERT HAZARD]	1c.
	1d. EXPOSURE: [INSERT HAZARD]	1d.
	1e. EXERTION: [INSERT HAZARD]	1e.
	1f. ENERGY SOURCE: [INSERT HAZARD]	1f.
2. [INSERT JOB STEP]	**2a. CONTACT:** [INSERT HAZARD]	2a.
	2b. CAUGHT: [INSERT HAZARD]	2b.

[1] Each Job or Operation consists of a set of tasks / steps. Be sure to list all the steps needed to perform job.
[2] A hazard is a potential danger. Break hazards into five types: Contact - victim is struck by or strikes an object; Caught - victim is caught on, caught in or caught between objects; Fall - victim falls to ground or lower level (includes slips and trips); Exertion - excessive strain or stress / ergonomics / lifting techniques; Exposure - inhalation/skin hazards.
[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift." Avoid general statements such as, "be careful."

	2c. FALL: [INSERT HAZARD]	2c.
	2d. EXPOSURE: [INSERT HAZARD]	2d.
	2e. EXERTION: [INSERT HAZARD]	2e.
	2f. ENERGY SOURCE: [INSERT HAZARD]	2f.

[1] Each Job or Operation consists of a set of tasks / steps. Be sure to list all the steps needed to perform job.
[2] A hazard is a potential danger. Break hazards into five types: Contact - victim is struck by or strikes an object;
Caught - victim is caught on, caught in or caught between objects; Fall - victim falls to ground or lower level (includes slips and trips); Exertion - excessive strain or stress / ergonomics / lifting techniques; Exposure - inhalation/skin hazards.
[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

JOB SAFETY ANALYSIS	Cntrl. No. GEN-011	DATE: 1/18/2015	☐NEW ☒REVISED	

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)
GENERIC	**Site Recon**	**Site Walk and Inspection**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
Anthony Giannetti	Staff Geologist	Daniel Abberton	SHSM
		Mike Ritorto	Project Hydrogeologist
		Joe Gentile	CHSM

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES	☐ GOGGLES ☐ FACE SHIELD ☒ HEARING PROTECTION: ear plugs as necessary ☒ SAFETY SHOES: Steel or composite toed	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: High-visibility vest or high-vis outerwear, sleeved shirt	☒ GLOVES: Leather/cut-resistant/chemical resistant ☒ OTHER: tyvek and rubber boots as necessary, dust mask as necessary

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Required Equipment: Site map and/or guide familiar with Site, operating cell phone or walkie-talkie if Site allows.

Commitment to LPS – All personnel onsite will actively participate in SPSA performance by verbalizing SPSAs throughout the day.

EXCLUSION ZONE (EZ): A minimum 10' exclusion zone will be maintained around equipment.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Check in with Site manager.	**1a. CONTACT/EXPOSURE/FALL:** Lack of communication could result in H&S incident.	1a. Inform Site personnel of work scope, timeline and location(s). 1a. Inquire about hazards and other activities taking place at the Site. 1a. Discuss emergency evacuation procedures and muster points with Site manager..
2. Traversing the Site and setting up at work locations.	**2a. CONTACT:** Property damage and personal injury caused by obstructions/vehicles or unauthorized personnel at remote Sites.	2a. Maintain speed limit of 5 mph on-site. 2a. All equipment must be stowed and secured prior to moving. Use wheel chocks on all construction vehicles when not in motion. 2a. Drive on established roadways. 2a. Yield to all pedestrians. 2a. Do not back up vehicle without spotter where visibility is limited; use pull-through spots or back into parking spots; use an audible signal (horn/back-up alarm) when backing up vehicles. 2a. Wear high visibility clothing/safety vest. If working at remote Site, add orange accessories during hunting season.
	2b. FALL: Uneven terrain and weather conditions. Overgrown shrubs and vines. Equipment in the work zone.	2b. Inspect walking path for uneven terrain, weather-related hazards (i.e., ice, puddles, snow, etc.), and obstructions prior to mobilizing equipment. 2b. Use established pathways and walk on stable, secure ground. 2b. Communicate traversing hazards with others
	2c. OVEREXERTION: Muscle strain while carrying equipment.	2c. When carrying equipment to/from work area, use proper lifting techniques; keep back straight, lift with legs, keep load close to body, never reach with a load. Ensure that loads are balanced to reduce the potential for muscle strain. Use mechanical assistance or make multiple trips to carry equipment. 2c. Two people or a mechanical lifting device are required when lifting objects over 50 lbs or when the shape makes the object difficult to lift.
	2d. EXPOSURE: Biological hazards - ticks, bees/wasps, poison ivy, insects, etc. (Ticks are most active any time the temperature is above freezing, typically from March to November.)	2d. Inspect area to avoid contact with biological hazards. 2d. Ticks: • Treat outer clothing including pants, shirts, socks, boots and hats the evening before use with Permethrin (allowing at least two hours before use). • Apply DEET to exposed skin before travelling to the Site and reapply after two hours. • Check for ticks during and after work. 2d. Bees: Use bee spray to remove nests. Protect exposed skin with insect repellent. 2d. Poison Ivy: • Identify areas of poison ivy and spray with weed killer. Don Tyvek and rubber boots while traversing poison ivy areas. • If skin comes in contact with poison ivy, wash skin thoroughly with soap and water.

[1] Each Job or Operation consists of a set of tasks / steps. Be sure to list all the steps needed to perform job.
[2] A hazard is a potential danger. Break hazards into five types: Contact - victim is struck by or strikes an object; Caught - victim is caught on, caught in or caught between objects; Fall - victim falls to ground or lower level (includes slips and trips); Exertion - excessive strain or stress / ergonomics / lifting techniques; Exposure - inhalation/skin hazards; Energy Source – electricity, pressure, compression/tension.
[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift." Avoid general statements such as, "be careful."

	2e. EXPOSURE: Heat Stress & Cold Stress. Personal injury from working in inclement weather conditions.	2e. Wear sunscreen with SPF 15 or greater on exposed skin whenever 30 minutes or more of sun exposure is expected. 2e. Watch for heat stress symptoms (muscle cramping, exhaustion, dizziness, rapid and shallow breathing). Take breaks as needed. 2e. Watch for cold stress symptoms (severe shivering, slowing of body movement, weakness, stumbling or inability to walk, collapse). Take breaks as needed. 2e. Wear appropriate rain gear as needed. 2e. Take frequent breaks if tired, wet, or cold/hot. Drink water. 2e. If lightning is observed, wait 30 minutes after last thunder boom/lightning bolt in a sheltered location (car acceptable) before starting work again.
3. Define and secure the work area.	**3a. CONTACT:** Personal injury or property damage from other vehicles on-site.	3a. Face traffic, maintain eye contact with oncoming vehicles, and establish a safe exit route. 3a. Look both ways in high traffic areas. 3a. Position vehicle to protect against oncoming traffic. 3a. Use 42" traffic cone and caution tape to delineate work area. Use a spotter in high traffic areas. 3a. Wear high visibility clothing/safety vest.
4. Walking near heavy equipment and machinery.	**4a. CONTACT:** Personal injury from Site and roadway traffic. Personal injury from flying debris. **4b. OVEREXERTION:** Personal injury from lifting/moving/rotating equipment. **4c. EXPOSURE:** Hearing damage from excavation activities. Inhalation/exposure to hazardous vapors and or dust. **4d. EXPOSURE:** Working in a remote area.	4a. See 3a. 4a. Place traffic cones to re-direct traffic flow around work area and to alert others as to activity taking place. Evaluate possible need for police detail and request as needed. 4a. Maintain a minimum exclusion zone of 10 feet from all equipment. Task specific JSAs should be referenced to determine the actual exclusion zone for the piece of equipment being used. 4a. Keep body parts out of the line of fire of pinch points. 4a. Routinely inspect work area and be aware of location of all Site personnel. Make eye contact with spotter, if provided, or operator prior to entering the work area. 4a. Wear safety glasses at all times. 4b. See 2c. 4c. Monitor air quality with multi-gas meter and dust meter, if necessary. Use water to suppress dust, if necessary. Wear dust mask, if necessary. 4c. Wear hearing protection if >85 dBA. 4c. Always wear leather gloves when handling any tools or equipment. Wear cut-resistant gloves (Kevlar or similar) when handling sharp objects, glassware or cutting tools. 4d. Use the "buddy system" whenever possible. If working alone, contact PM upon arrival/departure, as well as during work activities prior to commencing work. 4d. Always carry a communication (i.e., cell phone, walkie-talkie) or directional (i.e., map, compass, etc.) device when traversing remote areas.
5. Working in adverse weather conditions.	**5a. EXPOSURE:** Heat Stress & Cold Stress. Personal injury from working in inclement weather conditions.	5a. Watch for heat stress symptoms (muscle cramping, exhaustion, dizziness, rapid and shallow breathing). Take breaks as needed. 5a. Watch for cold stress symptoms (severe shivering, slowing of body movement, weakness, stumbling or inability to walk, collapse). Take breaks as needed. 5a. Wear appropriate rain gear as needed. 5a. Take frequent breaks if tired, wet, or cold/hot. Drink water. 5a. If lightning is observed, wait 30 minutes after last thunder boom/lightning bolt in a sheltered location (car acceptable) before starting work again.
6. Departing Site.	**6a. EXPOSURE:** Exposure to unnecessary hazards should personnel believe Roux is on-Site during an emergency and conduct a search.	6a. Sign out or notify Site personnel of your departure.

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Caught - victim is caught on, caught in or caught between objects; Fall - victim falls to ground or lower level (includes slips and trips); Exertion - excessive strain or stress / ergonomics / lifting techniques; Exposure - inhalation/skin hazards; Energy Source – electricity, pressure, compression/tension.
[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

JOB SAFETY ANALYSIS Ctrl. No.	DATE 1/23/2015	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY: **Generic**	WORK TYPE: **Drilling**	WORK ACTIVITY (Description): **Hollow Stem Auger Soil Borings /Well Installation**	
DEVELOPMENT TEAM	**POSITION / TITLE**	**REVIEWED BY:**	**POSITION / TITLE**
Gina Vanderlin	Project Scientist	Joseph Gentile	CSHM

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT			
☐ LIFE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES	☐ GOGGLES ☐ FACE SHIELD ☒ HEARING PROTECTION: (as needed) ☒ SAFETY SHOES steel or composite toe	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: fluorescent sleeved shirt or sleeved shirt and reflective safety vest.	☒ GLOVES: Leather, Nitrile and cut resistant ☒ OTHER: Insect Repellant, sunscreen (as needed)

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Truck-Mounted Drilling Rig or Track Rig, Saw, Hand Tools, Photoionization Detector, Multi-Gas Meter (or equivalent), Interface Probe, 20 lb. Fire Extinguisher, 42" Cones & Flags, "Work Area" Signs

COMMITMENT TO LPS - All personnel onsite will actively participate in SPSA performance by verbalizing SPSAs throughout the day.

EXCLUSION ZONE POLICY – All non-essential personnel shall maintain a **10 foot** exclusion zone while drill rig is engaged

"SHOW ME YOUR HANDS"
Driller and helper should show that hands are clear from controls and moving parts

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Mobilization of drilling rig	1a. **CONTACT**: Equipment or property damage. 1b. **FALL**: Slip/trip/fall hazards.	1a. The drill rig's tower/derrick will be lowered and secured prior to mobilization. 1a. A spotter should be utilized while moving or backing the drill rig. If personnel move into the path of the drilling rig, the drilling rig will be stopped until the path is again clear. 1a. Set-up the work area / position equipment in a manner that eliminates or reduces the need for backing of trucks and trailers. 1a. When backing up truck rig with an attached trailer use a second spotter if there is tight clearance simultaneously on multiple sides of the equipment or if turning angles limit driver visibility. 1a. Inspect the driving path for uneven terrain. Level or avoid if needed. 1b. Inspect walking path for uneven terrain, weather-related hazards (i.e., ice, puddles, snow, etc.), and obstructions prior to mobilizing equipment. 1b. Do not climb over stored materials/equipment; walk around. Practice good housekeeping. 1b. Use established pathways and walk on stable, secure ground. 1b. Use three points of contact when mounting or dismounting the rig.
2. Raising tower/derrick of drilling rig	2a. **CONTACT**: Overhead hazards. 2b**. CONTACT**: Pinch points when raising the rig; crushing hazard with stability of rig during set-up	2a. Prior to raising the tower/derrick, area above the drilling rig will be inspected for overhead hazards (wires, tree limbs, piping, or other structures) that may be contacted by the rig's tower or drilling rods. 2a. The tower/derrick must not be raised beneath overhead power lines unless approved by both the ExxonMobil and Roux PMs. 2a. Maintain at a minimum 10' from overhead structures. 2a. Do not move the rig while the tower/derrick is raised. 2b. Inspect the equipment prior to use and avoid placing hands near pinch points. 2b. Lower out riggers on rig to ensure stability prior to raising rig tower derrick. 2b. Inspect the set-up location for uneven terrain. Level or avoid area if needed.
3. Advancement of augers for soil borings and well material installation.	3a. **CONTACT:** Flying / spraying debris. 3b. **EXPOSURE:** Noise and dust.	3a. Wear minimum level D PPE 3a. Be aware of and avoid potential lines of fire. 3b. Wet borehole area with sprayer to minimize dust. Stand upwind and keep body positioned away from rig. 3b. Wear hearing protection while drill rig is operating/or the noise levels exceed 85dBA.

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
4. Advancement of augers for soil borings, and well material installation (Continued).	4c. **CAUGHT**: Limb/extremity pinching, abrasion, and crushing.	4c. Always wear leather gloves when making connections and using hand tools; wear cut-resistant (i.e., Kevlar) gloves when handling cutting tools. 4c. Test all emergency shutdown devices prior to drilling. 4c. Inspect drill head for worn surface or missing teeth; replace if damaged or blunt. 4c. Inspect augers; do not use if auger flight if damaged or bent. 4c. Ensure all jewelry is removed, loose clothing is secured, and PPE is secured close to the body. 4c. All non-essential personnel should stay away from the immediate work area; position body out of the line-of-fire of equipment particularly when installing auger flights. 4c. Drillers and helpers will understand and use the "Show Me Your Hands" Policy. 4c. Spinning augers should have an **exclusion zone of 20 feet** when in operation.
	4d. **CONTACT**: Equipment imbalance during advancement of drill equipment.	4d. Drillers will advance the borehole with caution to avoid causing the rig to become imbalanced and/or tip. 4d. The blocking and leveling devices used to secure the rig will be inspected by drillers and Roux personnel regularly to see if shifting has occurred.
	4e. **EXPOSURE**: Inhalation of contamination/vapors.	4e. Air monitoring using a calibrated photoionization detector (PID) will be used to periodically monitor the breathing zone of the work area. 4e. The Action Level for breathing zone air is five parts per million (sustained) as detected by the PID. 4e. If a reading of >5ppm is recorded, the Roux field personnel must temporarily cease work, instruct all Site personnel to step away from the area of elevated readings and inform the Roux PM of the condition. The Roux PM will then recommend additional appropriate precautions in accordance with the site specific health and safety plan.
	4f. **FALL**: Slip/trip/fall hazards.	4f. See 1b. 4f. Remove soil cuttings to avoid a tripping hazard from developing near augers.
	4g. **EXERTION**: Installing well casings and lifting augers.	4g. Keep back straight and bend at the knees. 4g. Utilize team lifting for objects over 50lbs. 4g. Use mechanical lifting device for odd shaped objects.
	4h. **CONTACT**: Using hand tools to install well casings and materials	4h. Wear cut resistant and leather gloves. 4h, Secure materials on a level surface before cutting 4h. Place hands out of the line of fire 4h. Inspect all tools prior to use and remove damaged tools from service
5. Cleaning the auger flights	5a. **CONTACT:** Cuts/scrapes or puncture wound from contacting rotating auger.	5a. Follow "No Hands" Procedure and make sure auger is out of gear before contacting auger with hands or tool. 5b. When using a cleaning tool, pull across your body with handle away from body; do not push toward the auger. 5b. Do not clean more than ¾ turn around the auger at a time. 5b. Wear cut resistant and leather gloves. 5b. Always use two hands when operating cleaning tool. 5b. Inspect any tool before use and remove from service if handle or metal are cracked/fatigued. 5b. Stand out of the line of fire.
6. Decontaminate equipment.	6a. **EXPOSURE/CONTACT:** To contamination (e.g., contaminated groundwater, vapors). 6b. **EXPOSURE**: To chemicals in cleaning solution (including ammonia)	6a. Wear chemical-resistant disposable gloves and safety glasses. 6a. Contain decontamination water so that it does not spill. 6a. Use an absorbent pad to clean spills, if necessary. 6b. See 5a.

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JOB SAFETY ANALYSIS Cntrl#: GEN-015	DATE 1/27/15	☐NEW ☒REVISED	PAGE 1 of 2
JSA TYPE CATEGORY: **GENERIC**	WORK TYPE: **Drilling**	WORK ACTIVITY (Description): **Monitoring and Recovery Well Development**	

DEVELOPMENT TEAM	**POSITION / TITLE**	**REVIEWED BY:**	**POSITION / TITLE**
Amy Hoffman	Staff Geologist	Mike Ritorto	Senior Hydrogeologist
Ron Lombino	Staff Geologist	Daniel Abberton	

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES	☐ GOGGLES ☐ FACE SHIELD ☒ HEARING PROTECTION (as needed) ☒ SAFETY SHOES: Composite-toe or steel toe boots	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: Fluorescent reflective vest or high visibility clothing	☒ GLOVES: Leather, Nitrile and cut resistant ☒ OTHER: Insect repellant, sunscreen (as needed)

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Required Equipment as needed: Truck Rig or support truck, Trailer, 42 inch Safety cones and flags, Caution Tape, Interface Probe, Power Source, Submercible Pump, Surge Block/Plunger, 20 lb. Fire Extinguisher, Holding Tanks and/or Buckets, Tools as needed: Socket and Pipe Wrench, Screw Driver, Pry Bar, Ratchet, Vault Key.

COMMITMENT TO LPS - All personnel onsite will actively participate in SPSA performance by verbalizing SPSAs throughout the day.

Maintain a 20 Foot Exclusion Zone During Development Activities

"SHOW ME YOUR HANDS"
Driller and helper should show that hands are clear from controls and moving parts

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Mobilization / Demobilization (**Review Mobilization and Demobilization JSA**)	1a. **CONTACT:** Equipment/property damage. 1b. **FALL:** Slip/trip/fall hazards.	1a. The truck rig's tower/derrick will be lowered and secured prior to mobilization. 1a. Set-up the work area / position equipment in a manner that eliminates or reduces the need for backing of trucks and trailers. 1a. All non-essential personnel should **maintain an exclusion zone of 20 feet**. 1a. Beep horn twice before backing up. 1a. When backing up with an attached trailer use a spotter if there is tight clearance simultaneously on multiple sides of the equipment or if turning angles limit driver visibility. Stay away from the line-of-fire. 1a. Inspect the driving path for uneven terrain. Level or avoid if needed. 1b Inspect walking path for uneven terrain, weather-related hazards (i.e., ice, puddles, snow, etc.), and obstructions prior to mobilizing equipment. 1b. Do not climb over stored materials/equipment; walk around. Store equipment at lowest potential energy.
2. Open/close well.	2a. **OVEREXERTION:** Muscle strain (some wells have large vault covers). 2b. **CAUGHT:** Pinch points associated with removing/replacing manholes and working with hand tools. 2c. **EXPOSURE:** Potentially hazardous vapors. 2d. **CONTACT:** Traffic.	2a. Keep back straight, lift with legs, keep load close to body, and never reach with a load. Ensure that loads are balanced to reduce the potential for muscle strain. Two people are required when lifting objects over 50 lbs or when the shape makes the object difficult to lift. 2b. Wear leather gloves when working with well vault/cover and hand tools. Do not put fingers under well vault/cover. 2b. Use ratchet and pry bar for well cover and inspect before use. 2c. No open flames/heat sources. 2c. Allow well to vent after opening it and before starting development activities to minimize exposure to vapors. Air monitoring must be performed prior to set up and during the well development activities. Work on upwind side of well. 2d. Wear required PPE including high visibility clothing or reflective vest. 2d. Delineate work area with 42" safety cones and/or other barriers. Position vehicle to protect against oncoming traffic. 2d. Face traffic, maintain eye contact with oncoming vehicles, and establish a safe exit route.

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
3. Develop well (mechanical surging).	3a. **CAUGHT:** Cut hazards and finger pinch points. 3b. **CONTACT/EXPOSURE:** Contamination (e.g., SPH, contaminated groundwater, vapors). 3c. **OVEREXERTION:** Muscle strain from lifting equipment. 3d. **CONTACT:** Injury while handling wench line/cable, or with active surging equipment	3a See 2b. 3a. Use required PPE including leather/cut-resistant gloves when handling development equipment. Identify finger/hand pinch points. Keep hands away from active surge equipment. 3a. All non-essential personnel should **maintain an exclusion zone of 20 feet**. 3b. See 2c. 3b. Wear Nitrile gloves and safety glasses. Insert and remove surge block/plunger and line/cable slowly to avoid splashing at the surface. 3b. Use an absorbent pad to clean any spills. 3c. See 2a. 3c. Use mechanical device to insert and remove surge block/plunger if greater than 50lb. 3d. If using a drill rig, inspect all wench lines/cables for any kinks or if frayed prior to use. Replace any damaged lines/cables. Review **Drill Rig checklist prior to development activities**. 3d. See 3a.
4. Purging well (pumping water to holding tanks/drums/buckets).	4a. **CAUGHT:** Pinch points associated with connecting hose to tank. Pinch points associated with handling pump and hoses. 4b. **FALL:** Using side mounted ladder when attaching hose to tank. Slip, trip, fall from lines/hoses 4c. **CONTACT:** Contamination (e.g., SPH, contaminated groundwater). 4d. **EXERTION:** Muscle strain from lifting/carrying equipment. 4e. **FALL:** Spilled purge water.	4a. See 3a. 4a. Ensure that fingers are not placed near coupling when attaching and securing hose(s). Do not place fingers under pump/hoses. Wear leather or cut-resistant gloves when handling pump/hose(s). 4a. Keep hands clear from any line of fire. 4b. Inspect ladder steps to make sure steps are not bent/damaged and free of debris/fluid. 4b. Use three points of contact at all times when using ladder. 4b. Utilize anti-whip cords on all compressed hoses. Keep hoses and lines coiled and organized out of designated walking paths around the work zone. 4c. Secure water hose. 4c. Do not overfill tanks, and purge/transfer liquids in such a manner that they do not splash. (See 3b). 4c. Dispose of used materials/PPE in the designated impacted PPE container. 4d. See 2a. 4e. Clean up any spills using absorbent pads or spill kits.
5. Decontaminate equipment	5a. **CONTACT/EXPOSURE:** Contamination (e.g., SPH, contaminated groundwater, vapors). 5b. **EXPOSURE/CONTACT:** Chemicals in cleaning solution	5a. See 3b. 5b. Decontaminate equipment in well-ventilated area. Wear nitrile gloves to avoid skin contact with cleaning solutions.

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JOB SAFETY ANALYSIS Ctrl. No. GEN-005	DATE 2/4/2015	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE:	WORK ACTIVITY (Description):	
Generic	**Gauging and Sampling**	**Gauging and Sampling**	
DEVELOPMENT TEAM	**POSITION / TITLE**	**REVIEWED BY:**	**POSITION / TITLE**
Gina Masciello	Project Scientist	Joe Gentile	Corp H&S Mgr
Louis Goldstein	Staff Engineer	Michael Ritorto	Project Hydrogeologist
		Louis Goldstein *(as part of annual review)*	Staff Engineer

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☒ LIFE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES	☐ GOGGLES ☐ FACE SHIELD ☐ HEARING PROTECTION ☒ SAFETY SHOES: Composite-toe or steel toe boots	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: Fluorescent reflective vest or high visibility clothing	☒ GLOVES: Leather, Nitrile and cut resistant ☒ OTHER: Knee pads, Insect Repellant, sunscreen (as needed)

REQUIRED AND / OR RECOMMENDED EQUIPMENT

42-inch Safety Cones, Caution Tape, Interface Probe and/or Water Level Meter, 20-lb., Type ABC Fire Extinguisher, Buckets. Tools as needed: Socket Wrench, Screw Driver, Crow Bar, Mallet, and Wire Brush.

Commitment to LPS – All personnel onsite will actively participate in SPSA performance by verbalizing SPSAs throughout the day.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Mobilization to monitoring well(s).	1a. **FALL:** Personal injury from slip/trip/fall due to uneven terrain and/or obstructions.	1a. Inspect pathway and plan for most suitable designated pathway prior to mobilization. 1a. Use established pathways, walk and/or drive on stable, secure ground and avoid steep hills or uneven terrain. 1a. If working near open water with an unguarded edge, wear life vest.
	1b. **CONTACT:** With traffic/third parties.	1b. Identify potential traffic sources and delineate work area with 42-inch traffic safety cones. Position vehicle to protect against oncoming traffic. Use caution tape to provide a more visible delineation of the work area if necessary. 1b. Wear appropriate PPE including high visibility clothing or reflective vest. 1b. Face traffic, maintain eye contact with oncoming vehicles, and establish a safe exit route.
	1c. **EXPOSURE:** To biological hazards.	1c. Inspect work area for bees and insects. 1c. Use insect/tick repellent as necessary.
2. Open/close well.	2a. **ERGNOMICS:** Muscle strain.	2a. Use proper lifting techniques; keep back straight, lift with legs and bend knees when reaching to open/close well.
	2b. **CAUGHT:** Pinch/crush points associated with removing/replacing manholes and working with hand tools.	2b. Wear leather gloves or cut resistant gloves when working with well cover and hand tools. 2b. Use proper tools (ratchet and pry bar for well cover) and inspect before use. 2b. Do not put fingers under well cover.
	2c. **CAUGHT:** Pinch points associated with placing J-plug back onto PVC pipe.	2c. See 2b. 2c. Keep fingers out of line-of-fire when securing cap
	2d. **EXPOSURE:** To potential hazardous vapors.	2d. No open flames/heat sources. 2d. To minimize exposure to vapors allow well to vent after opening it and before sampling activities begin. 2d. Stand up-wind, if possible, to avoid vapors.
3. Gauge well.	3a. **CONTACT:** With contamination (e.g. contaminated groundwater).	3a. Wear chemical-resistant disposable gloves (over cut-resistant gloves) and safety glasses when gauging well. 3a. Insert and remove probe slowly to avoid splashing. 3a. Use an absorbent pad to clean probe.
	3b. **CONTACT:** With traffic.	3b. See 1b.

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Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
4. Purge and sample well.	4a. **EXPOSURE/CONTACT:** To contamination (e.g., SPH, contaminated groundwater, vapors) and/or sample preservatives.	4a. Open and fill sample jars slowly to avoid splashing and contact with preservatives. 4a. Wear cut-resistant gloves and chemical-resistant disposable gloves when sampling. 4a. Fill sample containers over purge container to avoid spilling water onto the ground. 4a. Use an absorbent pad to clean spills. 4a. When using a bailer to purge a well, pull the bailer slowly from the well to avoid splash hazards. 4a. When sampling or purging the water using a bailer, pour out water slowly to reduce the potential for splash hazards with groundwater. 4a. When using a tubing valve always remove the valve slowly after sample collection to release any pressure and avoid pressurized splash hazards 4a. When collecting a groundwater sample always point sampling apparatus (tubing, bailer, etc.) away from face and body.
4. Purge and sample well (Continued).	4b. **CONTACT:** Personal injury from cuts, abrasions, or punctures by glassware or sharp objects. 4c. **ERGONOMICS:** Muscle strain while carrying equipment. 4d. **CONTACT:** With traffic. 4e. **CONTACT**: Pinch points with groundwater pump components (i.e. wheel, line, clamps) 4f. **ERGONOMICS**: Muscle strain from repetitive motion of bailing and sampling a well	4b. To avoid spills or breakage, place sample ware on even surface. 4b. Do not over tighten caps on glass sample ware. 4b. Wear chemical-resistant nitrile disposable gloves over cut-resistant (i.e. Kevlar) gloves when sampling and handling glassware (i.e., VOA vials) or when using cutting tools. 4c. Use proper lifting techniques when handling/moving equipment; bend knees and keep back straight. 4c. Use mechanical assistance or team lifting techniques when equipment is 50 lbs. or heavier. 4c. Make multiple trips to carry equipment. 4d. See 1b. 4e. Wear leather gloves when working with groundwater pumps 4e. Never place hands on or near pinch points such as the wheel, clamps or other moving parts during pump operations 4e. Use correct the correct mechanisms, such as a pump reel, to lower pump into well 4e. Never attempt to manually stop any moving part of equipment including hose reels and/or tubing. 4f. See 4c. 4f. Include a stretch break when repetitive motions are part of the task.
5. Management of purge water.	5a. **EXPOSURE/CONTACT:** To contamination (e.g., SPH, contaminated groundwater, vapors). 5b. **ERGONOMICS:** Muscle strain from lifting/carrying and moving containers.	5a. Do not overfill container and pour liquids slowly so that they do not splash. 5a. Properly dispose of used materials/PPE in appropriate container in designated storage area. 5b. Use proper lifting techniques when lifting / carrying or moving container(s) (see 4c.). 5b. Do not overfill container(s).
6. Decontaminate equipment.	6a. **EXPOSURE/CONTACT:** To contamination (e.g., SPH, contaminated groundwater, vapors). 6b. **CAUGHT:** Pinch points associated with handling hand tools	6a. Work on the upwind side, where possible, of decon area. 6a. Wear chemical-resistant disposable gloves and safety glasses. 6a. Use an absorbent pad to clean spills. 6b. See 2b. 6b. Inspect hand tools for sharp edges before decontaminating

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

JOB SAFETY ANALYSIS **Ctrl. No. GEN-006**	DATE 9/15/2015	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)	
Generic	**Surveying**	**Elevation Surveying**	
DEVELOPMENT TEAM	**POSITION / TITLE**	**REVIEWED BY:**	**POSITION / TITLE**
Mark M Emmons	Project Engineer	Daniel Abberton	Health and Safety Officer
Bjorn Wespestad	Senior Engineer	Michael Ritorto	Project Hydrogeologist

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES	☐ GOGGLES ☐ FACE SHIELD ☐ HEARING PROTECTION ☒ SAFETY SHOES: Steel-toe boots	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: Fluorescent reflective vest or high visibility clothing	☒ GLOVES: Cut-resistant or leather ☒ OTHER: Long sleeve Shirt

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Surveying equipment (i.e., leveling rod/measuring ruler, tripod and scope).

COMMITMENT TO LPS - All personnel onsite will actively participate in SPSA performance by verbalizing SPSAs throughout the day.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Check in with Site manager/ property owner.	**1a. CONTACT/EXPOSURE/FALL:** Lack of communication could result in H&S incident.	1a. Inform Site personnel of work scope, timeline and location(s). 1a. Inquire about other activities taking place at the Site. 1a. If applicable, obtain General Work permit for the day.
2. Locate surveying position for instrument and rod and set-up work area	2a. **FALL:** Slip/trip hazards. 2b. **CONTACT:** Traffic (surveying locations could potentially be located in parking areas and sidewalks). 2c. **OVEREXERTION:** Hazard due to carrying, lifting, and bending while transporting equipment. 2d. **CAUGHT/CONTACT:** Pinch Points / sharp edges associated with setting up the tripod.	2a. Inspect area for uneven terrain, weather-related hazards (i.e., ice, puddles, snow, etc.), and obstructions prior to setting up at the survey location. Keep eyes engaged with walking surface while in movement. Remember " Walking is Working" 2a. Conduct housekeeping and maintain clear paths to walk in and remove debris as required. 2b. Be aware of oncoming traffic. Utilize a flagman / spotter for locations in streets or high-traffic areas. 2b. Place 42 inch cones around the work area, and delineate work zone with caution tape ,snow fencing or safety bars, if necessary. 2b. Wear appropriate PPE including long sleeve high visibility clothing and or reflective safety vest. 2b. Face traffic, maintain eye contact with oncoming vehicles, and establish a safe exit route. 2c. Use proper body positioning and lifting techniques; keep back straight, lift with legs, keep load close to body, and never reach with a load. 2c. Avoid carrying too much equipment at one time and team-lift equipment that is more than 50 lb. 2d. Wear cut resistant gloves when handling the tripod and keep fingers away from pinch points located near moving parts of the tripod. Don't carry tripod by the pointed ends.
3. Open / close manhole cover to well that is being surveyed (if necessary).	3a. **OVEREXERTION:** Muscle strain 3b. **CAUGHT:** Pinch points associated with removing / replacing manholes and working with hand tools. 3c. **EXPOSURE:** To potentially hazardous vapors. To biological hazards. 3d. **CONTACT:** With traffic.	3a. See 1c. Bend knees when reaching to open well. Use manhole lifting hook or pry bar to avoid bending. 3b. Wear leather gloves or cut resistant gloves when working with well cover and hand tools. 3b. Use proper tools (ratchet and crowbar or pry bar for well cover) and inspect before use. 3b. Do not put fingers under well cover. 3c. No open flames/heat sources. 3c. To minimize exposure to vapors allow well to vent after opening it and before survey activities begin. 3c. Work on the upwind side of manhole/well. 3.c Use caution while opening up lids to inspect work area for bees and insects inside of covers. 3c. Use insect/tick repellent as necessary. 3d. See 2b.

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
4. Perform survey.	4a. **FALL:** Slip/trip hazards 4b. **CONTACT:** Traffic (surveying locations could be potentially located in parking areas and sidewalks)	4a. See 2a. 4b. See 2b. 4b. Personnel using the scope will be devoting most of their attention to the surveying activity and shall be aware of vehicular and pedestrian traffic. Personnel holding the measuring stick should be extra vigilant of survey personnel and communicate any potential hazards to the instrument person via handheld radio or similar means. Ensure reflective safety vest is worn.
5. Break down work area.	5a. **CONTACT:** Traffic (surveying locations can potentially be located in parking areas and sidewalks). 5b. **EXERTION:** Hazard due to carrying, lifting, and bending while transporting equipment	5a. See 2b. 5b. See 2c.

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JOB SAFETY ANALYSIS Ctrl. No. GEN-006	DATE 1/4/2018	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY: **Generic**	WORK TYPE: **Drilling**	WORK ACTIVITY (Description): **Direct Push Soil Borings / Well Installation**	
DEVELOPMENT TEAM	**POSITION / TITLE**	**REVIEWED BY:**	**POSITION / TITLE**
Timothy Zei	Project Hydrogeologist	Raymond Olson	Staff Assistant Geologist
		Christine Pietrzyk	Office Health & Safety Manager
		Brian Hobbs	Senior Health & Safety Manager
		Joe Gentile	Corporate Health & Safety Manager

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES	☐ GOGGLES ☐ FACE SHIELD ☒ HEARING PROTECTION: (as needed) ☒ SAFETY SHOES: Composite-toe or steel toe boots	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: Fluorescent reflective vest or high visibility clothing, Long Sleeve Shirt	☒ GLOVES: Leather, Nitrile and cut resistant ☒ OTHER: Insect Repellant, sunscreen (as needed)

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Geoprobe or Truck-Mounted Direct Push Drill Rig, Hand Tools, Photoionization Detector, Multi-Gas Meter (or equivalent), Macrocore liners, Liner Opening Tool, 20 lb. Type ABC Fire Extinguisher, 42” Cones & Flags, “Work Area” Signs, Water

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs

EXCLUSION ZONE (EZ) – All non-essential personnel will maintain a distance of 10 feet from drilling equipment while equipment is moving/engaged

“SHOW ME YOUR HANDS”
Driller and helper should show that hands are clear from controls and moving parts

Assess [1]**JOB STEPS**	**Analyze** [2]**POTENTIAL HAZARDS**	**Act** [3]**CRITICAL ACTIONS**
1. Mobilization of drilling rig (ensure the Subsurface Clearance Protocol and Drill Rig Checklist are completed)	**1a. CONTACT:** Equipment/property damage. **1b. FALL:** Slip/trip/fall hazards. **1c. CONTACT:** Crushing from roll-over.	1a. The drill rig's tower/derrick will be lowered and secured prior to mobilization. 1a. A spotter should be utilized while moving the drill rig. If personnel move into the path of the drill rig, the drill rig will be stopped until the path is again clear. Use a spotter for all required backing operations. 1a. Set-up the work area and position equipment in a manner that eliminates or reduces the need for backing of support trucks and trailers. 1a. When backing up truck rig with an attached trailer use a second spotter if there is tight clearance simultaneously on multiple sides of the equipment or if turning angles limit driver visibility. 1a. Inspect the driving path for uneven terrain. Level or avoid if needed. 1a. Drill rig should have a minimum **exclusion zone of 10 feet** for non-essential personnel (i.e., driller helper, geologist) when the rig is moving/ in operation. 1b. Inspect walking path for uneven terrain, weather-related hazards (i.e., ice, puddles, snow, etc.), and obstructions prior to mobilizing equipment. 1b. Do not climb over stored materials/equipment; walk around. Practice good housekeeping. 1b. Use established pathways and walk on stable, secure ground. 1c Geoprobe should cross all hills/obstructions head on with the mast down to reduce risk of roll-over.
2. Raising tower/derrick of drill rig	**2a. CONTACT:** Overhead hazards. **2b. CONTACT:** Pinch Points/Amputation Points when raising the rig and instability of rig	2a. Prior to raising the tower/derrick, the area above the drilling rig will be inspected for wires, tree limbs, piping, or other structures, that could come in contact with the rig's tower and/or drilling rods or tools. 2a. Maintain a safe distance of 10’ from overhead structures. 2b. Inspect the equipment prior to use and avoid pinch/amputation points. 2b. Lower outriggers to ensure stability prior to raising rig tower/derrick. 2b. If the rig needs to be mounted, be sure to use three points of contact.
3. Advancement of drilling equipment and well installation	**3a. CONTACT:** Flying debris **3b. EXPOSURE:** Noise and dust.	3a. Be aware of and avoid potential lines of fire and wear required PPE such as eye, ear, and hand protection. 3b. Wet borehole area with sprayer to minimize dust. 3b. Stand upwind and keep body away from rig. 3b. Dust mask should be worn if conditions warrant. 3b. Wear hearing protection when the drill rig is in operation.

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
3. Advancement of drilling equipment and well installation (Continued)	**3a. CONTACT:** Flying debris **3b. EXPOSURE:** Noise and dust. **3c. FALL:** Slip/trip/fall hazards. **3d. CAUGHT:** Limb/extremity pinching; abrasion/crushing. **3e. CONTACT:** Equipment imbalance during advancement of drill equipment. **3f. EXPOSURE:** Inhalation of contamination/vapors. **3g. EXERTION:** Potential for muscle strain/injury while lifting and installing well casings, lifting sand bags, and/or lifting rods.	3c. Contain drill cuttings and drilling water to prevent fall hazards from developing in work area. 3c. See 1b. 3d. Ensure all Emergency Safety Stop buttons function properly. 3d. Always wear leather gloves when making connections and using hand tools; wear cut-resistant (i.e., Kevlar) gloves when handling cutting tools. 3d. Inspect the equipment prior to use for potential pinch/amputation points. Keep hands away from pinch/amputation points and use of tools is preferable compared to fingers and hands. 3d. Inspect drill head for worn surface or missing teeth; replace if damaged or blunt. 3d. Ensure all jewelry is removed, loose clothing is secured, and PPE is secured close to the body. 3d. All non-essential personnel should stay away from the immediate work area; position body out of the line-of-fire of equipment. 3d. Drillers and helpers will understand and use the “Show Me Your Hands” Policy. 3d. Spinning rods/casing have an **exclusion zone of 10 feet** while in operation. 3e. Drillers will advance the borehole with caution to avoid causing the rig to become imbalanced and/or tip. 3e. The blocking and leveling devices used to secure the rig will be inspected by drillers and Roux personnel regularly to see if shifting has occurred. 3e. In addition, personnel and equipment that are non-essential to the advancement of the borehole will be positioned away from the rig at a distance that is at least as far as the boom is high (**minimum exclusion zone of 10 feet**). 3f. Monitor ambient air for dangerous conditions using a calibrated photoionization detector (PID) to periodically monitor the breathing zone of the work area. 3f. If a reading of >5ppm is recorded, the Roux field personnel must temporarily cease work, instruct all Site personnel to step away from the area of elevated readings and inform the Roux PM of the condition. The Roux PM will then recommend additional precautions in accordance with the site specific health and safety plan. 3f. Use a multi-gas meter to monitor ambient air for dangerous conditions (i.e. unsafe levels of carbon monoxide when drilling indoors or the presence of explosive vapors). 3g. Keep back straight and bend at the knees. 3g. Utilize team lifting for objects over 50lbs. 3g. Use mechanical lifting device for odd shaped objects.
4. Remove sample liner.	**4a. EXERTION:** Potential for muscle strain/injury while removing liner from probe rod. **4b. CONTACT:** Pinch points and cuts **4c. EXPOSURE:** Inhalation and/or dermal contact with contaminants.	4a Utilize team lifting for objects over 50lbs. 4a. Use hydraulic liner extruder if available. 4b. Place liner on sturdy surface when opening. 4b. Don cut-resistant gloves and use appropriate liner cutter when opening liners. 4b. Always cut away from the body. 4c. Wear chemical-resistant disposable gloves when handling liners. 4c. See 3e.
5. Decontaminate equipment.	**5a. EXPOSURE/CONTACT**: To contamination (e.g., Separate Phase Hydrocarbons (SPH), contaminated groundwater, vapors). **5b. EXPOSURE:** To chemicals in cleaning solution including ammonia.	5a. Wear chemical-resistant disposable gloves and safety glasses. 5a. Contain decontamination water so that it does not spill. 5a. Use an absorbent pad to clean spills, if necessary. 5a. Spray equipment from side angle, not straight on, to avoid backsplash. 5a. See 3b. 5b. See 4a. Review SDS to ensure appropriate precautions are taken and understood.

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JOB SAFETY ANALYSIS	Ctrl. No. GEN-009	DATE: 1/4/2018	☐ NEW ☒ REVISED	PAGE 1 of 1

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)
Generic	**O&M**	**Movement of 55-Gallon Drums/Drum Handling with Mobile Carrier**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
Michael Sarni	Technician	Brian Hobbs	Senior Health & Safety Manager
		Joe Gentile	Corporate Health & Safety Manager

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES	☐ GOGGLES ☐ FACE SHIELD ☐ HEARING PROTECTION ☒ SAFETY SHOES: Steel or composite toe	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: Fluorescent long sleeve shirt or long sleeve shirt and reflective safety vest.	☒ GLOVES: Cut-resistant gloves ☐ OTHER:

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Mobile Drum Carrier, safety cones, and caution tape

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs

EXCLUSION ZONE (EZ): A 10-foot exclusion zone will be maintained around heavy equipment (i.e. forklift).

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Preparing for and Inspection of Drum	**1a. FALL:** Tripping/falling due to uneven surface. Loose debris/garbage in work area.	1a. Clear area of loose garbage and debris. Inspect 55-gal drums for proper condition, labeling, check drum ring and bolts for tightness, inspect mobile drum carrier. 1a. Do a Test Lift to get a general sense of the weight of the drum. 1a. Inspect and use established pathways to avoid uneven terrain, weather-related hazards (i.e., debris, puddles, ice, etc.), and other obstructions. 1a. Secure work area and coordinate and communicate the planned work activities with other personnel working in the area. 1a. Delineate work area with 42” safety cones.
	1b. CONTACT/EXPOSURE: Drums could potentially be damaged or contain hazardous material. Mobile drum carrier could potentially be in poor working condition causing malfunctioning during operation.	1b. Prior to inspecting drums don cut-resistant gloves. If drum is not properly labeled, do not open and cease all drum transport activities. Immediately contact project manager and inform him/her of drum situation. 1b. Do not continue drum transport activities until further actions are determined by the project manager. 1b. If the drum is properly labeled, but leaking, improperly sealed or in poor condition, place drum in an over-pack drum. 1b. Inspect mobile drum carrier to ensure its overall integrity. Look for rust marks or potential weak points where the drum carrier could malfunction. Inspect the wheels to ensure that they easily turn and nothing is impeding their movement.
	1c. EXERTION/CAUGHT: Potential pinching/exertion hazards while securing ring/ tightening bolts	1c. Keep back straight and knees slightly bent while securing drum ring/tightening bolt. Wear cut-resistant gloves.
2. Position drum clamp tightly in between drum ribs, securing drum clamp to drum with chain	**2a. CAUGHT:** Pinching fingers between drum clamp and handle/chain.	2a. Attach drum clamp with chain and tighten until snug. Do not place hands between drum clamp and drum as the chain is tightened; wear cut resistant gloves. Keep face away from drum when handling in case of escaping vapors.

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift." Avoid general statements such as, "be careful."

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
3. Disengage safety latches on handle, pull handle down until drum is lifted off ground and safety latches are reengaged; slightly suspending drum off the ground	**3a. EXERTION/ CONTACT:** Potential muscle strain associated with lifting/engaging drum/handle. Drum could shift/slip downward and crush toes. **3b. CAUGHT:** Fingers could be pinched while engaging/disengaging safety latches on handle	3a. Ascertain whether the drum is overweight; if it is, then two people are needed to lower handle while drum is secured with clamp so that safety latches can be engaged. Keep body out of the line of fire of the handle (do not position head above handle) as it is being pushed down. Do not allow feet/toes to be positioned under the drum as it is being lifted; wear steel/composite toe boots. 3b. Wear cut-resistant gloves while disengaging/reengaging safety latches. 3b. Avoid placing hands in pinch points.
4. Transport drums to designated location and disengage drum clamp (repeat Step 3 in reverse order)	**4a. FALL:** Tripping/ falling due to obstructions and uneven terrain. Potential for drum to fall during transport.	4a. Ensure transport path is free of potential obstructions that may cause the drum/carrier to become unstable. Position drum clamp between the ribs on the drum to prevent possible slipping.

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JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)	
GENERIC	**Hand Tools**	**Pre-Clearing activities, including Air Knifing and Soil Vacuuming**	
DEVELOPMENT TEAM	**POSITION / TITLE**	**REVIEWED BY:**	**POSITION / TITLE**
Alyssa Lau	Staff Engineer	Daniel Abberton	SHSM
		Mike Ritorto	Senior Hydrogeologist
		Laura Jensen	Staff Hydrogeologist

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES	☐ GOGGLES ☒ FACE SHIELD (while air knifing) ☒ HEARING PROTECTION (as needed) ☒ SAFETY SHOES: Steel or composite toed	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: Fluorescent reflective vest or high visibility clothing	☒ GLOVES: Nitrile and cut resistant ☒ OTHER: Dust mask (as needed)

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Required Equipment: Air Knife, Vactor Truck (Vac Truck), Compressor, Hand Tools, Circular Saw, Dust Mask, Photoionization Detector, Multi-Gas Meter, Traffic Cones, Rigid Barrier, Caution Tape, 20 lb. Fire Extinguisher, “Work Area” and/or “Exclusion Zone” Signs

Commitment to LPS – All personnel onsite will actively participate in SPSA performance by verbalizing SPSAs throughout the day.

EXCLUSION ZONE: A 10 foot exclusion zone will be maintained around air knife and/or soil vacuum operations.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Verify pre-clearance protocol.	1a. **CONTACT**: Underground utility damage; property damage; personal injury. See Site Walk Inspection JSA for potential hazards.	1a. Confirm that local utility companies were contacted prior to drilling. 1a. Walk the Site to evaluate utility markings and review maps (**See Site Walk Inspection JSA for critical actions**). 1a. Review pre-clearing checklist form and sub-surface clearance form. Pre-clearing protocol indicates that clearance must be conducted to a minimum of 5 vertical feet below ground surface or 8 vertical feet below ground surface in the critical zone using hand tools.
2. Mobilize/demobilize and establish work area.	2a. **See Mobilization / Demobilization JSA for potential hazards.**	2a. **See Mobilization / Demobilization JSA for critical actions.**
3. Pre-clear with air knife, water lance, and soil vacuum, and/or clearance with hand tools	3a. **CONTACT**: Flying debris striking face or body	3a. **Maintain 10 foot exclusion zone.** Only (air knife/vac truck) operator and designated helper shall remain within exclusion zone while air knife/vac truck is active. Use the required PPE, including (at a minimum), cut resistant gloves, safety glasses with side shields, and long sleeved shirt. 3a. Wear a face shield to protect face from flying debris when using air knife. 3a. Aim air knife tip away from self and others, so to avoid line-of-fire hazards. 3a. Use anti-whip devices on compressor hoses.
	3b. **EXPOSURE/ENERGY SOURCE**: Inhalation/exposure to hazardous vapors; inhalation/exposure to dust; electrocution.	3b. Monitor breathing zone with a calibrated PID and multi-gas meter. If vapors sustain levels > 5 ppm, the Roux field personnel must temporarily cease work, instruct all Site personnel to step away from the area of elevated readings and inform the Roux Project Manager of the condition. The Roux Project Manager will then recommend additional precautions. 3b. Wear dust masks as needed 3b. Ensure no open flames/heat sources are present within the work area. 3b. No open flames/heat sources. 3b. Ensure vac truck is properly grounded prior to use. 3b. Do not use metal dig bar; use fiberglass or equivalent.
	3c. **CONTACT:** Damage to unknown/known utility with air knife.	3c. Avoid contacting utilities directly with the high pressure air stream and using the air knife tip as a physical digging tool. 3c. Keep the air knife tip constantly moving to reduce direct pressure on a potential utility. 3c. increase the distance between air knife tip and soil/utility. 3c. Continually remove soil slurry from hole with vacuum, which may have an abrasive effect on utility casings.
	3d. **ERGONOMICS** Poor body positioning when handling equipment and materials.	3d. Use proper body positioning and lifting techniques that minimizes muscle strain; keep back straight, lift with legs, keep load close to body, and never reach with a load.

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Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
3. Pre-clearing with air knife and soil vacuum, and/or clearance with hand tools (continued)	3d. **ERGONOMICS**: (continued) Poor body positioning when handling equipment and materials.	3d. Ensure that loads are balanced to reduce the potential for muscle strain. 3d. Two people or a mechanical lifting aid are required when lifting objects over 50 lb. or when the shape makes the object difficult to lift.
	3e. **FALL**: Tripping/falling due to uneven terrain, weather conditions, and materials/equipment stored at the Site.	3e. Inspect walking path for uneven terrain, weather-related hazards (e.g., ice, puddles, snow, etc.), and obstructions prior to mobilizing equipment. 3e. Walk around any stored materials/equipment; do not climb over. Practice good housekeeping. 3e. Use established pathways and walk on stable, secure ground. 3e. Equipment and tools will be stored at the lowest point of potential energy and out of the walkway and immediate work area (i.e., tools should not be propped against walls or nearby equipment or vehicles). 3e. Equipment and tools that are not anticipated to be used will be returned to a storage area that is out of the immediate work area. 3e. Ensure power cords/hoses are grouped when used within the work area. Mark out cords/hoses that cross pathways with traffic cones. 3e. Ensure all Site personnel and equipment stay a minimum of 2 feet from an open hole. Mark out open holes with traffic cones/caution tape, etc. 3e. Pre-cleared location will be finished flush to grade as to prevent a slip/trip hazard.
	3f. **CAUGHT**: Pinch points or amputation points associated with the equipment and vacuum hose.	3f. Always wear cut-resistant gloves when making connections and using hand tools. 3f. Inspect the equipment prior to use for potential pinch points. 3f. Test all emergency shutdown devices prior to using equipment. 3f. Ensure all jewelry is removed, loose clothing is secured, and PPE is secured close to the body. 3f. **All non-essential personnel shall maintain a 10 foot exclusion zone**; position body out of the line-of-fire. 3f. **Drillers and helpers will understand and use the "Show Me Your Hands Policy".**
	3g. **EXPOSURE**: Noise from vac truck and/or air compressor.	3g. Wear hearing protection when vac truck and air compressor are in operation. Otherwise, if sound levels exceed 85 dB, don hearing protection.
4. Move drum to staging area using drum cart.	4a. **EXPOSURE/CONTACT**: Contamination (e.g., Separate Phase Hydrocarbons (SPH), contaminated groundwater, soil).	4a. Wear chemically resistant gloves (i.e., Nitrile; worn in addition to cut resistant gloves). 4a. Do not overfill drums. Ensure that the drum lids are attached securely. 4a. Stage all drums in the designated storage area (per Roux Project Manager) and ensure they are labeled.
	4b. **ERGONOMICS**: Muscle strain while maneuvering drums with drum cart/lift gate.	4b. See 3d. Do not overfill drums. Use lift gate on back of truck to load and unload drums or drum cart to transport drums.
	4c. **CAUGHT**: Pinch points or amputation points associated with handling drum lid.	4c. Ensure that fingers are not placed under the lid of the drum. Wear cut-resistant gloves. Use 15/16" ratchet while sealing drum lid.
5. Decontaminate equipment and tools.	5a. **EXPOSURE/CONTACT**: To contamination (e.g., Separate Phase Hydrocarbons (SPH), contaminated groundwater, vapors).	5a. See 4a. 5a. Contain decontamination water (closed lid) so that it does not spill. 5a. Use an absorbent pad to clean spills, if necessary. 5a. Store all impacted materials/PPE in a designated storage container (per Roux Project Manager) and ensure the container is labeled.
	5b. **EXPOSURE**: To chemicals in cleaning solution.	5b. See 4a.

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Caught - victim is caught on, caught in or caught between objects; Fall - victim falls to ground or lower level (includes slips and trips); Exertion - excessive strain or stress / ergonomics / lifting techniques; Exposure - inhalation/skin hazards; Energy Source – electricity, pressure, compression/tension.
[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

JOB SAFETY ANALYSIS	Ctrl. No. GEN-015	DATE: 1/4/2018	☐NEW ☒REVISED	PAGE 1 of 2

JSA TYPE CATEGORY **GENERIC**	WORK TYPE **Site Recon**	WORK ACTIVITY (Description) **Mobilization/Demobilization**	
DEVELOPMENT TEAM	**POSITION / TITLE**	**REVIEWED BY:**	**POSITION / TITLE**
Rebecca Lowy	Staff Assistant Geologist	Brian Hobbs	Senior Health & Safety Manager
Tally Sodre	OHSM	Joe Gentile	Corporate Health & Safety Manager

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT			
☐ LIFE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES	☐ GOGGLES ☐ FACE SHIELD ☒ HEARING PROTECTION (as needed) ☒ SAFETY SHOES: <u>Steel Toe or composite toe</u>	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: <u>Fluorescent reflective vest of high-visibility clothing; long sleeve shirt; long pants</u>	☒ GLOVES: <u>Leather, nitrile, and cut resistant (as needed)</u> ☐ OTHER

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Required Equipment: None

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs

EXCLUSION ZONE (EZ): A 10-foot exclusion zone will be maintained around equipment in use..

Assess [1]**JOB STEPS**	**Analyze** [2]**POTENTIAL HAZARDS**	**Act** [3]**CRITICAL ACTIONS**
1. Mobilize/demobilize and establish work area	**1a. FALL:** Slip/trips/falls from obstructions, uneven terrain, weather conditions, heavy loads, and/or poor housekeeping.	1a. Use 3 points-of-contact/ensure secure footing when entering and exiting vehicle. 1a. Inspect walking path for uneven terrain, steep hills, obstructions, and/or weather-related hazards (i.e., ice, snow, and puddles) prior to mobilizing equipment. Use established pathways. Walk on stable/secure ground. 1a. Do not climb over stored materials/equipment; walk around. Practice good housekeeping; organize and store equipment neatly in one area at its lowest potential energy. 1a. Wear boots with adequate treads. 1a. Delineate unsafe areas with 42" cones, caution tape and/or flagging.
	1b. CONTACT: Personal injury and/or property damage caused by being struck by Site traffic or equipment used in Site activities.	1b. Observe and maintain the posted speed limits. 1b. When first arriving onsite, park vehicles in designated parking space and/or out of the way locations. Use parking brake on all vehicles and tire chocks on work trucks and trailers. 1b. Check in with Site Manager/Supervisor to ensure coordination with other Site activities and to discuss any special hazards. Ensure that short-service employees (SSE) are identified. 1b. Identify potential traffic sources. 1b. Wear PPE including high visibility clothing or reflective vest. 1b. Use a spotter while moving work vehicles; plan ahead to avoid backing whenever possible. 1b. Maintain a minimum 10' exclusion zone when vehicles are in motion. When backing up truck rig with an attached trailer use a second spotter if there is tight clearance simultaneously on multiple sides of the equipment or if turning angles limit driver-to-spotter visibility. 1b. Delineate work area with 42" cones, flags, caution tape, and/or other barriers. 1b. Position "Work Area" signs at Site entrances, if possible, or at either side of work area.

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift." Avoid general statements such as, "be careful."

Assess ¹JOB STEPS	Analyze ²POTENTIAL HAZARDS	Act ³CRITICAL ACTIONS
		1b. Position largest vehicle to protect against oncoming traffic. 1b. Face traffic, maintain eye contact with oncoming vehicles, use a spotter, and establish a safe exit route. 1b. Observe potential overhead and ground surface features that may interfere with moving equipment. Clear the path of physical hazards prior to initiating mobilization.
	1c. CAUGHT: Personal injury from pinch points and being in line-of-fire of vehicle and/or equipment.	1c. Make sure driver has engaged parking brake and placed wheel chocks in a position to prevent movement. Be sure that vehicle is parked in front/down gradient (positioned to best block oncoming traffic) of work area. 1c. Wear leather gloves when handling any tools or equipment. Wear cut-resistant gloves (Kevlar or similar) when handling sharp objects/cutting tools/glass. 1c. Keep body parts away from line-of-fire of equipment. 1c. Always carry tools by the handles and/or designated carrier. Ensure sharp-edged tools are sheathed/secure. 1c. Remove any loose jewelry. Avoid wearing loose clothing and/or ensure loose clothing is secure. 1c. Secure all items on the equipment, tighten up any items or features that have potential to shift or break during mobilization.
	1d. OVEREXERTION: Muscle strains while lifting/carrying equipment.	1d. Use body positioning and lifting techniques that avoid muscle strain; keep back straight, lift with legs, turn with whole body, keep load close to body, and never reach with a load. 1d. Ensure that loads are balanced. Use assistance (mechanical or additional person) to carry equipment that is either unwieldy or over 50 lbs.
	1e. EXPOSURE: Personal injury from exposure to biological and environmental hazards.	1e. Inspect area to avoid contact with biological hazards (i.e. poisonous plants, stinging insects, ticks, etc.). 1e. Wear long sleeved clothes treated with Permethrin, apply insect repellant containing DEET to exposed skin, and inspect clothes and skin for ticks during and after work. 1e. Apply sunscreen (SPF 15+) if exposure to sun for 30 minutes or more is expected.
	1f. EXPOSURE: Weather related injuries.	1f. Watch for heat stress symptoms (muscle cramping, exhaustion, dizziness, nausea, rapid and shallow breathing). Take breaks in cool places and hydrate as needed. 1f. Watch for cold stress symptoms (severe shivering, slowing of body movement, weakness, stumbling or inability to walk, collapse). Take breaks in warm areas as needed. 1f. Wear clothing appropriate for weather and temperature conditions (e.g., rain jackets, snow pants, multiple layers). 1f. If lightning is observed, wait 30 minutes in a sheltered location (car is acceptable) before resuming work.
	1g. EXPOSURE: Personal injury from noise hazards.	1g. Wear hearing protection if sound levels exceed 85 dBA (if you must raise your voice for normal conversation).

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JOB SAFETYANALYSIS Ctrl. No. GEN-020	DATE: 1/4/2018	☐NEW ☒REVISED	PAGE 1 of 2

JSA TYPE CATEGORY: **GENERIC**	WORK TYPE: **Gauging & Sampling**	WORK ACTIVITY (Description): **Soil Sampling**	
DEVELOPMENT TEAM	**POSITION / TITLE**	**REVIEWED BY:**	**POSITION / TITLE**
MaryBeth Lyons	Project Scientist	Brian Hobbs	Senior Health & Safety Manager
		Joe Gentile	Corporate Health and Safety Manager

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES ☒ FLAME RESISTANT CLOTHING (as needed)	☐ GOGGLES ☐ FACE SHIELD: ☒ HEARING PROTECTION: (as needed) ☒ SAFETY SHOES: Composite-toe or steel toe boots	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: Fluorescent reflective vest or high visibility clothing	☒ GLOVES: Leather, Nitrile and cut resistant ☒ OTHER: Insect repellant, sunscreen (as needed)

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Recommended Equipment: 42” traffic cones, caution tape, trowel

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs.

EXCLUSION ZONE (EZ): A 10-foot exclusion zone will be maintained around moving equipment, if present.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Secure location	**1a. CONTACT:** Personnel and vehicular traffic may enter the work area.	1a. If in an area with foot or vehicle traffic, delineate the work area with 42” traffic cones and/or caution tape to prevent exposure to traffic and inform others of work activity. 1a. Wear reflective vest and/or high visibility clothing. 1a. Face the direction of any vehicular traffic. Position vehicle to protect worker from traffic. 1a. Communicate work activity with adjacent work areas.
	1b. FALL: Tripping/falling due to uneven terrain or entry/exit from excavations.	1b. Inspect pathways and work area for uneven terrain, weather-related hazards (i.e., ice, puddles, snow, etc.), and obstructions. 1b. Use established pathways and walk on stable, secure ground. 1b. Stage equipment and tools in a convenient, stable, and orderly manner. Store equipment at lowest potential energy. 1b. Roux employees should stay 5 feet from in-progress excavations and trenches. Should entry to an excavation be required (when stabilization is complete), ladders must be employed for steep embankments, excavations, pits, and trenches.
	1c. EXPOSURE: Exposure to sun and excessive heat, possibly causing sunburn, heat exhaustion or heat stroke. Exposure to cold temperatures possibly causing cold stress. Skin burn as a result of fire, if applicable. Exposure to explosive vapors due to tank farm operations. Exposure to airborne dust due to high wind speeds. Biological hazards - ticks, bees/wasps, poison ivy, thorns, insects, etc.	1c. Wear sunscreen with an SPF 15 or greater whenever 30 minutes or more of exposure is expected. 1c. Use a tent to shade the work area from direct sunlight particularly when warm temperatures are expected. 1c. Be aware of the location of all Site personnel. 1c. Watch for heat stress symptoms (muscle cramping, exhaustion, dizziness, rapid and shallow breathing). 1c. Watch for cold stress symptoms (severe shivering, slowing of body movement, weakness, stumbling or inability to walk, collapse). 1c. Take breaks for rest and water as necessary. Move to an area that is well shaded or a climate controlled area (i.e., car, site trailer, etc.). 1c. No open flames/heat sources. 1c. Flame retardant clothing must be worn when specified by Site policy. 1c. Cell phones should be disabled when specified by Site policy. 1c. Pre-treat field clothing with Permethrin prior to site visit to kill ticks and insects. 1c. Wear long sleeved shirts and tuck in (or tape) pant legs into socks or boots to prevent ticks from reaching skin. 1c. Spray insect repellant containing DEET on exposed skin when working in overgrown areas of the Site. 1c. Inspect area to avoid contact with biological hazards. 1c. Wear cut-resistant gloves when handling branches, shrubs, etc. that may lie within the walking path. 1c. Wear spoggles if the average wind speeds are above 15 mph. 1c. Personnel shall examine themselves and co-worker’s outer clothing for ticks periodically when onsite. 1c. If skin comes in contact with poison ivy, wash skin thoroughly with soap and water. If rash persists after washing, immediately notify your supervisor, the OM and OHSM for possible consultation with a physician at an approved Occupational Health Clinic.

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Caught - victim is caught on, caught in or caught between objects; Fall - victim falls to ground or lower level (includes slips and trips); Exertion - excessive strain or stress / ergonomics / lifting techniques; Exposure - inhalation/skin hazards; Energy Source – electricity, pressure, compression/tension.
[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
2. Collect Soil Sample	**2a. CONTACT:** Personal injury from pinch points, cuts, and abrasions from sampling equipment tools, and material within soil sample. Personal injury from contact with moving equipment while sampling. Personal injury from contact with glass sample jars.	2a. Wear cut-resistant (i.e., Kevlar) gloves under chemical-resistant (nitrile) disposable gloves when handling soil samples and sampling jars. 2a. Where possible, use trowel or equivalent tool to avoid contact with soil. 2a. If sampling from bucket of heavy equipment, ensure all equipment is off and operator utilizes the "show me your hands" policy. 2a. See 1a.
	2b. EXPOSURE: Exposure to contamination (impacted soil) and/or lab preservatives.	2b. Wear chemical-resistant (nitrile) disposable gloves over cut resistant gloves to protect hands when handling samples; use containment material or plastic sheeting to protect surrounding areas. 2b. Wear safety glasses to protect eyes from dust or air-borne contaminants that may results from disturbing the soil. 2b. Where possible, remain upgradient from sample location if collecting soil sample from stockpile, drill rig, etc. to avoid breathing contaminant vapors, if they are present. 2b. When collecting soil sample from hand auger, put large zip lock bag over entire auger to prevent spillage of soil on to the ground. 2b. Open sample jars slowly and fill carefully to avoid contact with preservatives.
	2c. EXERTION: Exertion due to repetitive motion and ergonomics.	2c. Utilize a table or raised surface for soil sampling if multiple soil samples are going to be taken to minimize repetitive bending motion.
3. Decontaminate equipment	**3a. EXPOSURE/CONTACT:** Contamination (e.g., Separate Phase Hydrocarbons (SPH), contaminated vapors and/or soil). **3b. EXPOSURE:** Chemicals in cleaning solution including ammonia.	3a. Wear chemical-resistant (nitrile) disposable gloves and safety glasses. 3a. Use an absorbent pad to clean spills. 3a. Properly dispose of used materials/PPE in provided drums in designated drum storage area. 3a. Remain upwind of sample and avoid breathing contaminant vapors, if they are present. 3b. Wear chemical-resistant (nitrile) disposable gloves and safety glasses. 3b. Work on the upwind side of decontamination area. 3b. Use an absorbent pad to clean spills. 3b. Properly dispose of used materials/PPE in provided drums in designated drum storage area. Ensure that all drums are properly labeled and secured.

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JOB SAFETY ANALYSIS Ctrl. No. GEN-021	DATE: 1/4/2018	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY: **GENERIC**	WORK TYPE **Gauging and Sampling**	WORK ACTIVITY (Description) **Soil Vapor Sampling (Permanent Monitoring Points)**	
DEVELOPMENT TEAM	**POSITION / TITLE**	**REVIEWED BY:**	**POSITION / TITLE**
Jeff Wills	Project Hydrogeologist	Brian Hobbs	Senior Health & Safety Manager
Julie Moriarity	Project Scientist	Joe Gentile	Corporate Health and Safety Manager
REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT			
☐ LIFE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES	☐ GOGGLES ☐ FACE SHIELD ☐ HEARING PROTECTION ☒ SAFETY SHOES: Steel-toe boots	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: Fluorescent reflective vest or high visibility clothing	☒ GLOVES: Cut-resistant & Nitriles ☒ OTHER: Bug Spray, Sun Screen, Knee Pads or kneeling pad
REQUIRED AND / OR RECOMMENDED EQUIPMENT			
9/16" Socket and Wrench, Non-Toxic Clay, Teflon-Lined Tubing, Masterflex Tubing, Air Pump with Low Flow, Dry Cal, Enclosure (Bucket with 2 holes), Helium Gas Canister, Summa Canisters and Flow Controllers, MultiRae Photo Ionization Detector (PID), Helium Detector, Tubing Cutter, 42-inch Safety Cones, Caution Tape or Retractable Cone Bars			
COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs.			
EXCLUSION ZONE (EZ): A 5-foot exclusion zone will be maintained for non-essential personnel.			

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

Assess ¹JOB STEPS	Analyze ²POTENTIAL HAZARDS	Act ³CRITICAL ACTIONS
1. Define and secure work area.	**1a. FALL:** Potential tripping hazards. **1b. CONTACT:** Potential contact with moving vehicles or pedestrians. **1c. EXERTION:** Muscle strain while lifting and carrying equipment.	1a. Ensure work area is secure and inform others (third party) of work activity. 1a. Remove tripping hazards and inspect walking path for uneven terrain, weather-related hazards (i.e., ice, puddles, snow, etc.), and obstructions prior to mobilizing equipment. 1b. If working alongside roads, look both ways before entering roadways, face traffic, and utilize work vehicle to protect employees. 1b. Delineate work area (including vehicles) with traffic safety cones and caution tape or retractable cone bars. 1b. Maintain a 5-foot exclusion zone. 1b. Wear high visibility clothing or reflective safety vest. 1c. When carrying equipment to/from work area, keep back straight, lift with legs, keep load close to body, never reach with a load. Ensure that loads are balanced. Use mechanical assistance/make multiple trips to carry equipment.

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Assess ¹JOB STEPS	Analyze ²POTENTIAL HAZARDS	Act ³CRITICAL ACTIONS
2. Remove well cover / close well cover.	**2a. CONTACT/CAUGHT:** Pinch points and scrapes associated with hand tools and well covers. **2b. FALL:** Potential tripping hazards associated with installing bolts. **2c. EXERTION:** Physical exertion to remove bolts that were over torqued or stripped.	2a. Keep hands away from pinch points. 2a. Use hand tools with extensions to remove and replace well covers. 2a. Wear cut-resistant gloves. 2a. Use knee pads or kneeling pad when repetitive kneeling on rough ground is anticipated. 2b. Place security bolts in secure location so not to create tripping hazards. Replace security bolts so that they fit flush with monitoring well covers. 2c. Replace any security bolts that show signs of stripping. Do not over tighten. 2c. Use body positioning and bending techniques that minimize muscle strain; keep back straight, bend at the knees. 2c. See 2a.
3. Screen vapor point with PID.	**3a. FALL:** Potential tripping hazards associated with equipment. **3b. EXPOSURE:** Inhalation of soil vapor	3a. Place equipment in one area close to the sampling location. 3b. Identify area where equipment is to be stored within the work area (away from main walking path). 3a. Don't leave equipment on the ground. Return equipment to storage area between uses. 3b. Replace brass caps immediately upon completion to avoid soil vapors migrating to the surface through sample tubing. 3b. Stand upwind of sample point during screening activities.
4. Remove / replace brass caps at the end of the sam`ple tubing.	**4a. CONTACT:** Pinch points associated with hand tools and brass caps. **4b. EXPOSURE:** Potential pathway for vapors to migrate to land surface.	4a. Use wrench to remove and replace brass caps. 4a. Wear cut-resistant gloves to protect against pinch points and scrapes. 4b. See 3b. 4b. Stand up wind of sample point location.
5. Set up soil vapor sampling equipment and calibration of meters.	**5a. FALL:** Potential tripping hazards associated with equipment and tubing.5b. **5b. CONTACT:** Pinch points associated with handling equipment. **5c. EXPOSURE:** Inhalation of calibration gas and helium.	5a. See 3a. 5a. Keep tubing slack to a minimum and locate the summa canister as close to the sampling location as possible. 5a. Avoid stepping over equipment and tubing. 5b. Do not place fingers/hands under sampling equipment. 5b. Make multiple trips when unloading equipment in work area. 5b. Wear cut-resistant gloves to protect against pinch points while handling sampling equipment. 5c. Review SDS for each type of calibration gas used before calibrating. 5c. Calibrate meters in a well-ventilated area and keep air flow regulator away from face. 5c. Close valve on canisters after use to avoid inhalation of excess helium or calibration gas. 5c. Stand up wind of bucket during helium tracer gas test.

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
6. Cleaning Work Area.	**6a. FALL:** Potential tripping hazards associated with equipment and tubing. **6b. CONTACT:** Storing and transport of equipment in car.	6a. See 3a. 6a. See 3b. 6b. Ensure that equipment is placed securely in the vehicle. Do not stack equipment on top of each other. Secure equipment so that it will not slide while being transported. 6b. Wear cut-resistant gloves while handling/loading equipment.

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

APPENDIX B

Safety Data Sheets (SDSs) for Chemicals Used

Safety Data Sheet

according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), 29CFR1910/1200 and GHS Rev. 3

Effective date: 12.08.2015 **Revision** : 12.10.2015

Trade Name: Alconox

1 Identification of the substance/mixture and of the supplier

1.1 Product identifier

Trade Name: Alconox
Synonyms:
Product number: Alconox

1.2 Application of the substance / the mixture : Cleaning material/Detergent

1.3 Details of the supplier of the Safety Data Sheet

Manufacturer	**Supplier**
Alconox, Inc. 30 Glenn Street White Plains, NY 10603 1-914-948-4040	Not Applicable

Emergency telephone number:
ChemTel Inc
North America: 1-800-255-3924
International: 01-813-248-0585

2 Hazards identification

2.1 Classification of the substance or mixture:

In compliance with EC regulation No. 1272/2008, 29CFR1910/1200 and GHS Rev. 3 and amendments.

Hazard-determining components of labeling:
Tetrasodium Pyrophosphate
Sodium tripolyphosphate
Sodium Alkylbenzene Sulfonate

2.2 Label elements:

Skin irritation, category 2.
Eye irritation, category 2A.

Hazard pictograms:

Signal word: Warning

Hazard statements:
H315 Causes skin irritation.
H319 Causes serious eye irritation.

Precautionary statements:
P264 Wash skin thoroughly after handling.
P280 Wear protective gloves/protective clothing/eye protection/face protection.
P302+P352 If on skin: Wash with soap and water.
P305+P351+P338 If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing.
P321 Specific treatment (see supplemental first aid instructions on this label).
P332+P313 If skin irritation occurs: Get medical advice/attention.
P362 Take off contaminated clothing and wash before reuse.
P501 Dispose of contents and container as instructed in Section 13.

Safety Data Sheet

according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), 29CFR1910/1200 and GHS Rev. 3

Effective date: 12.08.2015 **Revision** : 12.10.2015

Trade Name: Alconox

Additional information: None.

Hazard description

Hazards Not Otherwise Classified (HNOC): None

Information concerning particular hazards for humans and environment:

The product has to be labelled due to the calculation procedure of the "General Classification guideline for preparations of the EU" in the latest valid version.

Classification system:

The classification is according to EC regulation No. 1272/2008, 29CFR1910/1200 and GHS Rev. 3 and amendments, and extended by company and literature data. The classification is in accordance with the latest editions of international substances lists, and is supplemented by information from technical literature and by information provided by the company.

3 Composition/information on ingredients

3.1 Chemical characterization : None

3.2 Description : None

3.3 Hazardous components (percentages by weight)

Identification	Chemical Name	Classification	Wt. %
CAS number: 7758-29-4	Sodium tripolyphosphate	Skin Irrit. 2 ; H315 Eye Irrit. 2; H319	12-28
CAS number: 68081-81-2	Sodium Alkylbenzene Sulfonate	Acute Tox. 4; H303 Skin Irrit. 2 ; H315 Eye Irrit. 2; H319	8-22
CAS number: 7722-88-5	Tetrasodium Pyrophosphate	Skin Irrit. 2 ; H315 Eye Irrit. 2; H319	2-16

3.4 Additional Information : None.

4 First aid measures

4.1 Description of first aid measures

General information: None.

After inhalation:

Maintain an unobstructed airway.
Loosen clothing as necessary and position individual in a comfortable position.

After skin contact:

Wash affected area with soap and water.
Seek medical attention if symptoms develop or persist.

After eye contact:

Rinse/flush exposed eye(s) gently using water for 15-20 minutes.
Remove contact lens(es) if able to do so during rinsing.
Seek medical attention if irritation persists or if concerned.

After swallowing:

Rinse mouth thoroughly.
Seek medical attention if irritation, discomfort, or vomiting persists.

4.2 Most important symptoms and effects, both acute and delayed

None

4.3 Indication of any immediate medical attention and special treatment needed:

No additional information.

5 Firefighting measures

5.1 Extinguishing media

Suitable extinguishing agents:
Use appropriate fire suppression agents for adjacent combustible materials or sources of ignition.

For safety reasons unsuitable extinguishing agents : None

5.2 Special hazards arising from the substance or mixture :
Thermal decomposition can lead to release of irritating gases and vapors.

5.3 Advice for firefighters

Protective equipment:
Wear protective eye wear, gloves and clothing.
Refer to Section 8.

5.4 Additional information :
Avoid inhaling gases, fumes, dust, mist, vapor and aerosols.
Avoid contact with skin, eyes and clothing.

6 Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures :
Ensure adequate ventilation.
Ensure air handling systems are operational.

6.2 Environmental precautions :
Should not be released into the environment.
Prevent from reaching drains, sewer or waterway.

6.3 Methods and material for containment and cleaning up :
Wear protective eye wear, gloves and clothing.

6.4 Reference to other sections : None

7 Handling and storage

7.1 Precautions for safe handling :
Avoid breathing mist or vapor.
Do not eat, drink, smoke or use personal products when handling chemical substances.

7.2 Conditions for safe storage, including any incompatibilities :
Store in a cool, well-ventilated area.

7.3 Specific end use(s):

No additional information.

Safety Data Sheet

according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), 29CFR1910/1200 and GHS Rev. 3

Effective date: 12.08.2015 **Revision** : 12.10.2015

Trade Name: Alconox

8 Exposure controls/personal protection

8.1 Control parameters :

7722-88-5, Tetrasodium Pyrophosphate, OSHA TWA 5 mg/m3.

8.2 Exposure controls

Appropriate engineering controls:

Emergency eye wash fountains and safety showers should be available in the immediate vicinity of use or handling.

Respiratory protection:

Not needed under normal conditions.

Protection of skin:

Select glove material impermeable and resistant to the substance.

Eye protection:

Safety goggles or glasses, or appropriate eye protection.

General hygienic measures:

Wash hands before breaks and at the end of work.

Avoid contact with skin, eyes and clothing.

9 Physical and chemical properties

Appearance (physical state, color):	White and cream colored flakes - powder	**Explosion limit lower**: **Explosion limit upper**:	Not determined or not available. Not determined or not available.
Odor:	Not determined or not available.	**Vapor pressure at 20°C**:	Not determined or not available.
Odor threshold:	Not determined or not available.	**Vapor density**:	Not determined or not available.
pH-value:	9.5 (aqueous solution)	**Relative density**:	Not determined or not available.
Melting/Freezing point:	Not determined or not available.	**Solubilities**:	Not determined or not available.
Boiling point/Boiling range:	Not determined or not available.	**Partition coefficient (n-octanol/water)**:	Not determined or not available.
Flash point (closed cup):	Not determined or not available.	**Auto/Self-ignition temperature**:	Not determined or not available.
Evaporation rate:	Not determined or not available.	**Decomposition temperature**:	Not determined or not available.

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Trade Name: Alconox

Flammability (solid, gaseous):	Not determined or not available.	**Viscosity**:	a. Kinematic: Not determined or not available. b. Dynamic: Not determined or not available.
Density at 20°C:	Not determined or not available.		

10 Stability and reactivity

10.1 Reactivity : None

10.2 Chemical stability : None

10.3 Possibility hazardous reactions : None

10.4 Conditions to avoid : None

10.5 Incompatible materials : None

10.6 Hazardous decomposition products : None

11 Toxicological information

11.1 Information on toxicological effects :

Acute Toxicity:

Oral:

: LD50 > 5000 mg/kg oral rat - Product .

Chronic Toxicity: No additional information.

Skin corrosion/irritation:

Sodium Alkylbenzene Sulfonate: Causes skin irritation. .

Serious eye damage/irritation:

Sodium Alkylbenzene Sulfonate: Causes serious eye irritation .

Tetrasodium Pyrophosphate: Rabbit - Risk of serious damage to eyes .

Respiratory or skin sensitization: No additional information.

Carcinogenicity: No additional information.

IARC (International Agency for Research on Cancer): None of the ingredients are listed.

NTP (National Toxicology Program): None of the ingredients are listed.

Germ cell mutagenicity: No additional information.

Reproductive toxicity: No additional information.

STOT-single and repeated exposure: No additional information.

Additional toxicological information: No additional information.

12 Ecological information

12.1 Toxicity:

Sodium Alkylbenzene Sulfonate: Fish, LC50 1.67 mg/l, 96 hours.
Sodium Alkylbenzene Sulfonate: Aquatic invertebrates, EC50 Daphnia 2.4 mg/l, 48 hours.
Sodium Alkylbenzene Sulfonate: Aquatic Plants, EC50 Algae 29 mg/l, 96 hours.
Tetrasodium Pyrophosphate: Fish, LC50 - other fish - 1,380 mg/l - 96 h.
Tetrasodium Pyrophosphate: Aquatic invertebrates, EC50 - Daphnia magna (Water flea) - 391 mg/l - 48 h.

12.2 Persistence and degradability: No additional information.

12.3 Bioaccumulative potential: No additional information.

12.4 Mobility in soil: No additional information.

General notes: No additional information.

12.5 Results of PBT and vPvB assessment:

PBT: No additional information.

vPvB: No additional information.

12.6 Other adverse effects: No additional information.

13 Disposal considerations

13.1 Waste treatment methods (consult local, regional and national authorities for proper disposal)

Relevant Information:

It is the responsibility of the waste generator to properly characterize all waste materials according to applicable regulatory entities. (US 40CFR262.11).

14 Transport information

14.1 UN Number: ADR, ADN, DOT, IMDG, IATA	None
14.2 UN Proper shipping name: ADR, ADN, DOT, IMDG, IATA	None
14.3 Transport hazard classes: ADR, ADN, DOT, IMDG, IATA	**Class:** None **Label:** None **LTD. QTY:** None

US DOT
Limited Quantity Exception: None

Bulk:	**Non Bulk:**
RQ (if applicable): None	**RQ (if applicable):** None
Proper shipping Name: None	**Proper shipping Name:** None
Hazard Class: None	**Hazard Class:** None
Packing Group: None	**Packing Group:** None
Marine Pollutant (if applicable): No additional information.	**Marine Pollutant (if applicable):** No additional information.

Safety Data Sheet
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	Comments: None	**Comments:** None
14.4	**Packing group:** ADR, ADN, DOT, IMDG, IATA	None
14.5	**Environmental hazards** :	None
14.6	**Special precautions for user:**	None
	Danger code (Kemler):	None
	EMS number:	None
	Segregation groups:	None
14.7	**Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code:** Not applicable.	
14.8	**Transport/Additional information:**	
	Transport category:	None
	Tunnel restriction code:	None
	UN "Model Regulation":	None

15 Regulatory information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture.

North American

SARA

Section 313 (specific toxic chemical listings): None of the ingredients are listed.
Section 302 (extremely hazardous substances): None of the ingredients are listed.

CERCLA (Comprehensive Environmental Response, Clean up and Liability Act) Reportable

Spill Quantity: None of the ingredients are listed.

TSCA (Toxic Substances Control Act):

Inventory: All ingredients are listed.
Rules and Orders: Not applicable.

Proposition 65 (California):

Chemicals known to cause cancer: None of the ingredients are listed.

Chemicals known to cause reproductive toxicity for females: None of the ingredients are listed.

Chemicals known to cause reproductive toxicity for males: None of the ingredients are listed.

Chemicals known to cause developmental toxicity: None of the ingredients are listed.

Canadian

Canadian Domestic Substances List (DSL):
All ingredients are listed.

EU

REACH Article 57 (SVHC): None of the ingredients are listed.

Germany MAK: Not classified.

Asia Pacific

Australia

Australian Inventory of Chemical Substances (AICS): All ingredients are listed.

China

Inventory of Existing Chemical Substances in China (IECSC): All ingredients are listed.

Japan

Inventory of Existing and New Chemical Substances (ENCS): All ingredients are listed.

Korea

Existing Chemicals List (ECL): All ingredients are listed.

New Zealand

New Zealand Inventory of Chemicals (NZOIC): All ingredients are listed.

Philippines

Philippine Inventory of Chemicals and Chemical Substances (PICCS): All ingredients are listed.

Taiwan

Taiwan Chemical Substance Inventory (TSCI): All ingredients are listed.

16 Other information

Abbreviations and Acronyms: None

Summary of Phrases

Hazard statements:

H315 Causes skin irritation.
H319 Causes serious eye irritation.

Precautionary statements:

P264 Wash skin thoroughly after handling.
P280 Wear protective gloves/protective clothing/eye protection/face protection.
P302+P352 If on skin: Wash with soap and water.
P305+P351+P338 If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing.
P321 Specific treatment (see supplemental first aid instructions on this label).
P332+P313 If skin irritation occurs: Get medical advice/attention.
P362 Take off contaminated clothing and wash before reuse.
P501 Dispose of contents and container as instructed in Section 13.

Manufacturer Statement:

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

NFPA: 1-0-0

Safety Data Sheet

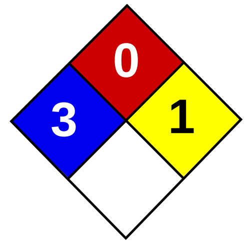
according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), 29CFR1910/1200 and GHS Rev. 3

Effective date: 12.08.2015 **Revision** : 12.10.2015

Trade Name: Alconox

HMIS: 1-0-0

Science Lab.com
Chemicals & Laboratory Equipment



Health	3
Fire	0
Reactivity	1
Personal Protection	

Material Safety Data Sheet
Hydrochloric acid MSDS

Section 1: Chemical Product and Company Identification

Product Name: Hydrochloric acid

Catalog Codes: SLH1462, SLH3154

CAS#: Mixture.

RTECS: MW4025000

TSCA: TSCA 8(b) inventory: Hydrochloric acid

CI#: Not applicable.

Synonym: Hydrochloric Acid; Muriatic Acid

Chemical Name: Not applicable.

Chemical Formula: Not applicable.

Contact Information:

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

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

Order Online: ScienceLab.com

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

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

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

Section 2: Composition and Information on Ingredients

Composition:

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

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

Section 3: Hazards Identification

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

Potential Chronic Health Effects:
Slightly hazardous in case of skin contact (sensitizer). CARCINOGENIC EFFECTS: Classified 3 (Not classifiable for human.) by IARC [Hydrochloric acid]. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance may be toxic to kidneys, liver, mucous membranes, upper respiratory tract, skin, eyes, Circulatory System, teeth. Repeated or prolonged exposure to the substance can produce target

organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation. Repeated or prolonged exposure to spray mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

Section 4: First Aid Measures

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

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

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

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

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

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

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion: Not available.

Fire Hazards in Presence of Various Substances: of metals

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

Fire Fighting Media and Instructions: Not applicable.

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

Special Remarks on Explosion Hazards:

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

Section 6: Accidental Release Measures

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

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

Section 7: Handling and Storage

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

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

Section 8: Exposure Controls/Personal Protection

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

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

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

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

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid.

Odor: Pungent. Irritating (Strong.)

Taste: Not available.

Molecular Weight: Not applicable.

Color: Colorless to light yellow.

pH (1% soln/water): Acidic.

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

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

Critical Temperature: Not available.

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

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

Vapor Density: 1.267 (Air = 1)

Volatility: Not available.

Odor Threshold: 0.25 to 10 ppm

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water, diethyl ether.

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

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Incompatible materials, water

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

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

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

Special Remarks on Corrosivity:

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

Polymerization: Will not occur.

Section 11: Toxicological Information

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

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

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

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

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

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

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

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

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

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

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:

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

Section 14: Transport Information

DOT Classification: Class 8: Corrosive material

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

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

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

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

Other Classifications:

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

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

HMIS (U.S.A.):

Health Hazard: 3

Fire Hazard: 0

Reactivity: 1

Personal Protection:

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

Health: 3

Flammability: 0

Reactivity: 1

Specific hazard:

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

Section 16: Other Information

References:

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

Other Special Considerations: Not available.

Created: 10/09/2005 05:45 PM

Last Updated: 05/21/2013 12:00 PM

MATERIAL SAFETY DATA SHEET

Prepared to U.S. OSHA, CMA, ANSI and Canadian WHMIS Standards

NFPA RATING

FLAMMABILITY: 4
HEALTH: 1
REACTIVITY: 0
OTHER

PART I *What is the material and what do I need to know in an emergency?*

1. PRODUCT IDENTIFICATION

CHEMICAL NAME; CLASS:	**ISOBUTYLENE - C_4H_8** Document Number: Isobutylene
PRODUCT USE:	For general analytical/synthetic chemical uses.
SUPPLIER/MANUFACTURER'S NAME: ADDRESS:	MESA Specialty Gases & Equipment 3619 Pendleton Avenue, Suite C Santa Ana, CA 92704
BUSINESS PHONE: EMERGENCY PHONE:	1-714-434-7102 INFOTRAC: 1-800-535-5053
DATE OF PREPARATION:	May 10, 1999

2. COMPOSITION and INFORMATION ON INGREDIENTS

CHEMICAL NAME	CAS #	mole %	EXPOSURE LIMITS IN AIR					
			ACGIH		OSHA			
			TLV ppm	STEL ppm	PEL ppm	STEL ppm	IDLH ppm	OTHER
Isobutylene	115-11-7	> 99.0%	There are no specific exposure limits for Isobutylene. Isobutylene is a simple asphyxiant (SA). Oxygen levels should be maintained above 19.5%.					
Maximum Impurities		< 1.0%	None of the trace impurities in this mixture contribute significantly to the hazards associated with the product. All hazard information pertinent to this product has been provided in this Material Safety Data Sheet, per the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200) and State equivalent standards.					

NE = Not Established C = Ceiling Limit See Section 16 for Definitions of Terms Used

NOTE: All WHMIS required information is included. It is located in appropriate sections based on the ANSI Z400.1-1993 format.

3. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW: Isobutylene is a colorless, liquefied, flammable gas with an unpleasant odor similar to burning coal. The liquefied gas rapidly turns into a gas at standard atmospheric temperatures and pressures. Isobutylene is an asphyxiant and presents a significant health hazard by displacing the oxygen in the atmosphere. Rapid evaporation of liquid from the cylinder may cause frostbite. Both the liquid and gas pose a serious fire hazard when accidentally released. The gas is heavier than air and may travel to a source of ignition and flash back to a leak or open container. Flame or high temperature impinging on a localized area of a cylinder of Isobutylene can cause the cylinder to rupture without activating the cylinder's relief devices. Provide adequate fire protection during emergency response situations.

SYMPTOMS OF OVEREXPOSURE BY ROUTE OF EXPOSURE: The most significant route of overexposure for this gas is by inhalation. The following paragraphs describe symptoms of exposure by route of exposure.

INHALATION: High concentrations of this gas can cause an oxygen-deficient environment. Individuals breathing such an atmosphere may experience symptoms which include headaches, ringing in ears, dizziness, drowsiness, unconsciousness, nausea, vomiting, and depression of all the senses. Under some circumstances of overexposure, death may occur. Isobutylene also has some degree of anesthetic action and can be mildly irritating to the mucous membranes. The effects associated with various levels of oxygen are as follows:

CONCENTRATION	**SYMPTOMS OF EXPOSURE**
12-16% Oxygen:	Breathing and pulse rate increased, muscular coordination slightly disturbed.
10-14% Oxygen:	Emotional upset, abnormal fatigue, disturbed respiration.
6-10% Oxygen:	Nausea and vomiting, collapse or loss of consciousness.
Below 6%:	Convulsive movements, possible respiratory collapse, and death.

OTHER POTENTIAL HEALTH EFFECTS: Contact with liquid or rapidly expanding gases (which are released under high pressure) may cause frostbite. Symptoms of frostbite include change in skin color to white or grayish-yellow. The pain after such contact can quickly subside.

HAZARDOUS MATERIAL INFORMATION SYSTEM

HEALTH	(BLUE)	1
FLAMMABILITY	(RED)	4
REACTIVITY	(YELLOW)	0
PROTECTIVE EQUIPMENT		B

EYES	RESPIRATORY	HANDS	BODY
	See Section 8		See Section 8

For routine industrial applications

See Section 16 for Definition of Ratings

HEALTH EFFECTS OR RISKS FROM EXPOSURE: An Explanation in **Lay Terms**. Overexposure to Isobutylene may cause the following health effects:

ACUTE: The most significant hazard associated with this gas is inhalation of oxygen-deficient atmospheres. Symptoms of oxygen deficiency include respiratory difficulty, headache, dizziness, and nausea. At high concentrations, unconsciousness or death may occur. Contact with liquefied gas or rapidly expanding gases may cause frostbite.

CHRONIC: There are currently no known adverse health effects associated with chronic exposure to Isobutylene.

TARGET ORGANS: Respiratory system.

PART II *What should I do if a hazardous situation occurs?*

4. FIRST-AID MEASURES

RESCUERS SHOULD NOT ATTEMPT TO RETRIEVE VICTIMS OF EXPOSURE TO ISOBUTYLENE WITHOUT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT. At a minimum, Self-Contained Breathing Apparatus and Fire-Retardant Personal Protective equipment should be worn. Adequate fire protection must be provided during rescue situations.

4. FIRST-AID MEASURES (Continued)

Remove victim(s) to fresh air as quickly as possible. Trained personnel should administer supplemental oxygen and/or cardio-pulmonary resuscitation, if necessary. Only trained personnel should administer supplemental oxygen.

In case of frostbite, place the frostbitten part in warm water. DO NOT USE HOT WATER. If warm water is not available, or is impractical to use, wrap the affected parts gently in blankets. Alternatively, if the fingers or hands are frostbitten, place the affected area in the armpit. Encourage victim to gently exercise the affected part while being warmed. Seek immediate medical attention.

Victim(s) must be taken for medical attention. Rescuers should be taken for medical attention, if necessary. Take copy of label and MSDS to physician or other health professional with victim(s).

5. FIRE-FIGHTING MEASURES

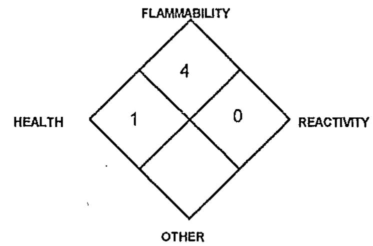
FLASH POINT (Closed Cup): -10°C (< 14°F)
AUTOIGNITION TEMPERATURE: 465°C (869°F)
FLAMMABLE LIMITS (in air by volume, %):

Lower (LEL): 1.8%
Upper (UEL): 9.6%

FIRE EXTINGUISHING MATERIALS: Extinguish Isobutylene fires by shutting off the source of the gas. Use water spray or a foam agent to cool fire-exposed containers, structures, and equipment.

UNUSUAL FIRE AND EXPLOSION HAZARDS: When involved in a fire, this material may ignite and produce toxic gases, including carbon monoxide and carbon dioxide.

NFPA RATING



See Section 16 for Definition of Ratings

DANGER! Fires impinging (direct flame) on the outside surface of unprotected pressure storage vessels of Isobutylene can be very dangerous. Direct flame exposure on the cylinder wall can cause an explosion either by BLEVE (Boiling Liquid Expanding Vapor Explosion), or by exothermic decomposition. This is a catastrophic failure of the vessel releasing the contents into a massive fireball and explosion. The resulting fire and explosion can result in severe equipment damage and personnel injury or death over a large area around the vessel. For massive fires in large areas, use unmanned hose holder or monitor nozzles; if this is not possible, withdraw from area and allow fire to burn.

Explosion Sensitivity to Mechanical Impact: Not sensitive.
Explosion Sensitivity to Static Discharge: Static discharge may cause Isobutylene to ignite explosively if released.

SPECIAL FIRE-FIGHTING PROCEDURES: Structural firefighters must wear Self-Contained Breathing Apparatus and full protective equipment. The best fire-fighting technique may be simply to let the burning gas escape from the pressurized cylinder, tank car, or pipeline. Stop the leak before extinguishing fire. If the fire is extinguished before the leak is sealed, the leaking gas could explosively re-ignite without warning and cause extensive damage, injury, or fatality. In this case, increase ventilation (in enclosed areas) to prevent flammable or explosive mixture formation. Structural firefighters must wear Self-Contained Breathing Apparatus and full protective equipment. Because of the potential for a BLEVE, evacuation of non-emergency personnel is essential. If water is not available for cooling or protection of vessel exposures, evacuate the area. Refer to the North American Emergency Response Guidebook for additional information. Other information for pre-planning can be found in the American Petroleum Institute Publications 2510 and 2510A.

6. ACCIDENTAL RELEASE MEASURES

SPILL AND LEAK RESPONSE: Uncontrolled releases should be responded to by trained personnel using pre-planned procedures. Proper protective equipment should be used. In case of a release, clear the affected area, protect people, and respond with trained personnel. Adequate fire protection must be provided. Minimum Personal Protective Equipment should be **Level B: fire-retardant protective clothing, gloves resistant to tears, and Self-Contained Breathing Apparatus.**

Use only non-sparking tools and equipment. Locate and seal the source of the leaking gas. Protect personnel attempting the shut off with water spray. Allow the gas to dissipate. Monitor the surrounding area for combustible gas levels and oxygen. Combustible gas concentration must be below 10% of the LEL (LEL = 1.8%) prior to entry. The atmosphere must have at least 19.5 percent oxygen before personnel can be allowed in the area without Self-Contained Breathing Apparatus. Attempt to close the main source valve prior to entering the area. If this does not stop the release (or if it is not possible to reach the valve), allow the gas to release in place or remove it to a safe area and allow the gas to be released there.

THIS IS AN EXTREMELY FLAMMABLE GAS. Protection of all personnel and the area must be maintained.

PART III *How can I prevent hazardous situations from occurring?*

7. HANDLING and STORAGE

WORK PRACTICES AND HYGIENE PRACTICES: As with all chemicals, avoid getting Isobutylene IN YOU. Do not eat or drink while handling chemicals. Be aware of any signs of dizziness or fatigue; exposures to fatal concentrations of Isobutylene could occur without any significant warning symptoms.

STORAGE AND HANDLING PRACTICES: Cylinders should be stored in dry, well-ventilated areas away from sources of heat. Compressed gases can present significant safety hazards. Store containers away from heavily trafficked areas and emergency exits. Post "No Smoking or Open Flames" signs in storage or use areas.

SPECIAL PRECAUTIONS FOR HANDLING GAS CYLINDERS: Protect cylinders against physical damage. Store in cool, dry, well-ventilated area, away from sources of heat, ignition and direct sunlight. Do not allow area where cylinders are stored to exceed 52°C (125°F). Isolate from oxidizers such as oxygen, chlorine, or fluorine. Use a check valve or trap in the discharge line to prevent hazardous backflow. Post "No Smoking or Open Flame" signs in storage and use areas. Cylinders should be stored upright and be firmly secured to prevent falling or being knocked over. Cylinders can be stored in the open, but in such cases, should be protected against extremes of weather and from the dampness of the ground to prevent rusting. Never tamper with pressure relief devices in valves and cylinders. Electrical equipment should be non-sparking or explosion proof. The following rules are applicable to situations in which cylinders are being used:

Before Use: Move cylinders with a suitable hand truck. Do not drag, slide, or roll cylinders. Do not drop cylinders or permit them to strike each other. Secure cylinders firmly. Leave the valve protection cap, if provided, in place until cylinder is ready for use.

During Use: Use designated CGA fittings and other support equipment. Do not use adapters. Do not heat cylinder by any means to increase the discharge rate of the product from the cylinder. Use check valve or trap in discharge line to prevent hazardous backflow into the cylinder. Do not use oils or grease on gas-handling fittings or equipment.

After Use: Close main cylinder valve. Replace valve protection cap, if provided. Mark empty cylinders "EMPTY".

NOTE: Use only DOT or ASME code containers. Earth-ground and bond all lines and equipment associated with Isobutylene. Close valve after each use and when empty. Cylinders must not be recharged except by or with the consent of owner. For additional information refer to the Compressed Gas Association Pamphlet P-1, *Safe Handling of Compressed Gases in Containers.* Additionally, refer to CGA Bulletin SB-2 "*Oxygen Deficient Atmospheres*".

PROTECTIVE PRACTICES DURING MAINTENANCE OF CONTAMINATED EQUIPMENT: Follow practices indicated in Section 6 (Accidental Release Measures). Make certain that application equipment is locked and tagged-out safely. Purge gas handling equipment with inert gas (e.g., nitrogen) before attempting repairs.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION

VENTILATION AND ENGINEERING CONTROLS: Use with adequate ventilation. Local exhaust ventilation is preferred, because it prevents Isobutylene dispersion into the work place by eliminating it at its source. If appropriate, install automatic monitoring equipment to detect the presence of potentially explosive air-gas mixtures and level of oxygen.

RESPIRATORY PROTECTION: Maintain oxygen levels above 19.5% in the workplace. Maintain level of gas below the level listed in Section 2 (Composition and Information on Ingredients). Use supplied air respiratory protection if oxygen levels are below 19.5% or during emergency response to a release of Isobutylene. If respiratory protection is required, follow the requirements of the Federal OSHA Respiratory Protection Standard (29 CFR 1910.134) or equivalent State standards.

EYE PROTECTION: Splash goggles or safety glasses, for protection from rapidly expanding gases and splashes of liquid Isobutylene.

HAND PROTECTION: Wear gloves resistant to tears when handling cylinders of Isobutylene. Use low-temperature protective gloves (e.g., Kevlar) when working with containers of liquid Isobutylene.

BODY PROTECTION: Use body protection appropriate for task. Transfer of large quantities under pressure may require protective equipment appropriate to protect employees from splashes of liquefied product, as well as fire retardant items.

9. PHYSICAL and CHEMICAL PROPERTIES

VAPOR DENSITY @ 21.1°C (70°F): 2.396 kg/m^3 (0.1496 lb/ft^3)
SPECIFIC GRAVITY (air = 1): 1.997
SOLUBILITY IN WATER: Insoluble.
EVAPORATION RATE (nBuAc = 1): Not applicable.
ODOR THRESHOLD: Not established.
COEFFICIENT WATER/OIL DISTRIBUTION: Not applicable.
pH: Not applicable.
FREEZING POINT: -140°C (-220.6°F)
BOILING POINT @ 1 atm: -6.9°C (19.6°F)
EXPANSION RATIO: Not applicable
VAPOR PRESSURE (psia): 39
SPECIFIC VOLUME (ft^3/lb): 6.7

APPEARANCE AND COLOR: Colorless gas with the unpleasant odor of burning coal. The liquid is also colorless and has the same unpleasant odor of burning coal.

HOW TO DETECT THIS SUBSTANCE (warning properties): There are no distinct warning properties. In terms of leak detection, fittings and joints can be painted with a soap solution to detect leaks, which will be indicated by a bubble formation.

10. STABILITY and REACTIVITY

STABILITY: Stable.

DECOMPOSITION PRODUCTS: When ignited in the presence of oxygen, this gas will burn to produce carbon monoxide and carbon dioxide.

MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE: Strong oxidizers (e.g., chlorine, bromine pentafluoride, oxygen, oxygen difluoride, and nitrogen trifluoride).

HAZARDOUS POLYMERIZATION: Will not occur.

CONDITIONS TO AVOID: Contact with incompatible materials and exposure to heat, sparks, and other sources of ignition. Cylinders exposed to high temperatures or direct flame can rupture or burst.

PART IV *Is there any other useful information about this material?*

11. TOXICOLOGICAL INFORMATION

TOXICITY DATA: The following information is for pure Isobutylene.

ISOBUTYLENE:
LC_{50} (rat, inhalation) = 620 g/m^3/4 hours
LC_{50} (mouse, inhalation) = 415 g/m^3/2 hours

SUSPECTED CANCER AGENT: Isobutylene is not found on the following lists: FEDERAL OSHA Z LIST, NTP, IARC, CAL/OSHA, and therefore is neither considered to be nor suspected to be a cancer-causing agent by these agencies.

IRRITANCY OF PRODUCT: Isobutylene may be mildly irritating to the mucous membranes. In addition, contact with rapidly expanding gases can cause frostbite to exposed tissue.

SENSITIZATION TO THE PRODUCT: Isobutylene is not known to cause sensitization in humans.

REPRODUCTIVE TOXICITY INFORMATION: Listed below is information concerning the effects of Isobutylene on the human reproductive system.

Mutagenicity: No mutagenic effects have been described for Isobutylene.
Embryotoxicity: No embryotoxic effects have been described for Isobutylene.
Teratogenicity: No teratogenic effects have been described for Isobutylene.
Reproductive Toxicity: No reproductive toxicity effects have been described for Isobutylene.

A mutagen is a chemical which causes permanent changes to genetic material (DNA) such that the changes will propagate through generational lines. An embryotoxin is a chemical which causes damage to a developing embryo (i.e., within the first eight weeks of pregnancy in humans), but the damage does not propagate across generational lines. A teratogen is a chemical which causes damage to a developing fetus, but the damage does not propagate across generational lines. A reproductive toxin is any substance which interferes in any way with the reproductive process.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Acute or chronic respiratory conditions may be aggravated by overexposure to Isobutylene.

11. TOXICOLOGICAL INFORMATION (Continued)

RECOMMENDATIONS TO PHYSICIANS: Administer oxygen, if necessary. Treat symptoms and eliminate exposure.

BIOLOGICAL EXPOSURE INDICES (BEIs): Currently, Biological Exposure Indices (BEIs) are not applicable for Isobutylene.

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL STABILITY: This gas will be dissipated rapidly in well-ventilated areas.

EFFECT OF MATERIAL ON PLANTS or ANIMALS: Any adverse effect on animals would be related to oxygen-deficient environments. No adverse effect is anticipated to occur to plant life, except for frost produced in the presence of rapidly expanding gases. See Section 11, Toxicological Information, for additional information on effects on animals.

EFFECT OF CHEMICAL ON AQUATIC LIFE: No evidence is currently available on the effects of Isobutylene on aquatic life.

13. DISPOSAL CONSIDERATIONS

PREPARING WASTES FOR DISPOSAL: Waste disposal must be in accordance with appropriate Federal, State, and local regulations. Return cylinders with any residual product to MESA Specialty Gases & Equipment Do not dispose of locally.

14. TRANSPORTATION INFORMATION

THIS MATERIAL IS HAZARDOUS AS DEFINED BY 49 CFR 172.101 BY THE U.S. DEPARTMENT OF TRANSPORTATION.

For Isobutylene Gas:

PROPER SHIPPING NAME:	Isobutylene
HAZARD CLASS NUMBER and DESCRIPTION:	2.1 (Flammable Gas)
UN IDENTIFICATION NUMBER:	UN 1055
PACKING GROUP:	Not Applicable
DOT LABEL(S) REQUIRED:	Flammable Gas

NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (1996): 115

Alternate Description:

PROPER SHIPPING NAME:	Petroleum gases, liquefied
HAZARD CLASS NUMBER and DESCRIPTION:	2.1 (Flammable Gas)
UN IDENTIFICATION NUMBER:	UN 1075
PACKING GROUP:	Not Applicable
DOT LABEL(S) REQUIRED:	Flammable Gas

NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (1996): 115

MARINE POLLUTANT: Isobutylene is not classified by the DOT as a Marine Pollutant (as defined by 49 CFR 172.101, Appendix B).

TRANSPORT CANADA TRANSPORTATION OF DANGEROUS GOODS REGULATIONS: THIS MATERIAL IS CONSIDERED AS DANGEROUS GOODS. Use the above information for the preparation of Canadian Shipments.

15. REGULATORY INFORMATION

U.S. SARA REPORTING REQUIREMENTS: Isobutylene is not subject to the reporting requirements of Sections 302, 304, and 313 of Title III of the Superfund Amendments and Reauthorization Act.

U.S. SARA THRESHOLD PLANNING QUANTITY: Not applicable.

U.S. CERCLA REPORTABLE QUANTITY (RQ): Not applicable.

CANADIAN DSL/NDSL INVENTORY STATUS: Isobutylene is on the DSL Inventory.

U.S. TSCA INVENTORY STATUS: Isobutylene is listed on the TSCA Inventory.

15. REGULATORY INFORMATION (Continued)

OTHER U.S. FEDERAL REGULATIONS: Isobutylene is subject to the reporting requirements of Section 112(r) of the Clean Air Act. The Threshold Quantity for this gas is 10,000 lb. Depending on specific operations involving the use of Isobutylene, the regulations of the Process Safety Management of Highly Hazardous Chemicals may be applicable (29 CFR 1910.119). Under this regulation Isobutylene is not listed in Appendix A; however, any process that involves a flammable gas on-site, in one location, in quantities of 10,000 lb (4,553 kg) or greater is covered under this regulation unless it is used as a fuel.

U.S. STATE REGULATORY INFORMATION: Isobutylene is covered under specific State regulations, as denoted below:

Alaska - Designated Toxic and Hazardous Substances: Liquefied Petroleum Gas.
California - Permissible Exposure Limits for Chemical Contaminants: Liquefied Petroleum Gas.
Florida - Substance List: Isobutylene.
Illinois - Toxic Substance List: No.
Kansas - Section 302/313 List: No.
Massachusetts - Substance List: Isobutylene.
Michigan - Critical Materials Register: No.
Minnesota - List of Hazardous Substances: Liquefied Petroleum Gas.
Missouri - Employer Information/Toxic Substance List: No.
New Jersey - Right to Know Hazardous Substance List: Isobutylene.
North Dakota - List of Hazardous Chemicals, Reportable Quantities: No.
Pennsylvania - Hazardous Substance List: Isobutylene.
Rhode Island - Hazardous Substance List: Liquefied Petroleum Gas.
Texas - Hazardous Substance List: Liquefied Petroleum Gas.
West Virginia - Hazardous Substance List: Liquefied Petroleum Gas.
Wisconsin - Toxic and Hazardous Substances: Liquefied Petroleum Gas.

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): Isobutylene is not on the California Proposition 65 lists.

LABELING:

DANGER: FLAMMABLE LIQUID AND GAS UNDER PRESSURE.
CAN FORM EXPLOSIVE MIXTURES WITH AIR.
MAY CAUSE FROSTBITE.

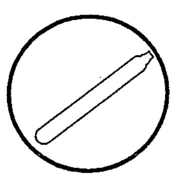
Keep away from heat, flames, and sparks.
Store and use with adequate ventilation.
Cylinder temperature should not exceed 52°C (125°F).
Do not get liquid in eyes, on skin, or clothing.
Close valve after each use and when empty.
Use in accordance with the Material Safety Data Sheet.

FIRST AID: **IF INHALED**, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

IN CASE OF FROSTBITE, obtain immediate medical attention.

DO NOT REMOVE THIS PRODUCT LABEL.

CANADIAN WHMIS SYMBOLS: **Class A:** Compressed Gas
Class B1: Flammable Gas



16. OTHER INFORMATION

The information contained herein is based on data considered accurate. However, no warranty is expressed or implied regarding the accuracy of these data or the results to be obtained from the use thereof. MESA Specialty Gases & Equipment assumes no responsibility for injury to the vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, MESA Specialty Gases & Equipment assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in his use of the material.

DEFINITIONS OF TERMS

A large number of abbreviations and acronyms appear on a MSDS. Some of these which are commonly used include the following:

CAS #: This is the Chemical Abstract Service Number which uniquely identifies each constituent. It is used for computer-related searching.

EXPOSURE LIMITS IN AIR:

ACGIH - American Conference of Governmental Industrial Hygienists, a professional association which establishes exposure limits. **TLV** - Threshold Limit Value - an airborne concentration of a substance which represents conditions under which it is generally believed that nearly all workers may be repeatedly exposed without adverse effect. The duration must be considered, including the 8-hour Time Weighted Average (**TWA**), the 15-minute Short Term Exposure Limit, and the instantaneous Ceiling Level (**C**). Skin absorption effects must also be considered.

OSHA - U.S. Occupational Safety and Health Administration. **PEL** - Permissible Exposure Limit - This exposure value means exactly the same as a TLV, except that it is enforceable by OSHA. The OSHA Permissible Exposure Limits are based in the 1989 PELs and the June, 1993 Air Contaminants Rule (Federal Register: 58: 35338-35351 and 58: 40191). Both the current PELs and the vacated PELs are indicated. The phrase, "Vacated 1989 PEL," is placed next to the PEL which was vacated by Court Order.

IDLH - Immediately Dangerous to Life and Health - This level represents a concentration from which one can escape within 30-minutes without suffering escape-preventing or permanent injury. **The DFG - MAK** is the Republic of Germany's Maximum Exposure Level, similar to the U.S. PEL. **NIOSH** is the National Institute of Occupational Safety and Health, which is the research arm of the U.S. Occupational Safety and Health Administration (OSHA). NIOSH issues exposure guidelines called Recommended Exposure Levels (**RELs**). When no exposure guidelines are established, an entry of **NE** is made for reference.

HAZARD RATINGS:

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM: Health Hazard: **0** (minimal acute or chronic exposure hazard); **1** (slight acute or chronic exposure hazard); **2** (moderate acute or significant chronic exposure hazard); **3** (severe acute exposure hazard; onetime overexposure can result in permanent injury and may be fatal); **4** (extreme acute exposure hazard; onetime overexposure can be fatal). Flammability Hazard: **0** (minimal hazard); **1** (materials that require substantial pre-heating before burning); **2** (combustible liquid or solids; liquids with a flash point of 38-93°C [100-200°F]); **3** (Class IB and IC flammable liquids with flash points below 38°C [100°F]); **4** (Class IA flammable liquids with flash points below 23°C [73°F] and boiling points below 38°C [100°F]. Reactivity Hazard: **0** (normally stable); **1** (material that can become unstable at elevated temperatures or which can react slightly with water); **2** (materials that are unstable but do not detonate or which can react violently with water); **3** (materials that can detonate when initiated or which can react explosively with water); **4** (materials that can detonate at normal temperatures or pressures).

NATIONAL FIRE PROTECTION ASSOCIATION: Health Hazard: **0** (material that on exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials); **1** (materials that on exposure under fire conditions could cause irritation or minor residual injury); **2** (materials that on intense or continued exposure under fire conditions could cause temporary incapacitation or possible residual injury); **3** (materials that can on short exposure could cause serious temporary or residual injury); **4** (materials that under very short exposure causes death or major residual injury).

NATIONAL FIRE PROTECTION ASSOCIATION (Continued): Flammability Hazard and Reactivity Hazard: Refer to definitions for "Hazardous Materials Identification System".

FLAMMABILITY LIMITS IN AIR:

Much of the information related to fire and explosion is derived from the National Fire Protection Association (**NFPA**). Flash Point - Minimum temperature at which a liquid gives off sufficient vapors to form an ignitable mixture with air. Autoignition Temperature: The minimum temperature required to initiate combustion in air with no other source of ignition. LEL - the lowest percent of vapor in air, by volume, that will explode or ignite in the presence of an ignition source. UEL - the highest percent of vapor in air, by volume, that will explode or ignite in the presence of an ignition source.

TOXICOLOGICAL INFORMATION:

Possible health hazards as derived from human data, animal studies, or from the results of studies with similar compounds are presented. Definitions of some terms used in this section are: **LD_{50}** - Lethal Dose (solids & liquids) which kills 50% of the exposed animals; **LC_{50}** - Lethal Concentration (gases) which kills 50% of the exposed animals; **ppm** concentration expressed in parts of material per million parts of air or water; **mg/m^3** concentration expressed in weight of substance per volume of air; **mg/kg** quantity of material, by weight, administered to a test subject, based on their body weight in kg. Data from several sources are used to evaluate the cancer-causing potential of the material. The sources are: **IARC** - the International Agency for Research on Cancer; **NTP** - the National Toxicology Program, **RTECS** - the Registry of Toxic Effects of Chemical Substances, **OSHA** and **CAL/OSHA**. IARC and NTP rate chemicals on a scale of decreasing potential to cause human cancer with rankings from 1 to 4. Subrankings (2A, 2B, etc.) are also used. Other measures of toxicity include **TDLo**, the lowest dose to cause a symptom and **TCLo** the lowest concentration to cause a symptom; **TDo**, **LDLo**, and **LDo**, or **TC**, **TCo**, **LCLo**, and **LCo**, the lowest dose (or concentration) to cause lethal or toxic effects. **BEI** - Biological Exposure Indices, represent the levels of determinants which are most likely to be observed in specimens collected from a healthy worker who has been exposed to chemicals to the same extent as a worker with inhalation exposure to the TLV. Ecological Information: EC is the effect concentration in water.

REGULATORY INFORMATION:

This section explains the impact of various laws and regulations on the material. **EPA** is the U.S. Environmental Protection Agency. **WHMIS** is the Canadian Workplace Hazardous Materials Information System. **DOT** and **TC** are the U.S. Department of Transportation and the Transport Canada, respectively. Superfund Amendments and Reauthorization Act (**SARA**); the Canadian Domestic/Non-Domestic Substances List (**DSL/NDSL**); the U.S. Toxic Substance Control Act (**TSCA**); Marine Pollutant status according to the **DOT**; the Comprehensive Environmental Response, Compensation, and Liability Act (**CERCLA or Superfund**); and various state regulations.

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MATERIAL SAFETY DATA SHEET

Prepared to U.S. OSHA, CMA, ANSI and Canadian WHMIS Standards

1. PRODUCT IDENTIFICATION

CHEMICAL NAME; CLASS: NON-FLAMMABLE GAS MIXTURE

Containing One or More of the Following Components in a Nitrogen Balance Gas: Oxygen, 0.0015-23.5%; Propane, 0-1.1%; n-Pentane, 0-0.75%; n-Hexane; 0-0.48%; Carbon Monoxide, 0.0005-1.0%; Hydrogen Sulfide, 0.001-0.025%

NOTE: MIXTURES COMPRISED OF AN AIR BALANCE GAS CONTAIN BETWEEN 19.5-23.5% OXYGEN.

SYNONYMS: Not Applicable

CHEMICAL FAMILY NAME: Not Applicable

FORMULA: Not Applicable

Document Number: 50016 (Replaces ISC MSDS No.1810-2187, 1810-2343, 1810-3366, 1810-3937 1810-7219, 1810-7599, 1810-6179)

Note: The Material Safety Data Sheet is for this gas mixture supplied in cylinders with 33 cubic feet (935 liters) or less gas capacity (DOT - 39 cylinders). This MSDS has been developed for various gas mixtures with the composition of components within the ranges listed in Section 2 (Composition and Information on Ingredients). Refer to the product label for information on the actual composition of the product.

PRODUCT USE:	Calibration of Monitoring and Research Equipment
SUPPLIER/MANUFACTURER'S NAME:	CALGAZ
ADDRESS:	821 Chesapeake Drive Cambridge, MD 21613
EMERGENCY PHONE:	CHEMTREC: 1-800-424-9300
BUSINESS PHONE:	1-410-228-6400
General MSDS Information	1-713/868-0440
Fax on Demand:	1-800/231-1366

2. COMPOSITION and INFORMATION ON INGREDIENTS

CHEMICAL NAME	CAS #	mole %	EXPOSURE LIMITS IN AIR					
			ACGIHTLV		OSHA		IDLH	OTHER
			TWA ppm	STEL ppm	TWA ppm	STEL ppm	ppm	ppm
Oxygen	7782-44-7	0.0015 - 23.5%	There are no specific exposure limits for Oxygen. Oxygen levels should be maintained above 19.5%.					
Propane	74-98-6	0 - 1.1%	2500	NE	1000	NE	2100	NIOSH REL: 1000 DFG MAK: 1000 ppm
n-Pentane	109-66-0	0 - 0.75%	600	750	1000 600 (Vacated 1989 PEL)	750 (Vacated 1989 PEL)	1500	NIOSH REL: TWA = 120 STEL = 610 (ceiling) 15 minutes DFG MAKs: TWA =1000 PEAK = 2•MAK, 60 min., momentary value
n-Hexane	110-54-3	0 - 0.48%	50	NE	500 50 (Vacated 1989 PEL)	NE	1100	NIOSH REL: 50 DFG MAK: 50
Hydrogen Sulfide	7783-06-4	0.001-0.025 %	10 NIC = 5	15 NIC = 5	10 (Vacated 1989 PEL)	20 (ceiling), 50 (10 min. peak, once per shift) 15 (Vacated 1989 PEL)	100	NIOSH REL: STEL = 10 (ceiling), 10 minutes DFG MAKs: TWA = 10 PEAK = 2•MAK, 10 min., momentary value
Carbon Monoxide	630-08-0	0.0005 - 1.0%	25	NE	50 35 (Vacated 1989 PEL)	200 (ceiling) (Vacated 1989 PEL)	1200	NIOSH RELs: TWA = 35 STEL = 200 ceiling DFG MAKs: TWA = 30 PEAK = 2•MAK, 15 min., average value, 1 hr interval DFG MAK Pregnancy Risk Classification: B
Nitrogen	7727-37-9	Balance	There are no specific exposure limits for Nitrogen. Nitrogen is a simple asphyxiant (SA). Oxygen levels should be maintained above 19.5%.					

NE = Not Established. NIC = Notice of Intended Change See Section 16 for Definitions of Terms Used.

NOTE: ALL WHMIS required information is included in appropriate sections based on the ANSI Z400.1-1998 format. This gas mixture has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all the information required by the CPR.

3. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW: This gas mixture is a colorless gas which has a rotten-egg odor (due to the presence of Hydrogen Sulfide). The odor cannot be relied on as an adequate warning of the presence of this gas mixture, because olfactory fatigue occurs after over-exposure to Hydrogen Sulfide. Hydrogen Sulfide and Carbon Monoxide (another component of this gas mixture) are toxic to humans in relatively low concentrations. Over-exposure to this gas mixture can cause skin or eye irritation, nausea, dizziness, headaches, collapse, unconsciousness, coma, and death. The Propane, n-Pentane, and n-Hexane components can cause anesthetic or peripheral neuropathy effects. Additionally, releases of this gas mixture may produce oxygen-deficient atmospheres (especially in small confined spaces or other poorly-ventilated environments); individuals in such atmospheres may be asphyxiated.

HAZARDOUS MATERIAL IDENTIFICATION SYSTEM		
HEALTH HAZARD	(BLUE)	3
FLAMMABILITY HAZARD	(RED)	0
PHYSICAL HAZARD	(YELLOW)	0
PROTECTIVE EQUIPMENT		
EYES / RESPIRATORY / HANDS / BODY		
See Section 8		
For Routine Industrial Use and Handling Applications		

SYMPTOMS OF OVER-EXPOSURE BY ROUTE OF EXPOSURE: The most significant route of over-exposure for this gas mixture is by inhalation.

INHALATION: Due to the small size of an individual cylinder of this gas mixture, no unusual health effects from over-exposure to the product are anticipated under routine circumstances of use. A significant health hazard associated with this gas mixture is the potential of inhalation of Hydrogen Sulfide, a component of this gas mixture. Such over-exposures may occur if this gas mixture is used in a confined space or other poorly-ventilated area. Over-exposures to Hydrogen Sulfide can cause dizziness, headache, and nausea. Exposure to this component can result in respiratory arrest, coma, or unconsciousness. Continuous inhalation of low concentrations of Hydrogen Sulfide may cause olfactory fatigue, so that the odor is no longer an effective warning of the presence of this gas. A summary of exposure concentrations and observed effects are as follows

CONCENTRATION OF HYDROGEN SULFIDE	OBSERVED EFFECT
0.3-30 ppm	Odor is obvious and unpleasant.
50 ppm	Eye irritation. Dryness and irritation of nose, throat.
Slightly higher than 50 ppm	Irritation of the respiratory system.
100-150 ppm	Temporary loss of smell.
200-250 ppm	Headache, vomiting nausea. Prolonged exposure may lead to lung damage. Exposures of 4-8 hours can be fatal.
300-500	Swifter onset of symptoms. Death occurs in 1-4 hours.
500 ppm	Headache, excitement, staggering, and stomach ache after brief exposure. Death occurs within 0.5 - 1 hour of exposure.
> 600 ppm	Rapid onset of unconsciousness, coma, death.
> 1000 ppm	Immediate respiratory arrest.
NOTE:	This gas mixture contains a maximum of 250 ppm Hydrogen Sulfide. The higher concentration values here are presented to delineate the complete health effects which have been observed for humans after exposure to Hydrogen Sulfide.

Inhalation over-exposures to atmospheres containing more than the Threshold Limit Value of Carbon Monoxide (25 ppm), another component of this gas mixture, can result in serious health consequences. Carbon Monoxide is classified as a chemical asphyxiant, producing a toxic action by combining with the hemoglobin of the blood and replacing the available oxygen. Through this replacement, the body is deprived of the required oxygen, and asphyxiation occurs.

Since the affinity of Carbon Monoxide for hemoglobin is about 200-300 times that of oxygen, only a small amount of Carbon Monoxide will cause a toxic reaction to occur. Carbon Monoxide exposures in excess of 50 ppm will produce symptoms of poisoning if breathed for a sufficiently long time. If this gas mixture is released in a small, poorly ventilated area (i.e. an enclosed or confined space), symptoms which may develop include the following:

CONCENTRATION OF CARBON MONOXIDE	OBSERVED EFFECT
All exposure levels: ..	Over-exposure to Carbon Monoxide can be indicated by the lips and fingernails turning bright red.
200 ppm:	Slight symptoms (i.e. headache) after several hours of exposure.
400 ppm:	Headache and discomfort experienced within 2-3 hours of exposure.
1,000 -2000 ppm:	Within 30 minutes, slight palpitations of the heart occurs. Within 1.5 hours, there is a tendency to stagger.
200-2500 ppm:	Within 2 hours, there is mental confusion, headaches, and nausea. Unconsciousness within 30 minutes.
> 2500 ppm:	Potential for collapse and death before warning symptoms.

Another hazard associated with this gas mixture is the potential for anesthetic and peripheral neuropathy effects after inhalation over-exposures to the Propane, n-Pentane and n-Hexane components of this gas mixture. Specific human over-exposure data are available for n-Pentane and n-Hexane, as follows:

CONCENTRATION OF n-PENTANE	OBSERVED EFFECT
Brief (10 minute) up to 5,000 ppm:	No symptoms.
Higher than 5,000 ppm:	Exhilaration, dizziness and headache can occur.
Long term:	Can cause chronic neurological disorder causing damage to the nerves in the hands and feet (peripheral neuropathy)

CONCENTRATION OF n-HEXANE	OBSERVED EFFECT
Brief (10 minute) at 1,500 ppm:	Irritation of the respiratory tract, nausea and headache.
5000 ppm:	Dizziness and drowsiness can occur.
Long term at 500 ppm:	Can affect the nerves in the arms and legs. Effects include numbing or tingling sensations in the fingers and toes, tiredness, muscle weakness, cramps and spasms in the leg, difficulty in holding objects or walking, abdominal pains, loss of appetite, weight loss. More serious exposures can cause damage to the nerves in the hands and feet (peripheral neuropathy).
Eyes and Vision:	Abnormal color perception and pigment changes in the eyes have been reported among industrial workers exposed to 423-1280 ppm for 5 years or more.
Blood Cells:	Mild forms of anemia have also been associated with exposure to hexane. These are of temporary nature.

Additionally, if mixtures of this gas mixture contain less than 19.5% Oxygen and are released in a small, poorly ventilated area (i.e. an enclosed or confined space), an oxygen-deficient environment may occur. Individuals breathing such an atmosphere may experience symptoms which include headaches, ringing in ears, dizziness, drowsiness, unconsciousness, nausea, vomiting, and depression of all the senses. Under some circumstances of over-exposure, death may occur. The following effects associated with various levels of oxygen are as follows:

CONCENTRATION OF OXYGEN	OBSERVED EFFECT
12-16% Oxygen:	Breathing and pulse rate increased, muscular coordination slightly disturbed.
10-14% Oxygen:	Emotional upset, abnormal fatigue, disturbed respiration.
6-10% Oxygen:	Nausea, vomiting, collapse, or loss of consciousness.
Below 6%:	Convulsive movements, possible respiratory collapse, and death.

SKIN and EYE CONTACT: The Hydrogen Sulfide component of this gas mixture may be irritating to the skin. Inflammation and irritation of the eyes can occur at very low airborne concentration of Hydrogen Sulfide (less than 10 ppm). Exposure over several hours may result in "gas eyes" or "sore eyes" with symptoms of scratchiness, irritation, tearing and burning. Above 50 ppm of Hydrogen Sulfide, there is an intense tearing, blurring of vision, and pain when looking at light. Over-exposed individuals may see rings around bright lights. Most symptoms disappear when exposure ceases. However, in serious cases, the eye can be permanently damaged.

HEALTH EFFECTS OR RISKS FROM EXPOSURE: An Explanation in Lay Terms. Over-exposure to this gas mixture may cause the following health effects:

ACUTE: Due to the small size of the individual cylinder of this gas mixture, no unusual health effects from exposure to the product are anticipated under routine circumstances of use. However, the Hydrogen Sulfide and Carbon Monoxide components of this gas mixture are toxic to humans. Over-exposure to this gas mixture can cause nausea, dizziness, headaches, collapse, unconsciousness, coma, and death. Due to the presence of Hydrogen Sulfide, over-exposures to this gas mixture can also irritate the skin and eyes; severe eye contamination can result in blindness.

Inhalation over-exposures to Propane, n-Pentane, and n-Hexane can cause anesthetic effects and motor neuropathy (i.e. pain and tingling in feet and hands).

3. HAZARD IDENTIFICATION (Continued)

CHRONIC: Abnormal color perception and pigment changes in the eyes have been reported among persons exposed to 420 -1300 ppm of n-Hexane for five years. Additionally, long-term exposure to low levels of n-Hexane or n-Pentane can affect the nerves in the arms and legs. Effects include numbing or tingling sensation, tiredness, cramps, spasms in legs, difficulty holding objects or walking, loss of appetite and weight loss. Pentane isomers, such as n-Pentane, and Propane can cause sensitization of the heart to epinephrine. Refer to Section 11 (Toxicology Information) for additional information on the components of this gas mixture.
TARGET ORGANS: ACUTE: Respiratory system, blood system, central nervous system, cardiovascular system. CHRONIC: Reproductive system, cardiovascular system.

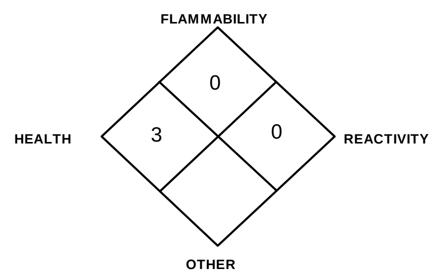
4. FIRST-AID MEASURES

RESCUERS SHOULD NOT ATTEMPT TO RETRIEVE VICTIMS OF EXPOSURE TO THIS GAS MIXTURE WITHOUT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT. At a minimum, Self-Contained Breathing Apparatus must be worn.
No unusual health effects are anticipated after exposure to this gas mixture, due to the small cylinder size. If any adverse symptom develops after over-exposure to this gas mixture, remove victim(s) to fresh air as quickly as possible. Only trained personnel should administer supplemental oxygen and/or cardio-pulmonary resuscitation if necessary.
Victim(s) who experience any adverse effect after over-exposure to this gas mixture must be taken for medical attention. Rescuers should be taken for medical attention if necessary. Take a copy of the label and the MSDS to physician or other health professional with victim(s).
SKIN EXPOSURE: If irritation of the skin develops after exposure to this gas mixture, immediately begin decontamination with running water. Minimum flushing is for 15 minutes. Remove exposed or contaminated clothing, taking care not to contaminate eyes. Victim must seek immediate medical attention.
EYE EXPOSURE: If irritation of the eye develops after exposure to this gas mixture, open victim's eyes while under gentle running water. Use sufficient force to open eyelids. Have victim "roll" eyes. Minimum flushing is for 15 minutes. Seek medical assistance immediately, preferably an ophthalmologist.
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Pre-existing respiratory conditions may be aggravated by over-exposure to this gas mixture. Carbon Monoxide, a component of this gas mixture, can aggravate some diseases of the cardiovascular system, such as coronary artery disease and angina pectoris. Because of the presence of Hydrogen Sulfide, n-Hexane or n-Pentane in this gas mixture, central nervous system conditions, eye disorders, or skin problems may be aggravated by over-exposure to this gas mixture.
RECOMMENDATIONS TO PHYSICIANS: Treat symptoms and eliminate over-exposure. Hyperbaric oxygen is the most efficient antidote to Carbon Monoxide poisoning, the optimum range being 2-2.5 atm. A special mask, or, preferably, a compression chamber to utilize oxygen at these pressures is required. Avoid administering stimulant drugs. Be observant for initial signs of pulmonary edema in the event of severe inhalation over-exposures.

5. FIRE-FIGHTING MEASURES

FLASH POINT: Not applicable.
AUTOIGNITION TEMPERATURE: Not applicable.
FLAMMABLE LIMITS (in air by volume, %):
Lower (LEL): Not applicable.
Upper (UEL): Not applicable.
FIRE EXTINGUISHING MATERIALS: Non-flammable gas mixture. Use extinguishing media appropriate for surrounding fire.
UNUSUAL FIRE AND EXPLOSION HAZARDS: This gas mixture contains toxic gases, Hydrogen Sulfide and Carbon Monoxide, and presents an extreme health hazard to firefighters. This gas mixture is not flammable; however, containers, when involved in fire, may rupture or burst in the heat of the fire.
Explosion Sensitivity to Mechanical Impact: Not Sensitive.
Explosion Sensitivity to Static Discharge: Not Sensitive.
SPECIAL FIRE-FIGHTING PROCEDURES: Structural firefighters must wear Self-Contained Breathing Apparatus and full protective equipment.

NFPA RATING



6. ACCIDENTAL RELEASE MEASURES

LEAK RESPONSE: Due to the small size and content of the cylinder, an accidental release of this gas mixture presents significantly less risk of over-exposure to Hydrogen Sulfide and Carbon Monoxide, the toxic components of this gas mixture, and other safety hazards related to the remaining components of this gas mixture, than a similar release from a larger cylinder. However, as with any chemical release, extreme caution must be used during emergency response procedures. In the event of a release in which the atmosphere is unknown, and in which other chemicals are potentially involved, evacuate immediate area. Such releases should be responded to by trained personnel using pre-planned procedures. Proper protective equipment should be used. In case of a leak, clear the affected area, protect people, and respond with trained personnel.

For emergency disposal, secure the cylinder and slowly discharge the gas to the atmosphere in a well-ventilated area or outdoors. Allow the gas mixture to dissipate. If necessary, monitor the surrounding area (and the original area of the release) for Hydrogen Sulfide, Carbon Monoxide, and Oxygen. Hydrogen Sulfide and Carbon Monoxide level must be below exposure level listed in Section 2 (Composition and Information on Ingredients) and Oxygen levels must be above 19.5% before non-emergency personnel are allowed to re-enter area.

If leaking incidentally from the cylinder, contact your supplier.

7. HANDLING and USE

WORK PRACTICES AND HYGIENE PRACTICES: Be aware of any signs of dizziness or fatigue; exposures to fatal concentrations of this gas mixture could occur without any significant warning symptoms, due to olfactory fatigue or oxygen deficiency. Do not attempt to repair, adjust, or in any other way modify cylinders containing a gas mixture with Hydrogen Sulfide or Carbon Monoxide. If there is a malfunction or another type of operational problem, contact nearest distributor immediately. Eye wash stations/safety showers should be near areas where this gas mixture is used or stored. All work operations should be monitored in such a way that emergency personnel can be immediately contacted in the event of a release. All work practices should minimize releases of Hydrogen Sulfide and Carbon Monoxide-containing gas mixtures.
STORAGE AND HANDLING PRACTICES: Cylinders should be firmly secured to prevent falling or being knocked-over. Cylinders must be protected from the environment, and preferably kept at room temperature (approximately 21°C, 70°F). Cylinders should be stored in dry, well-ventilated areas, away from sources of heat, ignition, and direct sunlight. Protect cylinders against physical damage.
Full and empty cylinders should be segregated. Use a first-in, first-out inventory system to prevent full containers from being stored for long periods of time. These cylinders are not refillable. **WARNING! Do not refill DOT 39 cylinders. To do so may cause personal injury or property damage.**
SPECIAL PRECAUTIONS FOR HANDLING GAS CYLINDERS: WARNING! Compressed gases can present significant safety hazards. During cylinder use, use equipment designed for these specific cylinders. Ensure all lines and equipment are rated for proper service pressure.
PROTECTIVE PRACTICES DURING MAINTENANCE OF CONTAMINATED EQUIPMENT: Follow practices indicated in Section 6 (Accidental Release Measures). Make certain that application equipment is locked and tagged-out safely. Always use product in areas where adequate ventilation is provided.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION

VENTILATION AND ENGINEERING CONTROLS: No special ventilation systems or engineering controls are needed under normal circumstances of use. As with all chemicals, use this gas mixture in well-ventilated areas. If this gas mixture is used in a poorly-ventilated area, install automatic monitoring equipment to detect the levels of Oxygen, Hydrogen Sulfide, and Carbon Monoxide.
RESPIRATORY PROTECTION: No special respiratory protection is required under normal circumstances of use. Use supplied air respiratory protection if Carbon Monoxide levels exceed the exposure levels given in Section 2 (Composition and Information on Ingredients) or if oxygen levels are below 19.5%, or if either level is unknown during emergency response to a release of this gas mixture. If respiratory protection is required for emergency response to this gas mixture, follow the requirements of the Federal OSHA Respiratory Protection Standard (29 CFR 1910.134) or equivalent State standards. The following NIOSH respiratory protection recommendations for Hydrogen Sulfide and Carbon Monoxide are provided for further information.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION (Continued)

NIOSH/OSHA RECOMMENDATIONS FOR HYDROGEN SULFIDE CONCENTRATIONS IN AIR:

Up to 100 ppm: Powered air-purifying respirator with cartridge(s) to protect against hydrogen sulfide; or gas mask with canister to protect against hydrogen sulfide; or SAR; or full-facepiece SCBA.

Emergency or Planned Entry into Unknown Concentration or IDLH Conditions: Positive pressure, full-facepiece SCBA; or positive pressure, full-facepiece SAR with an auxiliary positive pressure SCBA.

Escape: Gas mask with canister to protect against hydrogen sulfide; or escape-type SCBA

NOTE: The IDLH concentration for Hydrogen Sulfide is 100 ppm.

NIOSH/OSHA RECOMMENDATIONS FOR CARBON MONOXIDE CONCENTRATIONS IN AIR:

Up to 350 ppm Supplied Air Respirator (SAR)

Up to 875 ppm Supplied Air Respirator (SAR) operated in a continuous flow mode.

Up to 1200 ppm Gas mask with canister to protect against carbon monoxide; or full-facepiece SCBA; or full-facepiece Supplied Air Respirator (SAR).

Emergency or Planned Entry into Unknown Concentration or IDLH Conditions: Positive pressure, full-facepiece SCBA; or positive pressure, full-facepiece Supplied Air Respirator (SAR) with an auxiliary positive pressure SCBA.

Escape: Gas mask with canister to protect against carbon monoxide; or escape-type SCBA.

NOTE: End of Service Life Indicator (ESLI) required for gas masks.

EYE PROTECTION: Safety glasses. If necessary, refer to U.S. OSHA 29 CFR 1910.133 or appropriate Canadian Standards.

HAND PROTECTION: No special protection is needed under normal circumstances of use. If necessary, refer to U.S. OSHA 29 CFR 1910.138 or appropriate Standards of Canada.

BODY PROTECTION: No special protection is needed under normal circumstances of use. If a hazard of injury to the feet exists due to falling objects, rolling objects, where objects may pierce the soles of the feet or where employee's feet may be exposed to electrical hazards, use foot protection, as described in U.S. OSHA 29 CFR 1910.136.

9. PHYSICAL and CHEMICAL PROPERTIES

The following information is for Nitrogen, the main component of this gas mixture.

GAS DENSITY @ 32°F (0°C) and 1 atm: 0.072 lbs/ ft^3 (1.153 kg/m^3)

FREEZING/MELTING POINT @ 10 psig: -210°C (-345.8°F)

BOILING POINT: -195.8°C (-320.4°F)

SPECIFIC GRAVITY (air = 1) @ 70°F (21.1°C): 0.906

pH: Not applicable.

SOLUBILITY IN WATER vol/vol @ 32°F (0°C) and 1 atm: 0.023

MOLECULAR WEIGHT: 28.01

EVAPORATION RATE (nBuAc = 1): Not applicable.

EXPANSION RATIO: Not applicable.

ODOR THRESHOLD: Not applicable.

SPECIFIC VOLUME (ft^3/lb): 13.8

VAPOR PRESSURE @ 70°F (21.1°C) psig: Not applicable.

COEFFICIENT WATER/OIL DISTRIBUTION: Not applicable.

The following information is for the gas mixture.

APPEARANCE AND COLOR: This gas mixture is a colorless gas which has an rotten egg-like odor, due to the presence of Hydrogen Sulfide.

HOW TO DETECT THIS SUBSTANCE (warning properties): Continuous inhalation of low concentrations of Hydrogen Sulfide (a component of this gas mixture) may cause olfactory fatigue, so that there are no distinct warning properties. In terms of leak detection, fittings and joints can be painted with a soap solution to detect leaks, which will be indicated by a bubble formation. Wet lead acetate paper can be used for leak detection. The paper turns black in the presence of Hydrogen Sulfide. Cadmium chloride solutions can also be used. Cadmium solutions will turn yellow upon contact with Hydrogen Sulfide.

10. STABILITY and REACTIVITY

STABILITY: Normally stable in gaseous state.

DECOMPOSITION PRODUCTS: The thermal decomposition products of Propane, n-Hexane, and n-Pentane include carbon oxides. The decomposition products of Hydrogen Sulfide include water and sulfur oxides. The other components of this gas mixture do not decompose, per se, but can react with other compounds in the heat of a fire.

MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE: Titanium will burn in Nitrogen (the main component of this gas mixture). Lithium reacts slowly with Nitrogen at ambient temperatures. Components of this gas mixture (Hydrogen Sulfide, Propane, n-Pentane, n-Hexane) are also incompatible with strong oxidizers (i.e. chlorine, bromine pentafluoride, oxygen, oxygen difluoride, and nitrogen trifluoride). Carbon Monoxide is mildly corrosive to nickel and iron (especially at high temperatures and pressures). Hydrogen Sulfide is corrosive to most metals, because it reacts with these substances to form metal sulfides.

HAZARDOUS POLYMERIZATION: Will not occur.

CONDITIONS TO AVOID: Contact with incompatible materials. Cylinders exposed to high temperatures or direct flame can rupture or burst.

11. TOXICOLOGICAL INFORMATION

TOXICITY DATA: The following toxicology data are available for the components of this gas mixture:

NITROGEN: There are no specific toxicology data for Nitrogen. Nitrogen is a simple asphyxiant, which acts to displace oxygen in the

n-PENTANE:

LD_{50} (intravenous, mouse) = 446 mg/kg.

LC_{50} (inhalation, rat) = 364 g/m^3/4 hours

LCLo (inhalation, mouse) = 325 g/m^3/2 hours

n-HEXANE:

Eye, rabbit = 10 mg/ mild

TCLo (inhalation, rat) = 10,000 ppm/7 hr.

TCLo (inhalation, rat) = 5000 ppm/20 hours; teratogenic effects

LD50 (oral, rat) = 28710 mg/kg

LDLo (intraperitoneal, rat) = 9100 mg/kg

LCLo (inhalation, mouse) = 120,000 mg/kg

LD50 (rat, oral): 28,710 mg/kg

ACUTE INHALATION (mouse): 30,000 ppm, narcosis within 30 to 60 minutes; 35,000-40,000 ppm, convulsions and death.

DERMAL (rabbit): 2 to 5 ml/kg for 4 hours resulted in restlessness and discoordination,; death occurred at 5 ml/kg.

n-HEXANE (continued):

CHRONIC INHALATION (rat): 400-600 ppm, 5 days/week, peripheral neuropathy in 45 days; 850 ppm for 143 days, loss of weight and degeneration of the sciatic nerve. (mouse): 250 ppm, peripheral neuropathy within 7 months; no effects at 100 ppm.

PROPANE:

Long-Term Inhalation: No toxicity or abnormalities were observed when monkeys were exposed to approximately 750 ppm for 90 days. Similar results were obtained when monkeys were exposed to an aerosol spray containing 65% propane and isobutane.

CARBON MONOXIDE:

TCLo (inhalation, mouse) = 65 ppm/24 hours (7-18 preg): rep. effects

TCLo (inhalation, mouse) = 8 pph/1 hour (female 8D post): ter. effects

CARBON MONOXIDE (continued):

TCLo (inhalation, human) = 600 mg/m^3/10 minutes

LCLo (inhalation, man) = 4000 ppm/30 minutes

TCLo (inhalation, man) = 650 ppm/45 minutes: central nervous system and blood system effects.

LCLo (inhalation, human) = 5000 ppm/5 minutes

LCLo (inhalation, dog) = 4000 ppm/46 minutes

LCLo (inhalation, rabbit) = 4000 ppm

LC_{50} (inhalation, rat) = 1811 ppm/4 hours

LC_{50} (inhalation, guinea pig) = 2450 ppm/4 hours

LC_{50} (inhalation, guinea pig) = 5718 ppm/4 hours

LCLo (inhalation, mammal) = 5000 ppm/5 minutes

LD_{50} (inhalation, wild bird) = 1334 ppm

HYDROGEN SULFIDE:

LCLo (inhalation, human) = 600 ppm/30 minutes

LDLO (inhalation, man) = 5.7 mg/kg; central nervous system, pulmonary effects

HYDROGEN SULFIDE (continued):

LCLo (inhalation, human) = 800 ppm/5 minutes

LC_{50} (inhalation, rat) = 444 ppm

HYDROGEN SULFIDE (continued):

LC_{50} (inhalation, mouse) = 673 ppm/1 hour

LCLo (inhalation, mammal) = 800 ppm/5 minutes

SUSPECTED CANCER AGENT: The components of this gas mixture are not found on the following lists: FEDERAL OSHA Z LIST, NTP, CAL/OSHA, and IARC; therefore, they are not considered to be, nor suspected to be, cancer-causing agents by these agencies.

IRRITANCY OF PRODUCT: The Hydrogen Sulfide component of this gas mixture, is irritating to the eyes, and may be irritating to the skin.

SENSITIZATION OF PRODUCT: The components of this gas mixture are not known to be skin or respiratory sensitizers. Pentane isomers (i.e. n-Pentane) and Propane can cause cardiac sensitization to epinephrine.

REPRODUCTIVE TOXICITY INFORMATION: Listed below is information concerning the effects of this gas mixture on the human reproductive system.

Mutagenicity: No mutagenicity effects have been described for the components of this gas mixture.

Embryotoxicity: This gas mixture contains components that may cause embryotoxic effects in humans; however, due to the small total amount of the components, embryotoxic effects are not expected to occur.

Teratogenicity: This gas mixture is not expected to cause teratogenic effects in humans due to the small cylinder size and small total amount of all components. The Carbon Monoxide component of this gas mixture which exists up to 1%, can cause teratogenic effects in humans. Severe exposure to Carbon Monoxide during pregnancy has caused adverse effects and the death of the fetus. In general, maternal symptoms are an indicator of the potential risk to the fetus since Carbon Monoxide is toxic to the mother before it is toxic to the fetus.

Reproductive Toxicity: The components of this gas mixture are not expected to cause adverse reproductive effects in humans.

A mutagen is a chemical which causes permanent changes to genetic material (DNA) such that the changes will propagate through generation lines. An embryotoxin is a chemical which causes damage to a developing embryo (i.e. within the first eight weeks of pregnancy in humans), but the damage does not propagate across generational lines. A teratogen is a chemical which causes damage to a developing fetus, but the damage does not propagate across generational lines. A reproductive toxin is any substance which interferes in any way with the reproductive process.

BIOLOGICAL EXPOSURE INDICES (BEIs): Biological Exposure Indices (BEIs) have been determined for the components of this gas mixture, as follows:

CHEMICAL DETERMINANT	SAMPLING TIME	BEI
CARBON MONOXIDE • Carboxyhemoglobin in blood • Carbon monoxide in end-exhaled air	• End of shift • End of shift	• 3.5% of hemoglobin • 20 ppm
n-HEXANE • 2,5-Hexanedione in urine • n-Hexane in end-exhaled air	• End of shift	• 5 mg/g creatinine

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL STABILITY: The gas will be dissipated rapidly in well-ventilated areas. The following environmental data are applicable to the components of this gas mixture.

OXYGEN: Water Solubility = 1 volume Oxygen/32 volumes water at 20°C. Log K_{ow} = -0.65

PROPANE: Log K_{ow} = 2.38. Water Solubility = 62.4 ppm, 25°C. Propane is readily degraded by soil bacteria.

PENTANE: Log K_{ow} = 3.39. Water Solubility = 38.5 mg/L. LOG BCF (n-pentane) = calculated, 1.90 and 2.35, respectively. Photolysis, hydrolysis, and bioconcentration are not anticipated to be important fate processes. Biodegradation and soil adsorption are anticipated to be more important processes for this compound.

n-HEXANE: Log K_{ow} = 3.90-4.11. Water Solubility = 9.5 mg/L. Estimated Bioconcentration Factor =2.24 and 2.89. Bioconcentration in aquatic organisms is low. Hexane is volatile. Rapid volatilization from water and soil is anticipated for this compound. Hexane will float in slick on surface of the water

HYDROGEN SULFIDE: Water Solubility = 1 g/242 mL at 20°C.

CARBON MONOXIDE: Water solubility = 3.3 ml/100 cc at 0 °C, 2.3 ml at 20°C.

NITROGEN: Water Solubility = 2.4 volumes Nitrogen/100 volumes water at 0°C; 1.6 volumes Nitrogen/100 volumes water at 20°C.

EFFECT OF MATERIAL ON PLANTS or ANIMALS: No evidence is currently available on this gas mixture's effects on plant and animal life. The Hydrogen Sulfide and Carbon Monoxide components of this gas mixture, can be deadly to exposed animal life, producing symptoms similar to those experienced by humans. This gas mixture may also be harmful to plant life.

EFFECT OF CHEMICAL ON AQUATIC LIFE: No evidence is currently available on the effects of this gas effects on aquatic life. The presence of more than a trace of Carbon Monoxide is a hazard to fish. The following aquatic toxicity data are available for the Hydrogen Sulfide component of this gas mixture.

TLm (Asellussp) = 0.111 mg/L/96 hour
TLm (Cranfgonyx sp) =1.07 mg/L/96 hour
TLm (Gammarrus) = 0.84 mg/L/96 hour
LC_{50} (fly inhalation) = 380 mg/m^3/960 minutes
LC_{50} (fly inhalation) = 1500 mg/m^3/7 minutes
TLm (Lepomis macrochirus, bluegill sunfish) = 0.0478 mg/L/96 hour
TLm (Lepomis macrochirus, bluegill sunfish) = 0.0448 mg/L/96 hour at 21-22 °C
TLm (Pimephlaes promelas, fathead minnow) = 0.0071-0.55 mg/L/96 hour
TLm (Salvenilis foninalis, brook trout) = 0.0216-0.038 mg/L/96 hour at 8-12.5 °C

13. DISPOSAL CONSIDERATIONS

PREPARING WASTES FOR DISPOSAL PREPARING WASTES FOR DISPOSAL: Waste disposal must be in accordance with appropriate Federal, State, and local regulations. Cylinders with undesired residual product may be safely vented outdoors with the proper regulator. For further information, refer to Section 16 (Other Information).

14. TRANSPORTATION INFORMATION

THIS GAS MIXTURE IS HAZARDOUS AS DEFINED BY 49 CFR 172.101 BY THE U.S. DEPARTMENT OF TRANSPORTATION.

PROPER SHIPPING NAME: Compressed gases, n.o.s. (*Oxygen, Nitrogen)*or the gas component with the next highest concentration next to Nitrogen.

HAZARD CLASS NUMBER and DESCRIPTION: 2.2 (Non-Flammable Gas)
UN IDENTIFICATION NUMBER: UN 1956
PACKING GROUP: Not Applicable
DOT LABEL(S) REQUIRED: Class 2.2 (Non-Flammable Gas)
NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (2000): 126

MARINE POLLUTANT: The components of this gas mixture are not classified by the DOT as Marine Pollutants (as defined by 49 CFR 172.101, Appendix B).

SPECIAL SHIPPING INFORMATION: Cylinders should be transported in a secure position, in a well-ventilated vehicle. The transportation of compressed gas cylinders in automobiles or in closed-body vehicles can present serious safety hazards. If transporting these cylinders in vehicles, ensure these cylinders are not exposed to extremely high temperatures (as may occur in an enclosed vehicle on a hot day). Additionally, the vehicle should be well-ventilated during transportation.

Note: DOT 39 Cylinders ship in a strong outer carton (overpack). Pertinent shipping information goes on the outside of the overpack. DOT 39 Cylinders do not have transportation information on the cylinder itself.

TRANSPORT CANADA TRANSPORTATION OF DANGEROUS GOODS REGULATIONS: This gas is considered as Dangerous Goods, per regulations of Transport Canada.

PROPER SHIPPING NAME: Compressed gases, n.o.s. (*Oxygen, Nitrogen)*or the gas component with the next highest concentration next to Nitrogen.

HAZARD CLASS NUMBER and DESCRIPTION: 2.2 (Non-Flammable Gas)
UN IDENTIFICATION NUMBER: UN 1956
PACKING GROUP: Not Applicable
HAZARD LABEL: Class 2.2 (Non-Flammable Gas)
SPECIAL PROVISIONS: None
EXPLOSIVE LIMIT AND LIMITED QUANTITY INDEX: 0.12
ERAP INDEX: None
PASSENGER CARRYING SHIP INDEX: None
PASSENGER CARRYING ROAD VEHICLE OR PASSENGER CARRYING RAILWAY VEHICLE INDEX: 75
NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (2000): 126

NOTE: Shipment of compressed gas cylinders via Public Passenger Road Vehicle is a violation of Canadian law (Transport Canada Transportation of Dangerous Goods Act, 1992).

15. REGULATORY INFORMATION

ADDITIONAL U.S. REGULATIONS:

U.S. SARA REPORTING REQUIREMENTS: This gas is not subject to the reporting requirements of Sections 302, 304 and 313 of Title III of the Superfund Amendments and Reauthorization Act., as follows:

COMPONENT	SARA 302 (40 CFR 355, Appendix A)	SARA 304 (40 CFR Table 302.4)	SARA 313 (40 CFR 372.65)
n-Hexane	NO	YES	YES
Hydrogen Sulfide	YES	YES	YES

15. REGULATORY INFORMATION (Continued)

U.S. SARA THRESHOLD PLANNING QUANTITY: Section 302 EHS TPQ = Hydrogen Sulfide = 500 lbs (227 kg);
U.S. TSCA INVENTORY STATUS: The components of this gas mixture are listed on the TSCA Inventory.
U.S. CERCLA REPORTABLE QUANTITY (RQ): Hexane = 5000 lb (2270 kg); Hydrogen Sulfide = 100 lbs (45.4 lb)
OTHER U.S. FEDERAL REGULATIONS:

- Hydrogen Sulfide, Carbon Monoxide, Propane, n-Pentane and n-Hexane are subject to the reporting requirements of CFR 29 1910.1000.
- Hydrogen Sulfide, Propane and n-Pentane are subject to the reporting requirements of Section 112(r) of the Clean Air Act. The Threshold Quantity for each of these gases is 10,000 pounds and so this mixture will not be affected by the regulation.
- Depending on specific operations involving the use of this gas mixture, the regulations of the Process Safety Management of Highly Hazardous Chemicals may be applicable (29 CFR 1910.119). Hydrogen Sulfide is listed in Appendix A of this regulation. The Threshold Quantity for Hydrogen Sulfide under this regulation is 1500 lbs.
- This gas mixture does not contain any Class I or Class II ozone depleting chemicals (40 CFR part 82).
- Nitrogen, Oxygen and n-Hexane are not listed Regulated Substances, per 40 CFR, Part 68, of the Risk Management for Chemical Releases. Hydrogen Sulfide is listed under this regulation in Table 1 as a Regulated Substance (Toxic Substance), in quantities of 10,000 lbs (4,553 kg) or greater. Carbon Monoxide, Propane and n-Pentane are listed under this regulation in Table 3, as Regulated Substances (Flammable), in quantities of 10,000 lbs (4,553 kg) or greater, and so this mixture will not be affected by the regulation.

U.S. STATE REGULATORY INFORMATION: The components of this gas mixture are covered under the following specific State regulations:

Alaska - Designated Toxic and Hazardous Substances: Carbon Monoxide, Propane, n-Pentane, n-Hexane, Hydrogen Sulfide.
California - Permissible Exposure Limits for Chemical Contaminants: Carbon Monoxide, Nitrogen, Propane, n-Pentane, n-Hexane, Hydrogen Sulfide.
Florida - Substance List: Oxygen, Carbon Monoxide, n-Pentane, n-Hexane, Hydrogen Sulfide.
Illinois - Toxic Substance List: Carbon Monoxide, Propane, n-Pentane, n-Hexane, Hydrogen Sulfide.
Kansas - Section 302/313 List: No.
Massachusetts - Substance List: Oxygen, Carbon Monoxide, Propane, n-Pentane, n-Hexane, Hydrogen Sulfide.
Michigan - Critical Materials Register: No.
Minnesota - List of Hazardous Substances: Carbon Monoxide, Propane, n-Pentane, n-Hexane, Hydrogen Sulfide.
Missouri - Employer Information/Toxic Substance List t: n-Pentane, n-Hexane, Propane, Hydrogen Sulfide.
New Jersey - Right to Know Hazardous Substance List: Oxygen, Carbon Monoxide, Nitrogen, Propane, n-Pentane, n-Hexane.
North Dakota - List of Hazardous Chemicals, Reportable Quantities: Hydrogen Sulfide.
Pennsylvania - Hazardous Substance List: Oxygen, Carbon Monoxide, Nitrogen, Propane, n-Pentane, n-Hexane, Hydrogen Sulfide.
Rhode Island - Hazardous Substance List: Oxygen, Carbon Monoxide, Nitrogen, Propane, n-Pentane, n-Hexane, Hydrogen Sulfide.
Texas - Hazardous Substance List: n-Pentane, n-Hexane, Propane, Hydrogen Sulfide.
West Virginia - Hazardous Substance List: n-Pentane, n-Hexane, Propane, Hydrogen Sulfide.
Wisconsin - Toxic and Hazardous Substances: n-Pentane, n-Hexane, Propane, Hydrogen Sulfide

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): The Carbon Monoxide component of this gas mixture is on the California Proposition 65 lists as a chemical known to the State of California to cause birth defects or other reproductive harm.
ADDITIONAL CANADIAN REGULATIONS:

CANADIAN DSL/NDSL INVENTORY STATUS: The components of this gas mixture are on the Canadian DSL Inventory.
CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA) PRIORITIES SUBSTANCES LISTS: The components of this gas mixture are not on the CEPA Priorities Substances List.
CANADIAN WHMIS CLASSIFICATION: This gas mixture is categorized as a Controlled Product, Hazard Classes A and D2A, as per the Controlled Product Regulations.

16. OTHER INFORMATION

INFORMATION ABOUT DOT-39 NRC (Non-Refillable Cylinder) PRODUCTS

DOT 39 cylinders ship as hazardous materials when full. Once the cylinders are relieved of pressure (empty) they are not considered hazardous material or waste. Residual gas in this type of cylinder is not an issue because toxic gas mixtures are prohibited. Calibration gas mixtures typically packaged in these cylinders are Nonflammable n.o.s., UN 1956. A small percentage of calibration gases packaged in DOT 39 cylinders are flammable or oxidizing gas mixtures.

For disposal of used DOT-39 cylinders, it is acceptable to place them in a landfill if local laws permit. Their disposal is no different than that employed with other DOT containers such as spray paint cans, household aerosols, or disposable cylinders of propane (for camping, torch etc.). When feasible, we recommended recycling for scrap metal content. CALGAZ will do this for any customer that wishes to return cylinders to us prepaid. All that is required is a phone call to make arrangements so we may anticipate arrival. Scrapping cylinders involves some preparation before the metal dealer may accept them. We perform this operation as a service to valued customers who want to participate.

MIXTURES: When two or more gases or liquefied gases are mixed, their hazardous properties may combine to create additional, unexpected hazards. Obtain and evaluate the safety information for each component before you produce the mixture. Consult an Industrial Hygienist or other trained person when you make your safety evaluation of the end product. Remember, gases and liquids have properties which can cause serious injury or death.

Further information about the handling of compressed gases can be found in the following pamphlets published by: Compressed Gas Association Inc. (CGA), 1725 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202-4102. Telephone: (703) 412-0900.

P-1 *"Safe Handling of Compressed Gases in Containers"*
AV-1 *"Safe Handling and Storage of Compressed Gases"*
"Handbook of Compressed Gases"

PREPARED BY: CHEMICAL SAFETY ASSOCIATES, Inc.
PO Box 3519, La Mesa, CA 91944-3519
619/670-0609

Fax on Demand: 1-800/231-1366

AIR LIQUIDE

This Material Safety Data Sheet is offered pursuant to OSHA's Hazard Communication Standard, 29 CFR, 1910.1200. Other government regulations must be reviewed for applicability to this gas mixture. To the best of CALGAZ knowledge, the information contained herein is reliable and accurate as of this date; however, accuracy, suitability or completeness are not guaranteed and no warranties of any type, either express or implied, are provided. The information contained herein relates only to this specific product. If this gas mixture is combined with other materials, all component properties must be considered. Data may be changed from time to time. Be sure to consult the latest edition.

SIGMA-ALDRICH

sigma-aldrich.com

SAFETY DATA SHEET

Version 4.20
Revision Date 11/07/2017
Print Date 10/06/2018

1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name	:	Trizma® base
Product Number	:	T1503
Brand	:	Sigma
CAS-No.	:	77-86-1

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses	:	Laboratory chemicals, Synthesis of substances

1.3 Details of the supplier of the safety data sheet

Company	:	Sigma-Aldrich 3050 Spruce Street SAINT LOUIS MO 63103 USA
Telephone	:	+1 800-325-5832
Fax	:	+1 800-325-5052

1.4 Emergency telephone number

Emergency Phone #	:	+1-703-527-3887 (CHEMTREC)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

Not a hazardous substance or mixture.

2.2 GHS Label elements, including precautionary statements

Not a hazardous substance or mixture.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS

This substance is not considered to be persistent, bioaccumulating and toxic (PBT).

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Synonyms	:	2-Amino-2-(hydroxymethyl)-1,3-propanediol THAM Trometamol Tris base Tris(hydroxymethyl)aminomethane
Formula	:	$C_4H_{11}NO_3$
Molecular weight	:	121.14 g/mol
CAS-No.	:	77-86-1
EC-No.	:	201-064-4
Registration number	:	01-2119957659-16-XXXX

No components need to be disclosed according to the applicable regulations.

4. FIRST AID MEASURES

4.1 Description of first aid measures

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration.

In case of skin contact
Wash off with soap and plenty of water.

In case of eye contact
Flush eyes with water as a precaution.

If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water.

4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed
No data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture
No data available

5.3 Advice for firefighters
Wear self-contained breathing apparatus for firefighting if necessary.

5.4 Further information
No data available

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Avoid dust formation. Avoid breathing vapours, mist or gas.
For personal protection see section 8.

6.2 Environmental precautions
No special environmental precautions required.

6.3 Methods and materials for containment and cleaning up
Sweep up and shovel. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections
For disposal see section 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Further processing of solid materials may result in the formation of combustible dusts. The potential for combustible dust formation should be taken into consideration before additional processing occurs.
Provide appropriate exhaust ventilation at places where dust is formed.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities
Keep container tightly closed in a dry and well-ventilated place.

Hygroscopic. Store under inert gas.
Storage class (TRGS 510): 13: Non Combustible Solids

7.3 Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

Components with workplace control parameters

Contains no substances with occupational exposure limit values.

8.2 Exposure controls

Appropriate engineering controls

General industrial hygiene practice.

Personal protective equipment

Eye/face protection

Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection

Choose body protection in relation to its type, to the concentration and amount of dangerous substances, and to the specific work-place., The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection

Respiratory protection is not required. Where protection from nuisance levels of dusts are desired, use type N95 (US) or type P1 (EN 143) dust masks. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure

No special environmental precautions required.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: crystalline Colour: colourlesswhite
b)	Odour	No data available
c)	Odour Threshold	No data available
d)	pH	10.5 - 12

e)	Melting point/freezing point	Melting point/range: 168 °C (334 °F)
f)	Initial boiling point and boiling range	288 °C (550 °F) at 1,013 hPa (760 mmHg) - Decomposes below the boiling point.
g)	Flash point	No data available
h)	Evaporation rate	No data available
i)	Flammability (solid, gas)	Does not sustain combustion.
j)	Upper/lower flammability or explosive limits	No data available
k)	Vapour pressure	No data available
l)	Vapour density	No data available
m)	Relative density	No data available
n)	Water solubility	678 g/l at 20 °C (68 °F)
o)	Partition coefficient: n-octanol/water	log Pow: -2.31 at 20 °C (68 °F)
p)	Auto-ignition temperature	The substance or mixture is not classified as self heating.
q)	Decomposition temperature	No data available
r)	Viscosity	Not applicable
s)	Explosive properties	Not explosive
t)	Oxidizing properties	The substance or mixture is not classified as oxidizing.

9.2 Other safety information

Bulk density	800 kg/m3
Dissociation constant	8.22 at 25 °C (77 °F)

10. STABILITY AND REACTIVITY

10.1 Reactivity
No data available

10.2 Chemical stability
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions
No data available

10.4 Conditions to avoid
hygroscopic

10.5 Incompatible materials
Strong oxidizing agents

10.6 Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - Carbon oxides, Nitrogen oxides (NOx)
Other decomposition products - No data available
In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity
LD50 Oral - Rat - > 5,000 mg/kg
(OECD Test Guideline 425)

Inhalation: No data available

LD50 Dermal - Rat - > 5,000 mg/kg
(OECD Test Guideline 402)

No data available

Skin corrosion/irritation
Skin - Rabbit
Result: No skin irritation
(OECD Test Guideline 404)

Serious eye damage/eye irritation
Eyes - Rabbit
Result: No eye irritation
(OECD Test Guideline 405)

Respiratory or skin sensitisation
Buehler Test - Guinea pig
Does not cause skin sensitisation.
(OECD Test Guideline 406)

Germ cell mutagenicity
Result: Not mutagenic in Ames Test

in vitro assay
Result: negative
In vitro tests did not show mutagenic effects

Result: In vivo tests did not show any chromosomal changes.

Carcinogenicity

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity
No data available

No data available

Specific target organ toxicity - single exposure
No data available

Specific target organ toxicity - repeated exposure
No data available

Aspiration hazard
No data available

Additional Information

Repeated dose toxicity: Rat - Oral - Subacute toxicity - NOAEL : 1,000 mg/kg

RTECS: TY2900000

To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

12. ECOLOGICAL INFORMATION

12.1 Toxicity

Toxicity to daphnia and other aquatic: EC50 - Daphnia (water flea) - > 980 mg/l - 48 h

invertebrates		
Toxicity to algae	EC50 - Algae - 397 mg/l - 72 h	
	NOEC - Algae - 100 mg/l - 72 h	

12.2 Persistence and degradability

Biodegradability — Result: - Readily biodegradable. (OECD Test Guideline 301F)

12.3 Bioaccumulative potential

No bioaccumulation is to be expected (log Pow <= 4).

12.4 Mobility in soil

No data available

12.5 Results of PBT and vPvB assessment

This substance is not considered to be persistent, bioaccumulating and toxic (PBT).

12.6 Other adverse effects

No data available

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product
Offer surplus and non-recyclable solutions to a licensed disposal company.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
Not dangerous goods

IMDG
Not dangerous goods

IATA
Not dangerous goods

15. REGULATORY INFORMATION

SARA 302 Components
No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards
No SARA Hazards

Massachusetts Right To Know Components
No components are subject to the Massachusetts Right to Know Act.

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Tris (hydroxymethyl) aminomethane	77-86-1	

	CAS-No.	Revision Date
Tris (hydroxymethyl) aminomethane	77-86-1	

New Jersey Right To Know Components

	CAS-No.	Revision Date

Tris (hydroxymethyl) aminomethane	77-86-1

California Prop. 65 Components

This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

HMIS Rating

Health hazard:	0
Chronic Health Hazard:	
Flammability:	0
Physical Hazard	0

NFPA Rating

Health hazard:	0
Fire Hazard:	0
Reactivity Hazard:	0

Further information

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Preparation Information

Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

Version: 4.20 Revision Date: 11/07/2017 Print Date: 10/06/2018

APPENDIX C

Personal Protective Equipment (PPE) Management Program

PERSONAL PROTECTIVE EQUIPMENT MANAGEMENT PROGRAM

CORPORATE HEALTH AND SAFETY MANAGER	:	**Brian Hobbs, CIH, CSP**
EFFECTIVE DATE	:	**01/19**
REVISION NUMBER	:	**4**

TABLE OF CONTENTS

1. PURPOSE

Roux Associates, Inc. and its affiliated companies, Roux Environmental Engineering and Geology, D.P.C, and Remedial Engineering (collectively, “Roux”) has instituted the following program to establish guidelines for the selection of personal protective equipment (PPE) for use by Roux personnel performing field activities in hazardous environments. PPE is not meant to be a substitute for engineering, work practice, and/or administrative controls, but PPE should be used in conjunction with these controls to protect the employees in the work place. Clothing, body coverings, and other accessories designed to prevent worker exposure to workplace hazards are all types of PPE. To ensure adequate PPE employee-owned PPE is evaluated on a case-by-case basis to insure its adequacy, maintenance and sanitation.

2. SCOPE AND APPLICABILITY

These guidelines apply to all PPE selection decisions to be made in implementing the Roux program. The foundations for this program are the numerous Occupational Health and Safety Administration (OSHA) standards related to PPE cited in 29 CFR 1910 Subpart I, 29 CFR 1926 Subpart E, and the hazardous environment work employee protection requirements under the OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER) standard at 29 CFR 1910.120 and 1926.65. To ensure hazard assessments are documented the levels of protection, types of protection and tasks requiring protection are covered in site-specific Health and Safety Plans (HASPs) and Job Safety Analyses (JSAs).

3. PROCEDURES

Due to the varied nature of site activities and the different potential hazards associated with different sites, several aspects must be considered when selecting PPE. The following text describes PPE selection logic and provides guidelines and requirements for the appropriate selection and use of PPE.

3.1 Introduction

To harm the body, chemicals must first gain entrance. The intact skin and the respiratory tract are usually the first body tissues attacked by chemical contaminants. These tissues provide barriers to some chemicals but in many cases, are damaged themselves or are highly permeable by certain chemical compounds. Personal protective equipment therefore is used to minimize or eliminate chemical compounds coming into contact with these first barrier tissues.

The proper selection of equipment is important in preventing exposures. The PM making the selection will have to take several factors into consideration. The level of protection, type and kind of equipment selected depends on the hazardous conditions and in some cases cost, availability, compatibility with other equipment, and performance. An accurate assessment of all these factors must be made before work can be safely carried out.

3.2 Types of PPE

The type and selection of PPE must meet certain general criteria and requirements as required under OSHA 29 CFR 1910.132 and 1926.95. In addition to these general requirements, specific requirements and specifications exist for some types of PPE that form the basis of the protective clothing scheme. Following is a list of the common types of specific PPE and the specific requirements for the PPE type, where applicable:

1. Hard Hats - Regulated by 29 CFR 1910.135 and 1926.100; and, specified in ANSI Z89.1.

2. Face Shields and Safety Glasses - Regulated by 29 CFR 1910.133 and 1926.102; and, specified in ANSI Z87.1.
3. Respiratory Protection - Regulated by 29 CFR 1910.134 and 1926.103.
4. Hand Protection - Not specifically regulated.
5. Foot Protection - Regulated by 29 CFR 1910.136 and 1926.96; and, specified in ANSI Z41.1.
6. Protective Clothing (e.g., fully encapsulated suits, aprons) - Not specifically regulated.

3.3 Protective Clothing Selection Criteria

3.3.1 Chemicals Present

The most important factor in selecting PPE is the determination of what chemicals the employee may be exposed to. On field investigations, the number of chemicals may range from a few to several hundred. The exact chemicals or group of chemicals present at the site (certain groups tend to require similar protection) can be determined by collecting and analyzing samples of the air, soil, water, or other site media. When data are lacking, research into the materials used or stored at the site can be used to infer chemicals possibly on the site.

Once the known or suspected chemicals have been identified, and taking into consideration the type of work to be performed, the most appropriate clothing shall be selected.

Protective garments are made of several different substances for protection against specific chemicals. There is no universal protective material. All will decompose, be permeated by, or otherwise fail to protect under given circumstances. Fortunately, most manufacturers make guides to the use of their products (i.e., Dupont's Tyvek™ Permeation Guide). These guides are usually for gloves and coveralls and typically provide information regarding chemical degradation rates (failure of the material to maintain structural integrity when in contact with the chemical), and may provide information on the permeation rate (whether or not the material allows the chemical to pass through). When permeation tables are available, they shall be used in conjunction with degradation tables to determine the most appropriate protective material.

During most site work, chemicals are usually in mixed combinations and the protective materials are not in continuous contact with pure chemicals for long periods of time; therefore, the selected material may be adequate for the particular chemical and type of work being performed, yet not the "best" protecting material for all site chemicals and activities. Selection shall depend upon the most hazardous chemicals based on their hazards and concentrations. Sometimes layering, using several different layers of protective materials, affords the best protection.

3.3.2 Concentration of the Chemical(s)

One of the major criteria for selecting protective material is the concentration of the chemical(s) in air, liquid, and/or solid state. Airborne and liquid chemical concentrations should be compared to the OSHA standards and/or American Conference of Governmental Industrial Hygienists (ACGIH) and National Institute for Occupational Safety and Health (NIOSH) guidelines to determine the level of skin or other absorptive surface (e.g., eyes) protection needed. While these standards are not designed specifically for skin exposed directly to the liquid, they may provide skin designations indicative of chemicals known to have significant skin or dermal absorption effects. For example, airborne levels of PCB on-site may be low because it is not very volatile, so the inhalation hazard may be minimal; however, PCB-containing liquid coming in direct contact with the skin may cause overexposure. Thus, PCB has been assigned a skin designation in both the OSHA and ACGIH exposure limit tables.

3.3.3 Physical State

The characteristics of a chemical may range from nontoxic to extremely toxic depending on its physical state. Inorganic lead in soil would not be considered toxic to site personnel, unless it became airborne, since it is generally not absorbed through the intact skin. Organic lead in a liquid could be readily absorbed. Soil is frequently contaminated with hazardous materials. Concentrations will vary from a few parts per million to nearly one hundred percent. The degree of hazard is dependent on the type of soil and concentration of the chemical. Generally speaking, "dry" soils do not cause a hazard to site personnel if they take minimal precautions such as wearing some type of lightweight gloves.

3.3.4 Length of Exposure

The length of time a material is exposed to a chemical increases the probability of breakthrough. Determinations of actual breakthrough times for short-term exposures indicate that several different materials can be used which would be considered inadequate under long-term exposures. It should be kept in mind that during testing, a pure (100% composition) liquid is usually placed in direct contact with the material producing a worst-case situation.

3.3.5 Abrasion

When selecting protective clothing, the job the employee is engaged in must be taken into consideration. Persons moving drums or performing other manual tasks may require added protection for their hands, lower chest and thighs. The use of leather gloves and a heavy apron over the other normal protective clothing will help prevent damage to the normal PPE and thus reduce worker exposures.

3.3.6 Dexterity

Although protection from skin and inhalation hazards is the primary concern when selecting PPE, the ability to perform the assigned task must be maintained. For example, personnel cannot be expected to perform work that requires fine dexterity if they must wear a thick glove. Therefore, the PPE selection process must consider the task being performed and provide PPE alternatives or techniques that allow dexterity to be maintained while still protecting the worker (e.g., wearing tight latex gloves over more bulky hand protection to increase dexterity).

3.3.7 Ability to Decontaminate

If disposable clothing cannot be used, the ability to decontaminate the materials selected must be taken into consideration. Once a chemical contacts the material, it must be cleaned before it can be reused. If the chemical has completely permeated the material, it is unlikely that the clothing can be adequately decontaminated and the material should be discarded.

3.3.8 Climactic Conditions

The human body works best with few restraints from clothing. Protective clothing adds a burden by adding weight and restricting movement as well as preventing the natural cooling process. In severe situations, a modified work program must be used.

Some materials act differently when they are very hot and very cold. For example, PVC becomes almost brittle in very cold temperatures. If there are any questions about the stability of the protective materials under different conditions, the manufacturer should be contacted.

3.3.9 Work Load

Like climactic conditions, the type of work activity may affect work duration and the ability or personnel to perform certain tasks. Similarly, the amount of protective materials a person wears will affect their ability to perform certain tasks. For example, a person in a total encapsulating suit, even at 72 ^{o}F, cannot work for more than a short period of time without requiring a break.

The work schedule should be adjusted to maintain the health of the employees. Special consideration should be given to the selection of clothing that both protects and adds the least burden when personnel are required to perform strenuous tasks. Excessive bodily stress frequently represents the most significant hazard encountered during field work.

3.4 Types of Protective Materials

1. Cellulose or Paper
2. Natural and Synthetic Fibers
   a. Tyvek™
   b. Nomex™
3. Elastomers
   a. Polyethylene
   b. Saran
   c. Polyvinyl Chloride (PVC)
   d. Neoprene
   e. Butyl Rubber
   f. Viton

3.5 Protection Levels

3.5.1 Level A Protection

Level A protection (a fully encapsulated suit) is used when skin hazards exist or when there is no known data that positively rule out skin and other absorption hazards. Since Level A protection is extremely physiologically and psychologically stressful, the decision to use this protection must be carefully considered. At no time will Level A work be performed without the consent of the OM. The following conditions suggest a need for Level A protection:

- confined facilities where probability of skin contact is high;
- sites containing known skin hazards;
- sites with no established history to rule out skin and other absorption hazards;
- atmosphere immediately dangerous to life and health (IDLH) through the skin absorption route;
- site exhibiting signs of acute mammalian toxicity (e.g., dead animals, illnesses associated with past entry into site by humans);

- sites at which sealed drums of unknown materials must be opened;
- total atmospheric readings on the Photoionization Detector (PID), Flame Ionization Detector (FID), and similar instruments indicate 500 to 1,000 ppm of unidentified substances; and
- extremely hazardous substances (e.g., cyanide compounds, concentrated pesticides, Department of Transportation Poison "A" materials, suspected carcinogens and infectious substances) are known or suspected to be present and skin contact is possible.

The following items constitute Level A protection:

- open circuit, pressure-demand self-contained breathing apparatus (SCBA);
- totally encapsulated suit;
- gloves, inner (surgical type);
- gloves, outer;
- chemical protective;
- boots, chemical protective, steel toe and shank;
- radiation detector (if applicable); and
- communications.

3.5.2 Level B Protection

Level B protection is utilized when the highest level of respiratory protection is needed but hazardous material exposure to the few unprotected areas of the body is unlikely.

The following conditions suggest a need for Level B protection:

- the type and atmospheric concentration of toxic substances have been identified and they require the highest level of respiratory protection;
- IDLH atmospheres where the substance or concentration in the air does not present a severe skin hazard;
- the type and concentrations of toxic substances do not meet the selection criteria permitting the use of air purifying respirators; and
- it is highly unlikely that the work being done will generate high concentrations of vapors, gases or particulates, or splashes of materials that will affect the skin of personnel.

Personal protective equipment for Level B includes:

- open circuit, pressure-demand SCBA;
- chemical protective clothing:
- overalls and long-sleeve jacket; or
- coveralls;
- gloves, inner (surgical type); gloves, outer, chemical protective;
- boots, chemical protective, steel toe and shank; and
- communications optional.

3.5.3 Level C Protection

Level C protection is utilized when both skin and respiratory hazards are well defined and the criteria for the use of negative pressure respirators have been fulfilled (i.e., known contaminants and contaminant concentrations, acceptable oxygen levels, approved filter/cartridge available, known cartridge service life, etc.). Level C protection may require carrying an emergency escape respirator during certain initial entry and site reconnaissance situations, or when applicable thereafter.

Personal protective equipment for Level C typically includes:

- full facepiece air-purifying respirator;
- emergency escape respirator (optional);
- chemical protective clothing:
  - overalls and long-sleeved jacket; or
  - coveralls;
- gloves, inner (surgical type);
- gloves, outer, chemical protective; and
- boots, chemical protective, steel toe and shank.

3.5.4 Level D Protection

Level D is the basic work uniform. Personal protective equipment for Level D includes:

- coveralls;
- safety boots/shoes;
- eye protection;
- hand protection;
- reflective traffic safety vest (mandatory for traffic areas or railyard);
- hard hat (with face shield is optional); and
- emergency escape respirator is optional.

3.5.5 Level E Protection

Level E protection is used when radioactivity above 10 mr/hr is detected at the site. Personal protective equipment for Level E includes:

- coveralls;
- air purifying respirator;
- time limits on exposure;
- appropriate dermal protection for the type of radiation present; and
- radiation dosage monitoring.

3.5.6 Additional Considerations

Field work will contain a variety of situations due to chemicals in various concentrations and combinations. These situations may be partially ameliorated by following the work practices listed below:

1. Some sort of foot protection is needed on a site. If the ground to be worked on is contaminated with liquid and it is necessary to walk in the chemicals, some sort of protective "booties" can be worn over the boots. This cuts down on decontamination requirements. They are designed with soles to help prevent them from slipping around. If non-liquids are to be encountered, a Tyvek™ bootie could be used. If the ground contains any sharp objects, the advantage of booties is questionable. Boots should be worn with either cotton or wool socks to help absorb the perspiration.
2. If the site situation requires the use of hard hats, chin straps should be used if a person will be stooping over where his/her hat may fall off. Respirator straps should not be placed over the hard hats. This will affect the fit of the respirator.

   Some types of protective materials conduct heat and cold readily. In cold conditions, natural material clothing should be worn under the protective clothing. Protective clothing should be removed prior to allowing a person "to get warm". Applying heat, such as a space heater, to the outside of the protective clothing may drive the contaminants through. In hot weather, under clothing will absorb sweat. It is recommended that workers use all cotton undergarments.
3. Body protection should be worn and taped to prevent anything from running into the top of the boot. Gloves should be worn and taped to prevent substances from entering the top of the glove. Duct tape is preferred, but masking tape can be used. When aprons are used, they should be taped across the back for added protection. However, this should be done in such a way that the person has mobility.
4. Atmospheric conditions such as precipitation, temperature, wind direction, wind velocity, and pressure determine the behavior of contaminants in air or the potential for volatile material getting into the air. These parameters should be considered in determining the need for and the level of protection.
5. A program must be established for periodic monitoring of the air during site operations. Without an air monitoring program, any changes would go undetected and might jeopardize response personnel. Monitoring can be done with various types of air pumps and filtering devices followed by analysis of the filtration media; personnel dosimeters; and periodic walk-throughs by personnel carrying real-time survey instruments.
6. For operations in the exclusion zone, different levels of protection may be selected, and various types of chemical-resistant clothing may be worn. This selection should be based on the job function, reason for being in the area, and the potential for skin contact with, or inhalation of, the chemicals present.
7. Escape masks must be readily available when levels of respiratory protection do not include a SCBA and the possibility of an IDLH atmosphere exists. Their use can be made on a case-by-case basis. Escape masks could be strategically located at the site in areas that have higher possibilities of vapors, gases or particulates.

APPENDIX D

Subsurface Utility Clearance Management Program

SUBSURFACE UTILITY CLEARANCE MANAGEMENT PROGRAM

CORPORATE HEALTH AND SAFETY MANAGER	**:**	**Brian Hobbs, CIH, CSP**
EFFECTIVE DATE	**:**	**01/19**
REVISION NUMBER	**:**	**2**

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APPENDICES

1. PURPOSE

Roux Associates, Inc. and its affiliated companies, Roux Environmental Engineering and Geology, D.P.C, and Remedial Engineering (collectively, "Roux") has instituted the following program for completing proper utility mark-outs and for conducting subsurface clearance activities. This establishes a method to ensure, to the greatest extent possible, that utilities have been identified and contact and/or damage to underground utilities and other subsurface structures will be avoided.

2. SCOPE AND APPLICABILITY

The Subsurface Utility Clearance Management Program applies to all Roux employees, its contractors and subcontractors. Employees are expected to follow this program for all intrusive work involving Roux or other personnel (e.g., contractors/subcontractors) working for Roux unless the client's requirements are more stringent. Deviation from the program regardless of the specific work activity or work location must be pre-approved based on client's site knowledge, site experience and client's willingness for the use of this program. Any and all exceptions shall be documented and pre-approved by the Project Principal and the Office Manager.

3. PROCEDURES

3.1 Before Intrusive Activities

During the project kick-off meeting for intrusive activities the PM will review the Roux Subsurface Utility Clearance Checklist and Utility Verification (Appendix C) / Site Walkthrough Record (Appendix D) and the below bullet points with the project field team:

(Please note that these are intended as general reminders only and should not be solely relied upon.)

- Ensure the Mark-out / Stake-out Request Information Sheet (or one-call report) is complete and accurate for the site including address and cross streets and review for missing utilities. (Note: utility mark-out organizations do not have contracts with all utilities and it is often necessary to contact certain utilities separately such as the local water and sewer authorities).
- Have written confirmation prior to mobilizing to the site that the firm or Roux personnel performing the intrusive activity has correctly completed the mark-out notification process including requesting mark-outs, waiting for mark-outs to be applied to ground surfaces at the site, and receiving written confirmation of findings (via fax or email) from utility operators for all known or suspected utilities in the proposed area of intrusive activity, and provided utility owner written confirmation to Roux personnel for review and project files documentation.
- Do not begin any intrusive activity until all utilities mark-out has been completed (i.e., did all utilities mark-out the site?) and any unresolved mark-out issues are finalized. Perform a site walk to review the existing utilities and determine if said utilities have been located by the utility locators.

  (Note: The Tolerance Zone is defined as two feet plus half of the diameter or half of the greatest dimension (for elliptical sewers, duct banks and other non-cylindrical utilities) of a utility and two feet from the outside edge of any subsurface structure.)
- Install Pre-Clearance exploratory test holes (e.g., hand-dug test holes or other soft digging techniques) for the first 5-ft below land surface (BLS) at each location prior to conducting mechanized intrusive activities. The size of the pre-clearance exploratory test hole should be at a minimum twice the diameter of any downhole tool or boring device. (Note: Pre-Clearance exploratory test holes should be defined in the SOW/proposal provided to the client to prevent project delays and to allow adequate time for PM and PP to evaluate alternative approaches for the project. Alternative approaches will need to be pre-approved by the OM.

- For excavations, all utilities need to be marked and then exposed by hand following the protocols in this program. Pre-clearing for excavations may be performed by the “moat” technique (i.e., soft digging around the perimeter). In these cases, dig in small lifts (<12” for first 5 feet) using a dedicated spotter.) For Tolerance Zone work, unless otherwise agreed upon with the Utility Operator, work within the tolerance zone requires verification by means of hand-dug test holes performed to expose the utility. Once structures have been verified a minimum clearance of two feet must be maintained between the utility and any powered equipment.
- In addition, the following activities should be conducted:
  - Review the work scope to be performed with the site owner/tenant to determine if it may impact any utilities;
  - Attempt to procure any utility maps or historic drawings of subsurface conditions of the site;
  - **Determine the need for utility owner companies to be contacted or to have their representatives on site**;
  - Where mark-outs terminate at the property boundary, consider the use of private utility locating / GPR / geophysical-type services which may be helpful in locating utilities. Use of private utility locating firms, however, does not eliminate the legal requirement for the Excavator firm to submit a request for Public Utility Mark-outs. Also, the information provided by the service may be inaccurate and unable to locate subsurface utilities and structures in urban areas, landfills, urban fill areas and below reinforced slabs, etc. They should not be relied upon as the only means of performing utility clearance;
  - Documented description of the dig site which is included in the projects Health and Safety Plan (HASP) and one call report will be maintained in the field and distributed amongst Roux personnel its contractors and subcontractors; and
  - Documentation of the actual placement of mark outs in the field shall be collected using dated pictures, videos and/or sketches with distance from markings to fixed objects. All documentation shall be maintained within the project file.

3.2 During Intrusive Activities

The PM, field team lead or personnel performing oversight is to:

- Ensure the mark-out remains valid. (In certain states there are limits regarding the duration of time after the mark-out was applied to the ground surface work can be started or interrupted.) Additionally, the mark-outs must be maintained, documented, and in many cases refreshed periodically to be considered valid, this will be accomplished through calls to the one call center.
- Ensure intrusive activities are only performed within the safe boundaries of the mark-out as detailed in the One-Call Report.
- Halt all work if intrusive activities have resulted in discovery of an unmarked utility. Roux personnel shall notify the facility owner/operator and the one call center. All incidents such as this will be reported as per Roux Incident Investigation and Reporting Management Program.
- Halt all work if intrusive activities must take place outside of the safe boundaries of a mark-out and only proceed after new mark-outs are performed.
- Halt the intrusive activities and immediately consult with the PP if an unmarked utility is encountered.
- Completing any subsurface utility clearance incident reports that are necessary.

- If a utility cannot be found as marked Roux personnel shall notify the facility owner/operator directly or through the one call center. Following notification, the excavation may continue, unless otherwise specified in state law.
- Contractors/subcontractors must contact the one-call center to refresh the ticket when the excavation continues past the life of the ticket. Ticket life shall be dictated by state law however at a maximum ticket life shall not exceed 20 working days.

3.3 Stop Work Authority

Each Roux employee has Stop Work Authority which he or she will execute upon determination of any imminent safety hazard, emergency situation, or other potentially dangerous situation, such as hazardous weather conditions. This Stop Work Authority includes subsurface clearance issues such as the adequacy of a mark-out or identification during intrusive operations of an unexpected underground utility. Authorization to proceed with work will be issued by the PM/PP after such action is reviewed and resolved. The PM will initiate and execute all management notifications and contact with emergency facilities and personnel when this action is appropriate.

Appendix A - Definitions

Intrusive Work Activities	All activities such as digging or scraping the surface, including but not limited to, excavation, test pitting or trenching, soil vapor sampling or the installation of soil borings, soil vapor monitoring points and wells, or monitoring wells, and drilling within the basement slab of a recently demolished building.
Mark-out / Stake Out	The process of contracting with a competent and qualified company to confirm the presence or absence of underground utilities and structures. This process will clearly mark-out and delineate utilities that are identified so that intrusive work activities can be performed without causing disturbance or damage to the subsurface utilities and structures. After utility mark-outs are completed the soft digging will be completed prior to intrusive work.
Tolerance Zone	Defined as two feet on either side of the designated centerline of an identified utility, plus half of the diameter or half of the greatest dimension (for elliptical sewers, duct backs and other non-cylindrical utilities) of that utility and two feet from the outside edge of any subsurface structure.
Structure	For the purpose of this program a structure is defined as any underground feature that may a present potential source(s) of energy such as, but not limited to, utility vaults, bunkers, piping, electrical boxes, wires, conduits, culverts, utility lines, underground tanks and ducts.
Soft Digging	The safest way to remove material from unknown obstructions or services is by using tools such as a vactor or air knife, non-mechanical tools, or hand tools. The methods are clean and non-evasive and used for uncovering and exposing buried services, excavating and for providing a quick method of soil removal from sensitive areas.
Verification	Exploratory test-hole dug with hand tools within the Tolerance Zone to expose and verify the location, type, size, direction-of-run and depth of a utility or subsurface structure. Vacuum excavation (soft dig) methods can further facilitate exposure of a subsurface utility and accurately provide its location and identification prior to intrusive work approaching the Tolerance Zone.

Appendix B - Example of Completed One Call Report

Example Completed One-Call Report

New York 811

Send To: C_EMAIL   Seq No: 744

Ticket No: 133451007 ROUTINE

Start Date: 12/16/13 Time: 7:00 AM   Lead Time: 20

State: NY   County: QUEENS   Place: QUEENS
Dig Street: 46TH AVE   Address:
Nearest Intersecting Street: VERNON BLVD
Second Intersecting Street: 11TH ST

Type of Work: SOIL BORINGS
Type of Equipment: GEOPROBE
Work Being Done For: ROUX

In Street: X   On Sidewalk: X   Private Property: Other:
On Property Location if Private: Front: Rear: Side:

Location of Work: MARK THE ENTIRE NORTH SIDE OF THE STREET AND SIDEWALK OF:
46TH AVE BETWEEN VERNON BLVD AND 11TH STREET

Remarks:

Nad: Lat: Lon: Zone:
ExCoord NW Lat: 40.7475399 Lon: -73.9534811 SE Lat: 40.7457406 Lon: -73.9493680

Company : ZEBRA ENVIROMENTAL   Best Time: 6AM-5PM
Contact Name: DAVID VINES   Phone: (516)596-6300
Field Contact: DAVID VINES   Phone: (516)596-6300
Caller Address: 30 N PROSPECT AVE   Fax Phone: (516)596-4422
LYNBROOK, NY 11563
Email Address: david@zebraenv.com

Additional Operators Notified:

ATTNY01	AT&T CORPORATION	(903)753-3145
CEQ	CONSOLIDATED EDISON CO. OF N.Y	(800)778-9140
MCINY01	MCI	(800)289-3427
PANYNJ01	PORT AUTHORITY OF NY & NJ	(201)595-4841
VZQ	VERIZON COMMUNICATIONS	(516)297-1602

Link to Map for C_EMAIL: http://ny.itic.occinc.com/XGMZ-DF2-L23-YAY

Original Call Date: 12/11/13 Time: 1:15 PM Op: webusr
IMPORTANT NOTE: YOU MUST CONTACT ANY OTHER UTILITIES DIRECTLY

Appendix C - Roux Subsurface Utility Clearance Checklist

Roux Subsurface Utility Clearance Checklist ***Date of Revision – 12/3/14***

Work site set-up and work execution

ACTIVITY	Yes	No	N/A	COMMENTS INCLUDING JUSTIFICATION IF RESPONSE IS NO OR NOT APPLICABLE
Daily site safety meeting conducted, SPSAs performed, JSAs reviewed, appropriate work permits obtained.				
HASP is available and reviewed by site workers / visitors.				
Subsurface Utility Clearance Procedure has been reviewed with all site workers.				
Work area secured; traffic control established as needed. Emergency shut-off switch located. Fire extinguishers / other safety equipment available as needed.				
Utility mark-outs (public / private) clear and visible. Provide Excavator's Stake-Out Reference Number / Request Date / Time.				
Tolerance zone work identified.				
Work execution plan reviewed and adhered to (ground disturbance methods, clearance depths, any special utility protection requirements, or any other execution requirements; especially for Tolerance Zone work).				
Verbal endorsement received from Roux PM for any required field deviations to work execution plan.				

<u>Key reminders for execution</u>:

The Subsurface Utility Clearance Protocol should be referenced to determine all requirements while executing subsurface work. The bullet points below are intended as general reminders only and should not be solely relied upon.

- Tolerance zone is defined as two feet plus half of the diameter or half of the greatest dimension (for elliptical sewers, duct banks and other non-cylindrical utilities) of a utility and two feet from the outside of any subsurface structure.
- Install Pre-Clearance exploratory test holes (e.g., hand-dug test holes or vacuum excavation) must be performed for the first five feet below land surface (BLS) at each location prior to conducting mechanized intrusive activities. The size of the pre-clearance exploratory test hole should be at a minimum twice the diameter of any downhole tool or boring device. (Note: Pre-clearance exploratory test holes should be defined in the SOW/proposal provided to the client to prevent project delays and to allow adequate time for PM and PP to evaluate alternative approaches for the project. Alternate approaches will need to be pre-approved by the OM.
- For excavations, all utilities need to be marked and then exposed by hand following the protocols in this program. Pre-clearing for excavations may be performed by the "moat" technique (i.e., soft

digging around the perimeter). In these cases, dig in small lifts (<12" for first five feet) using a dedicated spotter.) For Tolerance Zone work, unless otherwise agreed upon with the Utility Operator, work within the tolerance zone requires verification by means of hand-dug test holes to expose the utility. Once structures have been verified a minimum clearance of two feet must be maintained between the utility and any powered equipment.

Appendix D - Utility Verification/Site Walkthrough Record

Employee Name:____

Date: ____

Instructions: For each utility suspected at the job site, indicate location on the job site, approximate burial depth, and means of detecting the utility. Leave blank if that utility is not believed to be present.

Utility	Description of Utility Location Identified Onsite	Approx. Depth (bls)	Method / Instrumentation used to determine Utility Location	Utility Owner Response (Date/Time)	Mark Out Indicates (Clear / Conflict)
Electrical Lines					
Gas Lines					
Pipelines					
Steam Lines					
Water Lines					
Sanitary and Stormwater Sewer lines					
Pressured Air-Lines					
Tank Vent Lines					
Fiber Optic Lines					
Underground Storage Tanks					
Phone Lines/ Other					

* bls - below land surface

Site Sketch Showing Utilities:

Color Code

- ELECTRIC
- Gas-oil Steam
- Communications CATV
- WATER
- Reclaimed Water
- SEWER
- Temp. Survey Markings
- Proposed Excavation

Other Comments / Findings:

Completed by: ______________________________

Signature: ______________________________ Date: ____________

APPENDIX E

Heavy Equipment Exclusion Zone Policy

**HEAVY EQUIPMENT EXCLUSION ZONE
MANAGEMENT PROGRAM**

CORPORATE HEALTH AND SAFETY MANAGER	**:**	**Brian Hobbs, CIH, CSP**
EFFECTIVE DATE	**:**	**01/2019**
REVISION NUMBER	**:**	**1**

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1. PURPOSE

The purpose of the Exclusion Zone Management Program is to establish the minimum clearance distance that must be maintained between workers and heavy equipment while equipment is in operation (i.e., engaged or moving). The intent is to have no personnel or equipment entering the Exclusion Zone while the equipment is in operation or moving to ensure that Roux and Subcontractor employees are not unnecessarily exposed to the hazards of the equipment.

2. SCOPE AND APPLICABILITY

This Management Program applies to all Roux Associates, Inc. and its affiliated companies, Roux Environmental Engineering and Geology, D.P.C, and Remedial Engineering (collectively, “Roux”) employees and their subcontractors who are performing field work and are potentially exposed to heavy equipment. For the purpose of this program, heavy equipment includes, but is not necessarily limited to: excavation equipment, drill rigs, vacuum trucks, forklifts, lull telehandlers, man lifts, bobcats, delivery trucks, etc.

3. PROCEDURES

As specified in the following sections of this Program, an Exclusion Zones must be established and maintained during activities involving the movement/operation of heavy equipment. The Exclusion Zone requirements apply to all personnel on the site but are primarily focused on those personnel who are required to be working in the vicinity of the equipment. The exclusion zone is in effect when heavy equipment is moving or engaged (ex. movement of an arm or bucket of an excavator, rotation of an auger, lifting of a load with a forklift, raising/lowering of a man lift, etc.).

1. The Exclusion Zone must meet the following minimum requirements:
   - A minimum distance of 10 feet from all heavy equipment and loads being moved by the equipment;
   - Greater than the swing/reach radius of any moving part on the heavy equipment (i.e., for large equipment this may mean an exclusion zone distance larger than 20 feet);
   - Greater than the tip-over distance of the heavy equipment; and
   - Greater than the radius of blind spots.

   > The size of the Exclusion Zone will need to be determined on a task-specific basis considering the size of the heavy equipment in use and the task being performed. Prior to all heavy equipment operations, the Exclusion Zone(s) distance must be specifically identified in the Job Safety Analysis (JSA).

2. The spotter (or another individual) should be assigned responsibility for enforcing the Exclusion Zone. The spotter should be positioned immediately outside of the Exclusion Zone within a clear line of sight of the equipment operator. The spotter must signal the operator to stop work if anyone or anything has the potential to enter or compromise the Exclusion Zone. The operator should stop work if the spotter is not within his/her line of sight. If multiple pieces of equipment are being used, each piece of equipment must have its own Exclusion Zone and spotter. For large excavation and demolition projects the spotter should be in constant radio contact (not cell phone) with the machine driver.
3. If an individual must enter the Exclusion Zone, the designated Spotter must signal the Equipment Operator to stop the equipment. Once the equipment is no longer moving (ex. movement of an arm of an excavator is STOPPED, lifting of a load with a forklift STOPPED, raising/lowering of a man lift is

STOPPED, etc.), the operator must DISENGAGE THE CONTROLS and STOP and SIGNAL BY "SHOWING HIS HANDS". This signal will indicate that it is safe for the personnel to enter the limits of the Exclusion Zone to perform the required activity. The equipment must remain completely stopped/disengaged until all personnel have exited the limits of the Exclusion Zone and the designated Spotter has signaled by "SHOWING HIS HANDS" to the Equipment Operator that it is safe to resume operations.

4. When entering the limits of the Exclusion Zone, personnel must at a minimum:
    - Establish eye contact with the operator and approach the heavy equipment in a manner that is in direct line of sight to the Equipment Operator;
    - Never walk under any suspended loads or raised booms/arms of the heavy equipment; and
    - Identify a travel path that is free of Slip/Trip/Fall hazards.
5. The Exclusion Zone should be delineated using cones with orange snow fence or solid poles between the cones, barrels, tape or other measures. For work in rights-of-way rigid barriers, such as Jersey barriers or temporary chain link fence should be used. For certain types of wide-spread or moving/mobile equipment operations, such delineation may not be practicable around pieces of equipment or individual work areas. In such instances, it is expected that the entire operation will be within a larger secure work area or that additional means will be utilized to ensure security of the work zone.

All subcontractors who provide heavy equipment operations to field projects must implement a program that meets or exceeds the expectations described above as well as any additional requirements that may be required on a client or site-specific basis.

3.1 Exceptions

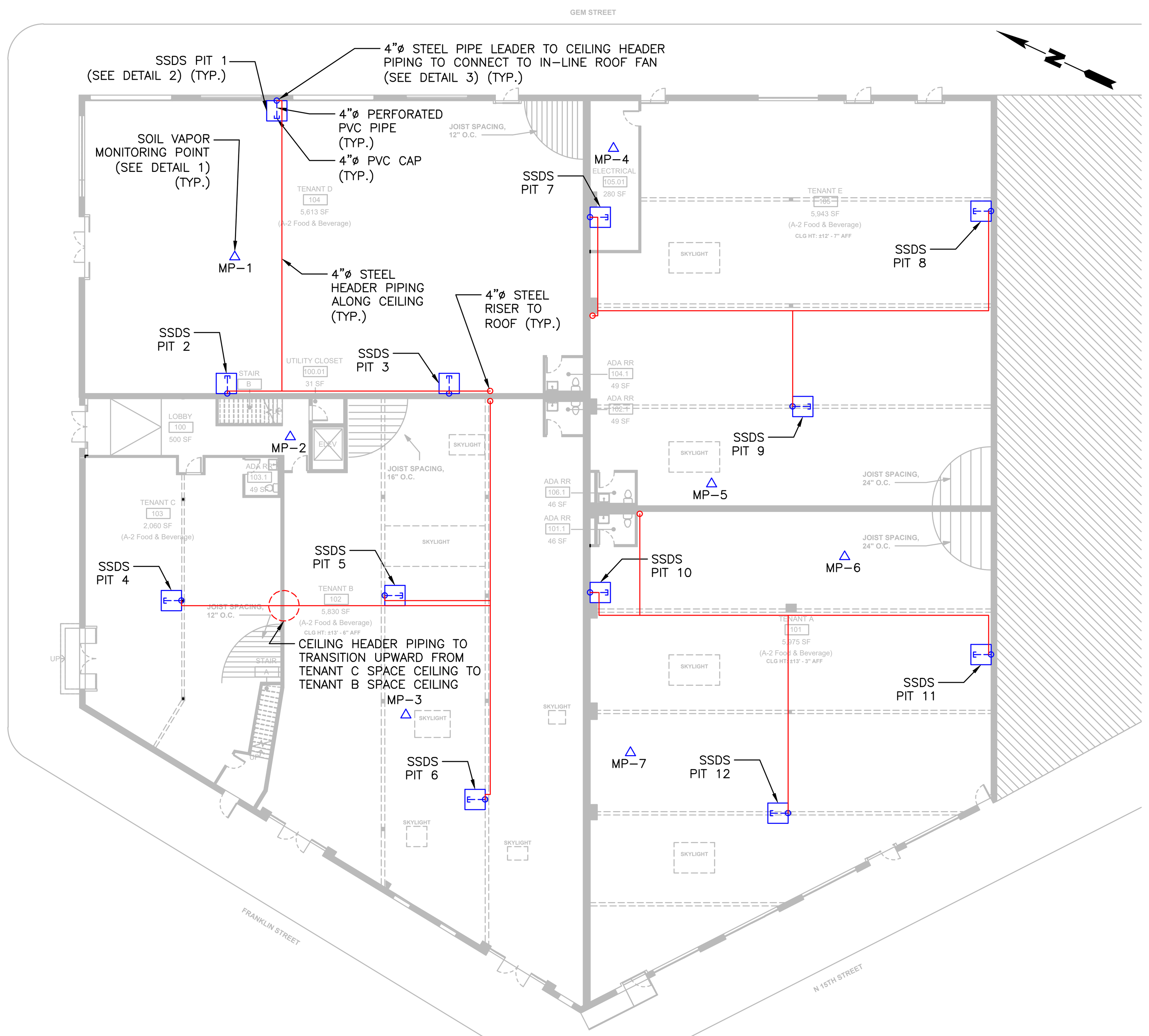
It is recognized that certain heavy equipment activities may require personnel to work within the limits of the Exclusion Zone as specified in this program. Such activities may include certain excavation clearance tasks, drill crew activities or construction tasks. However, any such activity must be pre-planned with emphasis on limiting the amount and potential exposure of any activity required within the zone. The critical safety steps to mitigate the hazards associated with working within the Exclusion Zone must be defined in the JSA and potentially other project-specific plans (i.e., critical lift plans, etc.), and approved by the Roux Project Principal and client representative, if required, prior to implementation.

4. TRAINING

Many Roux projects have different requirements that are client-specific or site-specific in nature. It is the responsibility of the Project Principal (or Project Manager if delegated this responsibility by the Project Principal) to ensure that the workers assigned to his/her projects are provided orientation and training with respect to these client and/or site-specific requirements.

APPENDIX B

Conceptual Sub-Slab Depressurization System
Design Drawing

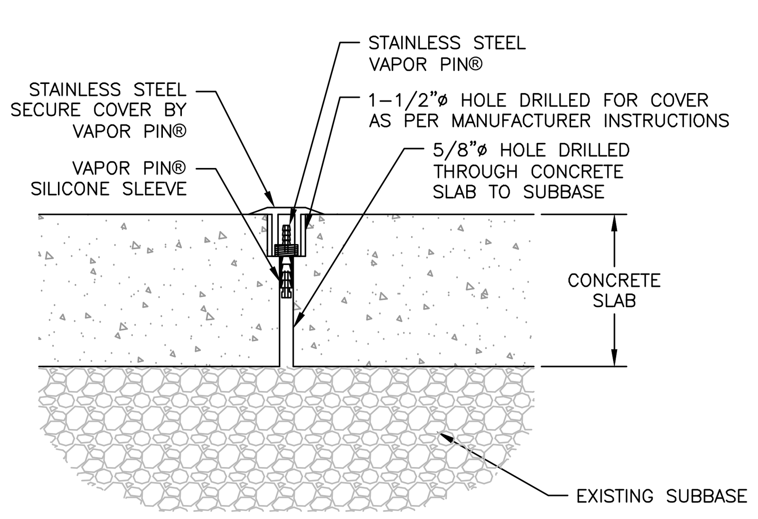


SUB–SLAB DEPRESSURIZATION SYSTEM PLAN

SCALE: 1" = 20'

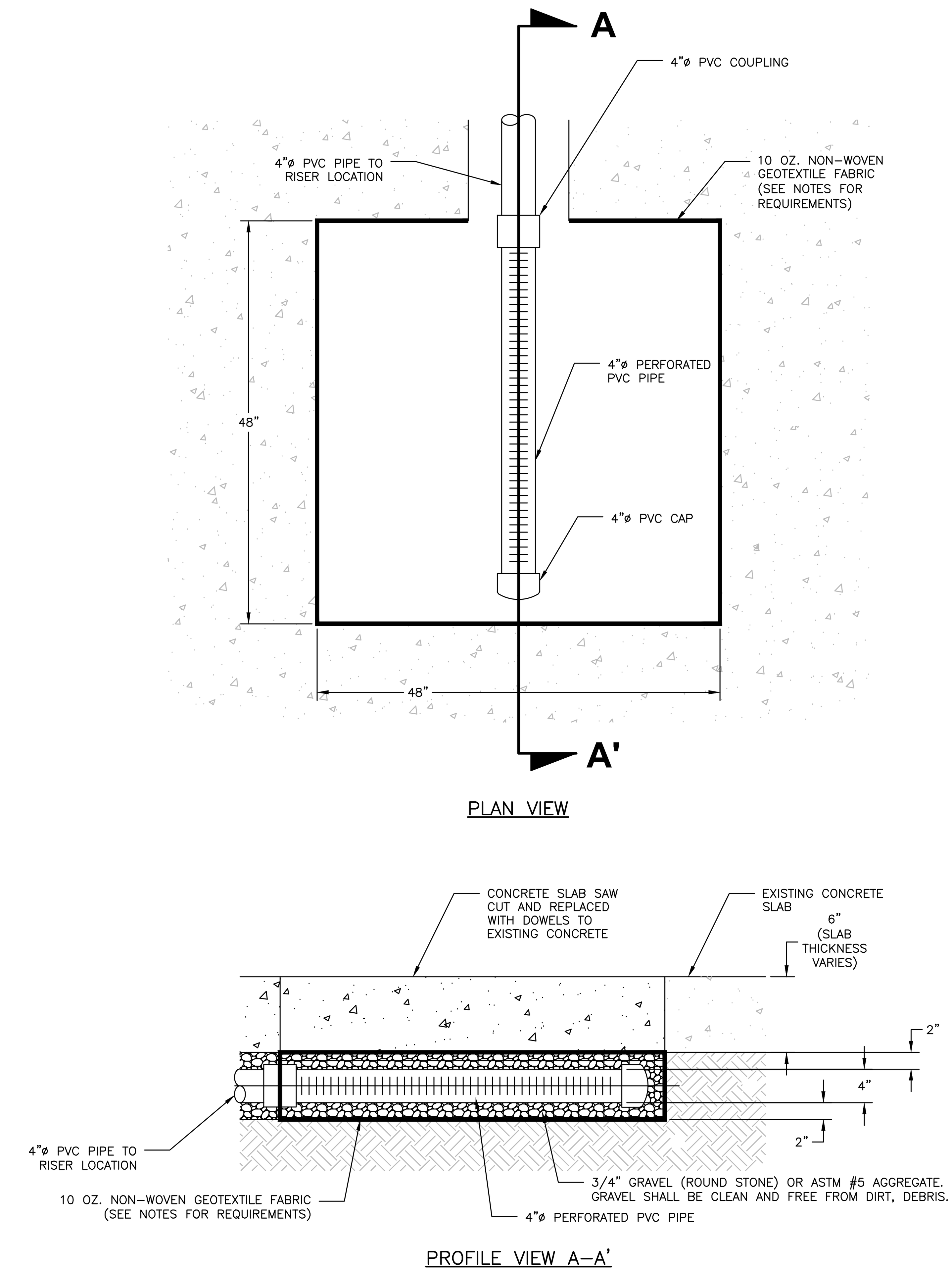
SUB–SLAB DEPRESSURIZATION SYSTEM NOTES

1. CONTRACTOR SHALL COORDINATE INSTALLATION OF SUB–SLAB DEPRESSURIZATION SYSTEM (SSDS) WITH THE FOUNDATION, PLUMBING, MECHANICAL AND ELECTRICAL CONTRACTORS.
2. CONTRACTOR SHALL COORDINATE WITH PLUMBING, MECHANICAL, CIVIL AND ELECTRICAL CONTRACTORS FOR ALL UTILITY CROSSINGS.
3. CONTRACTOR SHALL FIELD VERIFY THE DESIGN INVERT ELEVATIONS (BOTTOM OF PIPING) FOR PENETRATIONS. THE CONTRACTOR SHALL ALSO FIELD VERIFY THE HORIZONTAL OFFSETS FOR THE LOCATIONS OF THE VERTICAL RISERS.
4. ALL SSDS PIPING SHALL BE SLOPED TOWARDS THE PERFORATED PIPE SUCTION PITS TO PREVENT ANY POTENTIAL MOISTURE BUILD UP AND BLOCKAGES.
5. ALL ABOVE GRADE SSDS PIPING (ALONG WITH FITTINGS AND APPURTENANCES) SHALL CONSIST OF GALVANIZED STEEL, CAST–IRON, OR DUCTILE IRON PIPE AND INSTALLED IN ACCORDANCE WITH THE NYC PLUMBING CODE CHAPTERS 7 AND 9 FOR VENT PIPE.
6. PVC PIPE SHALL BE JOINED TOGETHER USING EITHER SOLVENTS, SLIP–JOINTS SECURED WITH SELF–TAPPING SCREWS OR THREADED CONNECTIONS.
7. ALL PENETRATIONS THROUGH THE FLOOR SHALL BE SEALED USING A SILICONE BASED WATERPROOF SEALANT OR EQUIVALENT.
8. EACH SSDS PIT SECTION (TENANT A, B/C, D AND E) SHALL BE INSTALLED WITH A RADONAWAY HS5500 IN–LINE FAN (QTY – 4). EACH SSDS PIT RISER PIPE SHALL BE INSTALLED WITH A VALVE AND RADONAWAY RSA1 VACUUM INDICATOR ALARM (QTY – 12).
9. THE SURFACES TO BE LINED WITH GEOTEXTILE SHALL BE FREE OF ALL ROCKS, STONES, SHARP OBJECTS OR CONSTRUCTION DEBRIS OF ANY KIND.
10. INSTALL GEOTEXTILE NONWOVEN FABRIC DIRECTLY ON FILL. MATERIAL OVERLAPS SHALL BE A MINIMUM OF 12" AND THE OVERLAPPED SEAMS WILL BE SEALED WITH TAPE.
11. NON–WOVEN GEOTEXTILE SHALL MEET OR EXCEED FOLLOWING PROPERTY VALUES:
    - 11.1. MINIMUM MASS PER UNIT AREA OF 10 OZ/YD^2 AS PER ASTM D 5261
    - 11.2. MINIMUM GRAB STRENGTH OF 250 LBS AS PER ASTM D 4632
    - 11.3. MINIMUM PUNCTURE STRENGTH OF 700 LBS AS PER ASTM D 6241
    - 11.4. MINIMUM ULTRAVIOLET RESISTANCE @ 500 HOURS OF 70% AS PER ASTM D 4355



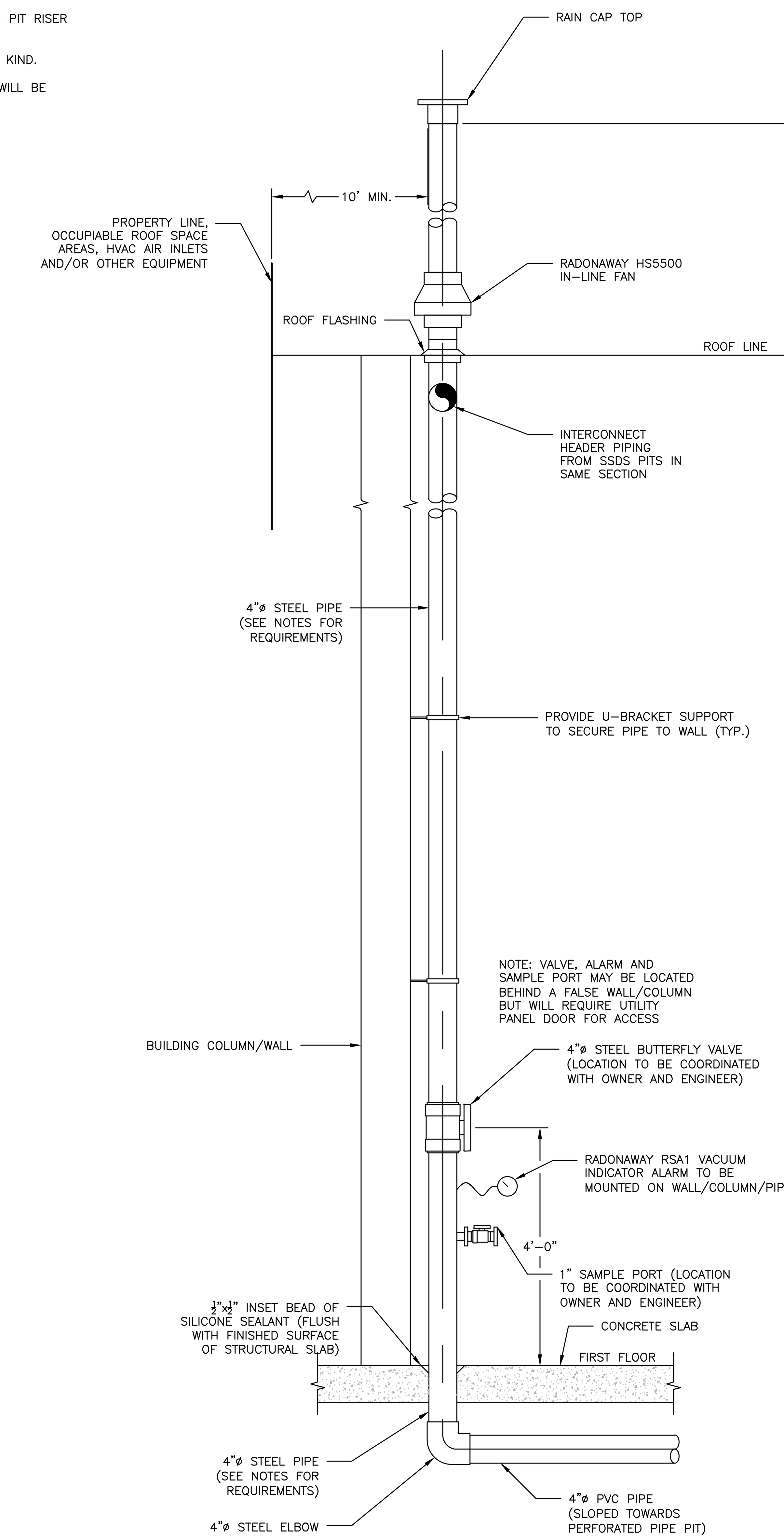
1 TYPICAL SOIL VAPOR MONITORING POINT DETAIL

SCALE: N.T.S.



2 SUB–SLAB DEPRESSURIZATION SYSTEM SUCTION PIT DETAIL

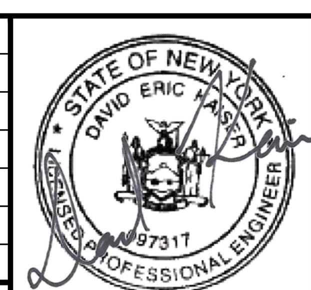
SCALE: N.T.S.



3 RISER DETAIL

SCALE: N.T.S.

NO.	DATE	REVISION DESCRIPTION	INT.
1	1/19/24	REVISE SSDS PIT LOCATIONS, PIPING AND IN-LINE FANS	D.E.K.



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ROUX
Roux Environmental Engineering and Geology, D.P.C.
209 SHAFTER STREET ISLANDIA NEW YORK 11749
(631) 232-2600

PROJECT NAME:
12 FRANKLIN STREET
BROOKLYN, NEW YORK 11222

PROJECT FOR:
FRANKLIN POINT LLC

TITLE:
CONCEPTUAL SUB-SLAB DEPRESSURIZATION PLAN AND DETAILS

DRAWING NO.
1
DRAWING 1 OF 1

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APPENDIX C

SSDS Pilot Study Report

Sub-Slab Depressurization System (SSDS) Pilot Test Report

Site:

12 Franklin Street
Brooklyn, NY

Prepared for:

Roux
209 Shafter Street
Islandia, NY 11749

Prepared by:

EnviroTrac Ltd
5 Old Dock Road
Yaphank, NY 11980

December 2023

A Full Service Environmental Consulting and Contracting Firm

Sub-Slab Depressurization System (SSDS) Pilot Study Report
12 Franklin Street, Brooklyn, NY

PURPOSE

This report is intended to summarize the results of the SSDS pilot study that was conducted by EnviroTrac on December 1st and December 4th, 2023. The purpose of the test was to determine the feasibility of implementing a full-scale SSD system as a viable means of mitigation throughout the existing building structure. The results of this study were used to determine the feasibility of this technology, as well as determining the required operating parameters and layout for the selected system.

TECHNICAL SCOPE OF WORK PERFORMED

1. **Pilot Test Equipment**

For the purpose of the pilot test, EnviroTrac mobilized its mobile SSD system equipment to conduct the study at representative locations. The mobile systems consist of a radon mitigation style vacuum blowers that were connected to the temporarily installed SSDS test wells. The test equipment also includes a vacuum gauge, a flow/sample port, associated piping, and discharge stack. Major system components of the mobile SSD system are described below.

Sub-Slab Depressurization Equipment:

- Extraction Blowers: – Radon Away Model No. GP-501, Vacuum Blower (110V, 1 Phase).
  - Max Flow: 66 SCFM
  - Max Vac: 4.1 "H_2O

  Radon Away Model No. HS-5000, Vacuum Blower (110V, 1 Phase)
  - Max Flow: 43 SCFM
  - Max Vac: 41 "H2O

Additional Test Equipment

- Dwyer Instruments Handheld Air Velocity Meter – Model 471B-1
- UEI Digital Manometer – EM201B (0.000 – 20.000 "H2O)

2. **Test Zones**

To facilitate the test, EnviroTrac installed four (4) 4-inch diameter temporary extraction wells (PT/SSD-4, PT/SSD-6, PT/SSD-7, & PT/SSD-12). A 5-inch diameter core drill was used to install a 4-inch diameter schedule 40 PVC pipe that was sealed to the floor slab penetration. The soil immediately below the slab was manually hand cleared in order to install the temporary extraction points. Each temporary extraction well was constructed using 4-inch diameter schedule 40 PVC well screen (20-slot) that extended down into the subgrade soil (~12" bgs) and was fitted with a PVC end cap. Gravel was installed around the well screen up to the elevation of the bottom of the existing concrete floor slab. The well screen was transitioned to solid schedule 40 PVC pipe at the bottom of the existing concrete floor slab with the annulus between the outside of the PVC pipe and the concrete edge sealed with quick setting hydraulic cement. Adequate time was given to allow for the sealant to set up prior to the commencement of the pilot test. Once the temporary points were set up, the test blowers were individually mounted to the top of the test well and a flexible hose was routed from the blower to the exterior of the building.

SSDS TESTING METHODOLOGY

Throughout the pilot study each extraction well was evaluated at varying operational conditions. Prior to starting the test, each test blower was connected to the piping riser extending from the test well. A flexible hose was routed from the blower and riser pipe to the exterior of the building. In order to monitor the sub-slab vacuum response of the test, several temporary vacuum monitoring points (VMPs) were installed through the concrete floor slab, at select locations. During the test, the vacuum blowers were configured to operate at the maximum rate for each relative to flow and vacuum. Throttling of the blowers was conducted by adjusting the mobile system piping manifold control valve. During each step, operating parameters such as applied flow, vacuum, and sub-slab vacuum responses were recorded. The applied extraction well flow and vacuum were measured from a monitoring point located in the extraction piping several feet above where the piping penetrates the floor slab. The wellhead vacuum and extraction flow rate for each step were recorded as the following:

PT/SSD-4

Step #	Wellhead Vacuum ("H2O)	Extraction Flow Rate (scfm)
1	2.37	5.6
2	3.94	8.2
3	4.03	8.5
4	7.40	11.8
5	8.30	13.8
6	8.30	14.2

PT/SSD-6

Step #	Wellhead Vacuum ("H2O)	Extraction Flow Rate (scfm)
1	2.50	9.8
2	3.60	12.1
3	3.70	12.6
4	4.35	13.3
5	4.42	15.5
6	4.45	14.0

PT/SSD-7

Step #	Wellhead Vacuum ("H2O)	Extraction Flow Rate (scfm)
1	3.20	4.8
2	3.82	6.0
3	4.20	6.2
4	10.20	11.2
5	11.80	13.6
6	11.82	13.6

PT/SSD-12

Step #	Wellhead Vacuum ("H2O)	Extraction Flow Rate (scfm)
1	2.9	3.2
2	4.28	4.6
3	4.30	4.5
4	14.50	10.0
5	14.30	10.6
6	15.30	11.2

During each step vacuum influence was recorded from each monitoring point utilizing a handheld digital manometer. For each step, the operating conditions were allowed to sufficiently stabilize at a steady state condition prior to the recording of any readings.

PILOT TESTING RESULTS

The field data collected during the SSD pilot test is included as an attachment to this report. Flow and vacuum readings were recorded during each step of the SSDS test, while vacuum influence was measured at each observation point. A copy of the pilot test data analysis, along with the associated data plots, are included in the Attachments of this report.

In order to determine the performance requirements at each of the SSD extraction zones, the pilot test data is used to generate a semi-logarithmic plot of sub-slab vacuum response vs. distance. From this plot the effective Radius of Influence (ROI) of each of the test steps of the pilot study is determined by finding the radial distance where a best fit logarithmic line plot of the data intersects the line y = 0.03 "H_2O (~7 pascals) vacuum response. Extrapolating out the results from the data set and the plots developed from TP/SSD-4, shows that applying a minimum vacuum of 7.9 "H2O at a flow rate of 13.1 cfm would achieve a minimum radius of influence (ROI) of ~25 feet. During the testing at this location, it was noted that at the lower value (vacuum and flow) testing steps, vacuum response measurements were inconsistent with typical expected values (i.e., diminishing measurements with increased distance from the test point). Therefore, these measurements were eliminated from the testing analysis of the extraction point. The same analysis applied to the data set and the plots developed from TP/SSD-6, shows that applying a minimum vacuum of 2.7 "H2O at a flow rate of 10.3 cfm would achieve a minimum radius of influence (ROI) of ~25 feet. For Test Point TP/SSD-7, results yielded a requirement of 8.0 "H2O at a flow of 10.0 cfm. For Test Point TP/SSD-12, results yielded a requirement of 35.7 "H2O at a flow of 20.1 cfm. However, it should be noted that at the time of testing, the underlying soil below the slab directly below underside of the concrete was found to be saturated in water. This water is presumed to be a result of the leaking roof in the area, which may have artificially created this saturated condition. As such, it is recommended that the results of the testing completed at PT/SSD-12 not be used for the overall evaluation of the testing results. In order to achieve complete vacuum coverage of the building footprint, the selected ROI would be used to assist in the layout of the full scale SSD System.

CONCLUSIONS AND RECOMENDATIONS

Based on the results tabulated, the pilot testing performed demonstrates that a full-scale SSD system can serve as an effective means of mitigation for the existing site building. If a target ROI of 25 feet is selected for each proposed extraction well, it was determined that a minimum vacuum of 8.1 "H_2O and an air flow rate of 13.1 CFM would need to be applied at each extraction wellhead throughout the building. These values were conservatively determined by taking the highest calculated value for applied vacuum and extracted flow rate. Appropriate consideration shall be addressed concerning the number and spacing of the proposed extraction wells. It should be noted that the results of the pilot study data could be extrapolated further to determine required system operational parameters at other selected ROIs.

Recommended Design Parameters (each extraction well):

- Target Radius of Influence (ROI): 25 feet
- Applied Vacuum: 8.0 "H_2O
- Applied Flow Rate: 13.1 CFM

FIGURES

1. Site Plan with Test Locations

ATTACHMENTS

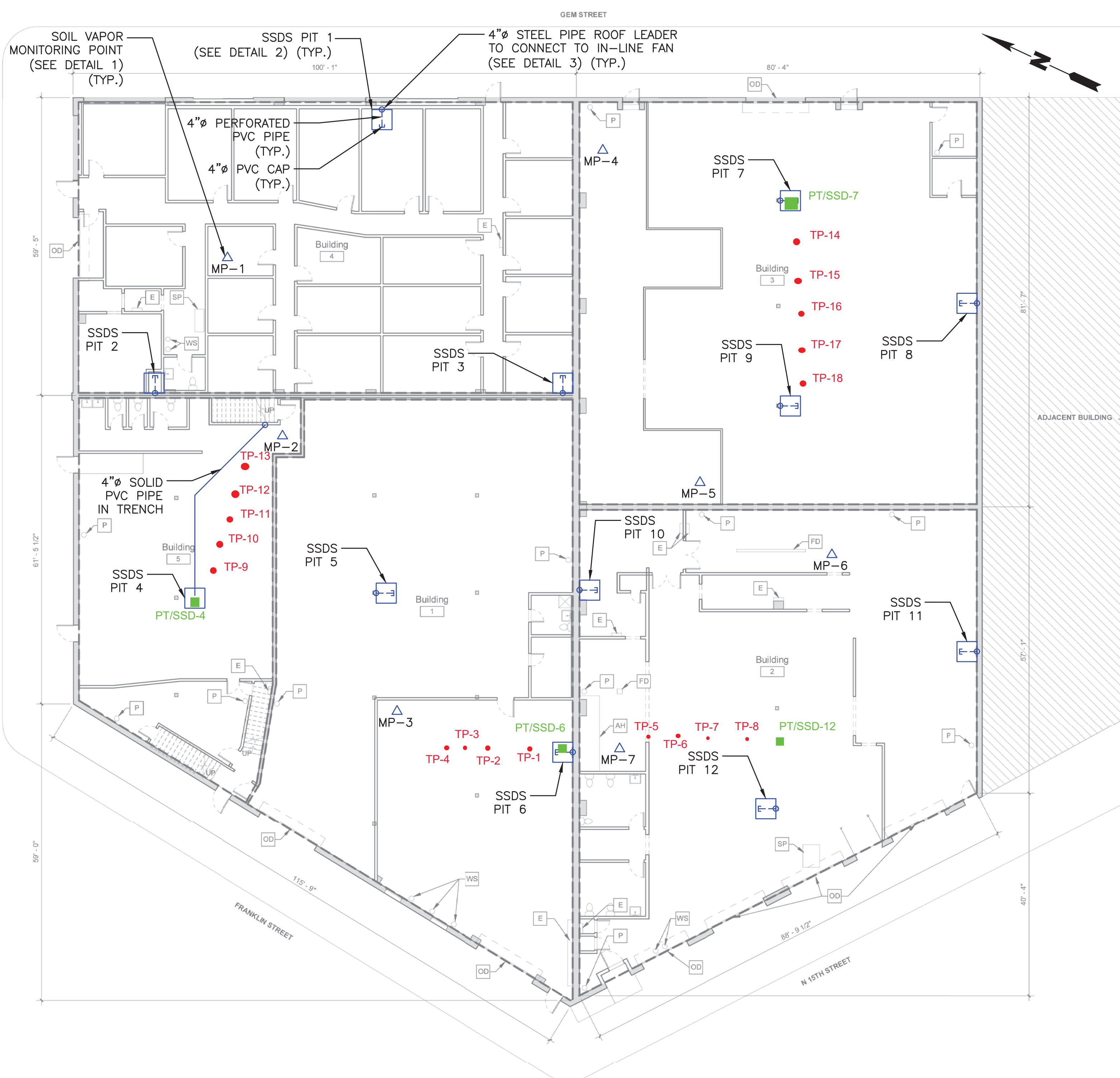
1. PT/SSD-4: Pilot Test Data – Field Measurements
2. PT/SSD-4: SSD Test Data Analysis
3. PT/SSD-4: Plot: SSD Vacuum Response vs. Monitoring Point Radial Distance
4. PT/SSD-4: Plot: Vacuum vs. ROI

5. PT/SSD-4: Plot: Air Flow Rate vs. ROI
6. PT/SSD-6: Pilot Test Data – Field Measurements
7. PT/SSD-6: SSD Test Data Analysis
8. PT/SSD-6: Plot: SSD Vacuum Response vs. Monitoring Point Radial Distance
9. PT/SSD-6: Plot: Vacuum vs. ROI
10. PT/SSD-6: Plot: Air Flow Rate vs. ROI
11. PT/SSD-7: Pilot Test Data – Field Measurements
12. PT/SSD-7: SSD Test Data Analysis
13. PT/SSD-7: Plot: SSD Vacuum Response vs. Monitoring Point Radial Distance
14. PT/SSD-7: Plot: Vacuum vs. ROI
15. PT/SSD-7: Plot: Air Flow Rate vs. ROI
16. PT/SSD-12: Pilot Test Data – Field Measurements
17. PT/SSD-12: SSD Test Data Analysis
18. PT/SSD-12: Plot: SSD Vacuum Response vs. Monitoring Point Radial Distance
19. PT/SSD-12: Plot: Vacuum vs. ROI
20. PT/SSD-12: Plot: Air Flow Rate vs. ROI
21. Test Blower(s) Specifications

REFERENCES

1. ASTM E1465-08a “Standard Practice for Radon Control Options for the Design and Construction of New Low-Rise Residential Buildings”
2. New York State Department of Environmental Conservation, (NYSDEC), DER-10 “Technical Guidance for Site Investigation and Remediation”

FIGURES



SUB-SLAB DEPRESSURIZATION SYSTEM PLAN

SCALE: 1" = 20'

ATTACHMENTS

EnviroTrac

Sub-Slab Depressurization (SSD) Pilot Test Data

Site Name: **12 Franklin Street Brooklyn, NY**

Test Date: 12/4/2023

Personnel: NZ/MM

Weather: 45 Clear

Extraction Well: PT/SSD-4

					Observation Well	Observation Well	Observation Well	Observation Well	Observation Well	Observation Well	Observation Well	Observation Well	Observation Well
					TP-9	TP-10	TP-11	TP-12	TP-13				
					*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)
					10	15	20	25	30				
Blower Model	Well Head Vac "H20	System Vac	Flow (scfm)	Time	Vacuum "$H_2$0	Vacuum "$H_2$0	Vacuum "$H_2$0	Vacuum "$H_2$0	Vacuum "$H_2$0	Vacuum "$H_2$0	Vacuum "$H_2$0	Vacuum "$H_2$0	Vacuum "$H_2$0
GP-501	2.37	25%	5.6	8:45	0.014	0.009	0.013	0.015	0.012				
	3.94	50%	8.2	8:55	0.020	0.022	0.020	0.022	0.019				
	4.03	100%	8.5	9:00	0.024	0.022	0.020	0.020	0.020				
HS5000	7.40	25%	11.8	9:10	0.035	0.030	0.030	0.034	0.030				
	8.3	50%	13.8	9:15	0.041	0.040	0.032	0.036	0.028				
	8.3	100%	14.2	9:20	0.040	0.046	0.034	0.027	0.028				

Comment / Notes:

* Distance measured from Test Point to each Monitoring Point

NM = Not Measured

Summary of SSD Pilot Test
12 Franklin Street
Brooklyn, NY

SSD Analysis

Test Date:	12/4/2023
Performed By:	EnviroTrac - NZ/MM
Extraction Point:	**PT/SSD-4**
Test Duration (min.):	1.0 hr
Wellhead Vacuum ("H2O):	2.37 to 8.3
Wellhead Flow (scfm):	5.6 to 14.2

PT/SSD-6

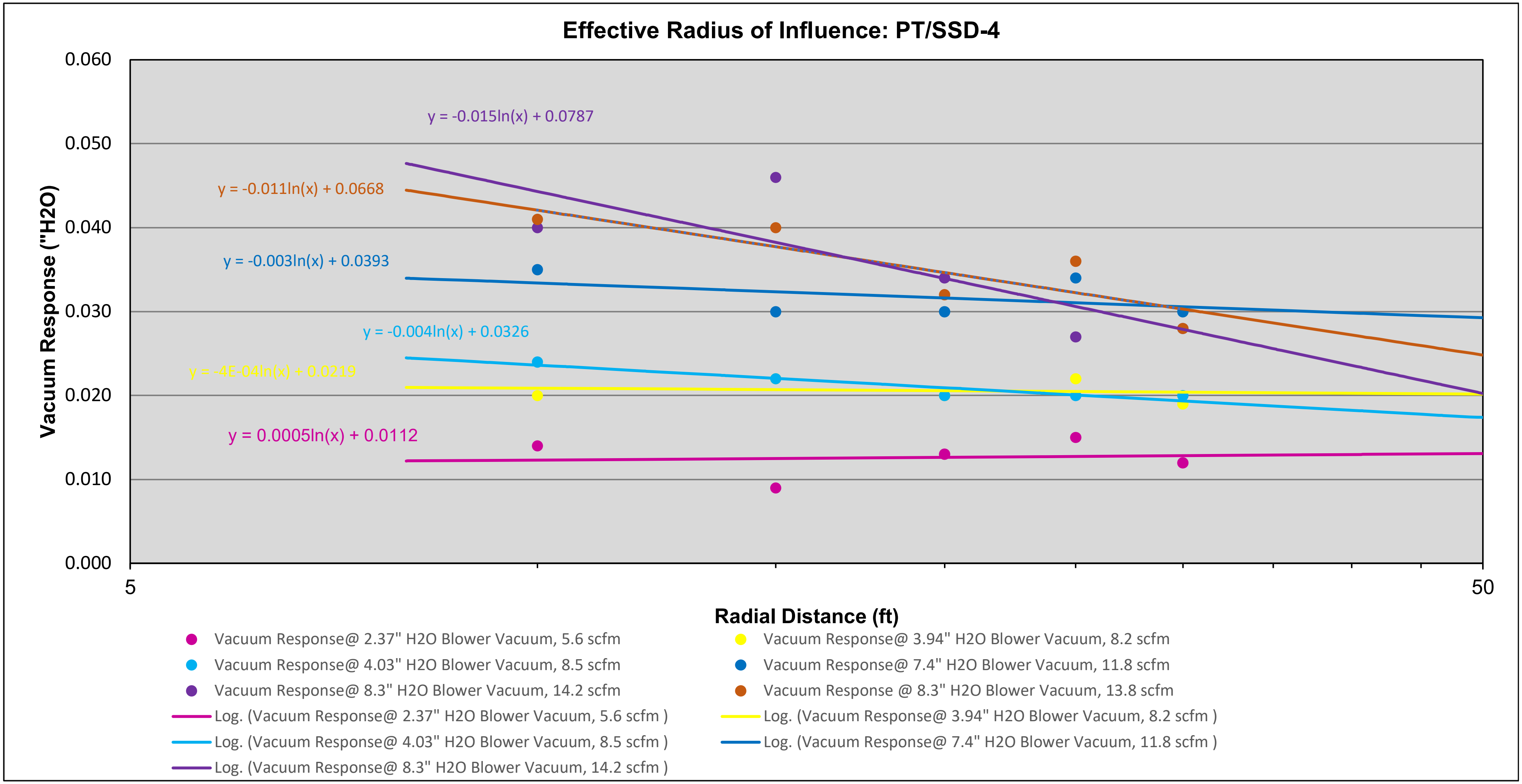
Radial Distance (ft.)	Vacuum Response@ 2.37" H2O Blower Vacuum, 5.6 scfm	Vacuum Response@ 3.94" H2O Blower Vacuum, 8.2 scfm	Vacuum Response@ 4.03" H2O Blower Vacuum, 8.5 scfm	Vacuum Response@ 7.4" H2O Blower Vacuum, 11.8 scfm	Vacuum Response @ 8.3" H2O Blower Vacuum, 13.8 scfm	Vacuum Response@ 8.3" H2O Blower Vacuum, 14.2 scfm	Reference Line 0.03 "H2O
10	0.014	0.020	0.024	0.035	0.041	0.040	0.030
15	0.009	0.022	0.022	0.030	0.040	0.046	0.030
20	0.013	0.020	0.020	0.030	0.032	0.034	0.030
25	0.015	0.022	0.020	0.034	0.036	0.027	0.030
30	0.012	0.019	0.020	0.030	0.028	0.028	0.030

Est ROI @ 0.03" H2O Threshold

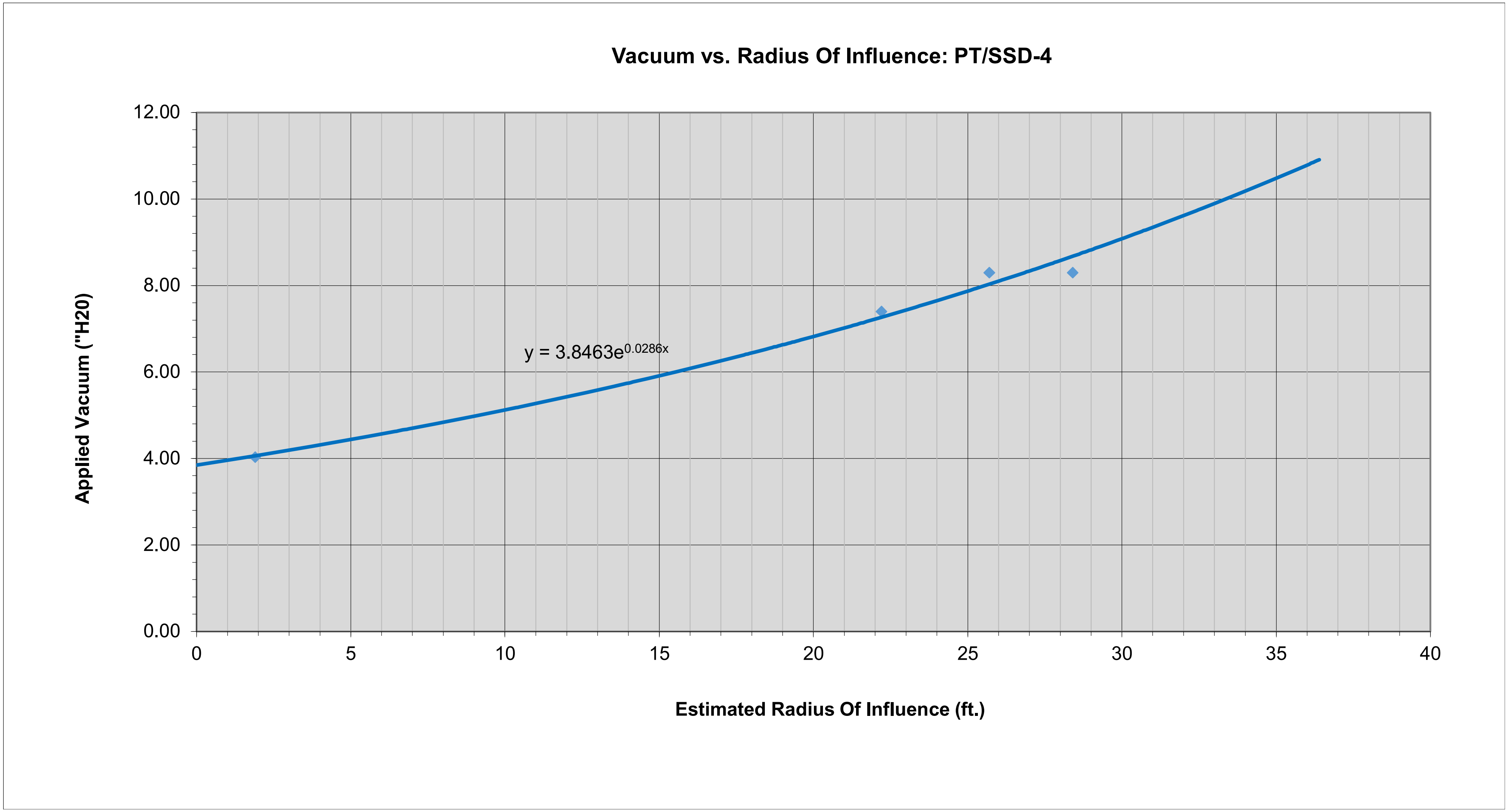
Est. ROI (ft.)	Vacuum ("H2O)	Flow (scfm)
NA	2.37	5.6
NA	3.94	8.2
1.9	4.03	8.5
22.2	7.40	11.8
28.4	8.30	13.8
25.7	8.30	14.2

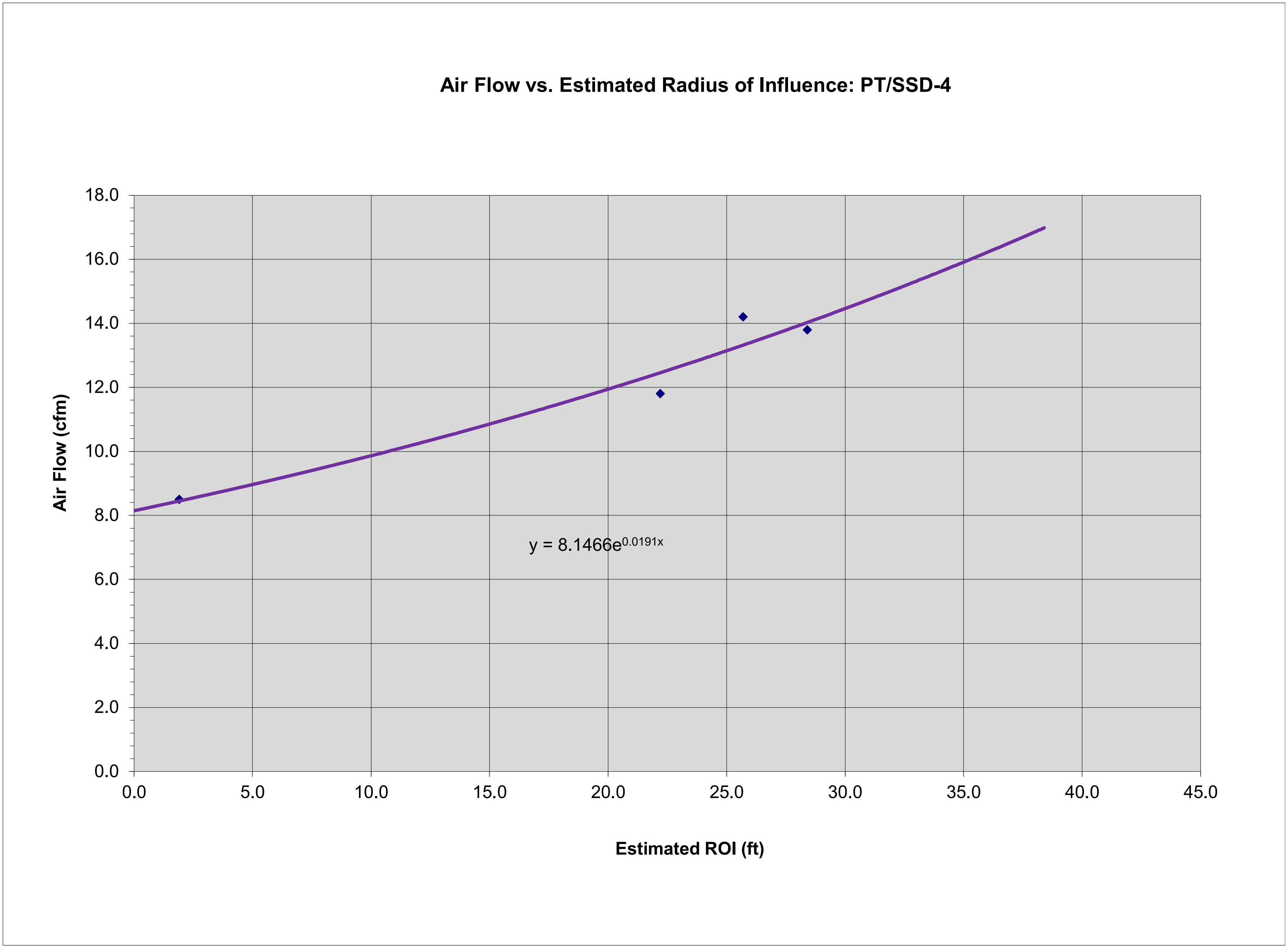
Minimum Parameters (per Extraction Point)

Target ROI (ft)	Design Vac ("H2O)	Design Flow (scfm)
25	7.9	13.1



Effective Radius of Influence: PT/SSD-4
0.060
0.050
0.040
0.030
0.020
0.010
0.000
Vacuum Response ("H2O)
y = -0.015ln(x) + 0.0787
y = -0.011ln(x) + 0.0668
y = -0.003ln(x) + 0.0393
y = -0.004ln(x) + 0.0326
y = -4E-04ln(x) + 0.0219
y = 0.0005ln(x) + 0.0112
5
50
Radial Distance (ft)
Vacuum Response@ 2.37" H2O Blower Vacuum, 5.6 scfm
Vacuum Response@ 3.94" H2O Blower Vacuum, 8.2 scfm
Vacuum Response@ 4.03" H2O Blower Vacuum, 8.5 scfm
Vacuum Response@ 7.4" H2O Blower Vacuum, 11.8 scfm
Vacuum Response@ 8.3" H2O Blower Vacuum, 14.2 scfm
Vacuum Response @ 8.3" H2O Blower Vacuum, 13.8 scfm
Log. (Vacuum Response@ 2.37" H2O Blower Vacuum, 5.6 scfm)
Log. (Vacuum Response@ 3.94" H2O Blower Vacuum, 8.2 scfm)
Log. (Vacuum Response@ 4.03" H2O Blower Vacuum, 8.5 scfm)
Log. (Vacuum Response@ 7.4" H2O Blower Vacuum, 11.8 scfm)
Log. (Vacuum Response@ 8.3" H2O Blower Vacuum, 14.2 scfm)


Vacuum vs. Radius Of Influence: PT/SSD-4
Applied Vacuum ("H20)
Estimated Radius Of Influence (ft.)
y = 3.8463e^0.0286x
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
5
10
15
20
25
30
35
40


Air Flow vs. Estimated Radius of Influence: PT/SSD-4
Air Flow (cfm)
Estimated ROI (ft)
y = 8.1466e^0.0191x
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0

Sub-Slab Depressurization (SSD) Pilot Test Data

Site Name: **12 Franklin Street**
Brooklyn, NY

Test Date: 12/1/2023

Personnel: NZ/MM

Weather: 40's Clear

Extraction Well: PT/SSD-6

					Observation Well	Observation Well	Observation Well	Observation Well	Observation Well	Observation Well	Observation Well	Observation Well	Observation Well
					TP-1	MP-7	TP-2	TP-3	TP-4				
					*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)
					5	8	15	25	30				
Blower Model	Well Head Vac "H20	System Vac	Flow (scfm)	Time	Vacuum "H_20	Vacuum "H_20	Vacuum "H_20	Vacuum "H_20	Vacuum "H_20	Vacuum "H_20	Vacuum "H_20	Vacuum "H_20	Vacuum "H_20
GP-501	2.50	25%	9.8	11:30	0.188	0.012	0.069	0.046	0.022				
	3.60	50%	12.1	11:40	0.242	0.018	0.086	0.061	0.031				
	3.70	100%	12.6	11:48	0.250	0.020	0.088	0.063	0.043				
HS5000	4.35	25%	13.3	12:05	0.280	0.024	0.098	0.070	0.047				
	4.42	50%	15.5	12:20	0.280	0.020	0.102	0.065	0.043				
	4.45	100%	14.0	12:30	0.285	0.025	0.115	0.073	0.047				

Comment / Notes:

* Distance measured from Test Point to each Monitoring Point

NM = Not Measured

Summary of SSD Pilot Test
12 Franklin Street
Brooklyn, NY

SSD Analysis

Test Date:	12/1/2023
Performed By:	EnviroTrac - NZ/MM
Extraction Point:	**PT/SSD-6**
Test Duration (min.):	1.0 hr
Wellhead Vacuum ("H2O):	2.5 to 4.45
Wellhead Flow (scfm):	9.8 to 14.0

PT/SSD-6

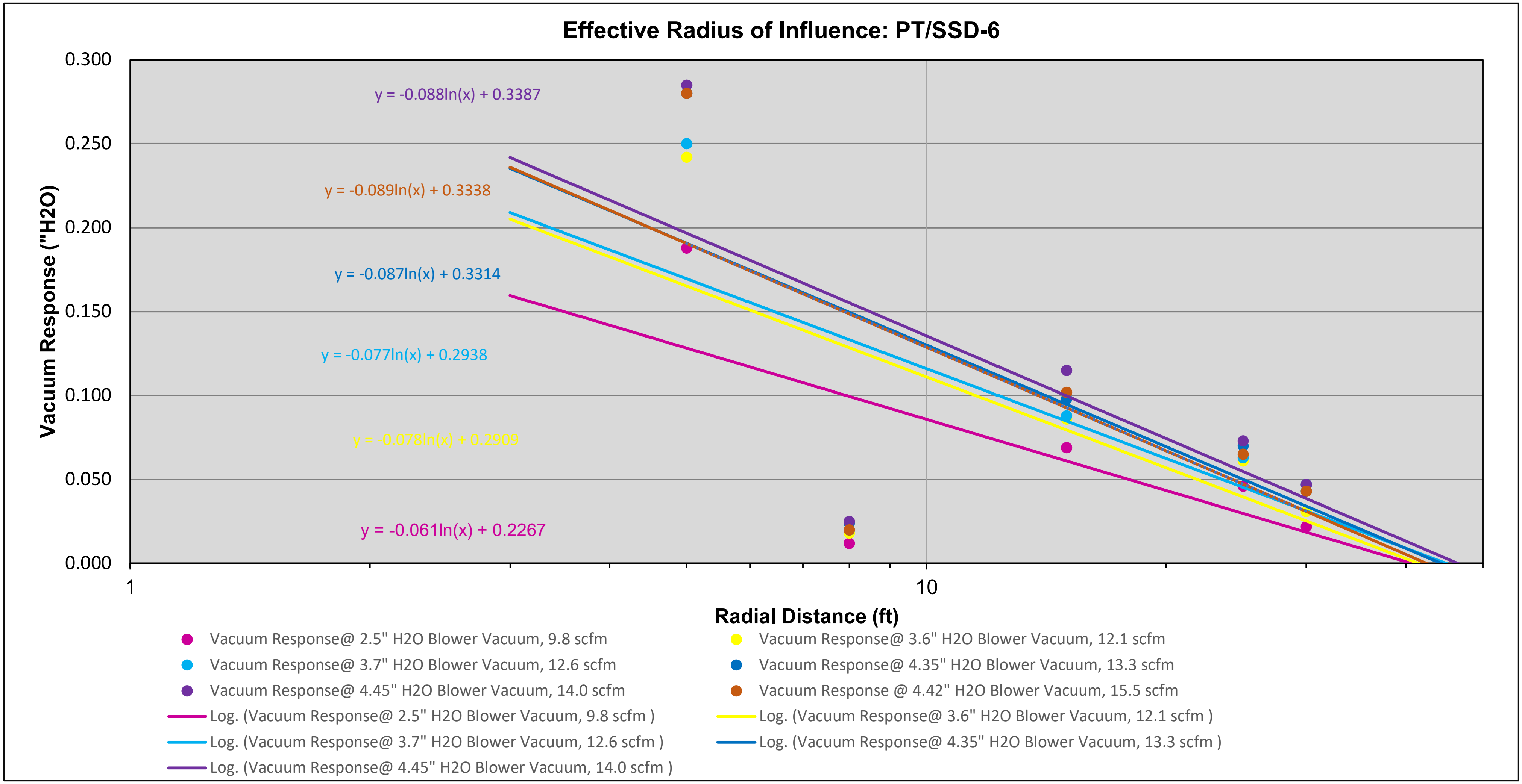
Radial Distance (ft.)	Vacuum Response@ 2.5" H2O Blower Vacuum, 9.8 scfm	Vacuum Response@ 3.6" H2O Blower Vacuum, 12.1 scfm	Vacuum Response@ 3.7" H2O Blower Vacuum, 12.6 scfm	Vacuum Response@ 4.35" H2O Blower Vacuum, 13.3 scfm	Vacuum Response @ 4.42" H2O Blower Vacuum, 15.5 scfm	Vacuum Response@ 4.45" H2O Blower Vacuum, 14.0 scfm	Reference Line 0.03 "H2O
5	0.188	0.242	0.250	0.280	0.280	0.285	0.030
8	0.012	0.018	0.020	0.024	0.020	0.025	0.030
15	0.069	0.086	0.088	0.098	0.102	0.115	0.030
25	0.046	0.061	0.063	0.070	0.065	0.073	0.030
30	0.022	0.031	0.043	0.047	0.043	0.047	0.030

Est ROI @ 0.03" H2O Threshold

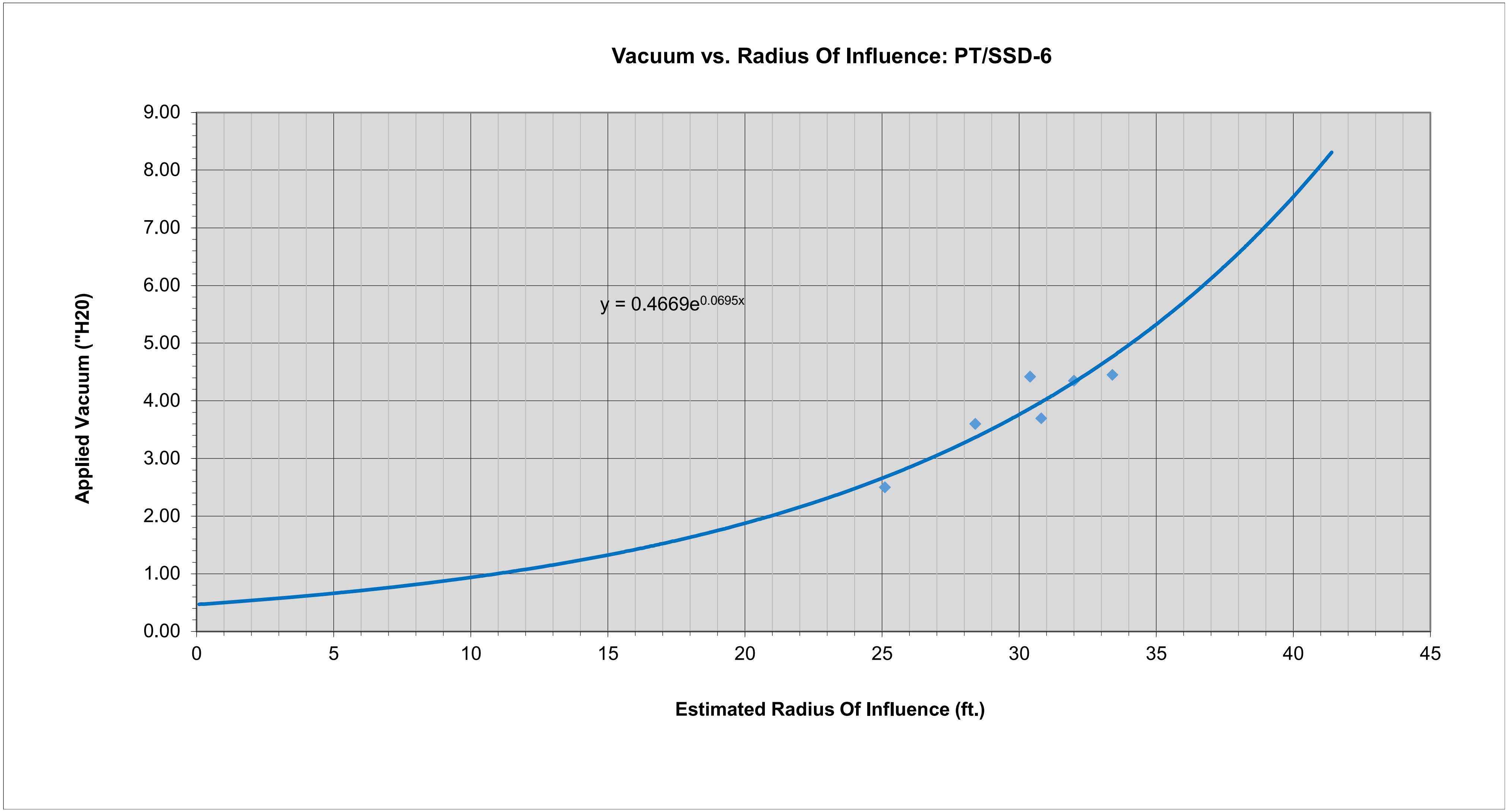
Est. ROI (ft.)	Vacuum ("H2O)	Flow (scfm)
25.1	2.50	9.8
28.4	3.60	12.1
30.8	3.70	12.6
32.0	4.35	13.3
30.4	4.42	15.5
33.4	4.45	14.0

Minimum Parameters (per Extraction Point)

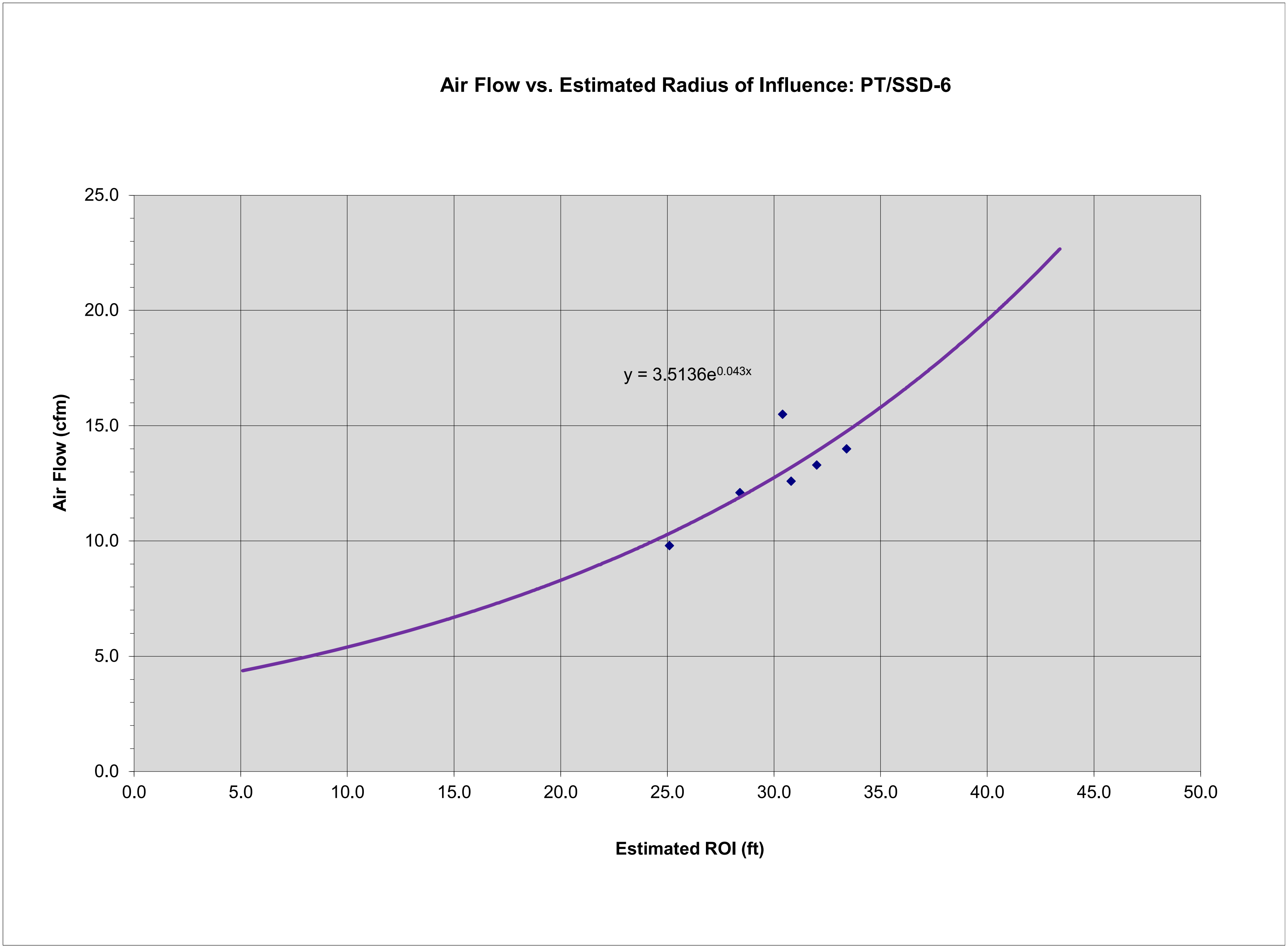
Target ROI (ft)	Design Vac ("H2O)	Design Flow (scfm)
25	2.7	10.3



Effective Radius of Influence: PT/SSD-6
y = -0.088ln(x) + 0.3387
y = -0.089ln(x) + 0.3338
y = -0.087ln(x) + 0.3314
y = -0.077ln(x) + 0.2938
y = -0.078ln(x) + 0.2909
y = -0.061ln(x) + 0.2267
Vacuum Response ("H2O)
0.300
0.250
0.200
0.150
0.100
0.050
0.000
1
10
Radial Distance (ft)
Vacuum Response@ 2.5" H2O Blower Vacuum, 9.8 scfm
Vacuum Response@ 3.6" H2O Blower Vacuum, 12.1 scfm
Vacuum Response@ 3.7" H2O Blower Vacuum, 12.6 scfm
Vacuum Response@ 4.35" H2O Blower Vacuum, 13.3 scfm
Vacuum Response@ 4.45" H2O Blower Vacuum, 14.0 scfm
Vacuum Response @ 4.42" H2O Blower Vacuum, 15.5 scfm
Log. (Vacuum Response@ 2.5" H2O Blower Vacuum, 9.8 scfm)
Log. (Vacuum Response@ 3.6" H2O Blower Vacuum, 12.1 scfm)
Log. (Vacuum Response@ 3.7" H2O Blower Vacuum, 12.6 scfm)
Log. (Vacuum Response@ 4.35" H2O Blower Vacuum, 13.3 scfm)
Log. (Vacuum Response@ 4.45" H2O Blower Vacuum, 14.0 scfm)



Vacuum vs. Radius Of Influence: PT/SSD-6
y = 0.4669e^0.0695x
Applied Vacuum ("H20)
Estimated Radius Of Influence (ft.)
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0
5
10
15
20
25
30
35
40
45



Air Flow vs. Estimated Radius of Influence: PT/SSD-6
y = 3.5136e^0.043x
Air Flow (cfm)
25.0
20.0
15.0
10.0
5.0
0.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
Estimated ROI (ft)

Sub-Slab Depressurization (SSD) Pilot Test Data

Site Name: **12 Franklin Street**
Brooklyn, NY

Test Date: 12/4/2023

Personnel: NZ/MM

Weather: 45 Clear

Extraction Well: PT/SSD-7

					Observation Well	Observation Well	Observation Well	Observation Well	Observation Well	Observation Well	Observation Well	Observation Well	Observation Well
					TP-14	TP-15	TP-16	TP-17	TP-18				
					*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)
					10	15	20	25	30				
Blower Model	Well Head Vac "H20	System Vac	Flow (scfm)	Time	Vacuum "H_20	Vacuum "H_20	Vacuum "H_20	Vacuum "H_20	Vacuum "H_20	Vacuum "H_20	Vacuum "H_20	Vacuum "H_20	Vacuum "H_20
GP-501	3.20	25%	4.8		0.118	0.063	0.036	0.015	0.002				
	3.82	50%	6		0.157	0.066	0.036	0.017	0.004				
	4.20	100%	6.2		0.162	0.075	0.034	0.018	0.004				
HS5000	10.20	25%	11.2		0.368	0.161	0.081	0.035	0.022				
	11.80	50%	13.6		0.410	0.188	0.088	0.044	0.020				
	11.82	100%	13.6		0.411	0.187	0.090	0.044	0.020				

Comment / Notes:

* Distance measured from Test Point to each Monitoring Point

NM = Not Measured

VMP-2 on other side of wall to the West

Summary of SSD Pilot Test

12 Franklin Street
Brooklyn, NY

SSD Analysis

Test Date:	12/4/2023
Performed By:	EnviroTrac - NZ/MM
Extraction Point:	**PT/SSD-7**
Test Duration (min.):	1.0 hr
Wellhead Vacuum ("H2O):	3.2 to 11.82
Wellhead Flow (scfm):	4.8 to 13.6

PT/SSD-6

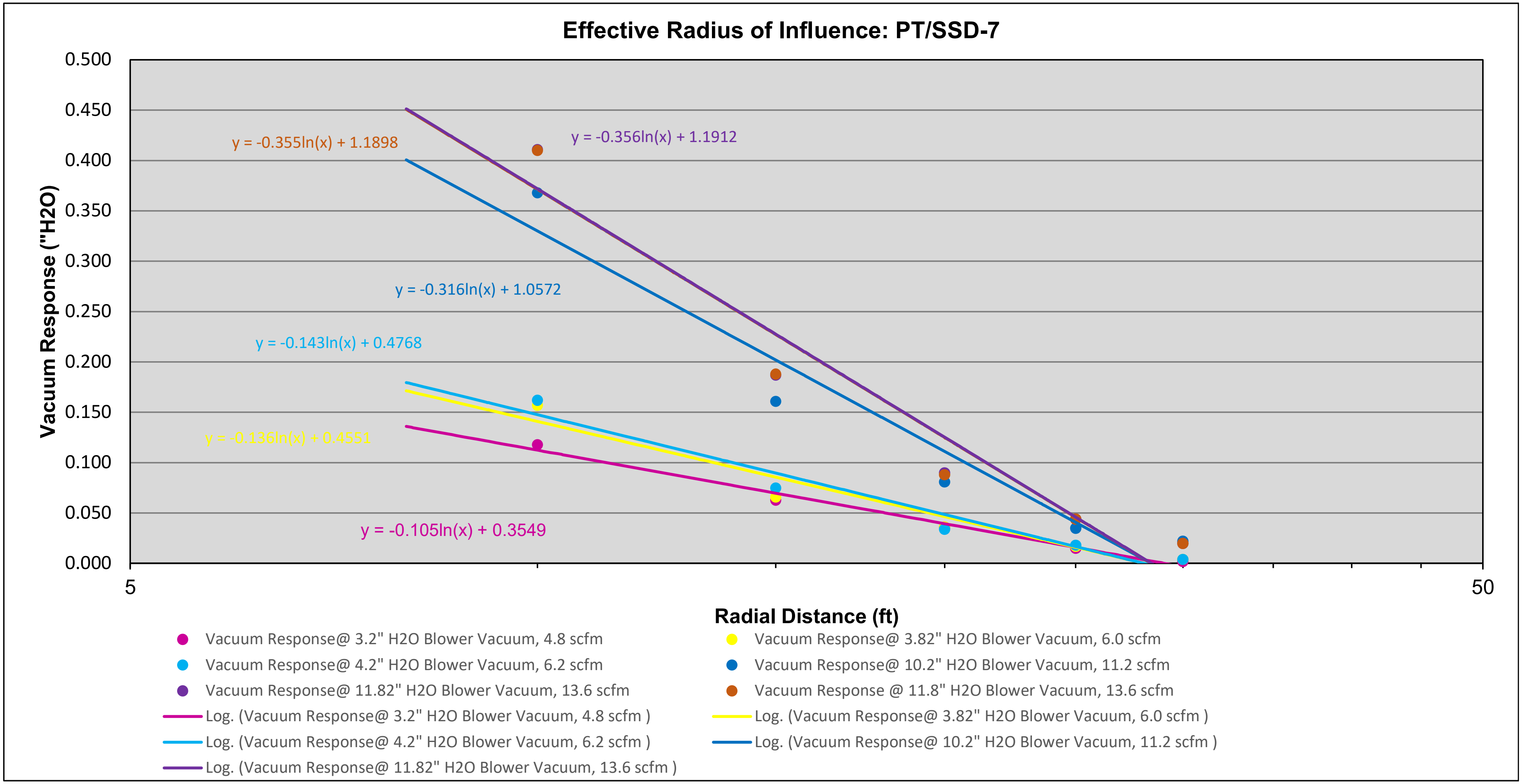
Radial Distance (ft.)	Vacuum Response@ 3.2" H2O Blower Vacuum, 4.8 scfm	Vacuum Response@ 3.82" H2O Blower Vacuum, 6.0 scfm	Vacuum Response@ 4.2" H2O Blower Vacuum, 6.2 scfm	Vacuum Response@ 10.2" H2O Blower Vacuum, 11.2 scfm	Vacuum Response @ 11.8" H2O Blower Vacuum, 13.6 scfm	Vacuum Response@ 11.82" H2O Blower Vacuum, 13.6 scfm	Reference Line 0.03 "H2O
10	0.118	0.157	0.162	0.368	0.410	0.411	0.030
15	0.063	0.066	0.075	0.161	0.188	0.187	0.030
20	0.036	0.036	0.034	0.081	0.088	0.090	0.030
25	0.015	0.017	0.018	0.035	0.044	0.044	0.030
30	0.002	0.004	0.004	0.022	0.020	0.020	0.030

Est ROI @ 0.03" H2O Threshold

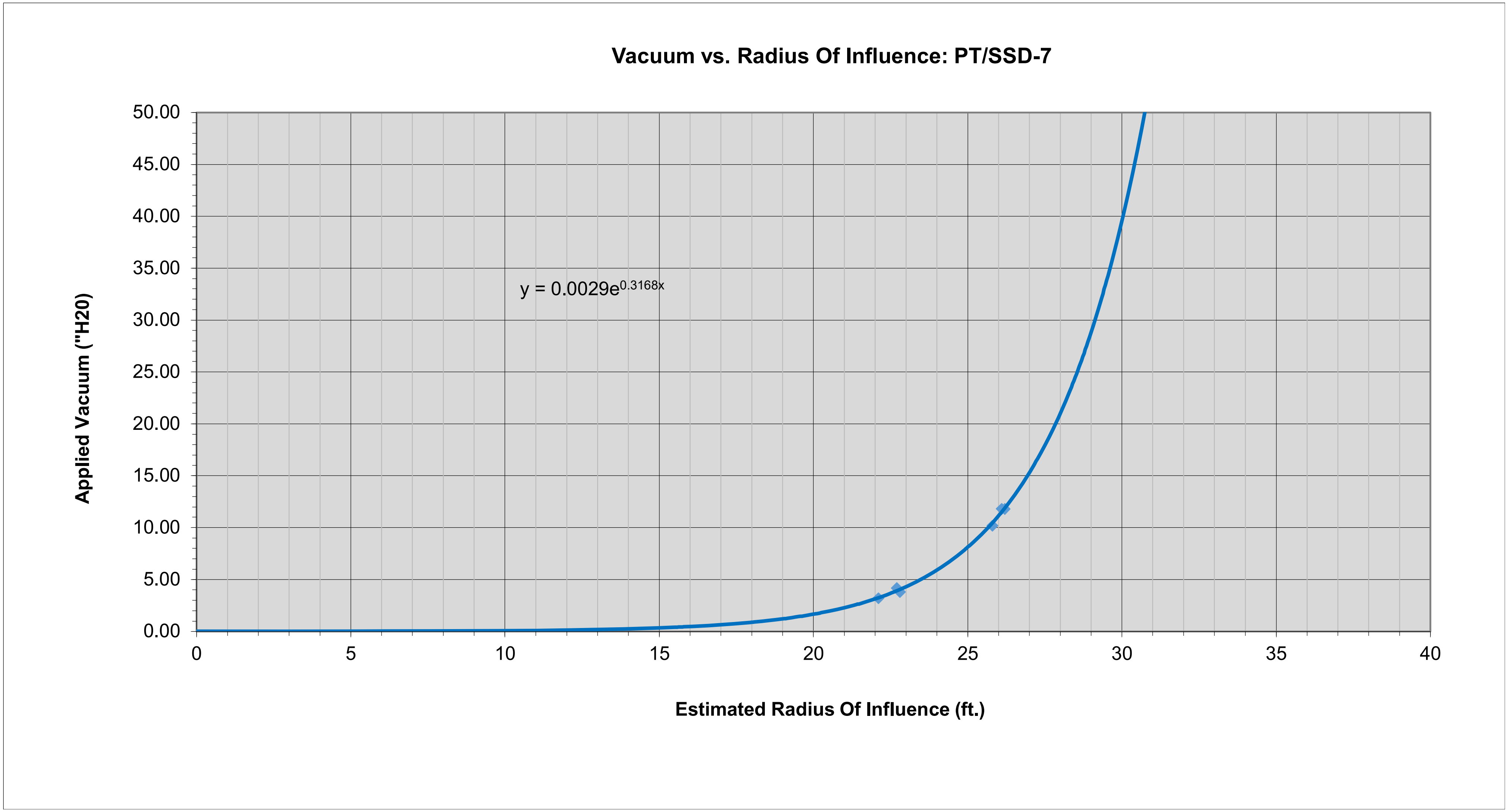
Est. ROI (ft.)	Vacuum ("H2O)	Flow (scfm)
22.1	3.20	4.8
22.8	3.82	6.0
22.7	4.20	6.2
25.8	10.20	11.2
26.2	11.80	13.6
26.1	11.82	13.6

Minimum Parameters (per Extraction Point)

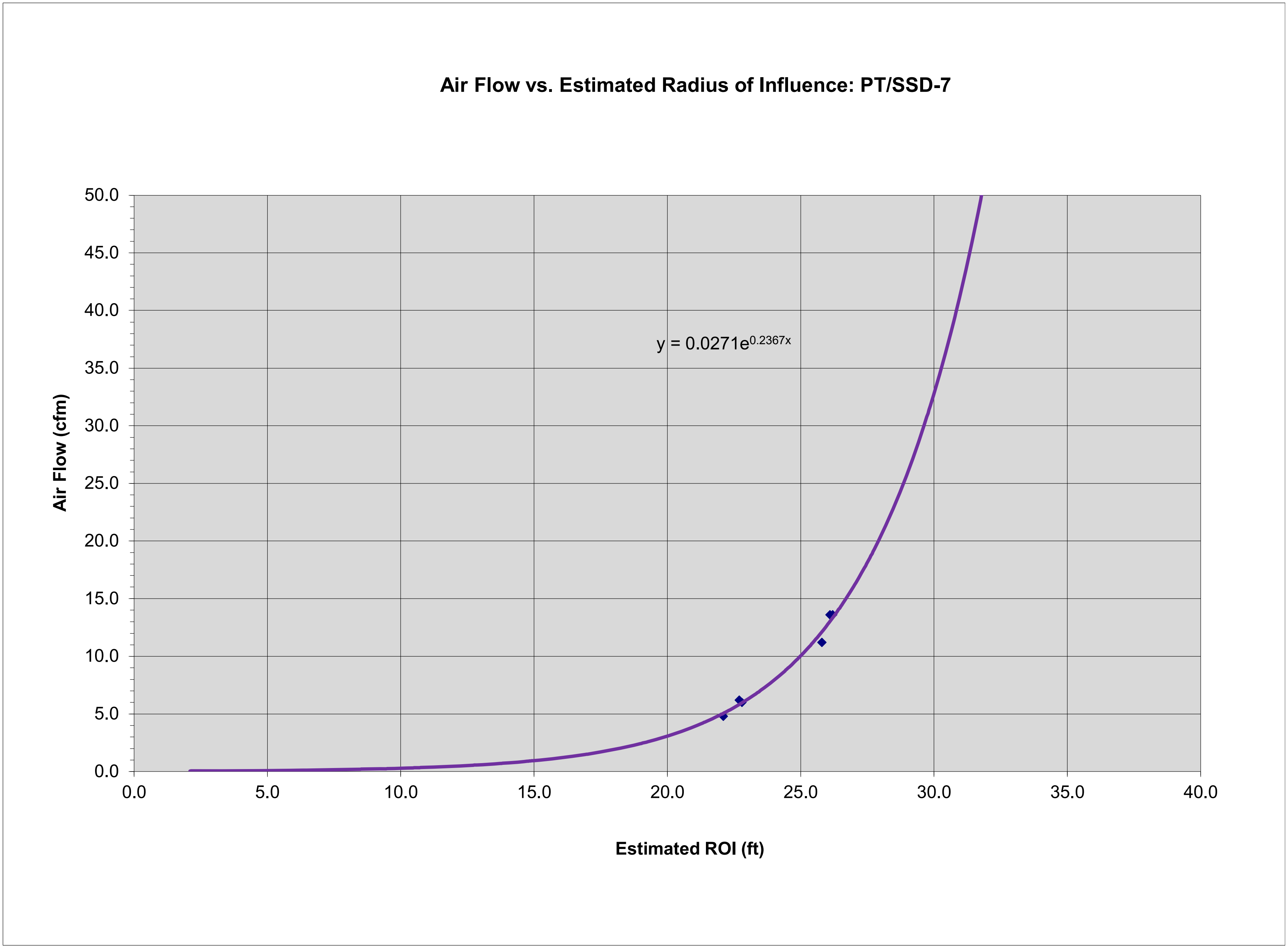
Target ROI (ft)	Design Vac ("H2O)	Design Flow (scfm)
25	8.0	10.0



Effective Radius of Influence: PT/SSD-7
Vacuum Response ("H2O)
0.500
0.450
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
5
50
Radial Distance (ft)
y = -0.355ln(x) + 1.1898
y = -0.356ln(x) + 1.1912
y = -0.316ln(x) + 1.0572
y = -0.143ln(x) + 0.4768
y = -0.136ln(x) + 0.4551
y = -0.105ln(x) + 0.3549
Vacuum Response@ 3.2" H2O Blower Vacuum, 4.8 scfm
Vacuum Response@ 3.82" H2O Blower Vacuum, 6.0 scfm
Vacuum Response@ 4.2" H2O Blower Vacuum, 6.2 scfm
Vacuum Response@ 10.2" H2O Blower Vacuum, 11.2 scfm
Vacuum Response@ 11.82" H2O Blower Vacuum, 13.6 scfm
Vacuum Response @ 11.8" H2O Blower Vacuum, 13.6 scfm
Log. (Vacuum Response@ 3.2" H2O Blower Vacuum, 4.8 scfm)
Log. (Vacuum Response@ 3.82" H2O Blower Vacuum, 6.0 scfm)
Log. (Vacuum Response@ 4.2" H2O Blower Vacuum, 6.2 scfm)
Log. (Vacuum Response@ 10.2" H2O Blower Vacuum, 11.2 scfm)
Log. (Vacuum Response@ 11.82" H2O Blower Vacuum, 13.6 scfm)



Vacuum vs. Radius Of Influence: PT/SSD-7
y = 0.0029e^0.3168x
Applied Vacuum ("H20)
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0
5
10
15
20
25
30
35
40
Estimated Radius Of Influence (ft.)


Air Flow vs. Estimated Radius of Influence: PT/SSD-7
y = 0.0271e^0.2367x
Air Flow (cfm)
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
Estimated ROI (ft)

Sub-Slab Depressurization (SSD) Pilot Test Data

Site Name: **12 Franklin Street Brooklyn, NY**

Test Date: 12/1/2023

Personnel: NZ/MM

Weather: 40's Clear

Extraction Well: **PT/SSD-12**

					Observation Well	Observation Well	Observation Well	Observation Well	Observation Well	Observation Well	Observation Well	Observation Well	Observation Well
					TP-8	TP-7	TP-6	TP-5	MP-7				
					*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)	*Distance (ft)
					10	15	20	25	30				
Blower Model	Well Head Vac "H20	System Vac	Flow (scfm)	Time	Vacuum "$H_2$0	Vacuum "$H_2$0	Vacuum "$H_2$0	Vacuum "$H_2$0	Vacuum "$H_2$0	Vacuum "$H_2$0	Vacuum "$H_2$0	Vacuum "$H_2$0	Vacuum "$H_2$0
GP-501	2.90	25%	3.2	12:50	0.018	0.006	0.000	0.000	0.000				
	4.28	50%	4.6	13:00	0.024	0.015	0.000	0.000	0.000				
	4.30	100%	4.5	13:10	0.025	0.015	0.000	0.000	0.000				
HS5000	14.50	25%	10	13:15	0.067	0.041	0.024	0.000	0.000				
	14.3	50%	10.6	13:20	0.071	0.044	0.020	0.000	0.000				
	15.3	100%	11.2	13:30	0.072	0.042	0.019	0.000	0.000				

Comment / Notes:

* Distance measured from Test Point to each Monitoring Point

NM = Not Measured

Wet soil noted below bottom of floor slab at time of test point installation

Summary of SSD Pilot Test
12 Franklin Street
Brooklyn, NY

SSD Analysis

Test Date:	12/1/2023
Performed By:	EnviroTrac - NZ/MM
Extraction Point:	**PT/SSD-12**
Test Duration (min.):	1.0 hr
Wellhead Vacuum ("H2O):	2.9 to 15.3
Wellhead Flow (scfm):	3.2 to 11.2

PT/SSD-6

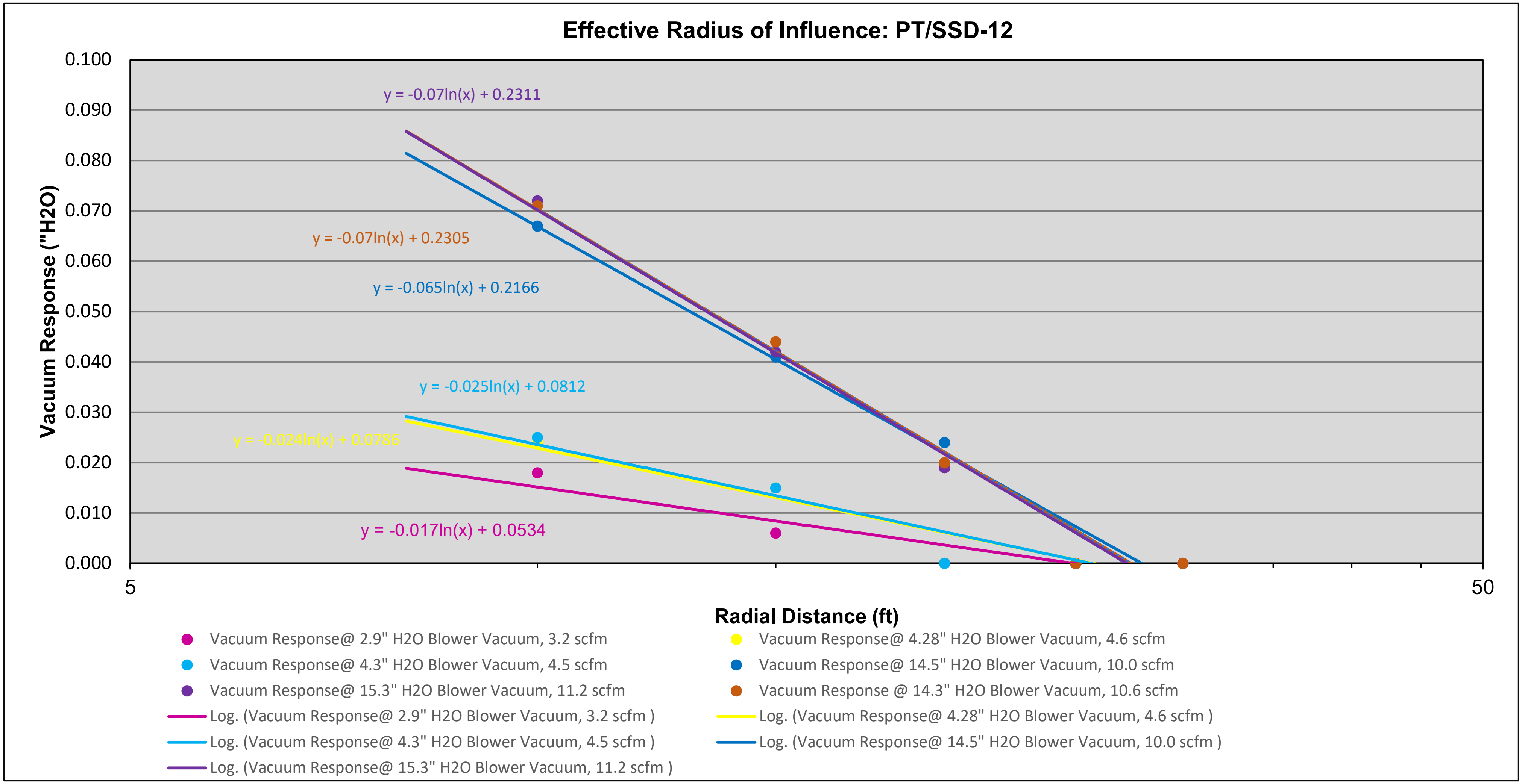
Radial Distance (ft.)	Vacuum Response@ 2.9" H2O Blower Vacuum, 3.2 scfm	Vacuum Response@ 4.28" H2O Blower Vacuum, 4.6 scfm	Vacuum Response@ 4.3" H2O Blower Vacuum, 4.5 scfm	Vacuum Response@ 14.5" H2O Blower Vacuum, 10.0 scfm	Vacuum Response @ 14.3" H2O Blower Vacuum, 10.6 scfm	Vacuum Response@ 15.3" H2O Blower Vacuum, 11.2 scfm	Reference Line 0.03 "H2O
10	0.018	0.024	0.025	0.067	0.071	0.072	0.030
15	0.006	0.015	0.015	0.041	0.044	0.042	0.030
20	0.000	0.000	0.000	0.024	0.020	0.019	0.030
25	0.000	0.000	0.000	0.000	0.000	0.000	0.030
30	0.000	0.000	0.000	0.000	0.000	0.000	0.030

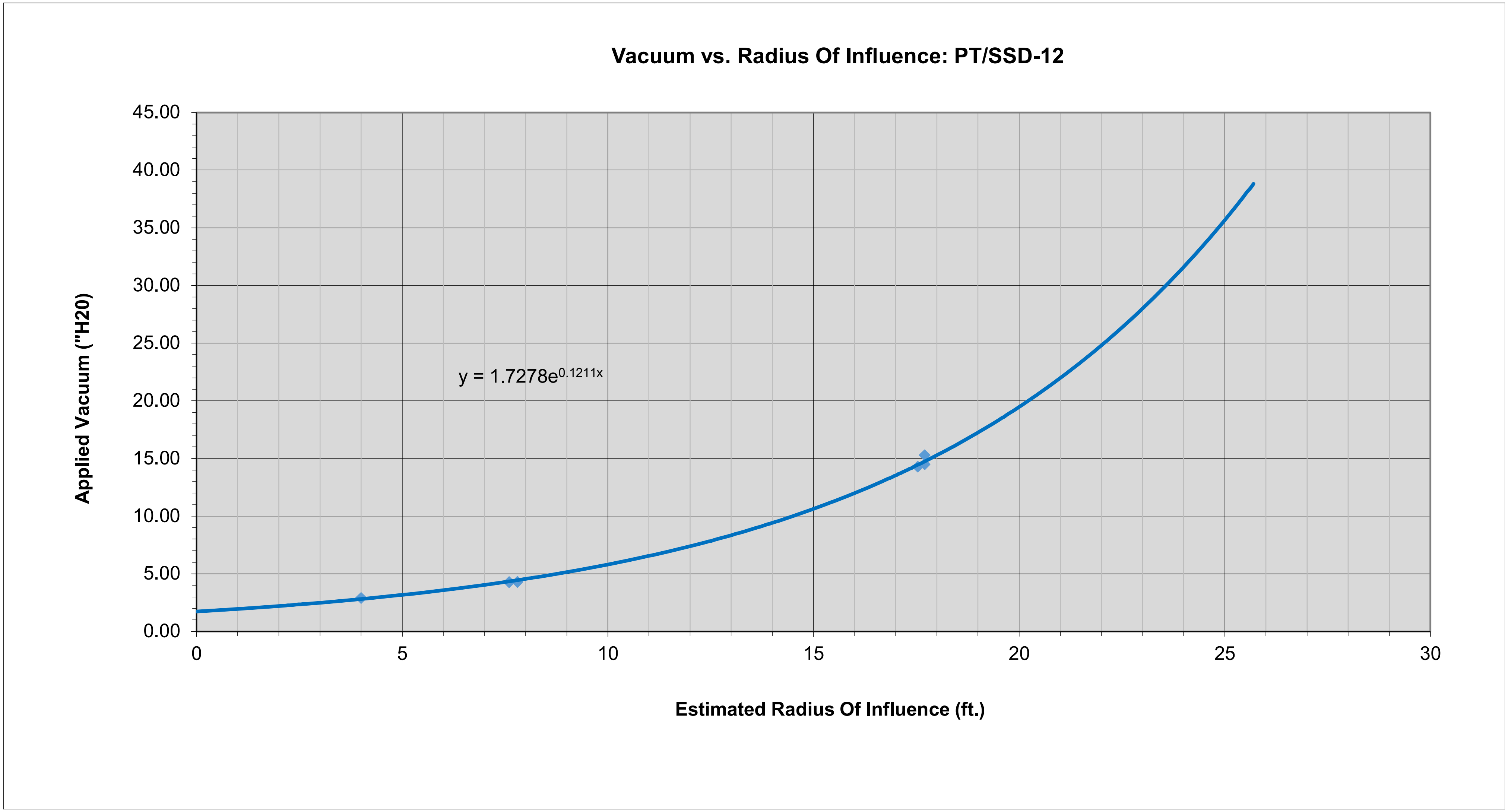
Est ROI @ 0.03" H2O Threshold

Est. ROI (ft.)	Vacuum ("H2O)	Flow (scfm)
4.0	2.90	3.2
7.6	4.28	4.6
7.8	4.30	4.5
17.7	14.50	10.0
17.5	14.30	10.6
17.7	15.30	11.2

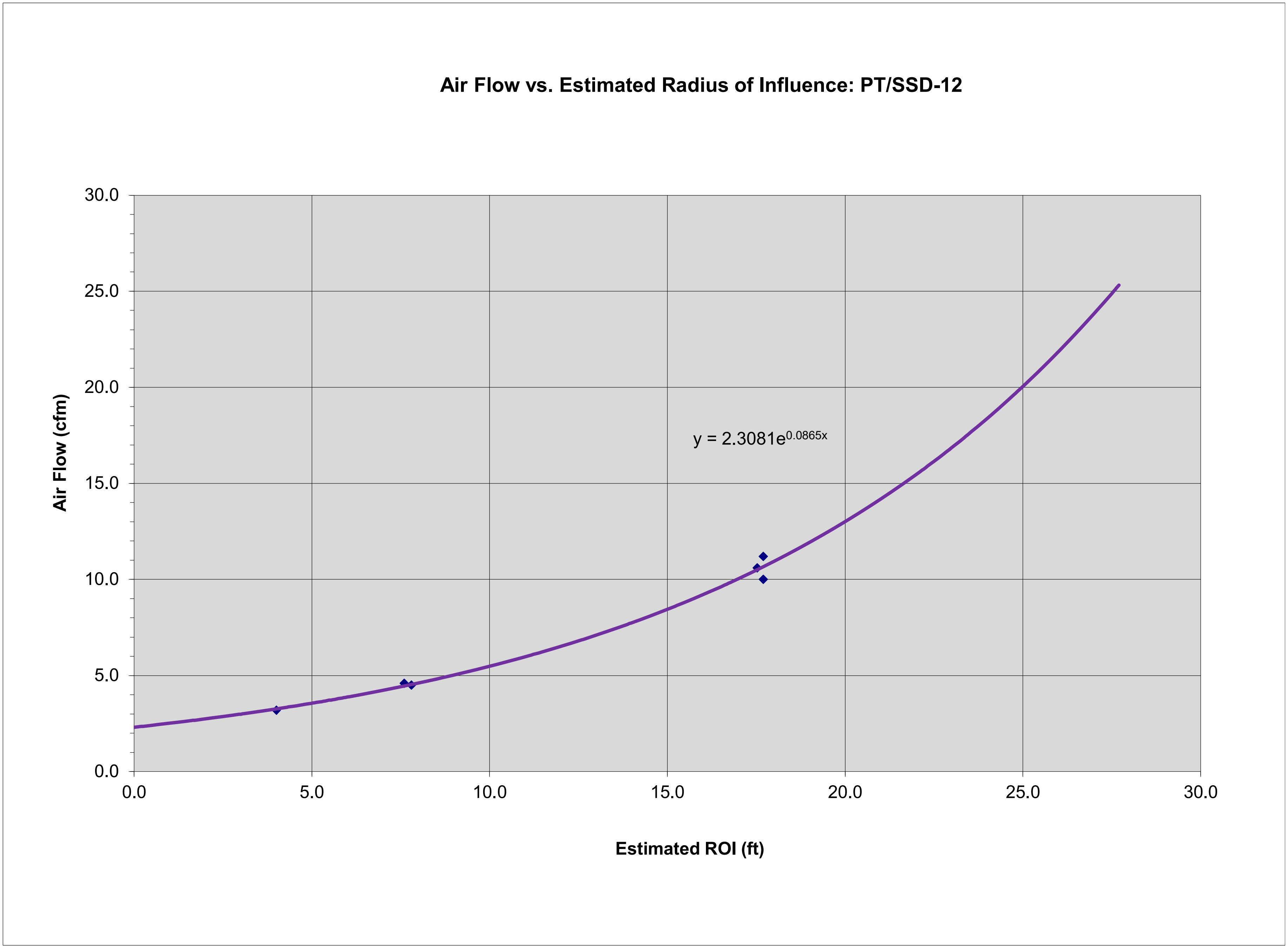
Minimum Parameters (per Extraction Point)

Target ROI (ft)	Design Vac ("H2O)	Design Flow (scfm)
25	35.7	20.1


Effective Radius of Influence: PT/SSD-12
Vacuum Response ("H2O)
0.100
0.090
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
5
50
Radial Distance (ft)
y = -0.07ln(x) + 0.2311
y = -0.07ln(x) + 0.2305
y = -0.065ln(x) + 0.2166
y = -0.025ln(x) + 0.0812
y = -0.024ln(x) + 0.0786
y = -0.017ln(x) + 0.0534
Vacuum Response@ 2.9" H2O Blower Vacuum, 3.2 scfm
Vacuum Response@ 4.28" H2O Blower Vacuum, 4.6 scfm
Vacuum Response@ 4.3" H2O Blower Vacuum, 4.5 scfm
Vacuum Response@ 14.5" H2O Blower Vacuum, 10.0 scfm
Vacuum Response@ 15.3" H2O Blower Vacuum, 11.2 scfm
Vacuum Response @ 14.3" H2O Blower Vacuum, 10.6 scfm
Log. (Vacuum Response@ 2.9" H2O Blower Vacuum, 3.2 scfm)
Log. (Vacuum Response@ 4.28" H2O Blower Vacuum, 4.6 scfm)
Log. (Vacuum Response@ 4.3" H2O Blower Vacuum, 4.5 scfm)
Log. (Vacuum Response@ 14.5" H2O Blower Vacuum, 10.0 scfm)
Log. (Vacuum Response@ 15.3" H2O Blower Vacuum, 11.2 scfm)



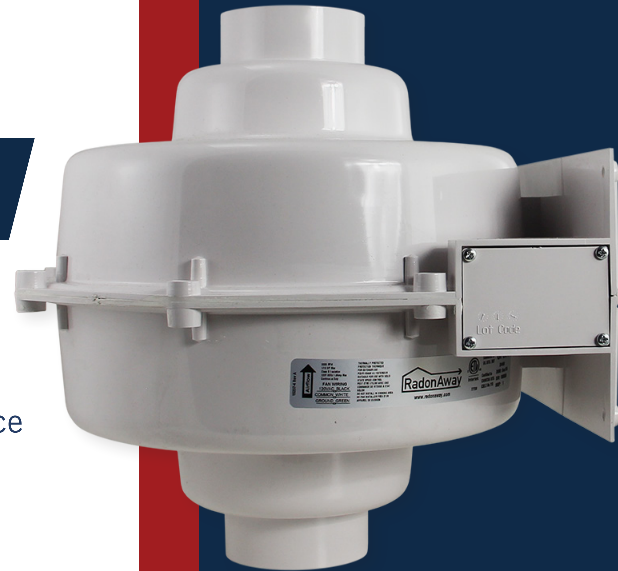
Vacuum vs. Radius Of Influence: PT/SSD-12
Applied Vacuum ("H20)
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0
5
10
15
20
25
30
y = 1.7278e^0.1211x
Estimated Radius Of Influence (ft.)



Air Flow vs. Estimated Radius of Influence: PT/SSD-12
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Air Flow (cfm)
y = 2.3081e^0.0865x
0.0
5.0
10.0
15.0
20.0
25.0
30.0
Estimated ROI (ft)

RadonAway®
The world's leading radon fan manufacturer

GP PRO SERIES



INSTALLS WHITE, STAYS WHITE

Radon Mitigation Fan

All RadonAway® fans are specifically designed for radon mitigation. GP Series Fans offer a wide range of performance options that make them ideal for most sub-slab radon mitigation systems.

Features

- NEW Stay-White™ housing
- Quiet operation
- Water-hardened motor
- Seams sealed under negative pressure (to inhibit radon leakage)
- Mounts on duct pipe or with integral flange
- 3" diameter ducts for use with 3" or 4" pipe
- Electrical box for hard wire or plug in
- ETL Listed - for indoor or outdoor use
- 4 interchangeable GP models

MODEL	P/N	FAN DUCT DIAMETER	WATTS	RECOM. MAX. OP. PRESSURE "WC	TYPICAL CFM vs. STATIC PRESSURE WC						
					1.0"	1.5"	2.0"	2.5"	3.0"	3.5"	4.0"
GP201	28465	3"	31-65	1.8	54	42	11	-	-	-	-
GP301	28466	3"	56-100	2.3	64	54	41	4	-	-	-
GP401	28467	3"	62-128	3.0	-	61	52	44	22	-	-
GP501	28468	3"	68-146	3.8	-	-	66	58	50	27	4

USA — Made in USA with U.S. and imported parts.

c ETL us Listed Intertek — ETL Listed

5 Years Warranty Period — All RadonAway® inline radon fans are covered by our 5-year, hassle-free warranty.

For Further Information, Contact Your Radon Professional:

Rev D 0517
P/N 02045

HS Series

The world's leading radon fan manufacturer

Radon Mitigation Fan

HS fans offer a proven solution for tough radon mitigation jobs, providing up to 25 times the suction of inline tube fans to deal with sand, tight soil or clay sub-slab material.

Features

- Internal condensate bypass
- Brackets for vertical mounting indoors and outdoors
- Inlet: 3.0” PVC / Outlet: 2.0” PVC
- Weight: 18 lbs.
- Size: 15.5”W x 13.3”H x 8.2”D
- Warranty: 1 year (3-year option available)

MODEL	WATTS	SOUND RATING (dBA)			RECOM. MAX. OP. PRESSURE “WC	TYPICAL CFM* vs. STATIC PRESSURE WC					
		OPEN	1/2	CLOSED		0"	10"	15"	20"	25"	35"
HS2000 with cord	174-307	56.5	56.2	51.9	14	63	37	12	-	-	-
HS3000 with cord	120-250	47.9	48.0	46.2	21	39	30	25	19	-	-
HS5000 with cord	223-385	56.0	55.3	53.1	35	44	37	33	29	25	16
HS2000E with switch box	174-307	56.5	56.2	51.9	14	63	37	12	-	-	-
HS3000E with switch box	120-250	47.9	48.0	46.2	21	39	30	25	19	-	-
HS5000E with switch box	223-385	56.0	55.3	53.1	35	44	37	33	29	25	16

*Made in the USA with U.S. and imported parts.

* CFM measured through suction.

For Further Information, Contact Your Radon Professional:

Rev C 0517
P/N 02002

APPENDIX D

Field Sampling Plan/Quality Assurance Project Plan

ROUX

Quality Assurance Project Plan/Field Sampling Plan

12 Franklin Street
Brooklyn, New York 11222

January 25, 2024

Prepared for:

Franklin Point LLC
Franklin Point Holding LLC
175 Great Neck Road, Suite #407
Great Neck, New York 11021

Prepared by:

Roux Environmental Engineering and Geology, D.P.C.
209 Shafter Street
Islandia, New York 11749

4170.0001Y104/CV

Environmental Consulting
& Management
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rouxinc.com

Table of Contents

Tables

Appendices

1. Introduction

Roux Environmental Engineering and Geology, D.P.C. (Roux), on behalf of Franklin Point LLC / Franklin Point Holding LLC (referred to herein as the Volunteer), has prepared this Quality Assurance Project Plan/Field Sampling Plan (QAPP/FSP) to describe the measures that will be taken to ensure the data generated during performance of the Interim Remedial Measures (IRM) Work Plan (IRMWP) and the Supplemental Remedial Investigation (SRI) Work Plan (SRIWP) for the 12 Franklin Street Site occupying Tax Block 2614, Lot 3, Brooklyn, New York (Site) are of quality sufficient to meet project-specific data quality objectives (DQOs). This QAPP/FSP also includes field sampling procedures.

Due to the presence of contaminated media at the Site, the Applicant plans to remediate the Site under the New York State Department of Environmental Conservation (NYSDEC) Brownfield Cleanup Program (BCP). This QAPP/FSP was prepared in accordance with the NYSDEC DER-10 Technical Guidance for Site Investigation and Remediation (DER-10) and the United States Environmental Protection Agency's (USEPA's) Guidance for the Data Quality Objectives Process (EPA QA/G 4).

1.1 Purpose

The QAPP/FSP describes in detail the field sampling and quality assurance/quality control (QA/QC) methods to be used during soil, indoor air, and ambient air sampling tasks performed during the Investigation.

This QAPP/FSP was prepared in accordance with the NYSDEC's DER-10 and provides guidelines and procedures to be followed by field personnel during performance of sampling during the Investigation. Information contained in this QAPP/FSP relates to:

- Sampling objectives (Section 2);
- Project organization (Section 3);
- Sample media, sampling locations, analytical suites, sampling frequencies, and laboratory analysis (Section 4);
- Field sampling procedures (Section 5);
- Sample handling, sample analysis, and quality assurance/quality control (Section 6); and
- Site control procedures and decontamination (Section 7).

2. Sampling Objectives

The objective of the proposed sampling is to determine the nature and extent of the potential contamination at the Site, to evaluate any additional areas of concern (AOCs), and to obtain a current representation of the environmental conditions at the Site.

Based on the review of the previous Phase I Environmental Site Assessments (ESAs) completed for the Site, the following areas of concern (AOC) were identified within the Site limits:

- Potential soil, groundwater, soil vapor, and indoor air contamination associated with former Site manufacturing uses.
- Potential soil, groundwater, and indoor air contamination associated with historically identified USTs.

Based on the existing data for the Site and known data gaps, the following objectives have been identified for the IRMWP and SRIWP:

- Fill data gaps from prior investigations (e.g., collect samples for PFAS).
- Evaluate quality of remaining soil after UST removal.
- Evaluate effectiveness of the sub-slab depressurization system (SSDS).

Environmental data collected during the IRM and SRI will be used to qualitatively assess the potential exposure of receptors to Site contaminants.

Sampling procedures are discussed in Section 5 of this QAPP/FSP. A discussion of the DQOs and quality assurance/quality control is provided in Section 6.

3. Project Organization

A general summary of the overall management structure and responsibilities of project team members are presented below. Professional profiles for the team are provided in Appendix A.

Project Principal

Mr. Robert Kovacs, P.G. of Roux will serve as Project Principal. The Project Principal is responsible for defining project objectives and bears ultimate responsibility for the successful completion of the investigation.

Remedial Engineer

The Remedial Engineer for this project will be Mr. David Kaiser, P.E. The Remedial Engineer is a registered professional engineer licensed by the State of New York. The Remedial Engineer will have primary direct responsibility for implementation of the IRMWP and SRIWP and future remedial program for the Site. The Remedial Engineer will certify that the investigation activities were observed by qualified environmental professionals under supervision as well as any other relevant provisions of ECL 27-1419 have been achieved in full conformance with the IRMWP and the SRIWP.

Project Manager

Ms. Rachel Henke of Roux will serve as Project Manager. The Project Manager is responsible for defining project objectives and bears ultimate responsibility for the successful completion of the work. This individual will provide overall management for the implementation of the scope of work and will coordinate all field activities. The Project Manager is also responsible for data review/interpretation and report preparation.

Field Team Leader

The Field Team Leader is Mr. Jack Rusk. The Field Team Leader bears the responsibility for the successful execution of the field program. The Field Team Leader will direct the activities of the technical staff in the field, as well as all subcontractors. The Field Team Leader will also assist in the interpretation of data and in report preparation. The Field Team Leader reports to the Project Manager.

Laboratory Project Manager

Laboratory analysis will be completed by Alpha Analytical Laboratories of Westborough, Massachusetts and Mansfield, Massachusetts, NYSDOH Environmental Laboratory Accreditation Program (ELAP)-certified laboratories (11148 and 11627, respectively). The Laboratory Project Manager is Karyn Raymond. The Laboratory Project Manager is responsible for sample container preparation, sample custody in the laboratory, and completion of the required analysis through oversight of the laboratory staff. The Laboratory Project Manager will ensure that quality assurance procedures are followed, and an acceptable laboratory report is prepared and submitted. The Laboratory Project Manager reports to the Field Team Leader.

Quality Assurance Officer

Charles J. McGuckin, P.E. of Roux will serve as the Quality Assurance Officer (QAO) for this project. The QAO is responsible for conducting reviews, inspections, and audits to ensure the data collection is conducted in accordance with the QAPP/FSP. The QAO's responsibilities range from ensuring effective field equipment decontamination procedures and proper sample collection to the review of all laboratory analytical data for completeness and usefulness. The QAO reports to the Project Manager and makes independent recommendations to the Field Team Leader.

4. Sample Media, Locations, Analytical Suites, and Frequency

The media to be sampled during the Investigation include soil, indoor air, and ambient air. Sampling locations, analytical suites, and frequency may vary by medium. A discussion of the sampling schedule for each medium is provided below, while the assumed number of field samples to be collected for each medium, including QC samples, is shown in Tables 1 and 2. Specifics regarding the collection of samples at each location and for each task are provided in Section 5 of this QAPP/FSP.

4.1 Soil Sampling

Soil samples are to be used to characterize the soil conditions for the AOCs at the Site, to gather additional data across the Site, and to collect data sufficient to define the nature and extent of impacted soils. Twenty two (22) soil samples are proposed to be taken at the locations shown in Figure 2 of the IRMWP, Figure 2 of the SRIWP, as summarized below.

Region of Site	Number of Samples	Analyses	Depth of Sample (ft bls)[1]
UST-1	5^	CP-51 VOCs, SVOCs	TBD (Sidewall and Bottom of UST Excavation)
UST-2	5^	CP-51 VOCs, SVOCs	TBD (Sidewall and Bottom of UST Excavation)
Throughout Site	12	ECs*	0-2

** As required by NYSDEC, ECs list includes the 40 Per- and Polyfluoroalkyl Substances (PFAS) listed in the NYSDEC April 2023 Guidelines for Sampling and Analysis of PFAS Under NYSDEC's Part 375 Remedial Programs. PFAS in soil will be analyzed by USEPA Draft Method 1633.

^ If the tanks are larger than anticipated, additional samples will be collected as dictated by DER-10.

The Alpha Standard Operating Procedures (SOPs) for completing ECs analysis, list of all EC compounds to be analyzed, and reporting limits/minimum detection limits for EC compounds are included in Appendix B.

All PFAS compounds will be analyzed and reported to 1 microgram per kilogram (μg/kg).

If odor/ visual evidence of contamination or elevated photoionization detector (PID) readings are noted, additional samples will be collected from the interval that exhibits the highest contamination.

4.2 Indoor Air and Outdoor Ambient Air Sampling

The proposed indoor air sampling locations are shown on Figure 3 of IRMWP. The ambient air location will be selected prior to the start of sampling. All indoor air and ambient air samples will be collected in accordance with the October 2006 (Updated May 2017) New York State Department of Health (NYSDOH) Guidance for Evaluating Soil Vapor Intrusion in the State of New York (NYSDOH Guidance).

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1 All depths measured from the bottom of the existing slab.

Region of Site	Sample Identification	Sample Depth
Indoor Air	IA-MP-1 through IA-MP-7	Breathing zone
Ambient Air	AA-1	Outdoor background atmospheric conditions

Samples will be analyzed at a NYSDOH Environmental Laboratory Approval Program-certified laboratory using USEPA Method TO-15 for VOCs. All indoor air and outdoor ambient air samples will be collected using pre-cleaned (batch certified) 2.7-liter summa canisters with regulators calibrated to collect samples over an 8-hour period.

Samples will be analyzed at a NYSDOH Environmental Laboratory Approval Program-certified laboratory using USEPA Method TO-15 for VOCs. All indoor air, and outdoor ambient air samples will be collected using pre-cleaned (batch certified) 2.7-liter summa canisters with regulators calibrated to collect samples over an 8-hour period.

Indoor and Ambient Air Sampling

As shown on Figure 3 of the IRMWP, seven indoor air samples (IA-1 through IA-7) will be collected from the lowest floor of the building (street-level) and co-located with the sub-slab vapor monitoring points (Figure 3 for proposed indoor and ambient air sampling locations). To the extent practicable, indoor air samples will be placed in well-ventilated and open area typical of the normal working environment.

The outdoor ambient air sample (AA-1) will be collected concurrently with the indoor air samples. The outdoor ambient air sample will serve to better define the background atmospheric conditions within the area of the Site. This canister will be placed in a location chosen to provide representative background results based on conditions at the time of sampling. The ambient air will be sampled concurrently with the indoor air samples and by utilizing the same sample collection methods and equipment.

5. Field Sampling Procedures

This section provides a detailed discussion of the field procedures to be used during sampling of the various media being evaluated as part of the IRMWP and SRIWP implementation. As discussed, the sample locations are shown on Figure 2 and 3 of the IRMWP and Figure 2 of the SRIWP and additional information, including intervals to be sampled and sample rationale is provided. Additional details regarding sampling procedures and protocols are described in Roux's relevant Standard Operating Procedures (SOPs), which are provided in Appendix B.

5.1 Soil Sampling

Details for the collection of soil samples are provided below.

Emerging Contaminant Sampling: For the emerging contaminant sampling, soil borings will be advanced to two ft below the bottom of the slab using soft-dig methods (i.e. hand auger, vacuum technology, etc.) and each location will be checked to verify the absence of potential underground utilities. Should a utility or other feature be observed during soft-dig activities, the sampling location will be relocated to no greater than ten feet away from the original proposed location. Should the sampling location need to be located at a distance greater than five feet from the original proposed location due to access constraints, Roux will consult the NYSDEC case manager prior to installing a boring at the new location.

All soil sampling activities will be completed in accordance with the NYSDEC Emerging Contaminant April 2023 Guidance. Additional necessary precautions will be taken when sampling for ECs in the field, including, but not limited to:

- Using the proper field clothing or personal protective equipment (PPE) (i.e., no materials will contain Gore-Tex or Tyvek);
- Avoid sampling equipment components/containers making contact with aluminum foil, low-density polyethylene (LDPE), glass, or polytetrafluoroethylene materials;
- Following PFAS field sampling guidelines (i.e., using sampling materials made from high-density polyethylene [HDPE], silicon, or stainless steel and avoid using equipment containing Teflon and using Sharpies, permanent markers, adhesives, and waterproof/plastic clipboards and notebooks); and
- Utilizing regular ice for sample presevation and only Alconox or Liquinox for decontamination.
- One soil sample will be collected from each emerging contaminant location at depths of 0-2 feet below the slab. A total of twelve samples will be taken from 12 locations.

UST Endpoint Soil Sampling: If suspected USTs are encountered, one endpoint sample will be collected from the bottom and four samples will be taken from each sidewall of each UST excavation. A total of ten samples are suspected to be taken from the two locations.

During sampling, lithology will be recorded and soil will be observed for evidence of contamination (e.g., staining, odors, and/or visible free-product) and placed immediately thereafter into large Ziploc® bags for recording headspace using a PID. After a minimum of 15 minutes for equilibration with the headspace in the Ziploc® bag, each sample will be screened for organic vapors using a PID equipped with a 10.6 eV lamp. Samples for possible VOC analysis will be placed in a laboratory-supplied jar or encore sampler prior to screening, due to the potential for loss of VOCs through volatilization. These samples will be placed in the laboratory-supplied containers and shipped to the laboratory under chain of custody procedures in accordance with Roux's SOPs in Appendix B.

Following sample collection, excavations will be sealed with grout to maintain the integrity of the existing vapor barrier. Contaminated soil cuttings, if encountered, will be placed in sealed and labeled U.S. Department of Transportation (DOT) approved 55-gallon drums pending characterization and off-site disposal at a permitted facility.

5.2 Indoor Air and Ambient Air Sampling

Seven indoor air samples and one ambient air sample will be collected after the installation of the SSDS to gain an understanding of current indoor air quality and to evaluate the effectiveness of the SSDS. Details for the collection of indoor air and ambient samples are provided below.

Seven indoor air samples will be collected from the lowest floor of the building (street-level). To the extent practicable, indoor air sample canisters will be placed in a well-ventilated and open area typical of the normal working environment. The indoor air samples will be collected using pre-cleaned 2.7-liter summa canisters with regulators calibrated to collect samples over an 8-hour period and analyzed using USEPA Method TO-15 SIM for VOCs.

One ambient air sample will be collected outside the building to characterize Site-specific background outdoor air conditions and to evaluate the potential influence, if any, of outdoor air on the indoor air sample. The outdoor ambient air samples will be collected outside the building within the Site bounds. The outdoor ambient air will be sampled concurrent with the indoor air samples and by utilizing the same sample collection methods and equipment. The outdoor ambient air sample will be collected concurrently with the indoor air samples. The ambient air sample will be collected using a pre-cleaned 2.7-liter summa canister with a regulator calibrated to collect the sample over an 8-hour period and analyzed using USEPA Method TO-15 SIM for VOCs. This canister will be placed in a location chosen to provide representative background results based on conditions at the time of sampling.

6. Sample Handling and Analysis

To ensure quality data acquisition and collection of representative samples, there are selective procedures to minimize sample degradation or contamination. These include procedures for preservation of the samples, as well as sample packaging, shipping procedures, and QA/QC.

6.1 Field Sample Handling

A discussion of the proposed number and types of samples to be collected during each task, as well as the analyses to be performed, can be found in Section 4 of this QAPP/FSP. The types of containers, volumes, and preservation techniques for the aforementioned testing parameters are presented in Table 3.

6.2 Sample Custody Documentation

The purpose of documenting sample custody is to ensure the integrity and handling of the samples is not subject to question. Sample custody will be maintained from the point of sampling through the analysis (and return of unused sample portions, if applicable).

Each individual collecting samples is personally responsible for the care and custody of the samples. All sample labels should be pre-printed or filled out using waterproof ink. The technical staff will review all field activities with the Field Team Leader to determine whether proper custody procedures were followed during the fieldwork and to decide if additional samples are required.

All samples being shipped offsite for analysis must be accompanied by a properly completed chain of custody form. The sample numbers will be listed on the chain of custody form. When transferring the possession of samples, individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents transfer of custody of samples from the sampler to another person, to/from a secure storage area, and to the laboratory.

Samples will be packaged for shipment and dispatched to the appropriate laboratory for analysis with a separate signed custody record enclosed in each sample box or cooler. Shipping containers will be locked and/or secured with strapping tape in at least two locations for shipment to the laboratory.

6.3 Sample Shipment

Laboratory analysis will be completed by Eurofins of Edison, NJ and Burlington, VT, Massachusetts, NYSDOH Environmental Laboratory Accreditation Program (ELAP)-certified laboratories. Sample packaging and shipping procedures are based upon USEPA specifications, as well as DOT regulations. The procedures vary according to potential sample analytes, concentration, and matrix and are designed to provide optimum protection for the samples and the public. Sample packaging and shipment must be performed using the general outline described below.

All samples will be shipped within 24 hours of collection and will be preserved appropriately from the time of sample collection. A description of the sample packing and shipping procedures is presented below:

1. Prepare cooler(s) for shipment:
   - tape drain(s) of cooler shut;
   - affix “This Side Up” arrow labels and “Fragile” labels on each cooler; and

- place mailing label with laboratory address on top of cooler(s).

2. Arrange sample containers in groups by sample number.
3. Ensure all bottle labels are completed correctly. Place clear tape over bottle labels to prevent moisture accumulation from causing the label to peel off.
4. Arrange containers in front of assigned coolers.
5. Place packaging material appropriately at the bottom of the cooler to act as a cushion for the sample containers.
6. Arrange containers in the cooler so they are not in contact with the cooler or other samples.
7. Fill remaining spaces with packaging material.
8. Ensure all containers are firmly packed in packaging material.
9. If ice is required to preserve the samples, ice cubes should be repackaged in Ziploc™ bags and placed on top of the packaging material.
10. Sign chain of custody form (or obtain signature) and indicate the time and date it was relinquished to courier as appropriate.
11. Separate chain of custody forms. Seal proper copies within a large Ziploc™ bag and tape to inside cover of cooler. Retain copies of all forms.
12. Close lid and latch.
13. Secure each cooler using custody seals.
14. Tape cooler shut on both ends.
15. Relinquish to overnight delivery service as appropriate. Retain air bill receipt for project records. (Note: All samples will be shipped for "NEXT A.M." delivery).

6.4 Quality Assurance/Quality Control

Judy Harry of Data Validation Services will review the analytical data for quality assurance and quality control in accordance with NYSDEC standards. The professional profile for Judy Harry is provided in Appendix A. A laboratory SOP for analysis of PFAS is included in Appendix B.

The primary DQO of the soil, indoor air and ambient air programs is that data be accurate and precise, thus, representative of the actual Site conditions. Accuracy refers to the ability of the laboratory to obtain a true value (i.e., compared to a standard) and is assessed through the use of laboratory quality control (QC) samples, including laboratory control samples and matrix spike samples, as well as through the use of surrogates, which are compounds not typically found in the environment that are injected into the samples prior to analysis. Precision refers to the ability to replicate a value and is assessed through both field and laboratory duplicate samples.

Sensitivity is also a critical issue in generating representative data. Laboratory equipment must be of sufficient sensitivity to detect target compounds and analytes at levels below NYSDEC standards and guidelines whenever possible. Equipment sensitivity can be decreased by field or laboratory contamination of samples, and by sample matrix effects. Assessment of instrument sensitivity is performed through the analysis of reagent blanks, near-detection-limit standards, and response factors. Potential field and/or laboratory contamination is assessed through use of trip blanks, method blanks, and equipment rinse blanks (also called "field blanks"). Field blanks for PFAS will be collected at a minimum frequency of one per day.

Table 1 lists the requirements for field and laboratory QC samples that will be analyzed to assess data accuracy and precision, as well as to determine if equipment sensitivity has been compromised. Table 2 lists the number/type of field and QA/QC samples that will be collected during the IRM and the SRI. Table 3 lists the preservation, holding times and sample container information.

All Investigation “assessment” analyses will be performed in accordance with the NYSDEC Analytical Services Protocol (ASP), using USEPA SW 846 methods.

All laboratory data are to be reported in NYSDEC ASP Category B deliverables and will be delivered to NYSDEC in electronic data deliverable (EDD) format as described on NYSDEC’s website (http://www.dec.ny.gov/chemical/62440.html) and recent updated procedures enacted in November 2018. A Data Usability Report will be prepared meeting the requirements in Section 2.2(a)1.ii and Appendix 2B of DER-10 for all data packages generated for the RI. The DUSR will be prepared by Judy Harry, a third-party data validator. Validator resume is included in Appendix A.

7. Site Control Procedures

Site control procedures, including decontamination and waste handling and disposal, are discussed below. Site control procedures have been developed to minimize both the risk of exposure to contamination and the spread of contamination during field activities at the Site. All personnel who come into designated work areas, including contractors and observers, will be required to adhere strictly to the conditions imposed herein and to the provisions of a Site-Specific Health and Safety Plan (HASP). The HASP is included as Appendix A to the IRMWP.

7.1 Decontamination

In an attempt to avoid the spread of contamination, all drilling and sampling equipment must be decontaminated at a reasonable frequency in a properly designed and located decontamination area. Detailed procedures for the decontamination of field and sampling equipment are included in Roux's SOPs included in Attachment 3. The location of the decontamination area will be determined prior to the start of field operations. The decontamination area will be constructed to ensure that all wash water generated during decontamination can be collected and containerized for proper disposal. All decontmination will be completed using the standard two step process using detergent (Alconox or Liquinox) and clean, PFAS-free water for sample equipment. All water sources used for equipment decontamination during EC sampling of soil will be verified in advance to be PFAS-free through laboratory analysis or certification, in accordance with the NYSDEC January 2021 Guidance.

7.2 Waste Handling and Disposal

All investigation derived waste (IDW) materials (drill cuttings, decontamination water, etc.) generated during the IRM and SRI will be consolidated, and stored in appropriate labeled bulk containers (drums, etc.), and temporarily staged at a designated IDW storage area onsite. Roux will coordinate waste characterization and disposal by appropriate means.

TABLES

1. Field and Laboratory QC Summary
2. Remedial Investigation Sampling Summary
3. Preservation, Holding Times, and Sample Containers

Table 1. Field and Laboratory QC Summary

QC Check Type	Minimum Frequency	Use
Field QC		
Duplicate	1 per matrix per 20 samples or SDG*	Precision
Trip Blank	1 per VOC cooler	Sensitivity
Field Blank (non-PFAS)	1 per matrix per 20 samples	Sensitivity
Field Blank (PFAS)	1 per matrix per day	Sensitivity
Laboratory QC		
Laboratory Control Sample	1 per matrix per SDG	Accuracy
Matrix Spike/Matrix Spike Duplicate/Matrix Duplica	1 per matrix per SDG	Accuracy/Precision
Surrogate Spike	All organics samples	Accuracy
Laboratory Duplicate	1 per matrix per SDG	Precision
Method Blank	1 per matrix per SDG	Sensitivity

Notes:
* SDG - Sample Delivery Group - Assumes a single extraction or preparation
** Provided to lab by field sampling personnel
PFAS - Per- and Polyfluoroalkyl Substances

Table 2. Remedial Action Sampling Summary

Sample Medium	Target Analytes	Field Samples	Replicates[1]	Trip Blanks[2]	Field Blanks[1]	Matrix Spikes[1]	Spike Duplicates[1]	Total No. of Samples
UST Endpoint Samples*	CP-51 VOCs	10	1	2	1	1	1	16
	CP-51 SVOCs	10	1	0	1	1	1	14
Emerging Contaminant Data Gap Samples	PFAS (List of 40)	12	1	0	6	1	1	21
SSDS Confirmation Indoor and Ambient Air Samples	TO-15 VOCs	8	1	0	0	0	0	9

Totals are estimated based on scope of work as written, actual sample quantities may vary based on field conditions. QA/QC sample quantities will be adjusted accordingly.

[1] Based on 1 per day for PFAS or 1 per 20 samples or 1 per Sample Delivery Group for all other parameters. Assumes up to 10 sampling events conducted over time as the excavation progress.

[2] Based on 1 cooler per day

* Assumes the two suspected USTs are found

TCL/Part 375 - USEPA Contract Laboratory Program Target Compound List

USEPA - United States Environmental Protection Agency

VOCs - Volatile Organic Compounds

SVOCs - Semivolatile Organic Compounds

PCBs - Polychlorinated Biphenyls

PFAS - Per- and Polyfluoroalkyl Substances

TAL - USEPA Contract Laboratory Program Target Analyte List

Table 3. Preservation, Holding Times and Sample Containers

Analysis	Matrix	Bottle Type	Preservation(a)	Holding Time(b)
CP-51 Volatile Organic Compunds (VOCs)	Soil	Three 5 gram Encore samplers One 2 oz plastic bottle, teflon lined cap	Cool to 4°C	48 hours, or 14 days if extruded into sealed vial and either frozen to -7 degrees C or extruded into methanol
CP-51 VOCs (For Field Blanks	Water	Three 40mL VOA vials, teflon lined cap	Hydrochloric Acid	14 days from sample collection
CP-51 Semi-Volatile Organic Compounds (SVOCs)	Soil	8 oz wide mouth glass, teflon lined cap	Cool to 4°C	14 days to extract, 40 days to analysis
CP-51 SVOCs (for Field Blanks)	Water	Two 250 milliliter amber glass, teflon lined cap		7 days to extract, 40 days to analysis
PFAS via Draft EPA 1633	Soil	One 4 oz HDPE bottle	Cool to 4°C	90 days to extract; 28 days from extraction to analysis
PFAS via Draft EPA 1633 (for Field Blanks)	Water	One 250 mL HDPE bottles, Two 500 mL HDPE bottles	Cool to 4°C	28 days to extract; 28 days from extraction to analysis. If frozen, the holding time to extraction is 90 days
VOCs via TO-15	Air	6 liter 8-hour runtime Summa canister	None	14 days from sample collection

[(a)] All soil and groundwater samples to be preserved in ice during collection and transport
[(b)] Days from date of sample collection.
PFAS - Per- and Polyfluoroalkyl Substances
USEPA - United States Environmental Protection Agency

APPENDICES

A. Professional Profiles

B. Standard Operating Procedures, Laboratory Detection Limits for Emerging Contaminants and NYSDEC Guidance for Sampling Emerging Contaminants

APPENDIX A

Professional Profiles

PROFESSIONAL PROFILE

Robert Kovacs, LSRP, PG

Principal Scientist

CONTACT INFORMATION

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209 Shafter Street
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EDUCATION

BA, Biological Sciences, University of Delaware, Newark, Delaware, 1999.

PROFESSIONAL LICENSES

Licensed Site Remediation Professional, New Jersey (License No. 627589)

New York State Professional Geologist (License No.000437)

NJDEP UST Certification Program-Subsurface Evaluator (License No. 239024)

EXPERIENCE SUMMARY

Twenty-three years of experience: Principal, Senior, Project, Staff and Staff Assistant Environmental Scientist at Roux, Islandia, New York.

TECHNICAL SPECIALTIES

Design, implementation and management of Environmental Site Assessments, Remedial Investigations, Remedial Actions, and Construction Support at Transportation, Industrial, and Brownfield Redevelopment sites; Development of regulatory strategy and regulatory agency negotiations; Characterization and decommissioning of industrial manufacturing facilities; Roux Corporate QA/QC Officer.

REPRESENTATIVE PROJECTS

- **Amtrak Sunnyside Yard State Superfund Site, Queens, New York.** Principal-in-Charge for multiple projects to support investigation and remediation activities at this State Superfund site. Mr. Kovacs was responsible for overseeing activities in all six Operable Units (OUs), including unsaturated and saturated soil, groundwater, separate-phase hydrocarbon, soil vapor and on-site sewer system. His responsibilities on these projects included PFAS investigations; UST removals; characterizing subsurface conditions, including soil (collected hundreds of soil samples to characterize the 130+ acre active railyard), as well as characterizing a 250,000-gallon PCB-contaminated separate-phase hydrocarbon plume. Additionally, he was responsible for overseeing the design and implementation of remediation activities, including soil excavation and offsite disposal, removal and abandonment of USTs ranging in sizes up to 17,000 gallons, demolition of contaminated buildings and infrastructure, and installation and operation of a dual phase high vacuum extraction (DPVE) system to recover PCB-contaminated separate-phase hydrocarbon through a network of over 40 recovery wells. Due to the highly volatile nature of the separate-phase hydrocarbon and the urban setting of this site, extensive emissions and odor engineering controls were used when excavating and managing soil and product. Additionally, extensive Community Air Monitoring was completed during all phases of work. Mr. Kovacs was also responsible for interaction with all regulatory agencies, as well as preparing and/or reviewing all major project reports and deliverables.

- **Amtrak Infrastructure Construction Projects.** Principal-in-Charge of several large infrastructure upgrade projects for Amtrak, including the Next Generation Acela Ready Track project, the Sunnyside Yard Security Enhancement project, the Sunnyside Yard Water Main Upgrade project, and the initial stages of the Intercity Trainset (ICT) project. Mr. Kovacs is serving as Project Principal, and involved in the planning, site characterization (including PFAS evaluations), construction oversight, and regulatory agency coordination associated with these projects.

- **Pharmaceutical Manufacturing Facility, Brooklyn, New York.** Project Manager/Project Principal for environmental work associated with the seven-block former manufacturing plant. This Site included a former 700,000 square foot manufacturing plant, as well as several other former industrial facilities with operations starting as far back as the 1850's. Responsibilities included UST removals; the design and completion of multiple phases of subsurface investigations to characterize soil and groundwater quality, as well as soil vapor. Contaminants included hydrocarbons, benzene, PCBs, and heavy metals, including lead, mercury, and arsenic. Work included development and preparation of investigation and remediation work plans, coordination and management of field investigations, including the installation of shallow and deep monitoring wells and soil borings using sonic drilling methods, completion of a geophysical survey, collection of groundwater samples, and management of remediation activities. Remediation activities included soil excavation, UST removals, and the installation of a soil vapor extraction and air sparging system. Work was completed under several different regulatory agencies, including NYSDEC and NYCOER. Also provided presentations to school authorities, including the NYC DOE, to communicate the progress of the project and to educate administrators regarding the Site's environmental issues.

- **Lendlease Java Street Waterfront Redevelopment – Greenpoint, New York.** Principal-in-Charge for this large redevelopment project located on the waterfront in Greenpoint, New York. This 2.6-acre site is being redeveloped into a mixed-use development, including a residential tower, retail space, and a shoreline esplanade with NYC Ferry terminal access. This project incorporates many green and sustainability initiatives in its design. Work on this project has included due diligence support, involving the completion of a Phase I and Phase II ESA, NYSDEC BCP application, preparation of a Remedial Investigation Report and Remedial Action Work Plan, as well as supporting Lendlease in negotiation with NYSDEC to maximize site preparation and tangible tax credits. Work also included implementing an extensive In-situ Waste Characterization program, including PFAS investigation, negotiating soil reuse, and developing and implementing a complex remedial design program and community air monitoring program. The remedy for the site included design of a Sub-Slab Depressurization System (SSDS) to mitigate vapors beneath the future building, as well as negotiation with NYSDEC and NYCOER to ensure 421a schedule requirements were achieved. As part of this work, soil borings, monitoring wells, piezometers, and soil vapor monitoring points were installed, and hydrogeologic cross sections were prepared. Additionally, as part of this project, the tidal influence of the East River on site groundwater was studied, and a benthic sediment investigation was conducted in the East River.
- **Industrial Warehouse Development – Bayshore, New York.** Principal-in-Charge for a proposed industrial warehouse development located in Bayshore, Long Island, NY. As part of the project an initial Phase II investigation and PFAS evaluation was completed at this industrial site that contains a large former landfill. A BCP Application was prepared and is currently under review by NYSDEC.
- **Affordable Housing Development – Bronx, New York.** Principal- in-Charge for the redevelopment of a former US Postal Service Fleet Maintenance facility located in the south Bronx. This site will be redeveloped into a 100% affordable housing complex. I was retained to complete all initial due diligence activities, including PFAS investigation, and to evaluate possible NYSDEC BCP eligibility. Once determined the site is a good candidate for the BCP, we prepared a BCP Application, and all required reporting. We also ensured that the site met 421a schedule requirements throughout the development and implementation of an Interim Remedial Measures (IRM) Plan. Full scale remediation is currently underway, including the remediation of hazardous soils, removal of USTs, and removal of multiple hydraulic lifts. Responsibilities also included design of a Sub-Slab Depressurization System (SSDS) to mitigate vapors beneath the future building.
- **Chlorinated Solvent Remediation – Parsippany-Troy Hills, New Jersey.** Principal-in-Charge for the Remedial Investigation and Remedial Action implementation associated with a former dry cleaner release located in Parsippany-Troy Hills, New Jersey. We were retained by one of the largest real estate developers in the United States to complete this project. Soil, groundwater, and subsurface vapor were impacted with chlorinated VOCs as a result of the former dry cleaner operations. Responsibilities included the design and management of a Supplemental RI that included the installation of soil borings, monitoring wells and the completion of groundwater vertical profiling. Additionally, Mr. Kovacs was responsible for the design, implementation, and management of an extensive groundwater remediation injection program in which approximately 200,000 pounds of Zero-Valent Iron (ZVI) and 2,500 gallons of Emulsified Vegetable Oil (EVO) were injected into the subsurface using pneumatic fracturing. Initial post-treatment results show over 95 percent reduction in concentrations of chlorinated VOCs in groundwater. Furthermore, he was responsible for the design, installation, and operation of a SVE system to address impacted vadose zone soil.
- **Brookfield Hudson Exchange West – Jersey City, New Jersey.** Principal-in-Charge and LSRP for the first three towers as part of this mixed-income development near the Jersey City waterfront. Overall, this project will include 11 residential towers. To date, two towers are completed, and one is about to begin construction. I am LSRP of record for: Phase 1A (625,000 square foot, 35-story tower), Phase 1B (432 unit, 35-story tower), and Phase 2 (60-story tower, with 802 Units and ShopRite supermarket planned for the second floor). Responsibilities included all initial site investigation, remedial design, and remedial implementation. Additionally, I was responsible for all compliance with NJDEP requirements, including preparation and certification of all reports, preparation of Remedial Action Permits, issuance of RAOs, and implementation of all post remedial activities and reporting.

- **Residential/Commercial Redevelopment – Brooklyn, New York.** Principal-in-Charge for a mixed-use development located in Red Hook, NY. Completed Phase II investigation and designed and implemented several Interim Remedial Measures. Also advised client on the most advantageous regulatory pathway to implement the redevelopment project. We are currently in the process of submitting a BCP Application to NYSDEC.
- **Chlorinated Solvent Release – Bernardsville, New Jersey.** Principal-in-Charge for the investigation of an extensive chlorinated solvent plume emanating from a former dry cleaner site. Contamination from this site has migrated far off site in groundwater, and has potentially impacted nearby surface water. Work includes installation of soil borings and monitoring wells to characterize contamination in soil, perched water, groundwater in the deep unconsolidated aquifer zone, as well as groundwater in the weathered bedrock matrix and bedrock matrix. Further, contamination from the Site is co-mingled with contamination from other solvent release sites, complicating NJDEP negotiations and investigation/remedial requirements. Mr. Kovacs serves as the LSRP of record for this project.
- **UST Spill Site – Brooklyn, New York.** Principal-in-Charge for the investigation of a Spill in Williamsburg, Brooklyn, New York. M. Kovacs lead the project team in successfully demonstrating to NYSDEC's Spills Group that impacts to a deep groundwater zone beneath the client's site were a result of offsite contamination migrating onsite from a nearby active gasoline station (not a result of the client's former industrial operations). Impacts included the presence of several feet of free-product in a deep groundwater zone. Furthermore, he was successful in getting the client's Spill Case closed, saving the client from additional investigation activities, and what will likely be a multi-million-dollar remediation to address free-product beneath a semi- confining clay zone.
- **Former Vehicle Maintenance Facility – Parlin, New Jersey.** Project Manager for the removal of (2) waste oil USTs, a subsurface oil water separator, piping, and remediation of associated petroleum contaminated soil at a former vehicle maintenance facility in Parlin, New Jersey. Roux was retained by one of the largest real estate developers in the United States to complete this project. This remediation was completed to allow for a new, national tenant to occupy this retail space. As part of this work, it was determined that a historic release occurred from the OWS, triggering a RI for petroleum-related VOCs and chlorinated VOCs in soil. Mr. Kovacs was also responsible for the development and implementation of the Remedial Action for the Site, which included excavation and off-site soil disposal. SESOIL modeling was also utilized to demonstrate groundwater (approximately 100 feet deep) was not impacted by the shallow soil contamination. As part of this project, he took a lead role in preparing the SI Report, RI Report, RAW, RAR, Receptor Evaluation, and the Unrestricted Use RAO.
- **NJ Transit Active Bus Facility, New Jersey.** Project Principal for the completion of a RI at an active bus garage located in Fairview, New Jersey for a major transit agency. Responsibilities included the delineation of a free-product plume, characterization of soil and groundwater quality, report preparation, and correspondence with the NJDEP. Moreover, Mr. Kovacs was responsible for implementing free-product Interim Remedial Measure efforts. Currently, he is finalizing the RI report for the Site, and managing the Remedial Action design, and supporting the LSRP in meeting all NJDEP administrative requirements.
- **Residential Hi-Rise Development – Manhattan, New York.** Principal-in-Charge for a redevelopment site in mid-town Manhattan working for a private developer who is building a mixed-use retail/commercial tower. Work included a Phase I ESA and Phase II ESA. As part of the Phase II shallow bedrock was identified in portions of the site, and an LNAPL plume was identified in the overburden soils. Responsibilities included bedrock evaluation, LNAPL recovery utilizing multiple different techniques. Responsibilities also included construction support, health and safety support, management of all soil excavated and transported off site, and the design of a Sub-Slab Depressurization System (SSDS) to mitigate vapors in the vadose zone beneath the new building structure that were emanating from groundwater.
- **Ship Dry Dock Facility – Hoboken, New Jersey.** Project Manager for the completion of a Preliminary Assessment and Site Investigation (PA/SI) at an active ship dry dock facility in Hoboken, New Jersey. Responsible for the coordination and management of field investigation activities, which included soil, groundwater, and sediment sampling, as well as the preparation of a PA and SI report. This work was completed on behalf of a potential buyer of the property who planned to redevelop this site into a New York City ferry terminal.
- **BICC Cables – Yonkers, New York.** Project Manager for the investigation and remediation of the interior and subsurface soils of a former cable manufacturing facility located in Yonkers, New York to be redeveloped into a movie studio. Responsibilities included the completion of several large-scale investigations, including the collection of wipe, soil and building material samples to characterize PCB and lead impacts at this 200,000+ square foot facility Additional tasks included oversight of the remediation of interior surfaces using several different methods for the removal of PCBs and lead, and remediation of a sub-surface drainage trench and process water system. Further work included the preparation of a

Remedial Investigation report and a Feasibility Study report for submittal to the NYSDEC.

- **Amtrak Electrical Substation – Rahway, New Jersey.** Project Manager for the RI and RA design and implementation at an active electrical substation in Rahway, New Jersey for a national passenger railroad agency. Responsibilities included completing an RI to delineate PCBs in soil, and the management of free- product recovery programs. Further, Mr. Kovacs was responsible for managing the RA at the Site, which included soil excavation and offsite disposal, and free- product recovery. As part of this project, he supported the Site LSRP and took a lead role in preparing the Supplemental RI Report, RAW, RAR, Receptor Evaluation, and the Unrestricted Use RAO. Additionally, he assisted the LSRP in satisfying all NJDEP administrative requirements, including preparation of forms, public notifications, and submittal of fees.

- **Echo Bay Redevelopment – New Rochelle, New York.** Project Manager for the completion of Phase I and Phase II Environmental Site Assessment activities associated with a proposed mixed-use redevelopment located in Westchester, New York. Work included management of subsurface investigation activities to characterize soil conditions, and working closely with client's architects and construction contractors to integrate the proposed site remediation into the project development plan (including evaluating multiple potential disposal scenarios). Site contaminants included hydrocarbons (including free-product plume from former USTs), and historic fill constituents.

- **Former Dry Cleaner – Ramsey, New Jersey.** Project manager for the SI, RI, and vapor intrusion investigation at a former dry cleaner in Ramsey, New Jersey. Responsibilities included managing and coordinating field investigations, preparing remedial cost estimates for redevelopment, and preparation of reports and satisfying NJDEP Administration requirements. This work is being done to support redevelopment of the Site for a large, national fitness center tenant.

- **Former Service Station – Patterson, New Jersey.** Project Manager for the implementation of a groundwater remediation injection program to address petroleum contamination at a former service station located in Paterson, New Jersey for a major transit agency. Responsibilities included implementation of a PA and SI to further investigate chlorinated VOCs at this Site. As part of this project, Mr. Kovacs took a lead role in preparing reports and the Permit-by-Rule Request, as well as assisting in satisfying all NJDEP administrative requirements.

- **NJ Transit Active Railyard – Roxbury Township, New Jersey.** Project manager for the investigation of a diesel release at an active railyard in. This release was caused by a faulty underground pipe located in the locomotive fueling area. The diesel release resulted in a free-product plume, groundwater impacts, and impacts to a subsurface drainage culvert and a nearby lake. Responsibilities included the development and coordination of a field investigation program, coordination of routine gauging and free-product recovery events, correspondence with NJDEP, and preparation of a baseline ecological evaluation. Additionally, Mr. Kovacs supported the Site LSRP in meeting all NJDEP administrative requirements.

Facility Demolition/Decommissioning

- **Former Pharmaceutical Manufacturing Facility Decommissioning, Brooklyn, New York.** Project Manager for the interior decontamination and decommissioning of a 700,000+ square foot former manufacturing facility located in Brooklyn, New York to allow for redevelopment of the building for commercial, retail, and light industrial use, and use as a movie studio, and for local food businesses. This redevelopment has earned significant positive press, as it is considered a highly beneficial reuse for the community. This project included the development of decontamination and decommissioning work plan, technical support of bidding process, and full time onsite engineering support of the entire project.

  Decontamination and decommissioning activities included removal/cleaning of hundreds of air handling units and dust collector units impacted with manufacturing dusts and residues, as well as thousands of feet of intricate vacuum, ventilation, and dust collection lines. This project also included the removal of concrete impacted with metals, PCBs, and/or VOCs, selective interior demolition, and decontamination of former laboratory, milling, compounding, blending, and packaging areas, as well as asbestos abatement. At the conclusion of this project, a Final Report was prepared, documenting in detail the extensive work completed and that the work plan objectives were achieved.

- **Former Pharmaceutical Manufacturing Facility Demolition, Brooklyn, New York.** Project Manager for the demolition of two former manufacturing buildings in Brooklyn, New York. Both buildings were impacted with hazardous levels of PCBs, mercury, and lead. Responsibilities included in situ waste characterization of building materials, oversight of hazardous waste removal, completion of waste manifests, and full-time Community Air Monitoring during all demolition activities. Additionally, Roux Associates performed daily inspections and monitoring to ensure the protection of a nearby elementary school and prepared a completion report at the conclusion of the project.

- **PCB Building Material Remediation.** Principal-in-Charge for the investigation and TSCA remediation of PCB containing paint in a former manufacturing area. This location (approximately

2,000 square feet in area, and two stories in height) was found to contain PCBs in the paint matrix at concentrations as high as 10,000 parts per million. The underlying building material (brick, concrete, and terra cotta) was also found to be impacted with PCBs from the paint. Responsibilities included preparation of a Self-Implementing Notification and Alternative Decontamination Methods and Verification Sampling Work Plan to remediate the PCBs under the TSCA regulatory framework. This project also included providing field oversight of the PCB remediation, completion of the extensive verification sampling program of the underlying porous building material, and collection of confirmation air samples and confirmation wipe samples outside of the exclusion zone to confirm proper function of all critical barriers. Following the successful completion of the project, a Final Report was prepared and submitted to USEPA documenting the entire project in detail.

Expert/Insurance Litigation Support

- Consulting Fact Witness for an insurance litigation claim where insured was seeking to be reimbursed for more than $15 million of previous environmental investigation/remediation costs. Mr. Kovacs responsibilities included a formal deposition and testifying in US District Federal Court – Eastern District of New York. Case resulted in favorable ruling for our client.
- Consulting expert for a PRP to the Gowanus Canal Superfund Site, Brooklyn, New York. Evaluated all RI data, performed fate and transport analysis, and evaluation of historic site operations to support facility *de minimis* status.

PROFESSIONAL TRAININGS

OSHA 40-Hour Health and Safety Course (29 CFR 1910.120)

OSHA 8-Hour Health and Safety Refresher Course (29 CFR 1910.120)

PUBLICATIONS

Significant Acceleration of Time Frame to Closure via Transition from Long-Term Biological Treatment to ZVI/EVO Injection, Kovacs, R., Senh, S., Silverstein, W., Moss, D., Kelley, R., Proceedings of the Tenth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, 2016.

Strategy to Overcome Sub-Slab Depressurization System Design and Operational Challenges in an Existing Building With Sensitive Tenant Use, Henke, R., Kovacs, R., Kaiser, D., Proceedings of the Twelfth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, 2022.

ROUX

PROFESSIONAL PROFILE

David E. Kaiser, PE

Senior Engineer I

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EDUCATION

BS, Civil Engineer, Hofstra University, 2006

PROFESSIONAL LICENSES

Professional Engineer (NY), 2017

Fundamentals of Engineering EIT, 2006

EXPERIENCE SUMMARY

Twelve years of experience: Project Engineer with Roux; Design Engineer with Bohler Engineering.

TECHNICAL SPECIALTIES

Engineering services including development and review of design drawings, implementation of design, development of technical specifications, review of construction submittals, development of SWPPPs, field management and site safety of various heavy construction projects, and civil/remediation engineering construction management. Designs have included stormwater drainage systems, NYCDEP sewer system, NYCDOB/DOT sidewalk project, and remedial system design. Additional services including budget management, permitting, project coordination, project scheduling, development of bid packages and cost estimating. Field management and construction oversight of heavy equipment construction including sewer construction, drainage construction, crane lift activities and remedial construction activities. Environmental site assessments focusing on soil, soil vapor, groundwater, and excavation dewatering investigations.

REPRESENTATIVE PROJECTS

- **Land Development Site Plan Preparation.** Design Engineer for the design and development of residential, commercial, and industrial site plan packages for Suffolk County, Nassau County and New York City Boroughs. Site plan packages for the various municipalities within Suffolk County, Nassau County and New York City included components such as: zoning analysis, site removals plan, site design and construction documents, water, and sewer system design (detention and retention systems), site grading and drainage plans, and lighting analysis and design.

- **Suffolk County Drywell Closure.** Senior Engineer for the planning and coordination of closing existing drywell structures serving as sanitary and industrial retention basins for an industrial facility. The project consisted of developing a sampling plan for the site, coordinating sampling and inspection of existing sanitary and industrial drywells in accordance with Suffolk County Department of Health Services Article 12, SOP No. 9-95 Pumpout and Soil Cleanup Criteria. Following the sampling event, a summary of results was prepared and sent to the SCDHS for review. Due to exceedances that were present within the septic tanks, a remedial action work plan was developed to identify the required steps for successful closure which included coordinating the SCDHS field inspection, extraction of contaminated liquids and solids, and proper disposal of the waste.

- **Property Drainage System Design and Construction.** Project Engineer for the design and development of a new on-site stormwater treatment system located at a former petroleum terminal in Brooklyn, NY. Design included drainage improvements and modifications for the former petroleum terminal to support ongoing remediation activities that were being conducted to facilitate the future closure of an existing in-ground oil/water separator and removal of associated piping, and to support the anticipated long-term remedy for, and potential future redevelopment of, the subject property. The proposed drainage modifications included the installation of new drainage structures, Contech treatment structures and conveyance piping to collect and treat stormwater runoff within the property, and bypass the existing in-ground oil/water separator, prior to discharging the stormwater via an existing SPDES outfall.

- **Utility Tunnel Extension.** Project Engineer for construction management of a utility tunnel extension and modification project. The project consisted of installation of a precast concrete stairway access to an existing utility tunnel, installation of a structural slab to span the tunnel extension, installation of a new base slab, installation of cast-in-place concrete walls and top slab, installation of sidewalks and relocation of all existing system piping and conduits. The work was performed in accordance with the requirements of the New York City Department of Buildings (NYCDOB) and the New York City Department of Transportation (NYCDOT).
- **Treatment System Building Upgrades.** Project Engineer for the review and implementation of engineering drawings for a metals removal system upgrade to an existing 450-gpm groundwater treatment system. The upgrades consisted of: relocating and reinstalling the existing oil/water separator tank on a steel spacer via crane; lifting and installing the existing 10,000 gallon equalization tank to be repurposed as a filter backwash solids removal tank; lifting and installing prefabricated concrete pads with a subbase of Geogrid BX1200 and 6” of aggregate size number 57 (as per NYCDDC Highway Specifications and ASTM C33) compacted to 95% Standard Proctor, under proposed tank locations; locating a new 20,000 gallon equalization/aeration tank on the new pad; installing of new blower motor and enclosure; and installing of new piping and appurtenances.
- **Recovery Well Construction.** Staff Engineer for the construction of aspects of a dual-phase free-phase petroleum product (free-product) and groundwater recovery well at a former petroleum terminal in Brooklyn, NY. Groundwater extracted from the recovery well would be conveyed through 4-inch diameter high density polyethylene standard dimension ratio 11 (HDPE SDR 11) piping and connected to an existing 6-inch HPDE SDR 11 force main piping network that transports the groundwater to an existing on-site groundwater treatment system. Any free-product recovered would be sent to an existing 2,000 gallon above ground storage tank (AST) via 1-inch double wall product piping. Electrical and signal conduits were routed to an existing well house where the system control components were housed.
- **Treatment System Building Roof Rehabilitation and Platform Installation.** Project/Staff Engineer for providing engineering design, review, and construction management of the rehabilitation of a roof and installation of an internal platform in an existing remediation groundwater treatment system building located at a former petroleum terminal in Brooklyn, NY. The roof rehabilitation project included the replacement of approximately 1,200 square feet of stainless steel decking, insulation and waterproofing. The project also included the construction of three new skylights and access ladders. The platform installation project included the installation of new steel members and fiberglass reinforced polymer (FRP) molded grating within the existing remediation groundwater treatment to provide a working platform for on-site technicians. The new steel members were bolted to existing infrastructure to limit on-site welding and the platform was installed with tubular steel handrails. Responsibilities included: ensuring that the development of the plans and technical specifications were in accordance with the New York City Construction Codes, New York State Building Standards and Codes, various ASTM standards, American Institute of Steel Construction (AISC) “Code of Standard Practice for Steel Buildings and Bridges,” and Steel Structures Painting Council (SSPC) Publications.
- **NYCDEP Private Storm and Sanitary Sewer System.** Project/Staff Engineer for the design and development of a New York City Department of Environmental Protection (NYCDEP) Private Storm and Sanitary Sewer System located at a former petroleum terminal in Brooklyn, NY. The sewer system comprised of over 2,600 LF of sewer in Greenpoint Brooklyn over two phases of construction. During the duration of this project responsibilities included: develop/revise NYCDEP sewer design plans and construction notes, address NYCDEP comments and markups, develop Bill of Materials, develop cost estimates, develop technical specifications, develop bid package, ensure compliance with NYCDEP and NYCDOT specifications and requirements, develop/revise NYCDOT Builder’s Pavement Plan (BPP), develop NYCDOT Maintenance and Protection of Traffic plans, conduct/participate in design construction meetings, review subcontractor submittals and cut sheets, address NYCDEP punch list items, management/oversight/coordination of subcontractor construction activities.
- **NYCDOB/NYCDOT Sidewalk Installation.** Project/Staff Engineer for the design, development, and installation of over 4,000 linear feet of new sidewalks over various phases located at a former petroleum terminal in Brooklyn, NY. The design, development, and installation of these sidewalks were in accordance with the New York City Department of Buildings and New York City Department of Transportation specifications and details of construction. During the duration of these projects my major responsibilities included: develop/revise NYCDOT Builder’s Pavement Plans, develop cost estimates, develop technical specifications, develop bid package, ensure compliance with NYCDOB and NYCDOT specifications and requirements, develop NYCDOT Maintenance and Protection of Traffic plans, conduct/participate in design construction meetings, ensure proper installation and testing of sidewalks in accordance with NYCDOB and NYCDOT,

management/oversight/coordination of subcontractor construction activities.

- **Sub Slab Depressurization System.** Staff Engineer for the design and construction of two sub slab depressurization systems (SSDS) located within the footprint of a petroleum remediation site where a new building was proposed to be built. These projects were part of an Interim Remedial Measure (IRM) Action Plan as approved by the NYSDEC to provide a preventative proactive measure to address potential soil vapor issues. The SSDSs were designed to operate passively; however, header piping was installed to allow for the installation of the necessary equipment if an active system was required. The SSDSs consisted of ¾-inch gravel with 4-inch diameter polyvinyl chloride (PVC) schedule 40 well screen used as soil gas collection piping and 6-inch diameter solid PVC used as the header piping. A vapor barrier/waterproofing membrane and nonwoven geotextile fabric were installed between the venting layer and the floor slab. All penetrations through the floor slab were sealed using a silicone based waterproof sealant. The scope of work included excavation and trench work for the SSDS; placement of pipe bedding; jointing and installation of the pipe fittings, valves, and appurtenances; installation of pipe sleeves and mechanical seals; and installation of nonwoven geotextile fabric and silicone based waterproof sealant.
- **Remediation System Signal Network Utility Expansion Oversight and Management.** Staff Engineer and Field Manager for the completion of a signal communication network expansion as part of a petroleum remediation system. My responsibilities included oversight of a subcontractor while installing level sensors within the product pull boxes to improve the safety of the system operations by continuously monitoring the underground product piping network for potential leaks, and programming, testing and verification of operation of sensors. The scope of work also included the installation of signal and control wiring from recovery well houses to subsurface vaults through existing conduit located beneath New York City streets located in Greenpoint Brooklyn. The signal expansion was part of an effort to integrate the sensor/components within the vaults with the existing remediation system’s programmable logic controllers (PLCs). The scope of work also included: development of programming to integrate input infrastructure to existing PLCs, development of human machine interface (HMI) screens to allow for remote viewing at the system control buildings, and installation of power supplies and other apparatuses as required for the operation of the new infrastructure. My responsibilities for this work included: subcontractor management, submittal and cut sheet review, scheduling management, 3rd party coordination, and construction meetings.
- **New York City Transit Plan Submission.** Staff Engineer for researching, preparing, and submitting New York City Transit (NYCT) Plans for various sites to seek approval for drilling and other subsurface activities in proximity to NYC Subways. The scope of work included visiting the Microfilm Room at the NYCT Office to obtain copies of the as-built plans, roof plans, profiles, sections, and alignments adjacent to the properties that our clients were proposing to perform subsurface work. Using these plans, develop proposed boring location plans and cross section plans, overlaying the NYCT plans to determine the proposed distance to adjacent NYCT structures. Ensured that these plans had the most up to date NYCT construction notes since these drawing became part of the projects' contract drawings. Submitted the plans and fees to the NYCT and coordinated with the NYCT inspectors assigned to each project ensuring that all requirements and questions were satisfied. Procured the associated NYCT approvals and distributed to the client so that they may proceed.
- **Stormwater Pollution Prevention Plan (SWPPP) Reports.** Staff Engineer for preparing and submitting Stormwater Pollution Prevention Plans (SWPPP) for various residential and commercial development sites in New York City and Long Island. The scope of work included preparation of SWPPP Reports in accordance with the most current New York State Department of Environmental Conservation (NYSDEC) regulations at the time including the 'General Permit for Stormwater Discharges from Construction Activity' and the 'New York State Stormwater Management Design Manual.' Preparation of the SWPPP Reports included: summarizing the site history and project description, soil geology, potential pollutants, erosion and sediment control practices, inspection and maintenance procedures, water quantity and water quality control plans, construction sequence scheduling, and the Notice of Intent (NOI) for each project as required by the NYSDEC.
- **Former Petroleum Storage Wetland and Canal Remediation Site.** Staff Engineer for daily construction oversight of subcontractors as a field manager and implementation of the site-specific health and safety plan as a Community Air Monitoring Program manager. The scope of work included conducting an on-site Community Air Monitoring Program monitoring for airborne dust and VOCs that were potentially generated by remedial and construction work activities. Stopping work and implementing best engineering/control practices if action levels were exceeded. Recording and providing QA/QC analysis of on-site weather and air monitoring data, as well as ensuring the proper operation of all instruments/monitors on a daily basis. Inspections were conducted of three on-site aboveground API concrete oil/water separators. Stormwater Pollution Prevention Plan (SWPPP)

inspections were performed, ensuring compliance with NYSDEC State Pollutant Discharge Elimination System (SPDES) General Permit for Stormwater Discharges from Construction Activity and daily reports were generated which would comprehensively document daily work activities and CAMP data and exceedances.

PROFESSIONAL PROFILE

Rachel Henke

Senior Scientist I

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EDUCATION

BS, Earth and Environmental Science, Lehigh University, 2014

BA, Biology, Lehigh University, 2014

EXPERIENCE SUMMARY

Nine years of experience: Senior Scientist I, Project Scientist, Staff Scientist, and Staff Assistant Scientist, Roux, Islandia, New York.

TECHNICAL SPECIALTIES

Design, implementation, and management of Remedial Investigations and Remedial Actions for sites in regulatory programs including the United States Environmental Protection Agency Superfund Program, the New York State Brownfield Cleanup Program, and the New York City Office of Environmental Remediation Voluntary Cleanup Program; Management of due diligence Phase I and Phase II Environmental Site Assessments; Preparation and management of Brownfield Cleanup Program Applications, Remedial Investigation Work Plans, Remedial Investigation Reports, Remedial Action Work Plans, and Final Engineering Reports; Investigation and evaluation of petroleum, chlorinated solvent and per- and poly fluoroalkyl substances (PFAS)-related contamination; Management of large-scale soil excavation projects including demolition, waste characterization, and construction activities.

REPRESENTATIVE PROJECTS

- Project manager for the Remedial Investigation and Remedial Action implementation associated with former dry cleaner and gas station releases at a 65,000 square foot property in the Bronx, New York. The site was enrolled in the New York State Brownfield Cleanup Program (NYS BCP) and successfully achieved a Track 4 Clean-Up. Responsibilities included the design and management of a Remedial Investigation. As part of this work, soil borings, monitoring wells, and soil vapor monitoring points were installed, and hydrogeologic cross sections were prepared. Additionally, as part of this project, a Remedial Action Work Plan, Final Engineering Report, Fact Sheets, and Monthly Reports were prepared in accordance with New York State Department of Environmental Conservation (NYSDEC) requirements. Current redevelopment plans include a mixed-use development with parking and limited landscaping.

- Project manager for a site enrolled in the NYSDEC BCP with chlorinated solvent contamination is sub-slab vapor and indoor air. Technical responsibilities included design and management of the Remedial Investigation and Interim Remedial Measure (IRM). The IRM included the design of a sub-slab depressurization system within the footprint of the existing site building. Following completion of the IRM, the site will be occupied by an educational facility for children with special needs.

- Project Manager providing technical strategy/ consulting on behalf of a potential responsible party (PRP) participating in a Federal Superfund Remedial Investigation/Feasibility Study (RI/FS) at an industrial waterway in Brooklyn, New York. Technical responsibilities include historical file review, litigation support, and public relations strategy development. Project management responsibilities include management of annual budget exceeding $1 million, management of various technical subcontractors on behalf of client and routine communication with litigation team.

- Project Manager for the preparation and implementation of an extensive Phase II Environmental Site Assessment Work Plan at a former ink ribbon and carbon manufacturer in Glen Cove, New York on behalf of a prospective purchaser. The Phase II ESA included groundwater, soil, and soil vapor sampling to investigate the potential presence of contamination at the Site associated with its historical industrial operations and listing as a State Superfund Site.

- Project manager of redevelopment project in New York City. The project consists of the demolition of an existing hotel located over an active commuter rail terminal and the excavation of soil/bedrock to allow for foundation installation. Environmental considerations on the project include site assessment, remediation design and oversight, soil characterization for offsite disposal. Coordinated with NYCDEP, Metropolitan Transit Authority, Metro North Railroad and other project stakeholders concerning community protection and monitoring concerns.
- Project manager responsible for the preparation and field implementation of a soil characterization work plan and a chlorinated solvent delineation work plan for a former Manufactured Gas Plant (MGP) site in Brooklyn, New York. The operation of the MGP led to contamination of subsurface soil and groundwater by coal tar, a byproduct of the gas manufacturing process, and as a result, the NYSDEC issued a Record of Decision specifying the required remedy for the Site. The remedy will include soil excavation and offsite thermal treatment, a sheet pile barrier wall, a vapor barrier and basement ventilation system. A comprehensive air monitoring program was conducted due to the concerns over coal tar residue emissions and odors on the surrounding community.
- Project Manager for an inactive solid waste landfill site in upstate New York that was investigated under the NYSDEC Inactive Landfill Initiative. Responsibilities included management of a groundwater investigation to examine the potential presence of per- and poly fluoroalkyl substances (PFAS) contamination.
- Project support for ongoing large and complex mixed use development of a 92-acre Site located in Syosset, New York. The site was accepted into the New York State BCP and has an extensive environmental history, including former use as a wire and conduit manufacturer (former NYS Inactive Hazardous Waste Site), former landfill (currently a Federal Superfund Site), and town DPW facility. Activities completed included compiling numerous historical environmental reports prepared for the site; interacting with NYSDEC, USEPA, NCDOH; completing a supplemental soil investigation (including extensive use of XRF Technology, as metals are the compound of concern); conducting a groundwater investigation (water is over 100 feet deep); and managing a Remedial Investigation that included a groundwater investigation to evaluate the potential presence of per- and poly fluoroalkyl substances (PFAS) contamination.
- Project Manager for the redevelopment of a 2.7-acre site in the South Ozone Park region of Queens, New York. The project was enrolled in the NYC OER Voluntary Cleanup Program (VCP) to address an E-designation on the property. During construction, over 35,000 CY of soil was transferred through the Clean Soil Bank, and the Site is on track to obtain a Track 1 Cleanup. When constructed, the project will be the first vertical logistics facility to serve the JFK Market.
- Project Manager for the redevelopment of a strip mall in East Orange, New Jersey that contained seven former and one operating dry cleaner, three former fueling stations, and a former automotive repair shop. Project scope included completing a New Jersey specific Preliminary Assessment and Site Investigation, assessing indoor air and IECs, and preparing and implementing a Remedial Investigation Work Plan and Remedial Action Work Plan.
- Project Manager for the redevelopment of a 3.1-acre site in the St. George region of Staten Island, New York. The project was enrolled in the NYC OER VCP, which transferred over 20,000 CY of soil through the Clean Soil Bank and will obtain a Track 1 Cleanup. When constructed, the project will include 62,000 sq ft of retail space, 109 residential apartments, a 180-room hotel, 125,000 sq ft of subgrade parking, and four rehabilitated historic U.S. Lighthouse Depot buildings.
- Project Manager for a site in the NYSDEC Spills Program in Brooklyn, New York. Responsibilities included a remedial investigation to delineate the nature and extent of the subsurface contamination; implementing an in situ chemical oxidation injection program utilizing RegenOx™ oxidant compound, which was injected into 28 injection points throughout the site; and designing and managing a hot spot excavation remedial measure to remove the source area that served as a continuing source of groundwater contamination.
- Project Manager for a high-end residential redevelopment project in Mineola, New York. Responsibilities included designing and implementing an in situ waste characterization program, excavation support, and the closure and abandonment of 10 Class V drywell structures. The drywell abandonment was conducted in accordance with the USEPA Underground Injection Control Program as administered by USEPA Region 2 and the Nassau County Department of Health (NCDOH). The project involved coordination with the client, the client's on-site subcontractor, the NCDOH, and the USEPA to successfully complete the job. A work plan and summary report were prepared to satisfy NCDOH and USEPA's requirements and obtain a No Further Action Letter.
- Project Manager for a high-end residential redevelopment project in New Rochelle, New York. Responsibilities included designing and implementing an in situ waste characterization program and excavation support. Despite being outside of the five boroughs of New York City, the Site was allowed to transfer soil through the NYCOER Clean Soil Bank. Responsibilities included coordination with the client, the client's on-site subcontractor to successfully complete the job.

- Project Manager of a site investigation project in Lynbrook, New York immediately downgradient of a 11.5-acre cemetery. Evaluated source of contaminants as a result of cemetery operations and historical site use including a manufactured gas plant and former dry cleaner. Collected soil, soil vapor, and groundwater samples to support delineation of pesticides and herbicides suspected to be emanating from the cemetery.
- Project Manager for the remediation of four drywell structures at a former pharmaceutical facility in Hauppauge, New York. The drywell remediation project was conducted in accordance with the Suffolk County Article XII requirements and entailed coordination with Suffolk County Department of Health Services (SCDHS). This project was unique in that the drywell sediment characterization and remediation work had to be completed within one month of receiving preliminary characterization data from SCDHS, with a threat of monetary penalty if this schedule was exceeded. The remediation and Remediation Summary Report were completed in the timeframe specified by SCDHS.
- Project Manager for the on-going site management of a redevelopment project in Corona, Queens, New York. The Site formerly operated as an automobile dealership and was accepted into the NYSDEC Brownfield Cleanup Program. A conditional Track 1 Cleanup was successfully completed at the Site in 2015, and the Site is now subject to a Site Management Plan (SMP). The final remedial design and SMP include a vapor barrier, active ventilation systems in the proposed sub-grade parking levels, and biannual groundwater monitoring to address the remaining CVOC contamination in regional groundwater.
- Project Manager and support to Expert Witness for a case on behalf of a PRP (Defendant) at a former landfill in upstate New York. The site is in the state superfund program and contained waste from Love Canal. Downgradient receptors include a residential community. The case involves the evaluation of mass contribution of specific chemicals, timing of disposal, and cost allocation. Complaint Index No. E161116/2017; Supreme Court of the State of New York, Niagara County.
- Support to Expert Witness for an on-going case between a major insurance carrier and a large multinational chemical manufacturer. The case involved categorizing past costs of 12 chemical sites across the country. Assisted in the preparation of the expert report on behalf of the insurance carrier (Defendant). Complaint No. 84 Civ. 1968 (JSR); U.S. District Court, Southern District of New York.
- Field Manager responsible for implementation of a Remedial Investigation Work Plan (RIWP) and Waste Characterization Sampling Plan at a 2.98-acre NYS BCP site containing chlorinated solvents, heavy metals, and petroleum compounds in soil, soil vapor, and groundwater over one city block in Astoria, New York. Responsibilities included soil and soil vapor sampling in addition to groundwater sampling for emerging contaminants (1,4-dioxane and PFAS).
- Field Manager for a site in the NYS BCP that also required a RCRA compliant facility closure. The site is a former paint factory located in Long Island City, New York. Due diligence environmental investigations determined historical site operations adversely impacted the subsurface, including a LNAPL plume in addition to petroleum hydrocarbon impacts to the soil and groundwater. Responsibilities included: 1) oversight of RCRA closure activities at the site that included emptying, cleaning, and scrapping 65 ASTs/vessels, decontaminating approximately 30,000 square feet of hazardous waste storage areas within the Paint Factory Building and collecting compliance samples, and 2) oversight of implementation of the RAWP, which included a large excavation requiring SOE and completion under a tent due to odor concerns, multiple ISCO injections, removal/ abandonment of USTs with a total capacity of over 200,000 gallons, and installation of a LNAPL recovery system.
- Sampling team leader tasked with the rapid assessment of soils outside 40 residential and sensitive-use properties located near the former battery recycling facility in Vernon, California. Lead emissions from the former facility are suspected of affecting surface and near-surface soils in surrounding areas as a result of aerial deposition. Responsibilities included conducting soil sample screening on each property at up to 15 locations on lawn areas, bare soils, garden areas, play areas, and roof drip-zones using an X-ray fluorescence (XRF) analyzer to submit the two largest sampling areas for confirmatory laboratory analysis.
- Field manager in charge of Pre-Design Investigation and Waste Characterization sampling event for a New York State BCP project in Brooklyn, New York. The site is an auto dealership with petroleum and chlorinated solvent contamination in soil and groundwater.
- Field Manager for aquifer tests completed at a closed landfill in Holtsville, New York. Field tasks included monitoring groundwater levels with a network of In Situ Level Trolls during a step-drawdown test and during a constant-rate pump test. Aquifer test data were subsequently used to determine hydrogeologic parameters of the aquifer beneath the Site using AQTESOLV software and various methods of analyses.
- Field Manager for a site in the NYCOER VCP. The site is a former gas station located in Manhattan, New York. Historical site operations adversely affected the subsurface through petroleum hydrocarbon impacts. Responsibilities included implementing a Community Air Monitoring Program (CAMP);

managing soils including transportation and disposal; collecting soil samples; and maintaining communication between subcontractors and Roux office support.

- Performed numerous Phase I and II Environmental Site Assessments for due diligence in connection with property transfers for the New York Metropolitan Area.
- Remedial construction manager responsible for soil excavation and waste removal oversight for development in Staten Island, New York. Responsibilities include oversight excavation, organization, and proper handling of waste manifests; performing Stormwater Pollution Prevention Plan (SWPPP) inspections; ensuring compliance with the Site Management Plan; health and safety oversight; and reporting NYCDEP and NYSDEC inspections to the client.
- Field Manager responsible for the implementation of a CAMP during excavation and disposal activities at multiple locations in Manhattan and Queens, New York. Ms. Henke monitored airborne dust and VOCs that were potentially generated by remedial action work activities and reviewed the collected data for exceedances of the New York State Department of Health (NYSDOH) guidelines.
- Site Safety Officer for various remedial investigation sites. Responsibilities include preparation of health and safety plans (HASPs), job safety analysis (JSA) documents development and review, on-site safety meeting management, safety document preparation (Lessons Learned, Near Loss, Field Audits, etc.), and planning/executing corrective actions.
- Assisted in the implementation of a large-scale waste characterization program and remedial investigation for a major redevelopment project in Flushing, New York that is enrolled in NYCOER VCP and E designation programs. The project included the coordination and oversight of an in situ waste characterization sampling of over 450,000 tons of soil and delineating a NYSDEC spill site within the project footprint.
- Assisted in bi-annual soil vapor monitoring round to surveil the largest subsurface free-product plume in North America at a former fuel and oil distribution terminal in Brooklyn, New York. Activities included the collection of soil vapor and ambient air samples from on-site and off-site monitoring wells using EPA method TO 15.

PROFESSIONAL TRAININGS

OSHA 40-hour HAZWOPER Training, 2014

OSHA 8-HOUR Refresher Training, Certificate Current

OSHA 30-hour Construction Safety Training, 2019

New York State Builders Association 4-Hour Stormwater Training, 2016

First Aid and CPR Certified

Loss Prevention System (LPS) Awareness, 8-Hour Certified

Transit Worker Identification Credential Card Holder

Metro North Railroad Contractor Safety and Security Training

NJTransit Contractor Safety and Security Training

Amtrak Contractor Safety and Security Training

PRESENTATIONS

G. Buermann, R. Henke, K. Olear, and A. Scholtz. Reckoning with Microplastics: The Looming Challenges, Pitfalls, and Uncertainties. 36th Environmental & Emerging Claim Manager Association Annual Conference (EECMA). April 21, 2022.

J. Rohrer and R. Henke. Microplastics: California and Beyond?: NGWA Problematic Groundwater Contaminants: More Than PFAS Forum. May 27, 2021.

JUDY V. HARRY
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Occupation:	Data Validator/Environmental Technical Consultant
Years Experience:	41
Education:	B.S., Chemistry, Magna cum laude, 1976, Phi Beta Kappa
Certifications:	New York State Woman-Owned Business Enterprise (WBE)

Relevant Work History:

Data Validation Services: September 1989 - present

Sole proprietor of Data Validation Services, a woman-owned small business registered with SAM, providing consultation/validation services to regulatory and commercial clients.

These services include the review of analytical laboratory data for compliance with respect to specific protocols, accuracy and defensibility of data, verification of reported values, and evaluation of quality parameters for analytical usability of results. Approved by USEPA, NYSDEC, NJDEP, NYSERDA, and NYCDEP as a data validator for projects, including USEPA Superfund, Brownfield, and lead sites, and those contracted through the NYSDEC Division of Hazardous Waste Remediation, Division of Solid Waste, and Division of Water Quality.

Performed validation for compliance with laboratory analytical protocols including USEPA OLM, USEPA OLC, USEPA ILM, USEPA DFLM, USEPA SOW3/90, USEPA SOW 7/87 CLP, USEPA SOW 2/88 CLP, USEPA SW846, RCRA, AFCEE, NYS 6 NYCRR Part 360, 40 CFR, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, including TO-15, 1989/1991/1995/2000/2005 NYSDEC ASPs, and 1987 NYSDEC CLP.

Performed validation according to the USEPA National and Regional SOPs and Functional Guidelines, AFCEE requirements, NYSDEC Validation Scope of Work, NYS DUSR, and NJDEP Division of Hazardous Site Mitigation/Publicly Funded Site Remediation SOPs.

Performed validation for USEPA Superfund Sites including Salem Acres, York Oil, Port Washington L-4 Landfill, Bridgeport Rental and Oil Services, GE-MRFA, MMR/ OTIS AFB, LCP, and Peter Cooper site; and for USEPA lead sites including SJ&J Piconne, Maska, Bowe System, Jones Sanitation, and Syossett Landfill, involving CLP, RAS, and SAS protocols.

Contracted for NYSDEC Superfund Standby Contracts with LMS Engineers, HDR, CDM Smith, Malcolm-Pirnie/ARCADIS, Ecology & Environment, Shaw Environmental, CG&I, O’Brien & Gere Engineers, and EC Jordan, involving samples collected at NYS Superfund Sites and analyzed under the NYSDEC ASP.

Performed validation services for NYSDEC Phase II remedial investigations, RI/FS projects, Brownfield sites, and PRP over-site projects for hazardous waste sites.

Performed validation services for clients conducting RI/FS activities involving samples of many matrices, including waste, air, sludges, leachates, solids/sediments, aqueous, and biota.

Clients have included AECOM, ARCADIS, Barton & Loguidice, Benchmark Engineering, Bergmann Associates, Blasland, Bouck & Lee, Brown and Caldwell, CDM Smith, CB&I Shaw Environmental, C&S Consulting Engineers, Chazen Companies, Clough Harbour & Associates, Columbia Analytical Services, C.T. Male, Dames & Moore, Day Engineering, EA Engineering, EcolSciences, Ecology & Environment, Ecosystems, EC Jordan, Environmental Chemical Corporation, EHRT, ENSR Consulting, ELM, ERM-Northeast, Fagan Engineers, Fanning Phillips & Molnar, FluorDaniel GTI, Frontier, Foster Wheeler Environmental Corp, Frontier Technical, Galson Consultants, GE&R, Geomatrix Consultants, GZA Environmental, Handex of N, H2M Group, HDR, HRP, IT Corp, Jacques Whitford, JTM Associates, Labella Associates, Langan Engineers, Leader Environmental, Lockwood, Kessler & Bartlett, LMS Engineers, Malcolm-Pirnie, Metcalf & Eddy, NWEC&C, O'Brien & Gere Engineers, Pace, Parsons Engineering-Science, Plumley Engineering, Prescott Environmental, P. W. Grosser, Rizzo Associates, Roux Associates, Sear Brown Group, SECOR, Shaw Environmental, Stantec, ThermoRemediation Inc., TRC Environmental, Turnkey Environmental Restoration, TVGA Engineering, URS Consultants, Wehran Emcon, Weston, YEC, and private firms.

Provided consultation services to laboratories regarding analytical procedures and protocol interpretation, and to law firms for litigation support.

Provided services to firms involving audits of environmental analytical laboratories to determine analytical capability, particularly for compliance with NYSDEC ASP and AFCEE requirements.

Guest speaker on a panel discussing Data Review/Compliance and Usability, for an analysis workshop for the New York Association of Approved Environmental Laboratories, 1993.

Adirondack Environmental Services: June 1987 - August 1989

Senior mass spectroscopist for AES. Responsible for GC/MS analyses of environmental samples by USEPA and NYSDEC protocols, development of the GC/MS laboratory, initiating the instrumental and computer operations from the point of installation, and for implementing the procedures and methodologies for Contract Laboratory Protocol.

CompuChem Laboratories: May 1982 - January 1987

Managed a GC/MS production laboratory; developed, implemented, and supervised QA/QC criteria at three different levels of review; and was responsible for the development and production of the analysis of environmental and clinical samples. Directed a staff of 23 technical and clerical personnel, and managed the extraction and GC/MS labs and data review operations.

Research Triangle Institute: December 1979 - May 1982

Worked as an analytical research chemist responsible for development of analytical methods for the EPA Federal Register at RTI. This involved analysis of biological and environmental samples for priority pollutants, primarily relating to wastewaters and to human sampling studies. Method development included modification and interfacing of the initially developed Tekmar volatile purge apparatus to GC/MS, development and refinement of methods for entrapment and concentration of the air medium for subsequent volatile analysis, and the analysis and resolution/ identification of individual PCB congeners within Aroclor mixtures by capillary column and mass spectra.

Guardsman Chemical Company: February 1977 - November 1979

Performed all quality control functions for the manufacturing plant. Performed research and development on coatings and dyes.

Almay Cosmetics: May 1976 - December 1976

Product evaluation chemist. Responsible for analytical QC of manufactured products.

Publication

Pellizzzari, E.D., Moseley, M.A., Cooper, S.D., Harry, J.V., Demian, B., & Mullin, M. D. (1985). Recent Advances in the Analysis of Polychlorinated Biphenyls in Environmental and Biological Media. *Journal of Chromatography,* 334(3) 277-314.

APPENDIX B

Standard Operating Procedures, Laboratory Detection Limits for Emerging Contaminants and NYSDEC Guidance for Sampling Emerging Contaminants

Date: May 5, 2000

1.0 PURPOSE

The purpose for this standard operating procedure (SOP) is to establish the guidelines for decontamination of all field equipment potentially exposed to contamination during drilling, and soil and water sampling. The objective of decontamination is to ensure that all drilling, and soil-sampling and water-sampling equipment is decontaminated (free of potential contaminants): 1) prior to being brought onsite to avoid the introduction of potential contaminants to the site; 2) between drilling and sampling events/activities onsite to eliminate the potential for cross-contamination between boreholes and/or wells; and 3) prior to the removal of equipment from the site to prevent the transportation of potentially contaminated equipment offsite.

In considering decontamination procedures, state and federal regulatory agency requirements must be considered because of potential variability between state and federal requirements and because of variability in the requirements of individual states. Decontamination procedures must be in compliance with state and/or federal protocols in order that regulatory agency(ies) scrutiny of the procedures and data collected do not result in non-acceptance (invalidation) of the work undertaken and data collected.

2.0 PROCEDURE FOR DRILLING EQUIPMENT

The following is a minimum decontamination procedure for drilling equipment. Drilling equipment decontamination procedures, especially any variation from the method itemized below, will be documented on an appropriate field form or in the field notebook.

2.1 The rig and all associated equipment should be properly decontaminated by the contractor before arriving at the test site.

2.2 The augers, drilling casings, rods, samplers, tools, rig, and any piece of equipment that can come in contact (directly or indirectly) with the soil, will be steam cleaned onsite prior to set up for drilling to ensure proper decontamination.

2.3 The same steam cleaning procedures will be followed between boreholes (at a fixed on-site location[s], if appropriate) and before leaving the site at the end of the study.

2.4 All on-site steam cleaning (decontamination) activities will be monitored and documented by a member(s) of the staff of Roux Associates, Inc.

2.5 If drilling activities are conducted in the presence of thick, sticky oils (e.g., PCBs) which coat drilling equipment, then special decontamination procedures may have to be utilized before steam cleaning (e.g., hexane scrub and wash).

2.6 Containment of decontamination fluids may be necessary (e.g., rinseate from steam cleaning) or will be required (e.g., hexane), and disposal must be in accordance with state and/or federal procedures.

3.0 PROCEDURE FOR SOIL-SAMPLING EQUIPMENT

The following is a minimum decontamination procedure for soil-sampling equipment (e.g., split spoons, stainless-steel spatulas). Soil-sampling equipment decontamination procedures, especially any variation from the method itemized below, will be documented on an appropriate field form or in the field notebook.

3.1 Wear disposable gloves while cleaning equipment to avoid cross-contamination and change gloves as needed.

3.2 Steam clean the sampler or rinse with potable water. If soil-sampling activities are conducted in the presence of thick, sticky oils (e.g., PCBs) which coat sampling equipment, then special decontamination procedures may have to be utilized before steam cleaning and washing in detergent solution (e.g., hexane scrub and wash).

3.3 Prepare a non-phosphate, laboratory-grade detergent solution and distilled or potable water in a clean bucket.

3.4 Disassemble the sampler, as necessary and immerse all parts and other sampling equipment in the solution.

3.5 Scrub all equipment in the bucket with a brush to remove any adhering particles.

3.6 Rinse all equipment with copious amounts of potable water followed by distilled or deionized water.

3.7 Place clean equipment on a clean plastic sheet (e.g., polyethylene)

3.8 Reassemble the cleaned sampler, as necessary.

3.9 Transfer the sampler to the driller (or helper) making sure that this individual is also wearing clean gloves or wrap the equipment with a suitable material (e.g., plastic bag, aluminum foil.

As part of the decontamination procedure for soil-sampling equipment, state and/or federal protocols must be considered. These may require procedures above those specified as minimum for Roux Associates, Inc., such as the use of nitric acid, acetone, etc. Furthermore, the containment and proper disposal of decontamination fluids must be considered with respect to regulatory agency(ies) requirements.

4.0 PROCEDURE FOR WATER-SAMPLING EQUIPMENT

The following is a decontamination procedure for water-sampling equipment (e.g., bailers, pumps). Water-sampling equipment decontamination procedures, especially any variation from the method itemized below, will be documented on an appropriate field form or in the field notebook.

4.1 Decontamination procedures for bailers follow:

a. Wear disposable gloves while cleaning bailer to avoid cross-contamination and change gloves as needed.

b. Prepare a non-phosphate, laboratory-grade detergent solution and potable water in a bucket.

c. Disassemble bailer (if applicable) and discard cord in an appropriate manner and scrub each part of the bailer with a brush and solution.

d. Rinse with potable water and reassemble bailer.

e. Rinse with copious amounts of distilled or deionized water.

f. Air dry.

g. Wrap equipment with a suitable material (e.g., clean plastic bag, aluminum foil).

h. Rinse bailer at least three times with distilled or deionized water before use.

4.2 Decontamination procedures for pumps follow:

a. Wear disposable gloves while cleaning pump to avoid cross-contamination and change gloves as needed.

b. Prepare a non-phosphate, laboratory-grade detergent solution and potable water in a clean bucket, clean garbage can, or clean 55-gallon drum.

c. Flush the pump and discharge hose (if not disposable) with the detergent solution and discard disposable tubing and/or cord in an appropriate manner.

d. Flush the pump and discharge hose (if not disposable) with potable water.

e. Place the pump on clear plastic sheeting.

f. Wipe any pump-related equipment (e.g., electrical lines, cables, discharge hose) that entered the well with a clean cloth and detergent solution, and rinse or wipe with a clean cloth and potable water.

g. Air dry.

h. Wrap equipment with a suitable material (e.g., clean plastic bag).

As part of the decontamination procedure for water-sampling equipment, state and/or federal protocols must be considered. These may require procedures above those specified as minimum for Roux Associates, Inc., such as the use of nitric acid, acetone, etc. Furthermore, the containment and proper disposal of decontamination fluids must be considered with respect to regulatory agency(ies) requirements.

Date: May 5, 2000

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish guidelines for the collection of soil samples for laboratory analysis. This SOP is applicable to soil samples collected from split-spoon samplers during drilling, hand auger samples, grab samples from stockpiled soils, surface samples, test pit samples, etc.

2.0 CONSIDERATIONS

Soil samples may be collected in either a random or biased manner. Random samples can be based on a grid system or statistical methodology. Biased samples can be collected in areas of visible impact or suspected source areas. Soil samples can be collected at the surface, shallow subsurface, or at depth. When samples are collected at depth the water content should be noted, since generally "soil sampling" is restricted to the unsaturated zone. Equipment selection will be determined by the depth of the sample to be collected. A thorough description of the sampling locations and proposed methods of sample collection should be included in the work plan.

Commonly, surface sampling refers to the collection of samples at a 0 to 6-inch depth interval. Certain regulatory agencies may define the depth interval of a surface sample differently, and this must be defined in the work plan. Collection of surface soil samples is most efficiently accomplished with the use of a stainless-steel trowel or scoop. For samples at greater depths a decontaminated bucket auger or power auger may be needed to advance the hole to the point of sample collection. Another clean bucket auger should then be used to collect the sample. To collect samples at depths of greater than approximately six feet the use of a drill rig and split spoon samples will usually be necessary. In some situations, sample locations are accessed with the use of a backhoe.

3.0 MATERIALS/EQUIPMENT

a. A work plan which outlines soil sampling requirements.

b. Field notebook, field form(s), maps, chain-of-custody forms, and custody seals.

c. Decontamination supplies (including: non-phosphate, laboratory grade detergent, buckets, brushes, potable water, distilled water, regulatory-required reagents, aluminum foil, plastic sheeting, etc.).

d. Sampling device (split-spoon sampler, stainless steel hand auger, stainless steel trowel, etc.).

e. Stainless steel spoons or spatulas.

f. Disposable sampling gloves.

g. Laboratory-supplied sample containers with labels.

h. Cooler with blue or wet ice.

i. Plastic sheeting.

j. Black pen and indelible marker.

k. Zip-lock bags and packing material.

l. Tape measure.

m. Paper towels or clean rags.

n. Masking and packing tape.

o. Overnight (express) mail forms.

4.0 DECONTAMINATION

All reusable sampling equipment will be thoroughly cleaned according to the decontamination SOP. Where possible, thoroughly pre-cleaned and wrapped sampling equipment should be used and dedicated to individual sampling locations. Disposable items such as sampling gloves, aluminum foil, and plastic sheeting will be changed after each use and discarded in an appropriate manner.

5.0 PROCEDURE

5.1 Prior to collecting soil samples, ensure that all sampling equipment has been thoroughly cleaned according to the decontamination SOP. If samples are to be collected at depth, then the boring must be advanced with thoroughly cleaned equipment to the desired sampling horizon and a different thoroughly cleaned sampler must be used to collect the sample.

5.2 Using disposable gloves and a pre-cleaned, stainless steel spatula or spoon, extract the soil sample from the sampler, measure the recovery, and separate the wash from the true sample. Where allowed by regulatory agency(ies), disposable plastic spoons may be used.

5.3 Place the sample in a laboratory-supplied, pre-cleaned sample container. This should be done as quickly as possible and this is especially important when sampling for volatile organic compounds (VOCs). Samples to be analyzed for VOCs must be collected prior to other constituents.

5.4 The sample container will be labeled with appropriate information such as, client name, site location, sample identification (location, depth, etc.), date and time of collection, and sampler's initials.

5.5 Using the remaining portion of soil from the sampler, log the sample in detail and record sediment characteristics (color, odor, moisture, texture, density, consistency, organic content, layering, grain size, etc.).

5.6 If soil samples are to be composited in the field, then equal portions from selected locations will be placed on a clean plastic sheet and homogenized. Alternately, several samples may be submitted to the laboratory for compositing by weight. The method used is dependent upon regulatory requirements. Specific compositing procedures shall be approved by the appropriate regulatory agency and described in the work plan. Samples to be analyzed for VOCs will not be composited unless required by a regulatory agency.

5.7 After the sample has been collected, labeled, and logged in detail, it is placed in a zip-lock bag and stored in a cooler at 4°C.

5.8 A chain-of-custody form is completed for all samples collected. One copy is retained and two are sent with the samples in a zip-lock bag to the laboratory. A custody seal is placed on the cooler prior to shipment.

5.9 Samples collected from Monday to Friday are to be delivered to the laboratory within 24 hours of collection. If Saturday delivery is unavailable, samples collected on Friday must be delivered by Monday morning. Check the work plan to determine if any analytes require a shorter delivery time.

5.10 The field notebook and appropriate forms should include, but not be limited to the following: client name, site location, sample location, sample depth, sample identification, date and time collected, sampler's name, method of sample collection, number and type of containers, geologic description of material, description of decontamination procedures, etc. A site map should be prepared with exact measurements to each sample location in case follow-up sampling is necessary.

5.11 All reusable sampling equipment must be thoroughly cleaned in accordance with the decontamination SOP. Following the final decontamination (after all samples are collected) the sampling equipment is wrapped in aluminum foil. Discard any gloves, foil, plastic, etc. in an appropriate manner that is consistent with site conditions.

END OF PROCEDURE

Date: May 5, 2000

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to establish guidelines for sample handling which will allow consistent and accurate results. Valid chemistry data are integral to investigations that characterize media-quality conditions. Thus, this SOP is designed to ensure that once samples are collected, they are preserved, packed and delivered in a manner which will maintain sample integrity to as great an extent as possible. The procedures outlined are applicable to most sampling events and any required modifications must be clearly described in the work plan.

2.0 CONSIDERATIONS

Sample containers, sampling equipment decontamination, quality assurance/quality control (QA/QC), sample preservation, and sample handling are all components of this SOP.

2.1 Sample Containers

Prior to collection of a sample, considerations must be given to the type of container that will be used to store and transport the sample. The type and number of containers selected is usually based on factors such as sample matrix, potential contaminants to be encountered, analytical methods requested, and the laboratory's internal quality assurance requirements. In most cases, the overriding considerations will be the analytical methodology, or the state or federal regulatory requirements because these regulations generally encompass the other factors. The sample container selected is usually based on some combination of the following criteria:

a. Reactivity of Container Material with Sample

Choosing the proper composition of sample containers will help to ensure that the chemical and physical integrity of the sample is maintained. For sampling potentially hazardous material, glass is the recommended container type because it is chemically inert to most substances. Plastic containers are not recommended for most hazardous wastes because the potential exists for contaminants to adsorb to the surface of the plastic or for the plasticizer to leach into the sample.

In some instances, however, the sample characteristics or analytes of interest may dictate that plastic containers be used instead of glass. Because some metals species will adhere to the sides of the glass containers in an aqueous matrix, plastic bottles (e.g., nalgene) must be used for samples collected for metals analysis. A separate, plastic container should accompany glass containers if metals analysis is to be performed along with other analyses. Likewise, other sample characteristics may dictate that glass cannot be used. For example, in the case of a strong alkali waste or hydrofluoric solution, plastic containers may be more suitable because glass containers may be etched by these compounds and create adsorptive sites on the container's surface.

b. Volume of the Container

The volume of sample to be collected will be dictated by the analysis being performed and the sample matrix. The laboratory must supply bottles of sufficient volume to perform the required analysis. In most cases, the methodology dictates the volume of sample material required to complete the analysis. However, individual laboratories may provide larger volume containers for various analytes to ensure sufficient quantities for duplicates or other QC checks.

To facilitate transfer of the sample from the sampler into the container and to minimize spillage and sample disturbance, wide-mouth containers are recommended. Aqueous volatile organic samples must be placed into 40-milliliter (ml) glass vials with polytetrafluoroethylene (PTFE) (e.g., TeflonTM) septums. Non-aqueous volatile organic samples should be collected in the same type of vials or in 4-ounce (oz) wide-mouth jars provided by the laboratory. These jars should have PTFE-lined screw caps.

c. Color of Container

Whenever possible, amber glass containers should be used to prevent photodegradation of the sample, except when samples are being collected for metals analysis. If amber containers are not available, then containers holding samples should be protected from light (i.e., place in cooler with ice immediately after filling).

d. Container Closures

Container closures must screw on and off the containers and form a leak-proof seal. Container caps must not be removed until the container is ready to be filled with the sample, and the container cap must be replaced (securely) immediately after filling it. Closures should be constructed of a material which is inert with respect to the sampled material, such as PTFE (e.g., TeflonTM). Alternately, the closure may be separated from the sample by a closure liner that is inert to the sample material such as PTFE sheeting. If soil or sediment samples are being collected, the threads of the container must be wiped clean with a dedicated paper towel or cloth, so the cap can be threaded properly.

e. Decontamination of Sample Containers

Sample containers must be laboratory cleaned by the laboratory performing the analysis. The cleaning procedure is dictated by the specific analysis to be performed on the sample. Sample containers must be carefully examined to ensure that all containers appear clean. Do not mistake the preservative as unwanted residue. The bottles should not be field cleaned. If there is any question regarding the integrity of the bottle, then the laboratory must be contacted immediately and the bottle(s) replaced.

f. Sample Bottle Storage and Transport

No matter where the sample bottles are, whether at the laboratory waiting to be packed for shipment or in the field waiting to be filled with sample, care must be taken to avoid contamination. Sample shuttles or coolers, and sample bottles must be stored and transported in clean environments. Sample bottles and clean sampling equipment must never be stored near solvents, gasoline, or other equipment that is a potential source of cross-contamination. When under chain of custody, sample bottles must be secured in locked vehicles, and custody sealed in shuttles or in the presence of authorized personnel. Information which documents that proper storage and transport procedures have been followed must be included in the field notebook and on appropriate field forms.

2.2 Decontamination of Sampling Equipment

Proper decontamination of all re-usable sampling equipment is critical for all sampling episodes. The SOP for Decontamination of Field Equipment and SOPs for method-specific or instrument-specific tasks must also be referred to for guidance for decontamination of various types of equipment.

2.3 Quality Assurance/Quality Control Samples

QA/QC samples are intended to provide control over the proper collection and tracking of environmental measurements, and subsequent review, interpretation and validation of generated analytical data. The SOPs for Collection of Quality Control Samples, for Evaluation and Validation of Data, and for Field Record Keeping and Quality Assurance/Quality Control must be referred to for detailed guidance regarding these respective procedures. SOPs for method-specific or instrument-specific tasks must also be referred to for guidance for QA/QC procedures.

2.4 Sample Preservation Requirements

Certain analytical methodologies for specific analytes require chemical additives in order to stabilize and maintain sample integrity. Generally, this is accomplished under the following two scenarios:

a. Sample bottles are preserved at the laboratory prior to shipment into the field.

b. Preservatives are added in the field immediately after the samples are collected.

Many laboratories provide pre-preserved bottles as a matter of convenience and to help ensure that samples will be preserved immediately upon collection. A problem associated with this method arises if not enough sample could be collected, resulting in too much preservative in the sample. More commonly encountered problems with this method include the possibility of insufficient preservative provided to achieve the desired pH level or the need for additional preservation due to chemical reactions caused by the addition of sample liquids to pre-preserved bottles. The use of pre-preserved bottles is acceptable; however, field sampling teams must always be prepared to add additional preservatives to samples if the aforementioned situations occur. Furthermore, care must be exercised not to overfill sample bottles containing preservatives to prevent the sample and preservative from spilling and therefore diluting the preservative (i.e., not having enough preservative for the volume of sample).

When samples are preserved after collection, special care must be taken. The transportation and handling of concentrated acids in the field requires additional preparation and adherence to appropriate preservation procedures. All preservation acids used in the field should be trace-metal or higher-grade.

2.5 Sample Handling

After the proper sample bottles have been received under chain-of-custody, properly decontaminated equipment has been used to collect the sample, and appropriate preservatives have been added to maintain sample integrity, the final step for the field personnel is checking the sample bottles prior to proper packing and delivery of the samples to the laboratory.

All samples should be organized and the labels checked for accuracy. The caps should be checked for tightness and any 40-ml volatile organic compound (VOC) bottles must be checked for bubbles. Each sample bottle must be placed in an individual Ziploc® bag to protect the label, and placed on ice. The bottles must be carefully packed to prevent breakage during transport. When several bottles have been collected for an individual sample, they should not be placed adjacent to each other in the cooler to prevent possible breakage of all bottles for a given sample. If there are any samples which are known or suspected to be highly contaminated, these should be placed in an individual cooler under separate chain-of-custody to prevent possible cross contamination. Sufficient ice (wet or blue packs) should be placed in the cooler to maintain the temperature at 4 degrees Celsius (°C) until delivery at the laboratory. Consult the work plan to determine if a particular ice is specified as the preservation for transportation (e.g., the United States Environmental Protection Agency does not like the use of blue packs because they claim that the samples will not hold at 4°C). If additional coolers are required, then they should be purchased. The chain-of-custody form should be properly completed, placed in a "zip-lock" bag, and placed in the cooler. One copy must be maintained for the project files. The cooler should be sealed with packing tape and a custody seal. The custody seal number should be noted in the field book. Samples collected from Monday through Friday will be delivered to the laboratory within 24 hours of collection. If Saturday delivery is not available, samples collected on Friday must be delivered by Monday morning. Check the work plan to determine if certain analytes require a shorter delivery time. If overnight mail is utilized, then the shipping bill must be maintained for the files and the laboratory must be called the following day to confirm receipt.

3.0 EQUIPMENT AND MATERIALS

3.1 General equipment and materials may include, but not necessarily be limited to, the following:

a. Sample bottles of proper size and type with labels.

b. Cooler with ice (wet or blue pack).

c. Field notebook, appropriate field form(s), chain-of-custody form(s), custody seals.

d. Black pen and indelible marker.

e. Packing tape, "bubble wrap," and "zip-lock" bags.

f. Overnight (express) mail forms and laboratory address.

g. Health and safety plan (HASP).

h. Work plan/scope of work.

i. Pertinent SOPs for specified tasks and their respective equipment and materials.

3.2 Preservatives for specific samples/analytes as specified by the laboratory. Preservatives must be stored in secure, spillproof glass containers with their content, concentration, and date of preparation and expiration clearly labeled.

3.3 Miscellaneous equipment and materials including, but not necessarily limited to, the following:

a. Graduated pipettes.

b. Pipette bulbs.

c. Litmus paper.

d. Glass stirring rods.

e. Protective goggles.

f. Disposable gloves.

g. Lab apron.

h. First aid kit.

i. Portable eye wash station.

j. Water supply for immediate flushing of spillage, if appropriate.

k. Shovel and container for immediate containerization of spillage-impacted soils, if appropriate.

4.0 PROCEDURE

4.1 Examine all bottles and verify that they are clean and of the proper type, number, and volume for the sampling to be conducted.

4.2 Label bottles carefully and clearly with project name and number, site location, sample identification, date, time, and the sampler's initials using an indelible marker.

4.3 Collect samples in the proper manner (refer to specific sampling SOPs).

4.4 Conduct preservation activities as required after each sample has been collected. Field preservation must be done immediately and must not be done later than 30 minutes after sample collection.

4.5 Conduct QC sampling, as required.

4.6 Seal each container carefully and place in an individual "zip lock" bag.

4.7 Organize and carefully pack all samples in the cooler immediately after collection (e.g., bubble wrap). Insulate samples so that breakage will not occur.

4.8 Complete and place the chain-of-custody form in the cooler after all samples have been collected. Maintain one copy for the project file. If the cooler is to be transferred several times prior to shipment or delivery to the laboratory, it may be easier to tape the chain-of-custody to the exterior of the sealed cooler. When exceptionally hazardous samples are known or suspected to be present, this should be identified on the chain-of-custody as a courtesy to the laboratory personnel.

4.9 Add additional ice as necessary to ensure that it will last until receipt by the laboratory.

4.10 Seal the cooler with packing tape and a custody seal. Record the number of the custody seal in the field notebook and on the field form. If there are any exceptionally hazardous samples, then shipping regulations should be examined to ensure the sample containers and coolers are in compliance and properly labeled.

4.11 Samples collected from Monday through Friday will be delivered to the laboratory within 24 hours of collection. If Saturday delivery is not available, samples collected on Friday must be delivered by Monday morning. Check the work plan to determine if certain analytes require a shorter delivery time.

4.12 Maintain the shipping bill for the project files if overnight mail is utilized and call the laboratory the following day to confirm receipt.

END OF PROCEDURE

Environment Testing

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Title: Analysis of Per- and Polyfluoroalkyl Substances (PFAS) in Water, Solid, and Biosolids by LC/MS/MS [Method 1633]

Electronic Copy Only

Approvals (Signature/Date):

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Amy Herrera Quality Assurance Manager	Date	Anthony Grimaldi Business Unit Manager	Date

Facility Distribution No. ___________ **Distributed To:**_______________________

1. Scope and Application

1.1. This procedure describes the analysis of water, soil, solids, and biosolids samples for the following compounds using liquid chromatography / tandem mass spectrometry (LC/MS/MS).

Table 1.1 **PFAS Supported**		
Compound Name	**Abbreviations**	**CAS #**
Perfluoroalkylcarboxylic acids (PFCAs)		
Perfluorobutanoic acid	PFBA	375-22-4
Perfluoropentanoic acid	PFPeA	2706-90-3
Perfluorohexanoic acid	PFHxA	307-24-4
Perfluoroheptanoic acid	PFHpA	375-85-9
Perfluorooctanoic acid	PFOA	335-67-1
Perfluorononanoic acid	PFNA	375-95-1
Perfluorodecanoic acid	PFDA	335-76-2
Perfluoroundecanoic acid	PFUnA	2058-94-8
Perfluorododecanoic acid	PFDoA	307-55-1
Perfluorotridecanoic acid	PFTrDA	72629-94-8
Perfluorotetradecanoic acid	PFTeDA	376-06-7
Perfluorinated sulfonic acids (PFSAs)		
Perfluorobutanesulfonic acid	PFBS	375-73-5
Perfluoropentanesulfonic acid	PFPeS	2706-91-4
Perfluorohexanesulfonic acid	PFHxS	355-46-4
Perfluoroheptanesulfonic acid	PFHpS	375-92-8
Perfluorooctanesulfonic acid	PFOS	1763-23-1
Perfluorononanesulfonic acid	PFNS	68259-12-1
Perfluorodecanesulfonic acid	PFDS	335-77-3
Perfluorododecansulfonic acid	PFDoS	79780-39-5
Perfluorinated sulfonamides (FOSAs)		
Perfluorooctanesulfonamide	PFOSA, (FOSA)	754-91-6
N-ethylperfluorooctanesulfonamide	NEtFOSA (Et-FOSA)	4151-50-2
N-methylperfluorooctanesulfonamide	NMeFOSA (Me-FOSA)	31506-32-8
Perfluorinated sulfonamide ethanols (FOSEs)		
2-(N-ethylperfluorooctanesulfonamido) ethanol	NEtFOSE (Et-FOSE)	1691-99-2
2-(N-methylperfluorooctanesulfonamido) ethanol	NMeFOSE (Me-FOSE)	24448-09-7
Perfluorinated sulfonamidoacetic acids (FOSAAs)		
N-ethylperfluorooctanesulfonamidoacetic acid	NEtFOSAA (EtFOSAA)	2991-50-6

Table 1.1
PFAS Supported

Compound Name	Abbreviations	CAS #
N-methylperfluoro octanesulfonamidoacetic acid	NMeFOSAA (MeFOSAA)	2355-31-9
Fluorotelomer sulfonic acids (FTS)		
1H,1H,2H,2H-perfluorohexane sulfonic acid *(4:2)*	4:2 FTS	757124-72-4
1H,1H,2H,2H-perfluorooctane sulfonic acid *(6:2)*	6:2 FTS	27619-97-2
1H,1H,2H,2H-perfluorodecane sulfonic acid *(8:2)*	8:2 FTS	39108-34-4
Fluorotelomer carboxylic acids (FTCAs)		
3-Perfluoropropyl propanoic acid	3:3 FTCA	356-02-5
3-Perfluoropentyl propanoic acid	5:3 FTCA	914637-49-3
3-Perfluoroheptyl propanoic acid	7:3 FTCA	812-70-4
Per-and Polyfluoroether carboxylic acids		
Perfluoro(2-propoxypropanoic) acid or Hexafluoropropylene oxide dimer acid	HFPO-DA, GenX	13252-13-6
4,8-dioxa-3H-perfluorononanoic acid	DONA, ADONA(1)	919005-14-4
Perfluoro-3-methoxypropanoic acid (PFMPA)	PFMPA (PFECA F)	377-73-1
Perfluoro-4-methoxybutanoic acid (PFMBA)	PFMBA (PFECA A)	863090-89-5
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	NFDHA (PFECA B)	151772-58-6
Ether sulfonic acids		
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9
Perfluoro(2-ethoxyethane) sulfonic acid	PFEESA (PES)	113507-82-7

***Note**: Abbreviations in parenthesis are the abbreviations used by the laboratory's LIMS where they differ from the abbreviation listed in Method 1633.*

(1) In some literature, the acronym ADONA refers to the ammonium salt, CAS 958445-44-8, and DONA refers to the parent acid. In Method 1633, ADONA refers to the parent acid. DONA is the acronym present on the laboratory raw data.

1.2. This method contains the sample extraction and analysis.

1.3. The working range of the method is listed below. The linear range can be extended by diluting the extracts. Note that all compounds are reported in their acid form.

Reporting limits and Method Detection Limits for individual compounds are provided in Table 1.

Table 1.2 Reporting Limits and Working Range			
Matrix	**Nominal Sample Size**	**Reporting Limit**	**Working Range**
Water	500 mL	2 ng/L – 50 ng/L	2 ng/L - 1560 ng/L
Leachate	100 mL	10 ng/L – 250 ng/L	10 ng/L – 7800 ng/L
Solid	5 g	0.2 ng/g – 5.0 ng/g	0.2 ng/g - 156 ng/g
Biosolids	0.5 g	2 ng/g – 50ng/g	2 ng/g – 1560ng/g

1.4. For DOD/DOE criteria, see Table B-24 in the QSM.

2. Summary of Method

2.1. Water samples are extracted using a solid phase extraction (SPE) cartridge. PFAS are eluted from the cartridge with an ammonium hydroxide (NH4OH)/methanol solution.

2.2. Solid/biosolids samples are extracted with a NH4OH/methanol solution using agitation over three extractions. The extract is centrifuged and diluted with water prior to SPE.

2.3. The final extracts are analyzed by LC/MS/MS. PFAS are separated from other components on a C18 column with a solvent gradient program using 10 mM ammonium acetate/water/acetonitrile (95/5) and acetonitrile. The mass spectrometer detector is operated in the electrospray (ESI) negative ion mode for the analysis of PFAS.

2.4. An isotope dilution technique is employed with this method for the compounds of interest. The isotope dilution analytes (IDA) consist of carbon-13 labeled analogs or deuterated analogs of the compounds of interest, and they are fortified into the samples at the time of extraction. This technique allows for the correction for analytical bias encountered when analyzing more chemically complex environmental samples. The isotopically labeled compounds are chemically similar to the compounds of concern and are therefore affected by sample-related interferences to the same extent as the compounds of concern. Compounds that do not have an identically labeled analog are quantitated by the IDA method using a closely related labeled analog.

2.5. Quantitation by the internal standard method is employed for the IDA analytes/recoveries. Peak response is measured as the area of the peak.

3. Definitions

3.1. PFCAs: Perfluorocarboxylic acids

3.2. PFSAs: Perfluorinated sulfonic acids

3.3. FOSA: Perfluorinated sulfonamide

3.4. PFOA: Perfluorooctanoic acid

3.5. PFOS: Perfluorooctane sulfonic acid

3.6. PTFE: Polytetrafluoroethylene (e.g. Teflon®)

3.7. SPE: Solid phase extraction

3.8. PP: Polypropylene

3.9. PE: Polyethylene

3.10. HDPE: High density polyethylene

3.11. AFFF: Aqueous Film Forming Foam

3.12. TDCA: Taurodeoxycholic acid

3.13. TCDA: Taurochenodeoxycholic acid

3.14. TUDCA: Tauroursodeoxycholic acid

3.15. IDA: Isotope dilution analyte (equivalent to EIS in reference method)

3.16. IS: Internal Standard (equivalent to NIS in reference method)

3.17. LCS: Laboratory control sample (equivalent to OPR in reference method)

3.18. Refer to the Glossary of the Eurofins Denver Quality Assurance Manual (QAM) for definitions of general analytical and QA/QC terms.

4. <u>Interferences</u>

4.1. PFAS have been used in a wide variety of manufacturing processes, and laboratory supplies should be considered potentially contaminated until they have been tested and shown to be otherwise. The materials and supplies used during the method validation process have been tested and shown to be clean (i.e., no contribution greater than ½ the quantitation (reporting) limit. These items are listed below in Section 6.

4.2. To avoid contamination of samples, standards are prepared in a ventilation hood in an area separate from where samples are extracted.

4.3. PTFE products can be a source of PFOA contamination. The use of PTFE in the procedure should be avoided or at least thoroughly tested before use. Polypropylene (PP) or polyethylene (PE, HDPE) products may be used in place of PTFE products to minimize PFOA contamination.

4.3.1. Standards and samples are injected from polypropylene autosampler vials with polypropylene screw caps once. Multiple injections may be performed on Primers when conditioning the instrument for analysis.

4.3.2. Random evaporation losses have been observed with the polypropylene caps causing high IDA recovery after the vial was punctured and sample re-injected. For this reason, it is best to inject standards and samples once in the analytical sequence.

4.3.3. Teflon-lined screw caps have detected PFAS at low concentrations. Repeated injection from the same Teflon-lined screw cap have detected PFNA at increasing concentration as each repeated injection was performed, therefore, it is best to use polypropylene screw caps.

4.4. Volumetric glassware and syringes are difficult to clean after being used for solutions containing high levels of PFOA. These items should be labeled for use only with similarly concentrated solutions or verified clean prior to re-use. To the extent possible, disposable labware is used.

4.5. Both branched and linear PFAS isomers can potentially be found in the environment. Linear and branched isomers are known to exist for PFOS, PFOA, PFHxS, PFBS, Et-FOSAA, and Me-FOSAA based upon the scientific literature. If multiple isomers are present for one of these PFAS they might be adjacent peaks that completely resolve or not, but usually with a deflection point resolved during peak integration. The later of these peaks matches the retention time of its labeled linear analog. In general, earlier peaks are the branched isomers and are not the result of peak splitting.

As of this writing, PFOS, PFOA, PFHxS, FOSA, Et-FOSA, Me-FOSA, Et-FOSE, ME-FOSE, Et-FOSAA and Me-FOSAA are commercially available as technical mixtures. These reference standards of the technical mixtures for these specific PFAS are used to ensure that all appropriate peaks are included during peak integration.

4.6. In an attempt to reduce PFOS bias, it is required that m/z 499>80 transition be used as the quantitation transition.

4.7. Aluminum foil should not be used for this analysis due to the potential interferences from the PFAS used as release agents.

4.8. All parts of the SPE manifold must be cleaned with 1% Ammonium Hydroxide in methanol and air dried prior to use. Sonicate all components that will fit into an ultrasonic bath with 1% Ammonium Hydroxide in methanol. When in use, after loading the same but prior to elution procedure, the manifold chamber must be rinsed with 1% ammonium hydroxide in methanol.

5. Safety

5.1. Employees must abide by the policies and procedures in the Environmental Health and Safety Manual, Radiation Safety Manual, and this document. All work must be stopped in the event of a known or potential compromise to the health or safety of an associate. The situation must be reported **immediately** to a supervisor, the EH&S Staff, or a senior manager.

5.2. This procedure may involve hazardous material, operations, and equipment. This SOP does not purport to address all the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum

5.3. Specific Safety Concerns

5.3.1. Preliminary toxicity studies indicate that PFAS could have significant toxic effects. In the interest of keeping exposure levels as low as reasonably achievable, PFAS and PFAS samples must be handled in the laboratory as hazardous and toxic chemicals.

5.3.2. The use of a filtering syringe with the SPE cartridge, if and when needed, presents an extreme risk of ergonomic injury due to the force needed to push a sample through a clogged cartridge. The risk includes both set-up and body position around the sample. Use step boxes to position oneself above the syringe and manifold and use ones entire body weight rather than just a thumb. Take routine breaks to offset the hazard.

5.3.3. Exercise caution when using syringes with attached filter disc assemblies. Application of excessive force has, upon occasion, caused a filter disc to burst during the process.

5.3.4. Laboratory procedures such as repetitive use of pipets, repetitive transferring of extracts and manipulation of filled separatory funnels and other glassware represent a significant potential for repetitive motion or other ergonomic injuries. Laboratory associates performing these procedures are in the best position to realize when they are at risk for these types of injuries. Whenever a situation is found in which an employee is performing the same repetitive motion, the employee shall immediately bring this to the attention of their supervisor, manager, or the EH&S staff. The task will be analyzed to determine a better means of accomplishing it.

5.3.5. Eye protection that satisfies ANSI Z87.1 (as per the NDSC Safety Manual), laboratory coat, and nitrile gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated will be removed and discarded; other gloves will be cleaned immediately.

5.3.6. Perfluorocarboxylic acids are acids and are not compatible with strong bases.

5.3.7. Methanol is highly flammable and is used throughout this procedure. Methanol should be stored away from any ignition sources and kept in closed containers with secondary containment measures or within a fume hood.

5.3.8. The use of vacuum systems presents the risk of imploding glassware. All glassware used during vacuum operations must be thoroughly inspected prior to each use. Glass that is chipped, scratched, cracked, rubbed, or marred in any manner must not be used under vacuum. It must be removed from service and replaced.

5.3.9. Glass containers are not to be used for “tumbling” soil samples.

5.4. Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **Note: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table**. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Material(1)	Hazards	Exposure Limit(2)	Signs and Symptoms of Exposure
Acetic Acid (3-2-1)	Corrosive Poison Flammable	10 ppm-TWA 15 ppm-STEL	Contact with concentrated solution may cause serious damage to the skin and eyes. Inhalation of concentrated vapors may cause serious damage to the lining of the nose, throat, and lungs. Breathing difficulties may occur.
Acetonitrile (2-3-0)	Flammable Poison	20 ppm-TWA	Early symptoms may include nose and throat irritation, flushing of the face, and chest tightness. Prolonged exposure to high levels of vapors may cause formation of cyanide anions in the body.
Ammonium Hydroxide (3-1-0)	Corrosive Poison	50 ppm-TWA	Severe irritant. Effects from inhalation of dust or mist vary from mild irritation to serious damage to the upper respiratory tract. Symptoms may include sneezing, sore throat or runny nose. Contact with skin can cause irritation or severe burns and scarring with greater exposures. Causes irritation of eyes, and with greater exposures it can cause burns that may result in permanent damage, including blindness. Brief exposure to 5000 PPM can be fatal.
Formic Acid (3-2-1)	Flammable Corrosive Toxic Irritant	5 ppm TWA 10 ppm STEL	Extremely destructive on contact with skin, mucous membranes, eyes, upper respiratory tract. Inhalation may result in spasms, inflammation and edema. Symptoms include burning sensation, coughing, wheezing, shortness of breath, headache, nausea, vomiting, depression.

Material(1)	Hazards	Exposure Limit(2)	Signs and Symptoms of Exposure
Methanol (2-3-0)	Flammable Poison Irritant	200 ppm PEL 250 ppm STEL	Harmful if swallowed, or absorbed through the skin. Causes eye, skin and respiratory tract irritation, and may cause central nervous system depression. A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness and dizziness. Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure. Irritant to the eyes.
Potassium Hydroxide (3-0-1)	Corrosive Poison	2 mg/m^3 (Ceiling)	Symptoms of inhalation may include coughing, sneezing, damage to the nasal or respiratory tract. High concentrations can cause lung damage. Contact with skin can cause irritation or severe burns and scarring with greater exposures. Causes irritation of eyes with tearing, redness, swelling.
(1) Always add acid to water to prevent violent reactions. (2) Exposure limit refers to the OSHA regulatory exposure limit.			

6. Equipment and Supplies

Due to the ubiquitous nature of PFAS, all disposable equipment (including, but not limited to vials, pipet tips, and SPE manifold parts) that directly contacts a sample or extract is subject to QC checks on a by-lot basis prior to use. At a minimum, the QC checks include either a rinse with DI water or an extraction with basic methanol to mimic the usage encountered during sample preparation. QC check data is kept on file for reference as needed. Processes for cleaning extraction manifolds and associated components are described in DV-OP-0004, *Glassware Cleaning*.

6.1. 15 mL polypropylene test tubes with polypropylene screw caps.

6.2. 50 mL graduated plastic centrifuge tubes.

6.3. 500, 250 and 125 mL HDPE bottles with HDPE screw caps. The average weight of the HDPE bottles with HDPE screw caps are calibrated once per year. The calibration is performed by weighing 10 bottles with caps and dividing by 10 to get the average weight.

6.4. Analytical balance capable of accurately weighing to the nearest 0.0001 g, and checked for accuracy each day it is used in accordance with DV-QA-0014.

6.5. Extract concentrator or nitrogen manifold with water bath heating to 65°C

6.6. Syringe filter, PALL/Acrodisc 0.2 um Nylon membrane, 25 mm, or equivalent. Do not use PTFE type filters.

6.7. 300 µL autosampler vials, polypropylene, with polypropylene screw caps, Waters PN 1860004112, or equivalent

6.8. SPE columns

6.8.1. Waters Oasis WAX 150 mg/6 cc (PN 186002493) or equivalent for DoD/DOE QSM samples

6.8.2. Phenomenex Strata PFAS WAX/GCB, 200mg/50mg/6cc (PN DZPRO-SPE) or equivalent. This cartridge incorporates a graphitized carbon

6.9. Graphitized carbon (Envi-Carb™ or equivalent) for DoD/DOE QSM samples

6.10. Silanized glass wool, Sigma-Aldrich PN 20411. Rinse with methanol 2 times and store in clean glass jar prior to use. Pack to half the height of WAX SPE cartridge barrel

6.11. Vacuum manifold for Solid Phase Extraction (SPE)

6.12. Vacuum pump

6.13. Miscellaneous laboratory apparatus (beakers, test tubes, volumetric flasks, pipettes, etc.). These should be disposable where possible, or marked and segregated for high-level versus low-level use

6.14. pH indicator paper, JT Baker Baker-pHIX pH 2.0-9.0, or equivalent

6.15. Centrifuge (Thermo Scientific Sorvall Legend X1, or equivalent), capable of reaching at least 4500 rpm

6.16. Vortex Mixer (Scientific Industries model SI-0236 or equivalent)

6.17. Shaker table (Eberbach model 6010, or equivalent) for soil extractions

6.18. Oven, capable of maintaining a temperature of 104ºC (±1ºC)

6.19. Pre-weighed 47 mm filter, Environmental Express part #F93447MM or equivalent

6.20. Liquid Chromatography/Tandem Mass Spectrometer (LC/MS/MS) –The instrument described below, or equivalent, may be used for this method. The HPLC is equipped with a refrigerated autosampler, an injection valve, and a pump capable of variable flow rate. The use of a column heater is required to maintain a stable temperature throughout the analytical run. Data is processed using Chrom Peak Review, version 2.3 or equivalent. The MS/MS is capable of running in the NI-ESI mode at the recommended flow rate with a minimum of 10 scans per peak.

6.20.1. SCIEX LC/MS/MS

This system consists of a Shimadzu HPLC interfaced with a SCIEX 5500+ Triple Quad MS, or equivalent. The instrument control and data acquisition software is SCIEX Analyst, version 1.6.3 or equivalent.

6.20.1.1. Shimadzu LC-40D HPLC equipped with an autosampler, two LC-40D pumps, one degassing unit, and one column oven, or equivalent.

6.20.1.2. Phenomenex Gemini C_{18} 3 µm, 2.0 mm x 50 mm, Part No. 00B-4439-B0, or equivalent.

6.20.1.3. PFAS Isolator column, Phenomenex Luna C_{18} 5 µm, 30 mm x 3 mm, part no. 00A-4252-Y0 or equivalent. This is plumbed between the UPLC pumps and autosampler valve to minimize PFAS background from the UPLC solvent lines and filters.

6.21. Preventive and routine maintenance is described in the table below

Table 6.21
HPLC/MS/MS Preventative Maintenance

As Needed:	**Daily (When in use)**
Change pump seals Change in-line filters in autosampler (HPLC) Check/replace in-line frit if excessive pressure or poor performance Replace column if no change following in-line frit change Clean corona needle Replace fused silica tube in ESI interface Clean lenses/Curtain Plate Clean skimmer Create all eluents in Reagent module, label eluent containers with TALS label and place 2nd label into maintenance log when put into use.	Check solvent reservoirs for sufficient level of solvent Verify that pump is primed, operating pulse free Check needle wash reservoir for sufficient solvent Verify capillary heater temperature functioning Verify vaporizer heater temperature Verify rough pump oil levels Verify turbo-pump functioning Verify nitrogen pressure for auxiliary and sheath gasses Verify that corona and multiplier are functioning
Semi-Annually	**Annually**
Replace rough-pump oil (4-6 months). Replace oil mist and odor elements. Replace activated alumina filter if applicable	Vacuum system components including fans and fan covers. Clean/replace fan filters, if applicable.

7. Reagents and Standards

7.1. Reagent grade chemicals shall be used in all tests whenever available. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on the Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.1.1. Acetic acid, glacial

7.1.2. Acetonitrile, JT Baker, HPLC Grade

7.1.3. Ammonium acetate (solid salt).

7.1.3.1. Ammonium acetate (10 M in water): Prepared by weighing 38.5 g of ammonium acetate and dissolving in 50 mL of water.

7.1.3.2. Ammonium acetate (10 mM in 95:5 Water: Acetonitrile): Prepared by transferring 1 mL of 10 M Ammonium Acetate solution into 999 mL of 95:5 Water: Acetonitrile for a total of 1L. This solution should be replaced every 7 days.

7.1.4. Ammonium hydroxide (NH_4OH), 30% in water, ACS reagent grade

7.1.4.1. Ammonium hydroxide (NH_4OH), 3% in water: Prepared by diluting 10 mL of ammonium hydroxide (30%) with 90 mL of reagent water for a total volume of 100 mL. Replace after 3 months.

7.1.4.2. Ammonium hydroxide (NH_4OH), 0.3% in methanol (v/v): Prepared by diluting 10 mL of ammonium hydroxide (30%) into 990 mL of methanol for a total of 1 L.

7.1.4.3. Ammonium hydroxide (NH4OH), 1% in methanol (v/v): Prepared by diluting 33 mL of ammonium hydroxide into 967 mL of methanol for a total of 1 L.

7.1.5. Formic Acid, greater than 96% purity or equivalent, ACS reagent grade

7.1.5.1. Formic Acid, 0.1 M, in water: Prepared by dissolving 4.6 g (3.77 mL) of formic acid into 1 L of reagent water. Replace after 2 years.

7.1.5.2. Formic Acid, 0.3 M, in water: Prepared by dissolving 13.8 g (11.3 mL) of formic acid into 1 L of reagent water. Replace after 2 years.

7.1.5.3. Formic Acid, 5% in water(v/v): Prepared by diluting 5 mL of formic acid into 95 mL of reagent water for a total volume of 100 mL. Replace after 2 years.

7.1.5.4. Formic Acid, 50% in water(v/v): Prepared by diluting 50 mL of formic acid with 50 mL of reagent water for a total volume of 100 mL. Replace after 2 years.

7.1.5.5. 1:1 0.1 M formic acid:methanol (v/v); Prepared by mixing equal volumes of methanol and 0.1 M formic acid. Replace after 2 years.

7.1.6. Methanol (MeOH)

7.1.7. Potassium Hydroxide (KOH) (solid, reagent grade).

7.1.7.1. Potassium hydroxide, 0.4% in methanol (w/v): Prepared by weighing 16 g of potassium hydroxide and dissolving in 4 L of methanol.

7.1.8. Ottawa Sand (blank matrix for solid samples)

7.1.9. Water, Nanopure or Millipore, must be free of interference and target analytes.

7.1.9.1. 95:5 Water: Acetonitrile: Prepared by diluting 200 mL of Acetonitrile with 3800 mL of Water. Final volume is 4 L.

7.1.10. Nitrogen, Ultra High Purity, used for the ESI interface, collision cell, and concentration of extracts.

7.1.11. Air, Ultra-Pure, used for vacuum and source gas.

7.1.12. 30:70 methanol: water (v/v), prepared by diluting 30 mL methanol with 70 mL HPLC reagent water or equivalent volume in respect to the ratio.

7.1.13. Instrument Blanks solution (94.375% MeOH, 4% H2O, 1% NH_4OH, 0.625% acetic acid): Prepare by combining 18.848 mL of MeOH, 0.348 mL reagent water, 0.128 mL glacial acetic acid and 0.676 mL 30% Ammonium Hydroxide in water. This solution is used to dilute the extracts of samples that exceed the calibration range (Section 12.1). Replace after 1 month.

7.1.14. Calibration solution (59% NH_4OH, 0.625% acetic acid in water): Prepare by combining 11.8 mL of NH_4OH and 2.2 mL of acetic acid and bring to final volume of 20 mL using HPLC grade water. Replace after 1 year.

7.2. Standards

7.2.1. PFAS are purchased as high purity solids (96% or greater) or as certified solutions. Standard materials are verified compared to a second source material at the time of initial calibration. The solid stock material is stored at room temperature or as specified by the manufacturer or vendor. Vendor expiration dates are used by the lab. Stocks and working solutions are given a 1-year expiration.

7.2.2. As of this writing, only PFOS, PFOA, PFHxS, FOSA, Et-FOSA, Me-FOSA, Et-FOSE, Me-FOSE, Et-FOSAA and Me-FOSAA are commercially available as technical mixtures. These reference standards of the technical mixtures for these specific PFAS are used to ensure that all appropriate peaks are included during peak integration.

7.2.3. If solid material is used for preparing a standard, stock standard solutions are prepared from the solids and are stored at 0 - 6°C. Stock standard solutions should be brought to room temperature before using. Standards are monitored for signs of degradation or evaporation. Standard solutions must be replaced at least annually from the date of preparation.

7.2.4. PFBS, PFHxS, PFHpS, PFOS, PFDS, and other PFAS are not available in the acid form, but rather as their corresponding salts, such as sodium or potassium. The standards are prepared and corrected for their salt content according to the equation below.

$$Mass_{acid} = \text{Measured } Mass_{salt} \times MW_{acid} / MW_{salt}$$

Where: MW_{acid} is the molecular weight of PFAA

MW_{salt} is the molecular weight of the purchased salt.

For example, the molecular weight of PFOS is 500.1295 and the molecular weight of NaPFOS is 523.1193. Therefore, the amount of NaPFOS used must be adjusted by a factor of 0.956.

7.2.5. For the primary source calibration solutions, individual solutions for each PFAS (both native and isotopically labelled) or PFAS mixtures (both native and isotopically labelled) are purchased from Wellington Laboratories, or other reputable vendors, and are predominantly at a concentration of 50 ug/mL in basic methanol for individual compounds or 1-5000 ng/mL in basic methanol for mixtures. In the case of the sulfonic compounds, the concentration is of the alkali (potassium or sodium) salt. The laboratory uses the concentration of the acid form when determining the concentration of individual sulfonic acids in solution (See Section 7.2.4 above).

7.2.6. While PFAS standards commercially purchased are supplied in glass ampoules, all subsequent transfers or dilutions performed by the analyst must be prepared and stored in polypropylene or HDPE containers. Vortex all standard solutions prior to removing aliquots.

7.3. **LC1633sp_IM: Intermediate spike solution, 80-2000 ng/L (nominal)** 100 ml of a mixed stock solution in methanol at a nominal concentration listed below. This mixed stock is used as the intermediate for the upper range of the ICAL and to create the QC spiking solution in sample preparation, using the recipe below:

Table 7.3
LC1633sp_IM Solution Recipe
The solutions below are combined and diluted to 100 mL in methanol

Analyte	Stock Conc. (µg/mL)	Aliquot (mL)	1633 IM/LCS Conc. (µg/mL)	Analyte	Stock Conc. (µg/mL)	Aliquot (mL)	1633 IM/LCS Conc. (µg/mL)
PFBA	50	0.64	0.320	6:2 FTS	47.4	0.64	0.300
PFPeA	50	0.32	0.160	8:2 FTS	47.9	0.64	0.300
PFHxA	50	0.16	0.080	FOSA	50	0.16	0.080
PFHpA	50	0.16	0.080	Me-FOSA	100	0.08	0.080
PFOA	50	0.16	0.080	Et-FOSA	100	0.08	0.080
PFNA	50	0.16	0.080	Me-FOSAA	50	0.16	0.080
PFDA	50	0.16	0.080	Et-FOSAA	50	0.16	0.080
PFUdA	50	0.16	0.080	Me-FOSE	50	1.60	0.800
PFDoA	50	0.16	0.080	Et-FOSE	50	1.60	0.800
PFTrDA	50	0.16	0.080	HFPO-DA	50	0.64	0.320
PFTeDA	50	0.16	0.080	DONA	47.1	0.64	0.300
PFBS	44.2	0.16	0.070	PFMPA (PFECA F)	50	0.32	0.160
PFPeS	46.9	0.16	0.075	PFMPA	50	0.32	0.160

Table 7.3
LC1633sp_IM Solution Recipe
The solutions below are combined and diluted to 100 mL in methanol

Analyte	Stock Conc. (µg/mL)	Aliquot (mL)	1633 IM/LCS Conc. (µg/mL)	Analyte	Stock Conc. (µg/mL)	Aliquot (mL)	1633 IM/LCS Conc. (µg/mL)
				(PFECA A)			
PFHxS	45.5	0.16	0.073	NFDHA (PFECA B)	50	0.32	0.160
PFHpS	47.6	0.16	0.076	9Cl-PF3ONS	46.6	0.64	0.300
PFOS	46.6	0.16	0.074	11Cl-PF3OUdS	47.1	0.64	0.300
PFNS	48	0.16	0.077	PFEESA (PES)	44.5	0.32	0.320
PFDS	48.2	0.16	0.077	3:3 FTCA	50	0.800	0.400
PFDoS	48.4	0.16	0.078	5:3 FTCA	50	4.00	2.00
4:2 FTS	46.7	0.64	0.300	7:3 FTCA	50	4.00	2.00

7.4. LC1633EPALSP: LCS Analyte Solution, 14-400 ng/mL (nominal)

100 ml of the LC1633sp_IM intermediate stock solution is diluted to a final volume of 500 mL using methanol. This mixed stock is used as an intermediate for the lower range of the ICAL and the LCS spike solution.

7.5. LC1633_EIS: 1633 Isotope Dilution Analyte Solution (Extracted Internal Standards (EIS)), 25-500 ng/mL

The 1633-EIS solution is added to all samples prior to extraction and used as an intermediate solution for preparation of the instrument calibration standards. 500 mL of the solution at a nominal concentration of 25-500 ng/mL is prepared from the individual solutions described in Section 7.2.5. using the recipe below:

Table 7.4
LC1633_EIS Recipe
The solutions below are combined and diluted to 500 mL with Methanol.

IDA/EIS	Stock Conc. (µg/mL)	Aliquot (mL)	IDA Mix Conc. (µg/mL)	IDA/EIS	Stock Conc. (µg/mL)	Aliquot (mL)	IDA Mix Conc. (µg/mL)
13C4-PFBA	50	2.00	0.20	13C8-PFOS	47.8	0.500	0.0478
13C5-PFPeA	50	1.00	0.10	13C2-4:2FTS	46.7	1.00	0.0934
13C5-PFHxA	50	0.500	0.050	13C2-6:2FTS	47.5	1.00	0.0950
13C4-PFHpA	50	0.500	0.050	13C2-8:2FTS	47.9	1.00	0.0958

Table 7.4
LC1633_EIS Recipe
The solutions below are combined and diluted to 500 mL with Methanol.

IDA/EIS	Stock Conc. (µg/mL)	Aliquot (mL)	IDA Mix Conc. (µg/mL)	IDA/EIS	Stock Conc. (µg/mL)	Aliquot (mL)	IDA Mix Conc. (µg/mL)
13C8-PFOA	50	0.500	0.050	13C8-FOSA	50	0.500	0.050
13C9-PFNA	50	0.250	0.025	d3-MeFOSA	50	0.500	0.050
13C6-PFDA	50	0.250	0.025	d5-EtFOSA	50	0.500	0.050
13C7-PFUdA	50	0.250	0.025	d3-MeFOSAA	50	1.00	0.100
13C2-PFDoA	50	0.250	0.025	d5-EtFOSAA	50	1.00	0.100
13C2-PFTeDA	50	0.250	0.025	d7-Me-FOSE	50	5.00	0.500
13C3-PFBS	46.5	0.500	0.0465	d9-Et-FOSE	50	5.00	0.500
13C3-PFHxS	50	0.500	0.047	13C3-HFPO-DA	50	2.00	0.200

7.6. LC1633_NIS: 1633 Internal Standard Analyte Solution (Non-Extracted Internal Standards (NIS)), 100-400 ng/mL

The 1633 IS solution is added to all extracts prior to analysis and used as an intermediate solution for preparation of the instrument calibration standards. 250 mL of the solution at a nominal concentration of 100-400 ng/mL is prepared from the individual solutions described in Section 7.2.5 using the recipe below.

Table 7.6
1633-IS Recipe
The solutions below are combined and diluted to 250 mL with Methanol.

IDA	Stock Conc. (µg/mL)	Aliquot (mL)	IDA Mix Conc. (µg/mL)	IDA	Stock Conc. (µg/mL)	Aliquot (mL)	IDA Mix Conc. (µg/mL)
13C3-PFBA	50	2.0	0.400	13C2-PFDA	50	0.5	0.100
13C2-PFHxA	50	1.0	0.200	18O2-PFHxS	47.3	1.0	0.189
13C4-PFOA	50	1.0	0.200	13C4-PFOS	47.8	1.0	0.191
13C5-PFNA	50	0.5	0.100				

7.7. Calibration Standards

Calibration solutions are prepared from the standards described in Sections 7.3, 7.4, 7.6, and 7.6, above. For each level, a 10 mL volumetric flask is filled with approx. 2 mL of Methanol. Add 1450 µL of 59% NH4OH/11% Acetic acid v/v in water (Section 7.1.14) and the appropriate amount (see table below) of the solutions are added, and then the flask is filled to the mark with methanol.

Table 7.7 1633 Calibration Solution Recipe									
PFAS Standards	Volume (mL) to add in 25 mL FV (25 mL)								
	CS-1	CS-2	CS-3	CS-4	CS-5	CS-6	CS-7	CS-8	CS-10
LC1633sp_IM (0.080-2.0 µg/mL)	0	0	0	0	0	0	1.575	3.90	19.525
LC1633EPALSP (0.014-0.400 µg/mL)	0.0825	0.1625	0.325	0.775	1.95	3.9	0	0	0
LC1633_EIS (0.025-0.5 µg/mL)	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
LC1633_NIS (0.1-0.4 µg/mL)	0.3125	0.3125	0.3125	0.3125	0.3125	0.3125	0.3125	0.3125	0.3125

7.7.1. Initial Calibration (ICAL) Levels (ng/mL)

Table 7.7.1 Initial Calibration Solution Concentrations (ng/mL)									
Compound	CS-1	CS-2	CS-3	CS-4	CS-5	CS-6	CS-7	CS-8	CS-10
PFBA	0.2	0.4	0.8	2	5	10	20	50	250
PFPeA	0.1	0.2	0.4	1	2.5	5	10	25	125
PFHxA	0.05	0.1	0.2	0.5	1.25	2.5	5	12.5	62.5
PFHpA	0.05	0.1	0.2	0.5	1.25	2.5	5	12.5	62.5
PFOA	0.05	0.1	0.2	0.5	1.25	2.5	5	12.5	62.5
PFNA	0.05	0.1	0.2	0.5	1.25	2.5	5	12.5	62.5
PFDA	0.05	0.1	0.2	0.5	1.25	2.5	5	12.5	62.5
PFUdA	0.05	0.1	0.2	0.5	1.25	2.5	5	12.5	62.5
PFDoA	0.05	0.1	0.2	0.5	1.25	2.5	5	12.5	62.5
PFTrDA	0.05	0.1	0.2	0.5	1.25	2.5	5	12.5	62.5
PFTeDA	0.05	0.1	0.2	0.5	1.25	2.5	5	12.5	62.5
PFBS	0.0442	0.0884	0.1768	0.442	1.105	2.21	4.42	11.05	55.25
PFPeS	0.0469	0.0938	0.1876	0.469	1.1725	2.345	4.69	11.725	58.625
PFHxS*	0.0455	0.091	0.182	0.455	1.1375	2.275	4.55	11.375	56.875
PFHpS	0.0476	0.0952	0.1904	0.476	1.19	2.38	4.76	11.9	59.5
PFOS*	0.0464	0.0928	0.1856	0.464	1.16	2.32	4.64	11.6	58
PFNS	0.048	0.096	0.192	0.48	1.2	2.4	4.8	12	60
PFDS	0.0482	0.0964	0.1928	0.482	1.205	2.41	4.82	12.05	60.25
PFDoS	0.0484	0.0968	0.1936	0.484	1.21	2.42	4.84	12.1	60.5
4:2 FTS	0.1868	0.3736	0.7472	1.868	4.67	9.34	18.68	46.7	233.5
6:2 FTS	0.1896	0.3792	0.7584	1.896	4.74	9.48	18.96	47.4	237
8:2 FTS	0.1916	0.3832	0.7664	1.916	4.79	9.58	19.16	47.9	239.5
FOSA	0.05	0.1	0.2	0.5	1.25	2.5	5	12.5	62.5
Me-FOSA*	0.05	0.1	0.2	0.5	1.25	2.5	5	12.5	62.5
Et-FOSA*	0.05	0.1	0.2	0.5	1.25	2.5	5	12.5	62.5
Me-FOSAA*	0.05	0.1	0.2	0.5	1.25	2.5	5	12.5	62.5

Table 7.7.1
Initial Calibration Solution Concentrations (ng/mL)

Compound	CS-1	CS-2	CS-3	CS-4	CS-5	CS-6	CS-7	CS-8	CS-10
Et-FOSAA*	0.05	0.1	0.2	0.5	1.25	2.5	5	12.5	62.5
Me-FOSE*	0.5	1	2	5	12.5	25	50	125	625
Et-FOSE*	0.5	1	2	5	12.5	25	50	125	625
HFPO-DA	0.2	0.4	0.8	2	5	10	20	50	250
DONA	0.1884	0.3768	0.7536	1.884	4.71	9.42	18.84	47.1	235.5
PFMPA (PFECA F)	0.1	0.2	0.4	1	2.5	5	10	25	125
PFMBA (PFECA A)	0.1	0.2	0.4	1	2.5	5	10	25	125
NFDHA (PFECA B)	0.1	0.2	0.4	1	2.5	5	10	25	125
9Cl-PF3ONS	0.1864	0.3728	0.7456	1.864	4.66	9.32	18.64	46.6	233
11Cl-PF3OUdS	0.1884	0.3768	0.7536	1.884	4.71	9.42	18.84	47.1	235.5
PFEESA (PES)	0.089	0.178	0.356	0.89	2.225	4.45	8.9	22.25	111.25
3:3 FTCA	0.2496	0.4992	0.9984	2.496	6.24	12.48	24.96	62.4	312
5:3 FTCA	1.248	2.496	4.992	12.48	31.2	62.4	124.8	312	1560
7:3 FTCA	1.248	2.496	4.992	12.48	31.2	62.4	124.8	312	1560
Labeled Isotope Dilution Analytes (IDA)									
13C4-PFBA	10	10	10	10	10	10	10	10	10
13C5-PFPeA	5	5	5	5	5	5	5	5	5
13C5-PFHxA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C4-PFHpA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C8-PFOA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C9-PFNA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C6-PFDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C7-PFUdA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C2-PFDoA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C2-PFTeDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C3-PFBS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C3-PFHxS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C8-PFOS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C2-4:2 FTS	5	5	5	5	5	5	5	5	5
13C2-6:2FTS	5	5	5	5	5	5	5	5	5
13C2-8:2FTS	5	5	5	5	5	5	5	5	5
13C8-FOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
d3-MeFOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
d5-EtFOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
d3-MeFOSAA	5	5	5	5	5	5	5	5	5
d5-EtFOSAA	5	5	5	5	5	5	5	5	5
d7-Me-FOSE	25	25	25	25	25	25	25	25	25
d9-Et-FOSE	25	25	25	25	25	25	25	25	25
13C3-HFPO-DA	10	10	10	10	10	10	10	10	10
Internal Standard (IS)									
13C3-PFBA	5	5	5	5	5	5	5	5	5
13C2-PFHxA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

Table 7.7.1
Initial Calibration Solution Concentrations (ng/mL)

Compound	CS-1	CS-2	CS-3	CS-4	CS-5	CS-6	CS-7	CS-8	CS-10
13C4-PFOA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C5-PFNA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C2-PFDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
18O2-PFHxS	2.365	2.365	2.365	2.365	2.365	2.365	2.365	2.365	2.365
13C4-PFOS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

** Both branched and linear isomers are used.*

***Note**: The above calibration levels are provided only as an example. The actual ICAL level used for each analytical batch will depend upon the LOQ requirements of the program.*

7.7.2. A technical (qualitative) grade standard which contains both linear and branched isomers for PFOA and PFNA is used as a retention time (RT) marker. This is used to integrate the total response for both linear and branched isomers of these analytes in environmental samples while relying on the initial calibration with the linear isomer quantitative standard. This technical (qualitative) grade standard is analyzed with every initial calibration and at the beginning of a daily sequence.

7.7.2.1. Additionally, standards of the bile acids (TDCA, {TUDCA and TCDA only if eluent is not acetonitrile}) at approximately 1.0 µg/mL are to be analyzed, after or with the qualitative standard for the initial calibration and prior to samples on non-ICAL days, and any time when DoD samples are analyzed. Be certain to attach those chromatograms to the document listed in Section 7.7.2.2.

7.7.2.2. Attach this document to the ICV from the associated ICAL by scanning the document and associating it to the file as a document type of High Res MS Tune in TALS and to the CCVL on non-CAL days. Use the following naming convention: "_TSTD_Instrument_Date." Example: _TSTD_LCMS9_15Mar2022.

7.7.2.3. The daily checks are attached to the CCVL of the sequence on non-CAL days.

7.8. LC1633_ICV Initial Calibration Verification Standard (ICV)

7.8.1. The ICV is prepared from commercially available mixed solutions from Wellington including PFC-MXF, PFC-MXG, PFC-MXH, PFC-MXI, and PFC-MXJ mixtures.

When available, individual stock solutions may be purchased from a vendor other than Wellington laboratories. If not available, a second lot from Wellington is sourced, and if that is not available, a second laboratory chemist will prepare the intermediate mixed solution for the ICV.

7.8.2. The mixes are combined with NIS and ESI by filling a 10 mL flask with approximately 2 mL of methanol and 580 µL of 59% NH_4OH/11% Acetic acid v/v in water (Section 7.1.14). The appropriate amount (see table below) of the solutions is added, and then the flask is filled to the mark with methanol to achieve the ratio of 94.375% MeOH, 4% H2O, 1% NH_4OH, 0.625% acetic acid.

Table 7.8.2
LC1633_ICV Recipe

PFAS Standards	Volume (mL) to add in 10 mL FV
PFAC-MXF	0.200
PFAC-MXG	0.250
PFAC-MXH	0.050
PFAC-MXI	0.050
PFAC-MXJ	0.025
LC1633_EIS	0.500
LC1633_NIS	0.125

8. Sample Collection, Preservation, and Storage

Laboratory default requirements for sample containers, sample size, preservation and holding time are detailed in the table below.

Table 8
Sample Collection, Preservation, and Storage Requirements

Matrix	Sample Container	Minimum Sample Size	Preservation	Holding Time
Water	2x 500 mL 1x 125 ml (TSS) HDPE bottle	500 mL	0-6°C	28 days if 0-6°C (1)
Solids	4 oz. HDPE wide-mouth container (2) (Separate jar for %moisture)	20 g	0-6°C	90 days

(1) There is a potential for transformation of Et-FOSE, Me-FOSE, Et-FOSAA, or Me-FOSAA in aqueous samples stored at 0-6ºC for more than 7 days. The transformation may cause a high bias in the observed concentration of other PFAS.

(2) If the sample is dewatered or cake (solid) then it may be collected in a 4oz soil jar. If sample is between 3-30% solids, then client should notify lab and request appropriate sample containers. Samples can split by the laboratory into solid and liquid phases for analysis upon request.

Extraction holding time is calculated from date of collection. Analytical holding time is determined from date of extraction.

8.1. Extracts are stored at 0 - 6°C and must be analyzed within 28 days of extraction.

8.2. Unless otherwise specified by client or regulatory program, after analysis, samples and extracts are retained for a minimum of 30 days after provision of the project report and then disposed of in accordance with applicable regulations.

8.3. Biphasic samples

8.3.1. Samples denoted as aqueous (groundwaters, surface waters, and wastewaters) with less than approximately 50 mg of solids content are prepared and handled as a liquid sample (Section 10.2) as determined by total suspected solids (TSS) analysis or per an experienced analyst. If a sample contains more than 50 mg solids, determine the TSS in the sample to then assess an appropriate extraction volume. If required by the client, contact the client for authorization to extract the sample at a reduced volume. Per client request, samples with more than 50 ppm TSS may require a second cartridge to be prepared in the event of cartridge clogging. In severe cases, the client will be contacted to determine if the sample should be extracted as a solid or liquid. Detailed descriptions of any deviations from the procedure must be documented in the LIMS NCM program. NCMs will be included for samples that have discoloration, excessive TSS or organic matter, organisms, odors, etc.

8.3.2. TSS Procedure

8.3.2.1. Use the 250 or 125 mL bottle

8.3.2.2. Aliquot a small volume for PFAS Pre-Screening

8.3.2.3. Use a pre-weighted filter (ProWeigh Filter)

8.3.2.4. Label each dish with a sample identifier

8.3.2.5. Scan each dish into the “Dish Value” field of the TALS batch

8.3.2.6. Copy the documented weight into the TALS batch as the “Tare Weight”

8.3.2.7. Assemble the needed filter apparatus

8.3.2.8. Insert the pre-weighed filter into the apparatus

1. MB = HPLC grade water
2. LCS = Celite, 500 mg/L TSS

8.3.2.9. Condition the filter with 10 mL of reagent water

8.3.2.10. Filter 10 mL of well-mixed sample through the filter to get a representative sample

8.3.2.11. Dry the filter for ~10 seconds by drawing vacuum through the filter

8.3.2.12. Use tweezers to carefully transfer the filter from the filtering apparatus back to its pre-weighed dish.

8.3.2.13. Dry the filter for a minimum of 1 hour at 104ºC ±1ºC

8.3.2.14. Transfer the filter to a rack until cool

8.3.2.15. Weigh the filter and residue using an analytical balance

8.3.2.16. Enter this value into the TALS batch as the "WT1" value.

8.3.2.17. Make sure the following values are correctly entered into the TALS batch

- Initial amount: 10 mL
- Final amount: 10 mL
- Nominal Amount Used = 10 mL (on batch information page)

8.3.2.18. TALS will calculate the TSS as follows:

Equation 1

$$TSS\ mg/L = \frac{Weight\ after\ drying\ (WT1)(mg) - Tare\ Weight\ (mg)}{0.01\ L}$$

8.3.2.19. If the TSS > 100 mg/L (50 mg/500 mL), then extract at a reduced volume.

8.3.2.20. An appropriate dilution will target a TSS of < 100 mg/L. Factors of 2, 4, and 10 should be used when determining the appropriate volume.

TSS (mg/L)	Volume reduction	Volume of sample
0-100	1x	500 mL
100-200	2x	250 mL
200-400	4x	100 mL
>400	10x	50 mL

Note: Under Batch Information, set "Perform Calculation" to "1" and "Nominal Amount Used" to 10 to perform auto calculations.

8.3.3. Samples considered solids (biosolids, sediments, and soils) are prepared and handled as solid samples following appropriate homogenization as per Section 10.6. Correction for moisture content is provided through the LIMS when required by the client.

8.3.4. In the event that results are required individually for the solid and aqueous phases of a sample, the phases are separated via centrifugation, and extracted separately using the appropriate preparation (Section 10.2 for the aqueous phase and Section 10.6 for the solid phase). The extracts are analyzed, and results reported for each phase separately.

9. Quality Control

9.1. The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the Eurofins Denver LIMS (TALS) Method Comments to determine specific QC requirements that apply. For SOPs that address only preparation, QC acceptable limits on the Initial Demonstration of Capability (IDOC)

9.1.1. The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in Eurofins Denver policy DV-QA-003P *Quality Control Program*.

9.1.2. Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), etc., are described in Eurofins Denver policy DV-QA-024P *QA/QC Requirements for Federal Programs*. This procedure meets all criteria for DoD QSM unless otherwise stated. Any deviation or exceptions from QSM requirements must have prior approval in the project requirements.

9.1.3. Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4. Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031 *Non -Conformance and Corrective Action System*. This is in addition to the corrective actions described in the following sections.

9.2. Initial Performance Studies

Before analyzing samples, the laboratory must establish a method detection limit (MDL). In addition, an initial demonstration of capability (IDOC) must be performed by each analyst on the instrument he/she will be using. On-going proficiency must be demonstrated by each analyst on an annual basis. See Section 12 for more details on detection limit studies, initial demonstrations of capability, and analyst training and qualification.

9.3. Batch Definition

Batches are defined at the sample preparation step. The batch is a set of up to 20 samples of the same matrix, plus required QC samples, processed using the same procedures and reagents within the same time period. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence. See QC policy DV-QA-003P *Quality control Program* for further details.

9.3.1. The quality control batch must contain a low level laboratory control sample (LLCS), a laboratory control sample (LCS) and a method blank. Laboratory generated QC samples (Blank, LLCS, LCS,) do not count toward the maximum 20 samples in a batch. Field QC samples are included in the batch count. In some cases, at client request, a matrix spike/matrix spike duplicate (MS/MSD) may be included in the batch. In the event that multiple MS/MSDs are run with a batch due to client requirements, the additional MS/MSDs do not count toward the maximum 20 samples in a batch.

9.4. QC Samples

9.4.1. Method Blank:

1.1.1 One method blank (MB, laboratory reagent blank) must be extracted with every process batch of similar matrix, not to exceed twenty (20) samples. For aqueous samples, the method blank is an aliquot of laboratory reagent water. For solid samples, the method blank is an aliquot of Ottawa sand wetted with reagent water. The method blank is processed in the same manner and at the same time as the associated samples. Corrective actions must be documented on a Non-Conformance memo, and then implemented when target analytes are detected in the method blank above the reporting limit or when IDA recoveries are outside of the control limits. Re-extraction of the blank, other batch QC and the affected samples are required when the method blank is deemed unacceptable. See policy DV-QA-003P *Quality Control Program* for specific acceptance criteria.

9.4.1.1. If the MB produces a peak within the retention time window of any of the analytes, determine the source of the contamination and eliminate the interference before processing samples.

9.4.1.2. The method blank must not contain any analyte at or above the reporting limit, greater than 1/3 the regulatory compliance limit or at or above 10% of the measured concentration of that analyte in the associated samples, whichever is higher.

9.4.1.2.1. DoD/DOE QSM: in addition to the above criteria, the method blank must not contain any analyte at or above ½ the reporting limit.

9.4.1.3. If there is no target analyte greater than the RL in the samples associated with an unacceptable method blank, the data may be reported with qualifiers. Such action should be taken in consultation with the client.

9.4.1.4. Re-extraction and reanalysis of samples associated with an unacceptable method blank is required when reportable concentrations are determined in the samples.

9.4.1.5. Refer to DV-QC-003P *Quality Control Program* for further details of the corrective actions.

9.4.1.6. The position of the method blank does not need to be rotated in the SPE manifold during SPE extraction if liners and reservoirs are rotated.

9.5. Laboratory Control Sample/ Laboratory Control Sample Duplicate (LCS/LCSD)

A laboratory control sample (LCS), defined as OPR (on-going precision and recovery) in Method 1633, must be extracted with every process batch of similar matrix, not to exceed twenty (20) samples. The LCS is an aliquot of laboratory matrix (e.g. water for aqueous samples and Ottawa sand for solids) spiked with analytes of known identity and concentration. The LCS must be processed in the same manner and at the same time as the associated samples. Corrective actions must be documented on a Non-Conformance memo, then implemented when recoveries of any spiked analyte are outside of the control limits. Re-extraction of the blank, other batch QC, and all associated samples are required if the LCS is deemed unacceptable. See DV-QA-003P *Quality Control Program* for specific acceptance criteria.

9.5.1. The control limits for the LCS are stored in TALS. As of this revision (Rev 2, 3rd Draft of Draft Method 1633), limits for aqueous samples are method defined. Limits for solids are advisory.

9.5.2. For DoD/DOE QSM, the lower recovery limits based on historical values must be greater than or equal to 40% for target PFAS.

9.6. Low Level Laboratory Control Sample (LLCS)

Low level LCS (LLCS), defined as LLOPR (low-level on-going precision and recovery) in Method 1633, must be extracted with every process batch of similar matrix, not to exceed twenty (20) samples. The LLCS is an aliquot of laboratory matrix (e.g. water for aqueous samples and Ottawa sand for solids) spiked with analytes of known identity and at a concentration of twice the RL. The LLCS must be processed in the same manner and at the same time as the associated samples. Corrective actions must be documented on a Non-Conformance memo, then implemented when recoveries of any spiked analyte are outside of the control limits. Re-extraction of the blank, other batch QC, and all associated samples are required if the LLCS is deemed unacceptable. See DV-QA-003P *Quality Control Program* for specific acceptance criteria.

9.6.1. The control limits for the LCS are stored in TALS. As of this revision (Rev 2, 3rd Draft of Draft Method 1633), limits for aqueous samples are method defined. Limits for solids are advisory.

9.6.2. For DoD/DOE QSM, the lower recovery limits based on historical values must be greater than or equal to 40%.

9.7. A laboratory duplicate (DU) must be extracted with every process batch of similar matrix, not to exceed twenty (20) samples. A DU is a second aliquot of a selected field sample that must be processed in the same manner and at the same time as the associated samples. If a client does not provide extra sample volume for a laboratory duplicate, a LCS/LCSD would be extracted to assess precision (Section 9.9). Any RPD failures must be documented in an NCM. RPD limits are stored in TALS.

9.8. Matrix Spike/ Matrix Spike Duplicate (MS/MSD)

Matrix spikes are not required for this method because any deleterious effect of the matrix is evident in the recoveries of the IDA. A matrix spike/matrix spike duplicate (MS/MSD or MS/SD) can be processed per client request. An MS/MSD pair is aliquots of a selected field sample spiked with analytes of known identity and concentration. The MS/MSD pair must be processed in the same manner and at the same time as the associated samples. Spiked analytes with recoveries or precision outside of the control limits must be within the control limits in the LCS. Corrective actions must be documented on a nonconformance memo, and then implemented when recoveries of any spiked analyte are outside of the control limits provided by TALS or by the client. Recovery limits for MS/MSD are the same as those used for the LCS.

9.8.1. For DoD/DOE QSM, the RPD limit for the MS/MSD pair is less than or equal to 30%.

9.9. A laboratory control sample duplicate (LCSD) may be added when insufficient sample volume is provided to process either a DU or MS/MSD pair, or is requested by the client. The LCSD is evaluated in the same manner as the LCS.

9.10. Instrument blanks (RB or CCB)

Instrument blanks are required at the beginning of an analytical sequence, after high level samples (>UCL) and every CCV. The blank should contain EIS and NIS to quantitate results. The blank should not contain any analyte > MDL. See DV-QA-003P *Quality Control Program* for specific acceptance criteria.

9.11. Initial calibration verification (ICV)

A second source standard is analyzed with the initial calibration curve. The concentration should be at the mid-range of the curve.

Corrective actions for the ICV include:

- Rerun the ICV
- Remake or acquire a new ICV
- Evaluate the instrument conditions(remake eluent, clean curtain plate)
- Evaluate the initial calibration standards
- Rerun the initial calibration

9.12. Isotope Dilution Analytes (Extractable Internal Standards (EIS))

9.12.1. The IDA solution is added to each field and QC sample at the time of extraction, as described in Section 10 (Procedure). As described in Section 7 (Reagents and Standards), this solution consists of isotopically labeled analogs of the analytes of interest.

9.12.2. IDA recoveries are flagged if they are outside of the acceptance limits stored in TALS. If IDA recoveries are outside of these limits, additional clean-up may be needed. If the recoveries cannot be met after clean up then re-extract a smaller aliquot.

9.12.2.1. If the IDA is just outside the control limits, re-analyze the extract at 1x prior to re-extraction. If in control, report the data.

9.12.3. Once sufficient data has been gathered, limits based on historical recoveries may be generated and implemented.

9.12.4. For DoD/DOE QSM, EIS limits based on historical recoveries are required. The lower recovery limit must be greater than or equal to 20%.

9.13. Ion Ratio

9.13.1. Compare the quantifier/qualifier SRM transition ratio in the sample to the SRM transition ratio in the standard.

Equation 2

$$Ion\ Ratio = \frac{Area\ Quantitation\ Ion\ (1°\ Transition)}{Area\ Qualitative\ Ion\ (2°\ Transition)}$$

9.13.2. The quantifier/qualifier SRM ion ratio should be within ±50% of the quantifier/qualifier SRM ion ratios calculated from the mid-level ICAL point.

9.13.2.1. If data is reported to the MDL the ratio should also be within ±50% of the quantifier/qualifier SRM ion ratios calculated from the initial daily CCV.

NOTE: two transition are monitored for PFPeA, but no corrective action is required if the ratio is outside the limits due to the extremely poor response for the qualifier transition.

9.13.3. If the ion ratio does not meet criteria after corrective actions, (extract clean-up, sample dilution, etc.), then data should be qualified if the ratio is not met.

9.13.3.1. Ion ratios must be in control in calibration solutions. If they are outside of limits, stop the analysis and correct the issues.

9.14. Internal Standards (Non-extractable Internal Standards (NIS))

Internal standards are spiked into every field sample, QC sample, standard, and instrument blank. They are used for quantitation of the IDA.

9.14.1. For Draft Method 1633, the internal standard area in the field and QC samples must be between 30-200% of the most recent CCV.

9.14.2. For DoD/DOE QSM, the following instances are required to be greater than the 30% of the average area of the calibration standards:

- The internal standard areas in undiluted extracts
- The internal standard areas in sample extracts where additional IS was added post-dilution.
- The internal standard areas in diluted extracts, once corrected for the dilution factor, when additional IS was not added post-dilution.

10. Procedure

10.1. One-time procedural variations are allowed only if deemed necessary in the professional judgment of a supervisor to accommodate variation in sample matrix, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using a non-conformance memo (NCM). The NCM process is described in more detail in SOP DV-QA-0031 *Non-Conformance and Corrective Action System*. The NCM shall be filed in the project file and addressed in the case narrative.

Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

Differences for samples run in accordance with the DoD/DOE QSM version 5.4 or higher are called out as needed in the procedures below.

10.2. Water Sample Preparation

10.2.1. Visually inspect samples for the presence of settled and/or suspended sediment/particulates. Samples >50 mg solids should be evaluated prior to extraction (Section 8.3.2 TSS Procedure). Compare sample to reference/comparison bottle. If the sample should be processed as a solid, biphasic, or reduced volume, contact the client for guidance prior to such action if contractually required. Invert samples to homogenize prior to adding any spiking solutions.

10.2.1.1. If TSS is > 100 mg/L, centrifugation may mitigate the sample clogging the cartridge in lieu of dilution.

10.2.2. Unknown samples may be screened prior to extraction using an external calibration curve and a 100x dilution factor.

10.2.2.1. Screening procedure may involve a reduced instrument run time and sample prep.

10.2.2.2. Evaluate the screening results to determine an appropriate volume to extract. If the on-column concentration is:

- <0.5 ng/mL = 1x (500 mL)
- Between 0.5 – 5 ng/mL = 10x (50 mL)
- Between 5 – 50 ng/mL = 100x (5 mL)
- Between 50 – 500 ng/mL = 1,000x (0.5 mL)
- Between 500 – 5000 ng/mL = 10,000x (0.05 mL)

10.2.3. Weigh the sample container prior to extraction and then weigh the sample container after extraction to determine the initial volume. Unless otherwise directed by client, use the entire sample volume, and spike directly into the sample container.

10.2.3.1. If the sample is identified as a leachate, prep at 100 mL. Sample should be collected in an appropriately sized container (i.e. 100-125 mL). If not, document the incorrect bottle type using an NCM and use a 100mL aliquot for the analysis.

10.2.4. Prepare additional aliquots of a field sample for the DU and MS/MSD, if requested.

10.2.5. Prepare three (3) 500 mL aliquots of HPLC-grade water for the method blank, LLCS and LCS, dependent upon container type submitted by the client. If a client specific DU and MS/MSD is not available, prep a fourth QC sample for the LCSD.

10.2.6. Check that the pH is 6.5 ± 0.5. If necessary, adjust pH with 50% formic acid and 3% ammonium hydroxide.

10.2.7. Vortex the LC1633EPALSP Native spike and LC1633_EIS IDA Mix solutions prior to use.

10.2.8. Add 0.250 mL of LC1633_EIS (Section 7.5) into each sample and QC sample, for a fixed concentration of 1.25-25 ng/mL in the final sample vial.

10.2.9. Spike the LCS and MS/MSD (if requested) with 1.0 mL of LC1633EPALSP Spike solution (Section 7.4), for a fixed concentration of 3.2 - 80 ng/mL in the final sample vial.

10.2.10. Spike the LLCS with the 100 µL of the LC1633EPALSP Spike solution (Section 7.4) using a 100µL or 200 µL pipette, for a fixed concentration of 0.32-8.0 ng/mL in the final sample vial.

10.2.11. Swirl or vortex all samples after adding spike solutions.

10.3. Solid Phase Extraction (SPE) of Aqueous Samples

10.3.1. Pack clean silanized glass wool to half the height of the WAX SPE cartridge barrel. As necessary, pack glass wool into the reservoir.

10.3.2. Condition the SPE cartridges (Section 6.8.2, Phenomenex Strata PFAS WAX/GCB, 200mg/50mg/6cc or equivalent) by passing the following solutions without drying the column.

10.3.2.1. For DOD/DOE samples, use the Oasis Wax Cartridges (Section 6.8.1)

Note: *The cartridges should not be allowed to go dry until the final elution step with methanol. At all of the other transition steps, the solvent/sample level should be stopped at the top of the column before the next liquid is added.*

WARNING: The use of a vacuum system creates the risk of glassware implosion. Inspect all glassware prior to use. Glassware with chips, scratches, rub marks or cracks must not be used.

10.3.3. Wash with 15.0 mL of 1.0% NH_4OH/methanol.

10.3.4. Wash with 5.0 mL of 0.3M formic acid. Close valve when ~ 200 µL remains on top to keep column wet. If needed, use HPLC grade water to keep the cartridge wet. After this step, the columns cannot go dry until the completion of loading and rinsing samples.

10.3.5. Appropriately label the columns and add the reservoir to the column. The QC samples do not need to be rotates as long a new liners and clean reservoirs as used with each batch.

10.3.6. Pour the samples into the reservoirs attached to the SPE columns and with vacuum, pull the entire sample volume through the cartridge at a rate of approximately 2 to 5 drops per second.

10.3.6.1. If the SPE column should clog (flow rate 1 drop every 10 seconds) prior to the entire content of the sample container passing through the column do the following:

1. Stop adding sample to the reservoir.
2. Return any remaining sample volume back to the original container.
3. Weigh the original container and record this weight into the worksheet notes field within the TALS extraction batch.
4. Determine the full volume of sample fortified by using the "Gross Weight" – (remaining sample volume – empty bottle weight)
5. Enter this value into the "Initial Amount" field in the TALS extraction batch.
6. Proceed to Section 10.4, noting that additional vacuum or pressure might be needed to elute the SPE column. If the cartridge remains clogged, use a syringe filter and hand pressure to add positive pressure to the cartridge.

10.3.7. After the entire sample has been loaded onto the column, rinse the sample bottle with two 5 mL aliquots of reagent water and pour into the column reservoir.

10.3.8. After the final loading of the sample but before completely passed through the column, rinse the SPE column with 5 mL of 1:1 0.1 M formic acid/MeOH.

10.3.9. After the sample and water rinse have completely passed through the cartridge, allow the column to dry with vacuum for between 15 seconds and 2 minutes.

10.3.10. Discard the rinses. Rinse out inside of manifold with 1% NH_4OH/Methanol

10.4. SPE Elution of Aqueous Samples – using 15 mL polypropylene test tubes as receiving tubes in the SPE manifold.

10.4.1. Add the collection tubes to the manifold. Rinse sample bottles with 5 mL of 1.0% NH_4OH/methanol and transfer to the column reservoir onto the cartridge. Elute the analytes from the cartridge by pulling the 1% NH_4OH/methanol through using low vacuum such that the solvent exits the cartridge in a dropwise fashion.

10.4.2. Air dry and weigh the bottles (record as the tare weight in TALS) to get the sample volume extracted.

10.4.3. Proceed to Section 10.5 for final volume.

For **DOD/DOE** samples proceed to Section 10.10.1 for loose graphitized carbon procedure.

10.5. Final volume for Aqueous Sample extracts

10.5.1. Add 25 µL of concentrated acetic acid to each sample. Cap, vortex, and set the samples aside.

10.5.2. Vortex the LC1633_NIS solution (IS solution) prior to use.

10.5.3. Add 62.5 µL of IS (Section 7.67.6) at 100-400 ng/mL concentration, into a new centrifuge tube.

10.5.4. Place a syringe filter (25 mm filter, 0.2 um nylon membrane) on a polypropylene syringe.

10.5.5. Decant the sample extract from section 10.5.1 into the polypropylene syringe fitted with a syringe filter.

10.5.6. Filter into the centrifuge tube that contains NIS from section 10.5.3.

10.5.7. Adjust final volume to 5 mL using 1.0% NH_4OH/methanol. Cap and vortex.

10.5.8. Transfer a portion of the extract to a 0.3 mL polypropylene micro vial. Archive the rest of the extract in a refrigerator for re-injection and dilution.

10.5.9. Seal the vial with a polypropylene screw or snap-top cap. Note: Teflon lined caps cannot be used due to detection of low-level concentration of PFAS. Tap down the vials prior to injection to ensure no air bubbles exist at the bottom

10.6. Solid and Biosolids Sample Preparation and Extraction

10.6.1. Visually inspect soil samples. Homogenize the entire sample in accordance with SOP DV-QA-0023 *Subsampling*. If the sample cannot be mixed in the container, pour into a larger QC'd PFAS-free container and mix thoroughly. Transfer the sample label to the new container.

10.6.2. All solid and biosolids samples must have their default mass increased by the percent moisture content prior to extraction.

10.6.2.1. Review TALS for the percent moisture results. Use the following equation to determine what adjustment is needed to the default masses listed in Section 10.6.3.

10.6.2.1.1. Dry wt. adjusted mass = default mass X (1+ percent moisture as a decimal)

NOTE: Do not add more than 10x the default mass, regardless of the percent moisture value.

10.6.3. Weigh a representative dry weight adjusted 5 g aliquot of sample (0.5 g for biosolids) into a 50 mL centrifuge tube. Weigh additional sample amounts for the matrix spike and matrix spike duplicate analyses if they are requested.

10.6.3.1. Do not batch solid sample and biosolids samples together due to the different masses.

10.6.4. For the method blank, LLCS and LCS matrix, use 5 g each of Ottawa sand wetted with 2.5 g of DI water or 0.5 g of Ottawa sand wetted with 250 µL of DI water for biosolids.

10.6.5. Vortex the LC1633EPALSP and LC1633_EIS solutions prior to use.

10.6.6. Add 0.250 mL of the LC1633_EIS solution (Section 7.5) into each sample and QC sample, for a fixed concentration of 1.25-25 ng/mL in the final sample vial.

10.6.7. Spike the LCS and MS/MSD (if requested) with 1.0 mL of the LC1633EPALSP Spike solution (Section 7.4), for a fixed concentration of 3.2 - 80 ng/mL in the final sample vial.

10.6.8. Spike the LLCS with 100 µL of the LC1633EPALSP Spike solution (Section 7.4), for a fixed concentration of 0.32-8.0 ng/mL in the final sample vial.

10.6.9. Cap the tubes, vortex samples and allow the spike to settle into the sample matrix for at least 30 minutes.

10.6.10. Add 10 mL of 0.3% NH_4OH/methanol to each sample. Cap and vortex.

10.6.11. Shake each sample on an orbital shaker at room temperature for 30 minutes.

10.6.12. Centrifuge each sample at 2800 rpm for 10 minutes.

10.6.13. Collect and decant the solvent into a new 50 mL tube.

10.6.14. Add 15 mL of 0.3% NH_4OH/methanol solution to the residue and vortex.

10.6.15. Shake each sample again on an orbital shaker at room temperature for 30 minutes.

10.6.16. Centrifuge each sample at 2800 rpm for 10 minutes.

10.6.17. Collect/decant the solvent into the centrifuge tube from Section 10.6.13.

10.6.18. Add 5 mL of 0.3% NH_4OH/methanol solution to the residue and vortex.

10.6.19. Centrifuge each sample at 2800 rpm for 10 minutes.

10.6.20. Collect/decant the solvent into the centrifuge tube from Section 10.6.13.

10.6.21. Add 10 mg of loose graphitized carbon to each sample and batch QC extract.

10.6.22. Hand-shake occasionally for no more than 5 minutes. It is important to minimize the time the sample extract is in contact with the carbon.

10.6.23. Immediately vortex for 30 seconds and centrifuge at 2800 rpm for 10 minutes.

10.6.24. Bring the sample up to 250 mL with reagent water. Cap and Vortex.

10.6.25. Check the pH to ensure pH is between 6.5 ± 0.5. Neutralize with 50% Formic Acid and 3% Ammonium Hydroxide and mix the contents well with vortex mixer.

10.7. Solid Phase Extraction (SPE) of Solid, and Biosolids Samples

10.7.1. Pack clean silanized glass wool to half the height of the WAX SPE cartridge barrel.

10.7.2. Condition the SPE cartridges (Section 6.8.1, Oasis Wax Cartridges) by passing the following without drying the column.

Note: *The cartridges should not be allowed to go dry until the final elution step with methanol. At all of the other transition steps, the solvent/sample level should be stopped at the top of the column before the next liquid is added.*

WARNING: The use of a vacuum system creates the risk of glassware implosion. Inspect all glassware prior to use. Glassware with chips, scratches, rub marks or cracks must not be used.

10.7.3. Wash with 15.0 mL of 1% NH_4OH/methanol.

10.7.4. Wash with 5.0 mL of 0.3M formic acid. Close valve when ~ 200 µL remains on top to keep column wet. After this step, the columns cannot go dry until the completion of loading and rinsing samples.

10.7.5. Appropriately label the columns and add the reservoir to the column. The QC samples do not need to be rotates as long a new liners and clean reservoirs as used with each batch.

10.7.6. Add samples to the columns and with vacuum, pull the entire 250 mL aliquot of the sample through the cartridge at a rate of approximately 2 to 5 drops per second.

10.7.7. After the entire sample has been loaded onto the column, rinse the centrifuge tube with two 5 mL aliquots of reagent water and pour into the column reservoir.

10.7.8. After the final loading of the sample but before completely passed through the column, rinse the SPE column with 5 mL of 1:1 0.1M formic acid/methanol.

10.7.9. After the sample and water rinse have completely passed through the cartridge, allow the column to dry with vacuum for 15 seconds to 2 minutes. Discard the rinses.

10.8. SPE Elution of Solid and Biosolids Samples – using 15 mL polypropylene test tubes as receiving tubes in the SPE manifold.

10.8.1. Vortex the LC1633_NIS solution prior to use.

10.8.2. Add 62.5 µL of LC1633_NIS (Section 7.6) at 100-400 ng/mL concentration into a new centrifuge tube.

10.8.3. Place the centrifuge tubes containing the NIS in the manifold.

10.8.4. Rinse 250 mL extract bottles with 5 mL of 1% NH_4OH/methanol and transfer to the column reservoir onto the cartridge. Elute the analytes from the cartridge by pulling the 1% NH_4OH/methanol through using low vacuum such that the solvent exits the cartridge in a dropwise fashion.

10.8.5. Proceed to Section 10.9 for final volume.

10.9. Final volume for Solid and Biosolids Sample extracts

10.9.1. Add 25 µL of concentrated acetic acid to each sample. Cap, vortex, and set the samples aside.

10.9.2. Bring up the final volume to 5 mL using 1.0% NH_4OH/methanol. Cap and vortex.

10.9.3. Place a syringe filter (25 mm filter, 0.2 um nylon membrane) on a polypropylene syringe.

10.9.4. Decant the sample extract into the polypropylene syringe fitted with a syringe filter.

10.9.5. Filter the eluted sample.

10.9.6. Transfer a portion of the extract to a 0.3 mL polypropylene micro vial. Archive the rest of the extracts for re-injection and dilution.

10.9.7. Seal the vial with a polypropylene screw top cap. Note: Teflon lined caps cannot be used due to detection of low level concentration of PFAS. Tap down the vials prior to injection to ensure no air bubbles exist at the bottom

10.10. Use of Loose Graphitized Carbon (Envi-Carb)

Analyses performed in accordance with the DOD/DOE QSM Table B-24 require the use of loose graphitized carbon in place of pre-packed cartridges for cleanups. Instructions for performing this cleanup are provided below:

10.10.1. **Water** Samples: Immediately following Section 10.4 (SPE elution) add 25 µL of acetic acid to each sample eluted in the collection tubes and vortex to mix. Add 10 mg of carbon to each sample and batch QC extract.

10.10.2. Hand-shake occasionally for no more than 5 minutes. It is important to minimize the time the sample extract is in contact with the carbon.

10.10.3. Immediately vortex for 30 seconds and centrifuge at 2800 rpm for 10 minutes.

10.10.4. **Water** Samples: Proceed to Section 10.5.2.

10.11. Instrument Analysis

Suggested operating conditions are listed in Tables 10.11-1-4 for the SCIEX LCMS systems:

Table 10.11 - 1
Recommended Instrument Operating Conditions

HPLC Conditions				
Column (Column temp = 45°C)	Phenomenex Gemini 3 µm C18 110Å, 50 X 2 mm			
Mobile Phase Composition	A = 10 mM Ammonium Acetate in 95/5 Water/Acetonitrile B = Acetonitrile			
Gradient Program	**Time**	**%A**	**%B**	**Flow Rate - mL/min**
	0	98	2	0.35
	0.2	98	2	0.35
	4.0	70	30	0.40
	7.0	45	55	0.40
	9.0	25	75	0.40
	10.0	5	95	0.40
	10.4	98	2	0.40
	11.8	98	2	0.40
	12.0	98	2	0.35
	Maximum pressure limit = 5,000 psi			
Injection Size	6 µL (fixed amount throughout the sequence).			
Run Time	~13.5 minutes			
Mass Spectrometer Interface Settings (SCIEX 5500)				
MS Interface Mode	ESI Negative Ion. Minimum of 10 scans/peak.			
Ion Spray Voltage (kV)	-4.5			
Entrance Potential (V)	5			
Declustering Potential (V)	25			
Desolvation Temp	550°C			
Curtain Gas	35 psi			
Collision Gas	10 psi			

Table 10.11 - 2
Masses/Transitions Utilized

ID	**Comments**	**Q1**	**Q3**	**RT**
11Cl-PF3OUdS	Native Analyte	630.9	450.9	9.59
11Cl-PF3OUdS_2	Native Analyte	632.9	452.9	9.59
13C2_PFDA	NIS (Internal Standard)	515.1	470.1	7.94
13C2_PFDoA	EIS (IDA)	615.1	570	8.95
13C2_PFHxA	NIS (Internal Standard)	315.1	270	5.52
13C2_PFHxA_2	NIS (Internal Standard)	315.1	119.4	5.52

Table 10.11 - 2 Masses/Transitions Utilized				
ID	**Comments**	**Q1**	**Q3**	**RT**
13C2_PFTeDA	EIS (IDA)	715.2	670	9.88
13C3_HFPO-DA	EIS (IDA)	286.9	168.9	5.80
13C3_HFPO-DA_2	EIS (IDA)	286.9	184.9	5.80
13C3_PFBA	NIS (Internal Standard)	216	172	3.15
13C3_PFBS	EIS (IDA)	302.1	79.9	5.55
13C3_PFBS_2	EIS (IDA)	302.1	98.9	5.55
13C3_PFHxS	EIS (IDA)	402.1	79.9	7.02
13C3_PFHxS_2	EIS (IDA)	402.1	98.8	7.02
13C4_PFBA	EIS (IDA)	216.8	171.9	3.15
13C4_PFHpA	EIS (IDA)	367.1	322	6.21
13C4_PFOA	NIS (Internal Standard)	417.1	172	6.81
13C4_PFOS	NIS (Internal Standard)	502.8	79.9	8.22
13C4_PFOS_2	NIS (Internal Standard)	502.8	98.9	8.22
13C5_PFHxA	EIS (IDA)	318	273	5.52
13C5_PFHxA_2	EIS (IDA)	318	120.3	5.52
13C5_PFNA	NIS (Internal Standard)	468	423	7.39
13C5_PFPeA	EIS (IDA)	268.3	223	4.64
13C6_PFDA	EIS (IDA)	519.1	474.1	7.94
13C7_PFUdA	EIS (IDA)	570	525.1	8.46
13C8_PFOA	EIS (IDA)	421.1	376	6.81
13C8_PFOS	EIS (IDA)	507.1	79.9	8.22
13C8_PFOS_2	EIS (IDA)	507.1	98.9	8.22
13C8_PFOSA	EIS (IDA)	506.1	77.8	8.65
13C9_PFNA	EIS (IDA)	472.1	427	7.39
18O2_PFHxS	NIS (Internal Standard)	403	83.9	7.02
3:3 FTCA	Native Analyte	241	177	4.06
3:3 FTCA_2	Native Analyte	241	117	4.06
4:2 FTS	Native Analyte	327.1	307	5.26
4.2 FTS_2	Native Analyte	327.1	80.9	5.26
5:3 FTCA	Native Analyte	341	237.1	5.79
5:3 FTCA_2	Native Analyte	341	217	5.79
6:2 FTS	Native Analyte	427.1	407	6.53
6:2 FTS_2	Native Analyte	427.1	80.9	6.53
7:3 FTCA	Native Analyte	441	316.9	7.00
7:3 FTCA_2	Native Analyte	441	336.9	7.00
8:2 FTS	Native Analyte	527.1	507	7.65
8:2 FTS_2	Native Analyte	527.1	80.8	7.65
9Cl-PF3ONS	Native Analyte	530.8	351	8.62

Table 10.11 - 2
Masses/Transitions Utilized

ID	Comments	Q1	Q3	RT
9Cl-PF3ONS_2	Native Analyte	532.8	353	8.62
d3MeFOSA	EIS (IDA)	515	219	9.69
d3-MeFOSAA	EIS (IDA)	573.2	419	7.88
d5EtFOSA	EIS (IDA)	531.1	219	10.01
d5-EtFOSAA	EIS (IDA)	589.2	419	8.11
d7N-MeFOSE	EIS (IDA)	623.2	58.9	9.55
d9N-EtFOSE	EIS (IDA)	639.2	58.9	9.86
DONA	Native Analyte	376.9	250.9	6.44
DONA_2	Native Analyte	376.9	84.8	6.44
EtFOSA	Native Analyte	526	219	10.01
EtFOSA_2	Native Analyte	526	169	10.01
HFPO-DA	Native Analyte	284.9	168.9	5.80
HFPO-DA_2	Native Analyte	284.9	184.9	5.80
M2-4:2FTS	EIS (IDA)	329.1	80.9	5.26
M2-4:2FTS_2	EIS (IDA)	329.1	309	5.26
M2-6:2FTS	EIS (IDA)	429.1	80.9	6.53
M2-6:2FTS_2	EIS (IDA)	429.1	409	6.53
M2-8:2FTS	EIS (IDA)	529.1	80.9	7.65
M2-8:2FTS_2	EIS (IDA)	529.1	509	7.65
MeFOSA	Native Analyte	511.9	219	9.69
MeFOSA_2	Native Analyte	511.9	169	9.69
N-EtFOSAA	Native Analyte	584.2	419.1	7.96
N-EtFOSAA_2	Native Analyte	584.2	526	7.96
N-EtFOSE	Native Analyte	630	58.9	9.86
NFDHA (PFECA B)	Native Analyte	295	201	5.45
NFDHA_2 (PFECA B_2)	Native Analyte	295	84.9	5.45
N-MeFOSAA	Native Analyte	570.1	419	7.75
N-MeFOSAA_2	Native Analyte	570.1	483	7.75
N-MeFOSE	Native Analyte	616.1	58.9	9.55
PFBA	Native Analyte	212.8	168.9	3.15
PFBS	Native Analyte	298.7	79.9	5.55
PFBS_2	Native Analyte	298.7	98.8	5.55
PFDA	Native Analyte	512.9	469	7.94
PFDA_2	Native Analyte	512.9	219	7.94
PFDoA	Native Analyte	613.1	569	8.95
PFDoA_2	Native Analyte	613.1	319	8.95
PFDoS	Native Analyte	699.1	79.9	10.12

Table 10.11 - 2 Masses/Transitions Utilized				
ID	**Comments**	**Q1**	**Q3**	**RT**
PFDoS_2	Native Analyte	699.1	98.8	10.12
PFDS	Native Analyte	599	79.9	9.22
PFDS_2	Native Analyte	599	98.8	9.22
PFEESA (PES)	Native Analyte	314.8	134.9	5.95
PFEESA_2 (PES_2)	Native Analyte	314.8	82.9	5.95
PFHpA	Native Analyte	363.1	319	6.21
PFHpA_2	Native Analyte	363.1	169	6.21
PFHpS	Native Analyte	449	79.9	7.65
PFHpS_2	Native Analyte	449	98.8	7.65
PFHxA	Native Analyte	313	269	5.52
PFHxA_2	Native Analyte	313	118.9	5.52
PFHxS	Native Analyte	398.7	79.9	6.86
PFHxS_2	Native Analyte	398.7	98.9	6.86
PFMBA (PFECA A)	Native Analyte	279	85.1	4.96
PFMPA (PFECA F)	Native Analyte	229	84.9	3.87
PFNA	Native Analyte	463	419	7.39
PFNA_2	Native Analyte	463	219	7.39
PFNS	Native Analyte	548.8	79.9	8.74
PFNS_2	Native Analyte	548.8	98.8	8.74
PFOA	Native Analyte	413	369	6.81
PFOA_2	Native Analyte	413	169	6.81
PFOS	Native Analyte	498.9	79.9	8.05
PFOS_2	Native Analyte	498.9	98.8	8.05
PFOSA	Native Analyte	498.1	77.9	8.65
PFOSA_2	Native Analyte	498.1	478	8.65
PFPeA	Native Analyte	263	219	4.64
PFPeA_2	Native Analyte	263	68.9	4.64
PFPeS	Native Analyte	349.1	79.9	6.36
PFPeS_2	Native Analyte	349.1	98.9	6.36
PFTeDA	Native Analyte	713.1	669	9.88
PFTeDA_2	Native Analyte	713.1	168.9	9.88
PFTrDA	Native Analyte	663	619	9.42
PFTrDA_2	Native Analyte	663	168.9	9.42
PFUdA	Native Analyte	563.1	519	8.46
PFUdA_2	Native Analyte	563.1	269.1	8.46
TCDA_1	Native Analyte	498.29	106.98	6.27
TCDA_2	Native Analyte	498.29	123.9	6.27
TCDA_3	Native Analyte	499.29	106.98	6.27

Table 10.11 - 2 Masses/Transitions Utilized				
ID	**Comments**	**Q1**	**Q3**	**RT**
TCDA_4	Native Analyte	499.29	123.9	6.27
TCDCA	Native Analyte	464.21	126	6.11
TUDCA	Native Analyte	464.2	126	5.42

Table 10.11 – 3 Recommended Instrument Operating Conditions Mass Spectrometer Scan Settings (SCIEX 5500+)							
RT	ID	MRM (win)	Dwell Weight	DP (volts)	EP (volts)	CE (volts)	CXP (volts)
6.27	TCDA_1	70	1	-65	-5	-58	-12
6.27	TCDA_2	70	1	-65	-5	-58	-12
6.27	TCDA_3	90	1	-65	-5	-58	-12
6.27	TCDA_4	90	1	-65	-5	-58	-12
6.11	TCDCA	120	1	-65	-5	-58	-12
5.42	TUDCA	120	1	-65	-5	-58	-12
3.15	13C3_PFBA	90	1	-25	-5	-12	-31
3.15	13C4_PFBA	90	1	-25	-5	-12	-31
3.15	PFBA	90	1	-25	-5	-12	-31
3.87	PFMPA (PFECA F)	70	1	-23	-10	-10	-16
4.06	3:3 FTCA	70	1	-46	-10	-11	-13
4.06	3:3 FTCA_2	70	1	-33	-10	-44	-15
4.64	13C5_PFPeA	80	1	-55	-7	-12	-13
4.64	PFPeA	80	1	-55	-7	-12	-13
4.64	PFPeA_2	80	1	-55	-7	-62	-15
4.96	PFMBA (PFECA A)	70	1	-5	-10	-16	-9
5.26	4.2FTS_2	70	1	-60	-10	-50	-12
5.26	4:2 FTS	70	1	-50	-7	-32	-10
5.26	M2-4:2FTS	70	1	-50	-7	-80	-10
5.26	M2-4:2FTS_2	70	1	-50	-7	-32	-10
5.55	13C3_PFBS	70	1	-55	-6	-58	-37
5.55	13C3_PFBS_2	70	1	-55	-6	-58	-37
5.45	NFDHA (PFECA B)	70	1	-35	-10	-14	-17
5.45	NFDHA_2 (PFECA B_2)	70	1	-35	-10	-34	-5
5.55	PFBS	70	1	-55	-6	-58	-37
5.55	PFBS_2	70	1	-55	-5	-40	-12
5.52	13C2_PFHxA	50	1	-55	-5	-14	-13
5.52	13C2_PFHxA_2	50	1	-55	-5	-26	-7

Table 10.11 – 3
Recommended Instrument Operating Conditions
Mass Spectrometer Scan Settings (SCIEX 5500+)

RT	ID	MRM (win)	Dwell Weight	DP (volts)	EP (volts)	CE (volts)	CXP (volts)
5.52	13C5_PFHxA	50	1	-60	-5	-12	-15
5.52	13C5_PFHxA_2	50	1	-60	-5	-30	-9
5.52	PFHxA	50	1	-55	-5	-14	-13
5.52	PFHxA_2	50	1	-55	-5	-26	-7
5.80	13C3_HFPO-DA	70	1	-15	-10	-5	-17
5.80	13C3_HFPO-DA_2	70	1	-75	-10	-18	-15
5.80	HFPO-DA	70	1	-15	-10	-5	-17
5.80	HFPO-DA_2	70	1	-75	-10	-18	-15
5.95	PFEESA (PES)	70	1	-98	-12	-28	-12
5.95	PFEESA_2 (PES_2)	70	1	-98	-12	-28	-12
5.79	5:3 FTCA	70	1	-10	-10	-18	-13
5.79	5:3 FTCA_2	70	1	-10	-10	-38	-11
6.21	13C4_PFHpA	70	1	-25	-6	-12	-41
6.21	PFHpA	70	1	-25	-6	-12	-41
6.21	PFHpA_2	70	1	-25	-6	-20	-10
6.36	PFPeS	70	1	-57	-9	-66	-40
6.36	PFPeS_2	70	1	-57	-9	-45	-12
6.44	DONA	70	1	-55	-10	-16	-17
6.44	DONA_2	70	1	-55	-10	-35	-17
6.53	6:2 FTS	70	1	-50	-7	-32	-10
6.53	6:2 FTS_2	70	1	-80	-10	-72	-12
6.53	M2-6:2FTS	70	1	-50	-7	-90	-10
6.53	M2-6:2FTS_2	70	1	-50	-7	-32	-10
6.81	13C4_PFOA	70	1	-70	-6	-24	-31
6.81	13C8_PFOA	70	1	-70	-6	-18	-31
6.81	PFOA	70	1	-70	-6	-18	-31
6.81	PFOA_2	70	1	-70	-6	-24	-31
7.02	13C3_PFHxS	65	1	-145	-12	-88	-11
7.02	13C3_PFHxS_2	65	1	-145	-12	-80	-13
7.02	18O2_PFHxS	65	1	-145	-12	-88	-11
6.86	PFHxS	65	1	-145	-12	-88	-11
6.86	PFHxS_2	65	1	-145	-12	-80	-13
7.00	7:3 FTCA	70	1	-27	-12	-18	-10
7.00	7:3 FTCA_2	70	1	-22	-12	-31	-35
7.39	13C5_PFNA	70	1	-25	-6	-14	-48
7.39	13C9_PFNA	70	1	-25	-6	-14	-48

Table 10.11 – 3
Recommended Instrument Operating Conditions
Mass Spectrometer Scan Settings (SCIEX 5500+)

RT	ID	MRM (win)	Dwell Weight	DP (volts)	EP (volts)	CE (volts)	CXP (volts)
7.39	PFNA	70	1	-25	-6	-14	-47
7.39	PFNA_2	70	1	-25	-6	-24	-47
7.65	PFHpS	70	1	-65	-11	-88	-46
7.65	PFHpS_2	70	1	-65	-11	-50	-12
7.65	8:2 FTS	70	1	-50	-7	-40	-15
7.65	8:2 FTS_2	70	1	-60	-10	-82	-9
7.65	M2-8:2FTS	70	1	-50	-7	-90	-15
7.65	M2-8:2FTS_2	70	1	-50	-7	-40	-15
7.94	13C2_PFDA	70	1	-25	-6	-16	-51
7.94	13C6_PFDA	70	1	-25	-6	-16	-51
7.94	PFDA	70	1	-25	-6	-16	-51
7.94	PFDA_2	70	1	-25	-6	-26	-12
7.88	d3-MeFOSAA	90	1	-40	-7	-36	-15
7.75	NMeFOSAA	90	1	-40	-7	-36	-15
7.75	NMeFOSAA_2	90	1	-75	-10	-22	-12
8.22	13C4_PFOS	90	1	-140	-9	-130	-13
8.22	13C4_PFOS_2	90	1	-140	-9	-98	-5
8.22	13C8_PFOS	90	1	-205	-9	-112	-11
8.22	13C8_PFOS_2	90	1	-205	-9	-112	-11
8.05	PFOS	90	1	-140	-9	-130	-13
8.05	PFOS_2	90	1	-140	-9	-98	-5
8.11	d5-EtFOSAA	90	1	-50	-7	-36	-15
7.96	NEtFOSAA	90	1	-50	-7	-36	-15
7.96	NEtFOSAA_2	90	1	-90	-10	-28	-12
8.62	9Cl-PF3ONS	70	1	-120	-10	-30	-17
8.62	9Cl-PF3ONS_2	70	1	-120	-10	-30	-15
8.46	13C7_PFUdA	70	1	-25	-7	-18	-54
8.46	PFUdA	70	1	-25	-7	-18	-54
8.46	PFUdA_2	70	1	-25	-7	-28	-12
8.74	PFNS	70	1	-75	-10	-113	-52
8.74	PFNS_2	70	1	-75	-8	-71	-12
8.95	13C2_PFDoA	70	1	-25	-5	-18	-54
8.95	PFDoA	70	1	-25	-5	-18	-54
8.95	PFDoA_2	70	1	-25	-5	-30	-12
8.65	13C8_PFOSA	75	1	-90	-8	-92	-11
8.65	PFOSA	75	1	-90	-8	-92	-11
8.65	PFOSA_2	75	1	-60	-10	-40	-8

Table 10.11 – 3
Recommended Instrument Operating Conditions
Mass Spectrometer Scan Settings (SCIEX 5500+)

RT	ID	MRM (win)	Dwell Weight	DP (volts)	EP (volts)	CE (volts)	CXP (volts)
9.22	PFDS	70	1	-30	-11	-130	-11
9.22	PFDS_2	70	1	-30	-11	-110	-17
9.42	PFTrDA	90	1	-25	-7	-20	-54
9.42	PFTrDA_2	90	1	-25	-7	-36	-12
9.59	11Cl-PF3OUdS	70	1	-160	-10	-40	-17
9.59	11Cl-PF3OUdS_2	70	1	-160	-10	-40	-15
9.88	13C2_PFTeDA	120	1	-25	-7	-22	-54
9.88	PFTeDA	120	1	-25	-7	-22	-10
9.88	PFTeDA_2	120	1	-25	-7	-36	-30
10.12	PFDoS	90	1	-10	-11	-76	-11
10.12	PFDoS_2	90	1	-10	-11	-130	-5
9.55	d7N-MeFOSE	70	1	-20	-5	-70	-10
9.55	N-MeFOSE	70	1	-20	-5	-70	-10
9.69	d3MeFOSA	70	1	-75	-7	-37	-15
9.69	MeFOSA	70	1	-75	-7	-37	-15
9.69	MeFOSA_2	70	1	-50	-2	-40	-6
9.86	d9N-EtFOSE	70	1	-20	-5	-70	-10
9.86	N-EtFOSE	70	1	-20	-5	-70	-10
10.01	d5EtFOSA	70	1	-75	-7	-37	-15
10.01	EtFOSA	70	1	-75	-7	-37	-15
10.01	EtFOSA_2	70	1	-50	-8	-40	-6

Table 10.11 – 4
Retention Times & Quantitation

Native Compounds	Typical Native RT (minutes)	IDA analog	Typical IDA RT (minutes)	Quantitation Method
PFBA	3.15	13C4_PFBA	3.15	Isotope Dilution
3:3 FTCA	4.06	13C5_PFPeA	4.64	Isotope Dilution
PFPeA	4.64	13C5_PFPeA	4.64	Isotope Dilution
PFBS	5.55	13C3-PFBS	5.55	Isotope Dilution
PFECA A (PFMBA)	4.96	13C5_PFPeA	4.64	Isotope Dilution
PES (PFEESA)	5.95	13C5_PFHxA	5.52	Isotope Dilution
PFECA B (NFDHA)	5.45	13C5_PFHxA	5.52	Isotope Dilution
4:2 FTS	5.26	13C2-4:2FTS	5.26	Isotope Dilution
PFHxA	5.52	13C5_PFHxA	5.52	Isotope Dilution
PFPeS	6.36	13C3_PFHxS	7.02	Isotope Dilution
HFPO-DA	5.80	13C3_HFPO-DA	5.80	Isotope Dilution
5:3 FTCA	5.79	13C5_PFHxA	5.52	Isotope Dilution

Table 10.11 – 4
Retention Times & Quantitation

Native Compounds	Typical Native RT (minutes)	IDA analog	Typical IDA RT (minutes)	Quantitation Method
PFECA_F (PFMPA)	3.87	13C5_PFPeA	4.64	Isotope Dilution
PFHpA	6.21	13C4_PFHpA	6.21	Isotope Dilution
PFHxS	6.86	13C3_PFHxS	7.02	Isotope Dilution
DONA	6.44	13C3_HFPO-DA	5.80	Isotope Dilution
6:2 FTS	6.53	13C2-6:2FTS	6.53	Isotope Dilution
PFOA	6.81	13C8_PFOA	6.81	Isotope Dilution
PFHpS	7.65	13C8_PFOS	8.22	Isotope Dilution
7:3 FTCA	7.00	13C5_PFHxA	5.52	Isotope Dilution
PFOS	8.05	13C8_PFOS	8.22	Isotope Dilution
PFNA	7.39	13C9_PFNA	7.39	Isotope Dilution
9Cl-PF3ONS	8.62	13C3_HFPO-DA	5.80	Isotope Dilution
PFOSA	8.65	13C8_PFOSA	8.65	Isotope Dilution
PFNS	8.74	13C8_PFOS	8.22	Isotope Dilution
PFDA	7.94	13C6_PFDA	7.94	Isotope Dilution
8:2 FTS	7.65	13C2-8:2FTS	7.65	Isotope Dilution
NMeFOSAA	7.75	d3-MeFOSAA	7.88	Isotope Dilution
PFDS	9.22	13C8_PFOS	8.22	Isotope Dilution
PFUdA (PFUnA)	8.46	13C7_PFUdA	8.46	Isotope Dilution
NEtFOSAA	7.96	d5-EtFOSAA	8.11	Isotope Dilution
N-MeFOSE	9.55	d7N-MeFOSE	9.55	Isotope Dilution
MeFOSA	9.69	d3MeFOSA	9.69	Isotope Dilution
11Cl-PF3OUdS	9.59	13C3_HFPO-DA	5.80	Isotope Dilution
N-EtFOSE	9.86	d9N-EtFOSE	9.86	Isotope Dilution
EtFOSA	10.01	d5EtFOSA	10.01	Isotope Dilution
PFDoA	8.95	13C2_PFDoA	8.95	Isotope Dilution
PFDoS	10.12	13C8_PFOS	8.22	Isotope Dilution
PFTrDA	9.42	13C2_PFDoA	8.95	Isotope Dilution
PFTeDA	9.88	13C2_PFTeDA	9.88	Isotope Dilution

10.11.1. Tune and calibrate the instrument as described in Section 10.

10.11.2. A typical run sequence is as follows:

- Wash instrument with 98%B at 0.35 mL/min
- Equilibrate at 2%B at 0.35 mL/min and monitor back pressure
- Rinse Blank (RB, not linked to anything)
- CCVL (referred to as an ISC in Method 1633)
- Qualitative verification standard (Technical Standard can be combined with bile salt interference check)
- Rinse Blank (RB, not linked to anything)
- Method blank
- LLCS

- LCS
- 10 samples: link to midpoint of ICAL
- CCV: link to midpoint of ICAL
- CCB
- 10 more samples: link to midpoint of ICAL
- CCV: link to midpoint of ICAL
- CCB
- Etc.
- At the end of the analysis batch, flush the system with >95%B to remove salt build-up.

10.12. Vortex all sample aliquots and standards prior to placing on the autosampler. Make sure there are no bubbles at the bottom on the conical vials.

10.13. Samples analyzed subsequent to any sample with results at or above the upper calibration limit must be evaluated for potential carryover, and corrective actions taken, as detailed below.

10.13.1. If carryover is suspected, those samples are to be re-analyzed from a fresh extract aliquot (i.e. go the archive of the extract).

10.13.2. Should there be instrument contamination, as evident by sample carryover, any sample >5X the UCL or instrument blanks with detections > RL:

- Analyze 20 blanks alternating between 1% formic acid/methanol and 1% formic acid/water.
- Then analyze 3 methanol only blanks.
- If the system is clean resume analyses. Proceed to 10.13.4. If not clean, proceed as directed below.

10.13.3. If the system is still contaminated the following items might need to be cleaned or replaced:

- Reverse flush the analytical column
- Reverse flush the isolation column
- Replace the column (isolation, analytical or both)
- Clean the cones/entry port
- Replace the PEEK tubing in the sample pathway
- Then, repeat 10.13.2.

10.13.4. Should a high-level sample be analyzed that triggers these steps then detections for those analytes over the next 2-3 days require additional evaluation (are all instrument blanks from the sequence < ½ RL) and possible re-analysis. If sample results replicate and the associated instrument blanks from the sequences are <1/2 RL then one can assume the system is under control and confirmation of positive detections can stop.

11. Calibration

11.1. For details of the calculations used to generate the regression equations, and how to use the factors generated by these equations, refer to NDSC-QA-QP44940 *Calibration Curves and Selection of Calibration Points*.

11.2. Routine instrument operating conditions are listed in the table in Section 6.21.

11.3. Instrument Tuning & Mass Calibration

11.3.1. Mass Calibration is performed by instrument manufacturer service representatives in accordance with the manufacturer's procedures during installation, and annually thereafter.

11.3.2. Instrument tuning is done initially when the method is first developed and thereafter as needed during troubleshooting. Tuning is done by infusing each individual compound (native and/or IDA) into the mobile phase using a tee fitting at a point just before the entrance to the electrospray probe. The responses for the parent and daughter ions for each compound are observed and optimized for sensitivity and resolution. Mass assignments are reviewed and updated as needed. The mass assignments must be within ± 0.2 amu of the values shown in the table in Section 10.11.

11.3.3. Once the optimal mass assignments (within ±0.2 amu of true) are made immediately following the initial tune, the lowest level standard from the initial calibration curve is assessed to ensure that a signal to noise ratio greater than 10 to 1 (S/N > 10:1) is achieved for each PFAS analyte. The first level standard from the initial calibration curve is used to evaluate the tune stability on an ongoing basis. The instrument mass windows are set initially at ± 0.2 amu of the true value; therefore, continued detection of the analyte transition with S/N > 10:1 serves as verification that the assigned mass remains within approximately ± 0.2 amu of the true value, which meets the tune criterion.

11.3.3.1. The instrument must have a valid mass calibration prior to sample analysis. This is verified through the acquisition of a full scan continuum mass spectrum of a PFAS stock standard. All masses must be verified to be within ± 0.2 amu of true value.

11.4. A new calibration curve must be generated after major changes to the system or when the continuing calibration criteria cannot be met. Major changes include, but are not limited to, new columns or pump seals. A new calibration is not required after minor maintenance.

11.5. With the exception of the circumstances delineated in policy NDSC-QA-QP44940 *Calibration Curves and Selection of Calibration Points*, it is not acceptable to remove points from a calibration curve. In any event, at least five points must be included in the calibration curve. Average Response Factor and linear fit calibrations require five points, whereas Quadratic (second order) calibrations require six points.

11.6. A fixed injection volume is used for quantitation purposes and is to be the same for both the sample and standards.

11.7. All units used in the calculations must be consistently uniform, such as concentration in ng/mL.

11.8. Initial Calibration

Refer to Section 12.4.2 for details relating to setting retention times and evaluating retention times.

11.8.1. A number of analytical standards of different analyte concentrations are used to generate the curve. Each standard is injected once to obtain the peak response for each analyte at each concentration. These standards define the working range of the analysis.

11.8.1.1. A minimum of six analytical standards is used when using average response factor and/or linear calibration fits, five of which must be ≥ RL.

11.8.1.2. A minimum of seven analytical standards is used when a quadratic fit is used to generate the curve, six of which must be ≥ RL.

11.8.2. Calibration is by average response factor, linear fit, or by quadratic fit. Quadratic fit is used for the analyte if the response is non-linear.

11.8.2.1. For average response factor (RFa), the relative standard deviation (RSD) for all compounds must be ≤ 20% for the curve to be valid.

11.8.2.2. Alternatively, for curve types including linear, quadratic, weighted or unweighted, the relative standard error (RSE) for all compounds must be ≤ 20% for the curve to be valid.

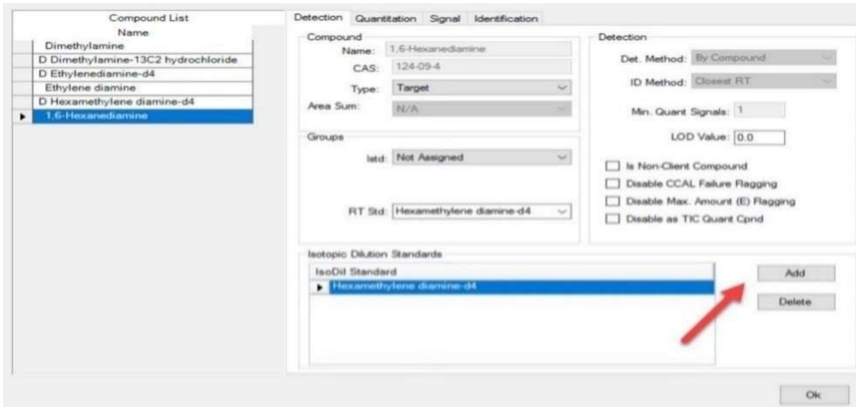
11.8.2.3. For linear fits, the intercept of the line must be less than ½ the reporting limit, and the relative standard error (RSE) must be ≤ 20%.

11.8.2.4. For quadratic fits, the intercept of the line must be less than ½ the reporting limit, and the relative standard error (RSE) must be ≤ 20%.

11.8.2.5. While not required by the method, the analyte readback should be 70-130% of the true value.

11.8.2.6. Please note for this method PFTrDA is quantitated against the average areas of the IDA 13C2-PFTeDA and 13C2-PFDoA. In order to set this quantitation up correctly in Chrom be certain to update the analyte PFTrDA per the example below (Figure 11.8.2.5).

Figure 11.8.2.5



11.9. Calibration Curve Fits

11.9.1. Linear regression or quadratic curves may be used to fit the data to a calibration function. Detailed descriptions and formulas for each fitting type can be found in NDSC-QA-QP44940.

11.9.2. The Chrom data system is programmed to complement the calibration evaluation guidelines in policy NDSC-QA-QP44940 by evaluating calibration curve fits in the order listed below. An optimal fit is recommended to the analyst, who may override based on evaluation of the residuals for each calibration level, as per policy NDSC-QA-QP44940.

- Average Response Factor
- Linear, 1/concentration^2 weighting
- Linear, 1/concentration weighting, forced through zero
- Quadratic, 1/concentration^2 weighting

11.9.3. The linear curve uses the following function:

Equation 3

$$y = bx + c$$

Where:

y	=	$\frac{Area\ (Analyte)}{Area\ (IDA)} \times Concentration(IDA)$
x	=	concentration
b	=	slope
c	=	intercept

11.9.4. The quadratic curve uses the following function:

Equation 4

$$y = ax^2 + bx + c$$

Where y, x, b, and c are the same as above, and a = curvature.

11.9.5. The functions for the linear 1/concentration weighting and linear 1/concentration^2 weighting curves can be found in the NDSC-QA-QP44940, Section 7.

11.9.5.1. Linear 1/concentration weighting, forced through zero

$$S^2 = \sum \frac{1}{x}(C_1 x + C_0 - y)^2 \qquad \text{Weighted sum of squares}$$

Regression equations:

$$\sum y = C_1 \sum x + n\, C_0$$

$$\sum y/x = n\, C_1 + C_0 \sum 1/x$$

Equation 5 Slope = C_1 $$C_1 = \frac{R_1}{R} = \frac{n \sum {}^{y}/_{x} - (\sum y)(\sum 1/x)}{n^2 - (\sum x)(\sum 1/x)}$$

Equation 6 Y- intercept = C_0 0

11.9.5.2 Linear 1/concentration^2 weighting, not forced through zero

$$S^2 = \sum \frac{1}{x^2}(C_1 x + C_0 - y)^2 \qquad \text{Weighted sum of squares}$$

Regression equations:

$$\sum \frac{y}{x} = (C_0 \sum \frac{1}{x}) + n\, C_1$$

$$\sum \frac{y}{x^2} = C_0 \sum \frac{1}{x^2} + C_1 \sum \frac{1}{x}$$

Equation 7 Slope = C_1 $$C_1 = \frac{R_1}{R} = \frac{(\sum \frac{1}{x})(\sum \frac{y}{x^2}) - (\sum \frac{y}{x})(\sum \frac{1}{x^2})}{(\sum \frac{1}{x})^2 - (\sum \frac{1}{x^2}) n}$$

Equation 8 Y- intercept = C_0 $$C_0 = \frac{R_0}{R} = \frac{(\sum \frac{y}{x})(\sum \frac{1}{x}) - n \sum \frac{y}{x^2}}{(\sum \frac{1}{x})^2 - (\sum \frac{1}{x^2})\, n}$$

11.9.6. Evaluation of Calibration Curves

The following requirements must be met for any calibration to be used:

- The signal to noise ratio for each analyte with quantifier/qualifier ions must be ≥ 3:1 in the lowest calibration standard for that component. For analytes with a quantifier ion only, the signal to noise ratio must be ≥ 10:1 in the lowest calibration standard.
- Response must increase with increasing concentration.
- The absolute value of the intercept of a regression line (linear or non-linear) at zero response must be less than the reporting limit.
- There should be no carryover at or above 1/2 MRL after a high ICAL standard.

If these criteria are not met, instrument conditions and standards will be checked, and the ICAL successfully repeated before continuing.

11.9.7. Weighting of Calibration Points

In linear and quadratic calibration fits, the points at the lower end of the calibration curve have less absolute variance than points at the high concentration end of the curve. This can cause severe errors in quantitation at the low end of the calibration. Because accuracy at the low end of the curve is very important for this analysis, it is preferable to increase the weighting of the lower concentration points. 1/concentration^2 or $1/x^2$ weighting is encouraged. Visual inspection of the line fitted to the data is important in selecting the best fit.

11.9.8. Bile Salts Interference Check

The laboratory must analyze a bile salts standard (TDCA, {TCDA and TUDCA only if the eluent is not acetonitrile}) after the initial calibration, prior to the analysis of samples and any time when DoD samples are analyzed, to check for interferences caused by bile salts. If an interference is present, the chromatographic conditions must be modified to eliminate the interference of TDCA (e.g. changing the retention time of TDCA such that it falls outside the retention time window for PFOS by more than 60 seconds with baseline resolution), and the initial calibration is repeated.

11.9.8.1. The check is required daily for all matrices when analyzing DoD/DOE QSM samples.

11.10. Initial Calibration Blank (ICB)

11.10.1. Immediately following the ICAL, a calibration blank is analyzed that consists of an injection of final extract solvent containing both IDA and IS.

11.10.2. The result for the calibration blank must be less than the MDL.

11.10.3. If the ICB is greater than the MDL then the source of contamination must be identified and any necessary cleaning completed, and then the instrument should be recalibrated.

11.11. Initial Calibration Verification (ICV)

11.11.1. Following the ICAL and the ICB, an ICV standard obtained from a different source or vendor than the ICAL standards is analyzed. This ICV standard is a mid-range standard.

11.11.2. The recovery for the ICV must be equal to or within 70-130% for all natives and IDA.

11.11.3. See Section 9.11 for corrective actions in the event that the ICV does not meet the criteria above.

11.12. Continuing Calibration Verification (CCV)

Analyze a CCV at the beginning of a run, the end of a run, and after every 10 samples to determine if the calibration is still valid. The exception is after an acceptable curve and ICV are run 10 samples can be analyzed before a CCV is required. The CCVs are at the mid-level range of the curve. The curve and ICV do not need to be run every day. To start an analytical sequence on days when an

ICAL is not performed, a CCVL (low standard at the RL) is analyzed and if it meets acceptance criteria a run can be started.

11.12.1. The recovery for the CCV standards must be equal to or within 70-130% for all natives and IDA.

11.12.2. If the analyte in a CCV fails due to a high recovery, but that analyte is not detected in the sample extract, then the sample can be reported with an NCM stating the high bias and sample is ND.

11.12.3. If this is not achieved, the instrument has drifted outside the calibration limits. The instrument must be recalibrated.

12. Calculations / Data Reduction

12.1. If the concentration of the analyte ions exceeds the working range as defined by the calibration standards, then the sample might require to be diluted and reanalyzed, based upon client need. It may be necessary to dilute samples due to matrix.

Dilute a subsample of the sample extract with methanolic ammonium hydroxide and acetic acid solution from Section 7.1.13 by a factor no greater than 10x and analyze the diluted extract.

12.2. Extracts can be diluted up to no more than 10X without diluting out the IDA, in most cases, and thus preserving quantitation via isotope dilution. IDA recovery must be >5% in the dilution. Use the IDA recoveries in the undiluted analysis to select the dilution factor, with the objective of keeping the IDA recoveries in the dilution above the 5% lower limit.

12.2.1. For example, if the IDA recovery for the affected analyte in the undiluted analysis is 50%, then the extract cannot be diluted more than 10X. If the IDA recovery of the affected analyte in the undiluted analysis is 30%, then the extract cannot be diluted more than 6X.

12.2.2. If the IDA response in the dilution is < 10:1 signal to noise or RT is off then the sample is to be re-extracted at a smaller aliquot.

12.2.3. If a dilution greater than 10X is needed, then the sample should be re-extracted at a smaller aliquot.

12.2.4. If a dilution is required, report the 1X data, including IDA, as primary data, and analyte of interest and associated IDA only from the dilution as secondary data.

12.2.5. If the response of the IDA in the diluted extract meets the S/N and retention time requirements and the IDA recovery is > 5%, then the compounds associated with the IDA can be used to quantify the target analytes

12.2.6. If the IDA recovery in the diluted extract does not met the requirements, then the compound cannot be measured by isotope dilution. The laboratory must take a smaller aliquot of the aqueous sample and dilute it to 500 mL with reagent water or smaller aliquot of solid sample and re-extract. Adjust compound concentration and detection limit to account for dilution.

12.3. Results less than the reporting limit are flagged in the client report as estimated. Generally, the "J" flag is used to denote ≥ MDL and ≤ RL, but the specific flag may change based on client requirements.

12.4. Qualitative Identification

12.4.1. The retention times of PFAS with labeled standards should be the same as that of the labeled IDA's to within 0.1 min. For PFAS with no labeled standards, the RT must be within ± 0.4 minutes of the ICAL or the most recent CCV standard.

Note: The IDA RT and native RT may be offset by 0.02 to 0.04 minutes.

PFBS, PFHxS, PFOS, Me-FOSAA, and Et-FOSAA have multiple chromatographic peaks using the LC conditions specified in the method due to the linear and branch isomers of these compounds. Most PFAS compounds are manufactured by one of two processes, ECF or fluorotelomerization. One gives rise to linear PFAS only while the other process produces both linear and branched isomers. Both branched and linear PFAS compounds can potentially be found in the environment. For the aforementioned compounds that give rise to more than one peak, all chromatographic peaks observed in the standard must be integrated and the areas totaled. Chromatographic peaks in the sample must be integrated in the same way as the calibration standard and concentrations reported as a total for each of these analytes.

12.4.2. The expected retention times (RT) are established in the Chrom data processing module during the processing of the ICAL by selecting Edit>Method>Update RT. Once the retention times are established Chrom will look for a peak within ± 0.25 minutes of the RT. The analyst confirms that the branched isomers present in the quantitative calibration standards for PFOS, PFHxS, Et-FOSAA and Me-FOSAA are within the ± 0.25 minute window. If they are not, an adjustment to the RT window is made. The analyst confirms the presence of the branched isomers in the technical (qualitative) standard as well and adjusts the RT window for an analyte if it is not present within the ± 0.25 minute window.

12.4.2.1. If a peak is detected within this window of ±0.25 minutes, Chrom will assign the absolute retention time at the apex of the peak. Chrom assigns the RT to the most predominant peak within this window. As the linear peak is the predominant peak in calibration solutions for those PFAS that are calibrated with the combination of both branched and linear isomers, those PFAS require additional evaluation in the event that the branched isomer is the predominant peak in a field sample and Chrom has not positively identified the peak due to the RT shift, as the apex may now be the branched isomer.

12.4.2.2. Additional evaluation is required if the field samples contain branched isomers not present in the quantitative or qualitative standards. The analyst confirms that only the peaks present in the calibration standards are included in the peak integration, or adjusts the peak integration to assure that only the peaks present in the standards are identified and quantitated.

12.4.2.3. RT are updated as needed based upon evaluation of the daily CCV.

12.4.3. The signal to noise ratio for both quantitative and qualitative ions/transitions must be ≥ 3:1 or > 10:1 if the analyte only has a single transition for a baseline deflection to be considered a peak. If this criterion is not met, the analyte is not considered and reported as "non-detect".

12.5. The ICAL established in Section 11 is used to calculate concentrations for the extracts.

12.6. Extract concentrations are calculated as below. The first equation applies Average Response Factor model, the second to a linear fit, and the third to the quadratic line fit.

Equation 9

$$Concentration\ (ng/mL) = \frac{y}{RRF}$$

Equation 10

$$Concentration\ (ng/mL) = \frac{y-c}{b}$$

Equation 11

$$Concentration\ (ng/mL) = \frac{-b \pm \sqrt{b^2-4ac-}}{2a}$$

Where:

y = $\frac{Area_{Target}}{Area_{IDA}} \times Concentration(IDA)$
RRF = Relative Response Factor
x = concentration
a = curvature
b = slope
c = intercept

12.7. Water Sample Result Calculation:

Equation 12

$$Concentration\ (ng/L) = \frac{C_{ex}V_t}{V_0}$$

Where:

C_{ex} = Concentration measured in sample extract (ng/mL)
V_t = Volume of total extract (mL)
V_o = Volume of water extracted (L), i.e. total volume fortified with IDA

12.8. Soil Sample Result Calculation:

Equation 13 $$Concentration\ (ng/g) = \frac{C_{ex}V_t}{W_s D}$$

Where ng/g = µg/kg and:

C_{ex}	=	Concentration measured in sample extract (ng/mL)
V_t	=	Volume of total extract (mL)
W_s	=	Weight of sample extracted (g)
D	=	Fraction of dry solids, which is calculated as follows:
		$\frac{100-\%\ moisture\ in\ samp}{100}$ (for dry weight result)

12.9. IDA Recovery Calculation:

Equation 14 $$\%\ Recovery = \frac{A_{IDA}Q_{IS}}{A_{IS}Q_{IDA}RRF_{IDA}} \times 100$$

Where:

RRF_{IDA}	=	Response Factor for IDA compound
A_{IDA}	=	Area response for IDA compound
A_{IS}	=	Area Response for IS compound
Q_{IS}	=	Amount of IS added
Q_{IDA}	=	Amount of IDA added

12.10. Raw data, calibration summaries, QC data, and sample results are reviewed by the analyst. These must also be reviewed thoroughly by a second qualified person. See the Data Review Policy (DV-QA-0020). These reviews are documented in TALS.

13. Method Performance

13.1. The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required expertise.

13.2. Method Detection Limit

The laboratory must generate a valid method detection limit for each analyte of interest. The MDL must be below the reporting limit for each analyte. The procedure for determination of the method detection limit is given in 40 CFR Part 136, Appendix B, and further defined in SOP NDSC-QA-SOP-42091 “Detection and Quantitation Limits” and policy DV-QA-003P *Quality Control Program*. MDLs are available in the Quality Assurance Department.

13.3. Initial Demonstration of Capability (IDOC)

13.3.1. The method initial demonstration of capability is performed by processing 4 LCS samples and a method blank. Compare the average recovery and RSD to the IPR limits in Table 5 of the reference method.

13.3.2. Each analyst performing this procedure must successfully analyze four LCS QC samples using current laboratory LCS control limits in the LIMS. IDOCs are approved by the Quality Assurance Manager and the Technical Director. IDOC records are maintained by the QA staff in the central training files.

14. Pollution Prevention

14.1. All waste will be disposed of in accordance with Federal, State and Local regulations.

14.2. Solid phase extraction used for water samples greatly reduces the amount of solvent used compared to liquid-liquid extraction.

14.3. Standards and reagents are purchased and prepared in volumes consistent with laboratory use to minimize the volume of expired standards and reagents requiring disposal.

14.4. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in Section 13 of the NDSC Safety Manual for “Waste Management and Pollution Prevention.”

14.5. Do not allow waste solvent to vent into the hoods. All solvent waste is stored in capped containers unless waste is being transferred.

14.6. Transfer waste solvent from collection cups (tri-pour and similar containers) to jugs and/or carboys as quickly as possible to minimize evaporation.

15. Waste Management

The following waste streams are produced when this method is carried out:

15.1. All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in the Environmental Health and Safety Manual, and DV-HS-001P *Waste Management Plan.*

15.2. The following waste streams are produced when this method is carried out:

15.2.1. Methanol waste – Flammable Solvent (C)

15.2.2. Water Samples, post extraction and all other aqueous waste generated by this procedure is collected and turned into the Waste Coordinator for incineration under waste stream PFOA.

15.2.3. Soil samples, post extraction and all other solid waste generate by this procedure such as disposable pipette tips and extraction bottles are collected and turned into the Waste coordinator for incineration under waste stream PFOA.

15.2.4. Vial waste – Collect in PFC waste containers

15.2.5. Instrument process waste – Flammable Solvent (C)

15.2.6. Expired Chemicals/Reagents/Standards – Contact Waste Coordinator.

NOTE: Radioactive and potentially radioactive or mixed waste must be segregated from non-radioactive waste as appropriate. Contact the Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

16. References

16.1. Draft Method 1633 – Analysis of Per- and Polyfluroalkyl Substances (PFAS) in Aqueous, Solid, Biosolids and Tissue Samples by LC-MS/MS, August 2021.

16.2. 2nd Draft Method 1633 – Analysis of Per- and Polyfluroalkyl Substances (PFAS) in Aqueous, Solid, Biosolids and Tissue Samples by LC-MS/MS, June 2022.

16.3. 3rd Draft Method 1633 – Analysis of Per- and Polyfluroalkyl Substances (PFAS) in Aqueous, Solid, Biosolids and Tissue Samples by LC-MS/MS, December 2022.

17. Method Modifications

17.1. Modifications from Method 1633 are detailed below:

17.1.1. An SPE cartridge with 200 mg of WAX and 50 mg of carbon is used for water extraction and solid matrices clean up. As a result solvents and elution procedures are different.

17.1.2. The CCVL (ISC) will be used to start the analytical sequence on non-ICAL days and is to meet both S/N (3:1 or 10:1) and CCV acceptance criteria.

17.1.3. The corrective action to be taken in the event of clogging occurring in the SPE columns that is described in Section 10.3.6.1 is in lieu of using a second SPE cartridge as described in the reference method unless required by a client.

17.1.4. Immediately following the loading of aqueous samples onto the SPE columns, sample bottles are rinsed with reagent water, and the reagent water added to the column reservoir. This step is addition to the basic methanol rinse as part of the SPE elution step.

17.1.5. 10 mM Ammonium acetate in 95/5 Water/Acetonitrile is used for the aqueous mobile phase. Since the laboratory is at elevation (5,344 ft/1629 m), ammonium acetate, a volatile buffer, volatilizes at a faster rate which leads to unstable retention times PFCAs and PFSAs.

17.1.6. Percent solids in aqueous samples is determined by visual comparison to a reference sample that contains 50 mg of solid material (carbon). If samples are more turbid the extracted volume is reduced or the sample is processed as a solid based upon consultation with the client.

17.1.7. Remove N2 Blow down set, instead bring sample volume to 250 mL prior to SPE Extraction

18. ATTACHMENTS

Attachment 1: Splitting biphasic samples (by client request only)

19. REVISION HISTORY

This section has been added beginning with Revision 0. Only details of the last two revisions are incorporated into this SOP. Prior revisions are documented in the QA files and available upon request.

- Revision 1, dated 24 May 2023
  - Updated entire document to reflect the 3rd draft of EPA Method 1633
  - Change IDA to EIS throughout the document
  - Table 1.1 updated compound names for consistency
  - Table 1.2 & Table 8 updated sample matrix, sample size, and holding time requirements
  - Added additional branched isomers to Section 4.5, 7.2.2
  - Added use of filtering syringe
  - Removed average weight of bottles in section 6.3
  - Section 6.0, 6.8.2: Updated cartridge information, Added vacuum (6.12), oven (6.18), pre-weighted filters (6.19), HPLC information (6.20), maintenance schedule (6.21)
  - Section 7.1.5 updated formic acid use for clarity
  - Section 7.2.1 added expiration date of 1 year for stocks and working solutions.
  - Section 7.7.2 Qualitative standards reduced to PFOA and PFNA only. Other analytes are incorporated in the calibration solution.
  - Updated stock and working solutions in sections 7.3 through 7.7
  - Table 8. Added statement regarding samples between 3-30% solids
  - Section 8.3 added section regarding TSS screening and procedures
  - Section 9.4.1.6, batch QC does not need to be rotated if new liners and clean reservoirs are used.
  - Section 9.5.1 & 9.6.1 reference to 3rd Draft
  - Section 9.7 added laboratory duplicate criteria
  - Section 9.9 added criteria for LCSD if MS/MSD or Du are not present.
  - Section 9.13: added transition for PFPeA
  - Section 9.14.1 updated NIS criteria per the 3rd draft
  - Section 10:
  - Water extraction: added TSS criteria (10.2.1), screening criteria (10.2.2), bottle type (10.2.3.1), moved pH check before sample spiking (10.2.5), spike names/references (10.2.7-10), glass wool (10.3.1), HPLC water (10.3.4), batch qc position in manifold (10.3.5), clog flow rate (10.3.6), dry cartridge time (10.3.9), air bubbles (10.5.9)
  - Solid extraction: sample volume adjustment due to failing QC (10.6.2.1), spike names/references (10.6.5-8), moved graphitized carbon extraction (10.6.20-23), bring sample volume to 250 mL prior to SPE (10.6.24), batch qc position in manifold (10.7.5), dry cartridge time (10.7.9)
  - Instrument analysis: injection volume (10.11), flush after run (10.11)
  - Updated CE for PFOA (Table 10.11-3)
  - Section 11: %RSE is used for linear, quadratic, weighted or unweighted regressions (11.8.2.2), read-back optional (11.8.2.5), signal-to-noise for quantifier ion only (11.9.6, 12.4.3), bile acids and acetonitrile only (11.9.8), instrument blank < MDL (11.10.3)
  - Added draft 3 to references (16.3)

- Revision 1, dated 14 October 2022
    - Changed Eurofins TestAmerica to Eurofins Denver throughout.
    - Updated section 11.9.5 to include weighting equations 4 through 7.
    - Updated Table 8 to include footnote.
    - Section 11.2 updated table to Section 6.18.
    - Section 11.3.2 updated mass resolution to 0.2 amu.
    - Section 11.3.3 updated mass resolution to 0.2 amu.
    - Updated section 11.3.2 to refer to table in section 10.11.
    - Updated Tables in section 10.11 to rename table from 10.12 to 10.11.

ATTACHMENT 1:
SPLITTING BIPHASIC SAMPLES (BY CLIENT REQUEST ONLY)

Samples that contain 3-30% solids may require splitting prior to analysis. Check with the PM on which matrix to extract per the client request. If both matrices require extraction, the sample will be split first, then spiked with EIS and extracted. The client shall provide two Client Sample IDs.

1. Weight the whole bottle and record the weight directly onto the bottle. Using the Login module, add an NCM (“Other- Observation”) that states sample was split into aqueous and solid fraction and record the initial whole bottle weight.
2. Centrifuge the whole bottle for 20 minutes at 35% using the large buckets that hold 500 mL bottles
3. Label a clean new 500 mL HPDE bottle with the Aqueous Sample ID
4. Carefully decant the aqueous layer from the solid in the bottle. Write the whole bottle weight onto the new 500 mL bottle.
5. If analyzing aqueous, check that the sample is logged for 1633_DRAFT_TSS and 1633_SPE
    a. Record the weight of the aqueous only fraction in TALS as a NCM. Do not adjust the volume.
6. If analyzing solids, check that the sample is logged for %Moisture and 1633_Shake
    a. Leave remaining volume in original container.
7. Proceed with **Section 10.2** for water extraction or **Section 10.6** for biosolid extraction.

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Department of Environmental Conservation

SAMPLING, ANALYSIS, AND ASSESSMENT OF PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS)

Under NYSDEC's Part 375 Remedial Programs

April 2023

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ERRATA SHEET for

SAMPLING, ANALYSIS, AND ASSESSMENT OF PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) Under NYSDEC's Part 375 Remedial Programs Issued January 17, 2020

Citation and Page Number	Current Text	Corrected Text	Date
Title of Appendix I, page 32	Appendix H	Appendix I	2/25/2020
Document Cover, page 1	Guidelines for Sampling and Analysis of PFAS	Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS) Under NYSDEC's Part 375 Remedial Programs	9/15/2020
Data Assessment and Application to Site Cleanup Page 3	Until such time as Ambient Water Quality Standards (AWQS) and Soil Cleanup Objectives (SCOs) for PFOA and PFOS are published	Until such time as Soil Cleanup Objectives (SCOs) for PFOA and PFOS are published	3/28/2023
Water Sample Results Page 3	PFOA and PFOS should be further assessed and considered as potential contaminants of concern in groundwater or surface water if PFOA or PFOS is detected in any water sample at or above 10 ng/L (ppt) and is determined to be attributable to the site, either by a comparison of upgradient and downgradient levels, or the presence of soil source areas, as defined below.	NYSDEC has adopted ambient water quality guidance values for PFOA and PFOS. Groundwater samples should be compared to the human health criteria of 6.7 ng/l (ppt) for PFOA and 2.7 ng/l (ppt) for PFOS. These guidance values also include criteria for surface water for PFOS applicable for aquatic life, which may be applicable at some sites. Drinking water sample results should be compared to the NYS maximum contaminant level (MCL) of 10 ng/l (ppt).Analysis to determine if PFOA and PFOS concentrations are attributable to the site should include a comparison between upgradient and downgradient levels, and the presence of soil source areas, as defined below.	3/28/2023
Soil Sample Results Page 3	Soil cleanup objectives for PFOA and PFOS have been proposed in an upcoming revision to 6 NYCRR Part 375-6. Until SCOs are in effect, the following are to be used as guidance values:	NYSDEC will delay adding soil cleanup objectives for PFOA and PFOS to 6 NYCRR Part 375-6 until the PFAS rural soil background study has been completed. Until SCOs are in effect, the following are to be used as guidance values:	3/28/2023
Protection of Groundwater Page 3	PFOA (ppb) 1.1 PFOS (ppb) 3.7	PFOA (ppb) 0.8 PFOS (ppb) 1.0	3/28/2023

Citation and Page Number	Current Text	Corrected Text	Date
Footnote 2 Page 3	The movement of PFAS in the environment is being aggressively researched at this time; that research will eventually result in more accurate models for the behaviors of these chemicals. In the meantime, DEC has calculated the guidance value for the protection of groundwater using the same procedure used for all other chemicals, as described in Section 7.7 of the Technical Support Document (http://www.dec.ny.gov/docs/remediation_hudson_pdf/techsuppdoc.pdf).	The Protection of Groundwater values are based on the above referenced ambient groundwater guidance values. Details on that calculation are available in the following document, prepared for the February 2022 proposed changes to Part 375 (https://www.dec.ny.gov/docs/remediation_hudson_pdf/part375techsupport.pdf). The movement of PFAS in the environment is being aggressively researched at this time; that research will eventually result in more accurate models for the behaviors of these chemicals. In the meantime, DEC has calculated the guidance value for the protection of groundwater using the same procedure used for all other chemicals, as described in Section 7.7 of the Technical Support Document (http://www.dec.ny.gov/docs/remediation_hudson_pdf/techsuppdoc.pdf).	3/28/2023
Testing for Imported Soil Page 4	If the concentrations of PFOA and PFOS in leachate are at or above 10 ppt (the Maximum Contaminant Levels established for drinking water by the New York State Department of Health), then the soil is not acceptable.	If the concentrations of PFOA and PFOS in leachate are at or above the ambient water quality guidance values for groundwater, then the soil is not acceptable.	3/28/2023
Routine Analysis, page 9	"However, laboratories analyzing environmental samples…PFOA and PFOS in drinking water by EPA Method 537, 537.1 or ISO 25101."	"However, laboratories analyzing environmental samples…PFOA and PFOS in drinking water by EPA Method 537, 537.1, ISO 25101, or Method 533."	9/15/2020
Additional Analysis, page 9, new paragraph regarding soil parameters	None	"In cases where site-specific cleanup objectives for PFOA and PFOS are to be assessed, soil parameters, such as Total Organic Carbon (EPA Method 9060), soil pH (EPA Method 9045), clay content (percent), and cation exchange capacity (EPA Method 9081), should be included in the analysis to help evaluate factors affecting the leachability of PFAS in site soils."	9/15/2020

Citation and Page Number	Current Text	Corrected Text	Date
Data Assessment and Application to Site Cleanup Page 10	Until such time as Ambient Water Quality Standards (AWQS) and Soil Cleanup Objectives (SCOs) for PFAS are published, the extent of contaminated media potentially subject to remediation should be determined on a case-by-case basis using the procedures discussed below and the criteria in DER-10. Target levels for cleanup of PFAS in other media, including biota and sediment, have not yet been established by the DEC.	Until such time as Ambient Water Quality Standards (AWQS) and Soil Cleanup Objectives (SCOs) for PFOA and PFOS are published, the extent of contaminated media potentially subject to remediation should be determined on a case-by-case basis using the procedures discussed below and the criteria in DER-10. Preliminary target levels for cleanup of PFOA and PFOS in other media, including biota and sediment, have not yet been established by the DEC.	9/15/2020
Water Sample Results Page 10	PFAS should be further assessed and considered as a potential contaminant of concern in groundwater or surface water (…) If PFAS are identified as a contaminant of concern for a site, they should be assessed as part of the remedy selection process in accordance with Part 375 and DER-10.	PFOA and PFOS should be further assessed and considered as potential contaminants of concern in groundwater or surface water (…) If PFOA and/or PFOS are identified as contaminants of concern for a site, they should be assessed as part of the remedy selection process in accordance with Part 375 and DER-10.	9/15/2020

Citation and Page Number	Current Text	Corrected Text	Date
Soil Sample Results, page 10	“The extent of soil contamination for purposes of delineation and remedy selection should be determined by having certain soil samples tested by Synthetic Precipitation Leaching Procedure (SPLP) and the leachate analyzed for PFAS. Soil exhibiting SPLP results above 70 ppt for either PFOA or PFOS (individually or combined) are to be evaluated during the cleanup phase.”	“Soil cleanup objectives for PFOA and PFOS will be proposed in an upcoming revision to 6 NYCRR Part 375-6. Until SCOs are in effect, the following are to be used as guidance values. “ [Interim SCO Table] “PFOA and PFOS results for soil are to be compared against the guidance values listed above. These guidance values are to be used in determining whether PFOA and PFOS are contaminants of concern for the site and for determining remedial action objectives and cleanup requirements. Site-specific remedial objectives for protection of groundwater can also be presented for evaluation by DEC. Development of site-specific remedial objectives for protection of groundwater will require analysis of additional soil parameters relating to leachability. These additional analyses can include any or all the parameters listed above (soil pH, cation exchange capacity, etc.) and/or use of SPLP. As the understanding of PFAS transport improves, DEC welcomes proposals for site-specific remedial objectives for protection of groundwater. DEC will expect that those may be dependent on additional factors including soil pH, aqueous pH, % organic carbon, % Sand/Silt/Clay, soil cations: K, Ca, Mg, Na, Fe, Al, cation exchange capacity, and anion exchange capacity. Site-specific remedial objectives should also consider the dilution attenuation factor (DAF). The NJDEP publication on DAF can be used as a reference: https://www.nj.gov/dep/srp/guidance/rs/daf.pdf. ”	9/15/2020

Citation and Page Number	Current Text	Corrected Text	Date
Testing for Imported Soil Page 11	Soil imported to a site for use in a soil cap, soil cover, or as backfill is to be tested for PFAS in general conformance with DER-10, Section 5.4(e) for the PFAS Analyte List (Appendix F) using the analytical procedures discussed below and the criteria in DER-10 associated with SVOCs. If PFOA or PFOS is detected in any sample at or above 1 µg/kg, then soil should be tested by SPLP and the leachate analyzed for PFAS. If the SPLP results exceed 10 ppt for either PFOA or PFOS (individually) then the source of backfill should be rejected, unless a site-specific exemption is provided by DER. SPLP leachate criteria is based on the Maximum Contaminant Levels proposed for drinking water by New York State's Department of Health, this value may be updated based on future Federal or State promulgated regulatory standards. Remedial parties have the option of analyzing samples concurrently for both PFAS in soil and in the SPLP leachate to minimize project delays. Category B deliverables should be submitted for backfill samples, though a DUSR is not required.	Testing for PFAS should be included any time a full TAL/TCL analyte list is required. Results for PFOA and PFOS should be compared to the applicable guidance values. If PFOA or PFOS is detected in any sample at or above the guidance values then the source of backfill should be rejected, unless a site-specific exemption is provided by DER based on SPLP testing, for example. If the concentrations of PFOA and PFOS in leachate are at or above 10 ppt (the Maximum Contaminant Levels established for drinking water by the New York State Department of Health), then the soil is not acceptable. PFOA, PFOS and 1,4-dioxane are all considered semi-volatile compounds, so composite samples are appropriate for these compounds when sampling in accordance with DER-10, Table 5.4(e)10. Category B deliverables should be submitted for backfill samples, though a DUSR is not required.	9/15/2020

Citation and Page Number	Current Text	Corrected Text	Date
Footnotes	None	[1] TOP Assay analysis of highly contaminated samples, such as those from an AFFF (aqueous film-forming foam) site, can result in incomplete oxidation of the samples and an underestimation of the total perfluoroalkyl substances. [2] The movement of PFAS in the environment is being aggressively researched at this time; that research will eventually result in more accurate models for the behaviors of these chemicals. In the meantime, DEC has calculated the soil cleanup objective for the protection of groundwater using the same procedure used for all other chemicals, as described in Section 7.7 of the Technical Support Document (http://www.dec.ny.gov/docs/remediation_hudson_pdf/techsuppdoc.pdf).	9/15/2020
Additional Analysis, page 9	In cases… soil parameters, such as Total Organic Carbon (EPA Method 9060), soil…	In cases… soil parameters, such as Total Organic Carbon (Lloyd Kahn), soil…	1/8/2021
Appendix A, General Guidelines, fourth bullet	List the ELAP-approved lab(s) to be used for analysis of samples	List the ELAP- certified lab(s) to be used for analysis of samples	1/8/2021
Appendix E, Laboratory Analysis and Containers	Drinking water samples collected using this protocol are intended to be analyzed for PFAS by ISO Method 25101.	Drinking water samples collected using this protocol are intended to be analyzed for PFAS by EPA Method 537, 537.1, 533, or ISO Method 25101	1/8/2021
Water Sample Results Page 9	"In addition, further assessment of water may be warranted if either of the following screening levels are met: a. any other individual PFAS (not PFOA or PFOS) is detected in water at or above 100 ng/L; or b. total concentration of PFAS (including PFOA and PFOS) is detected in water at or above 500 ng/L"	Deleted	6/15/2021

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Citation and Page Number	Current Text	Corrected Text	Date
Routine Analysis, Page XX	Currently, New York State Department of Health's Environmental Laboratory Approval Program (ELAP)… criteria set forth in the DER's laboratory guidelines for PFAS in non-potable water and solids (Appendix H - Laboratory Guidelines for Analysis of PFAS in Non-Potable Water and Solids).	Deleted	5/31/2022
Analysis and Reporting, Page XX	As of October 2020, the United States Environmental Protection Agency (EPA) does not have a validated method for analysis of PFAS for media commonly analyzed under DER remedial programs (non-potable waters, solids). DER has developed the following guidelines to ensure consistency in analysis and reporting of PFAS.	Deleted	5/31/2022
Routine Analysis, Page XX	LC-MS/MS analysis for PFAS using methodologies based on EPA Method 537.1 is the procedure to use for environmental samples. Isotope dilution techniques should be utilized for the analysis of PFAS in all media.	EPA Method 1633 is the procedure to use for environmental samples.	
Soil Sample Results, Page XX	Soil cleanup objectives for PFOA and PFOS will be proposed in an upcoming revision to 6 NYCRR Part 375-6	Soil cleanup objectives for PFOA and PFOS have been proposed in an upcoming revision to 6 NYCRR Part 375-6	
Appendix A	"Include in the text… LC-MS/MS for PFAS using methodologies based on EPA Method 537.1"	"Include in the text ….EPA Method 1633"	
Appendix A	"Laboratory should have ELAP certification for PFOA and PFOS in drinking water by EPA Method 537, 537.1, EPA Method 533, or ISO 25101"	Deleted	
Appendix B	"Samples collected using this protocol are intended to be analyzed for PFAS using methodologies based on EPA Method 537.1"	"Samples collected using this protocol are intended to be analyzed for PFAS using EPA Method 1633"	

Citation and Page Number	Current Text	Corrected Text	Date
Appendix C	"Samples collected using this protocol are intended to be analyzed for PFAS using methodologies based on EPA Method 537.1"	"Samples collected using this protocol are intended to be analyzed for PFAS using EPA Method 1633"	
Appendix D	"Samples collected using this protocol are intended to be analyzed for PFAS using methodologies based on EPA Method 537.1"	"Samples collected using this protocol are intended to be analyzed for PFAS using EPA Method 1633"	
Appendix G		Updated to include all forty PFAS analytes in EPA Method 533	
Appendix H		Deleted	
Appendix I	Appendix I	Appendix H	
Appendix H	"These guidelines are intended to be used for the validation of PFAS analytical results for projects within the Division of Environmental Remediation (DER) as well as aid in the preparation of a data usability summary report."	"These guidelines are intended to be used for the validation of PFAS using EPA Method 1633 for projects within the Division of Environmental Remediation (DER)."	
Appendix H	"The holding time is 14 days…"	"The holding time is 28 days…"	
Appendix H, Initial Calibration	"The initial calibration should contain a minimum of five standards for linear fit…"	"The initial calibration should contain a minimum of six standards for linear fit…"	
Appendix H, Initial Calibration	Linear fit calibration curves should have an R^2 value greater than 0.990.	Deleted	
Appendix H, Initial Calibration Verification	Initial Calibration Verification Section	Deleted	
Appendix H	secondary Ion Monitoring Section	Deleted	
Appendix H	Branched and Linear Isomers Section	Deleted	

Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS) Under NYSDEC's Part 375 Remedial Programs

Objective

New York State Department of Environmental Conservation's Division of Environmental Remediation (DER) performs or oversees sampling of environmental media and subsequent analysis of PFAS as part of remedial programs implemented under 6 NYCRR Part 375. To ensure consistency in sampling, analysis, reporting, and assessment of PFAS, DER has developed this document which summarizes currently accepted procedures and updates previous DER technical guidance pertaining to PFAS.

Applicability

All work plans submitted to DEC pursuant to one of the remedial programs under Part 375 shall include PFAS sampling and analysis procedures that conform to the guidelines provided herein.

As part of a site investigation or remedial action compliance program, whenever samples of potentially affected media are collected and analyzed for the standard Target Analyte List/Target Compound List (TAL/TCL), PFAS analysis should also be performed. Potentially affected media can include soil, groundwater, surface water, and sediment. Based upon the potential for biota to be affected, biota sampling and analysis for PFAS may also be warranted as determined pursuant to a Fish and Wildlife Impact Analysis. Soil vapor sampling for PFAS is not required.

Field Sampling Procedures

DER-10 specifies technical guidance applicable to DER's remedial programs. Given the prevalence and use of PFAS, DER has developed "best management practices" specific to sampling for PFAS. As specified in DER-10 Chapter 2, quality assurance procedures are to be submitted with investigation work plans. Typically, these procedures are incorporated into a work plan, or submitted as a stand-alone document (e.g., a Quality Assurance Project Plan). Quality assurance guidelines for PFAS are listed in Appendix A - Quality Assurance Project Plan (QAPP) Guidelines for PFAS.

Field sampling for PFAS performed under DER remedial programs should follow the appropriate procedures outlined for soils, sediments, or other solids (Appendix B), non-potable groundwater (Appendix C), surface water (Appendix D), public or private water supply wells (Appendix E), and fish tissue (Appendix F).

QA/QC samples (e.g. duplicates, MS/MSD) should be collected as specified in DER-10, Section 2.3(c). For sampling equipment coming in contact with aqueous samples only, rinsate or equipment blanks should be collected. Equipment blanks should be collected at a minimum frequency of one per day per site or one per twenty samples, whichever is more frequent.

Analysis and Reporting

The investigation work plan should describe analysis and reporting procedures, including laboratory analytical procedures for the methods discussed below. As specified in DER-10 Section 2.2, laboratories should provide a full Category B deliverable. In addition, a Data Usability Summary Report (DUSR) should be prepared by an independent, third-party data validator. Electronic data submissions should meet the requirements provided at: https://www.dec.ny.gov/chemical/62440.html.

DER has developed a *PFAS Analyte List* (Appendix G) for remedial programs to understand the nature of contamination at sites. It is expected that reported results for PFAS will include, at a minimum, all the compounds listed. If lab and/or matrix specific issues are encountered for any analytes, the DER project manager, in consultation with the DER chemist, will make case-by-case decisions as to whether certain analytes may be temporarily or permanently discontinued from analysis at each site. As with other contaminants that are analyzed for at a site, the *PFAS Analyte List* may be refined for future sampling events based on investigative findings.

Routine Analysis

EPA Method 1633 is the procedure to use for environmental samples. Reporting limits for PFOA and PFOS in aqueous samples should not exceed 2 ng/L. Reporting limits for PFOA and PFOS in solid samples should not exceed 0.5 µg/kg. Reporting limits for all other PFAS in aqueous and solid media should be as close to these limits as possible. If laboratories indicate that they are not able to achieve these reporting limits for the entire *PFAS Analyte List*, site-specific decisions regarding acceptance of elevated reporting limits for specific PFAS can be made by the DER project manager in consultation with the DER chemist. Data review guidelines were developed by DER to ensure data comparability and usability (Appendix H - Data Review Guidelines for Analysis of PFAS in Non-Potable Water and Solids).

Additional Analysis

Additional laboratory methods for analysis of PFAS may be warranted at a site, such as the Synthetic Precipitation Leaching Procedure (SPLP) and Total Oxidizable Precursor Assay (TOP Assay).

In cases where site-specific cleanup objectives for PFOA and PFOS are to be assessed, soil parameters, such as Total Organic Carbon (Lloyd Kahn), soil pH (EPA Method 9045), clay content (percent), and cation exchange capacity (EPA Method 9081), should be included in the analysis to help evaluate factors affecting the leachability of PFAS in site soils.

SPLP is a technique used to determine the mobility of chemicals in liquids, soils and wastes, and may be useful in determining the need for addressing PFAS-containing material as part of the remedy. SPLP by EPA Method 1312 should be used unless otherwise specified by the DER project manager in consultation with the DER chemist.

Impacted materials can be made up of PFAS that are not analyzable by routine analytical methodology. A TOP Assay can be utilized to conceptualize the amount and type of oxidizable PFAS which could be liberated in the environment, which approximates the maximum concentration of perfluoroalkyl substances that could be generated if all polyfluoroalkyl substances were oxidized. For example, some polyfluoroalkyl substances may degrade or transform to form perfluoroalkyl substances (such as PFOA or PFOS), resulting in an increase in perfluoroalkyl substance concentrations as contaminated groundwater moves away from a source. The TOP Assay converts, through oxidation, polyfluoroalkyl substances (precursors) into perfluoroalkyl substances that can be detected by routine analytical methodology.[1]

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[1] TOP Assay analysis of highly contaminated samples, such as those from an AFFF (aqueous film-forming foam) site, can result in incomplete oxidation of the samples and an underestimation of the total perfluoroalkyl substances.

Commercial laboratories have adopted methods which allow for the quantification of targeted PFAS in air and biota. The EPA's Office of Research and Development (ORD) is currently developing methods which allow for air emissions characterization of PFAS, including both targeted and non-targeted analysis of PFAS. Consult with the DER project manager and the DER chemist for assistance on analyzing biota/tissue and air samples.

Data Assessment and Application to Site Cleanup

Until such time as Soil Cleanup Objectives (SCOs) for PFOA and PFOS are published, the extent of contaminated media potentially subject to remediation should be determined on a case-by-case basis using the procedures discussed below and the criteria in DER-10. Preliminary target levels for cleanup of PFOA and PFOS in other media, including biota and sediment, have not yet been established by the DEC.

Water Sample Results

NYSDEC has adopted ambient water quality guidance values for PFOA and PFOS. Groundwater samples should be compared to the human health criteria of 6.7 ng/l (ppt) for PFOA and 2.7 ng/l (ppt) for PFOS. These human health criteria should also be applied to surface water that is used as a water supply. This guidance also includes criteria for surface water for PFOS applicable for aquatic life, which may be applicable at some sites. Drinking water sample results should be compared to the NYS maximum contaminant level (MCL) of 10 ng/l (ppt). Analysis to determine if PFOA and PFOS concentrations are attributable to the site should include a comparison between upgradient and downgradient levels, and the presence of soil source areas, as defined below.

If PFOA and/or PFOS are identified as contaminants of concern for a site, they should be assessed as part of the remedy selection process in accordance with Part 375 and DER-10.

Soil Sample Results

NYSDEC will delay adding soil cleanup objectives for PFOA and PFOS to 6 NYCRR Part 375-6 until the PFAS rural soil background study has been completed. Until SCOs are in effect, the following are to be used as guidance values:

Guidance Values for Anticipated Site Use	PFOA (ppb)	PFOS (ppb)
Unrestricted	0.66	0.88
Residential	6.6	8.8
Restricted Residential	33	44
Commercial	500	440
Industrial	600	440
Protection of Groundwater[2]	0.8	1.0

PFOA and PFOS results for soil are to be compared against the guidance values listed above. These guidance values are to be used in determining whether PFOA and PFOS are contaminants of concern for the site and for determining remedial action objectives and cleanup requirements. Site-specific remedial objectives for protection of groundwater can also be presented for evaluation by DEC. Development of site-specific remedial objectives for protection of groundwater will require analysis of additional soil parameters relating to leachability. These

[2] The Protection of Groundwater values are based on the above referenced ambient groundwater guidance values. Details on that calculation are available in the following document, prepared for the February 2022 proposed changes to Part 375 (https://www.dec.ny.gov/docs/remediation_hudson_pdf/part375techsupport.pdf). The movement of PFAS in the environment is being aggressively researched at this time; that research will eventually result in more accurate models for the behaviors of these chemicals. In the meantime, DEC has calculated the guidance value for the protection of groundwater using the same procedure used for all other chemicals, as described in Section 7.7 of the Technical Support Document (http://www.dec.ny.gov/docs/remediation_hudson_pdf/techsuppdoc.pdf).

additional analyses can include any or all the parameters listed above (soil pH, cation exchange capacity, etc.) and/or use of SPLP.

As the understanding of PFAS transport improves, DEC welcomes proposals for site-specific remedial objectives for protection of groundwater. DEC will expect that those may be dependent on additional factors including soil pH, aqueous pH, % organic carbon, % Sand/Silt/Clay, soil cations: K, Ca, Mg, Na, Fe, Al, cation exchange capacity, and anion exchange capacity. Site-specific remedial objectives should also consider the dilution attenuation factor (DAF). The NJDEP publication on DAF can be used as a reference: https://www.nj.gov/dep/srp/guidance/rs/daf.pdf.

Testing for Imported Soil

Testing for PFAS should be included any time a full TAL/TCL analyte list is required. Results for PFOA and PFOS should be compared to the applicable guidance values. If PFOA or PFOS is detected in any sample at or above the guidance values then the source of backfill should be rejected, unless a site-specific exemption is provided by DER based on SPLP testing, for example. If the concentrations of PFOA and PFOS in leachate are at or above the ambient water quality guidance values for groundwater, then the soil is not acceptable.

PFOA, PFOS and 1,4-dioxane are all considered semi-volatile compounds, so composite samples are appropriate for these compounds when sampling in accordance with DER-10, Table 5.4(e)10. Category B deliverables should be submitted for backfill samples, though a DUSR is not required.

Appendix A - Quality Assurance Project Plan (QAPP) Guidelines for PFAS

The following guidelines (general and PFAS-specific) can be used to assist with the development of a QAPP for projects within DER involving sampling and analysis of PFAS.

General Guidelines in Accordance with DER-10

- Document/work plan section title – Quality Assurance Project Plan
- Summarize project scope, goals, and objectives
- Provide project organization including names and resumes of the project manager, Quality Assurance Officer (QAO), field staff, and Data Validator
  - The QAO should not have another position on the project, such as project or task manager, that involves project productivity or profitability as a job performance criterion
- List the ELAP certified lab(s) to be used for analysis of samples
- Include a site map showing sample locations
- Provide detailed sampling procedures for each matrix
- Include Data Quality Usability Objectives
- List equipment decontamination procedures
- Include an "Analytical Methods/Quality Assurance Summary Table" specifying:
  - Matrix type
  - Number or frequency of samples to be collected per matrix
  - Number of field and trip blanks per matrix
  - Analytical parameters to be measured per matrix
  - Analytical methods to be used per matrix with minimum reporting limits
  - Number and type of matrix spike and matrix spike duplicate samples to be collected
  - Number and type of duplicate samples to be collected
  - Sample preservation to be used per analytical method and sample matrix
  - Sample container volume and type to be used per analytical method and sample matrix
  - Sample holding time to be used per analytical method and sample matrix
- Specify Category B laboratory data deliverables and preparation of a DUSR

Specific Guidelines for PFAS

- Include in the text that sampling for PFAS will take place
- Include in the text that PFAS will be analyzed by EPA Method 1633
- Include the list of PFAS compounds to be analyzed (*PFAS Analyte List*)
- Include the laboratory SOP for PFAS analysis
- List the minimum method-achievable Reporting Limits for PFAS
  - Reporting Limits should be less than or equal to:
    - Aqueous – 2 ng/L (ppt)
    - Solids – 0.5 µg/kg (ppb)
- Include the laboratory Method Detection Limits for the PFAS compounds to be analyzed
-
- Include detailed sampling procedures
  - Precautions to be taken
  - Pump and equipment types
  - Decontamination procedures
  - Approved materials only to be used
- Specify that regular ice only will be used for sample shipment
- Specify that equipment blanks should be collected at a minimum frequency of 1 per day per site for each matrix

Appendix B - Sampling Protocols for PFAS in Soils, Sediments and Solids

General

The objective of this protocol is to give general guidelines for the collection of soil, sediment and other solid samples for PFAS analysis. The sampling procedure used should be consistent with Sampling Guidelines and Protocols – Technological Background and Quality Control/Quality Assurance for NYS DEC Spill Response Program – March 1991 (http://www.dec.ny.gov/docs/remediation_hudson_pdf/sgpsect5.pdf), with the following limitations.

Laboratory Analysis and Containers

Samples collected using this protocol are intended to be analyzed for PFAS using EPA Method 1633.

The preferred material for containers is high density polyethylene (HDPE). Pre-cleaned sample containers, coolers, sample labels, and a chain of custody form will be provided by the laboratory.

Equipment

Acceptable materials for sampling include stainless steel, HDPE, PVC, silicone, acetate, and polypropylene. Additional materials may be acceptable if pre-approved by New York State Department of Environmental Conservation's Division of Environmental Remediation.

No sampling equipment components or sample containers should come in to contact with aluminum foil, low density polyethylene, glass, or polytetrafluoroethylene (PTFE, Teflon™) materials including sample bottle cap liners with a PTFE layer.

A list of acceptable equipment is provided below, but other equipment may be considered appropriate based on sampling conditions.

- stainless steel spoon
- stainless steel bowl
- steel hand auger or shovel without any coatings

Equipment Decontamination

Standard two step decontamination using detergent (Alconox is acceptable) and clean, PFAS-free water will be performed for sampling equipment. All sources of water used for equipment decontamination should be verified in advance to be PFAS-free through laboratory analysis or certification.

Sampling Techniques

Sampling is often conducted in areas where a vegetative turf has been established. In these cases, a pre-cleaned trowel or shovel should be used to carefully remove the turf so that it may be replaced at the conclusion of sampling. Surface soil samples (e.g. 0 to 6 inches below surface) should then be collected using a pre-cleaned, stainless steel spoon. Shallow subsurface soil samples (e.g. 6 to ~36 inches below surface) may be collected by digging a hole using a pre-cleaned hand auger or shovel. When the desired subsurface depth is reached, a pre-cleaned hand auger or spoon shall be used to obtain the sample.

When the sample is obtained, it should be deposited into a stainless steel bowl for mixing prior to filling the sample containers. The soil should be placed directly into the bowl and mixed thoroughly by rolling the material into the middle until the material is homogenized. At this point the material within the bowl can be placed into the laboratory provided container.

Sample Identification and Logging

A label shall be attached to each sample container with a unique identification. Each sample shall be included on the chain of custody (COC).

Quality Assurance/Quality Control

- Immediately place samples in a cooler maintained at 4 ± 2º Celsius using ice
- Collect one field duplicate for every sample batch, minimum 1 duplicate per 20 samples. The duplicate shall consist of an additional sample at a given location
- Collect one matrix spike / matrix spike duplicate (MS/MSD) for every sample batch, minimum 1 MS/MSD per 20 samples. The MS/MSD shall consist of an additional two samples at a given location and identified on the COC
- Request appropriate data deliverable (Category B) and an electronic data deliverable

Documentation

A soil log or sample log shall document the location of the sample/borehole, depth of the sample, sampling equipment, duplicate sample, visual description of the material, and any other observations or notes determined to be appropriate. Additionally, care should be performed to limit contact with PFAS containing materials (e.g. waterproof field books, food packaging) during the sampling process.

Personal Protection Equipment (PPE)

For most sampling Level D PPE is anticipated to be appropriate. The sampler should wear nitrile gloves while conducting field work and handling sample containers.

Field staff shall consider the clothing to be worn during sampling activities. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFAS materials should be avoided. All clothing worn by sampling personnel should have been laundered multiple times.

Appropriate rain gear (PVC, polyurethane, or rubber rain gear are acceptable), bug spray, and sunscreen should be used that does not contain PFAS. Well washed cotton coveralls may be used as an alternative to bug spray and/or sunscreen.

PPE that contains PFAS is acceptable when site conditions warrant additional protection for the samplers and no other materials can be used to be protective. Documentation of such use should be provided in the field notes.

Appendix C - Sampling Protocols for PFAS in Monitoring Wells

General

The objective of this protocol is to give general guidelines for the collection of groundwater samples for PFAS analysis. The sampling procedure used should be consistent with Sampling Guidelines and Protocols – Technological Background and Quality Control/Quality Assurance for NYS DEC Spill Response Program – March 1991 (http://www.dec.ny.gov/docs/remediation_hudson_pdf/sgpsect5.pdf), with the following limitations.

Laboratory Analysis and Container

Samples collected using this protocol are intended to be analyzed for PFAS using EPA Method 1633.

The preferred material for containers is high density polyethylene (HDPE). Pre-cleaned sample containers, coolers, sample labels, and a chain of custody form will be provided by the laboratory.

Equipment

Acceptable materials for sampling include: stainless steel, HDPE, PVC, silicone, acetate, and polypropylene. Additional materials may be acceptable if pre-approved by New York State Department of Environmental Conservation's Division of Environmental Remediation.

No sampling equipment components or sample containers should come in contact with aluminum foil, low density polyethylene, glass, or polytetrafluoroethylene (PTFE, Teflon™) materials including plumbers tape and sample bottle cap liners with a PTFE layer.

A list of acceptable equipment is provided below, but other equipment may be considered appropriate based on sampling conditions.

- stainless steel inertia pump with HDPE tubing
- peristaltic pump equipped with HDPE tubing and silicone tubing
- stainless steel bailer with stainless steel ball
- bladder pump (identified as PFAS-free) with HDPE tubing

Equipment Decontamination

Standard two step decontamination using detergent (Alconox is acceptable) and clean, PFAS-free water will be performed for sampling equipment. All sources of water used for equipment decontamination should be verified in advance to be PFAS-free through laboratory analysis or certification.

Sampling Techniques

Monitoring wells should be purged in accordance with the sampling procedure (standard/volume purge or low flow purge) identified in the site work plan, which will determine the appropriate time to collect the sample. If sampling using standard purge techniques, additional purging may be needed to reduce turbidity levels, so samples contain a limited amount of sediment within the sample containers. Sample containers that contain sediment may cause issues at the laboratory, which may result in elevated reporting limits and other issues during the sample preparation that can compromise data usability. Sampling personnel should don new nitrile gloves prior to sample collection due to the potential to contact PFAS containing items (not related to the sampling equipment) during the purging activities.

Sample Identification and Logging

A label shall be attached to each sample container with a unique identification. Each sample shall be included on the chain of custody (COC).

Quality Assurance/Quality Control

- Immediately place samples in a cooler maintained at 4 ± 2º Celsius using ice
- Collect one field duplicate for every sample batch, minimum 1 duplicate per 20 samples. The duplicate shall consist of an additional sample at a given location
- Collect one matrix spike / matrix spike duplicate (MS/MSD) for every sample batch, minimum 1 MS/MSD per 20 samples. The MS/MSD shall consist of an additional two samples at a given location and identified on the COC
- Collect one equipment blank per day per site and minimum 1 equipment blank per 20 samples. The equipment blank shall test the new and decontaminated sampling equipment utilized to obtain a sample for residual PFAS contamination. This sample is obtained by using laboratory provided PFAS-free water and passing the water over or through the sampling device and into laboratory provided sample containers
- Additional equipment blank samples may be collected to assess other equipment that is utilized at the monitoring well
- Request appropriate data deliverable (Category B) and an electronic data deliverable

Documentation

A purge log shall document the location of the sample, sampling equipment, groundwater parameters, duplicate sample, visual description of the material, and any other observations or notes determined to be appropriate. Additionally, care should be performed to limit contact with PFAS containing materials (e.g. waterproof field books, food packaging) during the sampling process.

Personal Protection Equipment (PPE)

For most sampling Level D PPE is anticipated to be appropriate. The sampler should wear nitrile gloves while conducting field work and handling sample containers.

Field staff shall consider the clothing to be worn during sampling activities. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFAS materials should be avoided. All clothing worn by sampling personnel should have been laundered multiple times.

Appropriate rain gear (PVC, polyurethane, or rubber rain gear are acceptable), bug spray, and sunscreen should be used that does not contain PFAS. Well washed cotton coveralls may be used as an alternative to bug spray and/or sunscreen.

PPE that contains PFAS is acceptable when site conditions warrant additional protection for the samplers and no other materials can be used to be protective. Documentation of such use should be provided in the field notes.

Appendix D - Sampling Protocols for PFAS in Surface Water

General

The objective of this protocol is to give general guidelines for the collection of surface water samples for PFAS analysis. The sampling procedure used should be consistent with Sampling Guidelines and Protocols – Technological Background and Quality Control/Quality Assurance for NYS DEC Spill Response Program – March 1991 (http://www.dec.ny.gov/docs/remediation_hudson_pdf/sgpsect5.pdf), with the following limitations.

Laboratory Analysis and Container

Samples collected using this protocol are intended to be analyzed for PFAS using EPA Method 1633.

The preferred material for containers is high density polyethylene (HDPE). Pre-cleaned sample containers, coolers, sample labels, and a chain of custody form will be provided by the laboratory.

Equipment

Acceptable materials for sampling include: stainless steel, HDPE, PVC, silicone, acetate, and polypropylene. Additional materials may be acceptable if pre-approved by New York State Department of Environmental Conservation's Division of Environmental Remediation.

No sampling equipment components or sample containers should come in contact with aluminum foil, low density polyethylene, glass, or polytetrafluoroethylene (PTFE, Teflon™) materials including sample bottle cap liners with a PTFE layer.

A list of acceptable equipment is provided below, but other equipment may be considered appropriate based on sampling conditions.

- stainless steel cup

Equipment Decontamination

Standard two step decontamination using detergent (Alconox is acceptable) and clean, PFAS-free water will be performed for sampling equipment. All sources of water used for equipment decontamination should be verified in advance to be PFAS-free through laboratory analysis or certification.

Sampling Techniques

Where conditions permit, (e.g. creek or pond) sampling devices (e.g. stainless steel cup) should be rinsed with site medium to be sampled prior to collection of the sample. At this point the sample can be collected and poured into the sample container.

If site conditions permit, samples can be collected directly into the laboratory container.

Sample Identification and Logging

A label shall be attached to each sample container with a unique identification. Each sample shall be included on the chain of custody (COC).

Quality Assurance/Quality Control

- Immediately place samples in a cooler maintained at 4 ± 2º Celsius using ice
- Collect one field duplicate for every sample batch, minimum 1 duplicate per 20 samples. The duplicate shall consist of an additional sample at a given location
- Collect one matrix spike / matrix spike duplicate (MS/MSD) for every sample batch, minimum 1 MS/MSD per 20 samples. The MS/MSD shall consist of an additional two samples at a given location and identified on the COC
- Collect one equipment blank per day per site and minimum 1 equipment blank per 20 samples. The equipment blank shall test the new and decontaminated sampling equipment utilized to obtain a sample for residual PFAS contamination. This sample is obtained by using laboratory provided PFAS-free water and passing the water over or through the sampling device and into laboratory provided sample containers
- Request appropriate data deliverable (Category B) and an electronic data deliverable

Documentation

A sample log shall document the location of the sample, sampling equipment, duplicate sample, visual description of the material, and any other observations or notes determined to be appropriate. Additionally, care should be performed to limit contact with PFAS containing materials (e.g. waterproof field books, food packaging) during the sampling process.

Personal Protection Equipment (PPE)

For most sampling Level D PPE is anticipated to be appropriate. The sampler should wear nitrile gloves while conducting field work and handling sample containers.

Field staff shall consider the clothing to be worn during sampling activities. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFAS materials should be avoided. All clothing worn by sampling personnel should have been laundered multiple times.

Appropriate rain gear (PVC, polyurethane, or rubber rain gear are acceptable), bug spray, and sunscreen should be used that does not contain PFAS. Well washed cotton coveralls may be used as an alternative to bug spray and/or sunscreen.

PPE that contains PFAS is acceptable when site conditions warrant additional protection for the samplers and no other materials can be used to be protective. Documentation of such use should be provided in the field notes.

Appendix E - Sampling Protocols for PFAS in Private Water Supply Wells

General

The objective of this protocol is to give general guidelines for the collection of water samples from private water supply wells (with a functioning pump) for PFAS analysis. The sampling procedure used should be consistent with Sampling Guidelines and Protocols – Technological Background and Quality Control/Quality Assurance for NYS DEC Spill Response Program – March 1991 (http://www.dec.ny.gov/docs/remediation_hudson_pdf/sgpsect5.pdf), with the following limitations.

Laboratory Analysis and Container

Drinking water samples collected using this protocol are intended to be analyzed for PFAS by EPA Method 537, 537.1, 533, or ISO Method 25101. The preferred material for containers is high density polyethylene (HDPE). Pre-cleaned sample containers, coolers, sample labels, and a chain of custody form will be provided by the laboratory.

Equipment

Acceptable materials for sampling include stainless steel, HDPE, PVC, silicone, acetate, and polypropylene. Additional materials may be acceptable if pre-approved by New York State Department of Environmental Conservation's Division of Environmental Remediation.

No sampling equipment components or sample containers should come in contact with aluminum foil, low density polyethylene, glass, or polytetrafluoroethylene (PTFE, Teflon™) materials (e.g. plumbers tape), including sample bottle cap liners with a PTFE layer.

Equipment Decontamination

Standard two step decontamination using detergent (Alconox is acceptable) and clean, PFAS-free water will be performed for sampling equipment. All sources of water used for equipment decontamination should be verified in advance to be PFAS-free through laboratory analysis or certification.

Sampling Techniques

Locate and assess the pressure tank and determine if any filter units are present within the building. Establish the sample location as close to the well pump as possible, which is typically the spigot at the pressure tank. Ensure sampling equipment is kept clean during sampling as access to the pressure tank spigot, which is likely located close to the ground, may be obstructed and may hinder sample collection.

Prior to sampling, a faucet downstream of the pressure tank (e.g., washroom sink) should be run until the well pump comes on and a decrease in water temperature is noted which indicates that the water is coming from the well. If the homeowner is amenable, staff should run the water longer to purge the well (15+ minutes) to provide a sample representative of the water in the formation rather than standing water in the well and piping system including the pressure tank. At this point a new pair of nitrile gloves should be donned and the sample can be collected from the sample point at the pressure tank.

Sample Identification and Logging

A label shall be attached to each sample container with a unique identification. Each sample shall be included on the chain of custody (COC).

Quality Assurance/Quality Control

- Immediately place samples in a cooler maintained at 4 ± 2º Celsius using ice
- Collect one field duplicate for every sample batch, minimum 1 duplicate per 20 samples. The duplicate shall consist of an additional sample at a given location
- Collect one matrix spike / matrix spike duplicate (MS/MSD) for every sample batch, minimum 1 MS/MSD per 20 samples. The MS/MSD shall consist of an additional two samples at a given location and identified on the COC
- If equipment was used, collect one equipment blank per day per site and a minimum 1 equipment blank per 20 samples. The equipment blank shall test the new and decontaminated sampling equipment utilized to obtain a sample for residual PFAS contamination. This sample is obtained by using laboratory provided PFAS-free water and passing the water over or through the sampling device and into laboratory provided sample containers.
- A field reagent blank (FRB) should be collected at a rate of one per 20 samples. The lab will provide a FRB bottle containing PFAS free water and one empty FRB bottle. In the field, pour the water from the one bottle into the empty FRB bottle and label appropriately.
- Request appropriate data deliverable (Category B) and an electronic data deliverable
- For sampling events where multiple private wells (homes or sites) are to be sampled per day, it is acceptable to collect QC samples at a rate of one per 20 across multiple sites or days.

Documentation

A sample log shall document the location of the private well, sample point location, owner contact information, sampling equipment, purge duration, duplicate sample, visual description of the material, and any other observations or notes determined to be appropriate and available (e.g. well construction, pump type and location, yield, installation date). Additionally, care should be performed to limit contact with PFAS containing materials (e.g. waterproof field books, food packaging) during the sampling process.

Personal Protection Equipment (PPE)

For most sampling Level D PPE is anticipated to be appropriate. The sampler should wear nitrile gloves while conducting field work and handling sample containers.

Field staff shall consider the clothing to be worn during sampling activities. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFAS materials should be avoided. All clothing worn by sampling personnel should have been laundered multiple times.

Appendix F - Sampling Protocols for PFAS in Fish

This appendix contains a copy of the latest guidelines developed by the Division of Fish and Wildlife (DFW) entitled "General Fish Handling Procedures for Contaminant Analysis" (Ver. 8).

Procedure Name: General Fish Handling Procedures for Contaminant Analysis

Number: FW-005

Purpose: This procedure describes data collection, fish processing and delivery of fish collected for contaminant monitoring. It contains the chain of custody and collection record forms that should be used for the collections.

Organization: Environmental Monitoring Section
Bureau of Ecosystem Health
Division of Fish and Wildlife (DFW)
New York State Department of Environmental Conservation (NYSDEC)
625 Broadway
Albany, New York 12233-4756

Version: 8

Previous Version Date: 21 March 2018

Summary of Changes to this Version: Updated bureau name to Bureau of Ecosystem Health. Added direction to list the names of all field crew on the collection record. Minor formatting changes on chain of custody and collection records.

Originator or Revised by: Wayne Richter, Jesse Becker

Date: 26 April 2019

Quality Assurance Officer and Approval Date: Jesse Becker, 26 April 2019

Appendix G – PFAS Analyte List

Group	Chemical Name	Abbreviation	CAS Number
Perfluoroalkyl sulfonic acids	Perfluorobutanesulfonic acid	PFBS	375-73-5
	Perfluoropentanesulfonic acid	PFPeS	2706-91-4
	Perfluorohexanesulfonic acid	PFHxS	355-46-4
	Perfluoroheptanesulfonic acid	PFHpS	375-92-8
	Perfluorooctanesulfonic acid	PFOS	1763-23-1
	Perfluorononanesulfonic acid	PFNS	68259-12-1
	Perfluorodecanesulfonic acid	PFDS	335-77-3
	Perfluorododecanesulfonic acid	PFDoS	79780-39-5
Perfluoroalkyl carboxylic acids	Perfluorobutanoic acid	PFBA	375-22-4
	Perfluoropentanoic acid	PFPeA	2706-90-3
	Perfluorohexanoic acid	PFHxA	307-24-4
	Perfluoroheptanoic acid	PFHpA	375-85-9
	Perfluorooctanoic acid	PFOA	335-67-1
	Perfluorononanoic acid	PFNA	375-95-1
	Perfluorodecanoic acid	PFDA	335-76-2
	Perfluoroundecanoic acid	PFUnA	2058-94-8
	Perfluorododecanoic acid	PFDoA	307-55-1
	Perfluorotridecanoic acid	PFTrDA	72629-94-8
	Perfluorotetradecanoic acid	PFTeDA	376-06-7
Per- and Polyfluoroether carboxylic acids	Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6
	4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4
	Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1
	Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5
	Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6
Fluorotelomer sulfonic acids	4:2 Fluorotelomer sulfonic acid	4:2-FTS	757124-72-4
	6:2 Fluorotelomer sulfonic acid	6:2-FTS	27619-97-2
	8:2 Fluorotelomer sulfonic acid	8:2-FTS	39108-34-4
Fluorotelomer carboxylic acids	3:3 Fluorotelomer carboxylic acid	3:3 FTCA	356-02-5
	5:3 Fluorotelomer carboxylic acid	5:3 FTCA	914637-49-3
	7:3 Fluorotelomer carboxylic acid	7:3 FTCA	812-70-4
Perfluorooctane sulfonamides	Perfluorooctane sulfonamide	PFOSA	754-91-6
	N-methylperfluorooctane sulfonamide	NMeFOSA	31506-32-8
	N-ethylperfluorooctane sulfonamide	NEtFOSA	4151-50-2
Perfluorooctane sulfonamidoacetic acids	N-methylperfluorooctane sulfonamidoacetic acid	N-MeFOSAA	2355-31-9
	N-ethylperfluorooctane sulfonamidoacetic acid	N-EtFOSAA	2991-50-6
Perfluorooctane sulfonamide ethanols	N-methylperfluorooctane sulfonamidoethanol	MeFOSE	24448-09-7
	N-ethylperfluorooctane sulfonamidoethanol	EtFOSE	1691-99-2

Group	Chemical Name	Abbreviation	CAS Number
Ether sulfonic acids	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (F-53B Major)	9Cl-PF3ONS	756426-58-1
	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (F-53B Minor)	11Cl-PF3OUdS	763051-92-9
	Perfluoro(2-ethoxyethane) sulfonic acid	PFEESA	113507-82-7

Appendix H - Data Review Guidelines for Analysis of PFAS in Non-Potable Water and Solids

General

These guidelines are intended to be used for the validation of PFAS using EPA Method 1633 for projects within the Division of Environmental Remediation (DER). Data reviewers should understand the methodology and techniques utilized in the analysis. Consultation with the end user of the data may be necessary to assist in determining data usability based on the data quality objectives in the Quality Assurance Project Plan. A familiarity with the laboratory's Standard Operating Procedure may also be needed to fully evaluate the data. If you have any questions, please contact DER's Quality Assurance Officer, Dana Barbarossa, at dana.barbarossa@dec.ny.gov.

Preservation and Holding Time

Samples should be preserved with ice to a temperature of less than 6°C upon arrival at the lab. The holding time is 28 days to extraction for aqueous and solid samples. The time from extraction to analysis for aqueous samples is 28 days and 40 days for solids.

Temperature greatly exceeds 6ºC upon arrival at the lab*	Use professional judgement to qualify detects and non-detects as estimated or rejected
Holding time exceeding 28 days to extraction	Use professional judgement to qualify detects and non-detects as estimated or rejected if holding time is grossly exceeded

*Samples that are delivered to the lab immediately after sampling may not meet the thermal preservation guidelines. Samples are considered acceptable if they arrive on ice or an attempt to chill the samples is observed.

Initial Calibration

The initial calibration should contain a minimum of six standards for linear fit and six standards for a quadratic fit. The relative standard deviation (RSD) for a quadratic fit calibration should be less than 20%.

The low-level calibration standard should be within 50% - 150% of the true value, and the mid-level calibration standard within 70% - 130% of the true value.

%RSD >20%	J flag detects and UJ non detects

Continuing Calibration Verification

Continuing calibration verification (CCV) checks should be analyzed at a frequency of one per ten field samples. If CCV recovery is very low, where detection of the analyte could be in question, ensure a low level CCV was analyzed and use to determine data quality.

CCV recovery <70 or >130%	J flag results

Blanks

There should be no detections in the method blanks above the reporting limits. Equipment blanks, field blanks, rinse blanks etc. should be evaluated in the same manner as method blanks. Use the most contaminated blank to evaluate the sample results.

Blank Result	Sample Result	Qualification
Any detection	<Reporting limit	Qualify as ND at reporting limit
Any detection	>Reporting Limit and >10x the blank result	No qualification
>Reporting limit	>Reporting limit and <10x blank result	J+ biased high

Field Duplicates

A blind field duplicate should be collected at rate of one per twenty samples. The relative percent difference (RPD) should be less than 30% for analyte concentrations greater than two times the reporting limit. Use the higher result for final reporting.

RPD >30%	Apply J qualifier to parent sample

Lab Control Spike

Lab control spikes should be analyzed with each extraction batch or one for every twenty samples. In the absence of lab derived criteria, use 70% - 130% recovery criteria to evaluate the data.

Recovery <70% or >130% (lab derived criteria can also be used)	Apply J qualifier to detects and UJ qualifier to non detects

Matrix Spike/Matrix Spike Duplicate

One matrix spike and matrix spike duplicate should be collected at a rate of one per twenty samples. Use professional judgement to reject results based on out of control MS/MSD recoveries.

Recovery <70% or >130% (lab derived criteria can also be used)	Apply J qualifier to detects and UJ qualifier to non detects of parent sample only
RPD >30%	Apply J qualifier to detects and UJ qualifier to non detects of parent sample only

Extracted Internal Standards (Isotope Dilution Analytes)

Problematic analytes (e.g. PFBA, PFPeA, fluorotelomer sulfonates) can have wider recoveries without qualification. Qualify corresponding native compounds with a J flag if outside of the range.

Recovery <50% or >150%	Apply J qualifier
Recovery <25% or >150% for poor responding analytes	Apply J qualifier
Isotope Dilution Analyte (IDA) Recovery <10%	Reject results

Signal to Noise Ratio

The signal to noise ratio for the quantifier ion should be at least 3:1. If the ratio is less than 3:1, the peak is discernable from the baseline noise and symmetrical, the result can be reported. If the peak appears to be baseline noise and/or the shape is irregular, qualify the result as tentatively identified.

Reporting Limits

If project-specific reporting limits were not met, please indicate that in the report along with the reason (e.g. over dilution, dilution for non-target analytes, high sediment in aqueous samples).

Peak Integrations

Target analyte peaks should be integrated properly and consistently when compared to standards. Ensure branched isomer peaks are included for PFAS where standards are available. Inconsistencies should be brought to the attention of the laboratory or identified in the data review summary report.

PFAS 1633 - Denver List/Limits

Method Description	Method Code	Prep Method	Analyte Description	CAS Number	RL	MDL	LOD	Units
Per- and Polyfluoroalkyl Substances by LC/MS/MS, QSM Table B-24 **(SOLIDS)**	1633_B24	1633_Shake	Perfluorobutanoic acid (PFBA)	375-22-4	0.800	0.0370		ug/Kg
			Perfluoropentanoic acid (PFPeA)	2706-90-3	0.400	0.0210		ug/Kg
			Perfluorohexanoic acid (PFHxA)	307-24-4	0.200	0.0210		ug/Kg
			Perfluoroheptanoic acid (PFHpA)	375-85-9	0.200	0.0220		ug/Kg
			Perfluorooctanoic acid (PFOA)	335-67-1	0.200	0.0420		ug/Kg
			Perfluorononanoic acid (PFNA)	375-95-1	0.200	0.0120		ug/Kg
			Perfluorodecanoic acid (PFDA)	335-76-2	0.200	0.0750		ug/Kg
			Perfluoroundecanoic acid (PFUnA)	2058-94-8	0.200	0.0280		ug/Kg
			Perfluorododecanoic acid (PFDoA)	307-55-1	0.200	0.0560		ug/Kg
			Perfluorotridecanoic acid (PFTriA)	72629-94-8	0.200	0.0280		ug/Kg
			Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.200	0.0170		ug/Kg
			Perfluorobutanesulfonic acid (PFBS)	375-73-5	0.200	0.0140		ug/Kg
			Perfluoropentanesulfonic acid (PFPeS)	2706-91-4	0.200	0.0130		ug/Kg
			Perfluorohexanesulfonic acid (PFHxS)	355-46-4	0.200	0.0200		ug/Kg
			Perfluoroheptanesulfonic acid (PFHpS)	375-92-8	0.200	0.0280		ug/Kg
			Perfluorooctanesulfonic acid (PFOS)	1763-23-1	0.200	0.0560		ug/Kg
			Perfluorononanesulfonic acid (PFNS)	68259-12-1	0.200	0.0280		ug/Kg
			Perfluorodecanesulfonic acid (PFDS)	335-77-3	0.200	0.0200		ug/Kg
			Perfluorododecanesulfonic acid (PFDoS)	79780-39-5	0.200	0.0170		ug/Kg
			4:2 FTS	757124-72-4	0.800	0.0770		ug/Kg
			6:2 FTS	27619-97-2	0.800	0.484		ug/Kg
			8:2 FTS	39108-34-4	0.800	0.116		ug/Kg
			Perfluorooctanesulfonamide (PFOSA)	754-91-6	0.200	0.0120		ug/Kg
			NMeFOSA	31506-32-8	0.200	0.0240		ug/Kg
			NEtFOSA	4151-50-2	0.200	0.0310		ug/Kg
			NMeFOSAA	2355-31-9	0.200	0.0250		ug/Kg
			NEtFOSAA	2991-50-6	0.200	0.0240		ug/Kg
			NMeFOSE	24448-09-7	2.00	0.0990		ug/Kg
			NEtFOSE	1691-99-2	2.00	0.110		ug/Kg
			HFPO-DA (GenX)	13252-13-6	0.800	0.0940		ug/Kg
			4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	919005-14-4	0.800	0.0810		ug/Kg
			PFMBA	863090-89-5	0.400	0.0190		ug/Kg
			NFDHA	151772-58-6	0.400	0.0480		ug/Kg
			PFMPA	377-73-1	0.400	0.0910		ug/Kg
			9Cl-PF3ONS	756426-58-1	0.800	0.0510		ug/Kg
			11Cl-PF3OUdS	763051-92-9	0.800	0.120		ug/Kg
			PFEESA	113507-82-7	0.400	0.0400		ug/Kg
			3:3 FTCA	356-02-5	1.00	0.176		ug/Kg
			5:3 FTCA	914637-49-3	5.00	0.365		ug/Kg
			7:3 FTCA	812-70-4	5.00	0.307		ug/Kg

Per- and Polyfluoroalkyl Substances by LC/MS/MS, QSM Table B-24 **(NPW)**	1633_B24	1633_SPE	Perfluorobutanoic acid (PFBA)	375-22-4	8.00	2.00		ng/L
			Perfluoropentanoic acid (PFPeA)	2706-90-3	4.00	1.00		ng/L
			Perfluorohexanoic acid (PFHxA)	307-24-4	2.00	0.500		ng/L
			Perfluoroheptanoic acid (PFHpA)	375-85-9	2.00	0.520		ng/L
			Perfluorooctanoic acid (PFOA)	335-67-1	2.00	0.640		ng/L
			Perfluorononanoic acid (PFNA)	375-95-1	2.00	0.500		ng/L
			Perfluorodecanoic acid (PFDA)	335-76-2	2.00	0.500		ng/L
			Perfluoroundecanoic acid (PFUnA)	2058-94-8	2.00	0.500		ng/L
			Perfluorododecanoic acid (PFDoA)	307-55-1	2.00	0.500		ng/L
			Perfluorotridecanoic acid (PFTriA)	72629-94-8	2.00	0.500		ng/L
			Perfluorotetradecanoic acid (PFTeDA)	376-06-7	2.00	0.500		ng/L
			Perfluorobutanesulfonic acid (PFBS)	375-73-5	2.00	0.300		ng/L
			Perfluoropentanesulfonic acid (PFPeS)	2706-91-4	2.00	0.500		ng/L
			Perfluorohexanesulfonic acid (PFHxS)	355-46-4	2.00	0.570		ng/L
			Perfluoroheptanesulfonic acid (PFHpS)	375-92-8	2.00	0.400		ng/L
			Perfluorooctanesulfonic acid (PFOS)	1763-23-1	2.00	0.500		ng/L
			Perfluorononanesulfonic acid (PFNS)	68259-12-1	2.00	0.400		ng/L
			Perfluorodecanesulfonic acid (PFDS)	335-77-3	2.00	0.500		ng/L
			Perfluorododecanesulfonic acid (PFDoS)	79780-39-5	2.00	0.900		ng/L
			4:2 FTS	757124-72-4	8.00	1.70		ng/L
			6:2 FTS	27619-97-2	8.00	2.50		ng/L
			8:2 FTS	39108-34-4	8.00	2.60		ng/L
			Perfluorooctanesulfonamide (PFOSA)	754-91-6	2.00	0.500		ng/L
			NMeFOSA	31506-32-8	2.00	0.500		ng/L
			NEtFOSA	4151-50-2	2.00	0.500		ng/L
			NMeFOSAA	2355-31-9	4.00	1.20		ng/L
			NEtFOSAA	2991-50-6	2.00	0.700		ng/L
			NMeFOSE	24448-09-7	20.0	5.00		ng/L
			NEtFOSE	1691-99-2	20.0	5.00		ng/L
			HFPO-DA (GenX)	13252-13-6	8.00	2.00		ng/L
			4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	919005-14-4	8.00	1.50		ng/L
			PFMBA	863090-89-5	4.00	1.00		ng/L
			NFDHA	151772-58-6	4.00	1.00		ng/L
			PFMPA	377-73-1	4.00	0.500		ng/L
			9Cl-PF3ONS	756426-58-1	8.00	1.00		ng/L
			11Cl-PF3OUdS	763051-92-9	8.00	2.00		ng/L
			PFEESA	113507-82-7	4.00	0.500		ng/L
			3:3 FTCA	356-02-5	10.0	1.50		ng/L
			5:3 FTCA	914637-49-3	50.0	10.0		ng/L
			7:3 FTCA	812-70-4	50.0	10.0		ng/L

Method Description	Method Code	Prep Method	Analyte Description	LCS - Low	LCS - High	LCS - RPD %	MS - Low
Per- and Polyfluoroalkyl Substances by LC/MS/MS, QSM Table B-24 **(SOLIDS)**	1633_B24	1633_Shake	Perfluorobutanoic acid (PFBA)	40	150	30	40
			Perfluoropentanoic acid (PFPeA)	40	150	30	40
			Perfluorohexanoic acid (PFHxA)	40	150	30	40
			Perfluoroheptanoic acid (PFHpA)	40	150	30	40
			Perfluorooctanoic acid (PFOA)	40	150	30	40
			Perfluorononanoic acid (PFNA)	40	150	30	40
			Perfluorodecanoic acid (PFDA)	40	150	30	40
			Perfluoroundecanoic acid (PFUnA)	40	150	30	40
			Perfluorododecanoic acid (PFDoA)	40	150	30	40
			Perfluorotridecanoic acid (PFTriA)	40	150	30	40
			Perfluorotetradecanoic acid (PFTeDA)	40	150	30	40
			Perfluorobutanesulfonic acid (PFBS)	40	150	30	40
			Perfluoropentanesulfonic acid (PFPeS)	40	150	30	40
			Perfluorohexanesulfonic acid (PFHxS)	40	150	30	40
			Perfluoroheptanesulfonic acid (PFHpS)	40	150	30	40
			Perfluorooctanesulfonic acid (PFOS)	40	150	30	40
			Perfluorononanesulfonic acid (PFNS)	40	150	30	40
			Perfluorodecanesulfonic acid (PFDS)	40	150	30	40
			Perfluorododecanesulfonic acid (PFDoS)	40	150	30	40
			4:2 FTS	40	150	30	40
			6:2 FTS	40	150	30	40
			8:2 FTS	40	150	30	40
			Perfluorooctanesulfonamide (PFOSA)	40	150	30	40
			NMeFOSA	40	150	30	40
			NEtFOSA	40	150	30	40
			NMeFOSAA	40	150	30	40
			NEtFOSAA	40	150	30	40
			NMeFOSE	40	150	30	40
			NEtFOSE	40	150	30	40
			HFPO-DA (GenX)	40	150	30	40
			4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	40	150	30	40
			PFMBA	40	150	30	40
			NFDHA	40	150	30	40
			PFMPA	40	150	30	40
			9Cl-PF3ONS	40	150	30	40
			11Cl-PF3OUdS	40	150	30	40
			PFEESA	40	150	30	40
			3:3 FTCA	40	150	30	40
			5:3 FTCA	40	150	30	40
			7:3 FTCA	40	150	30	40
Per- and Polyfluoroalkyl Substances by LC/MS/MS, QSM Table B-24 **(NPW)**	1633_B24	1633_SPE	Perfluorobutanoic acid (PFBA)	58	148	30	58
			Perfluoropentanoic acid (PFPeA)	54	152	30	54
			Perfluorohexanoic acid (PFHxA)	55	152	30	55
			Perfluoroheptanoic acid (PFHpA)	54	154	30	54
			Perfluorooctanoic acid (PFOA)	52	161	30	52
			Perfluorononanoic acid (PFNA)	59	149	30	59
			Perfluorodecanoic acid (PFDA)	52	147	30	52
			Perfluoroundecanoic acid (PFUnA)	48	159	30	48
			Perfluorododecanoic acid (PFDoA)	64	142	30	64
			Perfluorotridecanoic acid (PFTriA)	49	148	30	49
			Perfluorotetradecanoic acid (PFTeDA)	47	161	30	47
			Perfluorobutanesulfonic acid (PFBS)	62	144	30	62
			Perfluoropentanesulfonic acid (PFPeS)	59	151	30	59
			Perfluorohexanesulfonic acid (PFHxS)	57	146	30	57
			Perfluoroheptanesulfonic acid (PFHpS)	55	152	30	55
			Perfluorooctanesulfonic acid (PFOS)	58	149	30	58
			Perfluorononanesulfonic acid (PFNS)	52	148	30	52
			Perfluorodecanesulfonic acid (PFDS)	51	147	30	51
			Perfluorododecanesulfonic acid (PFDoS)	36	145	30	36
			4:2 FTS	67	146	30	67
			6:2 FTS	61	151	30	61
			8:2 FTS	63	152	30	63
			Perfluorooctanesulfonamide (PFOSA)	61	148	30	61
			NMeFOSA	63	145	30	63
			NEtFOSA	65	139	30	65
			NMeFOSAA	58	144	30	58
			NEtFOSAA	59	146	30	59
			NMeFOSE	71	136	30	71
			NEtFOSE	69	137	30	69
			HFPO-DA (GenX)	63	144	30	63
			4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	68	146	30	68
			PFMBA	55	148	30	55
			NFDHA	48	161	30	48
			PFMPA	51	145	30	51
			9Cl-PF3ONS	56	156	30	56
			11Cl-PF3OUdS	46	156	30	46
			PFEESA	56	151	30	56
			3:3 FTCA	62	129	30	62
			5:3 FTCA	63	134	30	63
			7:3 FTCA	50	138	30	50

PFAS 1633 - Denver List/Limits

Method Description	Method Code	Prep Method	Analyte Description	MS - High	MS - RPD %	Surrogate Low	Surrogate High
Per- and Polyfluoroalkyl Substances by LC/MS/MS, QSM Table B-24 **(SOLIDS)**	1633_B24	1633_Shake	Perfluorobutanoic acid (PFBA)	150	30		
			Perfluoropentanoic acid (PFPeA)	150	30		
			Perfluorohexanoic acid (PFHxA)	150	30		
			Perfluoroheptanoic acid (PFHpA)	150	30		
			Perfluorooctanoic acid (PFOA)	150	30		
			Perfluorononanoic acid (PFNA)	150	30		
			Perfluorodecanoic acid (PFDA)	150	30		
			Perfluoroundecanoic acid (PFUnA)	150	30		
			Perfluorododecanoic acid (PFDoA)	150	30		
			Perfluorotridecanoic acid (PFTriA)	150	30		
			Perfluorotetradecanoic acid (PFTeDA)	150	30		
			Perfluorobutanesulfonic acid (PFBS)	150	30		
			Perfluoropentanesulfonic acid (PFPeS)	150	30		
			Perfluorohexanesulfonic acid (PFHxS)	150	30		
			Perfluoroheptanesulfonic acid (PFHpS)	150	30		
			Perfluorooctanesulfonic acid (PFOS)	150	30		
			Perfluorononanesulfonic acid (PFNS)	150	30		
			Perfluorodecanesulfonic acid (PFDS)	150	30		
			Perfluorododecanesulfonic acid (PFDoS)	150	30		
			4:2 FTS	150	30		
			6:2 FTS	150	30		
			8:2 FTS	150	30		
			Perfluorooctanesulfonamide (PFOSA)	150	30		
			NMeFOSA	150	30		
			NEtFOSA	150	30		
			NMeFOSAA	150	30		
			NEtFOSAA	150	30		
			NMeFOSE	150	30		
			NEtFOSE	150	30		
			HFPO-DA (GenX)	150	30		
			4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	150	30		
			PFMBA	150	30		
			NFDHA	150	30		
			PFMPA	150	30		
			9Cl-PF3ONS	150	30		
			11Cl-PF3OUdS	150	30		
			PFEESA	150	30		
			3:3 FTCA	150	30		
			5:3 FTCA	150	30		
			7:3 FTCA	150	30		
Per- and Polyfluoroalkyl Substances by LC/MS/MS, QSM Table B-24 **(NPW)**	1633_B24	1633_SPE	Perfluorobutanoic acid (PFBA)	148	30		
			Perfluoropentanoic acid (PFPeA)	152	30		
			Perfluorohexanoic acid (PFHxA)	152	30		
			Perfluoroheptanoic acid (PFHpA)	154	30		
			Perfluorooctanoic acid (PFOA)	161	30		
			Perfluorononanoic acid (PFNA)	149	30		
			Perfluorodecanoic acid (PFDA)	147	30		
			Perfluoroundecanoic acid (PFUnA)	159	30		
			Perfluorododecanoic acid (PFDoA)	142	30		
			Perfluorotridecanoic acid (PFTriA)	148	30		
			Perfluorotetradecanoic acid (PFTeDA)	161	30		
			Perfluorobutanesulfonic acid (PFBS)	144	30		
			Perfluoropentanesulfonic acid (PFPeS)	151	30		
			Perfluorohexanesulfonic acid (PFHxS)	146	30		
			Perfluoroheptanesulfonic acid (PFHpS)	152	30		
			Perfluorooctanesulfonic acid (PFOS)	149	30		
			Perfluorononanesulfonic acid (PFNS)	148	30		
			Perfluorodecanesulfonic acid (PFDS)	147	30		
			Perfluorododecanesulfonic acid (PFDoS)	145	30		
			4:2 FTS	146	30		
			6:2 FTS	151	30		
			8:2 FTS	152	30		
			Perfluorooctanesulfonamide (PFOSA)	148	30		
			NMeFOSA	145	30		
			NEtFOSA	139	30		
			NMeFOSAA	144	30		
			NEtFOSAA	146	30		
			NMeFOSE	136	30		
			NEtFOSE	137	30		
			HFPO-DA (GenX)	144	30		
			4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	146	30		
			PFMBA	148	30		
			NFDHA	161	30		
			PFMPA	145	30		
			9Cl-PF3ONS	156	30		
			11Cl-PF3OUdS	156	30		
			PFEESA	151	30		
			3:3 FTCA	129	30		
			5:3 FTCA	134	30		
			7:3 FTCA	138	30		

APPENDIX E

Sub-Slab Depressurization System
Component Specifications

RadonAway®

The world's leading radon fan manufacturer

RSA1 ALARM

RADON SYSTEM ALARM

The RadonAway RSA1 Radon System Alarm is an advanced vacuum monitoring device utilizing piezoresistive pressure sensor (PPS) technology. It provides homeowners with an easy-to-read, easy-to-use system monitor that requires no interpretation. Audible and visual indicators alert the homeowners to low radon system vacuum pressure in compliance with the latest ANSI/AARST *Soil Gas Mitigation Standards* system monitor requirements.

This monitor does not measure radon levels.

FEATURES

- Easy Installation
- Pipe or Wall Mount (2" - 6" Pipe)
- Battery Operated (No Wiring Required)
- Modern, Compact Design
- Vacuum Sensing
- Visual and Audible Indicators
- Alarm* and Service Delay Functions
- Hush and Test Buttons

*Visual alert only during first 48 hours, 7 days or 30 days depending on selected delay

RSA1 ALARM BENEFITS

The RadonAway RSA1 Radon System Alarm is more than just an alarm. It is a required radon system component that adds value as an important safety feature when installed. The RSA1 also provides a future income stream when you tie it into a service program that includes system inspection and retesting.

Added Value At a low additional cost, homeowners can be assured that they will be alerted if their radon system is not operating properly. As a safety feature and a system requirement it provides you with an add-on item that sells itself.

Return Business As part of a radon system service program, your one-time system installation customer becomes a long-term customer.

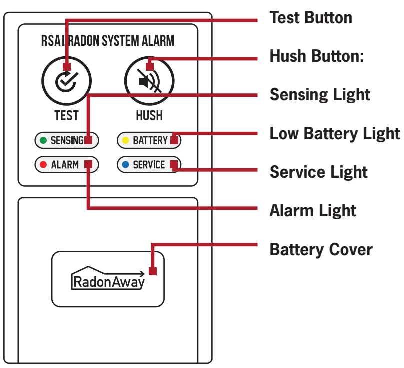
Mitigation Standard Compliance *Soil Gas Mitigation Standards for Existing Homes* (ANSI/AARST SGM-SF-2017) includes "Active Notification Monitors Required" (section 9.2.2), which states that "capacity for active visual and/or audible notification in the event of ASD (Active Soil Depressurization) fan or other mechanical failure shall be provided to actively warn occupants or other individuals responsible for monitoring." Installing the RSA1 Alarm with all your systems ensures that you are in compliance with this Radon Standard requirement.

RSA1 ALARM

PACKAGE INCLUDES

- RSA1 Radon System Alarm
- Wall Mount Adapter
- Pipe Mount Adapter
- Flexible Connector Elbow
- Battery
- Product Instructions

FUNCTIONAL SPECIFICATIONS



Sensing Light Normal Operation @:
-0.1" WC to -20" WC

Alarm Light:
Illuminates @ ≥90% reduction in baseline pressure

Service Light:
Illuminates upon 3+ Alarm activations within the selected alarm delay duration

Low Battery Light:
Illuminates @ <3.35 Volts (uses 3.6V 1/2 AA Battery)

Hush Button:
When pressed silences alarm for 7 days, also for alarm delay duration selection

Test Button:
When depressed activates audible alarm and illuminates lights

Alarm Dimensions:
2.19" x 3.75" x 1.37" (W x H x D)

Overpressure Condition:
+/- 20" WC (piezoresistive pressure sensor)

MOUNTING EXAMPLES


Remote horizontal pipe mount


Direct vertical pipe mount


Remote wall mount

RadonAway®

The world's leading radon fan manufacturer

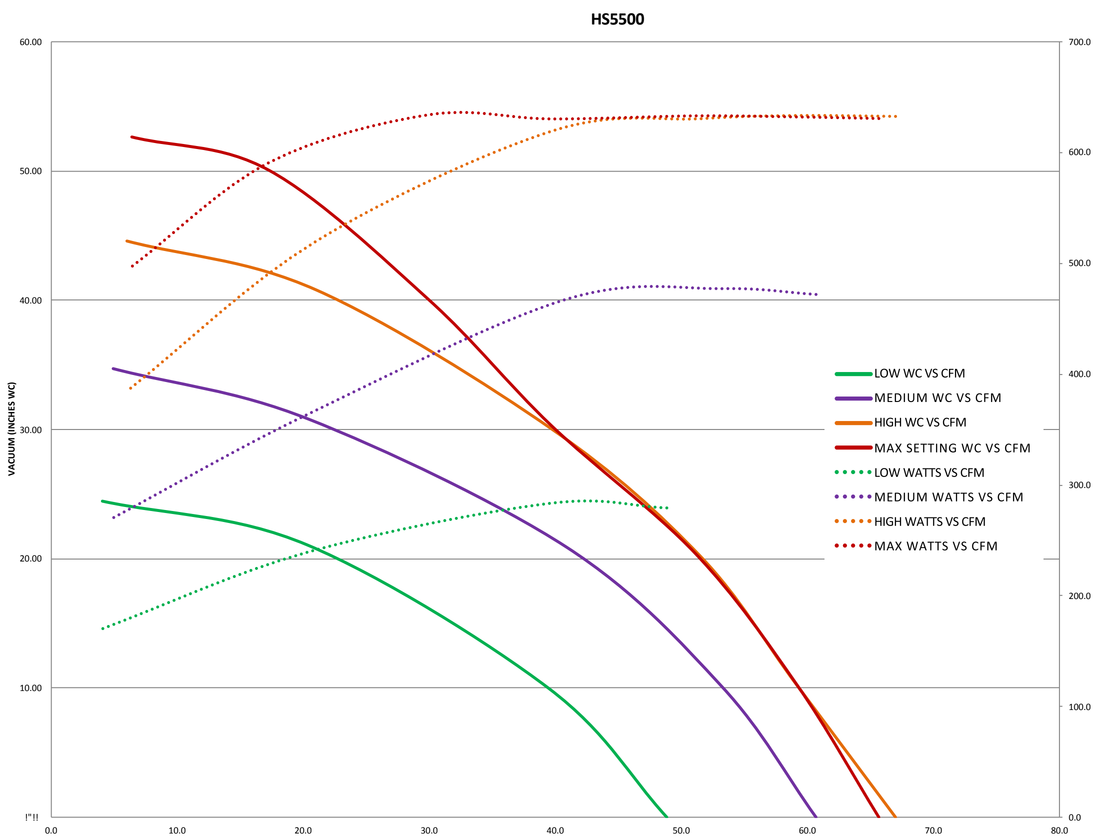
HS5500

RadonAway's new HS5500 is an ETL-listed high pressure blower that has been designed with the professional in mind. The HS5500 features multiple speed settings to meet site-specific pressures and air flows easily verified by a built in pressure gauge in the front cover of the unit. These blower units have a new electrical box design with a wire terminal strip along with two flexible pipe couplings for quick and easy site installation.

HS5500 FEATURES

- 4 Blower Speed Settings
- Integrated Condensate Bypass
- Designed for Easy Motor Replacement
- ETL Listed
- Built-in 60" Vacuum Gauge
- Quiet Operation
- 4-Stage Blower Designed for Harsh Environmental Conditions

SPEED SETTING	MAX RECOMMENDED OPERATING VACUUM	MAX OPERATING RANGE WATTS
LOW	20" WC	243-281
MEDIUM	30" WC	372-477
HIGH	40" WC	527-625
MAX	50" WC	591-632

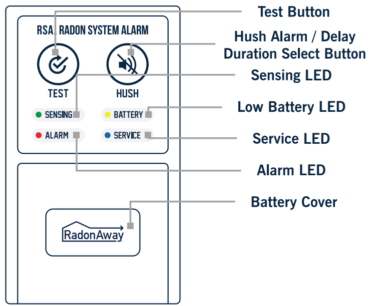


RSA1 Radon System Alarm

w/PPS Technology

US PATENT #11,513,017 B2

P/N 28535
Model# RSA1



ABOUT THE ALARM

The Radon System Alarm (alarm) is a vacuum monitoring product utilizing piezoresistive pressure sensor (PPS) technology. This product provides audible and visual indication when the Radon System vacuum pressure has dropped below the preset operating limit resulting in insufficient pressure to be effective.

BOX CONTENTS

- RSA1 Radon System Alarm
- Wall Mount Adapter (flat)
- Pipe Mount Adapter (curved)
- Silicone Alarm/Pipe Connector Elbow
- Battery
- Product Instructions
- Two Adapter Mounting Screws

FEATURES

- Easy Installation
- Battery Operated (No Wiring Required)
- Vacuum Sensing
- Visual and Audible Indicators
- Selectable Alarm & Service Delay Functions (48 Hours / 7 Days / 30 Days)
- Hush and Test Buttons
- Mounts on 2", 3", 4" or 6" Pipe, or Flat Surfaces

INSTALLATION INSTRUCTIONS

This alarm is for conditioned* indoor installations only and should be located in an area where it will be readily observed by the occupants. Outdoor installation will void the warranty!

*Conditioned: Living space or other space that is temperature and humidity controlled.

TOOLS NEEDED

A drill with 9/16" and 1/16" diameter drill bits are required for all installations to install the pipe connector bracket. A liquid level is recommended for proper alignment of the pipe insert bracket and/ or wall bracket.

DIRECT PIPE MOUNTING – HORIZONTAL & VERTICAL PIPE

1. Choose a location on the suction side of the radon fan (a minimum of 12 inches from fan) in an area readily observable by building occupants.
2. Drill a hole using a 9/16" drill bit. Clean hole of drill debris and burrs. NOTE: BEFORE AFFIXING THE ADAPTER, MAKE SURE THE PIPE LOCATION SURROUNDING THE HOLE IS CLEAN AND FREE OF DIRT, OILS, GREASE AND DEBRIS.
3. Without removing the protective film on the pipe mount adapter, test the fit by placing the adapter into the hole in the pipe and adjust hole if necessary.
4. Peel back the protective film on the mounting tape and insert the alarm bracket into the drilled hole, making sure it is level, and firmly press in place to seat mounting tape. NOTE: ADAPTER MUST BE PRESSED FIRMLY AGAINST PIPE FOR 30 SECONDS TO ENSURE THAT THE DOUBLESIDED TAPE BONDS TO THE PIPE AND BRACKET SURFACES.
5. Once the adapter has been affixed via the double-sided tape, secure the adapter plate using two of the four adapter plate holes and two screws provided with the alarm. Using a 1/16" drill bit, drill pilot holes in the pipe in the 9 and 3 O'clock positions and insert the two screws until flush with the bracket face. NOTE: REGARDLESS OF ADAPTER ORIENTATION (HORIZONTAL OR VERTICAL IN RELATION TO THE ALARM), USING THE TWO SCREW HOLES LOCATED AT 9 AND 3 O'CLOCK ENSURES THAT THE SCREWS DO NOT INTERFERE WITH SLIDING THE ALARM ONTO THE ADAPTER.
6. Connect the short leg end of the silicone pipe connector elbow to the alarm housing port located inside the battery compartment by pushing it onto the port barb.
7. Slide the alarm housing onto the pipe mounting with the alarm positioned in the vertical orientation.
8. Connect the open end of the silicone pipe connector elbow to the pipe mounting bracket port by pushing it onto the port barb.
9. The alarm is now installed and ready for activation. See ACTIVATION section for alarm activation instructions.

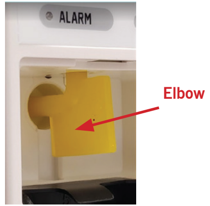
REMOTE – WALL MOUNTING

1. Mount the RSA1 Alarm within 50' of where the radon system piping will be monitored. Wall surface must be clean and free of dirt, oils and grease.
2. Using a liquid level and pencil, mark a line on the wall surface where the edge of the RSA1 housing will be located.
3. Mount the pipe adapter (at a minimum distance of 12 inches from the fan) on the suction side of the radon fan. Drill a hole using a 9/16" drill bit. Clean hole of drill debris and make sure the pipe surrounding the hole is clean and free of dirt, oils and grease.
4. Without removing the protective film on the pipe mount adapter, test the fit by placing the adapter into the hole in the pipe and adjust hole if necessary.
5. Peel back the protective film on the mounting tape and insert the pipe mounting bracket onto the radon system pipe.
6. Connect one end of the tubing (50' max; sold separately) to the pipe mount adapter by pushing the tubing onto the port barb. Route the tubing to the location where the RSA1 alarm will be mounted, avoiding pinching or kinking the tubing along the way.
7. Insert the tubing into the hole located at the bottom of the alarm housing until it reaches into the battery compartment.
8. Connect the tubing to the alarm housing by pushing the tubing onto the port barb. Slide the wall mounting bracket into the back of the alarm housing.
9. Peel back the protective film on the mounting tape and firmly press the assembled alarm/bracket assembly onto the wall to seat mounting tape, making sure it is aligned with the pencil mark previously placed on the wall.

Note: RSA1 uses a permanent tape that may cause damage if removed. If you must remove the mounted device, use a piece of dental floss or wire held tautly between two hands. Pull back and forth to split the tape, and release the mounted object. (See ACTIVATION section for alarm activation instructions).

ACTIVATION

Prior to alarm activation, make sure both ends of the silicone pipe connector elbow are connected and the mitigation fan is running. Ensure battery is properly seated. Alarm is now powered on and will begin the activation sequence automatically.



CALIBRATION

The RSA1 self-calibrates automatically upon installation of the battery. After the alarm is powered on, the system will run a 20-second initialization to measure baseline system operating pressure. The green sensing LED will flash during this time. A single beep of the buzzer will indicate the initialization is complete and the alarm is now active. No additional calibration is necessary.

AUDIBLE ALARM DELAY SELECTION

The RSA1 comes equipped with three optional audible & service alarm delays. To select the desired alarm delay duration complete the following steps:
Step 1: Press and hold "Hush" button for a minimum of 5 seconds to start the time delay selection mode.
Step 2: Keep "Hush" button held down until the desired time delay appears (every 5 seconds) as shown below:

LED States	Descriptions	Delay durations	Note
SENSING ALARM	Both the "SENSING" and the "ALARM" LED's are lighted up.	48 hours	Default
SENSING	Only the "SENSING" LED is lighted up.	7 days	Selected by holding down Hush button for 5 Seconds
ALARM	Only the "ALARM" LED is lighted up.	30 days	Selected by holding "Hush" button down for 10 seconds

Step 3: Stop depressing "Hush" button when desired time delay appears as indicated by the LEDs. Time delay selection mode will cycle in a continual loop until the "Hush" button is no longer depressed. Once the "Hush" button is no longer depressed the time delay mode will no longer be activated.

FUNCTIONAL MODES

Sensing Mode (Visual Only) - Green sensing LED blinks @ 60-second intervals (3 flashes).

Pre-Alarm Mode (Visual Only) - Red alarm LED blinks @ 60-second intervals when low or no pressure is sensed. Pre-alarm ends when the pressure is restored within the selected delay duration or it enters Alarm Mode.

Alarm Mode - After selected delay duration, buzzer beeps and Red alarm LED flashes, then no light or beep for 60 seconds, then repeat until "Hush" is pressed or system is serviced.

Service Mode - After 3 pre-alarm conditions occur within the selected delay duration, buzzer beeps and Blue service LED flashes, then no light or beeps for 60 seconds, then repeat until "Hush" is pressed or system is serviced.

Hush Mode - Silences audible sound for 7 days but visual remains as programmed; after 7 days goes back to sensing mode, alarm mode (with sound) or service mode (with sound).

Low Battery Mode - 1 "chirp" and simultaneous flash @ 5-minute intervals.

Test Mode - Audible "beep" sounds and all LEDs illuminate when "Test" button pressed.

FUNCTIONAL SPECIFICATIONS

Sensing Range:	-0.1"WC to -20"WC
Alarm Range:	≥90% reduction of baseline pressure
Service Condition:	3+ Pre-Alarm Trig. @ 48 Hrs After 48 Hours, 7 Days or 30 Days
Low Battery Condition:	<3.35 V
Hush Button:	Silences alarm sound for 7 days
Test Button:	Sounds alarm / activates lights
Dimensions:	W x H x D (2.19" x 3.75" x 1.37")
Overpressure:	±20"WC
Audible Alarm:	≈85 dba

Indicator LED Explanation

Sensing, Green LED (Flashing)
= Operating / Sensing
Alarm, Red LED (Flashing)
= Low / No Pressure (Vacuum)
Service, Blue LED (Flashing)
= Service Mode
Battery, Yellow LED (Flashing)
= Low Battery

BATTERY REPLACEMENT/ RE-INSTALLATION

1. Remove existing battery.
2. Press and hold "TEST" button for 15 seconds to ensure that the alarm is de-energized.
3. Be sure fan is operating and alarm tubing is still connected.
4. Install new battery and make sure it is properly seated.
5. 20-Second self-calibration operation will then begin.
(refer to CALIBRATION section for additional information).

WARRANTY INFORMATION

Subject to applicable consumer protection legislation, RadonAway warrants that the Alarm (model RSA1) will be free from defective material and workmanship for a period of (2) years from the date of purchase. Warranty is contingent on installation in accordance with the instructions provided. This warranty does not apply where repairs or alterations have been made or attempted by others; or the unit has been abused or misused. Warranty does not include damage in shipment unless the damage is due to the negligence of RadonAway. All other warranties, expressed or written, are not valid. To make a claim under these limited warranties, you must return the defective item to RadonAway with a copy of the purchase receipt. RadonAway is not responsible for installation or removal cost associated with this warranty.In no case is RadonAway liable beyond the repair or replacement of the defective product FOB RadonAway.

THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF. THERE IS NO WARRANTY OF MERCHANTIBILITY. ALL OTHER WARRANTIES, EXPRESSED OR WRITTEN, ARE NOT VALID.

For service under these warranties, contact RadonAway for a Return Material Authorization (RMA) number and shipping information. No returns can be accepted without an RMA. If factory return is required, the customer assumes all shipping costs to and from factory.

3 Saber Way Ward Hill, MA 01835

07/23 IN098 Rev H

HS2750 and HS5500 Installation & Operating Instructions

DO NOT CONNECT POWER SUPPLY UNTIL BLOWER IS COMPLETELY INSTALLED.
MAKE SURE ELECTRICAL SERVICE TO BLOWER IS LOCKED IN “OFF” POSITION. DISCONNECT POWER BEFORE SERVICING.

1. **WARNING!** Do not use blower in hazardous environments where blower electrical system could provide ignition to combustible or flammable materials.

2. **WARNING!** Check voltage at the blower to ensure it corresponds with nameplate. See Vapor Intrusion Application Note #AN001 for important information on VI Applications. RadonAway.com/vapor-intrusion

3. **WARNING!** Normal operation of this device may affect the combustion airflow needed for safe operation of fuel burning equipment. Check for possible backdraft conditions on all combustion devices after installation.

4. All wiring must be performed in accordance with the National Fire Protection Association’s (NFPA) “National Electrical Code, Standard #70”-current edition for all commercial and industrial work, and state and local building codes. All wiring must be performed by a qualified and licensed electrician.

5. **WARNING!** In the event that the blower is immersed in water, return unit to factory for service before operating.

6. **WARNING!** Do not twist or torque blower inlet or outlet piping as leakage may result.

7. **WARNING!** Do not leave blower unit installed on system piping without electrical power for more than 48 hours. Blower failure could result from this non-operational storage.

8. **WARNING!** TO REDUCE THE RISK OF FIRE, ELECTRIC SHOCK, OR INJURY TO PERSONS, OBSERVE THE FOLLOWING:

    a) Use this unit only in the manner intended by the manufacturer. If you have questions, contact the manufacturer.

    b) Before servicing or cleaning unit, switch power off at service panel and lock the service disconnecting means to prevent power from being switched on accidentally. When the service disconnecting means cannot be locked, securely fasten a prominent warning device, such as a tag, to the service panel.

1.0 SYSTEM DESIGN CONSIDERATIONS

1.1 INTRODUCTION
The HS2750 and HS5500 Blowers are intended for use by trained, certified/licensed, professional radon mitigators. The purpose of these instructions is to provide additional guidance for the most effective use of the HS2750 and HS5500 Blowers. These instructions should be considered supplemental to current industry standards and federal, state, county and local building codes and regulations. In the event of a conflict, those codes, practices and regulations take precedence over these instructions.

1.2 ENVIRONMENTALS
The HS2750 and HS5500 Blowers are designed to perform year-round in all but the harshest climates without additional concern for temperature or weather. For installations in an area of severe cold weather, please contact RadonAway for assistance. When not in operation, HS2750 and HS5500 Blowers should be stored in an area where the temperature is always greater than 32°F or less than 100°F. The HS2750 and HS5500 Blowers are thermally protected such that they will shut off when the internal temperature is above 185°F / 85°C. If the HS2750 or HS5500 Blower is idle in an area where the ambient temperature exceeds this shut off, it will not restart until the internal temperature falls below 75°C.

1.3 ACOUSTICS
The HS2750 or HS5500 Blower, when installed properly, operates with little or no noticeable noise to the building occupants. Recommended system design and installation considerations to minimize noise: When installing the HS2750 or HS5500 Blower above sleeping areas, select a location for mounting at the farthest possible distance. Avoid mounting near doors, fold-down stairs or other uninsulated structures which may transmit sound. Ensure a solid mounting for the HS2750 or HS5500 Blower to avoid structure-borne vibration or noise.

The velocity of the outgoing air must also be considered in the overall system design. With small diameter piping, in some cases a “rushing” sound of the outlet air may be audible. In these instances, the use of a RadonAway Exhaust Muffler (p/n 24002) is recommended.

1.4 GROUND WATER
Under no circumstances should water be allowed to be drawn into the inlet of the HS2750 and HS5500 Blowers as this may result in damage to the unit. The HS2750 or HS5500 Blower should be mounted at least 5 feet above the slab penetration to minimize the risk of filling the Blower with water in installations with occasional high water tables.

In the event that a temporary high water table results in water at or above slab level, water will be drawn into the riser pipes thus blocking air flow to the HS2750 or HS5500 Blower. The lack of cooling air will result in the Blower cycling on and off as the internal temperature rises above the thermal cutoff and falls upon shutoff. Should this condition arise, power down and disconnect the HS2750 or HS5500 Blower until the water recedes allowing for return to normal operation; then reconnect and power on to turn the Blower back on.

1.5 CONDENSATION & DRAINAGE
WARNING!: Failure to provide adequate drainage for condensation can result in system failure and damage the HS Blower.
Condensation is formed in the piping of a mitigation system when the air in the piping is chilled below its dew point. This can occur at points where the system piping goes through unheated space such as an attic, garage or outside. The system design must provide a means for water to drain back to a slab hole to remove the condensation.

The use of small diameter piping in a system increases the speed at which the air moves. The speed of the air can pull water uphill and, at sufficient velocity, it can actually move water vertically up the side walls of the pipe. This has the potential of creating a problem in the negative pressure (inlet) side piping. For HS2750 or HS5500 Blower inlet piping, the following table provides the minimum recommended pipe diameters as well as minimum pitch under several system conditions. Use this chart to size piping for a system.

Pipe Diameter	Minimum Rise per 1 Foot of Run*		
	@ 25 CFM	@ 50 CFM	@ 100 CFM
4”	1/32”	3/32”	3/8”
3”	1/8”	3/8”	1 1/2”

*Typical operational flow rates:

All exhaust piping should be 2” PVC.

1.6 SYSTEM MONITOR & LABEL

A properly designed system should incorporate a “System On” indicator for affirmation of system operation. The HS2750 and HS5500 Blowers come equipped with a built-in magnehelic pressure gauge located on the front cover which serves this purpose. Other indicator products such as u-tube manometers should be mounted at least 5 feet above the slab penetration to minimize the risk of filling the gauge with water in installations with occasional high water tables. If required, place in a conspicuous location a System Label (such as RadonAway P/N 15005-20) with instructions for contacting the installing contractor for service and also identifying the necessity for regular radon tests to be conducted.

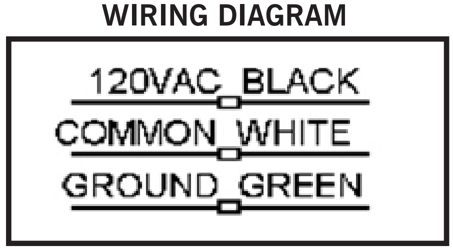
1.7 SLAB COVERAGE

The HS2750 or HS5500 Blower can provide coverage of well over 1000 sq. ft. per slab penetration. This will, of course, depend on the sub-slab aggregate in any particular installation and the diagnostic results. In general, sand and gravel are much looser aggregates than dirt and clay. Additional suction points can be added as required. It is recommended that a small pit (5 to 10 gallons in size; larger as needed) be created below the slab at each suction hole. When fine sand or dirt is present it is recommended that the pit be lined with a material such as clean gravel, size 4, 5, 56, or 6 as classified (ASTM C33).

1.8 ELECTRICAL WIRING

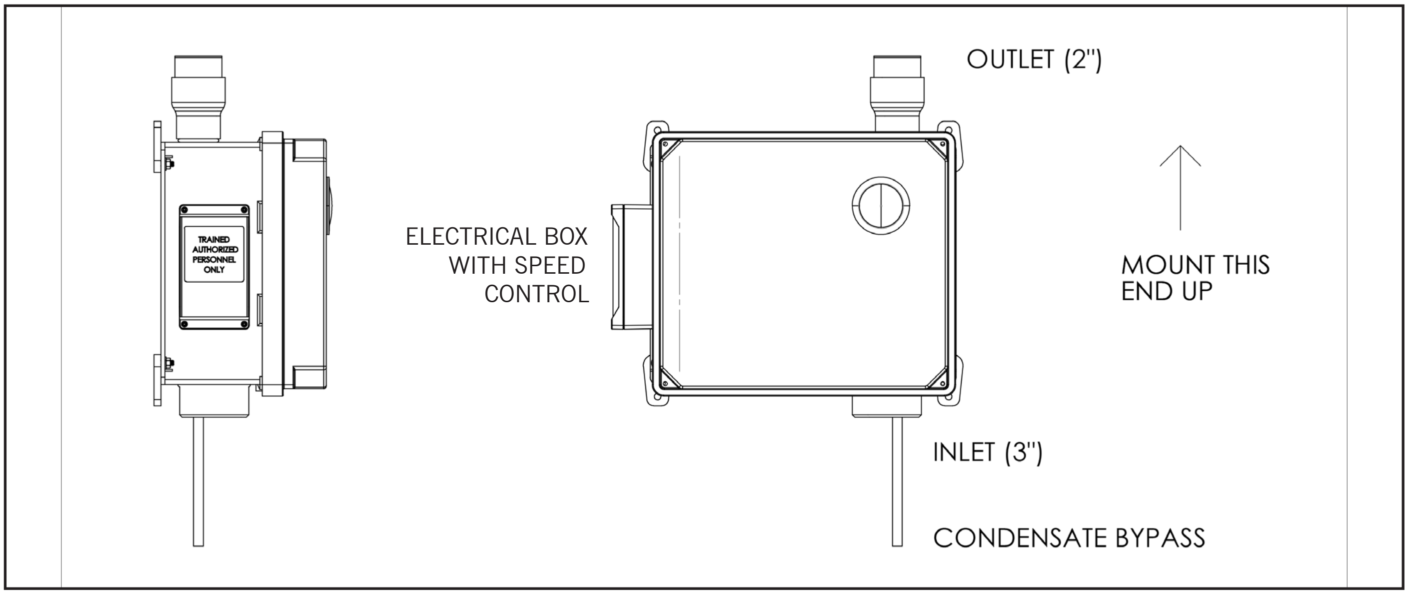
HS2750 or HSHS5500 Blower models come with an electrical switch box for hard wiring to a 120V electrical source. All wiring must be performed in accordance with the National Fire Protection Association’s (NFPA)”National Electrical Code, Standard #70”-current edition for all commercial and industrial work, and state and local building codes. All wiring must be performed by a qualified and licensed electrician. Outdoor installations require the use of a UL listed watertight conduit. Ensure that all exterior electrical boxes are outdoor rated and properly caulked to prevent water penetration into the box. A means, such as a weep hole, is recommended to drain the box.

WIRING DIAGRAM



1.9 SPEED CONTROLS

The HS2750 and HS5500 have 4-speed (low, medium, high, maximum) built-in speed controls. They are not safe for use with solid state speed controls.



2.0 INSTALLATION

2.1 MOUNTING

Mount the HS2750 or HS5500 Blower to the wall studs, or similar structure, in the selected location with (4) 1/4" x 1 1/2" lag screws (not provided). Ensure the HS2750 or HS5500 Blower is both plumb and level.

2.2 DUCTING CONNECTIONS

Make final ducting connection to HS2750 or HS5500 Blower with flexible couplings. Ensure all connections are tight. Do not twist or torque inlet and outlet piping on HS2750 or HS5500 Blower or leaks may result.
NOTE: Do NOT solvent weld fittings to unit hubs.

2.3 VENT MUFFLER INSTALLATION

Install the muffler assembly in the selected location in the outlet ducting. Solvent weld all connections. The muffler is normally installed above the roofline at the end of the vent pipe.

2.4 OPERATION CHECKS & ANNUAL SYSTEM MAINTENANCE

______ **Verify** all connections are tight and **leak-free**.

______ **Ensure** the HS2750 or HS5500 Blower and all ducting is secure and vibration-free.

______ **Verify** system vacuum pressure with Magnehelic. **Ensure** vacuum pressure is within normal operating range and **less than** the maximum recommended as shown below:

HS2750: 5" WC (low) / 10" WC (medium) / 15" WC (high) / 20" WC (maximum)
HS5500: 20" WC (low) / 30" WC (medium) / 40" WC (high) / 50" WC (maximum)

(Above are based on sea-level operation, at higher altitudes reduce above by about 4% per 1000 Feet.)
If these are exceeded, increase number of suction points.

______ **Verify Radon levels** by testing to applicable current industry standards and federal, state, county and local building codes and regulations.

HS2750 and HS5500 PRODUCT SPECIFICATIONS

Model	Speed Setting (Max. Op. Pressure: "WC@Sea Level)	Typical CFM vs Static Suction WC (Recommended Operating Range)								Power* Watts @ 120VAC
		2.5"	5.0"	7.5"	10.0"	12.5"	15.0"	20.0"	25.0"	
HS2750	**Low** (5")	33	24	n/a	n/a	n/a	n/a	n/a	n/a	112-123
	Medium (10")	47	42	34	25	n/a	n/a	n/a	n/a	199-245
	High (15")	n/a	n/a	47	43	33	23	n/a	n/a	266-337
	Maximum (20")	n/a	n/a	n/a	n/a	48	43	24	n/a	361-463

Shutoff Pressure ("WC @ Sea Level): Low 7.8", Med 13.5", High 17.6", Max 22.6"
**Power consumption varies with actual load conditions*

Model	Speed Setting (Max. Op. Pressure: "WC@Sea Level)	Typical CFM vs Static Suction WC (Recommended Operating Range)								Power* Watts @ 120VAC
		5.0"	10.0"	20.0"	25.0"	30.0"	35.0"	40.0"	50.0"	
HS5500	**Low** (20")	44	39	22	n/a	n/a	n/a	n/a	n/a	243-281
	Medium (30")	n/a	n/a	53	41	36	22	n/a	n/a	372-477
	High (40")	n/a	n/a	n/a	45	39	31	22	n/a	527-625
	Maximum (50")	n/a	n/a	n/a	n/a	n/a	34	29	17	591-632

Shutoff Pressure ("WC @ Sea Level): Low 24.5", Med 34.7", High 44.6", Max 52.6"
**Power consumption varies with actual load conditions*

Number Of Speeds: 4
Volts: 120
Hz: 60
AMPS (Max): 4
Inlet: 3" PVC (3.5" OD)
Outlet: 2" PVC (2.37" OD)
Mounting: Brackets for vertical mount
Weight: HS2750, 18 lbs; HS5500, 19.25 lbs
Size: 17.5" W x 9.0" D x 18.5" H
Minimum Recommended PVC Ducting (2" / 3" / 4" / 6" / 8"): 3" Inlet; 2" Outlet
Storage Temperature Range: 32°F-100°F
Thermal Cutout: 185°F / 85°C
Locked rotor protection

LISTED
Electric Fan

C ETL LISTED US
Intertek

Conforms to
UL STD. 507
Certified to
CAN/CSA STD.
C22.2 No.113

IMPORTANT INSTRUCTIONS TO INSTALLER

Inspect the RadonAway® HS2750 or HS5500 Blower for shipping damage within 15 days of receipt. **Notify RadonAway® of any damages immediately.** RadonAway® is not responsible for damages incurred during shipping.

Install the HS2750 or HS5500 Blower in accordance with all current industry standards and federal, state, county and local building codes and regulations.

Provide a copy of this instruction or comparable radon system and testing information to the building occupants after completing system installation.

Warranty

RadonAway® warrants that the HS2750/HS5500 Blower (the "Blower") will be free from defects in materials and workmanship for a period of 12 months from the date of purchase or 18 months from the date of manufacture, whichever is sooner (the "Warranty Term").

RadonAway® will replace or repair any Blower which fails due to defects in materials or workmanship during the Warranty Term. This Warranty is contingent on installation of the blower in accordance with the instructions provided. This Warranty does not apply where any repairs or alterations have been made or attempted by others, or if the unit has been abused or misused. Warranty does not cover damage in shipment unless the damage is due to the negligence of RadonAway®.

The Blower must be returned (at Owner's cost) to the RadonAway® factory. Any Blower returned to the factory will be discarded unless the Owner provides specific instructions along with the Blower when it is returned regardless of whether or not the Blower is actually replaced under this warranty. Proof of purchase must be supplied upon request for service under this Warranty.

2-YEAR EXTENDED WARRANTY WITH INSTALLATION BY A FACTORY-CERTIFIED PROFESSIONAL

RadonAway® will extend the Warranty Term of the Blower to twenty-four (24) months from date of purchase or thirty (30) months from the date of manufacture, whichever is sooner, if: (1) the Blower is installed in a professionally designed and professionally installed active soil depressurization system or installed as a replacement Blower in a professionally designed and professionally installed active soil depressurization system; and (2) proof of an installer Factory Training Certificate. Upon request, proof of purchase and/or proof of professional installation may be required for service under this warranty. No extended warranty is offered outside the Continental United States and Canada beyond the standard 12 months from the date of purchase or 18 months from the date of manufacture, whichever is sooner. RadonAway® is not responsible for installation, removal or delivery costs associated with this Warranty.

EXCEPT AS STATED ABOVE, THE HS2750/HS5500 BLOWERS ARE PROVIDED WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

IN NO EVENT SHALL RADONAWAY BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES ARISING OUT OF, OR RELATING TO, THE BLOWER OR THE PERFORMANCE THEREOF. RADONAWAY'S AGGREGATE LIABILITY HEREUNDER SHALL NOT IN ANY EVENT EXCEED THE AMOUNT OF THE PURCHASE PRICE OF SAID PRODUCT. THE SOLE AND EXCLUSIVE REMEDY UNDER THIS WARRANTY SHALL BE THE REPAIR OR REPLACEMENT OF THE PRODUCT, TO THE EXTENT THE SAME DOES NOT MEET WITH RADONAWAY'S WARRANTY AS PROVIDED ABOVE.

For service under this Warranty, contact RadonAway for a Return Material Authorization (RMA) number and shipping information. No returns can be accepted without an RMA. If factory return is required, the customer assumes all shipping costs, including insurance, to and from factory.

RadonAway®
3 Saber Way
Ward Hill, MA 01835 USA
TEL (978) 521-3703
FAX (978) 521-3964
Email to: Returns@RadonAway.com

Record the following information for your records:

Serial No. ____

Purchase Date: ____

APPENDIX F

Sub-Slab Depressurization System
Operations and Maintenance Form

SUB-SLAB DEPRESSURIZATION SYSTEM OPERATIONS AND MAINTENANCE FORM

Site Name:	12 Franklin Street	Inspection Date:	______
Street Address:	12 Franklin Street		
Location:	Brooklyn, NY	Inspection Personnel:	______
System:	Active Sub-Slab Depressurization System		
Blower:	______		______
Blower Range:			

INSPECTION ITEM DESCRIPTION	Yes	No	Comments/ Actions Taken (list actions taken if "No" is checked)
Is the system operating normally?	___	___	______
Are any warning lights on? (Please list those that are on)	___	___	______
If there is an alarm condition, was it fixed and the system restarted?	___	___	______
Is the blower enclosure in good condition?	___	___	______
Are the valves (at blower and aboveground piping) in good condition?	___	___	______
Is the vacuum filter in good condition?	___	___	______
Does the knock-out tank need to be drained? (Record amount draine	___	___	______
Are aboveground piping free of cracks, leaks, and support issues?	___	___	______
Are vacuum/pressure gauges at blower operating properly?	___	___	______
Are interior piping free of cracks, leaks, and support issues?	___	___	______

List maintenance activities that were performed or ______

other comments about the system: ______

Blower Influent	Vacuum (in. w.c.)	Comments

Blower Effluent	Pressure (in. w.c.)	Comments

PERFORM THE FOLLOWING ONLY IF A VACUUM READING AT THE MONITORING POINTS IS LESS THAN 0.004 IN. W.C.

INSPECTION ITEM DESCRIPTION	Yes	No	Comments/ Actions Taken (list actions taken if "No" is checked)
Are interior vacuum gauges operating properly?	___	___	______

Monitoring Point*	Vacuum (in. w.c.)	Comments
MP-1		
MP-2		
MP-3		
MP-4		
MP-5		
MP-6		
MP-7		

in. w.c. - inches of water
* Refer to Drawing 1 for locations of Soil Vapor Monitoring Points and Suction Points

ROUX