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SUPPLEMENTAL REMEDIAL INVESTIGATION WORK PLAN – PHASE 2

SULZER METCO, INC. SITE
1101 PROSPECT AVENUE
WESTBURY, NEW YORK
NYSDEC SITE NO. 130178

by
H & A of New York Engineering and Geology, LLP
Rochester, New York

for
New York State Department of Environmental Conservation
Albany, New York

File No. 0127841-008
November 2025

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November 4, 2025
File No. 0127841-008

New York State Department of Environmental Conservation
Division of Environmental Remediation
625 Broadway
Albany, NY 12233

Attention: Alexander Klein

Subject: Supplemental Remedial Investigation Work Plan - Phase 2
Sulzer Metco, Inc. Site
1101 Prospect Avenue
Westbury, New York
NYSDEC Site No. 130178

Ladies and Gentlemen:

On behalf of Oerlikon Metco (U.S.) Inc. (“Oerlikon Metco”), Respondent to the New York State Department of Environmental Conservation (NYSDEC) Order on Consent Index No.: CO1-20230807-157 (Order) dated October 6, 2023, H & A of New York Engineering and Geology, LLP (“Haley & Aldrich of New York”) is submitting this Supplemental Remedial Investigation Work Plan – Phase 2 (SRIWP-P2) for the subject site (“Site”) located at 1101 Prospect Avenue in Westbury, New York.

On August 6, 2025 Haley & Aldrich of New York submitted a Supplemental Remedial Investigation Report (SRIR) to the NYSDEC summarizing Supplemental RI activities conducted in 2024 to confirm whether previously identified low level impacts of tetrachloroethene (PCE) to sub-slab soil vapor remain at the Site and the nature and extent of per- and polyfluoroalkyl substances (PFAS) beneath the Site and off-Site in the downgradient direction from the highest PFAS concentrations detected in groundwater on Site. This SRIWP-P2 presents the scope of additional subsurface investigations recommended in the August 2025 SRIR and discussed with the NYSDEC, and has been developed in general accordance with the NYSDEC DER-10/Technical Guidance for Site Investigation and Remediation, dated May 3, 2010 (DER-10) and NYSDEC Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS), dated April 2023 (“NYSDEC 2023 PFAS Guidance”).

Sincerely yours,
H & A OF NEW YORK ENGINEERING AND GEOLOGY, LLP

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Enclosures

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https://haleyaldrich.sharepoint.com/sites/OerlikonMetcoUSInc/Shared Documents/0127841.1101 Prospect Ave/008 - PFAS RIWP/Deliverables/2025_PFAS_RIWP_Phase2/2025_1104_HANY_SulzerMetcoSite130178_SRIWP_Phase2_V2-F.docx

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SUPPLEMENTAL REMEDIAL INVESTIGATION WORK PLAN – PHASE 2
SULZER METCO, INC. SITE
1101 PROSPECT AVENUE
WESTBURY, NEW YORK
NYSDEC SITE NO. 130178

PREPARED FOR
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
ALBANY, NEW YORK

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1. Introduction and Purpose

This Supplemental Remedial Investigation Work Plan – Phase 2 (SRIWP-P2) has been prepared by H & A of New York Engineering and Geology, LLP (Haley & Aldrich of New York) on behalf of Oerlikon Metco (US) Inc. (Oerlikon Metco) as required by the New York State Department of Environmental Conservation (NYSDEC) Order on Consent Index No.: CO1-20230807-157 for the Sulzer Metco, Inc. Site (No. 130178) located at 1101 Prospect Avenue, Westbury, Nassau County, New York (Site; Figure 1). Oerlikon Metco is the Respondent to the Order. A Revised Remedial Investigation Work Plan (RIWP) was submitted to the NYSDEC on March 6, 2024, and approved with modifications on April 5, 2024.

The RIWP provided the scope of work for a supplemental remedial investigation (RI) to confirm whether previously identified low level impacts of tetrachloroethene (PCE) to sub-slab soil vapor remain at the Site and the nature and extent of per- and polyfluoroalkyl substances (PFAS) in soil and groundwater beneath the Site and off-Site groundwater in the downgradient direction from the historically highest PFAS concentrations detected at previously installed groundwater wells on the Site.

Supplemental RI activities have provided sufficient information to understand the nature and extent of chlorinated volatile organic compounds (CVOCs) in Site sub-slab soil vapor and indoor air. Continued annual monitoring of sub-slab soil vapor and indoor air during the heating season were recommended to confirm that future CVOC concentrations do not increase such that mitigation would be recommended by the New York State Department of Health (NYSDOH) Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York (NYSDOH SVI Guidance, 2006, with updates through 2024).

PFAS soil investigations conducted during the 2024 Supplemental RI activities were conducted proximal to and immediately downgradient from a former subsurface discharge leach field (referred to as "Outfall #3") and a drywell (D-4A), collectively referred to as the "Outfall #3 Area." Elevated concentrations of the regulated PFAS compounds perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) detected in groundwater monitoring wells MW-1 and MW-1D located adjacent to and immediately downgradient from the Outfall #3 Area suggest unidentified soils in the vicinity may be an ongoing source of the anomalous PFOA and PFOS concentrations observed in groundwater in the southeastern corner of the Site. The SRIR recommended that additional soil investigation activities be conducted to assess the potential for an unidentified source of PFAS upgradient and proximal to monitoring wells MW-1 and MW-1D. The SRIR also recommended that one additional cluster of groundwater monitoring wells be installed upgradient and proximal to the existing groundwater wells MW-1 and MW-1D, and all existing wells should be sampled again to confirm results to date. Finally, the SRIR recommended an additional assessment of unsaturated soils beneath the stormwater recharge basin in the northwest corner of the Site to evaluate the horizontal and vertical extent of PFOA detected in a surficial soil sample collected from the basin during Supplemental RI activities.

This SRIWP-P2 has been prepared in general accordance with the NYSDEC DER-10/Technical Guidance for Site Investigation and Remediation (DER-10) and NYSDEC Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS), dated April 2023 ("NYSDEC 2023 PFAS Guidance").

1.1 SITE DESCRIPTION

The Sulzer Metco, Inc. Site (No. 130178) is an approximately 6.88-acre active industrial property located at 1101 Prospect Avenue in a mixed-use area of Westbury, New York in the Town of North Hempstead (see Figures 1 and 2). The Site area is generally characterized as suburban with mixed-use industrial, commercial, and residential properties. The Site is bordered to the north and east by a private drive (Bridge Street), beyond which are the Nassau County Board of Cooperative Education Services (BOCES) buildings; to the south by Prospect Avenue, beyond which is the Nassau County Department of Public Safety (NCDPS; 1194 Prospect Avenue); and to the west by undeveloped land and the Wantagh State Parkway. The Site is developed with an approximately 170,000 square feet (approximately 15,800 square meters) one/two-story brick industrial building originally constructed in 1954.

1.2 SITE HISTORY

The Site building was originally owned by the Axluf Corporation, which was owned by the Metalizing Engineering Company (later known as Metco). Perkin-Elmer Corporation acquired Metco in 1971 and continued to operate the Site. The Sulzer Corporation acquired Metco from the Perkin-Elmer Corporation in 1994 and integrated the two companies under the name of Sulzer Metco. In 2014, the Oerlikon Group acquired the Metco division from Sulzer, and the name of the company was changed to Oerlikon Metco.

Oerlikon Metco is a manufacturer and supplier of thermal spray equipment and materials. Activities conducted at the Site, currently and historically, includes the manufacturing of thermal spray materials and equipment, research and development (R&D) of new thermal spray products, distribution and warehousing, field service/repair and systems integration, application of thermal spray coatings to customer supplied equipment, and shared service activities. Thermal spray involves spraying fine molten or semi molten metal and/or ceramic particles onto substrates to form a coating layer. The primary customers for the products manufactured at the Site are the aerospace, defense, and oil and gas industries.

To the best of its knowledge Oerlikon Metco does not manufacture, process, or use PFAS or PFAS-containing materials. Oerlikon Metco also has reported no knowledge of historical manufacturing, processing, or other activities using PFAS containing materials. Additionally, the facility is a zero-wastewater discharge facility.

According to available records, industrial solvents and degreasers were historically used in the manufacturing processes at the Site. Solvents were reportedly used circa 1955 to 1978 and included tetrachloroethene (PCE), trichloroethene (TCE), 1,1-dichloroethane (1,1-DCA), and 1,1,1-trichloroethane (TCA).

Prior to 1983, process and sanitary wastewater reportedly discharged "through a series of leach fields and recharge basins to the south and northeast of Building 1. There is limited information relating to the historic piping and discharge system (Dvirka and Bartilucci, 2007; AECOM, 2012, on behalf of the NYSDEC)." Historical State Pollution and Discharge Elimination System (SPDES) records reviewed by AECOM (2012) indicate that that sanitary and industrial wastewater, including spent solvents, were reportedly disposed into floor drains connected to on-Site subsurface discharge leach fields identified as "Outfalls #1 to #4" (see Figure 3). AECOM (2012) also indicated that sanitary wastewater was historically originally routed to cesspools, locations of which have not been identified. The Site was reportedly connected to the municipal sewer in 1983, at which time Outfalls #1 to #4 (Figure 3) were reportedly abandoned (Dvirka and Bartilucci, 2007; AECOM, 2012). It has been assumed that Outfalls #1 to #4 are the same as the leach fields and recharge basins mentioned in previous reports (Dvirka and Bartilucci, 2007; AECOM, 2012).

1.3 PHYSICAL SETTING

1.3.1 Topographic Conditions

The Site is relatively flat, with an approximate elevation of 138 feet above mean sea level (ft AMSL; North American Vertical Datum of 1988; Figure 2). A stormwater recharge basin is located in the northwest corner of the Site, with a bottom elevation of approximately 127 ft AMSL. There is a slight decreasing topographic gradient to the south and across Prospect Avenue to the NCDPS property. Ground surface elevations at the NCDPS property range between 136 ft AMSL in the northwest corner to 130 ft AMSL along the southern boundary.

1.3.2 Regional Geologic Conditions

According to the United State Geologic Survey (USGS, 2020) and previously prepared reports, the subsurface soils in the vicinity of the Site are generally described as Pleistocene-age glacial outwash deposits predominantly characterized by brown, medium to coarse grained sand with minor amounts of fine sand and silt. Regional subsurface geologic data suggest that these glacial outwash deposits extend to depths of approximately 55-75 feet below ground surface (ft bgs) and together comprise what is known as the Upper Glacial Aquifer (UGA). These glacial outwash deposits are typically underlain by Cretaceous-age interbedded sand and gravel deposits with sporadic silt and clay lenses, extending to depths >600 ft bgs, which together comprise what is known as the Magothy Aquifer and Matawan Group (Magothy).

1.3.3 Groundwater Hydrology

The groundwater systems on Long Island are comprised of three major aquifers: The Upper Glacial Aquifer, the Magothy Aquifer, and the Lloyd Aquifer. The groundwater table is typically observed at depths of approximately 55 to 65 ft bgs, near the geologic contact between the Upper Glacial and the Magothy Aquifers. Groundwater flow in the vicinity of the Site is generally to the south.

The Magothy Aquifer is a principal source of potable water in the vicinity of the Site. Municipal public water supply wells are located approximately 1 mile southwest and 1.2 miles southeast of the Site and are generally screened at depths between approximately 500 and 600 ft bgs.

1.3.4 Surface Water Conditions

Surface stormwater generated at the Site flows overland to catch basins in the parking lots surrounding the building. These catch basins are reportedly constructed as either singular or as interconnected dry wells (D&B, 2015), allowing collected stormwater to infiltrate into the subsurface.

Stormwater generated from the northwest portions of the building roof reportedly flows to the recharge basin in the northwest corner of the Site via piping located along the northern Site boundary (Dvirka and Bartilucci, 2007; D&B, 2015). Stormwater enters the recharge basin via an outfall in the northeast corner, with basin overflow pipe in the southwest corner of the recharge basin reportedly routed to two interconnected drywells located south of the recharge basin.

Stormwater generated on the southwestern portions of the building roof reportedly discharges to a series of eight interconnected drywells located in the driveway along the western side of the building and south of the recharge basin (Dvirka and Bartilucci, 2007; D&B, 2015). Roof drainage generated on the eastern portions of the building roof discharges to the ground surface, and asphalt pavement surface at the curb line of the parking lot via downspouts, and flows to nearby parking lot catch basins/drywells.

Two subsurface structures, identified herein as “Outfall #3” and drywell “D-4A,” are located in the southeast corner of the Site. The approximate locations of Outfall #3 and D-4A are shown on Figures 3 and 4, respectively. Available information regarding Outfall #3 is limited. The construction, size, and depth of the recharge structures and potential leach field is unknown. Anomalies detected by ground penetrating radar conducted prior to the subsurface investigations described herein are consistent with the general location, arrangement and connectivity of the structures depicted on historical drawings as Outfall #3. Based on the location and available records, Outfall #3 was connected to the sanitary sewer in 1983.

Dry well D-4A is shown on Figure 4 and continues to function. The D&B Engineers drainage inventory indicates dry well D-4A is 10 ft in diameter and 13.8 ft deep. The drainage inventory is summarized in the *Storm Water Basin and Diffusion Well Evaluation* dated August 26, 2016, prepared by D&B Engineers for Oerlikon Metco.

1.4 REGULATORY BACKGROUND AND PREVIOUS INVESTIGATIONS

Multiple investigations and remedial activities have been conducted at the Site, and include soil and groundwater investigations conducted by Geraghty & Miller in 1993 and 1994; additional investigations associated with the removal of a distribution box and settling tank by P.W. Grosser Consulting Engineer & Hydrologist in 1998; shallow and deep soil, groundwater, and soil vapor investigations conducted by AECOM in 2012; and two rounds of soil vapor testing conducted by Haley & Aldrich of New York in 2013 and 2014. Following these investigations, Oerlikon Metco entered the New York State Department of Environmental Conservation (NYSDEC) Brownfield Cleanup Program (BCP).

The Brownfield Cleanup Agreement (BCA) (Site No. C130178) was executed on December 29, 2014, between the NYSDEC and Oerlikon Metco (note that the BCA was ultimately terminated). A RI was completed under the BCP and included both historical investigation activities and comprehensive sampling events conducted in 2016 through 2017. The findings of the RI activities were reported in the Revised RI Report dated July 3, 2018, and included the identification of chlorinated volatile organic compounds (CVOCs) in sub-slab soil vapor at concentrations exceeding the New York State Department of Health (NYSDOH) Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York (NYSDOH VI Guidance, 2006, with updates through 2024).

Under the BCP, Haley & Aldrich of New York submitted to the NYSDEC a Revised Remedial Action Work Plan (RAWP) with Alternatives Analysis on July 3, 2018. The RAWP recommended a site remedy to address low levels of CVOC contamination in sub-slab vapor and shallow soil vapor. The recommended remedy was awaiting approval by the NYSDEC when in July 2018, NYSDEC requested that Oerlikon Metco collect Site groundwater samples for the analysis of “emerging contaminants,” which included PFAS compounds and 1,4-Dioxane.

PFAS were detected in groundwater samples collected in October 2018. At the request of NYSDEC, additional groundwater samples were collected by Haley & Aldrich of New York from the Site in May 2019, and from off-Site upgradient and downgradient locations in August 2019 (Figure 4). PFAS compounds were detected in each of the samples, with the highest concentrations detected in samples collected from Hydropunch™ boring HA-101 and monitoring wells MW-1 and MW-1D outside the southeast corner of the building and in the southeast corner of the Site. Elevated PFAS concentrations were generally proximal to and immediately down-gradient from Outfall #3 and drywell D-4A (Figures 3 and 4).

Following the supplemental groundwater investigation activities, PFAS were added as Contaminants of Concern (CoC) at the Site. In December 2022, the BCA was terminated, and the Site was listed as a Class 02 New York State Superfund Site (No. 130178) due to the presence of elevated concentrations of PCE in vapor beneath the Site building slab and for the detection of elevated concentrations of PFAS in groundwater upgradient from public water supply well(s). On October 7, 2023, NYSDEC issued the Order on Consent Index No.: CO1-20230807-157 to Oerlikon Metco for the preparation of a Remedial Investigation Work Plan (RIWP) to evaluate the extent of PFAS impacts at the Site. A Supplemental RI was conducted in accordance with a Revised RIWP for the Site submitted to the NYSDEC on March 6, 2024, and approved with modifications on April 5, 2024. A final Revised Remedial Investigation Work Plan (RIWP) was provided to the NYSDEC in May 2024.

1.4.1 Supplemental RI Activities - 2024

Supplemental RI activities conducted between March and November 2024 included:

- Sampling of sub-slab vapor and indoor air within the Site building for CVOCs,
- Sampling of unsaturated soils within the Outfall #3 Area for PFAS compounds,
- Installation and sampling of 27 groundwater monitoring wells for PFAS compounds. The monitoring wells were installed in “clusters” of three wells screened at aquifer depth intervals of approximately 75, 125, and 175 ft bgs on both the Oerlikon Metco site (1101 Prospect Avenue) and the downgradient Nassau County Public Safety Center property (1194 Prospect Avenue),
- Sampling of five previously existing groundwater monitoring wells on the Oerlikon Site for PFAS compounds.

Supplemental RI activities provided sufficient information to understand the nature and extent of chlorinated volatile organic compounds (CVOCs) in Site sub-slab soil vapor and indoor air and the information collected does not suggest there is a source present that would result in increasing concentrations of CVOCs in the sub-slab and indoor air. Continued annual monitoring of sub-slab soil vapor and indoor air during the heating season was recommended to confirm that future CVOC concentrations do not increase such that mitigation would be recommended by the New York State Department of Health (NYSDOH) Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York (NYSDOH SVI Guidance, 2006, with updates through 2024).

PFAS soil investigations conducted during the Supplemental RI activities were conducted proximal to and immediately downgradient from a former subsurface discharge leach field (referred to as “Outfall #3”) and a drywell (D-4A), collectively referred to as the “Outfall #3 Area” (see Table I for soil analytical results). Elevated concentrations of PFOA and PFOS detected in groundwater monitoring wells MW-1 and MW-1D located adjacent to and immediately downgradient from the Outfall #3 Area (see Table III) suggest unidentified soils in the vicinity may be an ongoing source of the anomalous PFAS concentrations observed in groundwater in the southeastern corner of the Site. The SRIR recommended that additional soil investigation activities be conducted to assess the potential for an unidentified source of PFAS upgradient and proximal to monitoring wells MW-1 and MW-1D. The SRIR also recommended that one additional cluster of groundwater monitoring wells be installed upgradient and proximal to MW-1 and MW-1D, and all existing wells should be sampled again to confirm results to date. Finally, the SRIR recommended an assessment of unsaturated soils beneath the stormwater recharge basin in the northwest corner of the Site to evaluate the horizontal and vertical extent of PFOA (see Table II) detected in a surficial soil sample collected from the basin during Supplemental RI activities.

1.5 PURPOSE OF SUPPLEMENTAL REMEDIAL INVESTIGATION ADDENDUM

The purpose of the SRIWP-P2 is to further refine the nature and extent of PFAS in soils and groundwater at the Site. The SRIWP-P2 investigation will evaluate the presence of PFAS in soils and groundwater upgradient and proximal to monitoring wells MW-1 and MW-1D and assess potential PFAS impacts to unsaturated soils beneath the stormwater recharge basin in the northwest corner of the Site.

2. Supplemental Remedial Investigation-Phase 2 Scope of Work

This SRIWP-P2 provides a description of the activities associated with additional focused remedial investigations of the PFAS in soils and groundwater proximal to monitoring wells MW-1 and MW-1D, and soils beneath the stormwater recharge basin in the northwest corner of the Site. Modifications to the scope of work provided in this section may be required due to equipment constraints, site access restrictions, field conditions, or other unexpected events. If modifications are deemed necessary, the NYSDEC will be contacted to obtain approval prior to proceeding.

The field investigations will be conducted in general conformance with the NYSDEC DER-10 Technical Guidance for Site Investigation and Remediation dated May 2010 (DER-10) and per the procedures described in Section 3. This work will also utilize a Quality Assurance Project Plan (QAPP) referenced in Section 3.6 (included in Appendix A), and a Health & Safety Plan (HASP) included in Appendix B. The Generic New York State Department of Health (NYSDOH) Community Air Monitoring Plan (Appendix C) will be implemented during subsurface drilling activities.

2.1 REGULATORY CONSIDERATIONS

2.1.1 Applicable Comparison Criteria

Analytical samples collected as part of the Remedial Investigation will be analyzed by Pace Analytical Laboratories of Westborough, Massachusetts (ELAP ID 11148). Soil and groundwater samples will be analyzed for 40 PFAS compounds via draft EPA Method 1633. Soil and groundwater PFAS data will be compared to NYSDEC regulatory criteria for PFAS, as specified in the NYSDEC document titled “Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS),” dated April 2023 (“NYSDEC 2023 PFAS Guidance”).

2.1.1.1 Soil

Soil data collected as part of Site remedial investigations will be compared to the protection of groundwater, commercial use, and industrial use criteria specified in the 2023 NYSDEC Guidance Values of Anticipated Site Use for the PFAS compounds, perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS). Protection of Groundwater Guidance Values for PFOA and PFOS in soil are 0.8 nanograms per gram (ng/g) and 1.0 ng/g, respectively.

2.1.1.2 Groundwater

Groundwater data will be compared to the NYSDEC-adopted ambient water quality guidance values for PFOA (6.7 ng/L) and for PFOS (2.7 ng/L), as specified in the NYSDEC 2023 PFAS Guidance.

2.2 SUPPLEMENTAL PHASE 2 PFAS INVESTIGATION

The purpose of the SRIWP-P2 investigation activities is to further assess the nature and extent of PFAS in soils and groundwater upgradient and proximal to monitoring wells MW-1 and MW-1D, and in soils beneath the stormwater recharge basin in the northwest corner of the Site. The Supplemental Phase 2 PFAS investigation activities will also be used to confirm the nature and extent of PFAS in groundwater at the Site and downgradient off-Site monitoring wells sampled in 2024.

A summary of the scope of work is included in the table below. More detailed procedures are provided in the following sections. A Sampling and Analysis Plan (SAP) is included as Table IV, attached. Figure 5 provides the approximate locations of proposed explorations, wells, and samples.

Media	Sample Type and Depth	Location Identification	Laboratory Analysis[1]
Soil	MW-1/1D Area *Advance four soil borings to approximately 60 ft bgs* • Grab soil samples will be collected every 5 ft bgs, with the last sample collected at the approximate depth of the water table observed in well MW-1 at the time of the drilling. Samples collected at 5, 15, 25, 35, 45, and 55 ft bgs will be held for lab analysis pending review of data from samples collected at 10, 20, 30, 40, 50 and 60 ft bgs.	HA-208, HA-209, HA-210, HA-211	PFAS (40 Target Compounds)
	Northwest Stormwater Recharge Basin *Advance two soil borings to approximately 20 ft bgs* • Grab soil samples will be collected at approximately 0.5-1.0, 1.0-2.0, and 10 ft bgs.	HA-212, HA-213	PFAS (40 Target Compounds
	Boring Cluster Upgradient from MW-1/1D *Advance three soil borings to approximately 75, 125, and 175 ft bgs* • Soils will be characterized by field geologist; soil grab samples will not be collected or analyzed.	HA-310A/B/C	No soil samples collected
Groundwater	*Conversion of the cluster of soil borings advanced upgradient from MW-1/1D into permanent monitoring wells.* • 10 ft long wells screen will terminate at approximately 75 (MW-310A), 125 (MW-310B) and 175 (MW-310C) ft bgs. • Wells MW-310A/B/C will be developed following completion. • Collection of groundwater samples from all permanent on-Site and downgradient off-Site wells	MW-301A/B/C MW-302A/B/C MW-303A/B/C MW-304A/B/C MW-305A/B/C MW-306A/B/C MW-307A/B/C MW-308A/B/C MW-309A/B/C MW-310A/B/C MW-1/1D, MW-2, MW-3, and MW-4	PFAS (40 Target Compounds)

Note:

[1] Refer to SAP in Table IV for detailed analyses.

2.2.1 Pre-Investigation Activities

Public and private utility and obstruction clearance will be conducted in advance of intrusive ground activities at each PFAS investigation location. Prior to the work, Dig Safely New York will be contacted to mark underground public utilities. A private utility locator will survey the area surrounding the proposed boring locations HA-208, HA-209, HA-210, HA-211 HA-212, HA-213. The survey may also identify other utilities and possible features beneath the asphalt surface that could obstruct or limit drilling. Survey methods may include, but are not necessarily limited to, electromagnetic (EM) detection and ground penetrating radar (GPR). The private utility locator will mark findings, including possible utilities, on the ground surface. Drilling locations will be adjusted as needed to avoid subsurface utilities.

2.2.2 MW-1/1D Area Soil Investigation

Four soil borings will be advanced upgradient and proximal to existing Site monitoring wells MW-1/1D, to the anticipated depth of the groundwater table, approximately 60 ft bgs. Collection and chemical analysis of soil samples collected from these borings will be used to assess potential PFAS impacts to soil upgradient and proximal to the locations of highest Site PFOS and PFOA groundwater concentrations. The proposed soil borings are designated HA-208 to HA-211, and are shown on Figure 5.

Soil borings HA-208 to HA-211 will be advanced by a drilling sub-contractor to the observed water table using a direct push GeoProbe drill rig. The soil borings will be logged by Haley & Aldrich of New York personnel in accordance with the Unified Soil Classification System (USCS) and screened continuously for volatile organic compounds (VOCs) using a photoionization detector (PID). Evidence of potential contamination will be described in soil boring logs. Grab soil samples will be collected from each soil boring at 5 ft depth intervals starting at 5 ft bgs and continuing to the observed water table, anticipated to occur at a depth of approximately 60 ft bgs. The depth/elevation of groundwater in MW-1 at the time of the drilling activities will be used to guide the sample depth interval at the water table. If evidence of contamination is observed such as staining, odor, or PID readings in soils between these prescribed grab sample intervals, additional soil grab samples may be collected. Grab soil samples will be submitted for laboratory analysis of PFAS compounds in accordance with the SAP presented in Table IV. Samples collected at 5, 15, 25, 35, 45, and 55 ft bgs will be held for lab analysis pending review of data from samples collected at 10, 20, 30, 40, 50 and 60 ft bgs.

Drilling spoils will be containerized and managed as investigation-derived waste per Section 3.5.

2.2.3 Northwest Stormwater Recharge Basin Soil Investigation

Two soil borings will be advanced within the northwest stormwater recharge basin to approximately 10 ft bgs. Collection and chemical analysis of soil samples collected from these borings will be used to assess potential PFAS impacts subsurface soils within the recharge basin. The proposed soil borings designated HA-212 and HA-213, are shown on Figure 5.

Soil borings HA-212 and HA-213 will be advanced by a drilling sub-contractor using a direct push drill rig. The soil borings will be logged by Haley & Aldrich of New York personnel in accordance with the Unified Soil Classification System (USCS) and screened continuously for VOCs using a PID. Evidence of potential contamination will be described in the soil boring logs. Grab soil samples will be collected from each soil boring at approximately 0.5-1.0 ft, 1.0-2.0 ft, and 10 ft bgs. If evidence of contamination is observed such as staining, odor, or PID readings in soils between these prescribed grab sample intervals, additional soil grab samples may be collected. Grab soil samples will be submitted for laboratory analysis of PFAS compounds in accordance with the SAP presented in Table IV.

Drilling spoils will be containerized and managed as investigation-derived waste per Section 3.5.

2.2.4 Groundwater Investigation

Three soil borings (HA-310A, HA-310B and HA-310C) will be advanced using sonic drilling methods immediately upgradient (north) of existing Site wells MW-1/1D. The borings will be “clustered” together in a group of three, with each boring located within approximately 10 ft of each other. At the cluster, a shallow “A”-series boring will be advanced to approximately 75 ft bgs, an intermediate “B”-series boring to approximately 125 ft bgs, and a deep “C”-series boring to approximately 175 ft bgs. Haley & Aldrich of New York personnel will log the C series soil boring in general conformance with the USCS and also screen soils continuously for VOCs using a PID. The A and B series borings will not be logged. Visual or olfactory evidence of contamination, if present, will be described in the soil boring logs. No grab samples will be collected from soil borings HA-310A/B/C. The preliminary monitoring well locations are presented on Figure 5. The actual well locations will be determined in the field based on accessibility and the results of the utility clearance described in Section 2.2.1.

Following advancement of each soil boring, a 2-inch diameter schedule 40 or 80 polyvinyl chloride (PVC) well with flush-threaded joints and machine-slotted well screens will be installed within the borehole, with a 10-ft length screen interval terminating at the bottom of each borehole. The A-series well will be screened immediately below the observed water table (~65 to 75 ft bgs), B-series well within saturated soils approximately 115 to 125 ft bgs, and C-series well within saturated soils from approximately 165 to 175 ft bgs. The well screens will be installed with filter sand backfill from approximately the well bottom to approximately 2 ft above the well screen interval. From the top of the filter sand surrounding each screened interval, a bentonite plug will be installed using non-coated bentonite pellets. Each well will be grouted with concrete to the surface and finished with a flush-mount well cap/cover at the ground surface.

Following well installation, the wells MW-310A/B/C will be developed per Section 3.3.1 and allowed to equilibrate for approximately one week prior to groundwater sampling. Prior to sampling, a synoptic round of static water level measurements will be collected per Section 3.3.2 to facilitate assessment of groundwater depths and flow direction at the Site at the time of the sampling activities.

Water levels will be collected at existing wells MW-1/1D, MW-2, MW-3, MW-4, and at the ten on-Site and off-Site well locations. The wells will be purged and sampled using low flow sampling methods with a 1-inch diameter bladder pump, per the procedures in Section 3.3.3. One groundwater sample from each well will be collected and submitted for laboratory analysis of PFAS compounds in accordance with the SAP presented in Table IV.

3. Field Sampling Procedures and Supporting Plans

3.1 EQUIPMENT PROCUREMENT, INSPECTION, AND CALIBRATION

SRIWP-P2 field activities require use of electronic instruments to monitor for environmental conditions and health and safety purposes. It is imperative the instruments are used and maintained properly to optimize their performance and minimize the potential for inaccuracies in the data obtained. Guidance on the usage, maintenance and calibration of electronic field equipment is included below:

- Monitoring equipment will be in proper working order and operated in accordance with manufacturer's recommendations.
- Field personnel will be responsible for maintaining and calibrating equipment in the field in accordance with manufacturer's recommendations.
- Instruments will be operated by personnel trained in the proper usage and calibration.

Calibration of an electronic instrument is critical to proper operation during its intended use. Such instruments are often sensitive to changes in temperature or humidity, and as a result their response and ability to monitor conditions and provide data can change significantly. Calibration of instruments shall be performed in accordance with the manufacturer's specifications. This includes the following parameters:

- Frequency
- Use of proper Calibration Gases or Chemical Standards
- Requirements for Factory Calibration

3.2 SOIL BORINGS

Soil borings will be advanced using either direct push or sonic drilling methods. Continuous soil cores will be collected and logged to describe soil conditions, moisture content, and the depth to the water table. Soil cores will be screened with a PID for the presence of organic vapor. Boring locations that will not be converted into monitoring wells will be backfilled with soil cuttings. The upper 5 ft of each boring will be backfilled with bentonite chips and a topsoil or asphalt patch will be applied to match the surrounding ground surface. The completed boring locations will be surveyed by a NYS-licensed land surveyor.

3.2.1 Soil Sampling

Soil grab samples will be collected in general accordance with the sampling protocols outlined in the NYSDEC's 2023 PFAS Guidance.

3.3 WELL INSTALLATION

Following advancement of each clustered soil boring, a 2-inch diameter schedule 80 polyvinyl chloride (PVC) well with flush-threaded joints and machine-slotted well screens will be installed within the borehole, with a 10-ft length screen interval terminating at the bottom of each borehole. The A-series well will be screened immediately below the observed water table (~65 to 75 ft bgs), B-series well within saturated soils approximately 115 to 125 ft bgs, and C-series well within saturated soils from approximately 165 to 175 ft bgs. The well screens will be installed with filter sand backfill from approximately the well bottom to approximately 2 ft above the well screen interval. From the top of the filter sand surrounding each screened interval, a bentonite plug will be installed using non-coated bentonite pellets. Each well will be grouted with cement/bentonite mixture to the surface and finished with a concrete surface seal and flush-mount well cap/cover at the ground surface.

3.3.1 Well Development

Newly installed monitoring wells (MW-310A/B/C) will be developed until turbidity reaches < 50 NTU or 10 well volumes are removed (whichever is first). Development will be performed using a battery-operated PFAS-free submersible pump no sooner than 24 hours following well completion (to allow grout curing) and at least one week prior to sampling. Per the NYSDEC 2023 PFAS Guidance, HDPE tubing will be used in the development of wells to minimize the introduction of PFAS compounds during well development activities. Between each well, the submersible pump will be decontaminated, as specified in Section 3.4 below.

Water generated by monitoring well development will be placed in steel 55-gallon drums and profiled for disposal as described in Section 3.5.

3.3.2 Monitoring Well Gauging

Site and downgradient off-Site monitoring wells will be gauged with a PFAS-free water level indicator no sooner than one week following development of the cluster wells MW-310A/B/C. If the monitoring wells are sealed with an airtight cap, the wells will be opened and allowed to equilibrate to atmospheric pressure for at least 15 minutes prior to gauging. After allowing each well to equilibrate (as necessary), the depth to water, and total well depth, will be measured and recorded for each monitoring well. Water level depths will be measured from top of the PVC casing (if present/ applicable); if an inner casing does not exist, measurements will be made from the top of the outer protective casing.

3.3.3 Groundwater Sampling

Groundwater samples will be collected from each Site monitoring well using low-flow sampling techniques in accordance with the sampling protocols outlined in the NYSDEC 2023 PFAS Guidance. During purging of the wells, field indicator parameters will be recorded to document aquifer stabilization prior to sampling. The samples will be collected using a stainless-steel PFAS-free submersible bladder pump with high-density polyethylene (HDPE) tubing. Sampling equipment will be decontaminated and/or replaced prior to use in a new sampling interval or location. This includes the use of clean nitrile gloves, rinsing stainless steel pumping materials in PFAS free detergents and water, and the replacement of HDPE tubing and internal polyethylene pump bladders.

3.4 DECONTAMINATION

Decontamination activities will be performed in a controlled area established on the Site. Care will be taken to minimize the potential for transfer of contaminated materials to the ground or onto other materials. Regardless of the size or nature of the equipment being decontaminated, the process will utilize a series of steps that involve removal of gross material (dirt, grease, oil etc.), washing with a detergent, and multiple rinsing steps. In lieu of a series of washes and rinse steps, steam cleaning with low-volume, high-pressure equipment (i.e., steam cleaner) is acceptable.

Exploration equipment (including drill rigs), and all monitoring equipment in contact with the sampling media must be decontaminated prior to initiating Site activities, in-between exploration locations to minimize cross-contamination, and prior to mobilizing off-Site after completion of Site work.

A decontamination pad must be constructed that is appropriate for the size and type of equipment being decontaminated. At a minimum, the decontamination pad will have the following elements:

- An impermeable barrier capable of containing decontaminated fluids;
- A low point where fluids will collect and can be transferred into appropriate containers;
- Durability to withstand equipment such as vehicle and foot traffic;
- Appropriate ancillary equipment such as racks to place decontaminated equipment to drain without further exposure to contaminated fluids;
- Labels to alert personnel as to the potential presence of contaminated materials.

The following specific decontamination procedure is recommended for sampling equipment and is generally consistent with decontamination protocols outlined in the NYSDEC 2023 PFAS Guidance:

- Brush loose soil off equipment;
- Wash equipment with laboratory grade detergent (i.e., Alconox or equivalent);
- Rinse equipment with PFAS-free water;
- Allow water to evaporate before reusing equipment.

3.5 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

Investigation-derived waste (IDW) materials generated during soil boring advancement, soil sampling, monitoring well installation, and groundwater sampling activities will consist of drill cuttings, groundwater (development, and pre-sample purge water), and decontamination water. Soil IDW will be containerized in either Department of Transportation (DOT)-approved 55-gallon drums or Hazardous Waste Roll-Off container(s) prior to sampling for waste disposal profiling. Water IDW will be stored in DOT-approved 55-gallons drums or a frac tank prior to sampling for waste disposal profiling. Drums, roll-off container(s), and frac tank(s) will be staged on-Site in a secured location prior to off-Site disposal.

3.6 QUALITY ASSURANCE PROJECT PLAN

A Quality Assurance Project Plan (QAPP) has been prepared for this SRIWP-P2 and is included in Appendix A.

3.6.1 Field Quality Control Procedures

Field QA/QC for the soil samples will include the collection and analysis of one field duplicate (FD) sample and one matrix spike/matrix spike duplicate (MS/MSD) sample per 20 soil samples analyzed. The FD and MS/MSD samples will be collected immediately following the collection of a corresponding soil sample from a given location.

Field QA/QC for groundwater samples will include the collection and analysis of one field duplicate (FD) sample and one matrix spike/matrix spike duplicate (MS/MSD) sample per 20 groundwater samples analyzed. Additionally, an equipment blank will be collected from non-dedicated groundwater sampling equipment. A single field blank (FB) will also be collected during the groundwater sampling event.

The FD, MS/MSD, equipment blank, and field blank samples will be analyzed for the PFAS analyte list specified in Appendix G of the NYSDEC 2023 PFAS Guidance, and as shown in the SAP (Table IV) of this SRIWP-P2. Field QA/QC samples are also not planned for soil and water disposal analysis.

3.6.2 Laboratory Quality Control Procedures

Soil and recovered groundwater samples will be submitted to a New York State Department of Health (NYSDOH)-accredited laboratory on a standard turnaround basis for reporting of analytical data. Laboratory quality control procedures include the addition of surrogate compounds, method blank analysis, preparation of laboratory control samples, and preparation of laboratory MS/MSD samples as described in the QAPP in Appendix B. Results will be reported using NYSDEC ASP Category B equivalent data deliverables. Samples collected for the disposal of soil and/or water will be reported using standard data deliverable packages.

3.6.3 Data Validation

The completeness of each laboratory data package associated with the soil and groundwater investigation will be evaluated by a NYSDEC-approved Data Validator. Soil disposal and recovered groundwater disposal sample analysis data will not be subject to this data validation procedure. The laboratory data report will include the sample chain of custody (COC) forms, analytical results, QC sample analysis summaries, and the supporting analytical instrument raw data.

Sample data generated through field activities and the laboratory analyses will be reduced and validated with guidance from:

- "National Functional Guidelines for Organic Superfund Methods Data Review”, EPA-540-R-2020-005, dated November 2020.
- New York State Department of Environmental Conservation (2023). Sampling, Analysis and Assessment of Per and Polyfluorinated Alkyl Substances (PFAS) under NYSDEC’s Part 375 Remedial Programs, April 2023.

The data qualifiers (if any) applied to the reported results will be assigned as prescribed by the procedures in the National Functional Guidelines.

3.7 HEALTH & SAFETY PLAN

A Site-specific Health & Safety Plan (HASP) has been prepared for the proposed RI Work Plan activities. A copy of the HASP is included as Appendix B of this Work Plan. The HASP covers on-Site investigations activities. A member of the field team will be designated to serve as the on-Site Health and Safety Officer throughout the field program. This person will report directly to the Project Manager and the Health and Safety Coordinator. The HASP will be subject to revision as necessary, based on new information that is discovered during the implementation of the field investigation.

3.8 COMMUNITY AIR MONITORING

A Community Air Monitoring Plan ("CAMP") will be implemented during ground intrusive, and soil IDW management/handling activities associated with the Remedial Investigation. The CAMP procedures will follow the Generic CAMP provided in Appendix 1A of NYSDEC DER-10 and will include real-time monitoring for volatile organic compounds (VOCs) and particulates (i.e., dust) at the upwind and downwind perimeter of each designated work area. A copy of the Generic CAMP is included in Appendix C. CAMP monitoring will not be conducted during the movements of IDW containerized in drums or covered roll-off containers.

4. Qualitative Exposure Assessments

4.1 FISH AND WILDLIFE RESOURCE IMPACT ANALYSIS (FWRIA)

The Site is located in a suburban setting. Review of records presented on the NYSDEC Environmental Resource Mapper did not identify water bodies, wetlands, or other ecologically significant areas within 0.25 miles of the Site. In accordance with Section 3.10.1(b) of NYSDEC DER-10, no FWRIA is needed.

4.2 QUALITATIVE HUMAN HEALTH EXPOSURE ASSESSMENT

An updated Qualitative Human Health Exposure Assessment (QHHEA) will be prepared using historical data and investigation data collected from this investigation to qualitatively evaluate the route, intensity, frequency, and duration of actual or potential human exposures to PFAS contaminants.

The QHHEA is being prepared to identify potential exposure pathways as part of past, present, or future events, characterize potentially exposed receptors, and identify the presence of unacceptable exposures (if any) and how they may be eliminated or mitigated. The assessment will be conducted in accordance with Section 3.3(4) and Appendix 3B of DER-10.

5. Reporting and Schedule

Once approval of this SRIWP-P2 is received, it is anticipated that field work can be scheduled to commence in late-fall 2025 with completion in winter 2025-2026. Following completion of the field work and data validation, a Supplement Remedial Investigation Report-Phase 2 (SRIR-P2) will be prepared in accordance with the NYSDEC DER-10 guidance that summarizes the results of the investigation and qualitative exposure assessments.

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TABLES

TABLE I
SUMMARY OF PFAS SOIL ANALYTICAL DATA - OUTFALL #3 AREA
OERLIKON METCO
WESTBURY, NJ

Location		**HA-201**	**HA-201**	**HA-201**	**HA-201**	**HA-201**	**HA-201**	**HA-201**
Sample Date		**08/26/2024**	**08/26/2024**	**08/26/2024**	**08/26/2024**	**08/26/2024**	**08/26/2024**	**08/26/2024**
Sample Type	**Protection Of Groundwater Guidance Values**	**N**	**N**	**N**	**N**	**N**	**FD**	**N**
Sample Depth (bgs)		**10 - 12 (ft)**	**20 - 22 (ft)**	**30 - 32 (ft)**	**40 - 42 (ft)**	**50 - 52 (ft)**	**60 - 62 (ft)**	**60 - 62 (ft)**
Sample Name		**HA-201-10.0-12.0**	**HA-201-20.0-22.0**	**HA-201-30.0-32.0**	**HA-201-40.0-42.0**	**HA-201-50.0-52.0**	**021063-082624-0001**	**HA-201-60.0-62.0**
Other								
Total Solids (%)	-	**85.7**	**85.3**	**97.9**	**86.4**	**95.3**	**88.3**	**84.8**
PFAS (ng/g)								
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	-	ND (0.754)	ND (0.772)	ND (0.781)	ND (0.763)	ND (0.739)	ND (0.785)	ND (0.798)
2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)	-	ND (4.71)	ND (4.83)	ND (4.88)	ND (4.77)	ND (4.62)	ND (4.91)	ND (4.99)
3-(Perfluoroheptyl)propanoic acid (7:3 FTCA)	-	ND (4.71)	ND (4.83)	ND (4.88)	ND (4.77)	ND (4.62)	ND (4.91)	ND (4.99)
3:3 Fluorotelomer carboxylic acid (3:3 FTCA)	-	ND (0.942)	ND (0.966)	ND (0.976)	ND (0.953)	ND (0.924)	ND (0.981)	ND (0.998)
4,8-Dioxa-3H-Perfluorononanoic Acid (ADONA)	-	ND (0.754)	ND (0.772)	ND (0.781)	ND (0.763)	ND (0.739)	ND (0.785)	ND (0.798)
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	-	ND (0.754)	ND (0.772)	ND (0.781)	ND (0.763)	ND (0.739)	ND (0.785)	ND (0.798)
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	-	ND (0.754)	ND (0.772)	ND (0.781)	ND (0.763)	ND (0.739)	**1.38**	**1.48**
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	-	ND (0.754)	ND (0.772)	ND (0.781)	ND (0.763)	ND (0.739)	ND (0.785)	ND (0.798)
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	-	ND (0.754)	ND (0.772)	ND (0.781)	ND (0.763)	ND (0.739)	ND (0.785)	ND (0.798)
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	-	ND (0.188)	ND (0.193)	ND (0.195)	ND (0.191)	ND (0.185)	ND (0.196)	ND (0.2)
N-Ethylperfluorooctane sulfonamide (N-EtFOSA)	-	ND (0.188)	ND (0.193)	ND (0.195)	ND (0.191)	ND (0.185)	ND (0.196)	ND (0.2)
N-Ethylperfluorooctane sulfonamidoethanol (N-EtFOSE)	-	ND (1.88)	ND (1.93)	ND (1.95)	ND (1.91)	ND (1.85)	ND (1.96)	ND (2)
N-Methyl Perfluorooctanesulfonamidoacetic Acid (MeFOSAA)	-	ND (0.188)	ND (0.193)	ND (0.195)	ND (0.191)	ND (0.185)	ND (0.196)	ND (0.2)
N-Methylperfluorooctane sulfonamide (N-MeFOSA)	-	ND (0.188)	ND (0.193)	ND (0.195)	ND (0.191)	ND (0.185)	ND (0.196)	ND (0.2)
N-Methylperfluorooctane sulfonamidoethanol (N-MeFOSE)	-	ND (1.88)	ND (1.93)	ND (1.95)	ND (1.91)	ND (1.85)	ND (1.96)	ND (2)
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	-	ND (0.377)	ND (0.386)	ND (0.391)	ND (0.381)	ND (0.369)	ND (0.392)	ND (0.399)
Perfluoro(2-ethoxyethane) sulphonic acid (PFEESA)	-	ND (0.377)	ND (0.386)	ND (0.391)	ND (0.381)	ND (0.369)	ND (0.392)	ND (0.399)
Perfluoro(4-methoxybutanoic) acid (PFMBA)	-	ND (0.377)	ND (0.386)	ND (0.391)	ND (0.381)	ND (0.369)	ND (0.392)	ND (0.399)
Perfluoro-2-propoxypropanoic acid (PFPrOPrA)(GenX) (HFPO-DA)	-	ND (0.754)	ND (0.772)	ND (0.781)	ND (0.763)	ND (0.739)	ND (0.785)	ND (0.798)
Perfluoro-3-methoxypropanoic acid (PFMPA)	-	ND (0.377)	ND (0.386)	ND (0.391)	ND (0.381)	ND (0.369)	ND (0.392)	ND (0.399)
Perfluorobutanesulfonic acid (PFBS)	-	ND (0.188)	ND (0.193)	ND (0.195)	ND (0.191)	ND (0.185)	ND (0.196)	ND (0.2)
Perfluorobutanoic acid (PFBA)	-	ND (0.754)	ND (0.772)	ND (0.781)	ND (0.763)	ND (0.739)	ND (0.785)	ND (0.798)
Perfluorodecanesulfonic acid (PFDS)	-	ND (0.188)	ND (0.193)	ND (0.195)	ND (0.191)	ND (0.185)	ND (0.196)	ND (0.2)
Perfluorodecanoic acid (PFDA)	-	ND (0.188)	ND (0.193)	ND (0.195)	ND (0.191)	ND (0.185)	ND (0.196)	ND (0.2)
Perfluorododecane sulfonic acid (PFDoDS)	-	ND (0.188)	ND (0.193)	ND (0.195)	ND (0.191)	ND (0.185)	ND (0.196)	ND (0.2)
Perfluorododecanoic acid (PFDoDA)	-	ND (0.188)	ND (0.193)	ND (0.195)	ND (0.191)	ND (0.185)	ND (0.196)	ND (0.2)
Perfluoroheptanesulfonic acid (PFHpS)	-	ND (0.188)	ND (0.193)	ND (0.195)	ND (0.191)	ND (0.185)	ND (0.196)	ND (0.2)
Perfluoroheptanoic acid (PFHpA)	-	ND (0.188)	ND (0.193)	ND (0.195)	ND (0.191)	ND (0.185)	ND (0.196)	ND (0.2)
Perfluorohexanesulfonic acid (PFHxS)	-	ND (0.188)	ND (0.193)	ND (0.195)	ND (0.191)	ND (0.185)	ND (0.196)	ND (0.2)
Perfluorohexanoic acid (PFHxA)	-	ND (0.188)	ND (0.193)	ND (0.195)	ND (0.191)	ND (0.185)	ND (0.196)	ND (0.2)
Perfluorononane sulfonic acid (PFNS)	-	ND (0.188)	ND (0.193)	ND (0.195)	ND (0.191)	ND (0.185)	ND (0.196)	ND (0.2)
Perfluorononanoic acid (PFNA)	-	ND (0.188)	ND (0.193)	ND (0.195)	ND (0.191)	ND (0.185)	ND (0.196)	ND (0.2)
Perfluorooctane sulfonamide (PFOSA)	-	ND (0.188)	ND (0.193)	ND (0.195)	ND (0.191)	ND (0.185)	ND (0.196)	ND (0.2)
Perfluorooctanesulfonic acid (PFOS)	1	**0.088 J**	ND (0.193)	ND (0.195)	**0.085 J**	ND (0.185)	ND (0.196)	ND (0.2)
Perfluorooctanoic acid (PFOA)	0.8	ND (0.188)	ND (0.193)	ND (0.195)	ND (0.191)	ND (0.185)	ND (0.196)	ND (0.2)
Perfluoropentanesulfonic acid (PFPeS)	-	ND (0.188)	ND (0.193)	ND (0.195)	ND (0.191)	ND (0.185)	ND (0.196)	ND (0.2)
Perfluoropentanoic acid (PFPeA)	-	ND (0.377)	ND (0.386)	ND (0.391)	ND (0.381)	ND (0.369)	ND (0.392)	ND (0.399)
Perfluorotetradecanoic acid (PFTeDA)	-	ND (0.188)	ND (0.193)	ND (0.195)	ND (0.191)	ND (0.185)	ND (0.196)	ND (0.2)
Perfluorotridecanoic acid (PFTrDA)	-	ND (0.188)	ND (0.193)	ND (0.195)	ND (0.191)	ND (0.185)	ND (0.196)	ND (0.2)
Perfluoroundecanoic acid (PFUnDA)	-	ND (0.188)	ND (0.193)	ND (0.195)	ND (0.191)	ND (0.185)	ND (0.196)	ND (0.2)

Notes:

1. *Results in red exceed the following criteria:*
   [A] - 2023 NYSDEC Protection of Groundwater Guidance Value
2. *Results in **bold** were detected.*
3. *ND - Not detected above reporting limit*
   J - Estimated value
   F -The ratio of quantifier ion response to qualifier ion response falls outside of the laboratory criteria. Results are considered to be an estimated maximum concentration
4. *Unvalidated data shown in table.*

TABLE I
SUMMARY OF PFAS SOIL ANALYTICAL DATA - OUTFALL #3 AREA
OERLIKON METCO
WESTBURY, NJ

Location **Sample Date** **Sample Type** **Sample Depth (bgs)** **Sample Name**	**Protection Of Groundwater Guidance Values**	**HA-202** **08/29/2024** **N** **10 - 12 (ft)** **HA-202-10.0-12.0**	**HA-202** **08/29/2024** **N** **20 - 22 (ft)** **HA-202-20.0-22.0**	**HA-202** **08/29/2024** **FD** **20 - 22 (ft)** **021063-082924-0001**	**HA-202** **08/29/2024** **N** **30 - 32 (ft)** **HA-202-30.0-32.0**	**HA-202** **08/29/2024** **N** **40 - 42 (ft)** **HA-202-40.0-42.0**	**HA-202** **08/29/2024** **N** **50 - 52 (ft)** **HA-202-50.0-52.0**	**HA-202** **08/29/2024** **N** **60 - 62 (ft)** **HA-202-60.0-62.0**
Other								
Total Solids (%)	-	**96.6**	**97.1**	**95.1**	**95**	**97.1**	**91.1**	**80.9**
PFAS (ng/g)								
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	-	ND (0.799)	ND (0.795)	ND (0.8)	ND (0.796)	ND (0.797)	ND (0.798)	ND (0.777)
2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)	-	ND (5)	ND (4.97)	ND (5)	ND (4.97)	ND (4.98)	ND (4.99)	ND (4.86)
3-(Perfluoroheptyl)propanoic acid (7:3 FTCA)	-	ND (5)	ND (4.97)	ND (5)	ND (4.97)	ND (4.98)	ND (4.99)	ND (4.86)
3:3 Fluorotelomer carboxylic acid (3:3 FTCA)	-	ND (0.999)	ND (0.994)	ND (1)	ND (0.995)	ND (0.996)	ND (0.998)	ND (0.972)
4,8-Dioxa-3H-Perfluorononanoic Acid (ADONA)	-	ND (0.799)	ND (0.795)	ND (0.8)	ND (0.796)	ND (0.797)	ND (0.798)	**0.259 J**
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	-	ND (0.799)	ND (0.795)	ND (0.8)	ND (0.796)	ND (0.797)	ND (0.798)	ND (0.777)
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	-	ND (0.799)	ND (0.795)	ND (0.8)	ND (0.796)	**1.05**	**0.398 J**	ND (0.777)
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	-	ND (0.799)	ND (0.795)	ND (0.8)	ND (0.796)	ND (0.797)	ND (0.798)	ND (0.777)
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	-	ND (0.799)	ND (0.795)	ND (0.8)	ND (0.796)	ND (0.797)	ND (0.798)	ND (0.777)
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	-	ND (0.2)	**2.9**	**2.76**	**7.45**	**0.786**	**0.821**	**2.57**
N-Ethylperfluorooctane sulfonamide (N-EtFOSA)	-	ND (0.2)	ND (0.199)	ND (0.2)	**0.117 J**	**0.212**	**0.184 J**	**0.393**
N-Ethylperfluorooctane sulfonamidoethanol (N-EtFOSE)	-	ND (2)	ND (1.99)	ND (2)	ND (1.99)	ND (1.99)	ND (2)	ND (1.94)
N-Methyl Perfluorooctanesulfonamidoacetic Acid (MeFOSAA)	-	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.199)	ND (0.2)	ND (0.194)
N-Methylperfluorooctane sulfonamide (N-MeFOSA)	-	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.199)	ND (0.2)	ND (0.194)
N-Methylperfluorooctane sulfonamidoethanol (N-MeFOSE)	-	ND (2)	ND (1.99)	ND (2)	ND (1.99)	ND (1.99)	ND (2)	ND (1.94)
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	-	ND (0.4)	ND (0.398)	ND (0.4)	ND (0.398)	ND (0.398)	ND (0.399)	ND (0.389)
Perfluoro(2-ethoxyethane) sulphonic acid (PFEESA)	-	ND (0.4)	ND (0.398)	ND (0.4)	ND (0.398)	ND (0.398)	ND (0.399)	**0.086 J**
Perfluoro(4-methoxybutanoic) acid (PFMBA)	-	ND (0.4)	ND (0.398)	ND (0.4)	ND (0.398)	ND (0.398)	ND (0.399)	**0.033 J**
Perfluoro-2-propoxypropanoic acid (PFPrOPrA)(GenX) (HFPO-DA)	-	ND (0.799)	ND (0.795)	ND (0.8)	ND (0.796)	ND (0.797)	ND (0.798)	**0.221 J**
Perfluoro-3-methoxypropanoic acid (PFMPA)	-	ND (0.4)	ND (0.398)	ND (0.4)	ND (0.398)	ND (0.398)	ND (0.399)	ND (0.389)
Perfluorobutanesulfonic acid (PFBS)	-	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.199)	ND (0.2)	ND (0.194)
Perfluorobutanoic acid (PFBA)	-	ND (0.799)	ND (0.795)	ND (0.8)	ND (0.796)	ND (0.797)	ND (0.798)	ND (0.777)
Perfluorodecanesulfonic acid (PFDS)	-	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.199)	ND (0.2)	ND (0.194)
Perfluorodecanoic acid (PFDA)	-	ND (0.2)	ND (0.199)	ND (0.2)	**0.079 JF**	ND (0.199)	ND (0.2)	ND (0.194)
Perfluorododecane sulfonic acid (PFDoDS)	-	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.199)	ND (0.2)	ND (0.194)
Perfluorododecanoic acid (PFDoDA)	-	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.199)	ND (0.2)	ND (0.194)
Perfluoroheptanesulfonic acid (PFHpS)	-	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.199)	ND (0.2)	ND (0.194)
Perfluoroheptanoic acid (PFHpA)	-	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.199)	ND (0.2)	**0.058 J**
Perfluorohexanesulfonic acid (PFHxS)	-	**0.078 J**	**0.194 J**	**0.205**	ND (0.199)	ND (0.199)	ND (0.2)	**0.064 J**
Perfluorohexanoic acid (PFHxA)	-	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.199)	ND (0.2)	ND (0.194)
Perfluorononane sulfonic acid (PFNS)	-	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.199)	ND (0.2)	ND (0.194)
Perfluorononanoic acid (PFNA)	-	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.199)	ND (0.2)	ND (0.194)
Perfluorooctane sulfonamide (PFOSA)	-	ND (0.2)	**3.53**	**1.51**	**3.51**	**1.37**	**1.36**	**2.35**
Perfluorooctanesulfonic acid (PFOS)	1	**0.358**	**5.01** [A]	**1.94** [A]	**12.2** [A]	**4.27** [A]	**3.27** [A]	**0.902**
Perfluorooctanoic acid (PFOA)	0.8	**0.136 J**	**0.261**	**0.327**	**0.1 J**	ND (0.199)	ND (0.2)	**0.112 J**
Perfluoropentanesulfonic acid (PFPeS)	-	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.199)	ND (0.2)	**0.056 J**
Perfluoropentanoic acid (PFPeA)	-	ND (0.4)	ND (0.398)	ND (0.4)	ND (0.398)	ND (0.398)	ND (0.399)	ND (0.389)
Perfluorotetradecanoic acid (PFTeDA)	-	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.199)	ND (0.2)	ND (0.194)
Perfluorotridecanoic acid (PFTrDA)	-	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.199)	ND (0.2)	ND (0.194)
Perfluoroundecanoic acid (PFUnDA)	-	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.199)	ND (0.2)	ND (0.194)

Notes:

1. *Results in red exceed the following criteria:*
   [A] - 2023 NYSDEC Protection of Groundwater Guidance Value
2. *Results in **bold** were detected.*
3. *ND - Not detected above reporting limit*
   J - Estimated value
   F -The ratio of quantifier ion response to qualifier ion response falls outside of the laboratory criteria. Results are considered to be an estimated maximum concentration
4. *Unvalidated data shown in table.*

TABLE I
SUMMARY OF PFAS SOIL ANALYTICAL DATA - OUTFALL #3 AREA
OERLIKON METCO
WESTBURY, NJ

Location		**HA-203**	**HA-203**	**HA-203**	**HA-203**	**HA-203**	**HA-203**
Sample Date		**08/30/2024**	**08/30/2024**	**08/30/2024**	**08/30/2024**	**08/30/2024**	**08/30/2024**
Sample Type	**Protection Of**	**N**	**N**	**N**	**N**	**N**	**N**
Sample Depth (bgs)	**Groundwater**	**10 - 12 (ft)**	**20 - 22 (ft)**	**30 - 32 (ft)**	**40 - 42 (ft)**	**50 - 52 (ft)**	**58 - 60 (ft)**
Sample Name	**Guidance Values**	**HA-203-10.0-12.0**	**HA-203-20.0-22.0**	**HA-203-30.0-32.0**	**HA-203-40.0-42.0**	**HA-203-50.0-52.0**	**HA-203-58.0-60.0**
Other							
Total Solids (%)	-	**95**	**95.2**	**95.1**	**95.6**	**92**	**81.2**
PFAS (ng/g)							
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	-	ND (0.796)	ND (0.799)	ND (0.792)	ND (0.789)	ND (0.795)	ND (0.789)
2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)	-	ND (4.97)	ND (4.99)	ND (4.95)	ND (4.93)	ND (4.97)	ND (4.93)
3-(Perfluoroheptyl)propanoic acid (7:3 FTCA)	-	ND (4.97)	ND (4.99)	ND (4.95)	ND (4.93)	ND (4.97)	ND (4.93)
3:3 Fluorotelomer carboxylic acid (3:3 FTCA)	-	ND (0.995)	ND (0.998)	ND (0.99)	ND (0.987)	ND (0.994)	ND (0.987)
4,8-Dioxa-3H-Perfluorononanoic Acid (ADONA)	-	ND (0.796)	ND (0.799)	ND (0.792)	ND (0.789)	ND (0.795)	ND (0.789)
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	-	ND (0.796)	ND (0.799)	ND (0.792)	ND (0.789)	ND (0.795)	ND (0.789)
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	-	ND (0.796)	**5.06**	**1.42**	ND (0.789)	ND (0.795)	ND (0.789)
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	-	ND (0.796)	ND (0.799)	ND (0.792)	ND (0.789)	ND (0.795)	ND (0.789)
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	-	ND (0.796)	ND (0.799)	ND (0.792)	ND (0.789)	ND (0.795)	ND (0.789)
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	-	ND (0.199)	ND (0.2)	ND (0.198)	ND (0.197)	ND (0.199)	ND (0.197)
N-Ethylperfluorooctane sulfonamide (N-EtFOSA)	-	ND (0.199)	ND (0.2)	ND (0.198)	ND (0.197)	ND (0.199)	ND (0.197)
N-Ethylperfluorooctane sulfonamidoethanol (N-EtFOSE)	-	ND (1.99)	ND (2)	ND (1.98)	ND (1.97)	ND (1.99)	ND (1.97)
N-Methyl Perfluorooctanesulfonamidoacetic Acid (MeFOSAA)	-	ND (0.199)	ND (0.2)	ND (0.198)	ND (0.197)	ND (0.199)	ND (0.197)
N-Methylperfluorooctane sulfonamide (N-MeFOSA)	-	ND (0.199)	ND (0.2)	ND (0.198)	ND (0.197)	ND (0.199)	ND (0.197)
N-Methylperfluorooctane sulfonamidoethanol (N-MeFOSE)	-	ND (1.99)	ND (2)	ND (1.98)	ND (1.97)	ND (1.99)	ND (1.97)
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	-	ND (0.398)	ND (0.399)	ND (0.396)	ND (0.395)	ND (0.397)	ND (0.395)
Perfluoro(2-ethoxyethane) sulphonic acid (PFEESA)	-	ND (0.398)	ND (0.399)	ND (0.396)	ND (0.395)	ND (0.397)	ND (0.395)
Perfluoro(4-methoxybutanoic) acid (PFMBA)	-	ND (0.398)	ND (0.399)	ND (0.396)	ND (0.395)	ND (0.397)	ND (0.395)
Perfluoro-2-propoxypropanoic acid (PFPrOPrA)(GenX) (HFPO-DA)	-	ND (0.796)	ND (0.799)	ND (0.792)	ND (0.789)	ND (0.795)	ND (0.789)
Perfluoro-3-methoxypropanoic acid (PFMPA)	-	ND (0.398)	ND (0.399)	ND (0.396)	ND (0.395)	ND (0.397)	ND (0.395)
Perfluorobutanesulfonic acid (PFBS)	-	ND (0.199)	ND (0.2)	ND (0.198)	ND (0.197)	ND (0.199)	ND (0.197)
Perfluorobutanoic acid (PFBA)	-	ND (0.796)	ND (0.799)	ND (0.792)	ND (0.789)	ND (0.795)	ND (0.789)
Perfluorodecanesulfonic acid (PFDS)	-	ND (0.199)	ND (0.2)	ND (0.198)	ND (0.197)	ND (0.199)	ND (0.197)
Perfluorodecanoic acid (PFDA)	-	ND (0.199)	ND (0.2)	ND (0.198)	ND (0.197)	ND (0.199)	ND (0.197)
Perfluorododecane sulfonic acid (PFDoDS)	-	ND (0.199)	ND (0.2)	ND (0.198)	ND (0.197)	ND (0.199)	ND (0.197)
Perfluorododecanoic acid (PFDoDA)	-	ND (0.199)	ND (0.2)	ND (0.198)	ND (0.197)	ND (0.199)	ND (0.197)
Perfluoroheptanesulfonic acid (PFHpS)	-	ND (0.199)	ND (0.2)	**0.048 J**	ND (0.197)	ND (0.199)	**0.047 J**
Perfluoroheptanoic acid (PFHpA)	-	ND (0.199)	ND (0.2)	**0.097 J**	ND (0.197)	**0.077 J**	**0.036 J**
Perfluorohexanesulfonic acid (PFHxS)	-	ND (0.199)	ND (0.2)	**0.178 J**	ND (0.197)	**0.11 J**	**0.065 J**
Perfluorohexanoic acid (PFHxA)	-	ND (0.199)	ND (0.2)	ND (0.198)	ND (0.197)	ND (0.199)	ND (0.197)
Perfluorononane sulfonic acid (PFNS)	-	ND (0.199)	ND (0.2)	ND (0.198)	ND (0.197)	ND (0.199)	ND (0.197)
Perfluorononanoic acid (PFNA)	-	ND (0.199)	ND (0.2)	ND (0.198)	ND (0.197)	ND (0.199)	ND (0.197)
Perfluorooctane sulfonamide (PFOSA)	-	ND (0.199)	ND (0.2)	ND (0.198)	ND (0.197)	ND (0.199)	ND (0.197)
Perfluorooctanesulfonic acid (PFOS)	1	ND (0.199)	**0.903**	**1.41 [A]**	**0.151 J**	**1.17 [A]**	**1.14 [A]**
Perfluorooctanoic acid (PFOA)	0.8	**0.096 J**	**0.216**	**0.754**	**0.098 J**	**0.42**	**0.202**
Perfluoropentanesulfonic acid (PFPeS)	-	ND (0.199)	ND (0.2)	ND (0.198)	ND (0.197)	ND (0.199)	ND (0.197)
Perfluoropentanoic acid (PFPeA)	-	ND (0.398)	ND (0.399)	ND (0.396)	ND (0.395)	ND (0.397)	ND (0.395)
Perfluorotetradecanoic acid (PFTeDA)	-	ND (0.199)	ND (0.2)	ND (0.198)	ND (0.197)	ND (0.199)	ND (0.197)
Perfluorotridecanoic acid (PFTrDA)	-	ND (0.199)	ND (0.2)	ND (0.198)	ND (0.197)	ND (0.199)	ND (0.197)
Perfluoroundecanoic acid (PFUnDA)	-	ND (0.199)	ND (0.2)	ND (0.198)	ND (0.197)	ND (0.199)	ND (0.197)

Notes:

1. *Results in red exceed the following criteria:*
   [A] - 2023 NYSDEC Protection of Groundwater Guidance Value
2. *Results in **bold** were detected.*
3. *ND - Not detected above reporting limit*
   J - Estimated value
   F -The ratio of quantifier ion response to qualifier ion response falls outside of the laboratory criteria. Results are considered to be an estimated maximum concentration
4. *Unvalidated data shown in table.*

TABLE I
SUMMARY OF PFAS SOIL ANALYTICAL DATA - OUTFALL #3 AREA
OERLIKON METCO
WESTBURY, NJ

Location **Sample Date** **Sample Type** **Sample Depth (bgs)** **Sample Name**	**Protection Of Groundwater Guidance Values**	**HA-204** **08/27/2024** **N** **10 - 12 (ft)** **HA-204-10.0-12.0**	**HA-204** **08/27/2024** **N** **20 - 22 (ft)** **HA-204-20.0-22.0**	**HA-204** **08/27/2024** **N** **30 - 32 (ft)** **HA-204-30.0-32.0**	**HA-204** **08/27/2024** **N** **40 - 42 (ft)** **HA-204-40.0-42.0**	**HA-204** **08/27/2024** **N** **50 - 52 (ft)** **HA-204-50.0-52.0**	**HA-204** **08/27/2024** **N** **60 - 62 (ft)** **HA-204-60.0-62.0**
Other							
Total Solids (%)	-	**91.8**	**93.2**	**93**	**94.2**	**97.2**	**98.9**
PFAS (ng/g)							
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	-	ND (0.792)	ND (0.769)	ND (0.769)	ND (0.8)	ND (0.766)	ND (0.798)
2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)	-	ND (4.95)	ND (4.81)	ND (4.81)	ND (5)	ND (4.79)	ND (4.98)
3-(Perfluoroheptyl)propanoic acid (7:3 FTCA)	-	ND (4.95)	ND (4.81)	ND (4.81)	ND (5)	ND (4.79)	ND (4.98)
3:3 Fluorotelomer carboxylic acid (3:3 FTCA)	-	ND (0.99)	ND (0.961)	ND (0.962)	ND (1)	ND (0.958)	ND (0.997)
4,8-Dioxa-3H-Perfluorononanoic Acid (ADONA)	-	ND (0.792)	ND (0.769)	ND (0.769)	ND (0.8)	ND (0.766)	ND (0.798)
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	-	ND (0.792)	ND (0.769)	ND (0.769)	ND (0.8)	ND (0.766)	ND (0.798)
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	-	ND (0.792)	ND (0.769)	ND (0.769)	ND (0.8)	ND (0.766)	ND (0.798)
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	-	ND (0.792)	ND (0.769)	ND (0.769)	ND (0.8)	ND (0.766)	ND (0.798)
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	-	ND (0.792)	ND (0.769)	ND (0.769)	ND (0.8)	ND (0.766)	ND (0.798)
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	-	ND (0.198)	**102**	**3.7 F**	**2.06**	**1.91**	**5.69**
N-Ethylperfluorooctane sulfonamide (N-EtFOSA)	-	ND (0.198)	**3.54**	**0.308**	ND (0.2)	ND (0.192)	**0.795**
N-Ethylperfluorooctane sulfonamidoethanol (N-EtFOSE)	-	ND (1.98)	ND (1.92)	ND (1.92)	ND (2)	ND (1.92)	ND (1.99)
N-Methyl Perfluorooctanesulfonamidoacetic Acid (MeFOSAA)	-	ND (0.198)	**0.131 JF**	ND (0.192)	ND (0.2)	ND (0.192)	ND (0.199)
N-Methylperfluorooctane sulfonamide (N-MeFOSA)	-	ND (0.198)	ND (0.192)	ND (0.192)	ND (0.2)	ND (0.192)	ND (0.199)
N-Methylperfluorooctane sulfonamidoethanol (N-MeFOSE)	-	ND (1.98)	ND (1.92)	ND (1.92)	ND (2)	ND (1.92)	ND (1.99)
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	-	ND (0.396)	ND (0.384)	ND (0.385)	ND (0.4)	ND (0.383)	ND (0.399)
Perfluoro(2-ethoxyethane) sulphonic acid (PFEESA)	-	ND (0.396)	ND (0.384)	ND (0.385)	ND (0.4)	ND (0.383)	ND (0.399)
Perfluoro(4-methoxybutanoic) acid (PFMBA)	-	ND (0.396)	ND (0.384)	ND (0.385)	ND (0.4)	ND (0.383)	ND (0.399)
Perfluoro-2-propoxypropanoic acid (PFPrOPrA)(GenX) (HFPO-DA)	-	ND (0.792)	ND (0.769)	ND (0.769)	ND (0.8)	ND (0.766)	ND (0.798)
Perfluoro-3-methoxypropanoic acid (PFMPA)	-	ND (0.396)	ND (0.384)	ND (0.385)	ND (0.4)	ND (0.383)	ND (0.399)
Perfluorobutanesulfonic acid (PFBS)	-	ND (0.198)	ND (0.192)	ND (0.192)	ND (0.2)	ND (0.192)	ND (0.199)
Perfluorobutanoic acid (PFBA)	-	ND (0.792)	ND (0.769)	ND (0.769)	ND (0.8)	ND (0.766)	ND (0.798)
Perfluorodecanesulfonic acid (PFDS)	-	ND (0.198)	ND (0.192)	ND (0.192)	ND (0.2)	ND (0.192)	ND (0.199)
Perfluorodecanoic acid (PFDA)	-	ND (0.198)	ND (0.192)	ND (0.192)	ND (0.2)	ND (0.192)	ND (0.199)
Perfluorododecane sulfonic acid (PFDoDS)	-	ND (0.198)	ND (0.192)	ND (0.192)	ND (0.2)	ND (0.192)	ND (0.199)
Perfluorododecanoic acid (PFDoDA)	-	ND (0.198)	ND (0.192)	ND (0.192)	ND (0.2)	ND (0.192)	ND (0.199)
Perfluoroheptanesulfonic acid (PFHpS)	-	ND (0.198)	ND (0.192)	ND (0.192)	ND (0.2)	ND (0.192)	**0.049 J**
Perfluoroheptanoic acid (PFHpA)	-	ND (0.198)	ND (0.192)	ND (0.192)	ND (0.2)	ND (0.192)	**0.057 J**
Perfluorohexanesulfonic acid (PFHxS)	-	ND (0.198)	ND (0.192)	ND (0.192)	ND (0.2)	ND (0.192)	**0.064 J**
Perfluorohexanoic acid (PFHxA)	-	ND (0.198)	ND (0.192)	ND (0.192)	ND (0.2)	ND (0.192)	ND (0.199)
Perfluorononane sulfonic acid (PFNS)	-	ND (0.198)	ND (0.192)	ND (0.192)	ND (0.2)	ND (0.192)	ND (0.199)
Perfluorononanoic acid (PFNA)	-	ND (0.198)	ND (0.192)	ND (0.192)	ND (0.2)	ND (0.192)	ND (0.199)
Perfluorooctane sulfonamide (PFOSA)	-	ND (0.198)	**27.6**	**1.2**	**0.559**	**0.568 F**	**2.76**
Perfluorooctanesulfonic acid (PFOS)	1	**0.227**	**6.17** [A]	**2.85** [A]	**2.53** [A]	**1.51** [A]	**4.95** [A]
Perfluorooctanoic acid (PFOA)	0.8	**0.082 J**	**0.214**	**0.317**	**0.415**	**0.226**	**2.04** [A]
Perfluoropentanesulfonic acid (PFPeS)	-	ND (0.198)	ND (0.192)	ND (0.192)	ND (0.2)	ND (0.192)	ND (0.199)
Perfluoropentanoic acid (PFPeA)	-	ND (0.396)	ND (0.384)	ND (0.385)	ND (0.4)	ND (0.383)	ND (0.399)
Perfluorotetradecanoic acid (PFTeDA)	-	ND (0.198)	ND (0.192)	ND (0.192)	ND (0.2)	ND (0.192)	ND (0.199)
Perfluorotridecanoic acid (PFTrDA)	-	ND (0.198)	ND (0.192)	ND (0.192)	ND (0.2)	ND (0.192)	ND (0.199)
Perfluoroundecanoic acid (PFUnDA)	-	ND (0.198)	ND (0.192)	ND (0.192)	ND (0.2)	ND (0.192)	ND (0.199)

Notes:
1. Results in red exceed the following criteria:
[A] - 2023 NYSDEC Protection of Groundwater Guidance Value
*2. Results in **bold** were detected.*
3. ND - Not detected above reporting limit
J - Estimated value
F -The ratio of quantifier ion response to qualifier ion response falls outside of the laboratory criteria. Results are considered to be an estimated maximum concentration
4. Unvalidated data shown in table.

TABLE I
SUMMARY OF PFAS SOIL ANALYTICAL DATA - OUTFALL #3 AREA
OERLIKON METCO
WESTBURY, NJ

Location		**HA-205**	**HA-205**	**HA-205**	**HA-205**	**HA-205**	**HA-205**
Sample Date		**08/28/2024**	**08/28/2024**	**08/28/2024**	**08/28/2024**	**08/28/2024**	**08/28/2024**
Sample Type	**Protection Of**	**N**	**N**	**N**	**N**	**N**	**FD**
Sample Depth (bgs)	**Groundwater**	**10 - 12 (ft)**	**20 - 22 (ft)**	**30 - 32 (ft)**	**40 - 42 (ft)**	**50 - 52 (ft)**	**50 - 52 (ft)**
Sample Name	**Guidance Values**	**HA-205-10.0-12.0**	**HA-205-20.0-22.0**	**HA-205-30.0-32.0**	**HA-205-40.0-42.0**	**HA-205-50.0-52.0**	**021063-082824-0001**
Other							
Total Solids (%)	-	**94.2**	**85.9**	**96.7**	**93.2**	**95.7**	**87.1**
PFAS (ng/g)							
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	-	ND (0.797)	ND (0.799)	ND (0.795)	ND (0.793)	ND (0.801)	ND (0.8)
2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)	-	ND (4.98)	ND (4.99)	ND (4.97)	ND (4.96)	ND (5)	ND (5)
3-(Perfluoroheptyl)propanoic acid (7:3 FTCA)	-	ND (4.98)	ND (4.99)	ND (4.97)	ND (4.96)	ND (5)	ND (5)
3:3 Fluorotelomer carboxylic acid (3:3 FTCA)	-	ND (0.996)	ND (0.998)	ND (0.994)	ND (0.992)	ND (1)	ND (1)
4,8-Dioxa-3H-Perfluorononanoic Acid (ADONA)	-	ND (0.797)	ND (0.799)	ND (0.795)	ND (0.793)	ND (0.801)	ND (0.8)
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	-	ND (0.797)	ND (0.799)	ND (0.795)	ND (0.793)	ND (0.801)	ND (0.8)
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	-	ND (0.797)	ND (0.799)	ND (0.795)	ND (0.793)	ND (0.801)	ND (0.8)
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	-	ND (0.797)	ND (0.799)	ND (0.795)	ND (0.793)	ND (0.801)	ND (0.8)
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	-	ND (0.797)	ND (0.799)	ND (0.795)	ND (0.793)	ND (0.801)	ND (0.8)
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	-	**1.75**	**1.89**	**0.912**	**0.447 F**	**0.389**	**2.91**
N-Ethylperfluorooctane sulfonamide (N-EtFOSA)	-	ND (0.199)	ND (0.2)	**0.463**	**0.264**	ND (0.2)	**0.591**
N-Ethylperfluorooctane sulfonamidoethanol (N-EtFOSE)	-	ND (1.99)	ND (2)	ND (1.99)	ND (1.98)	ND (2)	ND (2)
N-Methyl Perfluorooctanesulfonamidoacetic Acid (MeFOSAA)	-	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.198)	ND (0.2)	ND (0.2)
N-Methylperfluorooctane sulfonamide (N-MeFOSA)	-	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.198)	ND (0.2)	ND (0.2)
N-Methylperfluorooctane sulfonamidoethanol (N-MeFOSE)	-	ND (1.99)	ND (2)	ND (1.99)	ND (1.98)	ND (2)	ND (2)
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	-	ND (0.398)	ND (0.399)	ND (0.398)	ND (0.397)	ND (0.4)	ND (0.4)
Perfluoro(2-ethoxyethane) sulphonic acid (PFEESA)	-	ND (0.398)	ND (0.399)	ND (0.398)	ND (0.397)	ND (0.4)	ND (0.4)
Perfluoro(4-methoxybutanoic) acid (PFMBA)	-	ND (0.398)	ND (0.399)	ND (0.398)	ND (0.397)	ND (0.4)	ND (0.4)
Perfluoro-2-propoxypropanoic acid (PFPrOPrA)(GenX) (HFPO-DA)	-	ND (0.797)	ND (0.799)	ND (0.795)	ND (0.793)	ND (0.801)	ND (0.8)
Perfluoro-3-methoxypropanoic acid (PFMPA)	-	ND (0.398)	ND (0.399)	ND (0.398)	ND (0.397)	ND (0.4)	ND (0.4)
Perfluorobutanesulfonic acid (PFBS)	-	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluorobutanoic acid (PFBA)	-	ND (0.797)	ND (0.799)	ND (0.795)	ND (0.793)	ND (0.801)	ND (0.8)
Perfluorodecanesulfonic acid (PFDS)	-	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluorodecanoic acid (PFDA)	-	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluorododecane sulfonic acid (PFDoDS)	-	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluorododecanoic acid (PFDoDA)	-	**0.107 J**	ND (0.2)	ND (0.199)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluoroheptanesulfonic acid (PFHpS)	-	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluoroheptanoic acid (PFHpA)	-	**0.025 J**	**0.03 J**	ND (0.199)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluorohexanesulfonic acid (PFHxS)	-	**0.529**	**0.154 J**	ND (0.199)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluorohexanoic acid (PFHxA)	-	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluorononane sulfonic acid (PFNS)	-	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluorononanoic acid (PFNA)	-	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluorooctane sulfonamide (PFOSA)	-	**8.82**	**5.33**	**3.89**	**1.36**	**0.577**	**3.89**
Perfluorooctanesulfonic acid (PFOS)	1	**6.48** [A]	**1.16** [A]	**3.87** [A]	**0.824**	**1.39** [A]	**3.14** [A]
Perfluorooctanoic acid (PFOA)	0.8	**0.298**	**0.279**	ND (0.199)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluoropentanesulfonic acid (PFPeS)	-	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluoropentanoic acid (PFPeA)	-	ND (0.398)	ND (0.399)	ND (0.398)	ND (0.397)	ND (0.4)	ND (0.4)
Perfluorotetradecanoic acid (PFTeDA)	-	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluorotridecanoic acid (PFTrDA)	-	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluoroundecanoic acid (PFUnDA)	-	ND (0.199)	ND (0.2)	ND (0.199)	ND (0.198)	ND (0.2)	ND (0.2)

Notes:

1. *Results in red exceed the following criteria:*
   [A] - 2023 NYSDEC Protection of Groundwater Guidance Value
2. *Results in **bold** were detected.*
3. *ND - Not detected above reporting limit*
   J - Estimated value
   F -The ratio of quantifier ion response to qualifier ion response falls outside of the laboratory criteria. Results are considered to be an estimated maximum concentration
4. *Unvalidated data shown in table.*

TABLE I
SUMMARY OF PFAS SOIL ANALYTICAL DATA - OUTFALL #3 AREA
OERLIKON METCO
WESTBURY, NJ

Location		**HA-206**	**HA-206**	**HA-206**	**HA-206**	**HA-206**	**HA-206**
Sample Date		**08/29/2024**	**08/29/2024**	**08/29/2024**	**08/29/2024**	**08/29/2024**	**08/29/2024**
Sample Type	**Protection Of Groundwater Guidance Values**	**N**	**N**	**N**	**N**	**N**	**N**
Sample Depth (bgs)		**10 - 12 (ft)**	**20 - 22 (ft)**	**30 - 32 (ft)**	**40 - 42 (ft)**	**50 - 52 (ft)**	**60 - 62 (ft)**
Sample Name		**HA-206-10.0-12.0**	**HA-206-20.0-22.0**	**HA-206-30.0-32.0**	**HA-206-40.0-42.0**	**HA-206-50.0-52.0**	**HA-206-60.0-62.0**
Other							
Total Solids (%)	-	**96.1**	**93.5**	**94.7**	**97.4**	**95.1**	**79.7**
PFAS (ng/g)							
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	-	ND (0.788)	ND (0.818)	ND (0.785)	ND (0.794)	ND (0.8)	ND (0.799)
2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)	-	ND (4.93)	ND (5.11)	ND (4.91)	ND (4.96)	ND (5)	ND (4.99)
3-(Perfluoroheptyl)propanoic acid (7:3 FTCA)	-	ND (4.93)	ND (5.11)	ND (4.91)	ND (4.96)	ND (5)	ND (4.99)
3:3 Fluorotelomer carboxylic acid (3:3 FTCA)	-	ND (0.985)	ND (1.02)	ND (0.981)	ND (0.993)	ND (1)	ND (0.999)
4,8-Dioxa-3H-Perfluorononanoic Acid (ADONA)	-	ND (0.788)	ND (0.818)	ND (0.785)	ND (0.794)	ND (0.8)	ND (0.799)
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	-	ND (0.788)	ND (0.818)	ND (0.785)	ND (0.794)	ND (0.8)	ND (0.799)
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	-	ND (0.788)	ND (0.818)	ND (0.785)	ND (0.794)	ND (0.8)	ND (0.799)
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	-	ND (0.788)	ND (0.818)	ND (0.785)	ND (0.794)	ND (0.8)	ND (0.799)
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	-	ND (0.788)	ND (0.818)	ND (0.785)	ND (0.794)	ND (0.8)	ND (0.799)
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	-	ND (0.197)	ND (0.204)	**0.559**	ND (0.198)	**0.147 J**	**0.23**
N-Ethylperfluorooctane sulfonamide (N-EtFOSA)	-	ND (0.197)	ND (0.204)	ND (0.196)	ND (0.198)	ND (0.2)	ND (0.2)
N-Ethylperfluorooctane sulfonamidoethanol (N-EtFOSE)	-	ND (1.97)	ND (2.04)	ND (1.96)	ND (1.98)	ND (2)	ND (2)
N-Methyl Perfluorooctanesulfonamidoacetic Acid (MeFOSAA)	-	ND (0.197)	ND (0.204)	ND (0.196)	ND (0.198)	ND (0.2)	ND (0.2)
N-Methylperfluorooctane sulfonamide (N-MeFOSA)	-	ND (0.197)	ND (0.204)	ND (0.196)	ND (0.198)	ND (0.2)	ND (0.2)
N-Methylperfluorooctane sulfonamidoethanol (N-MeFOSE)	-	ND (1.97)	ND (2.04)	ND (1.96)	ND (1.98)	ND (2)	ND (2)
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	-	ND (0.394)	ND (0.409)	ND (0.392)	ND (0.397)	ND (0.4)	ND (0.4)
Perfluoro(2-ethoxyethane) sulphonic acid (PFEESA)	-	ND (0.394)	ND (0.409)	ND (0.392)	ND (0.397)	ND (0.4)	ND (0.4)
Perfluoro(4-methoxybutanoic) acid (PFMBA)	-	ND (0.394)	ND (0.409)	ND (0.392)	ND (0.397)	ND (0.4)	ND (0.4)
Perfluoro-2-propoxypropanoic acid (PFPrOPrA)(GenX) (HFPO-DA)	-	ND (0.788)	ND (0.818)	ND (0.785)	ND (0.794)	ND (0.8)	ND (0.799)
Perfluoro-3-methoxypropanoic acid (PFMPA)	-	ND (0.394)	ND (0.409)	ND (0.392)	ND (0.397)	ND (0.4)	ND (0.4)
Perfluorobutanesulfonic acid (PFBS)	-	ND (0.197)	ND (0.204)	ND (0.196)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluorobutanoic acid (PFBA)	-	ND (0.788)	ND (0.818)	ND (0.785)	ND (0.794)	ND (0.8)	ND (0.799)
Perfluorodecanesulfonic acid (PFDS)	-	ND (0.197)	ND (0.204)	ND (0.196)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluorodecanoic acid (PFDA)	-	ND (0.197)	ND (0.204)	ND (0.196)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluorododecane sulfonic acid (PFDoDS)	-	ND (0.197)	ND (0.204)	ND (0.196)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluorododecanoic acid (PFDoDA)	-	ND (0.197)	ND (0.204)	ND (0.196)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluoroheptanesulfonic acid (PFHpS)	-	ND (0.197)	**0.045 J**	**0.042 J**	ND (0.198)	ND (0.2)	ND (0.2)
Perfluoroheptanoic acid (PFHpA)	-	ND (0.197)	ND (0.204)	**0.064 J**	**0.023 J**	ND (0.2)	**0.027 J**
Perfluorohexanesulfonic acid (PFHxS)	-	ND (0.197)	**0.474**	**0.749**	**0.26**	**0.106 J**	**0.117 J**
Perfluorohexanoic acid (PFHxA)	-	ND (0.197)	ND (0.204)	ND (0.196)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluorononane sulfonic acid (PFNS)	-	ND (0.197)	ND (0.204)	ND (0.196)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluorononanoic acid (PFNA)	-	ND (0.197)	ND (0.204)	ND (0.196)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluorooctane sulfonamide (PFOSA)	-	ND (0.197)	ND (0.204)	**0.09 JF**	ND (0.198)	ND (0.2)	**0.116 JF**
Perfluorooctanesulfonic acid (PFOS)	1	**0.1 J**	**1.47** [A]	**2.64** [A]	**0.118 J**	**0.093 J**	**1.3** [A]
Perfluorooctanoic acid (PFOA)	0.8	**0.108 J**	**1.17** [A]	**0.863** [A]	**0.392**	**0.171 J**	**0.11 J**
Perfluoropentanesulfonic acid (PFPeS)	-	ND (0.197)	ND (0.204)	ND (0.196)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluoropentanoic acid (PFPeA)	-	ND (0.394)	ND (0.409)	ND (0.392)	ND (0.397)	ND (0.4)	ND (0.4)
Perfluorotetradecanoic acid (PFTeDA)	-	ND (0.197)	ND (0.204)	ND (0.196)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluorotridecanoic acid (PFTrDA)	-	ND (0.197)	ND (0.204)	ND (0.196)	ND (0.198)	ND (0.2)	ND (0.2)
Perfluoroundecanoic acid (PFUnDA)	-	ND (0.197)	ND (0.204)	ND (0.196)	ND (0.198)	ND (0.2)	ND (0.2)

Notes:
1. *Results in red exceed the following criteria:*
   [A] - 2023 NYSDEC Protection of Groundwater Guidance Value
2. *Results in **bold** were detected.*
3. *ND - Not detected above reporting limit*
   J - Estimated value
   F -The ratio of quantifier ion response to qualifier ion response falls outside of the laboratory criteria. Results are considered to be an estimated maximum concentration
4. *Unvalidated data shown in table.*

TABLE I
SUMMARY OF PFAS SOIL ANALYTICAL DATA - OUTFALL #3 AREA
OERLIKON METCO
WESTBURY, NJ

Location **Sample Date** **Sample Type** **Sample Depth (bgs)** **Sample Name**	**Protection Of Groundwater Guidance Values**	**HA-207** **08/28/2024** **N** **10 - 12 (ft)** **HA-207-10.0-12.0**	**HA-207** **08/28/2024** **N** **20 - 22 (ft)** **HA-207-20.0-22.0**	**HA-207** **08/28/2024** **N** **30 - 32 (ft)** **HA-207-30.0-32.0**	**HA-207** **08/28/2024** **N** **40 - 42 (ft)** **HA-207-40.0-42.0**	**HA-207** **08/28/2024** **N** **50 - 52 (ft)** **HA-207-50.0-52.0**	**HA-207** **08/28/2024** **N** **56 - 58 (ft)** **HA-207-56.0-58.0**
Other							
Total Solids (%)	-	**97.8**	**96.2**	**90.1**	**97**	**98.2**	**97.4**
PFAS (ng/g)							
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	-	ND (0.8)	ND (0.798)	ND (0.797)	ND (0.799)	ND (0.799)	ND (0.799)
2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)	-	ND (5)	ND (4.99)	ND (4.98)	ND (4.99)	ND (4.99)	ND (4.99)
3-(Perfluoroheptyl)propanoic acid (7:3 FTCA)	-	ND (5)	ND (4.99)	ND (4.98)	ND (4.99)	ND (4.99)	ND (4.99)
3:3 Fluorotelomer carboxylic acid (3:3 FTCA)	-	ND (1)	ND (0.998)	ND (0.996)	ND (0.999)	ND (0.998)	ND (0.999)
4,8-Dioxa-3H-Perfluorononanoic Acid (ADONA)	-	ND (0.8)	ND (0.798)	ND (0.797)	ND (0.799)	ND (0.799)	ND (0.799)
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	-	ND (0.8)	ND (0.798)	ND (0.797)	ND (0.799)	ND (0.799)	ND (0.799)
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	-	ND (0.8)	ND (0.798)	ND (0.797)	ND (0.799)	ND (0.799)	ND (0.799)
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	-	ND (0.8)	ND (0.798)	ND (0.797)	ND (0.799)	ND (0.799)	ND (0.799)
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	-	ND (0.8)	ND (0.798)	ND (0.797)	ND (0.799)	ND (0.799)	ND (0.799)
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	-	ND (0.2)	ND (0.2)	**1.69**	**1.62**	**0.785**	**0.462**
N-Ethylperfluorooctane sulfonamide (N-EtFOSA)	-	ND (0.2)	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.2)	ND (0.2)
N-Ethylperfluorooctane sulfonamidoethanol (N-EtFOSE)	-	ND (2)	ND (2)	ND (1.99)	ND (2)	ND (2)	ND (2)
N-Methyl Perfluorooctanesulfonamidoacetic Acid (MeFOSAA)	-	ND (0.2)	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.2)	ND (0.2)
N-Methylperfluorooctane sulfonamide (N-MeFOSA)	-	ND (0.2)	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.2)	ND (0.2)
N-Methylperfluorooctane sulfonamidoethanol (N-MeFOSE)	-	ND (2)	ND (2)	ND (1.99)	ND (2)	ND (2)	ND (2)
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	-	ND (0.4)	ND (0.399)	ND (0.398)	ND (0.4)	ND (0.399)	ND (0.399)
Perfluoro(2-ethoxyethane) sulphonic acid (PFEESA)	-	ND (0.4)	ND (0.399)	ND (0.398)	ND (0.4)	ND (0.399)	ND (0.399)
Perfluoro(4-methoxybutanoic) acid (PFMBA)	-	ND (0.4)	ND (0.399)	ND (0.398)	ND (0.4)	ND (0.399)	ND (0.399)
Perfluoro-2-propoxypropanoic acid (PFPrOPrA)(GenX) (HFPO-DA)	-	ND (0.8)	ND (0.798)	ND (0.797)	ND (0.799)	ND (0.799)	ND (0.799)
Perfluoro-3-methoxypropanoic acid (PFMPA)	-	ND (0.4)	ND (0.399)	ND (0.398)	ND (0.4)	ND (0.399)	ND (0.399)
Perfluorobutanesulfonic acid (PFBS)	-	ND (0.2)	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.2)	ND (0.2)
Perfluorobutanoic acid (PFBA)	-	ND (0.8)	ND (0.798)	ND (0.797)	ND (0.799)	ND (0.799)	ND (0.799)
Perfluorodecanesulfonic acid (PFDS)	-	ND (0.2)	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.2)	ND (0.2)
Perfluorodecanoic acid (PFDA)	-	ND (0.2)	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.2)	ND (0.2)
Perfluorododecane sulfonic acid (PFDoDS)	-	ND (0.2)	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.2)	ND (0.2)
Perfluorododecanoic acid (PFDoDA)	-	ND (0.2)	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.2)	ND (0.2)
Perfluoroheptanesulfonic acid (PFHpS)	-	ND (0.2)	ND (0.2)	**0.12 J**	**0.055 J**	**0.057 J**	**0.046 J**
Perfluoroheptanoic acid (PFHpA)	-	ND (0.2)	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.2)	**0.026 J**
Perfluorohexanesulfonic acid (PFHxS)	-	ND (0.2)	ND (0.2)	**0.081 J**	**0.09 J**	**0.101 J**	**0.151 J**
Perfluorohexanoic acid (PFHxA)	-	ND (0.2)	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.2)	ND (0.2)
Perfluorononane sulfonic acid (PFNS)	-	ND (0.2)	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.2)	ND (0.2)
Perfluorononanoic acid (PFNA)	-	ND (0.2)	ND (0.2)	**0.102 J**	ND (0.2)	ND (0.2)	ND (0.2)
Perfluorooctane sulfonamide (PFOSA)	-	**0.099 J**	ND (0.2)	**0.116 J**	**0.121 J**	ND (0.2)	ND (0.2)
Perfluorooctanesulfonic acid (PFOS)	1	**0.114 J**	**0.236**	**6.94 [A]**	**3.7 [A]**	**1.72 [A]**	**1.81 [A]**
Perfluorooctanoic acid (PFOA)	0.8	ND (0.2)	ND (0.2)	**0.459**	**0.304**	**0.459**	**0.829 [A]**
Perfluoropentanesulfonic acid (PFPeS)	-	ND (0.2)	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.2)	ND (0.2)
Perfluoropentanoic acid (PFPeA)	-	ND (0.4)	ND (0.399)	ND (0.398)	ND (0.4)	ND (0.399)	ND (0.399)
Perfluorotetradecanoic acid (PFTeDA)	-	ND (0.2)	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.2)	ND (0.2)
Perfluorotridecanoic acid (PFTrDA)	-	ND (0.2)	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.2)	ND (0.2)
Perfluoroundecanoic acid (PFUnDA)	-	ND (0.2)	ND (0.2)	ND (0.199)	ND (0.2)	ND (0.2)	ND (0.2)

Notes:

1. *Results in red exceed the following criteria:*
   [A] - 2023 NYSDEC Protection of Groundwater Guidance Value
2. *Results in **bold** were detected.*
3. *ND - Not detected above reporting limit*
   J - Estimated value
   F -The ratio of quantifier ion response to qualifier ion response falls outside of the laboratory criteria. Results are considered to be an estimated maximum concentration
4. *Unvalidated data shown in table.*

TABLE II

SUMMARY OF PFAS SURFICIAL SOIL AND DRYWELL SEDIMENT ANALYTICAL DATA

OERLIKON METCO

WESTBURY, NY

Location	**Protection Of Groundwater Guidance Values**	**SGS-D2**	**SGS-D4A**	**SGS-D6**	**SGS-DS1**	**SGS-RA1**	**SGS-RA2**
Sample Date		**10/29/2024**	**10/29/2024**	**10/29/2024**	**10/29/2024**	**10/29/2024**	**10/29/2024**
Sample Type		**Drywell Sediment**	**Drywell Sediment**	**Drywell Sediment**	**Surficial Soil**	**Surficial Soil**	**Surficial Soil**
Sample Name		**SGS-D2-20241029**	**SGS-D4A-20241029**	**SGS-D6-20241029**	**SGS-DS1-20241029**	**SGS-RA1-20241029**	**SGS-RA2-20241029**
Other							
Total Solids (%)	-	**89.9**	**77.5**	**79.4**	**89.1**	**82.7**	**71.1**
PFAS (ng/g)							
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	-	ND (0.797)	ND (0.803)	ND (0.802)	ND (0.796)	ND (0.797)	ND (0.8)
2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)	-	ND (4.98)	ND (5.02)	ND (5.01)	ND (4.97)	ND (4.98)	ND (5)
3-(Perfluoroheptyl)propanoic acid (7:3 FTCA)	-	ND (4.98)	ND (5.02)	ND (5.01)	ND (4.97)	ND (4.98)	ND (5)
3:3 Fluorotelomer carboxylic acid (3:3 FTCA)	-	ND (0.997)	ND (1)	ND (1)	ND (0.995)	ND (0.996)	ND (1)
4,8-Dioxa-3H-Perfluorononanoic Acid (ADONA)	-	ND (0.797) J	ND (0.803) J	ND (0.802) J	ND (0.796) J	ND (0.797) J	ND (0.8) J
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	-	ND (0.797)	ND (0.803) J	ND (0.802)	ND (0.796) J	ND (0.797)	ND (0.8)
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	-	ND (0.797)	ND (0.803) J	ND (0.802)	ND (0.796) J	ND (0.797)	ND (0.8) J
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	-	ND (0.797) J	ND (0.803) J	ND (0.802) J	ND (0.796) J	ND (0.797)	ND (0.8) J
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	-	ND (0.797)	ND (0.803)	ND (0.802)	ND (0.796)	ND (0.797)	ND (0.8)
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	-	**0.156 J**	ND (2.01)	ND (0.2) J	**3.06**	ND (0.199)	**0.053 J**
N-Ethylperfluorooctane sulfonamide (N-EtFOSA)	-	ND (0.199)	ND (0.201)	ND (0.2)	**0.138 J**	ND (0.199)	ND (0.2)
N-Ethylperfluorooctane sulfonamidoethanol (N-EtFOSE)	-	ND (1.99)	ND (2.01)	ND (2)	**0.602 J**	ND (1.99)	ND (2)
N-Methyl Perfluorooctanesulfonamidoacetic Acid (MeFOSAA)	-	ND (0.199) J	ND (0.201) J	ND (0.2)	ND (0.199) J	ND (0.199)	ND (0.2) J
N-Methylperfluorooctane sulfonamide (N-MeFOSA)	-	ND (0.199)	ND (0.201)	ND (0.2)	ND (0.199)	ND (0.199)	ND (0.2)
N-Methylperfluorooctane sulfonamidoethanol (N-MeFOSE)	-	ND (1.99)	ND (2.01)	ND (2)	ND (1.99)	ND (1.99)	ND (2)
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	-	ND (0.399)	ND (0.401)	ND (0.401)	ND (0.398)	ND (0.398)	ND (0.4)
Perfluoro(2-ethoxyethane) sulphonic acid (PFEESA)	-	ND (0.399)	ND (0.401)	ND (0.401)	ND (0.398)	ND (0.398)	ND (0.4)
Perfluoro(4-methoxybutanoic) acid (PFMBA)	-	ND (0.399)	ND (0.401)	ND (0.401)	ND (0.398)	ND (0.398)	ND (0.4)
Perfluoro-2-propoxypropanoic acid (PFPrOPrA)(GenX) (HFPO-DA)	-	ND (0.797)	ND (0.803)	ND (0.802)	ND (0.796)	ND (0.797)	ND (0.8)
Perfluoro-3-methoxypropanoic acid (PFMPA)	-	ND (0.399)	ND (0.401)	ND (0.401)	ND (0.398)	ND (0.398)	ND (0.4)
Perfluorobutanesulfonic acid (PFBS)	-	ND (0.199)	ND (0.201)	ND (0.2)	ND (0.199)	ND (0.199)	ND (0.2)
Perfluorobutanoic acid (PFBA)	-	**0.22 J**	ND (0.803)	ND (0.802)	**0.036 J**	ND (0.797)	**0.058 J**
Perfluorodecanesulfonic acid (PFDS)	-	**10.1**	**0.098 J**	**0.031 J**	**0.423**	ND (0.199)	**0.038 J**
Perfluorodecanoic acid (PFDA)	-	**1.51**	**0.04 J**	ND (0.2)	**0.212**	**0.053 J**	**1.16**
Perfluorododecane sulfonic acid (PFDoDS)	-	ND (0.199)	ND (0.201)	ND (0.2)	ND (0.199)	ND (0.199)	ND (0.2)
Perfluorododecanoic acid (PFDoDA)	-	**1.27**	**0.343**	**0.166 J**	**1.54 J**	**0.702**	**7.19**
Perfluoroheptanesulfonic acid (PFHpS)	-	ND (0.199)	ND (0.201)	ND (0.2)	ND (0.199)	ND (0.199)	ND (0.2)
Perfluoroheptanoic acid (PFHpA)	-	**0.45**	ND (0.201)	ND (0.2)	**0.029 J**	ND (0.199)	**0.129 J**
Perfluorohexanesulfonic acid (PFHxS)	-	ND (0.199)	ND (0.201)	ND (0.2)	ND (0.199)	ND (0.199)	**0.044 J**
Perfluorohexanoic acid (PFHxA)	-	**1.24**	ND (0.201)	ND (0.2)	**0.052 J**	ND (0.199)	**0.254**
Perfluorononane sulfonic acid (PFNS)	-	**0.038 J**	ND (0.201)	ND (0.2)	ND (0.199)	ND (0.199)	ND (0.2)
Perfluorononanoic acid (PFNA)	-	**0.566**	**0.031 J**	ND (0.2)	**0.071 J**	ND (0.199)	**0.356**
Perfluorooctane sulfonamide (PFOSA)	-	**0.116 J**	**0.143 J**	ND (0.2)	**0.384**	ND (0.199)	ND (0.2)
Perfluorooctanesulfonic acid (PFOS)	1	**0.14 J**	**0.184 J**	**0.072 J**	**0.302**	ND (0.199)	**0.127 J**
Perfluorooctanoic acid (PFOA)	0.8	**0.596**	ND (0.201)	**0.033 J**	**0.092 J**	ND (0.199)	**0.813** [A]
Perfluoropentanesulfonic acid (PFPeS)	-	ND (0.199)	ND (0.201)	ND (0.2)	ND (0.199)	ND (0.199)	ND (0.2)
Perfluoropentanoic acid (PFPeA)	-	**0.942**	ND (0.401)	ND (0.401)	**0.064 J**	ND (0.398)	**0.33 J**
Perfluorotetradecanoic acid (PFTeDA)	-	**0.624**	**0.479**	**0.383**	**1.56 J**	**1.08**	**6.12**
Perfluorotridecanoic acid (PFTrDA)	-	**0.837**	**0.384**	**0.198 J**	**1.28 J**	**0.474**	**4.25**
Perfluoroundecanoic acid (PFUnDA)	-	**0.514**	**0.074 J**	**0.032 J**	**0.38**	**0.094 J**	**1.62**

Notes:

1. *Results in red exceed the following criteria:*
   [A] - 2023 NYSDEC Protection of Groundwater Guidance Value
2. *Results in* ***bold*** *were detected.*
3. *ND - Not detected above reporting limit*
   J - Estimated value

TABLE III
SUMMARY OF PFAS GROUNDWATER ANALYTICAL RESULTS
OERLIKON METCO
WESTBURY, NY

Location	**NYSDEC Guidance Criteria**	**HA-101**	**HA-102**	**HA-103**	**HA-104**	**HA-105**	**HA-106**	**HA-107**
Sample Date		**5/13/2019**	**5/13/2019**	**5/14/2019**	**5/14/2019**	**5/14/2019**	**8/19/2019**	**8/19/2019**
Sample Type		**Primary**	**Primary**	**Primary**	**Primary**	**Primary**	**Primary**	**Primary**
Sample Name		**HA-101-051319-1130-65**	**HA-102-051319-1320-65**	**HA-103-051419-0815-65**	**HA-104-051419-1130-65**	**HA-105-051419-1410-65**	**HA-106-081919-1100-70**	**HA-107-081919-1315-70**
PFAS (ng/L)								
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	-	-	-	-	-	-	-	-
2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)	-	-	-	-	-	-	-	-
3-(Perfluoroheptyl)propanoic acid (7:3 FTCA)	-	-	-	-	-	-	-	-
3:3 Fluorotelomer carboxylic acid (3:3 FTCA)	-	-	-	-	-	-	-	-
4,8-Dioxa-3H-Perfluorononanoic Acid (ADONA)	-	-	-	-	-	-	-	-
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	-	-	-	-	-	-	-	-
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	-	ND (1.94)	ND (2.02)	ND (2.07)	ND (2.02)	ND (2.1)	ND (1.97)	ND (1.89)
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	-	ND (1.94)	ND (2.02)	ND (2.07)	ND (2.02)	ND (2.1)	ND (1.97)	ND (1.89)
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	-	-	-	-	-	-	-	-
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	-	**15.2**	**1.14 J**	ND (2.07)	ND (2.02)	ND (2.1)	ND (1.97)	ND (1.89)
N-Ethylperfluorooctane sulfonamide (N-EtFOSA)	-	-	-	-	-	-	-	-
N-Ethylperfluorooctane sulfonamidoethanol (N-EtFOSE)	-	-	-	-	-	-	-	-
N-Methyl Perfluorooctanesulfonamidoacetic Acid (MeFOSAA)	-	ND (1.94)	ND (2.02)	ND (2.07)	ND (2.02)	ND (2.1)	ND (1.97)	ND (1.89)
N-Methylperfluorooctane sulfonamide (N-MeFOSA)	-	-	-	-	-	-	-	-
N-Methylperfluorooctane sulfonamidoethanol (N-MeFOSE)	-	-	-	-	-	-	-	-
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	-	-	-	-	-	-	-	-
Perfluoro(2-ethoxyethane) sulphonic acid (PFEESA)	-	-	-	-	-	-	-	-
Perfluoro(4-methoxybutanoic) acid (PFMBA)	-	-	-	-	-	-	-	-
Perfluoro-2-propoxypropanoic acid (PFPrOPrA)(GenX) (HFPO-DA)	-	-	-	-	-	-	-	-
Perfluoro-3-methoxypropanoic acid (PFMPA)	-	-	-	-	-	-	-	-
Perfluorobutanesulfonic acid (PFBS)	-	**8.3**	**2.22**	**2.57**	**1.53 J**	**7.17**	**1.39 J**	**2.24**
Perfluorobutanoic acid (PFBA)	-	**18.5**	**9.96**	**4.56**	**10.2**	**17.4**	**8.09**	**8.34**
Perfluorodecanesulfonic acid (PFDS)	-	ND (1.94)	ND (2.02)	ND (2.07)	ND (2.02)	ND (2.1)	ND (1.97)	ND (1.89)
Perfluorodecanoic acid (PFDA)	-	**2.25**	**2.7**	**0.417 J**	**16.4**	**0.962 J**	**2.49**	ND (1.89)
Perfluorododecane sulfonic acid (PFDoDS)	-	-	-	-	-	-	-	-
Perfluorododecanoic acid (PFDoDA)	-	ND (1.94)	ND (2.02)	ND (2.07)	ND (2.02)	ND (2.1)	**0.594 J**	ND (1.89)
Perfluoroheptanesulfonic acid (PFHpS)	-	**59**	**1.46 J**	**1.07 J**	ND (2.02)	**18.4**	ND (1.97)	ND (1.89)
Perfluoroheptanoic acid (PFHpA)	-	**212**	**6.99**	**6.62**	**14.9**	**120**	**4.67**	**126**
Perfluorohexanesulfonic acid (PFHxS)	-	**510**	**1.44 J**	**2.08**	**3.51**	**231**	**0.587 J**	**4.35**
Perfluorohexanoic acid (PFHxA)	-	**80**	**12.7**	**8.19**	**13.4**	**47.9**	**14.1**	**32.4**
Perfluorononane sulfonic acid (PFNS)	-	-	-	-	-	-	-	-
Perfluorononanoic acid (PFNA)	-	**8.38**	**40.4**	**13.2**	**9.62**	**17.6**	**5.38**	**15**
Perfluorooctane sulfonamide (PFOSA)	-	**9.83**	ND (2.02)	ND (2.07)	ND (2.02)	ND (2.1)	**1.23 J**	ND (1.89)
Perfluorooctanesulfonic acid (PFOS)	2.7	**1320**	**626**	**5.9**	**38.8**	**41.8**	**11.8**	**4.35**
Perfluorooctanoic acid (PFOA)	6.7	**618**	**31.9**	**53**	**39.5**	**392**	**11.5**	**30.2**
Perfluoropentanesulfonic acid (PFPeS)	-	-	-	-	-	-	-	-
Perfluoropentanoic acid (PFPeA)	-	**30.3**	**16.7**	**6.56**	**12.7**	**35.6**	**15.4**	**11.5**
Perfluorotetradecanoic acid (PFTeDA)	-	ND (1.94)	ND (2.02)	ND (2.07)	ND (2.02)	ND (2.1)	ND (1.97)	ND (1.89)
Perfluorotridecanoic acid (PFTrDA)	-	ND (1.94)	ND (2.02)	**2.07 J**	ND (2.02)	ND (2.1)	ND (1.97)	ND (1.89)
Perfluoroundecanoic acid (PFUnDA)	-	**1.94 J**	**2.02 J**	**3.83**	ND (2.02)	ND (2.1)	**2.09**	ND (1.89)
US EPA PFAS (PFOS + PFOA)	-	**1940**	**658**	**58.9**	**78.3**	**434**	**23.3**	**34.6**
Semi-Volatile Organic Compounds (SIM) (ng/L)								
1,4-Dioxane	350	-	-	-	-	-	-	-

Notes:
*1. Results in **bold** were detected.*
2. ND - Not detected above reporting limit.
J - Estimated value (detections) or estimated reporting limit (on ND values)
R - Data rejected by validator
3. Results shaded gray exceed the April 2023 NYSDEC ambient water quality guidance values for human health.
4. Data has been validated by Haley & Aldrich, Inc.

TABLE III
SUMMARY OF PFAS GROUNDWATER ANALYTICAL RESULTS
OERLIKON METCO
WESTBURY, NY

Location	**NYSDEC**	**HA-108**	**HA-109**	**HA-110**	**HA-111**	**HA-111**	**HA-112**	**HA-113**
Sample Date	**Guidance**	**8/19/2019**	**8/20/2019**	**8/20/2019**	**8/20/2019**	**8/20/2019**	**8/20/2019**	**8/21/2019**
Sample Type	**Criteria**	**Primary**	**Primary**	**Primary**	**Primary**	**Duplicate**	**Primary**	**Primary**
Sample Name		**HA-108-081919-1430-70**	**HA-109-082019-1300-70**	**HA-110-082019-1015-70**	**HA-111-082019-0825-70**	**FD-082019-0001**	**HA-112-082019-1505-70**	**HA-113-082119-0810-70**
PFAS (ng/L)								
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	-	-	-	-	-	-	-	-
2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)	-	-	-	-	-	-	-	-
3-(Perfluoroheptyl)propanoic acid (7:3 FTCA)	-	-	-	-	-	-	-	-
3:3 Fluorotelomer carboxylic acid (3:3 FTCA)	-	-	-	-	-	-	-	-
4,8-Dioxa-3H-Perfluorononanoic Acid (ADONA)	-	-	-	-	-	-	-	-
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	-	-	-	-	-	-	-	-
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	-	ND (1.89)	ND (1.98)	ND (1.94)	ND (1.93)	ND (2)	ND (1.99)	ND (2.12)
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	-	ND (1.89)	ND (1.98)	ND (1.94)	ND (1.93)	ND (2)	ND (1.99)	ND (2.12)
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	-	-	-	-	-	-	-	-
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	-	ND (1.89)	ND (1.98)	ND (1.94)	ND (1.93)	ND (2)	ND (1.99)	ND (2.12)
N-Ethylperfluorooctane sulfonamide (N-EtFOSA)	-	-	-	-	-	-	-	-
N-Ethylperfluorooctane sulfonamidoethanol (N-EtFOSE)	-	-	-	-	-	-	-	-
N-Methyl Perfluorooctanesulfonamidoacetic Acid (MeFOSAA)	-	ND (1.89)	ND (1.98)	ND (1.94)	ND (1.93)	ND (2)	ND (1.99)	ND (2.12)
N-Methylperfluorooctane sulfonamide (N-MeFOSA)	-	-	-	-	-	-	-	-
N-Methylperfluorooctane sulfonamidoethanol (N-MeFOSE)	-	-	-	-	-	-	-	-
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	-	-	-	-	-	-	-	-
Perfluoro(2-ethoxyethane) sulphonic acid (PFEESA)	-	-	-	-	-	-	-	-
Perfluoro(4-methoxybutanoic) acid (PFMBA)	-	-	-	-	-	-	-	-
Perfluoro-2-propoxypropanoic acid (PFPrOPrA)(GenX) (HFPO-DA)	-	-	-	-	-	-	-	-
Perfluoro-3-methoxypropanoic acid (PFMPA)	-	-	-	-	-	-	-	-
Perfluorobutanesulfonic acid (PFBS)	-	**1.01 J**	**1.56 J**	**0.903 J**	**3.56**	**3.3**	**7.04**	**0.724 J**
Perfluorobutanoic acid (PFBA)	-	**2.79**	**2.94**	**2.03**	**18.1**	**16.5**	**6.41**	**26.3**
Perfluorodecanesulfonic acid (PFDS)	-	ND (1.89)	ND (1.98)	ND (1.94)	ND (1.93)	ND (2)	ND (1.99)	ND (2.12)
Perfluorodecanoic acid (PFDA)	-	**6.13**	**1.98 J**	**2.28**	**1.93 J**	**2 J**	**1.99 J**	**3.79**
Perfluorododecane sulfonic acid (PFDoDS)	-	-	-	-	-	-	-	-
Perfluorododecanoic acid (PFDoDA)	-	**0.451 J**	**0.48 J**	ND (1.94)	ND (1.93)	ND (2)	ND (1.99)	ND (2.12)
Perfluoroheptanesulfonic acid (PFHpS)	-	ND (1.89)	ND (1.98)	ND (1.94)	**0.857 J**	**0.888 J**	**16.6**	ND (2.12)
Perfluoroheptanoic acid (PFHpA)	-	**2.32**	**3.03**	**2.11**	**26.4**	**25.5**	**28.2**	**49.3**
Perfluorohexanesulfonic acid (PFHxS)	-	ND (1.89)	**1.5 J**	ND (1.94)	**6.33**	**5.59**	**65.5**	**3.37**
Perfluorohexanoic acid (PFHxA)	-	**3.25**	**8.48**	**4.49**	**28.5**	**27.2**	**14.2**	**76**
Perfluorononane sulfonic acid (PFNS)	-	-	-	-	-	-	-	-
Perfluorononanoic acid (PFNA)	-	**7.04**	**4.86**	**14.3**	**12.2**	**12.4**	**4.81**	**10**
Perfluorooctane sulfonamide (PFOSA)	-	ND (1.89)	ND (1.98)	ND (1.94)	ND (1.93)	ND (2)	ND (1.99)	ND (2.12)
Perfluorooctanesulfonic acid (PFOS)	2.7	**6.75**	**9.84**	**6.1**	**21.8**	**20.2**	**64.6**	**9.58**
Perfluorooctanoic acid (PFOA)	6.7	**7.72**	**8.13**	**5.28**	**84**	**78.2**	**84.4**	**101**
Perfluoropentanesulfonic acid (PFPeS)	-	-	-	-	-	-	-	-
Perfluoropentanoic acid (PFPeA)	-	**3.7**	**10.1**	**5.34**	**24.1**	**22.8**	**9.52**	**90.3**
Perfluorotetradecanoic acid (PFTeDA)	-	ND (1.89)	ND (1.98)	ND (1.94)	ND (1.93)	ND (2)	ND (1.99)	ND (2.12)
Perfluorotridecanoic acid (PFTrDA)	-	ND (1.89)	ND (1.98)	ND (1.94)	ND (1.93)	ND (2)	ND (1.99)	ND (2.12)
Perfluoroundecanoic acid (PFUnDA)	-	**0.917 J**	**2.01**	ND (1.94)	**0.672 J**	**0.488 J**	**0.41 J**	**0.593 J**
US EPA PFAS (PFOS + PFOA)	-	**14.5**	**18**	**11.4**	**106**	**98.4**	**149**	**111**
Semi-Volatile Organic Compounds (SIM) (ng/L)								
1,4-Dioxane	350	-	-	-	-	-	-	-

Notes:
*1. Results in **bold** were detected.*
2. ND - Not detected above reporting limit.
J - Estimated value (detections) or estimated reporting limit (on ND values)
R - Data rejected by validator
3. Results shaded gray exceed the April 2023 NYSDEC ambient water quality guidance values for human health.
4. Data has been validated by Haley & Aldrich, Inc.

TABLE III
SUMMARY OF PFAS GROUNDWATER ANALYTICAL RESULTS
OERLIKON METCO
WESTBURY, NY

Location	**NYSDEC**	**HA-114**	**HA-115**	**HA-116**	**HA-117**	**HA-118**	**HA-119**	**MW-1**
Sample Date	**Guidance**	**8/21/2019**	**8/21/2019**	**8/22/2019**	**8/22/2019**	**8/22/2019**	**8/22/2019**	**10/30/2018**
Sample Type	**Criteria**	**Primary**	**Primary**	**Primary**	**Primary**	**Primary**	**Primary**	**Primary**
Sample Name		**HA-114-082119-1130-70**	**HA-115-082119-1415-70**	**HA-116-082219-0815-70**	**HA-117-082219-0945-70**	**HA-118-082219-1050-70**	**HA-119-082219-1430-70**	**MW1-103018-1705**
PFAS (ng/L)								
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	-	-	-	-	-	-	-	-
2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)	-	-	-	-	-	-	-	-
3-(Perfluoroheptyl)propanoic acid (7:3 FTCA)	-	-	-	-	-	-	-	-
3:3 Fluorotelomer carboxylic acid (3:3 FTCA)	-	-	-	-	-	-	-	-
4,8-Dioxa-3H-Perfluorononanoic Acid (ADONA)	-	-	-	-	-	-	-	-
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	-	-	-	-	-	-	-	-
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	-	ND (1.9)	ND (1.93)	ND (1.98)	ND (1.93)	ND (1.89)	ND (1.89)	**57.8**
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	-	ND (1.9)	ND (1.93)	ND (1.98)	ND (1.93)	ND (1.89)	ND (1.89)	ND (1.91)
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	-	-	-	-	-	-	-	-
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	-	ND (1.9)	ND (1.93)	ND (1.98)	ND (1.93)	ND (1.89)	ND (1.89)	**10**
N-Ethylperfluorooctane sulfonamide (N-EtFOSA)	-	-	-	-	-	-	-	-
N-Ethylperfluorooctane sulfonamidoethanol (N-EtFOSE)	-	-	-	-	-	-	-	-
N-Methyl Perfluorooctanesulfonamidoacetic Acid (MeFOSAA)	-	ND (1.9)	ND (1.93)	ND (1.98)	ND (1.93)	ND (1.89)	ND (1.89)	ND (1.91)
N-Methylperfluorooctane sulfonamide (N-MeFOSA)	-	-	-	-	-	-	-	-
N-Methylperfluorooctane sulfonamidoethanol (N-MeFOSE)	-	-	-	-	-	-	-	-
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	-	-	-	-	-	-	-	-
Perfluoro(2-ethoxyethane) sulphonic acid (PFEESA)	-	-	-	-	-	-	-	-
Perfluoro(4-methoxybutanoic) acid (PFMBA)	-	-	-	-	-	-	-	-
Perfluoro-2-propoxypropanoic acid (PFPrOPrA)(GenX) (HFPO-DA)	-	-	-	-	-	-	-	-
Perfluoro-3-methoxypropanoic acid (PFMPA)	-	-	-	-	-	-	-	-
Perfluorobutanesulfonic acid (PFBS)	-	**2.22**	**2.88**	**2.22**	**2.61**	**4.18**	**1.88 J**	**12.7**
Perfluorobutanoic acid (PFBA)	-	**5.03**	**1.88 J**	**15.3**	**34.6**	**12.3**	**7.51**	**57.2**
Perfluorodecanesulfonic acid (PFDS)	-	ND (1.9)	ND (1.93)	ND (1.98)	ND (1.93)	ND (1.89)	ND (1.89)	ND (1.91)
Perfluorodecanoic acid (PFDA)	-	**1.9 J**	**1.93 J**	**3.3**	ND (1.93)	ND (1.89)	**1.89 J**	**1.94**
Perfluorododecane sulfonic acid (PFDoDS)	-	-	-	-	-	-	-	-
Perfluorododecanoic acid (PFDoDA)	-	**0.422 J**	ND (1.93)	ND (1.98)	ND (1.93)	ND (1.89)	ND (1.89)	ND (1.91)
Perfluoroheptanesulfonic acid (PFHpS)	-	ND (1.9)	ND (1.93)	ND (1.98)	ND (1.93)	ND (1.89)	ND (1.89)	**12.6**
Perfluoroheptanoic acid (PFHpA)	-	**6.78**	**1.33 J**	**27.9**	**32.4**	**9.77**	**6.12**	**167**
Perfluorohexanesulfonic acid (PFHxS)	-	ND (1.9)	ND (1.93)	**2.13**	**1.8 J**	**4.94**	**1.76 J**	**205**
Perfluorohexanoic acid (PFHxA)	-	**7**	**2.51**	**27.7**	**38.8**	**28.8**	**9.31**	**106**
Perfluorononane sulfonic acid (PFNS)	-	-	-	-	-	-	-	-
Perfluorononanoic acid (PFNA)	-	**1.93**	**1.14 J**	**17.2**	**0.722 J**	**1.58 J**	**2.5**	**5.55**
Perfluorooctane sulfonamide (PFOSA)	-	ND (1.9)	ND (1.93)	ND (1.98)	ND (1.93)	ND (1.89)	ND (1.89)	**9.3**
Perfluorooctanesulfonic acid (PFOS)	2.7	**3.57**	**4.45**	**6.19**	**0.861 J**	**3.72**	**20.3**	**803**
Perfluorooctanoic acid (PFOA)	6.7	**9.4**	**1.93 J**	**61.4**	**19.2**	**7.7**	**10.6**	**216**
Perfluoropentanesulfonic acid (PFPeS)	-	-	-	-	-	-	-	-
Perfluoropentanoic acid (PFPeA)	-	**7.95**	**3.51**	**33**	**33.5**	**38.6**	**12.8**	**74**
Perfluorotetradecanoic acid (PFTeDA)	-	ND (1.9)	ND (1.93)	ND (1.98)	ND (1.93)	ND (1.89)	ND (1.89)	ND (1.91)
Perfluorotridecanoic acid (PFTrDA)	-	ND (1.9)	ND (1.93)	ND (1.98)	ND (1.93)	ND (1.89)	ND (1.89)	ND (1.91)
Perfluoroundecanoic acid (PFUnDA)	-	**0.403 J**	**0.749 J**	**0.387 J**	**0.506 J**	ND (1.89)	**0.389 J**	ND (1.91)
US EPA PFAS (PFOS + PFOA)	-	**13**	**6.11 J**	**67.6**	**20.1 J**	**11.4**	**30.9**	-
Semi-Volatile Organic Compounds (SIM) (ng/L)								
1,4-Dioxane	350	-	-	-	-	-	-	ND (163)

Notes:
1. Results in ***bold*** *were detected.*
2. ND - Not detected above reporting limit.
J - Estimated value (detections) or estimated reporting limit (on ND values)
R - Data rejected by validator
3. Results shaded gray exceed the April 2023 NYSDEC ambient water quality guidance values for human health.
4. Data has been validated by Haley & Aldrich, Inc.

TABLE III
SUMMARY OF PFAS GROUNDWATER ANALYTICAL RESULTS
OERLIKON METCO
WESTBURY, NY

Location	**NYSDEC**	**MW-1**	**MW-1**	**MW-1**	**MW-1D**	**MW-2**	**MW-2**	**MW-2**	**MW-2**
Sample Date	**Guidance**	**5/15/2019**	**5/15/2019**	**11/25/2024**	**11/25/2024**	**10/30/2018**	**10/30/2018**	**5/15/2019**	**11/22/2024**
Sample Type	**Criteria**	**Primary**	**Duplicate**	**Primary**	**Primary**	**Primary**	**Duplicate**	**Primary**	**Primary**
Sample Name		**MW-1-051519-1155-65**	**FD-051519-0001**	**MW-01_20241125**	**MW-01D_20241125**	**MW2-103018-1415**	**DUP-103018-0001**	**MW-2-051519-0955-65**	**MW-02-20241122**
PFAS (ng/L)									
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	-	-	-	ND (5.96)	ND (8.05)	-	-	-	ND (6.51)
2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)	-	-	-	ND (37.2)	ND (50.3)	-	-	-	ND (40.7)
3-(Perfluoroheptyl)propanoic acid (7:3 FTCA)	-	-	-	ND (37.2)	ND (50.3)	-	-	-	**12 J**
3:3 Fluorotelomer carboxylic acid (3:3 FTCA)	-	-	-	ND (7.45)	ND (10.1) J	-	-	-	ND (8.13)
4,8-Dioxa-3H-Perfluorononanoic Acid (ADONA)	-	-	-	ND (5.96)	ND (8.05) J	-	-	-	ND (6.51)
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	-	-	-	ND (5.96) J	ND (8.05) J	-	-	-	ND (6.51) J
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	-	**2.63**	**2.5**	ND (5.96) J	ND (8.05) J	**14.4**	**13.2**	**28.3**	ND (6.51) J
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	-	ND (2.02)	ND (2.12)	ND (5.96)	ND (8.05) J	ND (2.2)	ND (2.02)	ND (2.01)	ND (6.51) J
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	-	-	-	ND (5.96)	ND (8.05)	-	-	-	ND (6.51)
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	-	**5.08**	**13.3**	**22.1**	ND (2.01)	ND (2.2)	ND (2.02)	ND (2.01)	ND (1.63)
N-Ethylperfluorooctane sulfonamide (N-EtFOSA)	-	-	-	ND (1.49)	ND (2.01)	-	-	-	ND (1.63)
N-Ethylperfluorooctane sulfonamidoethanol (N-EtFOSE)	-	-	-	ND (14.9)	ND (20.1)	-	-	-	ND (16.3)
N-Methyl Perfluorooctanesulfonamidoacetic Acid (MeFOSAA)	-	ND (2.02)	ND (2.12)	ND (1.49)	ND (2.01)	ND (2.2)	ND (2.02)	ND (2.01)	ND (1.63)
N-Methylperfluorooctane sulfonamide (N-MeFOSA)	-	-	-	ND (1.49)	ND (2.01)	-	-	-	ND (1.63) J
N-Methylperfluorooctane sulfonamidoethanol (N-MeFOSE)	-	-	-	ND (14.9)	ND (20.1)	-	-	-	ND (16.3)
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	-	-	-	ND (2.98) J	ND (4.02) J	-	-	-	ND (3.25)
Perfluoro(2-ethoxyethane) sulphonic acid (PFEESA)	-	-	-	ND (2.98)	ND (4.02)	-	-	-	ND (3.25)
Perfluoro(4-methoxybutanoic) acid (PFMBA)	-	-	-	ND (2.98)	ND (4.02)	-	-	-	ND (3.25)
Perfluoro-2-propoxypropanoic acid (PFPrOPrA)(GenX) (HFPO-DA)	-	-	-	ND (5.96)	ND (8.05)	-	-	-	ND (6.51)
Perfluoro-3-methoxypropanoic acid (PFMPA)	-	-	-	ND (2.98)	ND (4.02)	-	-	-	ND (3.25)
Perfluorobutanesulfonic acid (PFBS)	-	**9.38**	**9.86**	**8.07**	**5.02**	**2.44**	**2.8**	**0.39 J**	**0.813 J**
Perfluorobutanoic acid (PFBA)	-	**56.4**	**54.4**	**14.7**	**18.2 J**	**28.4**	**31.5**	**12.1**	**12.1**
Perfluorodecanesulfonic acid (PFDS)	-	ND (2.02)	ND (2.12)	ND (1.49)	ND (2.01)	ND (2.2)	ND (2.02)	ND (2.01)	ND (1.63)
Perfluorodecanoic acid (PFDA)	-	**3.36**	**3.55**	**2.57**	**1.28 J**	**18.4**	**21**	**26.6**	**33.6**
Perfluorododecane sulfonic acid (PFDoDS)	-	-	-	ND (1.49)	ND (2.01)	-	-	-	ND (1.63)
Perfluorododecanoic acid (PFDoDA)	-	ND (2.02)	ND (2.12)	ND (1.49)	ND (2.01) J	ND (2.2)	ND (2.02)	ND (2.01)	ND (1.63)
Perfluoroheptanesulfonic acid (PFHpS)	-	**21.1**	**24.1**	**35.6**	**8.1 J**	ND (2.2)	ND (2.02)	ND (2.01)	ND (1.63)
Perfluoroheptanoic acid (PFHpA)	-	**268**	**280**	**182**	**15**	**23.6**	**26.3**	**11**	**8.87 J**
Perfluorohexanesulfonic acid (PFHxS)	-	**349**	**360**	**650**	**14.9**	**0.771 J**	**0.794 J**	ND (2.01)	**1.43 J**
Perfluorohexanoic acid (PFHxA)	-	**105**	**106**	**60**	**21.1 J**	**46.2**	**51.2**	**19.2**	**32.9**
Perfluorononane sulfonic acid (PFNS)	-	-	-	ND (1.49)	ND (2.01)	-	-	-	ND (1.63)
Perfluorononanoic acid (PFNA)	-	**5.8**	**5.71**	**8.48**	**13.2**	**24**	**26.9**	**16.5**	**16.8**
Perfluorooctane sulfonamide (PFOSA)	-	**5.78**	**7.95**	**60.8 J**	**23.6 J**	ND (2.2)	ND (2.02)	ND (2.01)	**0.252 J**
Perfluorooctanesulfonic acid (PFOS)	2.7	**1130**	**1200**	**1790**	**246**	**5.91**	**5.51**	**3.86**	**6.65**
Perfluorooctanoic acid (PFOA)	6.7	**414**	**435**	**788**	**126**	**45.2**	**51.4**	**32.6**	**24.1**
Perfluoropentanesulfonic acid (PFPeS)	-	-	-	**28.6 J**	**1.36 J**	-	-	-	ND (1.63)
Perfluoropentanoic acid (PFPeA)	-	**49.8**	**49.7**	**26.3**	**23.7**	**64.3**	**70.9**	**23.9**	**21.8**
Perfluorotetradecanoic acid (PFTeDA)	-	ND (2.02)	ND (2.12)	ND (1.49)	ND (2.01) J	ND (2.2)	ND (2.02)	ND (2.01)	ND (1.63)
Perfluorotridecanoic acid (PFTrDA)	-	ND (2.02)	ND (2.12)	ND (1.49)	ND (2.01) J	ND (2.2)	ND (2.02)	ND (2.01)	ND (1.63)
Perfluoroundecanoic acid (PFUnDA)	-	ND (2.02)	ND (2.12)	ND (1.49)	ND (2.01)	ND (2.2)	ND (2.02)	ND (2.01)	**0.821 J**
US EPA PFAS (PFOS + PFOA)	-	**1540**	**1640**	-	-	-	-	**36.5**	-
Semi-Volatile Organic Compounds (SIM) (ng/L)									
1,4-Dioxane	350	-	-	-	-	ND (144)	ND (147)	-	-

Notes:
*1. Results in **bold** were detected.*
2. ND - Not detected above reporting limit.
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3. Results shaded gray exceed the April 2023 NYSDEC ambient water quality guidance values for human health.
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TABLE III
SUMMARY OF PFAS GROUNDWATER ANALYTICAL RESULTS
OERLIKON METCO
WESTBURY, NY

Location	**NYSDEC Guidance Criteria**	**MW-3**	**MW-3**	**MW-4**	**MW-4**	**MW-4**	**MW-301A**	**MW-301B**	**MW-301C**
Sample Date		**5/15/2019**	**11/22/2024**	**10/31/2018**	**5/15/2019**	**11/22/2024**	**11/14/2024**	**11/14/2024**	**11/14/2024**
Sample Type		**Primary**	**Primary**	**Primary**	**Primary**	**Primary**	**Primary**	**Primary**	**Primary**
Sample Name		**MW-3-051519-1615-65**	**MW-03-20241122**	**MW4-103118-1005**	**MW-4-051519-0435-65**	**MW-04-20241122**	**MW-301A-20241114**	**MW-301B-20241114**	**MW-301C-20241114**
PFAS (ng/L)									
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	-	-	ND (32)	-	-	ND (128)	ND (6.81)	ND (6.79)	ND (8.44)
2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)	-	-	ND (200)	-	-	ND (42.9)	ND (42.6)	ND (42.4)	ND (52.8)
3-(Perfluoroheptyl)propanoic acid (7:3 FTCA)	-	-	ND (200)	-	-	ND (42.9) J	ND (42.6)	ND (42.4)	ND (52.8)
3:3 Fluorotelomer carboxylic acid (3:3 FTCA)	-	-	ND (40) J	-	-	ND (8.58)	ND (8.51)	ND (8.49)	ND (10.6)
4,8-Dioxa-3H-Perfluorononanoic Acid (ADONA)	-	-	ND (32)	-	-	ND (6.86)	ND (6.81)	ND (6.79)	ND (8.44)
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	-	-	ND (32)	-	-	ND (6.86) J	ND (6.81) J	ND (6.79)	ND (8.44)
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	-	ND (2.24)	ND (32)	**3.32**	ND (2.06)	ND (6.86)	ND (6.81) J	**12.4 J**	ND (8.44) J
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	-	ND (2.24)	ND (32) J	ND (1.89)	ND (2.06)	ND (128)	ND (6.81) J	ND (6.79) J	ND (8.44) J
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	-	-	ND (32)	-	-	ND (128) J	ND (6.81) J	ND (6.79) J	ND (8.44) J
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	-	ND (2.24)	ND (8) J	**1.86 J**	ND (2.06)	ND (32) J	ND (1.7)	ND (1.7) J	ND (32)
N-Ethylperfluorooctane sulfonamide (N-EtFOSA)	-	-	ND (8) J	-	-	ND (1.72) J	ND (1.7)	ND (1.7) J	ND (2.11) J
N-Ethylperfluorooctane sulfonamidoethanol (N-EtFOSE)	-	-	ND (80)	-	-	ND (320)	ND (17)	ND (17) J	ND (21.1)
N-Methyl Perfluorooctanesulfonamidoacetic Acid (MeFOSAA)	-	ND (2.24)	ND (8)	**1.3 J**	ND (2.06)	ND (32) J	ND (1.7) J	ND (32)	ND (32)
N-Methylperfluorooctane sulfonamide (N-MeFOSA)	-	-	ND (8) J	-	-	ND (1.72) J	ND (1.7)	ND (1.7) J	ND (2.11)
N-Methylperfluorooctane sulfonamidoethanol (N-MeFOSE)	-	-	ND (80)	-	-	ND (320)	ND (17)	ND (17) J	ND (21.1)
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	-	-	ND (16) J	-	-	ND (3.43)	ND (3.4) J	ND (3.4) J	ND (4.22) J
Perfluoro(2-ethoxyethane) sulphonic acid (PFEESA)	-	-	ND (16)	-	-	ND (3.43)	ND (3.4)	ND (3.4)	ND (4.22)
Perfluoro(4-methoxybutanoic) acid (PFMBA)	-	-	ND (16)	-	-	ND (3.43)	ND (3.4) J	ND (3.4) J	ND (4.22) J
Perfluoro-2-propoxypropanoic acid (PFPrOPrA)(GenX) (HFPO-DA)	-	-	ND (32)	-	-	ND (6.86)	ND (6.81)	ND (6.79)	ND (8.44)
Perfluoro-3-methoxypropanoic acid (PFMPA)	-	-	ND (16)	-	-	ND (3.43)	ND (3.4)	ND (3.4)	ND (4.22)
Perfluorobutanesulfonic acid (PFBS)	-	ND (2.24)	ND (8)	**1.84 J**	**1.55 J**	**0.969 J**	**1.9**	**1.14 J**	**8.38**
Perfluorobutanoic acid (PFBA)	-	**209**	**10.4 J**	**83.2**	**183**	**112**	**9.23**	**2.63 J**	**22.4**
Perfluorodecanesulfonic acid (PFDS)	-	**1.47 J**	ND (8)	**30.4**	**40.6**	**19.4 J**	**2.9**	**1.03 J**	ND (2.11)
Perfluorodecanoic acid (PFDA)	-	**12.9**	ND (8)	**30.6**	**21.7**	**13.3 J**	**9.98**	**0.832 J**	ND (2.11)
Perfluorododecane sulfonic acid (PFDoDS)	-	-	ND (8)	-	-	ND (32)	ND (1.7)	ND (1.7)	ND (2.11)
Perfluorododecanoic acid (PFDoDA)	-	**1.52 J**	**1.32 J**	**2.18**	**1.44 J**	**0.763 J**	ND (1.7) J	ND (1.7) J	ND (2.11) J
Perfluoroheptanesulfonic acid (PFHpS)	-	ND (2.24)	ND (8)	ND (1.89)	ND (2.06)	ND (32) J	**0.528 J**	ND (1.7)	ND (2.11)
Perfluoroheptanoic acid (PFHpA)	-	**39.8**	**7 J**	**55.5**	**64.9**	**27 J**	**6.49**	**0.951 J**	**38.4**
Perfluorohexanesulfonic acid (PFHxS)	-	**0.65 J**	ND (8)	**4.3**	**5.61**	**0.866 J**	**2.41**	**0.28 J**	**4.13**
Perfluorohexanoic acid (PFHxA)	-	**34.3**	**14.9**	**199**	**883**	**528**	**18.2**	**3.28**	**36.6**
Perfluorononane sulfonic acid (PFNS)	-	-	ND (8)	-	-	ND (32)	**0.23 J**	ND (1.7)	ND (2.11)
Perfluorononanoic acid (PFNA)	-	**16.6**	**23**	**113**	**106**	**14.3**	**38.9**	**2.97**	**1.82 J**
Perfluorooctane sulfonamide (PFOSA)	-	ND (2.24)	ND (8)	**0.943 J**	ND (2.06)	ND (32)	**0.392 J**	ND (1.7)	ND (2.11)
Perfluorooctanesulfonic acid (PFOS)	2.7	**19.5**	**2.48 J**	**12.8**	**23.4**	**28.6 J**	**56.6**	**1.69 J**	**2.9**
Perfluorooctanoic acid (PFOA)	6.7	**15**	**13**	**150**	**42.9**	**199**	**15.1**	**1.66 J**	**101**
Perfluoropentanesulfonic acid (PFPeS)	-	-	ND (8) J	-	-	ND (1.72)	**0.23 J**	ND (1.7)	**0.844 J**
Perfluoropentanoic acid (PFPeA)	-	**307**	**15.8 J**	**374**	**1100**	**595**	**24.1**	**3.15 J**	**41.7**
Perfluorotetradecanoic acid (PFTeDA)	-	ND (2.24)	ND (8)	ND (1.89)	**0.272 J**	ND (32)	ND (1.7)	ND (1.7) J	ND (2.11) J
Perfluorotridecanoic acid (PFTrDA)	-	**2.24 J**	ND (8)	ND (1.89)	**2.06 J**	1.72 R	ND (1.7) J	ND (1.7) J	ND (2.11) J
Perfluoroundecanoic acid (PFUnDA)	-	**7.96**	**2.36 J**	**2.61**	**2.67**	ND (32)	**1.66 J**	**3.4**	**0.612 J**
US EPA PFAS (PFOS + PFOA)	-	**34.5**	-	-	**66.3**	-	-	-	-
Semi-Volatile Organic Compounds (SIM) (ng/L)									
1,4-Dioxane	350	-	-	ND (147)	-	-	-	-	-

Notes:
1. *Results in* ***bold*** *were detected.*
2. *ND - Not detected above reporting limit.*
   J - Estimated value (detections) or estimated reporting limit (on ND values)
   R - Data rejected by validator
3. *Results shaded gray exceed the April 2023 NYSDEC ambient water quality guidance values for human health.*
4. *Data has been validated by Haley & Aldrich, Inc.*

TABLE IV
SAMPLING AND ANALYSIS PLAN
OERLIKON METCO (US) INC.
SUPPLEMENTAL PFAS REMEDIAL INVESTIGATION - PHASE 2
WESTBURY, NEW YORK

Sample Type	Collection Scheme	# of Samples Anticipated	Location ID	Purpose	Analysis
Soil Borings Proximal to MW-1/1D (1)	Grab samples to be collected every 5 ft bgs to ~60 ft bgs[4]	~24 direct samples 2 field duplicate 2 MS/MSD[5]	HA-208, HA-209, HA-210, HA-211	Assess horizontal and vertical distribution of potential PFAS contamination in soils upgradient and proximal to MW-1/MW-1D	PFAS (40 Target Compounds[2]) EPA Method 1633
Soil Borings in Northwest Recharge Basin (1)	Grab samples to be collected at 0.5-1.0, 1.0-2.0, an 10 ft bgs	~6 direct samples 1 field duplicate 1 MS/MSD	HA-212, HA-213	Assess PFAS contamination in subsurface soils below the recharge basin	PFAS (40 Target Compounds[2]) EPA Method 1633
Soil Disposal Characterization Samples	Grab Samples from containerized IDW soils	Based on amount of soil IDW	N/A	To obtain contained-in determination from the NYSDEC and/or determine and receive approval from appropriate disposal facility	PFAS (40 Target Compounds[2]) , landfill/disposal characteristics to be determined by receiving landfill[3].
Groundwater Samples	Grab samples collected from Site and downgradient off-Site monitoring wells	35 direct samples 2 field duplicate 1 equipment blank 2 MS/MSD 1 field blank	MW-301A/B/C, MW-302A/B/C, MW-303A/B/C, MW-304A/B/C, MW-305A/B/C, MW-306A/B/C, MW-307A/B/C, MW-308A/B/C, MW-309A/B/C, MW-310A/B/C, MW-1, MW-1D, MW-2, MW-3, MW-4	Assess horizontal and vertical distribution of PFAS contamination in groundwater on and downgradient from the Site.	PFAS (40 Target Compounds[2]) EPA Method 1633

Abbreviations:
PFAS: Per- and Polyfluoroalkyl Substances
IDW: Investigation-Derived Waste
FD: Field Duplicate
MS/MSD: Matrix Spike/Matrix Spike Duplicate

Notes:
1. Samples will be grab samples from soil borings installed via direct push geoprobe methods.
2. PFAS analyte list specified in Appendix G of NYSDEC Guidelines for Sampling and Analysis of PFAS, April 2023
3. Analysis for disposal characterizations subject to specific landfill requirements.
4. Samples collected at 5, 15, 25, 35, 45, and 55 ft bgs will be held for lab analysis pending review of data from samples collected at 10, 20, 30, 40, 50 and 60 ft bgs
5. Does not include samples held for lab analysis. FD/MS/MSD quantities will be revised as needed

TABLE III
SUMMARY OF PFAS GROUNDWATER ANALYTICAL RESULTS
OERLIKON METCO
WESTBURY, NY

Location	**NYSDEC Guidance Criteria**	**MW-302A**	**MW-302A**	**MW-302B**	**MW-302C**	**MW-303A**	**MW-303B**	**MW-303C**	**MW-304A**
Sample Date		**11/13/2024**	**11/13/2024**	**11/13/2024**	**11/13/2024**	**11/12/2024**	**11/12/2024**	**11/12/2024**	**11/7/2024**
Sample Type		**Primary**	**Duplicate**	**Primary**	**Primary**	**Primary**	**Primary**	**Primary**	**Primary**
Sample Name		**MW-302A-20241113**	**DUP-01-20241113**	**MW-302B-20241113**	**MW-302C-20241113**	**MW-303A-20241112**	**MW-303B-20241112**	**MW-303C-20241112**	**MW-304A-20241107**
PFAS (ng/L)									
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	-	ND (6.39) J	ND (6.79) J	ND (6.95) J	ND (6.7) J	ND (6.59) J	ND (6.59) J	ND (6.87) J	ND (7.59)
2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)	-	ND (40)	ND (42.4)	ND (43.5)	ND (41.9)	ND (41.2)	ND (41.2)	ND (42.9)	ND (47.4)
3-(Perfluoroheptyl)propanoic acid (7:3 FTCA)	-	ND (40)	ND (42.4)	ND (43.5)	ND (41.9)	ND (41.2)	ND (41.2)	ND (42.9)	ND (47.4)
3:3 Fluorotelomer carboxylic acid (3:3 FTCA)	-	ND (7.99) J	ND (8.49) J	ND (8.69) J	ND (8.38) J	ND (8.23) J	ND (8.24) J	ND (8.59) J	ND (9.48)
4,8-Dioxa-3H-Perfluorononanoic Acid (ADONA)	-	ND (6.39)	ND (6.79)	ND (6.95)	ND (6.7)	ND (6.59)	ND (6.59)	ND (6.87)	ND (7.59) J
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	-	ND (6.39)	ND (6.79)	ND (6.95)	ND (6.7)	ND (6.59)	ND (6.59)	ND (6.87)	ND (7.59)
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	-	**9.54**	**9.01**	**9.12**	**5.13 J**	ND (6.59)	ND (6.59)	**16.6**	ND (7.59)
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	-	ND (6.39) J	ND (6.79) J	ND (6.95) J	ND (6.7) J	ND (6.59) J	ND (6.59) J	ND (6.87) J	ND (7.59)
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	-	ND (6.39) J	ND (6.79) J	ND (6.95) J	ND (6.7) J	ND (6.59) J	ND (6.59) J	ND (6.87) J	ND (7.59)
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	-	ND (1.6)	ND (1.7)	ND (1.74)	ND (1.68)	ND (1.65)	ND (1.65)	ND (1.72)	ND (1.9) J
N-Ethylperfluorooctane sulfonamide (N-EtFOSA)	-	ND (1.6)	ND (1.7) J	ND (1.74)	ND (1.68)	ND (1.65)	ND (1.65)	ND (1.72)	ND (1.9)
N-Ethylperfluorooctane sulfonamidoethanol (N-EtFOSE)	-	ND (16) J	ND (17) J	ND (17.4) J	ND (16.8) J	ND (16.5) J	ND (16.5) J	ND (17.2) J	ND (19)
N-Methyl Perfluorooctanesulfonamidoacetic Acid (MeFOSAA)	-	ND (1.6)	ND (1.7)	ND (1.74)	ND (1.68)	ND (1.65)	ND (1.65)	ND (1.72)	ND (1.9)
N-Methylperfluorooctane sulfonamide (N-MeFOSA)	-	ND (1.6)	ND (1.7) J	ND (1.74)	ND (1.68)	ND (1.65)	ND (1.65)	ND (1.72)	ND (1.9)
N-Methylperfluorooctane sulfonamidoethanol (N-MeFOSE)	-	ND (16)	ND (17)	ND (17.4)	ND (16.8)	ND (16.5)	ND (16.5)	ND (17.2)	ND (19)
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	-	ND (3.2)	ND (3.4)	ND (3.48)	ND (3.35)	ND (3.29)	ND (3.3)	ND (3.44)	ND (3.79)
Perfluoro(2-ethoxyethane) sulphonic acid (PFEESA)	-	ND (3.2) J	ND (3.4) J	ND (3.48) J	ND (3.35) J	ND (3.29) J	ND (3.3) J	ND (3.44) J	ND (3.79)
Perfluoro(4-methoxybutanoic) acid (PFMBA)	-	ND (3.2)	ND (3.4)	ND (3.48)	ND (3.35)	ND (3.29)	ND (3.3)	ND (3.44)	ND (3.79)
Perfluoro-2-propoxypropanoic acid (PFPrOPrA)(GenX) (HFPO-DA)	-	ND (6.39)	ND (6.79)	ND (6.95)	ND (6.7)	ND (6.59)	ND (6.59)	ND (6.87)	ND (7.59)
Perfluoro-3-methoxypropanoic acid (PFMPA)	-	ND (3.2)	ND (3.4)	ND (3.48)	ND (3.35)	ND (3.29)	ND (3.3)	**0.369 J**	ND (3.79)
Perfluorobutanesulfonic acid (PFBS)	-	**1.31 J**	**1.2 J**	**1.96**	**2.31**	ND (1.65)	**2.71**	**1.18 J**	**0.948 J**
Perfluorobutanoic acid (PFBA)	-	**4.94 J**	**4.08 J**	**6.71 J**	**21.7**	**7.37**	**16.6**	**23.9**	**9.14**
Perfluorodecanesulfonic acid (PFDS)	-	**0.503 J**	**0.594 J**	**1.79**	ND (1.68)	ND (1.65)	ND (1.65)	ND (1.72)	ND (1.9)
Perfluorodecanoic acid (PFDA)	-	**4.02 J**	**3.64 J**	**2.14 J**	**2.67 J**	**8.14 J**	ND (1.65) J	ND (1.72) J	**1.71 J**
Perfluorododecane sulfonic acid (PFDoDS)	-	ND (1.6)	ND (1.7)	ND (1.74)	ND (1.68)	ND (1.65)	ND (1.65)	ND (1.72)	ND (1.9)
Perfluorododecanoic acid (PFDoDA)	-	**2.08 J**	**1.93 J**	ND (1.74) J	ND (1.68) J	ND (1.65) J	ND (1.65) J	ND (1.72) J	ND (1.9)
Perfluoroheptanesulfonic acid (PFHpS)	-	**0.264 J**	ND (1.7) J	ND (1.74) J	ND (1.68) J	ND (1.65) J	**4.13 J**	**0.352 J**	ND (1.9)
Perfluoroheptanoic acid (PFHpA)	-	**3.34 J**	**2.9 J**	**2.77 J**	**26.2 J**	**7.34 J**	**17.3 J**	**19.2 J**	**13.6**
Perfluorohexanesulfonic acid (PFHxS)	-	**0.807 J**	**0.501 J**	**0.548 J**	**3.5**	**0.889 J**	**27.4**	**4.83**	**3.6**
Perfluorohexanoic acid (PFHxA)	-	**5.23 J**	**4.93 J**	**10.8 J**	**35.3 J**	**9.76 J**	**19.6 J**	**26.5 J**	**15.6**
Perfluorononane sulfonic acid (PFNS)	-	ND (1.6)	ND (1.7)	ND (1.74)	ND (1.68)	ND (1.65)	ND (1.65)	ND (1.72)	ND (1.9)
Perfluorononanoic acid (PFNA)	-	**2.55**	**2.47**	**11.1**	**2.66**	**5.33**	**5.32**	**4.34**	**39**
Perfluorooctane sulfonamide (PFOSA)	-	ND (1.6)	ND (1.7)	**0.487 J**	ND (1.68)	ND (1.65)	ND (1.65)	ND (1.72)	ND (1.9)
Perfluorooctanesulfonic acid (PFOS)	2.7	**5.19**	**5.02**	**3.99**	**3.49**	**3.94**	**45.6**	**7.02**	**25.7**
Perfluorooctanoic acid (PFOA)	6.7	**6.63**	**6.94**	**6.41**	**70.7**	**15.2**	**69.5**	**24.6**	**60**
Perfluoropentanesulfonic acid (PFPeS)	-	ND (1.6)	ND (1.7)	ND (1.74)	**0.654 J**	ND (1.65)	**1.78**	**1.6 J**	ND (1.9)
Perfluoropentanoic acid (PFPeA)	-	**6.13**	**6.21**	**13.8**	**42.4**	**12.5**	**17.6**	**24**	**14.7**
Perfluorotetradecanoic acid (PFTeDA)	-	ND (1.6) J	ND (1.7) J	ND (1.74) J	ND (1.68) J	ND (1.65) J	ND (1.65) J	ND (1.72) J	ND (1.9)
Perfluorotridecanoic acid (PFTrDA)	-	ND (1.6) J	ND (1.7) J	ND (1.74) J	ND (1.68) J	ND (1.65) J	ND (1.65) J	ND (1.72) J	ND (1.9)
Perfluoroundecanoic acid (PFUnDA)	-	**2.8**	**2.47**	**2.77**	ND (1.68)	**7.39**	ND (1.65)	ND (1.72)	ND (1.9)
US EPA PFAS (PFOS + PFOA)	-	-	-	-	-	-	-	-	-
Semi-Volatile Organic Compounds (SIM) (ng/L)									
1,4-Dioxane	350	-	-	-	-	-	-	-	-

Notes:
*1. Results in **bold** were detected.*
2. ND - Not detected above reporting limit.
J - Estimated value (detections) or estimated reporting limit (on ND values)
R - Data rejected by validator
3. Results shaded gray exceed the April 2023 NYSDEC ambient water quality guidance values for human health.
4. Data has been validated by Haley & Aldrich, Inc.

TABLE III
SUMMARY OF PFAS GROUNDWATER ANALYTICAL RESULTS
OERLIKON METCO
WESTBURY, NY

Location	**NYSDEC**	**MW-304B**	**MW-304C**	**MW-305A**	**MW-305B**	**MW-305C**	**MW-306A**	**MW-306B**	**MW-306C**
Sample Date	**Guidance**	**11/8/2024**	**11/8/2024**	**11/5/2024**	**11/4/2024**	**11/7/2024**	**11/21/2024**	**11/21/2024**	**11/21/2024**
Sample Type	**Criteria**	**Primary**	**Primary**	**Primary**	**Primary**	**Primary**	**Primary**	**Primary**	**Primary**
Sample Name		**MW-304B-20241108**	**MW-304C-20241108**	**MW-305A-20241105**	**MW-305B-20241104**	**MW-305C-20241107**	**MW-306A-20241121**	**MW-306B-20241121**	**MW-306AC-20241121**
PFAS (ng/L)									
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	-	ND (6.49)	ND (6.77)	ND (6.06)	ND (7.4)	ND (7)	ND (6.74)	ND (6.7)	ND (6.62)
2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)	-	ND (40.6)	ND (42.3)	ND (37.8)	ND (46.3)	ND (43.8)	ND (42.1)	ND (41.9)	ND (41.3)
3-(Perfluoroheptyl)propanoic acid (7:3 FTCA)	-	ND (40.6)	ND (42.3)	ND (37.8)	ND (46.3)	ND (43.8)	ND (42.1) J	ND (41.9) J	ND (41.3) J
3:3 Fluorotelomer carboxylic acid (3:3 FTCA)	-	ND (8.11)	ND (8.46)	ND (7.57)	ND (9.26) J	ND (8.75)	ND (8.42)	ND (8.38)	ND (8.27)
4,8-Dioxa-3H-Perfluorononanoic Acid (ADONA)	-	ND (6.49) J	ND (6.77) J	ND (6.06) J	ND (7.4)	ND (7) J	ND (6.74)	ND (6.7)	ND (6.62)
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	-	ND (6.49)	ND (6.77) J	**9.76 J**	ND (7.4) J	ND (7) J	ND (6.74)	ND (6.7)	ND (6.62)
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	-	**14.3**	ND (67.7) J	**3110**	**334**	**40.8**	**6.4 J**	ND (6.7) J	**6.75 J**
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	-	ND (6.49)	ND (6.77) J	ND (6.06) J	ND (7.4) J	ND (7)	ND (6.74)	ND (6.7)	ND (6.62)
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	-	ND (6.49)	ND (6.77)	ND (6.06)	ND (7.4)	ND (7)	ND (6.74)	ND (6.7)	ND (6.62)
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	-	ND (1.62)	ND (1.69)	ND (1.51)	ND (1.85)	ND (1.75) J	ND (1.68)	ND (1.68)	ND (1.65)
N-Ethylperfluorooctane sulfonamide (N-EtFOSA)	-	ND (1.62)	ND (1.69) J	ND (1.51)	ND (1.85) J	ND (1.75)	ND (1.68)	ND (1.68)	ND (1.65)
N-Ethylperfluorooctane sulfonamidoethanol (N-EtFOSE)	-	ND (16.2)	ND (16.9)	ND (15.1)	ND (18.5)	ND (17.5)	ND (16.8)	ND (16.8)	ND (16.5)
N-Methyl Perfluorooctanesulfonamidoacetic Acid (MeFOSAA)	-	ND (1.62)	ND (1.69)	ND (1.51)	ND (1.85) J	ND (1.75)	ND (1.68)	ND (1.68)	ND (1.65)
N-Methylperfluorooctane sulfonamide (N-MeFOSA)	-	ND (1.62)	ND (1.69) J	ND (1.51)	ND (1.85) J	ND (1.75)	ND (1.68)	ND (1.68)	ND (1.65)
N-Methylperfluorooctane sulfonamidoethanol (N-MeFOSE)	-	ND (16.2)	ND (16.9)	ND (15.1)	ND (18.5)	ND (17.5)	ND (16.8)	ND (16.8)	ND (16.5)
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	-	ND (3.24)	ND (3.38)	ND (3.03)	ND (3.7) J	ND (3.5)	ND (3.37) J	ND (3.35) J	ND (3.31) J
Perfluoro(2-ethoxyethane) sulphonic acid (PFEESA)	-	ND (3.24)	ND (3.38)	ND (3.03)	ND (3.7)	ND (3.5)	ND (3.37)	ND (3.35)	ND (3.31)
Perfluoro(4-methoxybutanoic) acid (PFMBA)	-	ND (3.24)	ND (3.38)	ND (3.03)	ND (3.7)	ND (3.5)	ND (3.37)	ND (3.35)	ND (3.31)
Perfluoro-2-propoxypropanoic acid (PFPrOPrA)(GenX) (HFPO-DA)	-	ND (6.49)	ND (6.77)	ND (6.06)	ND (7.4)	ND (7)	ND (6.74)	ND (6.7)	ND (6.62)
Perfluoro-3-methoxypropanoic acid (PFMPA)	-	ND (3.24)	ND (3.38)	ND (3.03)	ND (3.7)	ND (3.5)	ND (3.37)	ND (3.35)	ND (3.31)
Perfluorobutanesulfonic acid (PFBS)	-	**4.5**	**0.711 J**	**1.82**	**1.36 J**	**1.2 J**	**1.4 J**	**1.44 J**	**1.14 J**
Perfluorobutanoic acid (PFBA)	-	**11.7**	**2.66 J**	**5.78 J**	**4.26 J**	**3.11 J**	**4.94 J**	**6.43 J**	**7.03**
Perfluorodecanesulfonic acid (PFDS)	-	ND (1.62)	ND (1.69)	ND (1.51)	**0.648 J**	**0.91 J**	ND (1.68)	ND (1.68)	ND (1.65)
Perfluorodecanoic acid (PFDA)	-	ND (1.62)	ND (1.69)	**0.197 J**	**0.694 J**	**1.13 J**	**0.876 J**	**1.16 J**	**2.08**
Perfluorododecane sulfonic acid (PFDoDS)	-	ND (1.62)	ND (1.69)	ND (1.51)	ND (1.85)	ND (1.75)	ND (1.68)	ND (1.68)	ND (1.65)
Perfluorododecanoic acid (PFDoDA)	-	ND (1.62)	ND (1.69)	ND (1.51)	ND (1.85) J	ND (1.75)	**0.59 J**	ND (1.68) J	ND (1.65) J
Perfluoroheptanesulfonic acid (PFHpS)	-	ND (1.62)	ND (1.69)	**2.01**	ND (1.85)	ND (1.75)	ND (1.68)	ND (1.68)	ND (1.65)
Perfluoroheptanoic acid (PFHpA)	-	**13.3**	**4.98**	**2.77**	**0.629 J**	**1.5 J**	**3.17 J**	**4.25 J**	**7.19 J**
Perfluorohexanesulfonic acid (PFHxS)	-	**40.4**	**1.37 J**	**1.56**	ND (1.85)	ND (1.75)	**0.446 J**	**1.57 J**	**1.4 J**
Perfluorohexanoic acid (PFHxA)	-	**17.2**	**3.77**	**5.88**	**2.95**	**3.27**	**5.8**	**8.07**	**10.4**
Perfluorononane sulfonic acid (PFNS)	-	ND (1.62)	ND (1.69)	ND (1.51)	ND (1.85)	ND (1.75)	ND (1.68)	ND (1.68)	ND (1.65)
Perfluorononanoic acid (PFNA)	-	**2.21**	ND (1.69)	**10.8**	**4.33**	**3.93**	**3.32 J**	**5.67 J**	**4.94 J**
Perfluorooctane sulfonamide (PFOSA)	-	ND (1.62)	ND (1.69)	ND (1.51)	ND (1.85)	ND (1.75)	ND (1.68)	ND (1.68)	ND (1.65)
Perfluorooctanesulfonic acid (PFOS)	2.7	**6.98**	**0.846 J**	**123**	**2.02**	**2.63**	**3.56**	**4.34**	**12**
Perfluorooctanoic acid (PFOA)	6.7	**36**	**6.78**	**23.8**	**1.89**	**2.91**	**10.6**	**9.08**	**110**
Perfluoropentanesulfonic acid (PFPeS)	-	**1.2 J**	ND (1.69)	**0.227 J**	ND (1.85)	ND (1.75)	ND (1.68)	ND (1.68)	ND (1.65)
Perfluoropentanoic acid (PFPeA)	-	**15.3**	**2.9 J**	**5.18**	**2.9 J**	**4.31**	**6.52**	**9.52**	**15**
Perfluorotetradecanoic acid (PFTeDA)	-	ND (1.62)	ND (1.69)	ND (1.51)	ND (1.85) J	ND (1.75)	ND (1.68)	ND (1.68)	ND (1.65)
Perfluorotridecanoic acid (PFTrDA)	-	ND (1.62)	ND (1.69)	ND (1.51)	ND (1.85)	ND (1.75)	ND (1.68)	ND (1.68)	ND (1.65)
Perfluoroundecanoic acid (PFUnDA)	-	ND (1.62)	ND (1.69)	ND (1.51)	**1.81 J**	**4.78**	**2.73**	ND (1.68)	**0.645 J**
US EPA PFAS (PFOS + PFOA)	-	-	-	-	-	-	-	-	-
Semi-Volatile Organic Compounds (SIM) (ng/L)									
1,4-Dioxane	350	-	-	-	-	-	-	-	-

Notes:
*1. Results in **bold** were detected.*
2. ND - Not detected above reporting limit.
J - Estimated value (detections) or estimated reporting limit (on ND values)
R - Data rejected by validator
3. Results shaded gray exceed the April 2023 NYSDEC ambient water quality guidance values for human health.
4. Data has been validated by Haley & Aldrich, Inc.

TABLE III
SUMMARY OF PFAS GROUNDWATER ANALYTICAL RESULTS
OERLIKON METCO
WESTBURY, NY

Location	**NYSDEC Guidance Criteria**	**MW-307A**	**MW-307B**	**MW-307C**	**MW-308A**	**MW-308A**	**MW-308B**	**MW-308C**	**MW-309A**
Sample Date		**11/15/2024**	**11/15/2024**	**11/15/2024**	**11/19/2024**	**11/19/2024**	**11/19/2024**	**11/19/2024**	**11/20/2024**
Sample Type		**Primary**	**Primary**	**Primary**	**Primary**	**Duplicate**	**Primary**	**Primary**	**Primary**
Sample Name		**MW-307A-20241115**	**MW-307B-20241115**	**MW-307C-20241115**	**MW-308A-20241119**	**DUP-02-20241119**	**MW-308B-20241119**	**MW-308C-20241119**	**MW-309A-20241120**
PFAS (ng/L)									
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	-	ND (6.78)	ND (128)	ND (6.81)	ND (6.79)	ND (6.94)	ND (6.79)	ND (6.63)	ND (6.54)
2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)	-	ND (42.4)	ND (800)	ND (42.6)	ND (42.5)	ND (43.4)	ND (42.4)	ND (41.4)	ND (40.9)
3-(Perfluoroheptyl)propanoic acid (7:3 FTCA)	-	ND (42.4)	ND (800)	ND (42.6)	ND (42.5)	ND (43.4)	ND (42.4)	ND (41.4)	ND (40.9) J
3:3 Fluorotelomer carboxylic acid (3:3 FTCA)	-	ND (8.48)	ND (8.45)	ND (8.52)	ND (8.49)	ND (8.68)	ND (8.48)	ND (8.29)	ND (8.17)
4,8-Dioxa-3H-Perfluorononanoic Acid (ADONA)	-	ND (6.78)	ND (128)	ND (6.81)	ND (6.79)	ND (6.94)	ND (6.79)	ND (6.63)	ND (6.54)
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	-	ND (6.78)	ND (128) J	ND (6.81)	ND (6.79)	ND (6.94)	ND (6.79)	ND (6.63)	ND (6.54)
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	-	ND (6.78) J	ND (128) J	ND (6.81) J	ND (6.79) J	ND (6.94) J	**9.31 J**	**5.41 J**	ND (6.54) J
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	-	ND (6.78) J	ND (128)	ND (6.81) J	ND (6.79) J	ND (6.94) J	ND (6.79) J	ND (6.63) J	ND (6.54)
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	-	ND (6.78) J	ND (128)	ND (6.81) J	ND (6.79) J	ND (6.94) J	ND (6.79) J	ND (6.63) J	ND (6.54)
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	-	ND (1.7) J	ND (32)	ND (1.7)	ND (1.7)	ND (1.74)	ND (1.7)	ND (1.66)	ND (1.63)
N-Ethylperfluorooctane sulfonamide (N-EtFOSA)	-	ND (1.7) J	ND (1.69) J	ND (1.7)	ND (1.7)	ND (1.74)	ND (1.7)	ND (1.66)	ND (1.63)
N-Ethylperfluorooctane sulfonamidoethanol (N-EtFOSE)	-	ND (17) J	ND (16.9) J	ND (17)	ND (17) J	ND (17.4)	ND (17)	ND (16.6)	ND (16.3)
N-Methyl Perfluorooctanesulfonamidoacetic Acid (MeFOSAA)	-	ND (1.7) J	ND (32)	ND (1.7) J	ND (1.7) J	ND (1.74) J	ND (1.7) J	ND (1.66) J	ND (1.63)
N-Methylperfluorooctane sulfonamide (N-MeFOSA)	-	ND (1.7) J	ND (1.69) J	ND (1.7)	ND (1.7)	ND (1.74)	ND (1.7)	ND (1.66)	ND (1.63)
N-Methylperfluorooctane sulfonamidoethanol (N-MeFOSE)	-	ND (17) J	ND (16.9) J	ND (17)	ND (17) J	ND (17.4)	ND (17)	ND (16.6)	ND (16.3)
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	-	ND (3.39) J	ND (64) J	ND (3.41) J	ND (3.4) J	ND (3.47) J	ND (3.39) J	ND (3.32) J	ND (3.27) J
Perfluoro(2-ethoxyethane) sulphonic acid (PFEESA)	-	ND (3.39)	ND (64)	ND (3.41)	ND (3.4)	ND (3.47)	ND (3.39)	ND (3.32)	ND (3.27)
Perfluoro(4-methoxybutanoic) acid (PFMBA)	-	**0.78 J**	ND (3.38) J	ND (3.41) J	ND (3.4) J	ND (3.47) J	ND (3.39) J	ND (3.32) J	ND (3.27)
Perfluoro-2-propoxypropanoic acid (PFPrOPrA)(GenX) (HFPO-DA)	-	ND (6.78)	ND (6.76) J	ND (6.81)	ND (6.79)	ND (6.94)	ND (6.79)	ND (6.63)	ND (6.54)
Perfluoro-3-methoxypropanoic acid (PFMPA)	-	**0.593 J**	ND (3.38)	**0.29 J**	ND (3.4)	ND (3.47)	ND (3.39)	ND (3.32)	ND (3.27)
Perfluorobutanesulfonic acid (PFBS)	-	**3.86**	ND (32)	**1.66 J**	**1.25 J**	**1.41 J**	**4.4**	**1.83**	**1.63**
Perfluorobutanoic acid (PFBA)	-	**53.4**	**12.7**	**21.4**	**14.2**	**14.8**	**8.08**	**4.24 J**	**16.9**
Perfluorodecanesulfonic acid (PFDS)	-	ND (1.7)	ND (32)	ND (1.7)	ND (1.7)	ND (1.74)	ND (1.7)	ND (1.66)	ND (1.63)
Perfluorodecanoic acid (PFDA)	-	**0.381 J**	ND (32)	ND (1.7)	**1.3 J**	**1.36 J**	**0.602 J**	**0.381 J**	ND (1.63)
Perfluorododecane sulfonic acid (PFDoDS)	-	ND (1.7)	ND (32)	ND (1.7)	ND (1.7)	ND (1.74)	ND (1.7)	ND (1.66)	ND (1.63)
Perfluorododecanoic acid (PFDoDA)	-	ND (1.7) J	ND (32) J	ND (1.7) J	ND (1.7) J	ND (1.74) J	ND (1.7) J	ND (1.66) J	ND (1.63) J
Perfluoroheptanesulfonic acid (PFHpS)	-	**0.33 J**	ND (32)	**0.29 J**	**0.246 J**	**0.286 J**	ND (1.7)	ND (1.66)	ND (1.63)
Perfluoroheptanoic acid (PFHpA)	-	**40.5**	**21.1 J**	**19.7**	**6.81**	**5.7**	**7.04**	**4.08**	**6.52 J**
Perfluorohexanesulfonic acid (PFHxS)	-	**14.9**	ND (32)	**4.03**	**0.883 J**	**0.972 J**	**1.66 J**	**1.59 J**	**0.27 J**
Perfluorohexanoic acid (PFHxA)	-	**70**	**16.6 J**	**26.3**	**20.2**	**20.3**	**8.59**	**5.4**	**17.2**
Perfluorononane sulfonic acid (PFNS)	-	ND (1.7)	ND (32)	ND (1.7)	ND (1.7)	ND (1.74)	ND (1.7)	ND (1.66)	ND (1.63)
Perfluorononanoic acid (PFNA)	-	**5.98**	ND (32)	ND (1.7)	**11.9**	**12.8**	**2.83**	**2.77**	**0.621 J**
Perfluorooctane sulfonamide (PFOSA)	-	ND (1.7)	ND (1.69)	ND (1.7)	**0.544 J**	**0.572 J**	ND (1.7)	ND (1.66)	ND (1.63)
Perfluorooctanesulfonic acid (PFOS)	2.7	**13.4**	**9.92 J**	**4.38**	**46.7**	**47.9**	**8.09**	**7.59**	**1.22 J**
Perfluorooctanoic acid (PFOA)	6.7	**90.2**	**25.4 J**	**17.8**	**18.6**	**17**	**11.3**	**9.88**	**6.56**
Perfluoropentanesulfonic acid (PFPeS)	-	**0.754 J**	ND (32)	**1.17 J**	ND (1.7)	ND (1.74)	**0.407 J**	**0.332 J**	ND (1.63)
Perfluoropentanoic acid (PFPeA)	-	**64.8**	**15.9**	**22.5**	**38.6**	**39.9**	**8.17**	**6.15**	**19.2**
Perfluorotetradecanoic acid (PFTeDA)	-	ND (1.7) J	ND (32)	ND (1.7)	ND (1.7) J	ND (1.74)	ND (1.7)	ND (1.66)	ND (1.63) J
Perfluorotridecanoic acid (PFTrDA)	-	ND (1.7) J	ND (32)	ND (1.7) J	ND (1.7) J	ND (1.74) J	ND (1.7) J	ND (1.66) J	ND (1.63) J
Perfluoroundecanoic acid (PFUnDA)	-	ND (1.7)	ND (32)	ND (1.7)	ND (1.7)	ND (1.74)	ND (1.7)	ND (1.66)	ND (1.63)
US EPA PFAS (PFOS + PFOA)	-	-	-	-	-	-	-	-	-
Semi-Volatile Organic Compounds (SIM) (ng/L)									
1,4-Dioxane	350	-	-	-	-	-	-	-	-

Notes:
1. Results in ***bold*** *were detected.*
2. ND - Not detected above reporting limit.
J - Estimated value (detections) or estimated reporting limit (on ND values)
R - Data rejected by validator
3. Results shaded gray exceed the April 2023 NYSDEC ambient water quality guidance values for human health.
4. Data has been validated by Haley & Aldrich, Inc.

TABLE III
SUMMARY OF PFAS GROUNDWATER ANALYTICAL RESULTS
OERLIKON METCO
WESTBURY, NY

Location	**NYSDEC**	**MW-309B**	**MW-309C**	**QA/QC**	**QA/QC**	**QA/QC**	**QA/QC**	**QA/QC**	**QA/QC**
Sample Date	**Guidance**	**11/20/2024**	**11/20/2024**	**10/30/2018**	**05/13/2019**	**05/13/2019**	**05/15/2019**	**05/15/2019**	**08/19/2019**
Sample Type	**Criteria**	**Primary**	**Primary**	**Equipment Blank**	**Equipment Blank**	**Equipment Blank**	**Equipment Blank**	**Field Blank**	**Equipment Blank**
Sample Name		**MW-309B-20241120**	**MW-309C-20241120**	**EQUIPMENT BLANK-103018**	**EB-051319-0001**	**EB-051319-0002**	**EB-051519-0001**	**FB-051519-0001**	**EB-081919-0001**
PFAS (ng/L)									
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	-	ND (6.75)	ND (6.64)	-	-	-	-	-	-
2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)	-	ND (42.2)	ND (41.5)	-	-	-	-	-	-
3-(Perfluoroheptyl)propanoic acid (7:3 FTCA)	-	**12.6 J**	ND (41.5) J	-	-	-	-	-	-
3:3 Fluorotelomer carboxylic acid (3:3 FTCA)	-	ND (8.44)	ND (8.3)	-	-	-	-	-	-
4,8-Dioxa-3H-Perfluorononanoic Acid (ADONA)	-	ND (6.75)	ND (6.64)	-	-	-	-	-	-
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	-	ND (6.75)	ND (6.64)	-	-	-	-	-	-
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	-	**5.31 J**	**17.8 J**	**0.678 J**	ND (1.79)	ND (1.77)	ND (1.84)	ND (1.8)	ND (1.82)
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	-	ND (6.75)	ND (6.64)	ND (1.87)	ND (1.79)	ND (1.77)	ND (1.84)	ND (1.8)	ND (1.82)
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	-	ND (6.75)	ND (6.64)	-	-	-	-	-	-
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	-	ND (1.69)	ND (1.66)	ND (1.87)	ND (1.79)	ND (1.77)	ND (1.84)	ND (1.8)	ND (1.82)
N-Ethylperfluorooctane sulfonamide (N-EtFOSA)	-	ND (1.69)	ND (1.66)	-	-	-	-	-	-
N-Ethylperfluorooctane sulfonamidoethanol (N-EtFOSE)	-	ND (16.9)	ND (16.6)	-	-	-	-	-	-
N-Methyl Perfluorooctanesulfonamidoacetic Acid (MeFOSAA)	-	ND (1.69)	ND (1.66)	ND (1.87)	ND (1.79)	ND (1.77)	ND (1.84)	ND (1.8)	ND (1.82)
N-Methylperfluorooctane sulfonamide (N-MeFOSA)	-	ND (1.69)	ND (1.66)	-	-	-	-	-	-
N-Methylperfluorooctane sulfonamidoethanol (N-MeFOSE)	-	ND (16.9)	ND (16.6)	-	-	-	-	-	-
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	-	ND (3.38) J	ND (3.32) J	-	-	-	-	-	-
Perfluoro(2-ethoxyethane) sulphonic acid (PFEESA)	-	ND (3.38)	ND (3.32)	-	-	-	-	-	-
Perfluoro(4-methoxybutanoic) acid (PFMBA)	-	ND (3.38)	ND (3.32)	-	-	-	-	-	-
Perfluoro-2-propoxypropanoic acid (PFPrOPrA)(GenX) (HFPO-DA)	-	ND (6.75)	ND (6.64)	-	-	-	-	-	-
Perfluoro-3-methoxypropanoic acid (PFMPA)	-	ND (3.38)	ND (3.32)	-	-	-	-	-	-
Perfluorobutanesulfonic acid (PFBS)	-	**3**	**2.83**	ND (1.87)	ND (1.79)	ND (1.77)	ND (1.84)	ND (1.8)	ND (1.82)
Perfluorobutanoic acid (PFBA)	-	**5.48 J**	**5.48 J**	ND (1.87)	ND (1.79)	ND (1.77)	ND (1.84)	ND (1.8)	ND (1.82)
Perfluorodecanesulfonic acid (PFDS)	-	ND (1.69)	ND (1.66)	ND (1.87)	ND (1.79)	ND (1.77)	ND (1.84)	ND (1.8)	ND (1.82)
Perfluorodecanoic acid (PFDA)	-	**2.26**	**4.96**	ND (1.87)	ND (1.79)	ND (1.77)	ND (1.84)	ND (1.8)	ND (1.82)
Perfluorododecane sulfonic acid (PFDoDS)	-	ND (1.69)	ND (1.66)	-	-	-	-	-	-
Perfluorododecanoic acid (PFDoDA)	-	ND (1.69) J	ND (1.66) J	ND (1.87)	ND (1.79)	ND (1.77)	ND (1.84)	ND (1.8)	ND (1.82)
Perfluoroheptanesulfonic acid (PFHpS)	-	ND (1.69)	ND (1.66)	ND (1.87)	ND (1.79)	ND (1.77)	ND (1.84)	ND (1.8)	ND (1.82)
Perfluoroheptanoic acid (PFHpA)	-	**5.19 J**	**5.55 J**	ND (1.87)	ND (1.79)	ND (1.77)	ND (1.84)	ND (1.8)	ND (1.82)
Perfluorohexanesulfonic acid (PFHxS)	-	**0.869 J**	**0.98 J**	ND (1.87)	ND (1.79)	ND (1.77)	ND (1.84)	ND (1.8)	ND (1.82)
Perfluorohexanoic acid (PFHxA)	-	**7.09 J**	**8.51**	ND (1.87)	ND (1.79)	ND (1.77)	ND (1.84)	ND (1.8)	ND (1.82)
Perfluorononane sulfonic acid (PFNS)	-	ND (1.69)	ND (1.66)	-	-	-	-	-	-
Perfluorononanoic acid (PFNA)	-	**4.3 J**	**4.25 J**	ND (1.87)	ND (1.79)	ND (1.77)	ND (1.84)	ND (1.8)	ND (1.82)
Perfluorooctane sulfonamide (PFOSA)	-	ND (1.69)	ND (1.66)	ND (1.87)	ND (1.79)	ND (1.77)	ND (1.84)	ND (1.8)	ND (1.82)
Perfluorooctanesulfonic acid (PFOS)	2.7	**5.07**	**7.95**	ND (1.87)	ND (1.79)	ND (1.77)	ND (1.84)	ND (1.8)	ND (1.82)
Perfluorooctanoic acid (PFOA)	6.7	**11.1**	**11**	ND (1.87)	ND (1.79)	ND (1.77)	ND (1.84)	ND (1.8)	ND (1.82)
Perfluoropentanesulfonic acid (PFPeS)	-	ND (1.69)	ND (1.66)	-	-	-	-	-	-
Perfluoropentanoic acid (PFPeA)	-	**8.46**	**9.52**	ND (1.87)	ND (1.79)	ND (1.77)	ND (1.84)	ND (1.8)	ND (1.82)
Perfluorotetradecanoic acid (PFTeDA)	-	ND (1.69)	ND (1.66)	ND (1.87)	ND (1.79)	ND (1.77)	ND (1.84)	ND (1.8)	ND (1.82)
Perfluorotridecanoic acid (PFTrDA)	-	ND (1.69)	ND (1.66)	ND (1.87)	ND (1.79)	**0.489 J**	ND (1.84)	ND (1.8)	ND (1.82)
Perfluoroundecanoic acid (PFUnDA)	-	ND (1.69)	ND (1.66)	ND (1.87)	**0.516 J**	**1.08 J**	ND (1.84)	ND (1.8)	ND (1.82)
US EPA PFAS (PFOS + PFOA)	-	-	-	-	ND (1.79)	ND (1.77)	ND (1.84)	ND (1.8)	ND (1.82)
Semi-Volatile Organic Compounds (SIM) (ng/L)									
1,4-Dioxane	350	-	-	ND (150)	-	-	-	-	-

Notes:
1. Results in ***bold*** *were detected.*
2. ND - Not detected above reporting limit.
J - Estimated value (detections) or estimated reporting limit (on ND values)
R - Data rejected by validator
3. Results shaded gray exceed the April 2023 NYSDEC ambient water quality guidance values for human health.
4. Data has been validated by Haley & Aldrich, Inc.

TABLE III
SUMMARY OF PFAS GROUNDWATER ANALYTICAL RESULTS
OERLIKON METCO
WESTBURY, NY

Location	**NYSDEC**	**QA/QC**	**QA/QC**	**QA/QC**	**QA/QC**	**QA/QC**	**QA/QC**
Sample Date	**Guidance**	**08/19/2019**	**08/21/2019**	**10/29/2024**	**11/19/2024**	**11/19/2024**	**11/22/2024**
Sample Type	**Criteria**	**Field Blank**	**Equipment Blank**	**Equipment Blank**	**Equipment Blank**	**Field Blank**	**Equipment Blank**
Sample Name		**FB-081919-0001**	**EB-082119-0002**	**EB-20241029**	**EB-01-20241119**	**FB-01-20241119**	**EB-02-20241122**
PFAS (ng/L)							
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	-	-	-	ND (6.04)	ND (7.06)	ND (6.57)	ND (6.97)
2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)	-	-	-	ND (37.8)	ND (44.1)	ND (41.1)	ND (43.6)
3-(Perfluoroheptyl)propanoic acid (7:3 FTCA)	-	-	-	ND (37.8)	ND (44.1)	ND (41.1)	ND (43.6) J
3:3 Fluorotelomer carboxylic acid (3:3 FTCA)	-	-	-	ND (7.56)	ND (8.83)	ND (8.21)	ND (8.71)
4,8-Dioxa-3H-Perfluorononanoic Acid (ADONA)	-	-	-	ND (6.04) J	ND (7.06)	ND (6.57)	ND (6.97)
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	-	-	-	ND (6.04)	ND (7.06)	ND (6.57)	ND (6.97)
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	-	ND (1.8)	ND (1.78)	ND (6.04)	ND (7.06) J	ND (6.57) J	ND (6.97)
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	-	ND (1.8)	ND (1.78)	ND (6.04)	ND (7.06) J	ND (6.57) J	ND (6.97) J
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	-	-	-	ND (6.04)	ND (7.06) J	ND (6.57) J	ND (6.97)
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	-	ND (1.8)	ND (1.78)	ND (1.51)	ND (1.76)	ND (1.64)	ND (1.74)
N-Ethylperfluorooctane sulfonamide (N-EtFOSA)	-	-	-	ND (1.51)	ND (1.76)	ND (1.64)	ND (1.74)
N-Ethylperfluorooctane sulfonamidoethanol (N-EtFOSE)	-	-	-	ND (15.1)	ND (17.6)	ND (16.4)	ND (17.4)
N-Methyl Perfluorooctanesulfonamidoacetic Acid (MeFOSAA)	-	**0.751 J**	ND (1.78)	ND (1.51)	ND (1.76) J	ND (1.64) J	ND (1.74)
N-Methylperfluorooctane sulfonamide (N-MeFOSA)	-	-	-	ND (1.51)	ND (1.76)	ND (1.64)	ND (1.74)
N-Methylperfluorooctane sulfonamidoethanol (N-MeFOSE)	-	-	-	ND (15.1)	ND (17.6)	ND (16.4)	ND (17.4)
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	-	-	-	ND (3.02)	ND (3.53) J	ND (3.28) J	ND (3.48)
Perfluoro(2-ethoxyethane) sulphonic acid (PFEESA)	-	-	-	ND (3.02)	ND (3.53)	ND (3.28)	ND (3.48)
Perfluoro(4-methoxybutanoic) acid (PFMBA)	-	-	-	ND (3.02)	ND (3.53) J	ND (3.28) J	ND (3.48)
Perfluoro-2-propoxypropanoic acid (PFPrOPrA)(GenX) (HFPO-DA)	-	-	-	ND (6.04)	ND (7.06)	ND (6.57)	ND (6.97)
Perfluoro-3-methoxypropanoic acid (PFMPA)	-	-	-	ND (3.02)	ND (3.53)	ND (3.28)	ND (3.48)
Perfluorobutanesulfonic acid (PFBS)	-	ND (1.8)	ND (1.78)	ND (1.51)	ND (1.76)	ND (1.64)	ND (1.74)
Perfluorobutanoic acid (PFBA)	-	ND (1.8)	ND (1.78)	ND (6.04)	ND (7.06)	ND (6.57)	ND (6.97)
Perfluorodecanesulfonic acid (PFDS)	-	ND (1.8)	ND (1.78)	ND (1.51)	ND (1.76)	ND (1.64)	ND (1.74)
Perfluorodecanoic acid (PFDA)	-	**1.48 J**	ND (1.78)	ND (1.51)	ND (1.76)	ND (1.64)	ND (1.74)
Perfluorododecane sulfonic acid (PFDoDS)	-	-	-	ND (1.51)	ND (1.76)	ND (1.64)	ND (1.74)
Perfluorododecanoic acid (PFDoDA)	-	ND (1.8)	ND (1.78)	ND (1.51)	ND (1.76) J	ND (1.64) J	ND (1.74)
Perfluoroheptanesulfonic acid (PFHpS)	-	ND (1.8)	ND (1.78)	ND (1.51)	ND (1.76)	ND (1.64)	ND (1.74)
Perfluoroheptanoic acid (PFHpA)	-	ND (1.8)	ND (1.78)	ND (1.51)	ND (1.76)	ND (1.64)	ND (1.74) J
Perfluorohexanesulfonic acid (PFHxS)	-	ND (1.8)	ND (1.78)	ND (1.51)	ND (1.76)	ND (1.64)	ND (1.74)
Perfluorohexanoic acid (PFHxA)	-	**0.588 J**	ND (1.78)	ND (1.51)	ND (1.76)	ND (1.64)	ND (1.74)
Perfluorononane sulfonic acid (PFNS)	-	-	-	ND (1.51)	ND (1.76)	ND (1.64)	ND (1.74)
Perfluorononanoic acid (PFNA)	-	ND (1.8)	ND (1.78)	ND (1.51)	ND (1.76)	ND (1.64)	ND (1.74)
Perfluorooctane sulfonamide (PFOSA)	-	ND (1.8)	ND (1.78)	ND (1.51)	ND (1.76)	ND (1.64)	ND (1.74)
Perfluorooctanesulfonic acid (PFOS)	2.7	ND (1.8)	ND (1.78)	ND (1.51)	ND (1.76)	ND (1.64)	ND (1.74)
Perfluorooctanoic acid (PFOA)	6.7	**2.32**	ND (1.78)	ND (1.51)	ND (1.76)	ND (1.64)	ND (1.74)
Perfluoropentanesulfonic acid (PFPeS)	-	-	-	ND (1.51)	ND (1.76)	ND (1.64)	ND (1.74)
Perfluoropentanoic acid (PFPeA)	-	ND (1.8)	ND (1.78)	ND (3.02)	ND (3.53)	ND (3.28)	ND (3.48)
Perfluorotetradecanoic acid (PFTeDA)	-	ND (1.8)	ND (1.78)	ND (1.51)	ND (1.76)	ND (1.64) J	ND (1.74)
Perfluorotridecanoic acid (PFTrDA)	-	ND (1.8)	ND (1.78)	ND (1.51)	ND (1.76) J	ND (1.64) J	ND (1.74)
Perfluoroundecanoic acid (PFUnDA)	-	ND (1.8)	ND (1.78)	ND (1.51)	ND (1.76)	ND (1.64)	ND (1.74)
US EPA PFAS (PFOS + PFOA)	-	**2.32**	ND (1.78)	-	-	-	-
Semi-Volatile Organic Compounds (SIM) (ng/L)							
1,4-Dioxane	350	-	-	-	-	-	-

Notes:
1. *Results in **bold** were detected.*
2. *ND - Not detected above reporting limit.*
   J - Estimated value (detections) or estimated reporting limit (on ND values)
   R - Data rejected by validator
3. *Results shaded gray exceed the April 2023 NYSDEC ambient water quality guidance values for human health.*
4. *Data has been validated by Haley & Aldrich, Inc.*

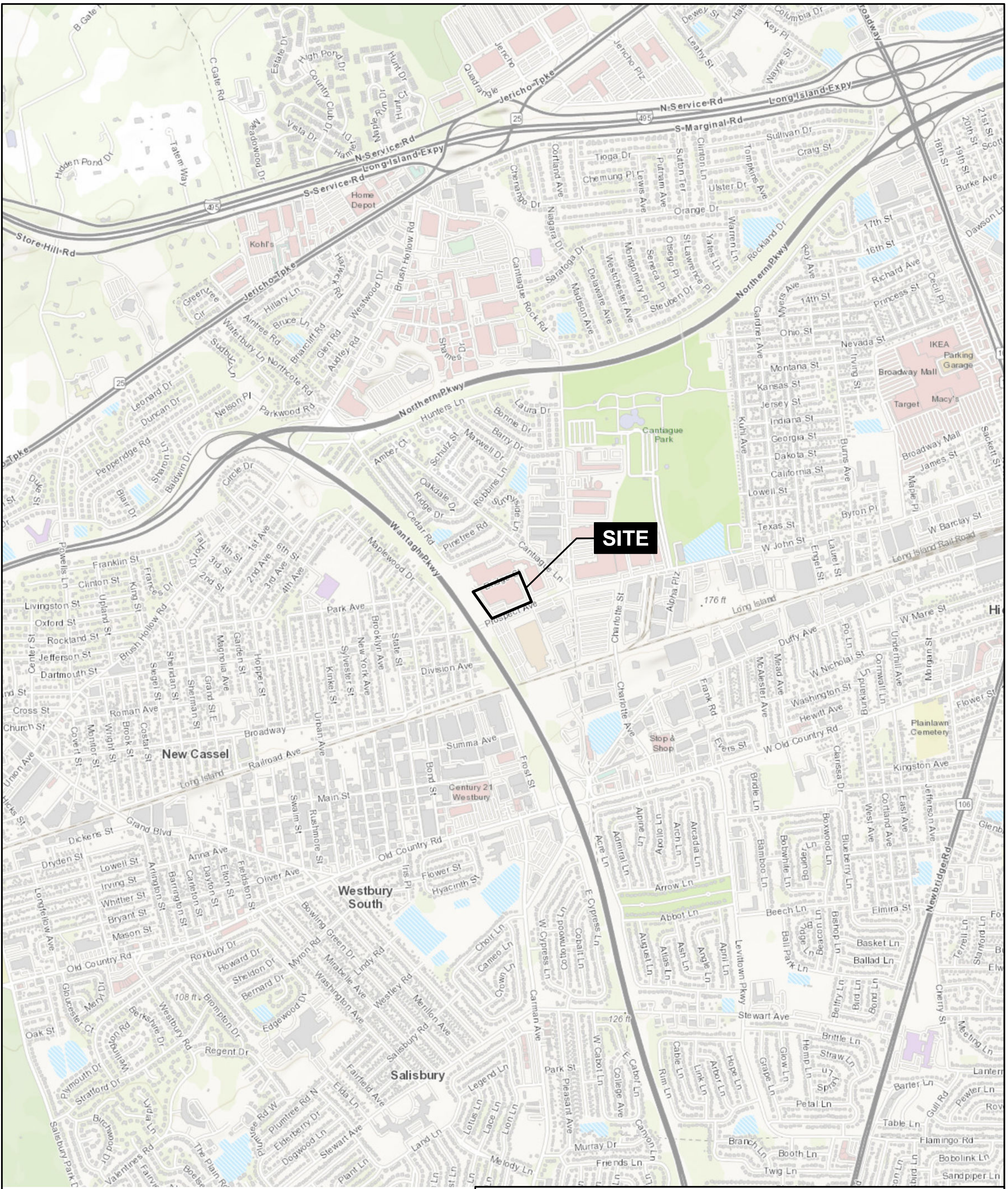
TABLE IV
SAMPLING AND ANALYSIS PLAN
OERLIKON METCO (US) INC.
SUPPLEMENTAL PFAS REMEDIAL INVESTIGATION - PHASE 2
WESTBURY, NEW YORK

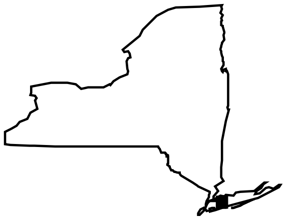
Sample Type	**Collection Scheme**	**# of Samples Anticipated**	**Location ID**	**Purpose**	**Analysis**
Soil Borings Proximal to MW-1/1D (1)	Grab samples to be collected every 5 ft bgs to ~60 ft bgs[4]	~24 direct samples 2 field duplicate 2 MS/MSD[5]	HA-208, HA-209, HA-210, HA-211	Assess horizontal and vertical distribution of potential PFAS contamination in soils upgradient and proximal to MW-1/MW-1D	PFAS (40 Target Compounds[2]) EPA Method 1633
Soil Borings in Northwest Recharge Basin (1)	Grab samples to be collected at 0.5-1.0, 1.0-2.0, an 10 ft bgs	~6 direct samples 1 field duplicate 1 MS/MSD	HA-212, HA-213	Assess PFAS contamination in subsurface soils below the recharge basin	PFAS (40 Target Compounds[2]) EPA Method 1633
Soil Disposal Characterization Samples	Grab Samples from containerized IDW soils	Based on amount of soil IDW	N/A	To obtain contained-in determination from the NYSDEC and/or determine and receive approval from appropriate disposal facility	PFAS (40 Target Compounds[2]) , landfill/disposal characteristics to be determined by receiving landfill[3].
Groundwater Samples	Grab samples collected from Site and downgradient off-Site monitoring wells	35 direct samples 2 field duplicate 1 equipment blank 2 MS/MSD 1 field blank	MW-301A/B/C, MW-302A/B/C, MW-303A/B/C, MW-304A/B/C, MW-305A/B/C, MW-306A/B/C, MW-307A/B/C, MW-308A/B/C, MW-309A/B/C, MW-310A/B/C, MW-1, MW-1D, MW-2, MW-3, MW-4	Assess horizontal and vertical distribution of PFAS contamination in groundwater on and downgradient from the Site.	PFAS (40 Target Compounds[2]) EPA Method 1633

Abbreviations:
PFAS: Per- and Polyfluoroalkyl Substances
IDW: Investigation-Derived Waste
FD: Field Duplicate
MS/MSD: Matrix Spike/Matrix Spike Duplicate

Notes:
1. Samples will be grab samples from soil borings installed via direct push geoprobe methods.
2. PFAS analyte list specified in Appendix G of NYSDEC Guidelines for Sampling and Analysis of PFAS, April 2023
3. Analysis for disposal characterizations subject to specific landfill requirements.
4. Samples collected at 5, 15, 25, 35, 45, and 55 ft bgs will be held for lab analysis pending review of data from samples collected at 10, 20, 30, 40, 50 and 60 ft bgs
5. Does not include samples held for lab analysis. FD/MS/MSD quantities will be revised as needed

FIGURES





MAP SOURCE: ESRI
USGS QUAD: HICKSVILLE, NY
SITE COORDINATES: 40°45'52.7"N, 73°33'14.4"W

HALEY ALDRICH

OERLIKON METCO
1101 PROSPECT AVENUE
WESTBURY, NEW YORK

PROJECT LOCUS

APPROXIMATE SCALE: 1 IN = 2000 FT
AUGUST 2025

FIGURE 1

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LEGEND

- SITE BOUNDARY
- GROUND SURFACE ELEVATION CONTOUR, IN FEET ABOVE MEAN SEA LEVEL
- RAILROAD

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. TOPOGRAPHIC CONTOUR DATA SOURCE: NASSAU COUNTY
3. AERIAL IMAGE SOURCE: NEARMAP, 14 JUNE 2024

HALEY ALDRICH

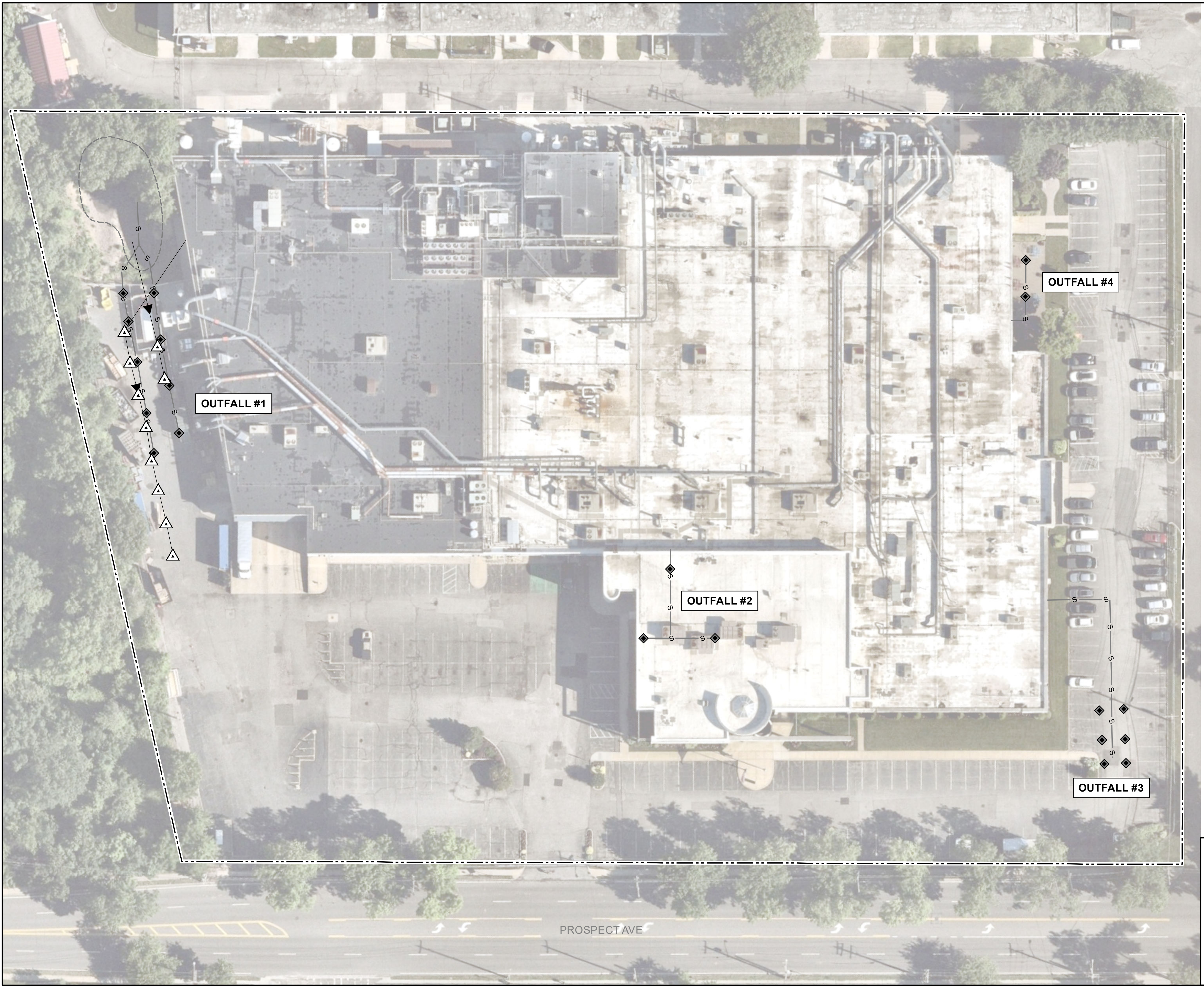
OERLIKON METCO
1101 PROSPECT AVENUE
WESTBURY, NEW YORK

SITE PLAN

AUGUST 2025

FIGURE 2

GIS: \\haleyaldrich.com\share\phx_common\Projects\Oerlikon Metco\127841_Westbury\Global\GIS\Maps\2025_08\127841_010_0002_SITE_PLAN.mxd - anichols - 4/1/2025 9:40:47 AM



LEGEND

△	RECHARGE BASIN AND NORTHWEST ROOF DRAINAGE OUTFALL LINE DRY WELL
—▶—	RECHARGE BASIN AND NORTHWEST ROOF DRAINAGE OUTFALL LINE
◆	HISTORIC DRAINAGE STRUCTURE DRY WELL
—s—	HISTORIC DRAINAGE STRUCTURE PIPING
⬚	STORMWATER BASIN
—·—·—	PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

2. HISTORIC OUTFALL/DRAINAGE STRUCTURE/LEACH FIELD DATA SOURCE: SITE CHARACTERIZATION REPORT, PREPARED BY AECOM, DATED 2012. LOCATIONS OF APPARENT COVERED DRYWELL STRUCTURES AND DRAINAGE LINE ASSOCIATED WITH "OUTFALL #3" WERE IDENTIFIED BY NOVA GEOPHYSICAL ENGINEERING THROUGH GROUND PENETRATING RADAR SURVEY ON 14 AUGUST 2024.

3. RECHARGE BASIN AND NORTHWEST ROOF DRAINAGE OUTFALL LINES AND INTERCONNECTED DRY WELL SOURCE: DB ARCHITECTS AND ENGINEERS, NORTH SIDE DRAINAGE EVALUATION, 23 OCTOBER 2015.

4. AERIAL IMAGERY SOURCE: NEARMAP, 14 JUNE 2023

N

0 60 120

MAP SCALE IN FEET

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OERLIKON METCO
1101 PROSPECT AVENUE
WESTBURY, NEW YORK

HISTORICAL SUBSURFACE DRAINAGE STRUCTURES AND LEACH FIELDS

AUGUST 2025

FIGURE 3

GIS FILE PATH: \\haleyaldrich.com\share\phx_common\Projects\Oerlikon Metco\127841_Westbury\Global\GIS\Maps\2025_08\127841_010_0003_HISTORICAL_DRAINAGE_STRUCTURES.mxd — USER: anichols — LAST SAVED: 4/7/2025 5:16:45 PM

LEGEND

◒	SOIL BORING (H&A, 2024)
△	SURFACE SOIL OR DRY WELL SEDIMENT GRAB SAMPLE (H&A, 2024)
⊕	GROUNDWATER GRAB SAMPLE (H&A, 2018/2019)
◓	HYDROPUNCH GROUNDWATER GRAB SAMPLE (AECOM, 2012)
▲	GROUNDWATER MONITORING WELL (AECOM, 2012; H&A, 2024)
— · · —	SITE BOUNDARY
—	GROUND SURFACE ELEVATION CONTOUR, IN FEET ABOVE MEAN SEA LEVEL

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. GROUNDWATER MONITORING WELL, SOIL BORING, AND SURFACE SOIL/DRY WELL SEDIMENT SAMPLE LOCATIONS SURVEYED BY DPK LAND SURVEYING, DECEMBER 2024.
3. TOPOGRAPHIC CONTOUR DATA SOURCE: NASSAU COUNTY
4. AERIAL IMAGE SOURCE: NEARMAP, 14 JUNE 2024

N

0 150 300
SCALE IN FEET

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OERLIKON METCO
1101 PROSPECT AVENUE
WESTBURY, NEW YORK

EXPLORATION LOCATION PLAN

AUGUST 2025

FIGURE 4

GIS: \\haleyaldrich.com\share\phx_common\Projects\Oerlikon Metco\127841_Westbury\Global\GIS\Maps\2025_08\127841_010_0004_EXPLORATION_LOCATION_PLAN.mxd - anichols - 8/20/2025 2:01:12 PM

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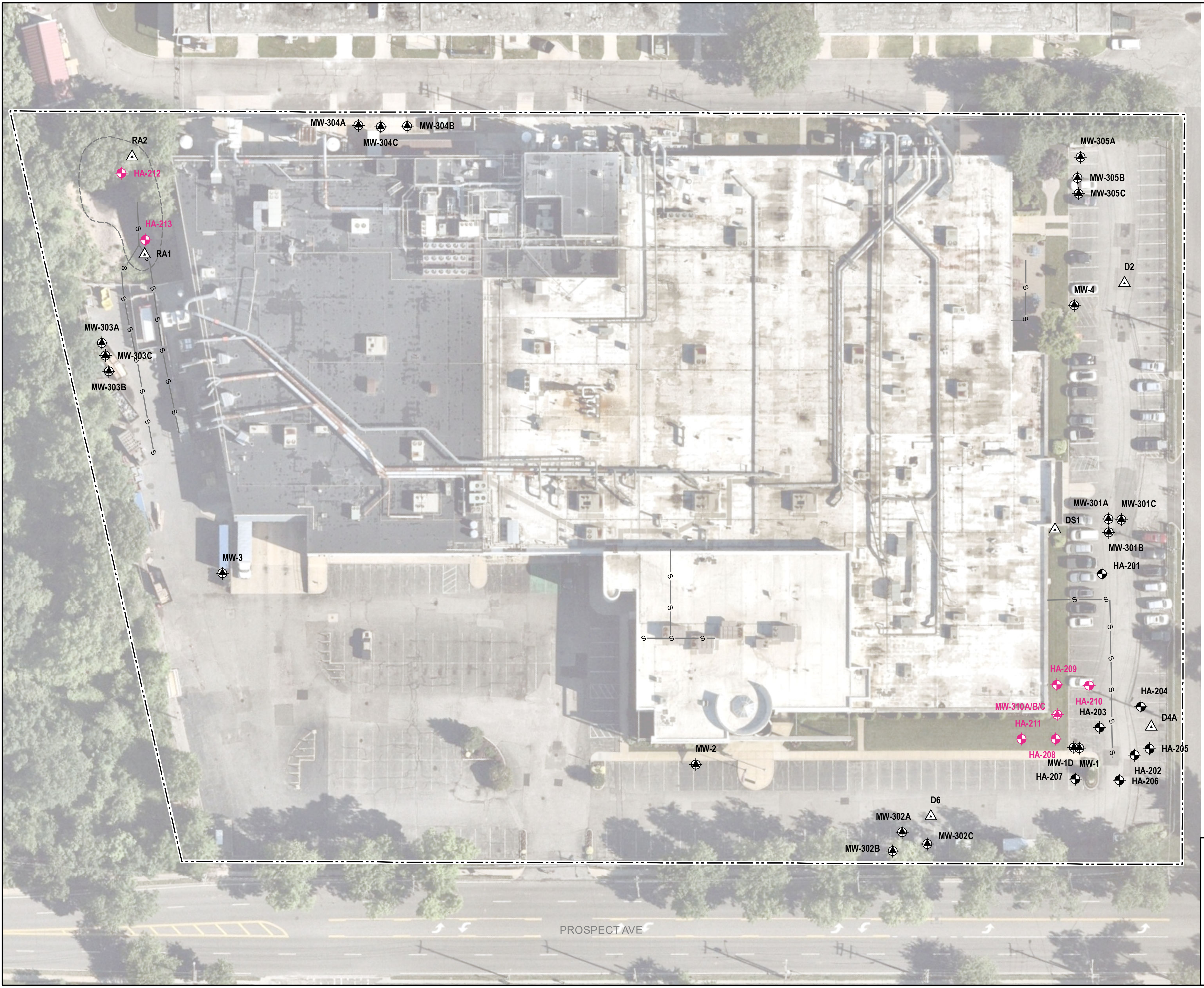


LEGEND

⊕	PROPOSED SOIL BORING
⊕	PROPOSED 3-WELL CLUSTER
⊕	MONITORING WELL
⊕	SOIL BORING (H&A, 2024)
△	SURFACE SOIL OR DRY WELL SEDIMENT GRAB SAMPLE (H&A, 2024)
—S—	HISTORIC DRAINAGE STRUCTURE PIPING
▭	STORMWATER BASIN
—·—·—	PROPERTY BOUNDARY

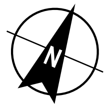
NOTES

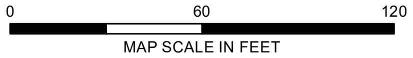
1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

2. HISTORIC OUTFALL/DRAINAGE STRUCTURE/LEACH FIELD DATA SOURCE: SITE CHARACTERIZATION REPORT, PREPARED BY AECOM, DATED 2012. LOCATIONS OF APPARENT COVERED DRYWELL STRUCTURES AND DRAINAGE LINE ASSOCIATED WITH "OUTFALL #3" WERE IDENTIFIED BY NOVA GEOPHYSICAL ENGINEERING THROUGH GROUND PENETRATING RADAR SURVEY ON 14 AUGUST 2024.

3. RECHARGE BASIN AND NORTHWEST ROOF DRAINAGE OUTFALL LINES AND INTERCONNECTED DRY WELL SOURCE: DB ARCHITECTS AND ENGINEERS, NORTH SIDE DRAINAGE EVALUATION, 23 OCTOBER 2015.

4. AERIAL IMAGERY SOURCE: NEARMAP, 14 JUNE 2023





HALEY ALDRICH

OERLIKON METCO
1101 PROSPECT AVENUE
WESTBURY, NEW YORK

PROPOSED ADDITIONAL SUPPLEMENTAL REMEDIAL INVESTIGATION EXPLORATIONS

AUGUST 2025

FIGURE 5

APPENDIX A
Quality Assurance Project Plan

REPORT ON

QUALITY ASSURANCE PROJECT PLAN (QAPP)
OERLIKON METCO (US), INC.
WESTBURY, NEW YORK

by
Haley & Aldrich of New York
Rochester, New York

for
Oerlikon Metco (US) Inc.
Westbury, New York

File No. 0127841-008
October 2025

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1. Project Description

This Quality Assurance Project Plan (QAPP) presents the organization, objectives, planned activities, and specific quality assurance/quality control (QA/QC) procedures associated with the investigation activity for a per- and polyfluoroalkyl substances (PFAS) Remedial Site Investigation (Site). Protocols for sample collection, sample handling and storage, chain of custody (COC) procedures, and laboratory and field analyses are described or specifically referenced to related investigation documents.

This QAPP addresses the QA/QC elements in the USEPA QAPP policy and other relevant guidance documents.

1.1 INTRODUCTION

This QAPP has been prepared on behalf of Oerlikon Metco (US) Inc. (Oerlikon Metco). The QAPP is a component of the Remedial Investigation (RI) Work Plan that also includes the field sampling procedures and Health and Safety Plan (HASP).

1.1.1 Project Objectives

The primary objectives for data collection activities include:

- Define the nature and extent of PFAS constituents in environmental media (soil and groundwater) and VOCs constituents in indoor and outdoor ambient air and sub-slab soil vapor at the Site.
- Collect sufficient data and information to evaluate the risk to human health and the environment, if any, associated with the constituents.
- Collect sufficient data for applicable contaminated media to assess potential receptors and complete exposure pathways.

The purpose of the investigation is as follows:

- Evaluate the potential presence of PFAS in overburden soils in the southeast corner of the Site, and to delineate the nature and extent of PFAS-impacted groundwater in the vicinity of this area. Groundwater from the northern upgradient property boundary will be collected and analyzed for PFAS contaminants to evaluate concentrations in groundwater migrating onto the Site. Additionally, groundwater on the southerly and downgradient property will be collected and analyzed to assess if PFAS- impacted groundwater may be migrating offsite.

- To further assess the current concentrations of VOCs in sub-slab vapor and indoor air in the Machine Shop area of the Site building since the conduct of previous comprehensive sampling events in 2016 and 2017. The results will be used to inform future potential monitoring or sub-slab vapor mitigation actions.

Associated specific objectives for field and laboratory data collection are discussed in Section 1.4 of this plan.

1.1.2 Project Status/Phase

The project status and investigation approach are presented in the Project Work Plan and subsequent amendments or sampling programs.

1.2 SITE DESCRIPTION

The general Site description is provided and is incorporated here by reference to the following Project Work Plan Sections:

Site Location	RI Work Plan Figure 1
Investigation Locations	RI Work Plan Figure 2
Investigation Scope of Work	RI Work Plan Section 3
Field Sampling Procedures and Supporting Plans	RI Work Plan Section 4

1.3 SITE HISTORY

The site history and description is provided in the RI Work Plan Section 2.

1.4 PROJECT OBJECTIVES AND INTENDED DATA USE

1.4.1 Target Parameter List

The investigative program includes the sampling and analysis of environmental media for the presence of PFAS constituents based on historical operations at the Site.

The field and laboratory parameters are summarized below and presented in Tables 1.1, 1.2 and 1.3.

1.4.1.1 Field Parameters

Concurrent with sample collection, several field parameters will be determined by the field sampling personnel. For soils and solid matrices, these field parameters will include visual observations, odor identification, and volatile organic compound (VOC) screening using handheld monitoring equipment.

For aqueous groundwater samples the following parameters will be determined with field testing equipment: pH, specific conductivity, and temperature. The low-flow purging techniques utilized for groundwater sampling may also include the additional field parameters: turbidity, dissolved oxygen, and oxidation/reduction potential (ORP).

1.4.1.2 Laboratory Parameters

The laboratory parameters to be analyzed for soil include:

- Per- and polyfluoroalkyl substances (PFAS) using DRAFT EPA method 1633

The laboratory parameters to be analyzed for groundwater include:

- Per- and polyfluoroalkyl substances (PFAS) using DRAFT EPA method 1633

The laboratory parameters to be analyzed for air and soil vapor include:

- Volatile Organic Compounds (VOCs) using method TO-15/TO-15 SIM

Tables 1.1, 1.2 and 1.3 present the Protection Action Levels (PALs) and Reporting Limits (RL) for each compound or analyte. The RLs have been established based on method detection limit (MDL) studies performed by Alpha Analytical Inc. in accordance with the procedures established in the Federal Register, Title 40, Part 136. MDLs are updated on an annual basis.

1.5 SAMPLING LOCATIONS

The RI Work Plan provides a summary and rationale for the sample locations at the Site. It is possible, however, that depending on the nature of encountered field conditions, sampling locations may change. The person responsible for making such decisions will be the Field Quality Assurance (QA) Officer whose responsibilities are described in Section 2 of this QAPP. Any change of the sampling strategy will only be implemented after approval from the Project Manager.

1.6 PROJECT SCHEDULE

The schedule and projected milestones are presented in Section 6 of the RI Plan.

2. Project Organization and Responsibilities

The Project Manager will have the primary responsibility for the implementation of the Project Work Plan. This section defines the roles and responsibilities of the individuals who will perform the investigation activities.

2.1 MANAGEMENT RESPONSIBILITIES

A description of the project organization and responsibilities of key personnel are as follows.

2.1.1 Regulatory Agency Project Coordinator

The Regulatory Agency Project Coordinator has the overall responsibility for oversight of all phases of the Investigation.

2.1.2 Client Project Manager

The Client Project Manager is responsible for implementing the project and has the authority to commit the resources necessary to meet project objectives and requirements. The Project Manager's primary function is to ensure that technical, financial, and scheduling objectives are achieved successfully. The Project Manager will provide the major point of contact and control matters concerning the project and represent the project team at regulatory agency meetings and public hearings. The Project Manager will define project objectives and develop a detailed project schedule. The Project Manager will establish project policy and procedures to address the specific needs of the project as a whole, as well as the objectives of each task.

2.1.3 Consultant Project Director

The Consultant Project Director will provide final review of significant work products and may participate in technical meetings with the NYSDEC. The Consultant Project Director will ensure that overall technical quality is maintained. The Consultant Project Director will be actively involved in the direction of the project. The Consultant Project Director has overall responsibility for ensuring that the project objectives are met.

The Consultant Project Director will:

- Acquire and apply technical and other resources as needed to ensure performance within budget and schedule restraints.
- Review work performed on each task to ensure quality, responsiveness, and timeliness.
- Be responsible for the preparation and quality of interim and final reports.
- Communicate with Stakeholders about the progress of the project.

2.1.4 Consultant Project Manager

The Consultant Project Manager is responsible for managing the implementation of the RI Work Plan and other activities and coordinating the collection of data pertaining to the Investigation stages. The Consultant Project Manager is responsible for technical QC and project oversight.

2.1.5 Consultant Project Coordinator

The Consultant Project Coordinator will assist the Consultant Project Director and the Consultant Project Manager in day-to-day project management. The Consultant Project Coordinator is responsible for coordinating field activities and the procurement of project subcontractors. Additional responsibilities include:

- Assisting in monitoring the progress and quality
- Preparing and reviewing reports
- Providing technical support of project activities

2.2 QUALITY ASSURANCE (QA) RESPONSIBILITIES

The Quality Assurance (QA) team will consist of a QA Officer and the Consultant Project Manager whose responsibilities are described as follows.

2.2.1 Quality Assurance (QA) Officer

The Quality Assurance (QA) Officer reports directly to the Consultant Project Manager and will be responsible for ensuring that the quality assurance and quality control (QA/QC) procedures prescribed in this plan are implemented. The QA Officer will be responsible for overseeing the review of field and laboratory data. Additional responsibilities include:

- Assuring the application and effectiveness of the QAPP by the analytical laboratory and the project staff;
- Conducting internal QA/QC of the investigation activities;
- Providing input to the Consultant Project Director, the Consultant Project Manager, and the Consultant Project Coordinator for corrective actions required resulting from the above-mentioned evaluation; and
- Preparation and review of laboratory data validation and audit reports.

The QA Officer will be assisted by the data validation staff in the evaluation and validation of field and laboratory generated data. The QA Officer will monitor the performance of the laboratory to ensure that the Data Quality Objectives (DQOs) for the project are met.

2.2.2 Regulatory Agency Quality Assurance Officer

The Regulatory Agency QA Officer may review this QAPP. Additional Regulatory Agency responsibilities for the project may include:

- Conducting external performance and system audits of the laboratories.
- Reviewing and evaluating field and analytical laboratory procedures.

2.3 LABORATORY RESPONSIBILITIES

2.3.1 Laboratory Project Manager

The Laboratory Project Manager will report directly to the QA Officer and will be responsible for ensuring all resources of the laboratory are available on an as-required basis. The Laboratory Project Manager will also be responsible for the approval of the final analytical reports and approval of the laboratory's ability to adhere to the QAPP.

2.3.2 Laboratory Operations Manager

The Laboratory Operations Manager will report to the Laboratory Project Manager and will be responsible for coordinating laboratory analysis, supervising in-house COC reports, scheduling sample analyses, overseeing data review, and overseeing preparation of analytical reports.

2.3.3 Laboratory QA Officer

The Laboratory QA Officer will have sole responsibility for review and validation of the analytical laboratory data generated as part of the investigation. The Laboratory QA Officer will sign all final laboratory data reports provided from the analysis of the project samples and will provide Case Narrative descriptions of any data quality issues encountered during the analyses conducted by the laboratory. The Laboratory QA Officer will also define appropriate QA procedures, overview QA/QC documentation.

2.3.4 Laboratory Sample Custodian

The Laboratory Sample Custodian will report to the Laboratory Operations Manager and will be responsible for the following:

- Receiving and inspecting the incoming sample containers
- Recording the condition of the incoming sample containers
- Signing appropriate documents
- Verifying COC and its correctness
- Notifying the Laboratory Project Manager and Laboratory Operations Manager of sample receipt and inspection
- Assigning a unique identification number and customer number and entering each into the sample receiving log
- Initiating transfer of samples to lab sections
- Controlling and monitoring access/storage of samples and extracts

2.3.5 Laboratory Technical Personnel

The laboratory technical staff will have the primary responsibility in the performance of sample analysis and the execution of the QA procedures developed to determine the data quality. These activities will include the proper preparation and analysis of the project samples in accordance with the contract laboratory's Quality Assurance Manual and associated Standard Operating Procedures (SOPs).

2.3.6 Data Validation Staff

The data validation staff will be independent of the laboratory and familiar with the analytical procedures performed. The validation will include a review of each validation criterion as prescribed by the guidelines presented in Section 9.2.2 of this document, based on the phase of Corrective Action activity, and be presented in a formal written report for submittal to the Consultant Project Manager.

2.4 FIELD RESPONSIBILITIES

2.4.1 Consultant Field QA Officer

The Consultant Field QA Officer is responsible for the overall operation of the field team and reports directly to the Consultant Project Director and Consultant Project Manager. The Consultant Field QA Officer works with the project Health and Safety Officer to conduct operations in compliance with the project HASP. The Consultant Field QA Officer will facilitate communication and coordinate efforts between the Consultant Project Director and the field team members. Other responsibilities include:

Developing and implementing field related work plans, ensuring schedule compliance, and adhering to management developed project requirements

- Coordinating and managing field staff, including sampling and drilling
- Performing field system audits
- Overseeing QC for technical data provided by the field staff
- Preparing and approving of text and graphics required for field team efforts
- Coordinating and overseeing technical efforts of subcontractors assisting the field team
- Identifying problems in the field, resolving difficulties in consultation with the Consultant Project Director, Project QA Officer, and Consultant Project Manager, and implementing and documenting corrective action procedures
- Participating in preparation of the final reports

2.4.2 Field Team Personnel

Field Team Personnel involved will be responsible for:

- Performance of field activities as detailed in the Project Work Plan and in compliance with the DQO outlined in this QAPP for the specific activity being conducted.

3. Quality Assurance Objectives for Measurement Data

The RI Work Plan and associated QAPP are designed to produce data of the quality necessary to achieve the project objectives for the specific phase of the project and meet or exceed the minimum standard requirements for field and analytical methods. The overall QA objective for measurement data is to develop and implement procedures for field sampling, COC, lab analyses, and reporting that will provide results which are adequate for supporting the specific Corrective Action activity objectives and legally defensible in a court of law. The QAPP program will include:

- A mechanism for ongoing control of measurements and evaluation of data quality.
- A measure of data quality in terms of precision, accuracy, representativeness, completeness, and comparability.

The following section is a general discussion of the criteria used to measure the field and laboratory analytical data quality. The Standard Operating Procedures (SOPs) for the laboratory methods of analysis are provided in Attachment A.

3.1 PRECISION

3.1.1 Definition

Precision is defined as a quantitative measure of the degree to which two or more measurements are in agreement. Precision will be stated in terms of relative percent difference (RPD). The overall precision of measurement data is a mixture of sampling and analytical factors. Precision will be determined by collecting and analyzing field duplicate samples and by creating and analyzing laboratory duplicates from one or more of the field samples. The analytical results from the field duplicate samples will provide data on sampling precision. The results from the laboratory created duplicate samples will provide data on analytical precision.

3.1.2 Field Precision Sample Objectives

Field precision will be assessed through collection and measurement of the RPD for field duplicates of investigation samples Table 2 summarizes the frequency of QA/QC samples that will be collected for soil and groundwater samples. Field QA/QC samples will not be collected as part of sub-slab vapor and indoor/outdoor air sampling activities. Field QA/QC samples are also not planned for soil and water disposal analysis.

3.1.3 Laboratory Precision Sample Objectives

Laboratory duplicate analyses will be performed through the use of laboratory duplicates, lab control sample/lab control sample duplicates (LCS/LCSD) and/or matrix spike/matrix spike duplicates (MS/MSD) analyses. Table 2 summarizes the frequency of QA/QC samples that will be collected for soil, groundwater, indoor and outdoor ambient air and sub-slab soil vapor samples.

3.2 ACCURACY

3.2.1 Definition

Accuracy relates to the bias in a measurement system. Bias is the difference between the observed and the "true" value. Sources of error are the sampling process, field contamination, preservation techniques, sample handling, sample matrix, sample preparation, and analytical procedure limitations.

3.2.2 Field Accuracy Objectives

Sampling bias will be assessed by evaluating the results of field and equipment rinse blanks. Field and equipment rinse blanks will be collected as appropriate for each sampling effort.

Field equipment blanks will be collected whenever samples are collected for per- and polyfluorinated alkyl substances (PFAS). Due to the presence of PFAS in common consumer products and in equipment typically used for sample collection, a field blank will be collected to check for residual PFAS that may be a source of sample contamination.

Equipment rinse blanks will be collected from non-dedicated sampling equipment by passing laboratory purified water over and/or through the respective decontaminated field equipment utilized during each sampling effort if the equipment will be reused to collect several samples. Equipment rinse blanks will be analyzed for PFAS constituents for the respective sampling effort for which environmental media have been collected. (Note: If dedicated or disposable sampling equipment is used, equipment rinse samples will not be collected as part of that field effort).

3.2.3 Laboratory Accuracy Objectives

Analytical bias will be assessed through the analysis of laboratory control samples (LCS) and Site-specific matrix spike (MS) samples. LCS and MS/MSD sample analysis will be performed as prescribed by the analytical method SOPs. LCS analyses will be performed with each analytical batch of project samples to determine the accuracy of the analytical system.

The results of the LCS and MS/MSD analyses will be presented in a summary table reporting format and evaluated versus the acceptance criteria presented in the laboratory analytical reports. Current acceptance criteria are presented in Table 2.

The accuracy of organic parameter analyses is also monitored through the analysis of system monitoring or surrogate compounds. Surrogate compounds are added to each sample, standard, blank, and QC samples prior to the sample preparation and analysis. Surrogate compound percent recoveries provide information on the effect of the sample matrix on the accuracy of the analyses and are evaluated against the acceptance criteria presented in laboratory analytical reports. Current acceptance criteria are presented in Table 2.

3.3 REPRESENTATIVENESS

3.3.1 Definition

Representativeness expresses the degree to which sample data accurately and precisely represents a characteristic of a population, a parameter variation at a sampling point, or an environmental condition.

Representativeness is a qualitative parameter that is dependent upon the design of the sampling program. The representativeness criterion is satisfied by proper selection of sampling locations and quantity of samples collected.

3.3.2 Measures to Ensure Representativeness of Field Data

Representativeness will be addressed by describing sampling techniques and the rationale used to select sampling locations. Sampling locations may be biased (based on existing data, instrument surveys, observations, etc.) or unbiased (completely random or stratified-random approaches).

For this project, sampling will be biased; that is, sampling associated with the soil, groundwater, indoor and outdoor ambient air and sub-slab soil vapor will be based on the observed presence/absence of Site-specific contaminants, and/or Site knowledge. Specific sampling technique descriptions, which allow consistency, repetitiveness, and thus representativeness, are provided in Section 4 of the RI Work Plan.

3.3.3 Measures to Ensure Representativeness of Laboratory Data

Representativeness in the laboratory is ensured by using proper analytical procedures and analyzing field duplicate samples. By definition field duplicate samples are collected to be representative of a given point in space and time. Thus, sample duplicates provide both precision and representativeness information.

3.4 COMPLETENESS

3.4.1 Definition

Completeness is a measure of the amount of valid (usable) data obtained from a measuring system compared to the amount that was expected to be obtained under normal conditions. The completeness goal for all data uses is that a sufficient amount of valid data be generated so that determinations can be made related to the intended data use with a high degree of confidence.

3.4.2 Field Completeness Objectives

Completeness is a measure of the amount of valid measurements obtained from all measurements taken in this project. Field completeness objective for this project will be 90 percent.

3.4.3 Laboratory Completeness Objectives

Laboratory data completeness objective is a measure of the amount of valid data obtained from all laboratory measurements. The evaluation of the data completeness will be performed at the conclusion of each sampling and analysis effort. Corrective actions such as revised sample handling procedures will be implemented if problems are noted.

The completeness of the data generated will be determined by comparing the amount of valid data, based on independent validation, with the total data set. The completeness objective will be 90 percent.

3.5 COMPARABILITY

3.5.1 Definition

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another.

3.5.2 Measures to Ensure Comparability of Field Data

Sample data should be comparable with other measurement data for similar samples and sample conditions. This goal is achieved through using SOPs to collect, preserve, store, and analyze representative samples and the reporting of analytical results. The field SOPs for the various activities to be conducted during this investigation provide guidelines to generate reproducible results.

3.5.3 Measures to Ensure Comparability of Laboratory Data

Comparability of laboratory data will also be measured with the results from the analysis of Standard Reference Materials (SRM) obtained from either USEPA Cooperative Research and Development Agreement (CRADA) suppliers or the National Institute of Standards and Technology (NIST) (formerly National Bureau of Standards) for instrument initial and continuing calibration verification. The reported analytical data will be presented in standard units of mass of contaminant within a known volume or mass of environmental media.

- Solid Matrices - micrograms (µg) contaminant per kilogram (kg) for organic analyses, and milligrams (mg) contaminant per kg for inorganic analyses of media (Dry Weight).
- Aqueous Matrices – nanograms (ng) contaminant per liter (L) for PFAS analysis, µg contaminant per L of media for organic analyses, and mg per L for inorganic analyses.
- Air and Sub-slab Soil Vapor - - micrograms (µg) contaminant per cubic meter (M^3).

Additional guidance on analytical data reporting procedures is provided in the laboratory SOPs.

3.6 DECISION RULES

3.6.1 Definition

The decision rule is a statement that prescribes a course of action or non-action to be taken based on assumptions to test its logical and empirical consequences.

3.6.2 Decision Rule Objective

The rationale for sample locations, sample number, and analytical parameters is provided in the main text of the RI Work Plan. The decision rule for the sampling and analysis data collected is as follows:

- Samples will be collected discreetly and biased towards locations with the highest likelihood to encounter maximum contaminant concentrations and locations on the upgradient and downgradient boundaries of the Site and off-site to delineate the impacted media.

- Identify project action levels (PALs) including, “Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS)” NYSDEC, April 2023 and the “Guidance for Evaluating Soil Vapor Intrusion in the State of New York”, NYSDOH, October 2006, with current updates.
- The maximum contaminant concentration of the valid data set for each parameter will be evaluated by comparison to the PALs determined under Step 2 to evaluate the potential for adverse impacts to human health and the environment.

3.7 LEVEL OF QUALITY CONTROL EFFORT

Equipment rinse, field, and method blanks samples, field duplicate samples, laboratory control samples (LCS), and matrix spike (MS) samples will be prepared and analyzed to determine the data quality provided by the sampling and analysis activities conducted during the execution of the investigation program.

Field blanks will be collected whenever samples are collected for PFAS. The laboratory will provide reagent grade (PFAS free) deionized (DI) water in a sealed container. When sampling soil at a location to be analyzed for PFAS, the field technician will open this container and pour the water directly from that container into a PFAS sampling container, exposing the DI water to the sampling environment. This container will then be labeled appropriately and sent to the laboratory with the site samples.

Equipment rinse blanks provide the ability to assess the potential for cross-contamination of samples between sample locations. If non-disposable or non-dedicated equipment are used in the collection of samples, following the decontamination of the non-dedicated sampling equipment, one equipment rinse blank will be collected for every 20 groundwater investigative samples or 1 per sampling event if less than 20 samples are collected.

Method blank samples will be prepared by the laboratory and analyzed concurrently with all project samples to assess potential contamination introduced during the analytical process. Method blanks will be prepared and/or analyzed at a frequency required by the analytical method.

Field duplicate samples will be collected and analyzed to evaluate sampling and analytical reproducibility. One field duplicate will be collected for every 20 or fewer investigative samples collected during sampling activities, excluding sub-slab soil vapor, indoor air, outdoor air, and waste samples.

MS provides information to assess the precision and accuracy of the analysis of the target parameters within the environmental media collected at the Site. MS will be performed in duplicate for all parameters. Initially, one MS/MSD will be collected for every 20 or fewer investigative samples per sample matrix (e.g., soil, groundwater). Aqueous MS/MSD samples require triple the normal sample volume for all required analysis. MS/MSD will not be collected for sub-slab soil vapor, indoor air, outdoor air, and waste samples.

4. Sampling Procedures

Samples of groundwater, soil, indoor air, outdoor air and sub-slab soil vapor will be obtained throughout the investigation phases. The sampling procedures will be consistent with the objectives of the project and the particular phase of the investigation and as agreed to with the regulatory agency.

Section 3 of the RI Work Plan describes each of the sampling tasks and objectives for the field investigations.

4.1 SAMPLE CONTAINERS

Sample containers for each sampling task will be provided by the project laboratory. The containers will be cleaned by the manufacturer to meet or exceed the analyte specifications established in the USEPA, "Specifications and Guidance for Obtaining Contaminant-Free Sample Containers", April 1992, OSWER Directive #9240.0-0.5A.

Certificates of analysis for each lot of sample containers used during the sampling program will be maintained by the laboratory and will be available upon request. The appropriate sample containers, preservation method, maximum holding times, and shipping information for each target parameter and sampling task are provided in Table 3.

4.2 SAMPLE LABELING

Each sample will be labeled with a unique sample number that will facilitate tracking and cross-referencing of sample information. Field blank and field duplicate samples also will be numbered with a unique sample number to prevent analytical bias of field QC samples.

4.3 FIELD QC SAMPLE COLLECTION

4.3.1 Equipment Rinse Blank Sample Collection

Equipment rinse blank samples will be collected when non-dedicated or non-disposable sampling equipment is used to collect samples. Equipment rinse blanks consist of laboratory purified water that has been routed through decontaminated sampling equipment and collected into the appropriate containers.

4.3.2 Field Blank

Field blank samples will be collected at the locations of groundwater sampling locations selected for the analysis of PFAS.

4.3.3 Field Duplicate Sample Collection

4.3.3.1 Water Samples

Field duplicate samples will be collected concurrently with the investigative sample alternating the filling of each sample container using the procedures identified in the Section 4 of the RI Work Plan.

4.3.3.2 Soil Samples

Soil field duplicates will be collected concurrently with the investigative sample using the procedures identified in the Section 4 of the RI Work Plan.

4.3.4 MS/MSD Sample Collection

MS/MSD sample collection for aqueous and soil samples requires triple the sample volume.

5. Custody Procedures

Custody is one of several factors necessary for the admissibility of environmental data as evidence in a court of law. Custody procedures help to satisfy the two major requirements for admissibility: relevance and authenticity. Sample custody is addressed in three parts: field sample collection, laboratory analysis, and final evidence files. Final evidence files, including all originals of laboratory reports, are maintained under document control in a secure area.

Custody of a sample begins when it is collected by or transferred to an individual and ends when that individual relinquishes or disposes of the sample. A sample or evidence file is under your custody if:

- The item is in actual possession of a person,
- The item is in the view of the person after being in actual possession of the person,
- The item was in actual possession but is stored to prevent tampering, and
- The item is in a designated and identified secure area.

5.1 FIELD CUSTODY PROCEDURES

Field personnel will be required to keep written records of field activities on applicable preprinted field forms, in a bound field notebook, or in an electronic format. The records provide the means of recording data collecting activities. Non-electronic records will be written legibly in ink and will contain pertinent field data and observations. Written entry errors or changes will be crossed out with a single line, dated, and initialed by the person making the correction. The records will be periodically reviewed by the Consultant Field QA Officer.

Each title page will include the field team member's name, project name, project start date, project end date, and unique page number.

The beginning of each entry in the record will contain the following information:

- Date
- Start time
- Weather
- Names of field personnel (including subcontractors)
- Level of personal protection used at the Site
- Names of all visitors and the purpose of their visit

For each measurement and sample collected the following will be recorded:

- Detailed description of sample point
- Equipment used to collect sample or make measurement and the date equipment was last calibrated
- Time sample was collected

- Sample description
- Depth sample was collected
- Volume and number of containers
- Sampler identification

5.1.1 Field Procedures

The data quality can be affected by sample collection activities. If the integrity of collected samples is questionable, the data, regardless of its analytical quality, will also be questionable.

The following procedure describes the process to maintain the integrity of the samples:

- Upon collection, samples are placed in the proper containers. The sample container, preservation methods, shipping, and packaging requirements are presented in Table 3.
- Samples will be assigned a unique sample number and will have a sample label affixed to the sample container. The information to be placed on the sample label will include the sample ID number, the sample type, the sampler's name, date collected, preservation technique, and analytical parameter and method to be performed. Information on the labels will be completed with a ballpoint pen or indelible marker, or pre-printed labels if available, which would contain most of the required information. The remaining information would then be added.
- Samples will be properly and appropriately preserved by field personnel in order to minimize loss of the constituent(s) of interest due to physical, chemical, or biological mechanisms.
- Appropriate volumes will be collected to ensure that the project action levels can be successfully achieved and that the required QC Sample Analyses can be completed.

5.1.2 Transfer of Custody and Shipment Procedures

- A chain of custody (COC) record will be completed during sample collection and will accompany each shipment identifying the contents of the shipment. The COC record will accompany the samples to the laboratory. The field personnel collecting the samples will be responsible for the custody of the samples until the samples are relinquished to the laboratory. Sample transfer will require the individuals relinquishing and receiving the samples to sign, date, and note the time of sample transfer on the COC record.
- Samples will be shipped or delivered in a timely fashion to the laboratory so that holding times and/or analysis times as prescribed by the methodology can be met.
- Soil and groundwater samples will also be transported in containers (coolers) packed with ice. Samples will be packaged for shipment and shipped to the appropriate laboratory for analysis. The samples will be packed to prevent breakage and movement during shipping. If one COC is used and there are multiple coolers, copies of the COC should be placed in all coolers. The number of coolers must be written on the COC. If one COC per cooler is completed and if coolers split up samples, copies of the original COC may be placed in all coolers related to that sample ID with page numbers (i.e., 1 of 3) on the batched COCs and coolers to alert the lab of the common sample delivery group (SDG). Samples in polyethylene containers will be placed upright directly in the sample cooler and limited to one layer of samples per each cooler. Additional bubble

wrap or packaging material will be added to fill the cooler. Shipping containers may be secured with strapping tape and/or custody tape for shipment to the laboratory.

- When samples are split with a regulatory agency and Site representatives, a separate COC will be prepared for the samples and marked to indicate to whom the samples are being split. The person relinquishing the samples to the regulatory agency, or the Site will require the representative's signature acknowledging sample receipt.
- If samples are sent by a commercial carrier, a bill of lading will be used. A copy of the bill of lading will be retained as part of permanent documentation. Commercial carriers will not sign the custody record. The COC record will be sealed inside the sample cooler.
- Samples will be picked up by a laboratory courier or transported overnight by a courier to the laboratory preferably the same day they are collected (and never longer than 1 day delay) unless collected on a weekend or holiday. In these cases, the samples will be stored in a secure location until delivery to the lab. Additional ice will be added to the cooler as needed to maintain proper preservation temperatures.

5.2 LABORATORY CHAIN OF CUSTODY PROCEDURES

A full-time sample custodian will be assigned the responsibility of sample control. It will be the responsibility of the sample custodian to receive all incoming samples. Once received, the custodian will document that the custody tape on the coolers is unbroken, that each sample is received in good condition (e.g., unbroken, cooled, etc.), that the associated paperwork, such as COC forms, have been completed, and will sign the COC forms. In special cases, the custodian will document from appropriate sub-samples that COC with proper preservation has been accomplished. The custodian will also document that sufficient sample volume has been received to complete the analytical program. The sample custodian will then place the samples into secure, limited access storage (refrigerated storage, if required). The sample custodian will assign a unique number to each incoming sample for use in the laboratory. The unique number will then be entered into the sample-receiving log. The laboratory date of receipt will also be noted.

Consistent with the analyses requested on the COC form, analyses by the laboratory's analysts will begin in accordance with the appropriate methodologies. Samples will be removed from secure storage only after internal COC sign-out procedures have been followed.

5.3 STORAGE OF SAMPLES

Sample containers with volume remaining will be returned to secure and limited access storage. Upon completion of all laboratory analyses for each sample submittal and generation of the laboratory report, samples will be stored by the sample custodian. The length of time that samples are held will be at least 30 days after reports have been submitted. Disposal of remaining samples will be completed in compliance with all Federal, State, and local requirements.

Laboratory custody procedures and document control for those samples analyzed by the project laboratory will be carried out using the laboratory's SOPs provided in Appendix A.

5.4 FINAL PROJECT FILES CUSTODY PROCEDURES

The final project file will be the central repository for all documents with information relevant to sampling and analysis activities as described in this QAPP. The Consultant Project Manager will be the custodian of the project file. The project files for the sampling activity, including all relevant records, reports, logs, field notebooks, pictures, subcontractor reports, and data reviews will be maintained in a secured, limited access area and under custody of the Consultant Project Manager or his designee.

The final project file will include:

- Project plans and drawings
- Field data records
- Sample identification documents and soil boring/monitoring well logs
- All COC documentation
- Correspondence
- References, literature
- Laboratory data deliverables
- Data validation and assessment reports
- Progress reports, QA reports
- Final report

The laboratory will be responsible for maintaining analytical logbooks, laboratory data, and sample COC documents, both hard copy and electronic. Raw laboratory data files and copies of hard copy reports will be inventoried and maintained by the laboratory for a period of 6 years, at which time the laboratory will contact QA Officer regarding the disposition of the project related files.

6. Calibration Procedures and Frequency

This section describes procedures for maintaining the accuracy for all the instruments and measurement equipment, which will be used for conducting field tests and laboratory analyses. These instruments and equipment will be calibrated prior to each use or according to a periodic schedule.

6.1 FIELD INSTRUMENT CALIBRATION PROCEDURES

Instruments and equipment used to gather, generate, or measure environmental data will be calibrated as specified in Section 4 of the RI Work Plan.

The field instruments are likely to include dissolved oxygen meters, pH meters, turbidity meters, specific conductance meters, and photoionization detectors (PIDs). Field instruments will be used for real-time sample measurement during monitoring well sampling and organics screening for both on-Site screening of soil samples and for health and safety air monitoring, as described in the HASP. On-Site air monitoring for health and safety purposes and the screening of soil samples may be accomplished using PIDs.

Field instruments will be calibrated prior to use and the calibration will be verified after a maximum of ten measurements or at a minimum beginning of the day, middle of the day, and end of day.

Satisfactory completion of the pre-operation inspection will be noted on the Field Sampling Record, along with the results of each field measurement.

6.2 LABORATORY INSTRUMENT CALIBRATION PROCEDURES

Calibration procedures for a specific laboratory instrument will consist of initial calibration, initial calibration verification, and continuing calibration verification. The Laboratory SOPs present the specific calibration procedures for each method of analysis. The SOP for each analysis performed in the laboratory describes the calibration procedures, their frequency, acceptance criteria, and the conditions that will require calibration. In all cases, the initial calibration will be verified using an independently prepared calibration verification solution.

The use of materials of known purity and quality will be utilized for the analysis of environmental samples. The laboratory will carefully monitor the use of all laboratory materials including solutions, standards, and reagents through well-documented procedures.

All solid chemicals and acids/bases used by the laboratory will be reagent grade or better. All gases will be high purity or better. All SRMs or Performance Evaluation (PE) Materials will be obtained from approved vendors of the NIST, the USEPA Environmental Monitoring Support Laboratories (EMSL), or reliable CRADA certified commercial sources.

All materials including standards or standard solutions will be dated upon receipt, and will be identified by material name, lot number, purity or concentration, supplier, receipt/preparation date, recipient/preparer's name, expiration date, and all other pertinent information.

7. Analytical Procedures

Analytical procedures to be utilized for off-Site analysis of environmental samples will be based on referenced USEPA analytical protocols and the laboratory SOPs that implement these methods. These project-specific SOPs are provided in Attachment B to this QAPP.

7.1 FIELD ANALYTICAL PROCEDURES

Field analytical procedures include the measurement of pH/temperature, specific conductivity, dissolved oxygen, turbidity, and ORP during sampling of groundwater, and the qualitative measurement of VOC during the collection of soil samples at the Site.

Laboratory preparation and analytical SOPs and the methods upon which they are based are provided in Appendix A of this document and are based on the USEPA methodology requirements in “Sampling, Analysis and Assessment of PFAS under NYSDEC Part 375 Remedial Program”, NYSDEC, April 2023 and “Guidance on Evaluating Soil Vapor Intrusion in New York State”, NYSDOH, October 2006.

7.1.1 List of Project Target Compounds and Laboratory Detection Limits

A complete listing of project target compounds and project RLs, MDLs and PALs for each analyte are listed in Tables 1.1, 1.2 and 1.3. MDLs have been experimentally determined by the project laboratory using the procedure identified in 40 CFR, Part 136 Appendix B.

7.1.2 List of Method Specific Quality Control Criteria

The laboratory SOPs include a section that presents the minimum QC requirements for the project analyses. Section 8 references the frequency of the associated QC samples for each sampling effort and matrix.

8. Internal Quality Control Checks

This section presents the internal QC checks that will be employed for field and laboratory measurements.

8.1 FIELD QUALITY CONTROL

QC procedures for pH/temperature, turbidity, and conductivity of water samples and PID screening soil samples will include calibrating the instruments as described in Section 6.1 of this QAPP, measuring duplicate samples and checking the reproducibility of the measurements by taking multiple readings on a single sample or the measurement reference standards. The QC information for field equipment is stated in Section 3 of this QAPP. Assessment of field sampling precision and bias will be made by collecting field duplicates and equipment rinse blanks for laboratory analysis. Collection of the samples will be in accordance with the applicable procedures in Section 4.3.

8.1.1 Equipment Rinse Blanks

Internal QC checks will include analysis of equipment rinse blanks to validate successful equipment cleaning activities if the equipment is used and decontaminated between sampling locations. Whenever possible, dedicated equipment will be employed to reduce the possibility of cross-contamination of samples.

8.1.2 Field Duplicate Samples

Field duplicate samples are collected in a similar fashion to investigative samples at a minimum frequency of 1 duplicate per 20 investigative samples by matrix. Field duplicate samples are analyzed by the laboratory to evaluate matrix, sample, and analytical reproducibility. Field duplicate samples will not be collected while sampling for sub-slab soil vapor, indoor air, or outdoor air.

8.1.3 Field Blank

Field blank samples will be collected at the location of groundwater sampling locations selected for the analysis of PFAS in accordance with DRAFT EPA Method 1633. The field blank samples will be submitted along with the project samples for concurrent analysis of the PFAS target parameters.

8.2 LABORATORY PROCEDURES

The laboratories identified in Section 7 of this QAPP have QC programs to ensure the reliability and validity of the analysis performed at the laboratory. All analytical procedures are documented in writing as SOPs and each SOP includes a QC section, which addresses the minimum QC requirements for the procedure. The internal QC checks may vary slightly for each individual procedure but, in general, will include the following QC requirements:

- Calibration Standards
- Instrument Performance Checks – Organics
- Initial and Continuing Calibration Checks

- Internal Standard Performance
- Method Blank Samples
- LCSs and QC Check Samples
- MS/MSD
- Surrogates
- Blind Check Samples

All data will be properly recorded. The data package will include a summary of QC data as presented in Section 9.3.2. Any samples analyzed in nonconformance with QC criteria will be reanalyzed by the laboratory, if sufficient volume is available.

9. Data Reduction, Validation, and Reporting

All data generated through in field activities or by the laboratory operation shall be reduced and validated prior to reporting in accordance with the following procedures.

9.1 DATA REDUCTION

9.1.1 Field Data Reduction Procedures

Field data reduction procedures will be minimal in scope compared to those implemented in the laboratory setting. Only direct read instrumentation will be employed in the field. The pH, conductivity, temperature, turbidity, and PID readings collected in the field will be generated from direct read instruments following calibration per manufacturer's recommendations. Such data will be written into field logbooks immediately after measurements are taken. If errors are made, results will be legibly crossed out, initialed, and dated by the field member, and corrected in a space adjacent to the original entry. Later, when the results forms required for this study are being filled out, the Consultant Project Coordinator will review the forms to determine whether any transcription errors have been made by the field crew.

9.1.2 Laboratory Data Reduction Procedures

For this project, the equations that will be employed in reducing data are found in the appropriate chapter of SW-846, Third Edition. Two of these equations, expressing analytical accuracy and precision, are presented in Section 3 of this QAPP. Such formulae make pertinent allowances for matrix type. All calculations are checked at the conclusion of each operating day. Errors are noted; corrections are made, but the original notations are crossed out legibly. Analytical results for soil samples shall be calculated and reported on a dry weight basis.

QC data (e.g., laboratory duplicates, surrogates, MS, and MSD) will be compared to the method acceptance criteria or laboratory acceptance criteria when no method criteria are available. Data considered to be acceptable will be entered into the laboratory computer system. Data summaries will be sent to the Laboratory QA Officer for review. If approved, data are logged into the project database format. Unacceptable data shall be appropriately qualified in the project report. Case narratives will be prepared, which will include information concerning data that fell outside acceptance limits and any other anomalous conditions encountered during sample analysis.

9.2 DATA VALIDATION

Data validation procedures shall be performed for both field and laboratory operations as described below.

9.2.1 Procedures Used to Evaluate Field Data

Procedures to evaluate field data for this project will include review of field logbooks and checking for transcription errors to project specific documents. This task will be the responsibility of the Consultant Field QA Officer.

9.2.2 Procedures to Validate Laboratory Data

The Haley & Aldrich QA Officer or designee will perform analytical data validation using the following documents as guidance for the review process.

- Sampling, Analysis and Assessment of PFAS under NYSDEC Part 375 Remedial Program, April 2023.
- United States Environmental Protection Agency, 2014a. Analysis of Volatile Organic Compounds in Air Contained in Canisters by Method TO-15, SOP NO. HW-31, Revision 6. June 2014.

Completeness checks will be administered on all laboratory data packages to determine that all required data deliverables are present. At a minimum, deliverables will include sample chain of custody (COC) forms, a case narrative, analytical results, QC summaries, and supporting information.

A Stage 2A data review and validation as defined by "Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use", 2009 will be performed on each laboratory data package consisting of the following:

9.2.2.1 Organic Analysis

- Technical holding times compliance
- Method, Equipment Rinse and field blank results
- System monitoring compounds (surrogate spikes) recoveries
- Matrix Spike/ Matrix Spike Duplicate (MS/MSD) analysis results
- Laboratory Control Sample (LCS) analysis results
- Field duplicate sample analysis results

9.2.2.2 Inorganic Analysis

- Technical holding time Compliance
- Method or Initial and Continuing Blank sample results
- LCS analysis results,
- MS/MSD and Matrix Duplicate (MD) sample analysis results
- Field duplicate sample analysis result

If QC issues are suspected during the Stage 2A validation, a higher stage of validation may be performed on the data.

The data package for waste samples will include: sample COC forms, analytical results, and QC summaries. The laboratory data package will be reviewed for completeness but a data validation will not be performed on waste samples except that.

Following the completion of the completeness check and the Stage 2A data validation, a Data Usability Summary Report (DUSR) will be prepared to provide guidance to the data user on the applicability of the reported results to achieve the project objectives.

9.3 DATA REPORTING

Data reporting procedures shall be carried out for field and laboratory operations as indicated below.

9.3.1 Field Data Reporting

Field data reporting shall be conducted principally through the transmission of report sheets containing tabulated results of all measurements made in the field and documentation of all field calibration activities.

9.3.2 Laboratory Data Reporting

The laboratory data reporting package will be sufficient to perform a data validation in accordance with protocols described in Section 9.2.2. The task of reporting laboratory data will be initiated after the completion of data validation.

The Laboratory Project Manager will perform a final review of the QC data summary packages and case narratives to determine whether the report meets the project requirements. In addition to the record of the COC, the final laboratory data report format shall consist of the following:

- Title Page
    - Project name and number
    - Laboratory project or lot number
    - Signature of the Laboratory QA Officer or his designee
    - Date issued
- Table of Contents - Laboratory Report Contents
- Case Narrative
    - Number of samples and respective matrices
    - Laboratory analysis performed
    - Any deviations from intended analytical strategy
    - Definition of data qualifiers used
    - QC procedures utilized and references to the acceptance criteria
    - Condition of samples "as received"
    - Discussion of whether or not sample holding times were met
    - Discussion of technical problems or other observations which may have created analytical difficulties
    - Discussion of laboratory QC checks which failed to meet project criteria
- Analytical Methods Summary - Methods of Sample Preparation and Analyses for Samples
- Analytical Sample Summary - Cross-Reference Table of Laboratory Sample to Project Sample Identification Numbers
- Shipping and Receiving Documents
    - Sample container documentation
    - Sample reception information and original COC record

- Chemistry Data Package by Analysis
    - Sample Results
        - Sample quantitation reporting limit (RL), reporting MDL, and estimated values between the RL and MDL
        - Methods of sample preparation and analyses for samples
        - Raw data for sample results (dated chromatograms, parameter specific quantitation reports, mass spectra, and instrument printouts (not required for OMM and waste samples)
    - QC Summary Data with Current Control Limits
        - MS/MSD recoveries, LCS, method blank results, and surrogate recoveries
        - GC/MS tuning results and internal standards (organics)
        - MS recoveries and MD RPDs, LCS, method blank results
        - Serial dilutions, reagent blank results, and interference check standards (inorganics)

The project laboratory will also be provided in an electronic data deliverables (EDDs) EQuIS® 4-file format. The laboratory data will be downloaded into the EDDs directly from the laboratory information management system (LIMS). A NYSDEC-compatible EDD will be submitted to NYSDEC prior to the approval of Phase 2 of the SRIR.

10. Performance and System Audits

A performance audit is an independently obtained quantitative comparison with data routinely obtained in the field or the laboratory. Performance audits include two separate, independent parts: internal and external audits.

10.1 FIELD PERFORMANCE AND SYSTEM AUDITS

10.1.1 Internal Field Audit Responsibilities

Internal audits of field activities include the review of sampling and field measurements conducted by the Consultant Field QA Officer. The audits will verify that procedures are being followed. Internal field audits will be conducted once during the initial phase of the sampling program and at the conclusion of the project. The audits will include examination of the following:

- Field sampling records, screening results, instrument operating records
- Sample collection
- Handling and packaging in compliance with procedures
- Maintenance of QA procedures
- COC reports

Follow-up audits will be conducted to correct deficiencies and to verify that procedures are maintained throughout the investigation.

10.1.2 External Field Audit Responsibilities

External audits may be conducted by the Regulatory Agency Project Coordinator at any time during the field operations. These audits may or may not be announced and are at the discretion of the regulatory agency. The external field audits can include (but are not limited to) the following:

- Sampling equipment decontamination procedures
- Sample bottle preparation procedures
- Sampling procedures
- Examination of HASPs
- Procedures for verification of field duplicates
- Field screening practices

10.2 LABORATORY PERFORMANCE AND SYSTEM AUDITS

10.2.1 Internal Laboratory Audit Responsibilities

System audits, as opposed to performance audits, are strictly qualitative and consist of an on-Site review of a laboratory's QA system and physical facilities for calibration and measurement.

Laboratory system audits will be conducted by the Laboratory Project QA Officer or designee. The system audit includes an examination of laboratory documentation such as: sample receiving logs, sample storage, COC procedures, sample preparation and analysis, and instrument operating records.

The performance audits include analysis of performance evaluation samples along with project samples. The Laboratory Project QA Officer will evaluate the analytical results to determine acceptable QC performance.

At the conclusion of internal system audits, reports are provided to the laboratory's operating divisions for appropriate comment and remedial/corrective action where necessary. Records of audits and corrective actions are maintained by the Laboratory QA Officer.

10.2.2 External Laboratory Audit Responsibilities

External audits will be conducted as required, by appropriate QA personnel of the regulatory agency and may be conducted at least once prior to sampling and analysis activities.

External audits may include any of the following:

- Review of laboratory analytical procedures
- Laboratory on-site visits
- Submission of performance evaluation samples for analysis

Failure of any of the above audit procedures may lead to laboratory disqualification, and another suitable laboratory may have to be chosen. An on-site review may consist of:

- Sample receipt procedures
- Custody, sample security, and log-in procedures
- Review of instrument calibration logs
- Review of QA procedures
- Review of logbooks
- Review of analytical SOPs
- Personnel interviews

A review of a data package from samples recently analyzed by the laboratory can include (but not be limited to) the following:

- Comparison of resulting data to the SOP or method
- Verification of initial and continuing calibrations within control limits
- Verification of surrogate recoveries and instrument timing results
- Review of extended quantitation reports for comparisons of library spectra to instrument spectra, where applicable
- Assurance that samples are analyzed within holding times

11. Preventative Maintenance

11.1 FIELD INSTRUMENT PREVENTATIVE MAINTENANCE

The field equipment preventative maintenance program ensures the effective completion of the sampling effort and is designed to minimize equipment downtime. Program implementation is concentrated in three areas:

- Maintenance responsibilities
- Maintenance schedules
- Inventory of critical spare parts and equipment

The maintenance responsibilities for field equipment will be assigned to the task leaders in charge of specific field operations. Field personnel will be responsible for daily field checks and calibrations and for reporting any problems with the equipment. The maintenance schedule will follow the manufacturer's recommendations. In addition, the field personnel will be responsible for determining that critical spare parts are included with the field equipment. An adequate inventory of spare parts will be maintained. The inventory will primarily contain parts that are subject to frequent failure, have limited useful lifetimes, and/or cannot be obtained in a timely manner.

11.2 LABORATORY INSTRUMENT PREVENTATIVE MAINTENANCE

Analytical instruments at the laboratory will undergo routine and/or preventative maintenance. The extent of the preventative maintenance will be a function of the complexity of the equipment.

Generally, annual preventative maintenance service will involve cleaning, adjusting, inspecting, and testing procedures designed to deduce instrument failure and/or extend useful instrument life. Between visits, routine operator maintenance and cleaning will be performed according to manufacturer's specifications by laboratory personnel.

Maintenance records will be placed on file at the laboratory and can be made available upon request.

12. Specific Routine Procedures Used to Assess Data Precision, Accuracy, and Completeness

The following sections include the procedures and formulae utilized to assess the levels of precision, accuracy, and completeness achieved during the associated sample analyses.

12.1 FIELD MEASUREMENTS

Field generated information such as pH and specific conductance data will be reviewed for validity. The review will be performed by the Consultant Field QA Officer and typically includes bound logbooks/forms, data entry, and calculation checks. Field data will be assessed by the Consultant Field QA Officer who will review the field results for compliance with the established QC criteria that are specified in Section 3. The accuracy of pH and specific conductance will be assessed using daily instrument calibration, calibration check, and blank data.

12.2 LABORATORY DATA

Laboratory results will be assessed for compliance with required precision, accuracy, and completeness detailed in the following subsections.

12.2.1 Precision

The precision of laboratory analysis will be assessed by comparing the analytical results between MS/MSD analyses. The RPD will be calculated for each pair of duplicate analyses (laboratory MS/MSDs and field duplicates).

12.2.2 Accuracy

The accuracy of laboratory results will be assessed for compliance with the established QC criteria that are described in Sections 3 and 8 of the QAPP using the analytical results of method blanks, reagent/preparation blank, SRMs or QC check samples, and MS/MSD samples. The percent recovery (%R) of MS samples and SRMs will be calculated.

12.2.3 Completeness

Completeness will be assessed by comparing the number of valid (usable) results to the total possible number of results using the formula presented in Section 12.1.

12.3 STATISTICAL EVALUATIONS

In the examination of data and determination of their precision and accuracy, standard statistical formulae will be used. Further details are provided in the following subsections.

12.3.1 Percent Recovery

The percent recovery of a parameter is calculated by dividing the amount recovered by the true amount added and multiplying by 100. The percent recoveries of spiked samples are evaluated to establish the analytical accuracy of a measurement. Percent recovery is calculated using the following formula:

$$\%R = \frac{SSR - SR}{SA} \times 100\%$$

where:

SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added

12.3.2 Relative Percent Difference

The RPD is calculated by dividing the absolute value of the difference between two numbers by their arithmetic mean and multiplying by 100. The RPD is used to evaluate the analytical precision of two replicate measurements (i.e., MS/MSD). RPD is calculated using the following formula:

$$RPD = \frac{|R1 - R2|}{\frac{R1 + R2}{2}} \times 100\%$$

where:

R_1 = value of first result
R_2 = value of second result

13. Corrective Action

13.1 FIELD CORRECTIVE ACTION

Corrective action is intended to address problems that arise by identification, recommendation, approval, and implementation of measures that counter unacceptable procedures or deficient QC performance. The Consultant Field QA Officer and QA Officer will be responsible for ensuring the quality of the sampling procedures and environmental data and as such, will be responsible for initiating corrective action when appropriate.

The corrective action procedures will be as follows:

- Identify/define the problem.
- Assign responsibility for investigating the problem.
- Investigate/determine the cause of the problem.
- Determine an appropriate corrective action to eliminate the problem.
- Implement the corrective action.
- Evaluate the effectiveness of the corrective action.
- Verify that the corrective action has eliminated the problem.
- Prepare a written record detailing the problem, corrective action utilized, and solution of the problem.
- Submit the Corrective Action Record (CAR) to whoever initiated the corrective action and the Project QA Officer and Consultant Project Manager.

The above procedures may be implemented through the use of the Systems Audit as described previously. Any Field Team member of the project may initiate corrective action procedures by reporting in writing the nature of the suspected problem to the Consultant Project Manager or QA Officer. The Consultant Project Manager will begin corrective action by relating the problem to appropriate personnel.

13.2 LABORATORY CORRECTIVE ACTION

The following paragraphs define the corrective action decision process relative to possible noncompliant events encountered during laboratory analysis of the project samples. Corrective actions will be initiated by the laboratory QA personnel and will be implemented by laboratory staff chemists under the oversight of the laboratory QA personnel. As with field corrective actions, the laboratory QA personnel will document the problem, the corrective action undertaken, and the resolution of the problem. The corrective actions will be performed prior to release of the data from the laboratory.

Documentation will be provided to the Laboratory QA Officer, QA Officer, Consultant Project Manager, and Project Manager.

13.3 CORRECTIVE ACTION DURING DATA VALIDATION AND DATA ASSESSMENT

The QA Officer may identify the need for corrective action during either the data validation or data assessment processes. Potential types of corrective action may include resampling by the field team or reinjection/reanalysis of samples by the laboratory (if possible).

These actions are dependent upon the ability to mobilize the field team, whether the data to be collected is necessary to meet the required QA objectives (i.e., the holding time for samples is not exceeded). When the QA Officer identifies a corrective action situation, the Project Manager will be responsible for approving the implementation of corrective action, including resampling, during data assessment. All corrective actions will be documented by the Consultant Project Manager.

14. Quality Assurance Reports

Critically important to the successful implementation of the QA Plan is a reporting system that provides the means by which the program can be reviewed, problems identified, and programmatic changes made to improve the plan.

QA reports to management include:

- Audit reports, internal and external audits with responses
- Performance evaluation sample results; internal and external sources
- Daily QA/QC exception reports/corrective actions

QA/QC corrective action reports will be prepared by the QA Officer when appropriate and presented to the project and/or laboratory management personnel so that performance criteria can be monitored for all analyses from each analytical department.

References

1. New York State Department of Environmental Conservation, NYSDEC, Division of Environmental Remediation, Sampling, Analysis and Assessment of Per- and Polyfluoroalkyl Substances (PFAS) under NYSDEC Part 375 Remedial Program, April 2023.
2. New York State Department of Environmental Conservation, NYSDEC, Division of Environmental Remediation, Technical Guidance for Site Investigation and Remediation, DER-10, May 2010.
3. New York State Department of Health, NYSDOH, Guidance for Evaluating Soil Vapor Intrusion in New York State, October 2006 with updates.
4. United States Environmental Protection Agency (1991). Preparation Aids for the Development of Category I Quality Assurance Project Plans. USEPA/600/8-91/003, Risk Reduction Engineering Laboratory, Office of Research and Development, Cincinnati, Ohio, February 1991.
5. United States Environmental Protection Agency, (1999). EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations. EPA QA/R-5 Interim Final, November 1999.

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TABLES

TABLE 1.1

SOIL PARAMETER LIST WITH LABORATORY REPORTING LIMITS

1101 PROSPECT AVENUE

WESTBURY, NEW YORK

Analyte	CAS#	Laboratory Limits		Unit	Protection Action Levels (PALs)*
		Method Detection Limit (MDL)	Reporting Limit (RL)		
PFAAs by EPA 1633					
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	763051-92-9	0.17	0.8	ng/g	NS
1H,1H,2H,2H-Perfluorodecanesulfonic Acid (8:2FTS)	39108-34-4	0.39	0.8	ng/g	NS
1H,1H,2H,2H-Perfluorohexanesulfonic Acid (4:2FTS)	757124-72-4	0.081	0.8	ng/g	NS
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (6:2FTS)	27619-97-2	0.28	0.8	ng/g	NS
2,3,3,3-Tetrafluoro-2-[1,1,2,2,3,3,3-Heptafluoropropoxy]-Propanoic Acid (HFPO-DA)	13252-13-6	0.10	0.8	ng/g	NS
2H,2H,3H,3H-Perfluorooctanoic Acid (5:3FTCA)	914637-49-3	0.50	5	ng/g	NS
3-Perfluoroheptyl Propanoic Acid (7:3FTCA)	812-70-4	1.76	5	ng/g	NS
3-Perfluoropropyl Propanoic Acid (3:3FTCA)	356-02-5	0.14	1	ng/g	NS
4,8-Dioxa-3h-Perfluorononanoic Acid (ADONA)	919005-14-4	0.15	0.8	ng/g	NS
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	756426-58-1	0.20	0.8	ng/g	NS
N-Ethyl Perfluorooctane Sulfonamide (NEtFOSA)	4151-50-2	0.11	0.2	ng/g	NS
N-Ethyl Perfluorooctanesulfonamido Ethanol (NEtFOSE)	1691-99-2	0.51	2	ng/g	NS
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	2991-50-6	0.082	0.2	ng/g	NS
N-Methyl Perfluorooctane Sulfonamide (NMeFOSA)	31506-32-8	0.10	0.2	ng/g	NS
N-Methyl Perfluorooctanesulfonamido Ethanol (NMeFOSE)	24448-09-7	0.25	2	ng/g	NS
N-Methyl Perfluorooctanesulfonamidoacetic Acid (NMeFOSAA)	2355-31-9	0.10	0.2	ng/g	NS
Nonafluoro-3,6-Dioxaheptanoic Acid (NFDHA)	151772-58-6	0.10	0.4	ng/g	NS
Perfluoro(2-Ethoxyethane)Sulfonic Acid (PFEESA)	113507-82-7	0.083	0.4	ng/g	NS
Perfluoro-3-Methoxypropanoic Acid (PFMPA)	377-73-1	0.041	0.4	ng/g	NS
Perfluoro-4-Methoxybutanoic Acid (PFMBA)	863090-89-5	0.031	0.4	ng/g	NS
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	0.043	0.2	ng/g	NS
Perfluorobutanoic Acid (PFBA)	375-22-4	0.050	0.8	ng/g	NS
Perfluorodecanesulfonic Acid (PFDS)	335-77-3	0.032	0.2	ng/g	NS
Perfluorodecanoic Acid (PFDA)	335-76-2	0.075	0.2	ng/g	NS
Perfluorododecane Sulfonic Acid (PFDoDS)	79780-39-5	0.038	0.2	ng/g	NS
Perfluorododecanoic Acid (PFDoA)	307-55-1	0.041	0.2	ng/g	NS
Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	0.037	0.2	ng/g	NS
Perfluoroheptanoic Acid (PFHpA)	375-85-9	0.023	0.2	ng/g	NS
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	0.059	0.2	ng/g	NS
Perfluorohexanoic Acid (PFHxA)	307-24-4	0.046	0.2	ng/g	NS
Perfluorononanesulfonic Acid (PFNS)	68259-12-1	0.042	0.2	ng/g	NS
Perfluorononanoic Acid (PFNA)	375-95-1	0.078	0.2	ng/g	NS
Perfluorooctanesulfonamide (FOSA)	754-91-6	0.043	0.2	ng/g	NS
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	0.079	0.2	ng/g	1
Perfluorooctanoic Acid (PFOA)	335-67-1	0.052	0.2	ng/g	0.8
Perfluoropentanesulfonic Acid (PFPeS)	2706-91-4	0.023	0.2	ng/g	NS
Perfluoropentanoic Acid (PFPeA)	2706-90-3	0.056	0.4	ng/g	NS
Perfluorotetradecanoic Acid (PFTA)	376-06-7	0.11	0.2	ng/g	NS
Perfluorotridecanoic Acid (PFTrDA)	72629-94-8	0.053	0.2	ng/g	NS
Perfluoroundecanoic Acid (PFUnA)	2058-94-8	0.051	0.2	ng/g	NS

Notes:

NS=Not specified

* Protection of Groundwater values

TABLE 1.2
GROUNDWATER PARAMETER LIST WITH LABORATORY REPORTING LIMITS
1101 PROSPECT AVENUE
WESTBURY, NEW YORK

Analyte	CAS#	Laboratory Limits		Unit	Protection Action Levels (PALs)
		Method Detection Limit (MDL)	Reporting Limit (RL)		
PFAAs by EPA 1633					
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1H,1H,2H,2H-Perfluorodecanesulfonic Acid (8:2FTS)	39108-34-4	2.49	6.4	ng/l	NS
1H,1H,2H,2H-Perfluorohexanesulfonic Acid (4:2FTS)	757124-72-4	1.67	6.4	ng/l	NS
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (6:2FTS)	27619-97-2	2.16	6.4	ng/l	NS
2,3,3,3-Tetrafluoro-2-[1,1,2,2,3,3,3-Heptafluoropropoxy]-Propanoic Acid (HFPO-DA)	13252-13-6	0.90	6.4	ng/l	NS
2H,2H,3H,3H-Perfluorooctanoic Acid (5:3FTCA)	914637-49-3	9.36	40	ng/l	NS
3-Perfluoroheptyl Propanoic Acid (7:3FTCA)	812-70-4	6.31	40	ng/l	NS
3-Perfluoropropyl Propanoic Acid (3:3FTCA)	356-02-5	2.64	8.0	ng/l	NS
4,8-Dioxa-3h-Perfluorononanoic Acid (ADONA)	919005-14-4	1.01	6.4	ng/l	NS
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	756426-58-1	1.32	6.4	ng/l	NS
N-Ethyl Perfluorooctane Sulfonamide (NEtFOSA)	4151-50-2	0.74	1.6	ng/l	NS
N-Ethyl Perfluorooctanesulfonamido Ethanol (NEtFOSE)	1691-99-2	1.96	16	ng/l	NS
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	2991-50-6	0.86	1.6	ng/l	NS
N-Methyl Perfluorooctane Sulfonamide (NMeFOSA)	31506-32-8	0.70	1.6	ng/l	NS
N-Methyl Perfluorooctanesulfonamido Ethanol (NMeFOSE)	24448-09-7	3.76	16	ng/l	NS
N-Methyl Perfluorooctanesulfonamidoacetic Acid (NMeFOSAA)	2355-31-9	0.87	1.6	ng/l	NS
Nonafluoro-3,6-Dioxaheptanoic Acid (NFDHA)	151772-58-6	1.89	3.2	ng/l	NS
Perfluoro(2-Ethoxyethane)Sulfonic Acid (PFEESA)	113507-82-7	0.35	3.2	ng/l	NS
Perfluoro-3-Methoxypropanoic Acid (PFMPA)	377-73-1	0.46	3.2	ng/l	NS
Perfluoro-4-Methoxybutanoic Acid (PFMBA)	863090-89-5	0.42	3.2	ng/l	NS
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	0.54	1.6	ng/l	NS
Perfluorobutanoic Acid (PFBA)	375-22-4	1.02	6.4	ng/l	NS
Perfluorodecanesulfonic Acid (PFDS)	335-77-3	0.37	1.6	ng/l	NS
Perfluorodecanoic Acid (PFDA)	335-76-2	0.65	1.6	ng/l	NS
Perfluorododecane Sulfonic Acid (PFDoDS)	79780-39-5	0.61	1.6	ng/l	NS
Perfluorododecanoic Acid (PFDoA)	307-55-1	0.74	1.6	ng/l	NS
Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	0.43	1.6	ng/l	NS
Perfluoroheptanoic Acid (PFHpA)	375-85-9	0.32	1.6	ng/l	NS
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	0.38	1.6	ng/l	NS
Perfluorohexanoic Acid (PFHxA)	307-24-4	0.47	1.6	ng/l	NS
Perfluorononanesulfonic Acid (PFNS)	68259-12-1	0.50	1.6	ng/l	NS
Perfluorononanoic Acid (PFNA)	375-95-1	0.50	1.6	ng/l	NS
Perfluorooctanesulfonamide (FOSA)	754-91-6	0.43	1.6	ng/l	NS
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	0.73	1.6	ng/l	2.7
Perfluorooctanoic Acid (PFOA)	335-67-1	0.70	1.6	ng/l	6.7
Perfluoropentanesulfonic Acid (PFPeS)	2706-91-4	0.28	1.6	ng/l	NS
Perfluoropentanoic Acid (PFPeA)	2706-90-3	0.86	3.2	ng/l	NS
Perfluorotetradecanoic Acid (PFTA)	376-06-7	0.42	1.6	ng/l	NS
Perfluorotridecanoic Acid (PFTrDA)	72629-94-8	0.60	1.60	ng/l	NS
Perfluoroundecanoic Acid (PFUnA)	2058-94-8	0.70	1.60	ng/l	NS

Notes:
NS=No standard or guidance value available

TABLE 1.3
AIR AND SOIL VAPOR PARAMETER LIST WITH LABORATORY REPORTING LIMITS
1101 PROSPECT AVENUE
WESTBURY, NEW YORK

Analyte	CAS#	Laboratory Limits		Protection Action Levels (PALs)* (µg/m3)
		Reporting Limit (RL) (µg/m3)	Reporting Limit (RL) (ppbv)	
VOCs by TO-15 for Indoor and Outdoor Air				
1,1,2,2-Tetrachloroethane	79-34-5	1.37	0.2	NS
1,1,2-Trichloroethane	79-00-5	1.09	0.2	NS
1,1-Dichloroethane	75-34-3	0.809	0.2	NS
1,2,4-Trichlorobenzene	120-82-1	1.48	0.2	NS
1,2,4-Trimethylbenzene	95-63-6	0.983	0.2	NS
1,2-Dibromoethane	106-93-4	1.54	0.2	NS
1,2-Dichlorobenzene	95-50-1	1.2	0.2	NS
1,2-Dichloroethane	107-06-2	0.809	0.2	NS
1,2-Dichloropropane	78-87-5	0.924	0.2	NS
1,3,5-Trimethylbenzene	108-67-8	0.983	0.2	NS
1,3-Butadiene	106-99-0	0.442	0.2	NS
1,3-Dichlorobenzene	541-73-1	1.2	0.2	NS
1,4-Dichlorobenzene	106-46-7	1.2	0.2	NS
1,4-Dioxane	123-91-1	0.721	0.2	NS
2,2,4-Trimethylpentane	540-84-1	0.934	0.2	NS
2-Butanone	78-93-3	1.47	0.5	NS
2-Hexanone	591-78-6	0.82	0.2	NS
3-Chloropropene	107-05-1	0.626	0.2	NS
4-Ethyltoluene	622-96-8	0.983	0.2	NS
4-Methyl-2-pentanone	108-10-1	2.05	0.5	NS
Acetone	67-64-1	2.38	1	NS
Benzene	71-43-2	0.639	0.2	NS
Benzyl chloride	100-44-7	1.04	0.2	NS
Bromodichloromethane	75-27-4	1.34	0.2	NS
Bromoform	75-25-2	2.07	0.2	NS
Bromomethane	74-83-9	0.777	0.2	NS
Carbon disulfide	75-15-0	0.623	0.2	NS
Chlorobenzene	108-90-7	0.921	0.2	NS
Chloroethane	75-00-3	0.528	0.2	NS
Chloroform	67-66-3	0.977	0.2	NS
Chloromethane	74-87-3	0.413	0.2	NS
cis-1,3-Dichloropropene	10061-01-5	0.908	0.2	NS
Cyclohexane	110-82-7	0.688	0.2	NS
Dibromochloromethane	124-48-1	1.7	0.2	NS
Dichlorodifluoromethane	75-71-8	0.989	0.2	NS
Ethanol	64-17-5	9.42	5	NS
Ethyl Acetate	141-78-6	1.8	0.5	NS
Ethylbenzene	100-41-4	0.869	0.2	NS
Freon-113	76-13-1	1.53	0.2	NS
Freon-114	76-14-2	1.4	0.2	NS
Heptane	142-82-5	0.82	0.2	NS
Hexachlorobutadiene	87-68-3	2.13	0.2	NS
Isopropanol	67-63-0	1.23	0.5	NS
Methyl tert butyl ether	1634-04-4	0.721	0.2	NS
Methylene chloride	75-0902	1.74	0.5	10
n-Hexane	110-54-3	0.705	0.2	NS
o-Xylene	95-47-6	0.869	0.2	NS
p/m-Xylene	108-38-3 & 106-42-3	1.74	0.4	NS
Styrene	100-42-5	0.852	0.2	NS
Tertiary butyl Alcohol	75-65-0	1.52	0.5	NS
Tetrahydrofuran	109-99-9	1.47	0.5	NS
Toluene	108-88-3	0.754	0.2	NS
trans-1,2-Dichloroethene	156-60-5	0.793	0.2	NS
trans-1,3-Dichloropropene	10061-02-6	0.908	0.2	NS
Trichlorofluoromethane	75-69-4	1.12	0.2	NS
Vinyl bromide	593-60-2	0.874	0.2	NS
VOCs by TO-15-SIM for Indoor and Outdoor Air				

TABLE 1.3
AIR AND SOIL VAPOR PARAMETER LIST WITH LABORATORY REPORTING LIMITS
1101 PROSPECT AVENUE
WESTBURY, NEW YORK

Analyte	CAS#	Laboratory Limits		Protection Action Levels (PALs)* (µg/m3)
		Reporting Limit (RL) (µg/m3)	Reporting Limit (RL) (ppbv)	
1,1,1-Trichloroethane	71-55-6	0.109	0.02	10
1,1-Dichloroethene	75-35-4	0.079	0.02	1
Carbon tetrachloride	56-23-5	0.126	0.02	1
cis-1,2-Dichloroethene	156-59-2	0.079	0.02	1
Tetrachloroethene	127-18-4	0.136	0.02	10
Trichloroethene	79-01-6	0.107	0.02	1
Vinyl chloride	75-01-4	0.051	0.02	0.2
VOCs by TO-15 for Soil Vapor				
1,1,1-Trichloroethane	71-55-6	1.09	0.2	1000
1,1,2,2-Tetrachloroethane	79-34-5	1.37	0.2	NS
1,1,2-Trichloroethane	79-00-5	1.09	0.2	NS
1,1-Dichloroethane	75-34-3	0.809	0.2	NS
1,1-Dichloroethene	75-35-4	0.793	0.2	60
1,2,4-Trichlorobenzene	120-82-1	1.48	0.2	NS
1,2,4-Trimethylbenzene	95-63-6	0.983	0.2	NS
1,2-Dibromoethane	106-93-4	1.54	0.2	NS
1,2-Dichlorobenzene	95-50-1	1.2	0.2	NS
1,2-Dichloroethane	107-06-2	0.809	0.2	NS
1,2-Dichloropropane	78-87-5	0.924	0.2	NS
1,3,5-Trimethylbenzene	108-67-8	0.983	0.2	NS
1,3-Butadiene	106-99-0	0.442	0.2	NS
1,3-Dichlorobenzene	541-73-1	1.2	0.2	NS
1,4-Dichlorobenzene	106-46-7	1.2	0.2	NS
1,4-Dioxane	123-91-1	0.721	0.2	NS
2,2,4-Trimethylpentane	540-84-1	0.934	0.2	NS
2-Butanone	78-93-3	1.47	0.5	NS
2-Hexanone	591-78-6	0.82	0.2	NS
3-Chloropropene	107-05-1	0.626	0.2	NS
4-Ethyltoluene	622-96-8	0.983	0.2	NS
4-Methyl-2-pentanone	108-10-1	2.05	0.5	NS
Acetone	67-64-1	2.38	1	NS
Benzene	71-43-2	0.639	0.2	NS
Benzyl chloride	100-44-7	1.04	0.2	NS
Bromodichloromethane	75-27-4	1.34	0.2	NS
Bromoform	75-25-2	2.07	0.2	NS
Bromomethane	74-83-9	0.777	0.2	NS
Carbon disulfide	75-15-0	0.623	0.2	NS
Carbon tetrachloride	56-23-5	1.26	0.2	60
Chlorobenzene	108-90-7	0.921	0.2	NS
Chloroethane	75-00-3	0.528	0.2	NS
Chloroform	67-66-3	0.977	0.2	NS
Chloromethane	74-87-3	0.413	0.2	NS
cis-1,2-Dichloroethene	156-59-2	0.793	0.2	60
cis-1,3-Dichloropropene	10061-01-5	0.908	0.2	NS
Cyclohexane	110-82-7	0.688	0.2	NS
Dibromochloromethane	124-48-1	1.7	0.2	NS
Dichlorodifluoromethane	75-71-8	0.989	0.2	NS
Ethanol	64-17-5	9.42	5	NS
Ethyl Acetate	141-78-6	1.8	0.5	NS
Ethylbenzene	100-41-4	0.869	0.2	NS
Freon-113	76-13-1	1.53	0.2	NS
Freon-114	76-14-2	1.4	0.2	NS
Heptane	142-82-5	0.82	0.2	NS
Hexachlorobutadiene	87-68-3	2.13	0.2	NS
Isopropanol	67-63-0	1.23	0.5	NS
Methyl tert butyl ether	1634-04-4	0.721	0.2	NS
Methylene chloride	75-0902	1.74	0.5	1000
n-Hexane	110-54-3	0.705	0.2	NS

TABLE 1.3

AIR AND SOIL VAPOR PARAMETER LIST WITH LABORATORY REPORTING LIMITS

1101 PROSPECT AVENUE
WESTBURY, NEW YORK

Analyte	CAS#	Laboratory Limits		Protection Action Levels (PALs)* (µg/m3)
		Reporting Limit (RL) (µg/m3)	Reporting Limit (RL) (ppbv)	
o-Xylene	95-47-6	0.869	0.2	NS
p/m-Xylene	108-38-3 & 106-42-3	1.74	0.4	NS
Styrene	100-42-5	0.852	0.2	NS
Tertiary butyl Alcohol	75-65-0	1.52	0.5	NS
Tetrachloroethene	127-18-4	1.36	0.2	1000
Tetrahydrofuran	109-99-9	1.47	0.5	NS
Toluene	108-88-3	0.754	0.2	NS
trans-1,2-Dichloroethene	156-60-5	0.793	0.2	NS
trans-1,3-Dichloropropene	10061-02-6	0.908	0.2	NS
Trichloroethene	79-01-6	1.07	0.2	60
Trichlorofluoromethane	75-69-4	1.12	0.2	NS
Vinyl bromide	593-60-2	0.874	0.2	NS
Vinyl chloride	75-01-4	0.511	0.2	60

Notes:

NS=No standard or guidance value available

*New York State Department of Health (NYSDOH) Updates to Soil Vapor / Indoor Air Decision Matrices (notice May 2017)

TABLE 2
LABORATORY AND FIELD QUALITY CONTROL OBJECTIVES
1101 PROSPECT AVENUE
WESTBURY, NEW YORK

Quality Control Sample/Process Assessed	Measurement Quality Indicator	Frequency	Acceptance Criteria	Corrective Action
LABORATORY QA/QC				
Method Blank	Accuracy	1 per analytical batch of 20 samples	No target analyte above one-tenth the amount in any sample	Reanalyze blank and samples. Qualify as necessary.
LCS or LCS/LCSD	Accuracy and Precision	1 per analytical batch of 20 samples	Method Specific Criteria per lab SOP or NYSDEC's Part 375 Remedial Programs	Reprepare and reanalyze blank and samples. Qualify as necessary.
MS/MSD (PFAS only)	Accuracy and Precision	1 per analytical batch of 20 samples	Method Specific Criteria per lab SOP or NYSDEC's Part 375 Remedial Programs	Qualify as necessary.
Surrogate (TO-15 only)	Accuracy	Each sample	Method Specific Criteria per lab SOP	Re-extract and reanalyze. Qualify as necessary.
Extracted Internal Standards (PFAS only)	Accuracy	Each sample	Method Specific Criteria per lab SOP or NYSDEC's Part 375 Remedial Programs	Re-extract and reanalyze. Qualify as necessary.
FIELD QA/QC				
Field Blank	Accuracy	1 per event per sampler	No target analyte above one-tenth the amount in any sample	Qualify as necessary
Equipment Rinse Blank	Accuracy	1 per event per sampler	No target analyte above one-tenth the amount in any sample	Qualify as necessary
Field Duplicate	Precision	1 per analytical batch of 20 samples	RPD <30% for water and soil for analytes >2 times the RL RPD <35% for air for analytes >5 times the RL	Qualify as necessary.

TABLE 3
SAMPLE CONTAINERS, PRESERVATIVES AND HOLDING TIMES

1101 PROSPECT AVENUE
WESTBURY, NEW YORK

Parameter	Method	Container/ Sample Preservation	Holding Time
Water Sample Containers, Preservatives and Holding Times			
PFAS	1633	3 - Plastic 500ml unpreserved	28 days from sample collection to extraction, then 28 days from extraction to analysis
Soil Sample Containers, Preservatives and Holding Times			
PFAS	1633	1 - Plastic 8oz unpreserved	28 days from sample collection to extraction, then 40 days from extraction to analysis
Air and Soil Vapor Sample Containers, Preservatives and Holding Times			
VOCs (Indoor and Outdoor Air)	TO-15 and TO-15 SIM	2.7-L canister	30 days
VOCs (Soil Vapor)	TO-15	6-L canister	30 days

APPENDIX A
Laboratory Analytical Standard Operating Procedure

Method 1633 Analysis of Per- and Polyfluoroalkyl Substances (PFAS) in Aqueous, Solid, Biosolids and Tissue Samples by LC-MS/MS

References: Method 1633 - Analysis of Per- and Polyfluoroalkyl Substances (PFAS) in Aqueous, Solid, Biosolids, and Tissue Samples by LC-MS/MS (2nd Draft - June 2022)

DOD QSM (US Department of Defense Quality Systems Manual for Environmental Laboratories, version 5.4, 20221)

1. Scope and Application

Matrices: Drinking water, Non-potable Water, Tissues, Biosolids and Soil Matrices

Definitions: Refer to Alpha Analytical Quality Manual.

1.1 Method 1633 is for use in the Clean Water Act (CWA) for the determination of the per- and polyfluoroalkyl substances (PFAS) in Table 1 in aqueous, solid (soil, biosolids, sediment) and tissue samples by liquid chromatography/mass spectrometry (LC-MS/MS).

1.2 The method calibrates and quantifies PFAS analytes using isotopically labeled standards. Where linear and branched isomers are present in the sample and either qualitative or quantitative standards containing branched and linear isomers are commercially available, the PFAS analyte is reported as a single analyte consisting of the sum of the linear and branched isomer concentrations

1.3 This is a liquid chromatography/tandem mass spectrometry (LC/MS/MS) method for the determination of selected perfluorinated alkyl substances (PFAS) in Non-Drinking Water, tissue soil and biosolid Matrices. Accuracy and precision data have been generated for the compounds listed in Table 1.

1.4 The data report packages present the documentation of any method modification related to the samples tested. Depending upon the nature of the modification and the extent of intended use, the laboratory may be required to demonstrate that the modifications will produce equivalent results for the matrix. Approval of all method modifications is by one or more of the following laboratory personnel before performing the modification: Area Supervisor, Department Supervisor, Laboratory Director, or Quality Assurance Officer.

1.5 This method is restricted to use by or under the supervision of analysts experienced in the operation of the LC/MS/MS and in the interpretation of LC/MS/MS data. Each analyst must demonstrate the ability to generate acceptable results with this method by performing an initial demonstration of capability.

2. Summary of Method

2.1 Environmental samples are prepared and extracted using method-specific procedures. Sample extracts are subjected to cleanup procedures designed to remove interferences. Analyses of the sample extracts are conducted by LC-MS/MS in the multiple reaction monitoring (MRM) mode. Sample concentrations are determined by isotope dilution or extracted internal standard quantification using isotopically labeled compounds added to the samples before extraction.

2.2 Aqueous samples are spiked with isotopically labeled standards, extracted using solid-phase extraction (SPE) cartridges and undergo cleanup using carbon before analysis.

2.3 Solid samples are spiked with isotopically labeled standards, extracted into basic methanol, and cleaned up by carbon and SPE cartridges before analysis

2.4 Tissue samples are spiked with isotopically labeled standards, extracted in potassium hydroxide and acetonitrile followed by basic methanol, and cleaned up by carbon and SPE cartridges before analysis.

2.5 A sample extract is injected into an LC equipped with a C18 column that is interfaced to an MS/MS). The analytes are separated and identified by comparing the acquired mass spectra and retention times to reference spectra and retention times for calibration standards acquired under identical LC/MS/MS conditions. The concentration of each analyte is determined by using the isotope dilution technique. Extracted Internal Standards (EIS) analytes are used to monitor the extraction efficiency of the method analytes.

2.6 Method Modifications from Reference

N/A

3. Reporting Limits

The reporting limit for PFAS's are listed in Table 8.

4. Interferences

4.1 PFAS standards, extracts and samples should not come in contact with any glass containers or pipettes as these analytes can potentially adsorb to glass surfaces. PFAS analyte and EIS standards commercially purchased in glass ampoules are acceptable; however, all subsequent transfers or dilutions performed by the analyst must be prepared and stored in polypropylene containers.

4.2 Method interferences may be caused by contaminants in solvents, reagents (including reagent water), sample bottles and caps, and other sample processing hardware that lead to discrete artifacts and/or elevated baselines in the chromatograms. The method analytes in this method can also be found in many common laboratory supplies and equipment, such as PTFE (polytetrafluoroethylene) products, LC solvent lines, methanol, aluminum foil, SPE sample transfer lines, etc. All items such as these must be routinely demonstrated to be free from interferences (less than 1/2 the RL for each method analyte) under the conditions of the analysis by analyzing laboratory reagent blanks as described in Section 9.1. Subtracting blank values from sample results is not permitted.

4.3 Matrix interferences may be caused by contaminants that are co-extracted from the sample. The extent of matrix interferences will vary considerably from source to source, depending upon the nature of the water. Humic and/or fulvic material can be co-extracted during SPE and high levels can cause enhancement and/or suppression in the electrospray ionization source or low recoveries on the SPE sorbent. Total organic carbon (TOC) is a good indicator of humic content of the sample.

4.4 SPE cartridges can be a source of interferences. The analysis of field and laboratory reagent blanks can provide important information regarding the presence or absence of such interferences. Brands and lots of SPE devices should be tested to ensure that contamination does not preclude analyte identification and quantitation.

5. Health and Safety

5.1 The toxicity or carcinogenicity of each reagent and standard used in this method is not fully established; however, each chemical compound should be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be reduced to the lowest possible level by whatever means available. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Additional references to laboratory safety are available in the Chemical Hygiene Plan.

5.2 All personnel handling environmental samples known to contain or to have been in contact with municipal waste must follow safety practices for handling known disease causative agents.

5.3 PFOA has been described as “likely to be carcinogenic to humans.” Pure standard materials and stock standard solutions of these method analytes should be handled with suitable protection to skin and eyes, and care should be taken not to breathe the vapors or ingest the materials.

6. Sample Collection, Preservation, Shipping and Handling

6.1 Sample Collection for Aqueous Samples

6.1.1 Samples must be collected in two (2) 500-mL or 250-mL high density polyethylene (HDPE) container with an unlined plastic screw cap. All sample containers must have linerless HDPE or polypropylene caps.

6.1.2 The sample handler must wash their hands before sampling and wear nitrile gloves while filling and sealing the sample bottles. PFAS contamination during sampling can occur from a number of common sources, such as food packaging and certain foods and beverages. Proper hand washing and wearing nitrile gloves will aid in minimizing this type of accidental contamination of the samples.

6.1.3 Open the tap and allow the system to flush until the water temperature has stabilized (approximately 3 to 5 min). Collect samples from the flowing system.

6.1.4 Fill sample bottles. Samples do not need to be collected headspace free.

6.1.5 After collecting the sample and cap the bottle. Keep the sample sealed from time of collection until extraction.

6.1.6 Maintain all aqueous samples protected from light at 0 - 6 ºC from the time of collection until shipped to the laboratory. Samples must be shipped as soon as practical with sufficient ice to maintain the sample temperature below 6 ºC during transport and be received by the laboratory within 48 hours of collection. The laboratory must confirm that the sample temperature is 0 - 6 ºC upon receipt. Once received by the laboratory, the samples must be stored at ≤ -20 ºC until sample preparation.

6.2 Sample Collection for Soil and Sediment samples.

6.2.1 Grab samples are collected in polypropylene containers. Sample containers and contact surfaces containing PTFE shall be avoided. Samples should fill no more than ¾ full.

6.2.2 Maintain solid samples protected from light (in HDPE containers) at 0 - 6 ºC from the time of collection until receipt at the laboratory. The laboratory must confirm that the sample temperature is 0 - 6 ºC upon receipt. Once received by the laboratory, the samples must be stored at ≤ -20 ºC until sample preparation.

6.3 Sample Collection for fish and other tissue samples

6.3.1 Once received by the laboratory, the samples must be maintained protected from light at ≤ -20 ºC until prepared. Store unused samples in HDPE containers or wrapped in aluminum foil at ≤ -20 ºC.

6.3.2 The nature of the tissues of interest may vary by project. Field sampling plans and protocols should explicitly state the samples to be collected and if any processing will be conducted in the field (e.g., filleting of whole fish or removal of organs). All field procedures must involve materials and equipment that have been shown to be free of PFAS.

6.4 Sample Preservation

Not applicable.

6.5 Sample Shipping

Samples must be chilled during shipment and must not exceed 0 – 6 °C during the first 48 hours after collection. Sample temperature must be confirmed to be at or below 0 – 6 °C when the samples are received at the laboratory. Samples stored in the lab must be held at or below 6 °C until extraction but should not be frozen.

NOTE: Samples that are significantly above 0 – 6 ° C, at the time of collection, may need to be iced or refrigerated for a period of time, in order to chill them prior to shipping. This will allow them to be shipped with sufficient ice to meet the above requirements.

6.6 Sample Handling

6.6.1 Aqueous samples (including leachates) should be analyzed as soon as possible; however, samples may be held in the laboratory for up to 90 days from collection, when stored at ≤ -20 ºC and protected from the light. When stored at 0 - 6 ºC and protected from the light, aqueous samples may be held for up to 28 days, with the caveat that issues were observed with certain perfluorooctane sulfonamide ethanols and perfluorooctane sulfonamidoacetic acids after 7 days. These issues are more likely to elevate the observed concentrations of other PFAS compounds via the transformation of these precursors if they are present in the sample.

6.6.2 Solid samples (soils and sediments) and tissue samples may be held for up to 90 days, if stored by the laboratory in the dark at either 0 - 6 ºC or ≤ -20 ºC, with the caveat that samples may need to be extracted as soon as possible if NFDHA is an important analyte.

6.6.3 Biosolids samples may be held for up to 90 days, if stored by the laboratory in the dark at 0 - 6 ºC or at -20 ºC. Because microbiological activity in biosolids samples at 0 - 6 ºC may lead to production of gases which may cause the sample to be expelled from the container when it is opened, as well as producing noxious odors, EPA recommends that samples be frozen if they need to be stored for more than a few days before extraction. Store sample extracts in the dark at less than 0 - 4 ºC until analyzed. If stored in the dark at less than 0 - 4 ºC, sample extracts may be stored for up to 90 days, with the caveat that issues were observed for some ether sulfonates after 28 days. These issues may elevate the observed concentrations of the ether sulfonates in the extract over time. Samples may need to be extracted as soon as possible if NFDHA is an important analyte.

7. Equipment and Supplies

7.1 SAMPLE CONTAINERS – 500-mL or 250-mL high density polyethylene (HDPE) bottles fitted with unlined screw caps. Sample bottles must be discarded after use.

7.2 SAMPLE JARS – 8-ounce wide mouth high density polyethylene (HDPE) bottles fitted with unlined screw caps. Sample bottles must be discarded after use.

7.3 POLYPROPYLENE BOTTLES – 4-mL narrow-mouth polypropylene bottles.

7.4 CENTRIFUGE TUBES – 50-mL conical polypropylene tubes with polypropylene screw caps for storing standard solutions and for collection of the extracts.

7.5 AUTOSAMPLER VIALS – Polypropylene 0.7-mL autosampler vials with polypropylene caps.

7.5.1 NOTE: Polypropylene vials and caps are necessary to prevent contamination of the sample from PTFE coated septa. However, polypropylene caps do not reseal, so evaporation occurs after injection. Thus, multiple injections from the same vial are not possible.

7.6 POLYPROPYLENE GRADUATED CYLINDERS – Suggested sizes include 25, 50, 100 and 1000-mL cylinders.

7.7 Auto Pipets – Suggested sizes include 5, 10, 25, 50, 100, 250, 500, 1000, 5000 and 10,000-µls.

7.8 PLASTIC PIPETS – Polypropylene or polyethylene disposable pipets.

7.9 Silanized glass wool (Sigma-Aldrich, Cat # 20411 or equivalent) – store in a clean glass jar and rinsed with methanol (2 times) prior to use.

7.10 Disposable syringe filter, 25-mm, 0.2-µm Nylon membrane, PALL/Acrodisc or equivalent

7.11 Variable volume pipettes with disposable HDPE or polypropylene tips (10 µL to 5 mL) used for preparation of calibration standards and spiked samples.

7.12 ANALYTICAL BALANCE – Capable of weighing to the nearest 0.0001 g.

7.13 ANALYTICAL BALANCE – Capable of weighing to the nearest 0.1 g.

7.14 SOLID PHASE EXTRACTION (SPE) APPARATUS FOR USING CARTRIDGES

7.14.1 SPE CARTRIDGES – (Waters Oasis WAX 150 mg, Cat # 186002493 or equivalent). The SPE sorbent must have a pKa above 8 so that it remains positively charged during the extraction.

7.14.1.1 Note: SPE cartridges with different bed volume (e.g., 500 mg) may be used; however, the laboratory must demonstrate that the bed volume does not negatively affect analyte absorption and elution, by performing the initial demonstration of capability analyses described in Section.

7.14.2 VACUUM EXTRACTION MANIFOLD – A manual vacuum manifold with large volume sampler for cartridge extractions, or an automatic/robotic sample preparation system designed for use with SPE cartridges, may be used if all QC requirements discussed in Section 9 are met. Extraction and/or elution steps may not be changed or omitted to accommodate the use of an automated system. Care must be taken with automated SPE systems to ensure the PTFE commonly used in these systems does not contribute to unacceptable analyte concentrations in the MB.

7.14.3 SAMPLE DELIVERY SYSTEM – Use of a polypropylene transfer tube system, which transfers the sample directly from the sample container to the SPE cartridge, is recommended, but not mandatory. Standard extraction manifolds come equipped with PTFE transfer tube systems. These can be replaced with 1/8” O.D. x 1/16” I.D. polypropylene or polyethylene tubing cut to an appropriate length to ensure no sample contamination from the sample transfer lines. Other types of non-PTFE tubing may be used provided it meets the MB and LCS QC requirements.

7.15 EXTRACT CONCENTRATION SYSTEM – Extracts are concentrated by evaporation with nitrogen using a water bath set no higher than 55 °C.

7.16 LABORATORY OR ASPIRATOR VACUUM SYSTEM – Sufficient capacity to maintain a vacuum of approximately 10 to 15 inches of mercury for extraction cartridges.

7.17 LIQUID CHROMATOGRAPHY (LC)/TANDEM MASS SPECTROMETER (MS/MS) WITH DATA SYSTEM

7.17.1 LC SYSTEM – Instrument capable of reproducibly injecting up to 10-µL aliquots and performing binary linear gradients at a constant flow rate near the flow rate used for development of this method (0.4 mL/min). The LC must be capable of pumping the water/methanol mobile phase without the use of a degasser which pulls vacuum on the mobile phase bottle (other types of degassers are acceptable). Degassers which pull vacuum on the mobile phase bottle will volatilize the ammonium acetate mobile phase causing the analyte peaks to shift to earlier retention times over the course of the analysis batch. The usage of a column heater is optional.

7.17.2 LC/TANDEM MASS SPECTROMETER – The LC/MS/MS must be capable of negative ion electrospray ionization (ESI) near the suggested LC flow rate of 0.4 mL/min. The system must be capable of performing MS/MS to produce unique product ions for the method analytes within specified retention time segments. A minimum of 10 scans across the chromatographic peak is required to ensure adequate precision.

7.17.3 DATA SYSTEM – An interfaced data system is required to acquire, store, reduce, and output mass spectral data. The computer software should have the capability of processing stored LC/MS/MS data by recognizing an LC peak within any given retention time window. The software must allow integration of the ion abundance of any specific ion within specified time or scan number limits. The software must be able to calculate relative response factors, construct linear regressions or quadratic calibration curves, and calculate analyte concentrations.

7.17.4 INSTRUMENT COLUMNS

7.17.4.1 ANALYTICAL: C18 column, 1.7 µm, 50 x 2.1 mm (Waters Acquity UPLC® BEH or equivalent)

7.17.4.2 OPTIONAL GUARD COLUMN: (Phenomenex Kinetex® Evo C18 or equivalent)

8. Reagents and Standards

8.1 GASES, REAGENTS, AND SOLVENTS – Reagent grade or better chemicals must be used.

8.1.1 REAGENT WATER – Purified water which does not contain any measurable quantities of any method analytes or interfering compounds greater than 1/2 the RL for each method analyte of interest. Prior to daily use, at least 3 L of reagent water should be flushed from the purification system to rinse out any build-up of analytes in the system's tubing.

8.1.2 METHANOL (CH_3OH, CAS#: 67-56-1) – High purity, demonstrated to be free of analytes and interferences.

8.1.3 AMMONIUM ACETATE ($NH_4C_2H_3O_2$, CAS#: 631-61-8) – High purity, demonstrated to be free of analytes and interferences.

8.1.4 ACETIC ACID (H_3CCOOH, CAS#: 64-19-7) - High purity, demonstrated to be free of analytes and interferences.

8.1.5 1M AMMONIUM ACETATE/REAGENT WATER – High purity, demonstrated to be free of analytes and interferences.

8.1.6 2mM AMMONIUM ACETATE/METHANOL:WATER (5:95) – To prepare, mix 2 ml of 1M AMMONIUM ACETATE,1 ml ACETIC ACID and 50 ml METHANOL into I Liter of REAGENT WATER.

8.1.7 ACETONITRILE – UPLC grade or equivalent, store at room temperature

8.1.8 TOLUENE – HPLC grade or equivalent.

8.1.9 ACETONE – pesticide grade or equivalent

8.1.10 AMMONIUM ACETATE – (Caledon Ultra LC/MS grade or equivalent

8.1.11 AMMONIUM HYDROXIDE (NH_3, CAS#: 1336-21-6) – High purity, demonstrated to be free of analytes and interferences.

8.1.12 METHANOLIC AMMONIUM HYDROXIDE (0.3%) - add ammonium hydroxide (1 mL, 30%) to methanol (99 mL), store at room temperature, replace after 1 month

8.1.13 METHANOLIC AMMONIUM HYDROXIDE (1%) - add ammonium hydroxide (3.3 mL, 30%) to methanol (97 mL), store at room temperature, replace after 1 month

8.1.14 METHANOLIC AMMONIUM HYDROXIDE (2%) - add ammonium hydroxide (6.6 mL, 30%) to methanol (93.4 mL), store at room temperature, replace after 1 month

8.1.15 METHANOLIC POTASSIUM HYDROXIDE (0.05 M) – add 3.3 g of potassium hydroxide to 1 L of methanol, store at room temperature, replace after 3 months

8.1.16 METHANOL WITH 4% WATER, 1% AMMONIUM HYDROXIDE AND 0.625% ACETIC ACID - add ammonium hydroxide (3.3 mL, 30%), reagent water (1.7 mL) and acetic acid (0.625 mL) to methanol (92 mL), store at room temperature, replace after 1 month. This solution is used to prepare the instrument blank and calibration standards (Section 8.3.2).

8.1.17 FORMIC ACID – (greater than 96% purity or equivalent).

8.1.18 FORMIC ACID (aqueous, 0.1 M) - dissolve formic acid (4.6 g) in reagent water (1 L), store at room temperature, replace after 2 years

8.1.19 FORMIC ACID (aqueous, 0.3 M) - dissolve formic acid (13.8 g) in reagent water (1 L), store at room temperature, replace after 2 years

8.1.20 FORMIC ACID (aqueous, 5% v/v) - mix 5 mL formic acid with 95 mL reagent water, store at room temperature, replace after 2 years

8.1.21 FORMIC ACID (methanolic 1:1, 0.1 M formic acid/methanol) - mix equal volumes of methanol and 0.1 M formic acid, store at room temperature, replace after 2 years

8.1.22 FORMIC ACID (aqueous, 50% v/v) - mix 50 mL formic acid with 50 mL reagent water, store at room temperature, replace after 2 years

8.1.23 POTASSIUM HYDROXIDE – certified ACS or equivalent

8.1.24 CARBON - – EnviCarb® 1-M-USP or equivalent, verified by lot number before use, store at room temperature. Loose carbon allows for better adsorption of interferent organics. Note: The single-laboratory validation laboratory achieved better performance with loose carbon than carbon cartridges. Loose carbon will be used for the multi-laboratory validation to set statistically based method criteria.

8.1.25 NITROGEN – Used for the following purposes: Nitrogen aids in aerosol generation of the ESI liquid spray and is used as collision gas in some MS/MS instruments. The nitrogen used should meet or exceed instrument manufacturer's specifications. In addition, Nitrogen is used to concentrate sample extracts (Ultra High Purity or equivalent).

8.1.26 ARGON – Used as collision gas in some MS/MS instruments. Argon should meet or exceed instrument manufacturer's specifications. Nitrogen gas may be used as the collision gas provided sufficient sensitivity (product ion formation) is achieved.

8.2 REFERENCE MATRICES - Matrices in which PFAS and interfering compounds are not detected by this method. These matrices are to be used to prepare the batch QC samples.

8.2.1 Reagent water - purified water, Type I

8.2.2 Solid reference matrix Ottawa Sand or equivalent

8.2.3 Tissue Reference matrix – Cod loin or other animal tissue demonstrated to be PFAS free

8.3 STANDARD SOLUTIONS – When a compound purity is assayed to be 96% or greater, the weight can be used without correction to calculate the concentration of the stock standard. PFAS analyte and IS standards commercially purchased in glass ampoules are acceptable; however, all subsequent transfers or dilutions performed by the analyst must be prepared and stored in polypropylene containers and are stored at ≤4 °C. Standards for sample fortification generally should be prepared in the smallest volume that can be accurately measured to minimize the addition of excess organic solvent to aqueous samples.

8.3.1 Stock standards and diluted stock standards are stored at ≤4 °C. Prepare a spiking solution, containing the method analytes listed in Table 1, in methanol from prime stocks. The solution is used to prepare the calibration standards and to spike the known reference QC samples that are analyzed with every batch. Quantitative standards containing a mixture of branched and linear isomers must be used for method analytes if they are commercially available. Currently, these include PFOS, PFHxS, NEtFOSAA, and NMeFOSAA.

8.3.2 Calibration standard solutions – A series of calibration solutions containing the target analytes and the Labeled extracted internal standards (EIS) and non-extracted internal standards (NIS) is used to establish the initial calibration of the analytical instrument. Table 4 represents the concentrations of the native, EIS and NIS analytes of the calibration curve. Calibration standard solutions are made using the solution described in section 8.1.16.

8.3.3 ISOTOPE DILUTION EXTRACTED INTERNAL STANDARD (EIS) – Isotopically labelled analogs of the target analytes to be used for the quantification of target analytes. EIS stock standard solutions are purchased in glass ampoules and are stored in accordance with the manufacturer's recommendations. The EIS stock solution to be used for the fortification of samples and QC in accordance with the isotope dilution procedure. Table 2 represents the EIS concentrations and nominal sample amounts added to each field sample and QC element.

8.3.4 ISOTOPE DILUTION NON-EXTRACTED INTERNAL STANDARDS (NIS) – Isotopically labelled analogs to be added post extraction for the measurement of EIS extraction efficiency and is added to the final volume of all extractions. Table 3 represents the EIS concentrations and nominal sample amounts added to each field sample and QC element.

9. Quality Control

9.1 Method Blank

9.1.1 A Method Blank (MB) is required with each extraction batch to confirm that potential background contaminants are not interfering with the identification or quantitation of method analytes. An aliquot of reagent water that is treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents and standards. Prep and analyze a MB for every 20 samples. If the MB produces a peak within the retention time window of any analyte that would prevent the determination of that analyte, determine the source of contamination, and eliminate the interference before processing samples. Background contamination must be reduced to an acceptable level before proceeding. Background from method analytes or other contaminants that interfere with the measurement of method analytes must be below the RL. If the method analytes are detected in the MB at concentrations equal to or greater than this level, then all data for the problem analyte(s) must be considered invalid for all samples in the extraction batch.

9.2 Laboratory Control Sample (LCS)

9.2.1 Low Level LCS or OPR (Ongoing Precision Recovery) sample is required with each extraction batch. A LLCS or OPR samples is a method blank spiked with known quantities of analytes. The fortified concentration of the LCS is spiked at 2X the LOQ. Default limits of 70-130% of the true value may be used for analytes until sufficient replicates have been analyzed to generate proper control limits. Calculate the percent recovery (%*R*) for each analyte using the equation:

9.2.2 An LCS or OPR (Ongoing Precision Recovery) sample is required with each extraction batch. A LCS or OPR samples is a method blank spiked with known quantities of analytes. The fortified concentration of the LCS is spiked at the midpoint of the calibration curve. Default limits of 70-130% of the true value may be used for analytes until sufficient replicates have been analyzed to generate proper control limits. Calculate the percent recovery (%*R*) for each analyte using the equation:

$$\%R = \frac{A \times 100}{B}$$

Where:

A = measured concentration in the fortified sample
B =fortification concentration.

9.1.1 Where applicable, in the absence of additional sample volume required to perform matrix specific QC, LCSD's are to be extracted and analyzed. The concentration and analyte recovery criteria for the LCSD must be the same as the batch LCS The RSD's must fall within ≤30% of the true value for medium and high-level replicates, and ≤50% for low level replicates. Calculate the relative percent difference (RPD) for duplicate MSs (MS and MSD) using the equation:

$$\text{RPD} = \frac{|\text{LCS} - \text{LCSD}|}{(\text{LCS} + \text{LCSD}) / 2} \times 100$$

9.1.2 If the LCS and or LCSD results do not meet these criteria for method analytes, then all data for the problem analyte(s) must be considered invalid for all samples in the extraction batch.

9.3 Non-extracted Internal Standard Area (NIS)

Each time an initial calibration is performed, use the data from all the initial calibration standards used to meet the linearity test in Section 10.3.3.3 to calculate the mean area response for each of the NIS compounds, using the equation below.

$$\text{Mean Area}_{\text{NISi}} = \sum \text{AREA}_{\text{NISi}} / \text{n}$$

where:

AreaNISi = Area counts for the ith NIS, where i ranges from 1 to 7, for the seven NIS compounds listed in Table 1
n = The number of ICAL standards (the default value is n = 6). If a different number of standards is used for the ICAL, for example, to increase the calibration range or by dropping a point at either end of the range to meet the linearity criterion, change 6 to match the actual number of standards used)

Record the mean areas for each NIS for use in evaluating results for sample analyses. There is no acceptance criterion associated with the mean NIS area data.

9.4 Extracted Internal Standards (EIS)

9.4.1 The EIS standard is fortified into all samples, CCVs, MBs, LCSs, MSs, MSDs, FD, and FRB prior to extraction. It is also added to the CAL standards. The EIS is a means of assessing method performance from extraction to final chromatographic measurement. Calculate the recovery (%R) for the EIS using the following equation:

$$\%R = (A / B) \times 100$$

Where:

A = calculated EIS concentration for the QC or Field Sample
B = fortified concentration of the EIS.

9.4.2 Default limits of 50-150% may be used for analytes until sufficient replicates have been analyzed to generate proper control limits. A low or high percent recovery for a sample, blank, or CCV does not require discarding the analytical data but it may indicate a potential problem with future analytical data. When EIS recovery from a sample, blank, or CCV are outside control limits, check 1) calculations to locate possible errors, 2) standard solutions for degradation, 3) contamination, and 4) instrument performance. For CCVs and QC elements spiked with all target analytes, if the recovery of the corresponding target analytes meet the acceptance criteria for the EIS in question, the data can be used but all potential biases in the recovery of the EIS must be documented in the sample report. If the associated target analytes do not meet the acceptance criteria, the data must be reanalyzed.

9.5 Matrix Spike (MS/MSD)

9.5.1 Analysis of an MS is prepared one per preparation batch (if required).

9.5.2 Aliquots of field samples that have been fortified with a known concentration of target compounds, prior to sample preparation and extraction, and analyzed to measure the effect of matrix interferences. The use of MS/MSD samples is generally not required in isotope dilution methods because the labeled compounds added to every sample provide more performance data than spiking a single sample in each preparation batch. Aliquots of field samples

9.5.3 Analyte recoveries may exhibit matrix bias. For samples fortified at or above their native concentration, recoveries should range between 50-150%. If the accuracy of any analyte falls outside the designated range, and the laboratory performance for that analyte is shown to be in control in the LCS, the recovery is judged to be matrix biased. The result for that analyte in the unfortified sample is labeled suspect/matrix to inform the data user that the results are suspect due to matrix effects.

9.6 Laboratory Duplicate

9.6.1 FIELD DUPLICATE OR LABORATORY FORTIFIED SAMPLE MATRIX DUPLICATE (FD or MSD) – Within each extraction batch (not to exceed 20 Field Samples), a minimum of one FD or MSD must be analyzed. Duplicates check the precision associated with sample collection, preservation, storage, and laboratory procedures. If method analytes are not routinely observed in Field Samples, an MSD should be analyzed rather than an FD.

9.6.2 Calculate the relative percent difference (*RPD*) for duplicate measurements (*FD1* and *FD2*) using the equation:

$$\text{RPD} = \frac{|\text{FD1} - \text{FD2}|}{(\text{FD1} + \text{FD2}) / 2} \times 100$$

9.6.3 RPDs for FDs should be ≤30%. Greater variability may be observed when FDs have analyte concentrations that are within a factor of 2 of the RL. At these concentrations, FDs should have RPDs that are ≤50%. If the RPD of any analyte falls outside the designated range, and the laboratory performance for that analyte is shown to be in control in the CCV, the recovery is judged to be matrix biased. The result for that analyte in the unfortified sample is labeled suspect/matrix to inform the data user that the results are suspect due to matrix effects.

9.6.4 If an MSD is analyzed instead of a FD, calculate the relative percent difference (RPD) for duplicate MSs (MS and MSD) using the equation:

$$\text{RPD} = \frac{|\text{MS} - \text{MSD}|}{(\text{MS} + \text{MSD}) / 2} \times 100$$

9.6.5 RPDs for duplicate MSs should be ≤30% for samples fortified at or above their native concentration. Greater variability may be observed when MSs are fortified at analyte concentrations that are within a factor of 2 of the RL. MSs fortified at these concentrations should have RPDs that are ≤50% for samples fortified at or above their native concentration. If the RPD of any analyte falls outside the designated range, and the laboratory performance for that analyte is shown to be in control in the LCSD where applicable, the result is judged to be matrix biased. If no LCSD is present, the associated MS and MSD are to be re-analyzed to determine if any analytical has occurred. If the resulting RPDs are still outside control limits, the result for that analyte in the unfortified sample is labeled suspect/matrix to inform the data user that the results are suspect due to matrix effects.

9.7 Bile Salt Interference Check

9.7.1 The laboratory must analyze a TDCA standard after the initial calibration, prior to the analysis of tissue samples, to check for interferences caused by bile salts. If an interference is present, the chromatographic conditions must be modified to eliminate the interference from TDCA (e.g., changing the retention time of TDCA such that it falls outside the

9.8 Initial Calibration Verification (ICV)

9.8.1 After each ICAL, analyze a QCS sample from a source different from the source of the CAL standards. If a second vendor is not available, then a different lot of the standard should be used. The QCS should be prepared and analyzed just like a CCV. Acceptance criteria for the QCS are identical to the CCVs; the calculated amount for each analyte must be ± 30% of the expected value. If measured analyte concentrations are not of acceptable accuracy, check the entire analytical procedure to locate and correct the problem.

9.9 Instrument Sensitivity Check (ISC)

9.9.1 At the start of each 12-hour shift, analyze a standard at the LOQ. The signal-to-noise ratio of the ISC standard must be greater than or equal to 3:1. If the requirements cannot be met, the problem must be corrected before analyses can proceed

9.10 Continuing Calibration Verification (CCV)

9.10.1 CCV Standards must be analyzed at the beginning of each analysis batch, after every 10 Field Samples, and at the end of the analysis batch.

9.10.2 The recovery of native and isotopically labeled compounds for the CVs must be within 70 - 130%

9.10.3

9.11 Method-specific Quality Control Samples

9.11.1 Instrument Blank – During the analysis of a batch of samples, a solvent blank is analyzed after samples containing high level of target compounds (e.g., calibration, CV) to monitor carryover from the previous injection. The injection blank consists of the solution in

Section 8.1.16 fortified with the EIS and NIS for quantitation purposes.

9.12 Example Method Sequence

- INSTRUMENT BLANK
- INSTRUMENT SENSITIVITY CHECK
- CALIBRATION VERIFICATION STANDARD
- QUALITATIVE IDENTIFICATION STANDARDS
- TDCA STANDARD (only if analyzing tissues)
- INSTRUMENT BLANK
- METHOD BLANK
- LOW-LEVEL LCS/OPR
- OPR/LCS
- SAMPLE (10 or fewer)
- CALIBRATION VERIFICATION STANDARD
- INSTRUMENT BLANK
- SAMPLE (10 or fewer)
- CALIBRATION VERIFICATION STANDARD
- INSTRUMENT BLANK

10. Procedure

10.1 Equipment Set-up

10.1.1 This procedure may be performed manually or in an automated mode using a robotic or automatic sample preparation device. If an automated system is used to prepare samples, follow the manufacturer's operating instructions, but all extraction and elution steps must be the same as in the manual procedure. Extraction and/or elution steps may not be changed or omitted to accommodate the use of an automated system. If an automated system is used, the MBs should be rotated among the ports to ensure that all the valves and tubing meet the MB requirements.

10.1.2 Some of the PFAS's adsorb to surfaces, including polypropylene. Therefore, the aqueous sample bottles must be rinsed with the elution solvent whether extractions are performed manually or by automation. The bottle rinse is passed through the cartridge to elute the method analytes and is then collected.

10.1.3 The SPE cartridges and sample bottles described in this section are designed as single use items and should be discarded after use. They may not be refurbished for reuse in subsequent analyses.

10.1.4 All SPE apparatus, including manifolds, tubing and sample ports must be thoroughly rinsed following each use with 1% methanolic ammonium hydroxide, followed by Methanol and then DI water. Additionally, sample manifold ports and transfer tubing should be inspected regularly for signs of wear and/or discoloration. When such observations are made, the associated components should be replaced.

10.1.5 Prior to the start of any extraction, sample site information must be evaluated for any potentially high level PFAS concentrations or sample matrix irregularities that may impact the extraction process. If such samples are identified, aqueous samples may be pre-screened via direct aqueous injection prior to analysis to estimate the potential PFAS concentrations present.

10.1.6 To perform a direct aqueous injection (DAI) screen, the sample should be inverted several times to try and evenly disperse any organic matter present. A 1 ml aliquot (or less depending on the matrix) is to be taken from the parent sample, volume adjusted to 1 ml with reagent water if less than 1ml, fortified with EIS and NIS spiking solutions to match the concentrations of an extracted sample (typically 5 µl per 1 ml DAI), and then analyzed under the same analytical conditions as field samples.

10.2 Sample Preparation of Aqueous Samples

10.2.1 Samples are preserved, collected, and stored as presented in Section 6.

10.2.2 Determine sample volume. Weigh all samples to the nearest 1g. If visible sediment is present, centrifuge and decant into a new HDPE bottle and record the weight of the new container.

NOTE: Some of the PFAS's adsorb to surfaces, thus the sample volume may not be transferred to a graduated cylinder for volume measurement.

10.2.3 The MB, LCS and FRB may be prepared by measuring reagent water with a polypropylene graduated cylinder or filling an HDPE sample bottle to near the top.

10.2.4 Check that the pH is 6.5 ± 0.5. If necessary, adjust pH with 50% formic acid or ammonium hydroxide and 3% aqueous ammonium hydroxide. The extract is now ready for solid-phase extraction (SPE) and cleanup.

10.2.5 Add 20 µL of the EIS to each sample and QC, cap and invert to mix.

10.2.6 If the sample is an LCS, LCSD, MS, or MSD, add the necessary amount of analyte PDS. Cap and invert each sample to mix.

10.3 Sample Prep and Extraction Protocol for Soils, Solids and Sediments.

10.3.1 Homogenize and weigh 5 grams of sample (measured to the nearest hundredth of a gram) into a 50 ml polypropylene centrifuge tube. For laboratory control blanks and spikes, 5 grams of clean sand is used.

10.3.1.1 For Biosolids and other complex matrices, a small aliquot may be required due to co-extracted matrix interferences.

10.3.1.2 For batch QC samples using 5 g of reference solid, add 2.5 g of reagent water. The addition of reagent water to the sand provides a matrix closer in composition to real-world samples.

10.3.2 Add 20 µL of the EIS to each sample and QC.

10.3.3 If the sample is an LCS, LCSD, MS, or MSD, add the necessary amount of analyte PDS. Cap and invert each sample to mix.

10.3.4 Vortex the samples to evenly disperse the spiking solutions and allow to equilibrate for 30 minutes.

10.3.5 To all samples, add 10 ml of 0.3% methanolic ammonium hydroxide, cap, vortex for 25 seconds.

10.3.6 Following mixing, shake each sample for 30 minutes on a shaker table.

10.3.7 Centrifuge each sample at 2800RPM for 10 minutes.

10.3.8 Remove the supernatant and transfer to a clean 50 ml polypropylene centrifuge tube.

10.3.9 Repeat steps 10.3.4 to 10.3.7, with 15 ml of 0.3% methanolic ammonium hydroxide, combining the supernatants.

10.3.10 Add 5ml of 0.3% methanolic ammonium hydroxide to the sample, vortex for 25 seconds and centrifuge each sample at 2800RPM for 10 minutes.

10.3.11 Remove the supernatant and transfer to the same 50 ml polypropylene centrifuge tube containing eluates from the previous cycles.

10.3.12 Add 10 mg of carbon to the combined extract, mix by occasional hand shaking for no more than five minutes and then centrifuge at 2800 rpm for 10 minutes. Immediately decant the extract into a 50 ml polypropylene centrifuge tube.

10.3.13 Dilute to approximately 35 mL with reagent water. Samples containing more than 50% water may yield extracts that are greater than 35 mL in volume; therefore, do not add water to these. Determine the water content in the sample as follows (percent moisture is determined from the % solids):

Water Content in Sample = (Sample Weight * Percent moisture) / 100

10.3.14 Concentrate each extract at approximately 55 ºC with a gentle N2 flow to a final volume that is based on the water content of the sample (see table below). Allow extracts to concentrate for 10 minutes, then mix (by vortex if the volume is < 20. Continue concentrating and mixing every 5 minutes until the extract has been reduced to the required volume as specified in the table below. If the extract volume appears to stop dropping, the concentration must be stopped and the volume at which it was stopped recorded.

Water Content in Sample	Concentrated Final Volume
< 5 grams	15 ml
5-8 grams	15-20 ml
8-9 grams	20-22.5 ml
9-10 grams	22.5-25 ml

10.3.15 Add 40 - 50 mL of reagent water to the extract and vortex. Check that the pH is 6.5 ±0.5 and adjust as necessary with 50% formic acid or 30% ammonium hydroxide, or with 5% formic acid and 3% aqueous ammonium hydroxide. The extracts are ready for SPE and cleanup.

10.4 Sample Prep and Extraction Protocol for Tissues.

10.4.1 Homogenize and weigh 2 grams of sample (measured to the nearest hundredth of a gram) into a 50 ml polypropylene centrifuge tube. For laboratory control blanks and spikes, 2 grams of clean tissue is used.

10.4.2 Add 20 µL of the EIS PDS to each sample and QC.

10.4.3 If the sample is an LCS, LCSD, MS, or MSD, add the necessary amount of analyte PDS. Cap and invert each sample to mix.

10.4.4 Add 10 mL of 0.05M KOH in methanol to each sample. Vortex to disperse the tissue then place tubes on a mixing table to extract for at 16 hours. Centrifuge at 2800 rpm for 10 minutes and collect the supernatant in a 50-mL polypropylene centrifuge tube.

10.4.5 Add 10 mL of acetonitrile to remaining tissue in the 50-mL centrifuge tube, vortex to mix and disperse the tissue. Sonicate for 30 minutes. Centrifuge at 2800 rpm for 10 minutes and collect the supernatant, adding it to the 50-mL centrifuge tube containing the initial extract.

10.4.6 Add 5 mL of 0.05M KOH in methanol to the remaining sample in each centrifuge tube. Vortex to disperse the tissue and hand mix briefly. Centrifuge at 2800 rpm for 10 minutes and collect the supernatant, adding it to the 50-mL centrifuge tube containing the first two extracts.

10.4.7 Add 10 mg of carbon to the combined extract, mix by occasional hand shaking over a period of no more than five minutes and then centrifuge at 2800 rpm for 10 minutes. Immediately decant the extract into a 50-mL centrifuge tube.

10.4.8 Add 1 mL of reagent water to each tube and concentrate each extract at approximately 55 ºC with a gentle N2 flow to a final volume of 2.5 ml.

10.4.9 Add reagent water to each evaporation/concentrator tube to dilute the extracts to 50 mL. Check that the pH = 6.5 ± 0.5 and adjust as needed with 50% formic acid, or ammonium hydroxide or with 5% formic acid and 3% aqueous ammonium hydroxide. The extracts are ready for SPE and cleanup.

10.5 SPE Extract: All matrices

10.5.1 Pack clean silanized glass wool to half the height of the WAX SPE cartridge barrel.

10.5.2 Pre-condition the cartridges by washing them with 3 X 5 mL of 1% methanolic ammonium hydroxide, discarding the wash volumes.

10.5.3 Rinse the cartridge with 5 mL of 0.3M formic acid, allowing the cartridge to drain using gravity only, discarding the rinse volume. Do not allow the cartridge to go dry

10.5.4 Adjust the vacuum so that the approximate flow rate is ~5 mL/min and load the sample across the cartridge. Do not allow the cartridge to go dry before all the sample has passed through.

10.5.5 Once all the sample has passed across the cartridge, rinse the walls of the reservoir with 2 X 5 mL reagent water, loading the rinse across the cartridge.

10.5.6 Rinse the walls of the reservoir with 5 mL of 1:1 0.1M formic acid/methanol and pass the rinse through the cartridge using vacuum. Dry the cartridge by pulling air through for 15 seconds.

10.5.7 Rinse the inside of the sample bottle with 5 mL of 1% methanolic ammonium hydroxide. Use vacuum to pull the elution solvent through the cartridge and into the collection tubes. When the cartridge bed and glass wool are submerged, stop the cartridge flow by closing the valve, keeping the sorbent bed and wool submerged.

10.5.8 Let the wetted sorbent bed and wool soak for 1 minute.

10.5.9 Open the cartridge valve and collect the eluate into a 15 ml polypropylene collection tube.

10.5.10 Add 25 µL of concentrated acetic acid to each sample eluted in the collection tubes and vortex to mix.

10.5.11 Add 10 mg of carbon to each sample and batch QC extract, using a 10-mg scoop. Handshake occasionally for no more than 5 minutes. It is important to minimize the time the sample extract is in contact with the carbon. Immediately vortex (30 seconds) and centrifuge at 2800 rpm for 10 minutes.

10.5.12 Add NIS solution to a clean collection tube. Place a syringe filter (25-mm filter, 0.2-µm nylon membrane) on a 5-mL polypropylene syringe. Take the plunger out and carefully decant the sample supernatant into the syringe barrel. Replace the plunger and filter the entire extract into the new collection tube containing the NIS.

10.5.13 Vortex to mix and transfer a portion of the extract into a .7-mL polypropylene LC vial for LC-MS/MS analysis. Cap the collection tube containing the remaining extract and store at 4 °C

10.6 Sample Volume Determination

10.6.1 If using weight to determine volume, weigh the empty bottle to the nearest 1 g and determine the sample weight by subtraction of the empty bottle weight from the original sample weight. Assume a sample density of 1.0 g/mL. In either case, the sample volume will be used in the final calculations of the analyte concentration.

10.7 Initial Calibration - Demonstration and documentation of acceptable initial calibration is required before any samples are analyzed. After the initial calibration is successful, a CCV is required at the beginning and end of each period in which analyses are performed, and after every tenth Field Sample.

10.7.1 ESI-MS/MS TUNE

10.7.1.1 Calibrate the mass scale of the MS with the calibration compounds and procedures prescribed by the manufacturer.

10.7.1.2 Optimize the [M-H]- or [M-CO$_2$]- for each method analyte by infusing approximately 0.5-1.0 µg/mL of each analyte (prepared in the initial mobile phase conditions) directly into the MS at the chosen LC mobile phase flow rate (0.4 mL/min). This tune can be done on a mix of the method analytes. The MS parameters (voltages, temperatures, gas flows, etc.) are varied until optimal analyte responses are determined.

The method analytes may have different optima requiring some compromise between the optima.

The Mass spec conditions found in Table 7 show the Sciex Triple Quad 5500+ operation conditions used in this method.

10.7.1.3 Optimize the product ion for each analyte by infusing approximately 0.5-1.0 µg/mL of each analyte (prepared in the initial mobile phase conditions) directly into the MS at the chosen LC mobile phase flow rate (approximately 0.4 mL/min). This tune can be done on a mix of the method analytes. The MS/MS parameters (collision gas pressure, collision energy, etc.) are varied until optimal analyte responses are determined. Typically, the carboxylic acids have very similar MS/MS conditions, and the sulfonic acids have similar MS/MS conditions.

The conditions found on table 5 are representative of expected tune optimizations for each analyte. If conditions other the ones close to the values provided in table 5 are achieved, the process should be re-performed and/or instrument maintenance performed to resolve the problem.

10.7.2 Establish LC operating parameters that optimize resolution and peak shape. Modifying the standard or extract composition to more aqueous content to prevent poor shape is not permitted.

Table 6 represents the operation conditions of a Sciex Exion LC system when running this method.

10.7.3 Inject 2µl of a mid-level CAL standard under LC/MS conditions to obtain the retention times of each method analyte. Divide the chromatogram into retention time windows each of which contains one or more chromatographic peaks. During MS/MS analysis, fragment a small number of selected precursor ions ([M-H]-) for the analytes in each window and choose the most abundant product ion. For maximum sensitivity, small mass windows of ±0.5 daltons around the product ion mass were used for quantitation.

10.7.4 Inject a mid-level CAL standard under optimized LC/MS/MS conditions to ensure that each method analyte is observed in its MS/MS window and that there are at least 10 scans across the peak for optimum precision.

NOTE: PFHxS, PFOS, NMeFOSAA, and NEtFOSAA have multiple chromatographic peaks using the LC conditions in Table 7 due to chromatographic resolution of the linear and branched isomers of these compounds. Most PFAS's are produced by two different processes. One process gives rise to linear PFAS's only while the other process produces both linear and branched isomers. Thus, both branched and linear PFAS's can potentially be found in the environment. For the aforementioned compounds that give rise to more than one peak, all the chromatographic peaks observed in the standard must be integrated and the areas totaled. Chromatographic peaks in a sample must be integrated in the same way as the CAL standard.

10.7.5 Prepare a set of CAL standards as outlined in table 5. The lowest concentration CAL standard must be at or below the LOQ.

10.7.6 The LC/MS/MS system is calibrated using the isotope dilution technique. Target analytes are quantitated against their isotopically labeled analog (Extracted Internal Standard) where commercially available. If a labeled analog is not commercially available, the extracted internal standard with the closest retention time and /or closest chemical similarity is to be used. Use the LC/MS/MS data system software to generate a linear regression or quadratic calibration curve for each of the analytes. This curve must always be forced through zero and may be concentration weighted, if necessary. Forcing zero allows for a better estimate of the background levels of method analytes. A minimum of 5 levels are required for a linear calibration model and a minimum of 6 levels are required for a quadratic calibration model.

10.7.7 CALIBRATION ACCEPTANCE CRITERIA – A linear fit is acceptable if the calculated RSD or RSE for each target analyte is ≤20%. If linear or Quadratic regressions are used, coefficient of determination (r^2) values must be greater than 0.99. When quantitated using the initial calibration curve, each calibration point at or above the LOQ for each analyte must calculate to be within 70-130% of its true value. The calculate value of each EIS analyte must be within 50-150% of its true value. If these criteria cannot be met, corrective action is taken to reanalyze the CAL standards, restrict the range of calibration.

10.7.8 Bile salts interference check - The laboratory must analyze a TDCA standard after the initial calibration, prior to the analysis of tissue samples, to check for interferences caused by bile salts. If an interference is present, the chromatographic conditions must be modified to eliminate the interference from TDCA (e.g., changing the retention time of TDCA such that it falls outside the retention window for PFOS by at least one minute), and the initial calibration repeated.

10.8 CONTINUING CALIBRATION CHECK (CCV)

– Minimum daily calibration verification is as follows. Verify the initial calibration at the beginning and end of each group of analyses, and after every tenth sample during analyses. In this context, a “sample” is considered to be a Field Sample. MBs, CCVs, LCSs, MSs, FDs FRBs and MSDs are not counted as samples. The beginning CCV of each analysis batch must be at or below the RL in order to verify instrument sensitivity prior to any analyses. If standards have been prepared such that all low CAL points are not in the same CAL solution, it may be necessary to analyze two CAL standards to meet this requirement. Alternatively, the analyte concentrations in the analyte PDS may be customized to meet these criteria. Subsequent CCVs should alternate between a medium and Low concentration CAL standard.

10.8.1 Inject an aliquot of the appropriate concentration CAL standard and analyze with the same conditions used during the initial calibration.

10.8.2 Calculate the concentration of each analyte and EIS in the CCV. The calculated amount for each native and EIS analyte for medium level CCVs must be within ± 30% of the true. If these conditions do not exist, then all data for the problem analyte must be considered invalid, and remedial action should be taken which may require recalibration. Any Field or QC Samples that have been analyzed since the last acceptable calibration verification should be reanalyzed after adequate calibration has been restored, with the following exception. If the CCV fails because the calculated concentration is greater than 130% for a particular method analyte, and Field Sample extracts show no detection for that method analyte, non-detects may be reported without re-analysis.

10.8.3 REMEDIAL ACTION – Failure to meet CCV QC performance criteria may require remedial action. Major maintenance, such as cleaning the electrospray probe, atmospheric pressure ionization source, cleaning the mass analyzer, replacing the LC column, etc., requires recalibration and verification of sensitivity by analyzing a CCV at or below the LOQ.

10.9 EXTRACT ANALYSIS

10.9.1 The same operating conditions used for the initial calibration and summarized in Tables 6 and 7 are to be used.

10.9.2 Prior to analysis of sample extracts, the Instrument mass calibration verification must be performed using standards whose mass range brackets the masses of interest and performed in the negative ion mode. The mass calibration is verified if the calculated mass is within ± .2 daltons of the specified mass.

10.9.3 Establish an appropriate retention time window for each analyte. This should be based on measurements of actual retention time variation for each method analyte in CAL standard solutions analyzed on the LC over the course of time. A value of plus or minus three times the standard deviation of the retention time obtained for each method analyte while establishing the initial calibration can be used to calculate a suggested window size. However, the experience of the analyst should weigh heavily on the determination of the appropriate retention window size.

10.9.4 Calibrate the system by either the analysis of a calibration curve or by confirming the initial calibration is still valid by analyzing a CCV.

10.9.5 Begin analyzing Field Samples, including QC samples, at their appropriate frequency by injecting the same size aliquots under the same conditions used to analyze the CAL standards.

10.9.6 For concentrations at or above the method LOQ, the total (branched and linear isomer) quantification ion response to the total (branched and linear isomer) confirmation ion response ratio must fall within ± 50% of the ratio observed in the midpoint initial calibration standard.

10.9.7 At the conclusion of data acquisition, use the same software that was used in the calibration procedure to identify peaks of interest in predetermined retention time windows. Use the data system software to examine the ion abundances of the peaks in the chromatogram. Identify an analyte by comparison of its retention time with that of the corresponding method analyte peak in a reference standard.

10.9.8 The analyst must not extrapolate beyond the established calibration range. If an analyte peak area exceeds the range of the initial calibration curve, the sample should be re-extracted with a reduced sample volume in order to bring the out of range target analytes into the calibration range. If a smaller sample size would not be representative of the entire sample, the following options are recommended. Re-extract an additional aliquot of sufficient size to ensure that it is representative of the entire sample. Spike it with a higher concentration of internal standard. Prior to LC/MS analysis, dilute the sample so that it has a concentration of internal standard equivalent to that present in the calibration standard. Then, analyze the diluted extract.3

10.9.9 In instances where re-extraction is not an option, dilute a subsample of the sample extract with 0.1% acetic acid by a factor no greater than 10x adjust the amount of the NIS in the diluted extract, and analyze the diluted extract. If the responses for each EIS in the diluted extract meet the S/N and retention time, and the EIS recoveries from the analysis of the diluted extract are greater than 5%, then the compounds associated with those EISs may be quantified using isotope dilution. Use the EIS recoveries from the original analysis to select the dilution factor, with the objective of keeping the EIS recoveries in the dilution above that 5% lower limit. If the adjusted EIS recoveries are below 5%, the dilution is assumed invalid. If the adjusted EIS recoveries are greater than 5%, adjust the compound concentrations, detection limits, and minimum levels to account for the dilution.

11. Data Evaluation, Calculations and Reporting

11.1 Complete chromatographic resolution is not necessary for accurate and precise measurements of analyte concentrations using MS/MS. In validating this method, concentrations were calculated by measuring the product ions listed in Table 9.

11.2 Calculate analyte concentrations using the multipoint calibration established in Section 10.9. Do not use daily calibration verification data to quantitate analytes in samples. Adjust final analyte concentrations to reflect the actual sample volume determined in Section 10.8

C_{ex} = (Area of target analyte * Concentration of Labeled analog) / (area of labeled analog * CF)

$C_s = (C_{ex}$ / sample volume in ml) * 1000

C_{ex} = The concentration of the analyte in the extract
CF = calibration factor from calibration.

11.3 Prior to reporting the data, the chromatogram should be reviewed for any incorrect peak identification or poor integration.

11.4 PFHxS, PFOS, PFOA, NMeFOSAA, and NEtFOSAA have multiple chromatographic peaks using the LC conditions in Table 7 due to the linear and branch isomers of these compounds (Sect. 10.10.4.). The areas of all the linear and branched isomer peaks observed in the CAL standards for each of these analytes must be summed and the concentrations reported as a total for each of these analytes.

11.5 Calculations must utilize all available digits of precision, but final reported concentrations should be rounded to an appropriate number of significant figures (one digit of uncertainty), typically two, and not more than three significant figures.

12. Contingencies for Handling Out-of-Control Data or Unacceptable Data

12.1 Section 9.0 outlines sample batch QC acceptance criteria. If non-compliant organic compound results are to be reported, the Organic Section Head and/or the Laboratory Director, and the Operations Manager must approve the reporting of these results. The laboratory Project Manager shall be notified and may choose to relay the non-compliance to the client, for approval, or other corrective action, such as re-sampling and re-analysis. The analyst, Data Reviewer, or Department Supervisor performing the secondary review initiates the project narrative, and the narrative must clearly document the non-compliance and provide a reason for acceptance of these results.

12.2 All results for the organic compounds of interest are reportable without qualification if extraction and analytical holding times are met, preservation requirements (including cooler temperatures) are met, all QC criteria are met, and matrix interference is not suspected during extraction or analysis of the samples. If any of the below QC parameters are not met, all associated samples must be evaluated for re-extraction and/or re-analysis.

13. Method Performance

13.1 Detection Limit Study (DL) / Limit of Detection Study (LOD) / Limit of Quantitation (LOQ)

13.1.1 The laboratory follows the procedure to determine the DL, LOD, and/or LOQ as outlined in Alpha SOP ID 1732. These studies performed by the laboratory are maintained on file for review.

13.2 Demonstration of Capability Studies

13.2.1 Refer to Alpha SOP ID 1739 for further information regarding IDC/DOC Generation.

13.2.2 The analyst must make a continuing, annual, demonstration of the ability to generate acceptable accuracy and precision with this method.

14. Pollution Prevention and Waste Management

14.1 Refer to Alpha's Chemical Hygiene Plan and Hazardous Waste Management and Disposal SOP for further pollution prevention and waste management information.

14.2 This method utilizes SPE to extract analytes from water. It requires the use of very small volumes of organic solvent and very small quantities of pure analytes, thereby minimizing the potential hazards to both the analyst and the environment as compared to the use of large volumes of organic solvents in conventional liquid-liquid extractions.

14.3 The analytical procedures described in this method generate relatively small amounts of waste since only small amounts of reagents and solvents are used. The matrices of concern are finished drinking water or source water. However, laboratory waste management practices must be conducted consistent with all applicable rules and regulations, and that laboratories protect the air, water, and land by minimizing and controlling all releases from fume hoods and bench operations. Also, compliance is required with any sewage discharge permits and regulations, particularly the hazardous waste identification rules and land disposal restrictions.

15. Referenced Documents

Chemical Hygiene Plan – ID 2124

SOP ID 1732 Detection Limit (DL), Limit of Detection (LOD) & Limit of Quantitation (LOQ) SOP

SOP ID 1739 Demonstration of Capability (DOC) Generation SOP

SOP ID 1728 Hazardous Waste Management and Disposal SOP

16. Attachments

Table 1: Names, Abbreviations, and CAS Registry Numbers for Target PFAS, Extracted Internal Standards and Non-extracted Internal Standards

Parameter	Acronym	CAS
PER- and POLYFLUOROALKYLETHER CARBOXYLIC ACIDS (PFECAs)		
Tetrafluoro-2-(heptafluoropropoxy)propanoic 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
PERFLUOROALKYLCARBOXILIC 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
Perfluoorotetradecanoic acid	PFTeDA	376-06-7
PERFLUOROALKYL SULFONIC ACIDS (PFASs)		
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
CHLORO-PERFLUOROALKYLSULFONATE		
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9
Perfluoro(2-ethoxyethane)sulfonic acid	PFEESA	113507-82-7
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid	9Cl-PF3ONS	756426-58-1
FLUOROTELOMER CARBOXYLIC ACIDS		
3-Perfluoropropyl propanoic acid	3:3FTCA	356-02-5
2H,2H,3H,3H-Perfluorooctanoic acid	5:3FTCA	914637-49-3
Perfluoroheptyl propanoic acid	7:3FTCA	812-70-4
PERFLUOROOCTANESULFONAMIDES		
Perfluorooctanesulfonamide	PFOSA	754-91-6
N-methylperfluoro-1-octanesulfonamide	NMeFOSA	31506-32-8
N-ethylperfluoro-1-octanesulfonamide	NEtFOSA	4151-50-2
PERFLUOROCTANE SULFONAMIDE ETHANOLS		
N-Methyl perfluorooctanesulfonamidoethanol	NMeFOSE	24448-09-7
N-ethyl perfluorooctanesulfonamidoethanol	NEtFOSE	1691-99-2
TELOMER SULFONIC ACIDS		

1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	4:2FTS	757124-72-4
1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	6:2FTS	27619-97-2
1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	8:2FTS	39108-34-4
PERFLUOROOCTANESULFONAMIDOACETIC ACIDS		
N-methyl perfluorooctanesulfonamidoacetic acid	NMeFOSAA	2355-31-9
N-ethyl perfluorooctanesulfonamidoacetic acid	NEtFOSAA	2991-50-6
PERFLUOROETHER AND POLYETHER CARBOXYLIC ACIDS		
Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1
Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5
Perfluoro(2-ethoxyethane)sulfonic acid	PFEESA	113507-82-7
Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6

Table 2: Stock and Nominal Extracted Internal Standard Concentrations

Isotope Labeled Standard	Conc. of EIS Stock (ng/mL)	Nominal amount of EIS added to extracts (ng)
M4PFBA	2000	40
M5PFPeA	1000	20
M5PFHxA	500	10
M4PFHpA	500	10
M8PFOA	500	10
M9PFNA	250	5
M6PFDA	250	5
M7PFUdA	250	5
MPFDoA	250	5
M2PFTeDA	250	5
M3PFBS	466	9.32
M3PFHxS	474	9.48
M8PFOS	479	9.58
M2-4:2FTS	938	18.8

Isotope Labeled Standard	Conc. of EIS Stock (ng/mL)	Nominal amount of EIS added to extracts (ng)
M2-6:2FTS	951	19
M2-8:2FTS	960	19.2
M8FOSA	500	10
d3-N-MeFOSA	500	10
d5-N-EtFOSA	500	10
d3-N-MeFOSAA	1000	20
d5-N-EtFOSAA	1000	20
d7-N-MeFOSE	5000	100
d9-N-EtFOSE	5000	100
M3HFPO-DA	2000	40

Table 3: Stock and Nominal Non-Extracted Internal Standard Concentrations

Isotope Labeled Standard	Conc. of EIS Stock (ng/mL)	Nominal amount of EIS added to extracts (ng)
M3PFBA	1000	40
M2PFHxA	500	10
M4PFOA	500	10
M5PFNA	250	5
M2PFDA	250	5
18O2PFHxS	474	9.48
M4PFOS	479	9.58

Table 4: Initial Calibration levels and Concentrations

Analyte	Cal A	Cal B (LOQ)	CAL C	Cal D	Cal E (CCV)	Cal F	Cal G	Cal H	Cal I
PFBA	.4	.8	2	5	10	20	50	250	500
PFPeA	.2	.4	1	2.5	5	10	25	125	250
PFHxA	.1	.2	.5	1.25	2.5	5	12.5	62.5	125
PFHpA	.1	.2	.5	1.25	2.5	5	12.5	62.5	125
PFOA	.1	.2	.5	1.25	2.5	5	12.5	62.5	125
PFNA	.1	.2	.5	1.25	2.5	5	12.5	62.5	125
PFDA	.1	.2	.5	1.25	2.5	5	12.5	62.5	125
PFUnA	.1	.2	.5	1.25	2.5	5	12.5	62.5	125
PFDoA	.1	.2	.5	1.25	2.5	5	12.5	62.5	125
PFTrDA	.1	.2	.5	1.25	2.5	5	12.5	62.5	125
PFTA	.1	.2	.5	1.25	2.5	5	12.5	62.5	125
PFBS	0.089	0.177	0.444	1.11	2.22	4.44	11.1	55.4	111
PFPeS	0.094	0.188	0.471	1.18	2.35	4.71	11.8	58.8	118

PFHxS	0.091	0.183	0.457	1.14	2.29	4.57	11.4	57.1	114
PFHpS	0.095	0.191	0.477	1.19	2.38	4.77	11.9	59.6	119
PFOS	0.093	0.186	0.464	1.16	2.32	4.64	11.6	58	116
PFNS	0.096	0.192	0.481	1.20	2.41	4.81	12	60.1	120
PFDS	0.097	0.193	0.483	1.21	2.41	4.83	12.1	60.3	121
PFDOS	0.097	0.194	0.485	1.21	2.43	4.85	12.1	60.6	121.
4:2FTS	0.375	0.75	1.88	4.69	9.38	18.8	46.9	234	469
6:2FTS	0.38	0.76	1.9	4.75	9.5	19	47.5	238	475
8:2FTS	0.384	0.768	1.92	4.8	9.6	19.2	48	240	480
PFOSA	.1	.2	.5	1.25	2.5	5	12.5	62.5	125
NMeFOSA	.1	.2	.5	1.25	2.5	5	12.5	62.5	125
NEtFOSA	.1	.2	.5	1.25	2.5	5	12.5	62.5	125
NMeFOSAA	.1	.2	.5	1.25	2.5	5	12.5	62.5	125
NEtFOSAA	.1	.2	.5	1.25	2.5	5	12.5	62.5	125
NMeFOSE	1	2	5	12.5	25	50	125	625	1250
NEtFOSE	1	2	5	12.5	25	50	125	625	1250
HFPO-DA	.4	.8	2	5	10	20	50	250	500
ADONA	0.378	0.756	1.89	4.73	9.45	18.9	47.3	236	473
9Cl-PFONS	0.374	0.748	1.87	4.68	9.35	18.7	46.8	234	468
11Cl-PFOUdS	0.378	0.756	1.89	4.73	9.45	18.9	47.3	236	473
PFMPA	.2	.4	1	2.5	5	10	25	125	250
PFMBA	.2	.4	1	2.5	5	10	25	125	250
PFEESA	0.178	0.356	0.89	2.23	4.45	8.9	22.3	111	223
NFDHA	.2	.4	1	2.5	5	10	25	125	250
3:3FTCA	.5	1	2.5	6.25	12.5	25	62.5	312	624
5:3FTCA	2.5	5	12.5	31.3	62.5	125	312	1560	3120
7:3FTCA	2.5	5	12.5	31.3	62.5	125	312	1560	3125
M4PFBA	10	10	10	10	10	10	10	10	10
M5PFPeA	5	5	5	5	5	5	5	5	5
M5PFHxA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
M4PFHpA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
M8PFOA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
M9PFNA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
M6PFDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
M7PFUdA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
MPFDoA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25

M2PFTeDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
M3PFBS	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33
M3PFHxS	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37
M8PFOS	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
M2-4:2FTS	4.69	4.69	4.69	4.69	4.69	4.69	4.69	4.69	4.69
M2-6:2FTS	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76
M2-8:2FTS	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
M8FOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
d3-N-MeFOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
d5-N-EtFOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
d3-N-MeFOSAA	5	5	5	5	5	5	5	5	5
d5-N-EtFOSAA	5	5	5	5	5	5	5	5	5
d7-N-MeFOSE	25	25	25	25	25	25	25	25	25
d9-N-EtFOSE	25	25	25	25	25	25	25	25	25
M3HFPO-DA	10	10	10	10	10	10	10	10	10
M3PFBA	5	5	5	5	5	5	5	5	5
M2PFHxA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
M4PFOA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
M5PFNA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
M2PFDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
18O2PFHxS	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37
M4PFOS	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4

Table 5: Expected Mass Transitions and instrument conditions.

Q1	Q2	Analyte	DP Volts	CE Volts
213.032	169.022	PFBA	-50	-14
263.039	219.03	PFPeA	-55	-12
263.039	68.9	PFPeA_2	-55	-55
313.047	269.037	PFHxA	-45	-12
313.047	119	PFHxA_2	-45	-28
363.055	319.045	PFHpA	-60	-12
363.055	169.022	PFHpA_2	-60	-24
413.063	369.053	PFOA	-65	-14
413.063	169.022	PFOA_2	-65	-23
463.071	419.061	PFNA	-70	-14
463.071	219.03	PFNA_2	-70	-24

513.078	469.069	PFDA	-80	-16
513.078	219.03	PFDA_2	-80	-30
563.086	519.076	PFUnA	-85	-18
563.086	269.037	PFUnA_2	-85	-25
613.094	569.084	PFDoA	-85	-18
613.094	319.045	PFDoA_2	-85	-28
663.102	619.092	PFTrDA	-85	-20
663.102	169.022	PFTrDA_2	-85	-36
713.11	669.1	PFTA	-70	-22
713.11	169.022	PFTA_2	-70	-38
299.092	80.062	PFBS	-100	-65
299.092	99.061	PFBS_2	-100	-40
349.1	80.062	PFPeS	-100	-75
349.1	99.061	PFPeS_2	-100	-60
399.107	80.062	PFHxS	-120	-75
399.107	99.061	PFHxS_2	-120	-80
449.115	80.062	PFHpS	-140	-95
449.115	99.061	PFHpS_2	-140	-80
499.113	80.062	PFOS	-145	-108
499.113	99.061	PFOS_2	-145	-85
549.131	80.062	PFNS	-180	-100
549.131	99.061	PFNS_2	-180	-100
599.139	80.062	PFDS	-170	-110
599.138	99.061	PFDS_2	-170	-100
699.154	80.062	PFDoS	-160	-150
699.154	99.061	PFDoS_2	-160	-130
327.146	307.139	4:2FTS	-100	-28
327.146	81.07	4:2FTS_2	-100	-50
427.161	407.155	6:2FTS	-120	-33
427.161	81.07	6:2FTS_2	-120	-65
527.177	507.17	8:2FTS	-140	-39
527.177	81.07	8:2FTS_2	-140	-85
498.146	78.07	FOSA	-150	-90
498.146	478	FOSA_2	-150	-35
512.163	219.03	NMeFOSA	-130	-35
512.163	169.022	NMeFOSA_2	-130	-40
526.192	219.03	NEtFOSA	-140	-35
526.192	169.022	NEtFOSA_2	-140	-35
570.202	419.061	NMeFOSAA	-100	-28

570.202	483	NMeFOSAA_2	-100	-22
584.229	419.061	NEtFOSAA	-100	-28
584.229	526.192	NEtFOSAA_2	-100	-38
616.1	58.9	NMeFOSE	-90	-70
630	58.9	NEtFOSE	-80	-75
285.035	169.022	HFPO-DA	-60	-12
285.035	184.9	HFPO-DA_2	-60	-18
377.06	251.028	ADONA	-65	-18
377.06	84.8	ADONA_2	-65	-48
530.8	351.05	9Cl-PFONS	-130	-38
532.8	353	9Cl-PFONS_2	-130	-38
630.9	451.031	11Cl-PFOUdS	-145	-41
632.9	452.9	11Cl-PFOUdS_2	-145	-41
241.085	177.069	3:3FTCA	-60	-12
241.085	117	3:3FTCA_2	-60	-50
341.101	237.072	5:3FTCA	-70	-20
341.101	217	5:3FTCA_2	-70	-35
441.117	316.9	7:3FTCA	-85	-30
441.117	337.088	7:3FTCA_2	-85	-20
315.093	135.013	PFEESA	-100	-35
315.093	82.9	PFEESA_2	-100	-25
229.032	85.006	PFMPA	-40	-25
279.042	85.006	PFMBA	-45	-25
295.032	201	NFDHA	-30	-15
295.032	84.9	NFDHA_2	-30	-40
217.001	171.999	MPFBA	-50	-14
268.001	222.999	M5PFPeA	-55	-12
318.009	273.007	M5PFHxA	-45	-12
367.024	322.022	M4PFHpA	-60	-12
421.002	376	M8PFOA	-65	-14
472.002	427	M9PFNA	-70	-14
519.033	474.03	M6PFDA	-80	-16
570.033	525.031	M7-PFUdA	-85	-18
615.079	570.033	MPFDoA	-85	-18
715.094	670.092	M2PFTeDA	-70	-22
302.069	80.062	M3PFBS	-100	-65
402.084	80.062	M3PFHxS	-120	-74
507.062	80.062	M8PFOS	-145	-85
329.13	81.07	M2-4:2FTS	-100	-50

429.162	81.07	M2-6:2FTS	-120	-65
529.162	81.07	M2-8:2FTS	-140	-85
506.077	78.07	M8FOSA	-150	-90
515.183	219.03	d3-NMeFOSA	-130	-35
531.222	219.03	d5-NEtFOSA	-140	-35
573.22	419.061	d3-NMeFOSAA	-75	-28
589.259	419.061	d5-NEtFOSAA	-90	-28
623.2	58.9	d7-NMeFOSE	-100	-28
639.2	58.9	d9-NEtFOSE	-100	-28
287.02	169.022	M3HFPO-DA	-60	-12
216.009	171.999	M3PFBA	-50	-14
315.032	270.03	M2PFHxA	-45	-12
417.032	372.03	M4PFOA	-65	-14
468.032	423.03	M5PFNA	-70	-14
515.063	470.061	M2PFDA	-80	-16
403.107	84.062	18O2-PFHxS	-120	-74
503.093	80.062	M4PFOS	-145	-85

Table 6: LC Method Conditions

Time (min)	**2 mM Ammonium Acetate (5:95 CH/H_2O)**	**100% Acetonitrile**	**Gradient Curve**
Initial	100.0	0.0	0
.2	100.0	0.0	2
4	70	30	7
7	45	55	8
9	25	80	8
10	5	95	6
10.4	98	2	10
11.8	100	0	7
12	100	0	1
Waters Aquity UPLC ® BEHC_{18} 2.1 x 50 mm packed with 1.7 µm BEH C_{18} stationary phase Flow rate of 0.4 mL/min 2 µL injection			

Table 7: ESI-MS Method Conditions

ESI Conditions	
Polarity	Negative ion
Curtain Gas	30
Collision gas	9
Ion Spray Voltage	-4500
Desolvation gas temp.	500 ºC
Ion Source Gas 1	30
Ion Source Gas 2	50
Entrance Poitential	-10
Exic Cell Potential	-11

Table 8. Reporting limits by Matrix

Compound	Aqueous (ng/L)	Solid (ng/g)	Tissue (ng/g)
PFBA	6.4	0.8	2
PFPeA	3.2	0.4	1
PFHxA	1.6	0.2	0.5
PFHpA	1.6	0.2	0.5
PFOA	1.6	0.2	0.5
PFNA	1.6	0.2	0.5
PFDA	1.6	0.2	0.5
PFUnA	1.6	0.2	0.5
PFDoA	1.6	0.2	0.5
PFTrDA	1.6	0.2	0.5
PFTA	1.6	0.2	0.5
PFBS	1.6	0.2	0.5
PFPeS	1.6	0.2	0.5
PFHxS	1.6	0.2	0.5
PFHpS	1.6	0.2	0.5
PFOS	1.6	0.2	0.5
PFNS	1.6	0.2	0.5
PFDS	1.6	0.2	0.5
PFDoS	1.6	0.2	0.5
4:2FTS	6.4	0.8	2
6:2FTS	6.4	0.8	2
8:2FTS	6.4	0.8	2
FOSA	1.6	0.2	2
NMeFOSA	1.6	0.2	0.5

NEtFOSA	1.6	0.2	0.5
NMeFOSAA	1.6	0.2	0.5
NEtFOSAA	1.6	0.2	0.5
NMeFOSE	16	2	5
NEtFOSE	16	2	5
HFPO-DA	6.4	0.8	2
ADONA	6.4	0.8	2
9Cl-PFONS	6.4	0.8	2
11Cl-PFOUdS	6.4	0.8	2
3:3FTCA	8	1	2.5
5:3FTCA	40	5	12.5
7:3FTCA	40	5	12.5
PFEESA	3.2	0.4	1
PFMPA	3.2	0.4	1
PFMBA	3.2	0.4	1
NFDHA	3.2	0.4	1

Determination of Volatile Organic Compounds in Air Using Specially-Prepared Canisters and Analyzed by GC/MS

References: **Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air - Second Edition.** U.S. Environmental Protection Agency. EPA/625/R-96/010b. Office of Research and Development National Risk Management Research Laboratory. Center for Environmental Research Information. Cincinnati, Ohio. January 1999.

Method TO-15: Determination of Volatile Organic Compounds (VOCs) In Air Collected In Specially-Prepared Canisters and Analyzed By Gas Chromatography Mass Spectrometry (GC/MS). U.S. Environmental Protection Agency. EPA/625/R-96/010b. Office of Research and Development National Risk Management Research Laboratory. Center for Environmental Research Information. Cincinnati, Ohio. January 1999.

1. Scope and Application

Matrices: Ambient Air, Soil Gas, Soil Vapor

Definitions: Refer to Section 16 and Alpha Analytical Quality Systems Manual

This SOP describes the procedure for the analysis of volatile organic compounds (VOCS) in ambient air. The whole air samples are collected in fused-silica lined (FSL) stainless steel canisters, or Tedlar® bags. The VOCs are subsequently separated by gas chromatography (GC) and measured by mass selective detector (MSD).

The organic compounds that are amenable to this method are listed in Table 9. Other compounds may also be amenable provided they meet the QA/QC requirements of the method.

The data report packages present the documentation of any method modification related to the samples tested. Depending upon the nature of the modification and the extent of intended use, the laboratory may be required to demonstrate that the modifications will produce equivalent results for the matrix. Approval of all method modifications is by one or more of the following laboratory personnel before performing the modification: Area Supervisor, Department Supervisor, Laboratory Director, or Quality Assurance Officer.

This method is restricted to use by or under the supervision of analysts experienced in the operation of the GC/MS and in the interpretation of GC/MS data. Each analyst must demonstrate the ability to generate acceptable results with this method by performing an initial demonstration of capability.

This SOP contains addendums for various state-specific requirements. The criteria in these addenda (Addendum C-F) must be adhered to for projects conducted under the state programs.

2. Summary of Method

Samples are collected in precleaned, evacuated FSL canisters or Tedlar® bags.

Samples are pre-concentrated using the Entech 7200 or 7200A Cryogenic Concentrator. A specified volume of sample is pulled using a vacuum pump through a mass flow controller. The sample is cryogenically concentrated to a volume of less than one mL on a Tenax® trap.

Following pre-concentration, the sample is refocused on the GC transfer line. This step further reduces the sample volume to less than one microliter for injection.

The sample is then injected into the GC, which is used to separate the compounds of interest. All compounds are detected using an MSD.

2.1 Method Modifications from Reference

Initial Calibration modifications: If a target analyte cannot meet the %RSD criteria for relative response factor calibration, then linear regression may be used. A minimum of five calibration points must be incorporated and a correlation coefficient of 0.995 or greater must be achieved. The calibration plot must be printed and approval by a supervisor must be obtained prior to calibration acceptance. If any compound is calibrated using linear regression then after the ICV and prior to any sample analysis, a low point standard must be analyzed to confirm there is no bias resulting from the linear regression calibration used. Recovery of the low point standard must be 60-140% using the linear regression curve.

Continuing calibration and laboratory controlled spike (LCS) modifications: The recoveries of all analytes must be within 70% to 130% of the true value. If more than 10% of the compounds fail these criteria, or if one compound has a recovery less than 50% or greater than 150% the LCS must be re-analyzed. If failure occurs a second time, the instrument must be re-calibrated. Recoveries greater than 150% may be acceptable, provided analytes are not detected in the samples.

Initial Calibration Verification modification: Two analytes are allowed to be greater than 30% RSD, but less than 40%.

Sample Duplicate modifications: Up to 10% of the target analyte detections may exceed acceptance criteria. If more variation occurs, the sample analysis must be repeated. If an analyte detected in one of the analysis at >5x the reporting limit, and not detected in the duplicate analysis, the analysis must be repeated. If an analyte is detected in one analysis at <5x the reporting limit and not detected in the duplicate analysis, the RPD is not calculable (NC) and the analysis does not have to be repeated. If an analyte is not detected in both the original and duplicate analysis, the RPD is NC.

Section 8.4.1.2 of the TO-15 method requires all canisters to be leak checked for a period of 24 hr via pressurization of the canister. The laboratory conducts the leak check by measuring the vacuum of the canister after a minimum of a 24 hr. period has elapsed, not by pressurizing the canister as per the method.

The % RSD for any analyte must be < 30%, as outlined in Section 10.2.2.7 of this SOP.

Humidified nitrogen is used in place of zero air due to the frequency of detection of VOCs in zero air, particularly at SIM detection limits.

There is no NIST-traceable second source standard currently available for the analytes listed in Table 1, Table 3B, and Table A-7.

3. Reporting Limits

Table 9 lists target analytes and Reported Detection Limit information.

4. Interferences

4.1 Contamination may occur in the sampling system if canisters are not properly cleaned before use. Additionally, all other sampling equipment (e.g., pump and flow controllers) must be thoroughly cleaned to ensure that the filling apparatus will not contaminate samples.

4.2 System carryover can be a potential problem, particularly for the heavier molecular weight hydrocarbons. Carryover can occur after the analysis of standards or high-level samples. Measures that must be taken to remove this contamination can include the analysis of multiple blanks, lab air, and the purging of the autosampler with nitrogen.

4.3 High moisture content, methane levels and/or carbon dioxide levels may interfere with the chromatography and trapping of target analytes. Dilutions may be performed on these samples; however, the reporting limits will then be elevated.

5. Health and Safety

The toxicity or carcinogenicity of each reagent and standard used in this method is not fully established; however, each chemical compound should be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be reduced to the lowest possible level by whatever means available. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Additional references to laboratory safety are available in the Chemical Hygiene Plan.

All personnel handling environmental samples known to contain or to have been in contact with municipal waste must follow safety practices for handling known disease causative agents.

All employees performing laboratory procedures must have read and understood the Alpha Analytical Chemical Hygiene Plan. All laboratory procedures must be performed in accordance with the provisions and policies of the manual. All accidents, injuries, spills, or unsafe conditions must be reported immediately to the laboratory manager, and such occurrences must be thoroughly documented.

The analyst must wear a lab coat, gloves, and safety glasses while preparing solutions or handling samples.

Preparation of liquid standards must be performed under a properly functioning fume hood. Preparation and venting of gaseous standards must also be performed under a properly functioning fume hood.

6. Sample Collection, Preservation, Shipping and Handling

6.1 Sample Collection

6.1.1 FSL canister samples can be collected as grab samples or as time-integrated samples. Time-integrated samples can be collected for a maximum of 12 hours using 2.7-liter canisters, or a maximum of 24 hours to 7 days using 6-liter canisters. One liter canisters are typically used for soil vapor sampling with a sampling flowrate of 100-200 ml/min.

6.1.1.1 Grab samples are collected by opening the canister valve and allowing the canister to fill to ambient pressure. This process takes approximately one minute.

6.1.1.2 Time-integrated samples require the use of a properly calibrated flow controller. The flow controller, if provided by Alpha, is calibrated prior to sample collection and is documented in the Alpha ACS LIMs (Refer to Alpha SOP # 2190 for Canister and Flow Controller Preparation).

6.1.2 Tedlar® bag samples typically can be collected as grab or composite samples and may require a pumping system or evacuated box.

6.1.3 Upon receipt at the laboratory, all samples are assigned unique laboratory identification numbers, checked for possible discrepancies, etc. (See SOP # 1559.)

6.2 Sample Preservation

Canisters-None. Tedlar® bags-should be protected from light.

6.3 Sample Shipping

All samples must be accompanied by a chain of custody form, which documents the date, and time of sample collection.

6.4 Sample Handling

The pressure of all FSL canister samples is measured upon receipt at the laboratory and documented in the ACS LIMs (See Alpha SOP #2190). A pressure gauge is attached to the canister inlet, the canister valve is briefly opened and the pressure is recorded. The gauge apparatus used to measure ambient air samples must be separate from that used to measure soil vapor or other matrices known to have elevated levels of VOCs to avoid cross-contamination.

Samples with pressures greater than -15 inches Hg are considered acceptable for analysis.

Samples with less than -15 inches Hg should be pressurized to > -15 inches Hg in order for the concentrator system to accurately draw the correct volume, resulting in a dilution of the sample. For ambient air samples, the client must be notified prior to sample analysis since this dilution may cause reporting limits to be elevated above project action levels.

Any samples that undergo pressurization prior to analysis are documented in the instrument software. Refer to Section 10.3.3.6 for the calculation of dilution factors due to pressurization of samples.

Refer to SOP # 1559 for Sample Management information.

FSL canister and Tedlar® bag samples are stored in the Volatiles Laboratory until analysis has been completed. Tedlar® bag samples are stored in opaque containers.

The recommended holding time for the analysis of FSL canister samples for TO-15 is 30 days from date of collection. The recommended holding time for the analysis of Tedlar® bag samples for TO-15 is 48-72 hours from date of collection. Tedlar® bag samples requiring TO-15 analysis may be transferred into canisters upon receipt at the laboratory in order to extend the holding time of the sample to 30 days.

Samples designated by client to be held for subsequent analyses or are “on hold” are to be kept in a designated area in the laboratory. “Hold” samples are discarded upon client authorization or after holding time expiration date.

7. Equipment and Supplies

7.1 Microliter syringes: 10, 25,and 500 µL

7.2 Gas tight syringes: 1 mL, 5 mL, 25 mL, 50 mL, and 100 mL

7.3 FSL canisters: 1.0, 2.7, 6.0 and 15 Liter

7.4 Tedlar® bags: Various sizes. Alpha supplies 5-Liter sizes. All bags must have polypropylene fittings which are recommended for the analysis of Sulfides and Mercaptans (see App. A).

7.5 Stop watch

7.6 Sample Concentrator

7.6.1 The concentrator system consists of two separate pieces of equipment: (1) Entech Model 7016D VOC Autosampler, and (2) Entech Model 7200 or 7200A Cryogenic Concentrator using liquid nitrogen.

7.6.2 A vacuum pump (Vaccubrand Model ME2 or similar) delivers the sample from the autosampler to the cryogenic concentrator FSL-lined steel tubing.

7.7 Gas Chromatograph System

7.7.1 Gas chromatograph - Shimadzu 2010, 2030

7.7.2 Chromatographic column: Restek RTX-1; 60 meters, 0.25 mm or 0.32 mm ID, 1 micron film thickness

7.7.3 Transfer line from column to GC injection port: Hydroguard ™ 0.32 mm capillary tubing connected to column with Restek Vu-Union connector.

7.8 Mass Spectrometer System

7.8.1 Mass spectrometer - Shimadzu 2010, 2020

7.8.2 The mass spectrometer must be capable of scanning from 29 to 270 amu every 3 seconds or less, utilizing 70 volts (nominal) electron energy in the electron impact ionization mode and producing a mass spectrum that meets all the criteria in Table 5 when 50 ng of 4- bromofluorobenzene is injected. For SIM (selective ion monitoring) analysis, the system must be capable of simultaneous SIM/full scan acquisition.

7.8.3 Data System - Shimadzu GC/MS Solutions software for data acquisition and Agilent Enviroquant version E.02.00 for data processing.

7.9 Dilution Systems

7.9.1 Entech 4600A Dynamic Dilution System- for performing sample dilutions in canisters and Entech 4700 Precision Diluter preparing calibration standards in canisters. .

7.10 Primary flow measurement device: BIOS Cell Defender 510 or equivalent

8. Reagents and Standards

8.1 DI Water or Carbon-filtered tap water

8.2 High purity purge and trap grade methanol (Fisher part # A453-1 or equivalent) for MS source cleaning

8.3 Ultra high purity (UHP) helium for the GC/MS system

8.4 Ultra high purity (UHP) nitrogen for standard preparation

8.5 NIST certified TO-15 gas standards, purchased from Linde (formerly Spectra Gases). Standards are stored at room temperature and expire per vendor's expiration date, unless re-certified. Recertified standards are received with an updated certificate of analysis which includes a new expiration date.

8.6 Neat chemicals: Listed in Table 1, Table A-1, and Table 3B, ≥ 98% purity.

8.7 Liquid nitrogen: For the concentrator system and/or GC cooling

8.8 Primary Standards

8.8.1 Primary standard mixtures of TO-15 analytes are purchased certified gaseous standards already prepared as well as gaseous standards prepared in the laboratory by injecting neat chemicals into Tedlar® bags (See Table 1).

8.8.2 Table 1 indicates volumes of neat chemicals that are injected into 20 L of zero air or UHP nitrogen to obtain primary standard concentrations for all analytes.

8.8.3 Purchased primary standards are assigned a CSS # (commercially supplied standard) upon receipt for tracking purposes. Preparation of primary standards must be entered into the primary standard preparation logbook (Form No.: 117-11).

8.8.4 Standards are valid per the manufacturer's expiration date as noted.

8.9 Secondary Standards

8.9.1 Prepare secondary standards in canisters using the Entech 4700 Precision Diluter at a minimum of two concentration levels. Table 3A and 3B outlines the preparation steps for each secondary standard.

8.9.2 Prior to preparation of the standards, verify that an appropriate vacuum exists in the canister (>0.5 psia). Figure 3 demonstrates the standard preparation system. Primary standards prepared in Tedlar bags are injected into a canister (typically

15 L) using an injection tee with a septum or transferred from purchased and / or prepared cylinders via the precision diluter.

8.9.3 Attach the transfer lines from the primary standards to the dynamic diluter.

8.9.4 Prior to the injection of the gaseous standards, allow the dynamic diluter to equilibrate for a approximately 25 minutes by allowing each standard channel to flush for a minimum of 5 min. Be sure the vent line is attached to the outlet.

8.9.5 After equilibrating the system, attach the canister to the outlet of the diluter. Flush line with nitrogen for 20 sec prior to attaching canister. Load in the appropriate configuration and standard preparation method (TO15 ICAL, DIAZ, or TO15 LCS) into the precision dilution software for the corresponding target concentration (TO15 ICAL 100 ppbV, TO15 ICAL 10 ppbV).

Equation 1: Flow rate calculation:

$$\mathbf{T_f = V_{std} / F_{std}}$$

Where:

T_f = standard transfer time, minutes
V_{std} = standard volume, mL
F_{std} = standard flowrate, mL/min

8.9.6 Inject the appropriate amount of Tedlar bag primary standard and/or the low vapor pressure compounds listed in Table 3B into the injection port tee. This injection must be done while the canister is below atmospheric pressure.

8.9.7 When all the primary standards have been added to the canister, the canister will be pressurized to the programmed final pressure using the precision diluter.

NOTE: Standard canisters prepared for analysis using the autosampler must have a maximum pressure of 30 psia to ensure proper and consistent sampling by the instrument.

8.9.8 Label the canister accordingly and record the standard preparation in the secondary standard (SS) preparation logbook (Form No.: 12925).

8.9.9 The ICV/LCS standard is prepared in the same manner, using primary standards of differing lot #s, at a concentration of 10 ppbV

Secondary standards are valid for 6 months.

8.10 Internal Standard and BFB Tuning Standard/Surrogate Standard

An internal standard (Bromochloromethane, 1,4-Difluorobenzene, and Chlorobenzene-D5) and tuning/surrogate standard containing Toluene-D8, 1,2-Dichloroethane-D4, and Bromofluorobenzene (BFB) are prepared as two separate gas standards at 25 ppbV (2 year expiration date). The internal standards and BFB / surrogates are loaded onto the sample trap prior to the calibration standard(s), sample, or QC sample(s) via a mass flow controller. The concentration of the internal standard and BFB / surrogates added is based upon the nominal concentration of sample that is analyzed. If the nominal volume of sample is 250 mL, then 100 mL of the 25 ppbV internal standard mix will yield a true value of 10 ppbV for the internal standards and BFB. Using equation 7, the ug/m^3 equivalent of BFB injected 179 ug/m^3 or 179 ng/L (MW of BFB = 175). Thus, the total ng injected is:

$$\text{Total ng} = 179 \text{ ng/L} \times 0.100 \text{ L} = 17.9 \text{ ng}$$

8.11 Instrument Calibration Standards

Calibration standards are prepared by injecting different volumes of the secondary standards into the concentrator/GC/MS system. The low standard will be used to establish the reporting limit for sample analyses. These are described in more detail in Section 10.

9. Quality Control

The laboratory must maintain records to document the quality of data that is generated. Ongoing data quality checks are compared with established performance criteria to determine if the results of analyses meet the performance characteristics of the method. Quality control limits may also be found in the Laboratory Information Management System(LIMs)

At a minimum, for each day of analysis, a Continuing Calibration standard, Laboratory Method Blank, Laboratory Control Spike and Laboratory Duplicate must be analyzed. Laboratory Control Spike Duplicate (LCSD) will be analyzed only upon client request.

9.1 Laboratory Method Blank(s)

A FSL canister pressurized to 30 psia with humidified nitrogen is utilized as the Laboratory Method Blank. This method blank must be free of target analyte contamination at or above the reporting limit. If it is not, the system must be evaluated for possible sources of contamination. Once the source is determined and eliminated, the Blank must be reanalyzed.

A Laboratory Method Blank must be run after samples suspected of being highly contaminated to determine if sample carryover has occurred. If samples have been analyzed using an autosampler, data must be evaluated for potential carryover and re-analyses conducted, as appropriate.

9.2 Laboratory Control Sample (LCS) / Laboratory Control Spike Duplicate (LCSD)

NOTE: A Laboratory Control Spike Duplicate is only performed when specified by the project requirements and/or upon Client request.

Laboratory Control Spike - A Laboratory Control Spike (LCS) is prepared by spiking an evacuated FSL canister with a different primary standard solution than that used for the calibration or a purchased gaseous standard with the components of interest may be used. If the recovery is not within acceptance criteria, the LCS may be analyzed a second time. If the LCS failure continues, the instrument must be recalibrated. Refer to Section 12 for appropriate corrective actions to be taken. QC limits are subject to change for any particular analyte, if deemed necessary after review of QC control limits.

9.3 Initial Calibration Verification (ICV)

A mid-range calibration standard must be analyzed after the initial calibration and prior to sample analysis, and must be a different source than that used for the initial calibration. See section 10.4.1 for additional criteria. Otherwise, sample analysis may proceed.

9.4 Continuing Calibration Verification (CCV)

A mid-range calibration standard must be analyzed prior to sample analysis. This standard is of a different source than that used for the LCS/LCSD pair, typically the same source as the initial calibration standards. See section 10.4. or additional criteria. If repeated failure of the CCV occurs, the instrument must be recalibrated. Otherwise, sample analysis may proceed. The LCS may also be utilized as the continuing calibration unless otherwise defined in an addendum.

9.5 Matrix Spike

Not applicable.

9.6 Laboratory Duplicate

Laboratory Duplicate is a replicate analysis of a sample. The RPD of duplicate analyses must not exceed 25. Up to 10% of the target analyte detections may exceed acceptance criteria. The criteria does not need to be applied to concentrations less than 5X the reporting limit. If more variation occurs, the sample analysis must be repeated. If an analyte is detected in one analysis at >5x the reporting limit and not detected in the duplicate analysis, the analysis must be repeated. If an analyte is detected in one analysis at <5x the reporting limit and not detected in the duplicate analysis, the RPD is not calculable (NC) and the analysis does not have to be repeated. If an analyte is not detected in both the original and duplicate analyses, the RPD is NC. Equation 9 is used to calculate the RPD.
The sample chosen for duplicate analysis should not be a trip blank, field blank, or equipment blank. The sample chosen for duplicate analysis must be rotated among clients and/or sites. If possible, field duplicates should not be chosen for duplicate analysis, nor should outside air samples if indoor air samples are also included in the analytical batch. Refer to Appendices D - F for agency –specific criteria on laboratory duplicate criteria.

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Equation 9: RPD Calculation

$$\mathbf{RPD = ABS(C_s - C_d) / [(C_s + C_d)/2]*100}$$

where:

RPD = relative percent difference
C_s = concentration in original sample analysis
C_d = concentration in duplicate sample analysis

9.7 Method-specific Quality Control Samples

9.7.1 **BFB Tune -** A successful BFB spectrum must meet the criteria in Table 5 prior to sample analysis. If a successful BFB spectrum is not obtained, the MS must be retuned and the BFB spectrum re-evaluated prior to analyzing samples.

9.7.2 **Internal Standards -** The internal standard area counts of each sample, blank, and Laboratory Control Sample are evaluated against the corresponding continuing calibration standard. The internal standard area counts must be within 60-140% of the continuing calibration standard area counts. If the retention times of the internal standards must be within +/- 0.33 min. If the internal standards fall outside this range, the sample, blank, or Laboratory Control Sample must be reanalyzed. In addition, area counts for internal standards for continuing calibration must be within 60-140% recovery of initial calibration. Refer to Sect. 12 for contingencies on samples exhibiting internal standard recovery failures.

9.7.3 **TIC Internal Standards -** Internal standards used for the quantitation of TICs must be evaluated by comparing the total ion area counts of the internal standards in the samples to the total ion area counts of the internal standards in the blanks. The internal standard area counts must be within 50-200% of the blank area counts. If the internal standards fall outside this range, a different internal standard or an estimated internal standard total ion area must be used to quantitate the TIC. This estimate can be done by using the total ion area from a blank or a clean sample within the analytical batch.

9.8 Method Sequence

- BFB Tune Check
- Calibration Standards (initial) or Continuing Calibration
- Laboratory Control Sample (may be used as the ICV or CCV)
- Laboratory Control Sample Duplicate (if needed)
- Laboratory Method Blank
- Samples
- Laboratory Duplicate

Injections may be made until 24 hours after the injection used to check the BFB tune.

All analytical sequences must be recorded in the instrument software and documented in the instrument logbook (Form 117-09).

10. Procedure

10.1 Equipment Set-up

10.1.1 Canister Cleaning and Certification

Refer to Alpha SOP #2190 for canister and flow controller preparation.

10.1.2 Sample Preparation and Concentration

Ensure the integrity of the canister sample as described in Section 6.4. General description of procedure: A 3-stage concentration technique called Cold-Trap Dehydration is used to analyze VOC's in air. The air sample is first concentrated to about a 0.5cc volume by drawing an aliquot of sample simultaneously through a cold trap (no packing material) and then through a Tenax trap. The cold trap is then heated to 10 °C and is held there while slowly passing helium through it to transfer these compounds to the Tenax trap, leaving most of the moisture in the cold trap. Sweeping the VOC's from the first to the second trap with only 20cc of helium results in a transfer of less than 0.5 µL of water (40 mL @ 100% RH @ 10 °C) which can be easily handled by benchtop mass spectrometers. The 20 cc transfer volume also serves to flush the CO_2 through the Tenax trap. After transfer to the second trap, the VOC's are back-flushed while heating to be further focused on an open-tubular focusing trap (cryofocuser) for rapid injection onto the analytical column. Internal standard is added directly to the first stage cryogenic trap prior to the sample by a mass flow controller (MFC). MFC controlled introduction is advantageous over loop injection as it remains consistent with the mechanism used to measure the sample volume.

Connect the canisters or Tedlar® bag(s) to the Entech 7016D Autosampler. For FSL canisters: Align the tubing from one of the 16 positions to the canister inlet position. Push the inlet line into the orifice of the canister and hold in place while tightening the fitting finger tight. Turn the stainless steel nut ¼ turn more with a wrench. The canister valves must be closed at this point. For Tedlar® bags: Connect the valve of the Tedlar® bag with the autosampler line using an adapter fitting.

For canister samples, leak check all inlet connections using the leak check procedure included with the Entech software. The software will indicate if there is a change in vacuum over a period of 30 sec. The vacuum must not increase more than 2 psia. Analysis cannot begin until the leak check has passed for each canister being tested and/or the source of the leak has been determined..

Open the canister or bag valves.

Set up the sequence of the Entech system to withdraw 250 mL from each sample. If high concentrations are expected, lower volumes can be used (minimum of 25 mL).. Samples suspected to contain elevated concentrations (i.e. soil vapor, sub-slab, landfill gas) should be pre-screened prior to analysis to obtain more precise dilution information. If screening results indicate elevated concentrations of non-target analytes, the sample should be diluted such that the peak height of the non-target analyte is approximately 10X greater than the peak height of the first internal standard. Recommended concentrator operating parameters are provided in Table 6.

10.2 Initial Calibration

10.2.1 GC Conditions (Shimadzu 2010, 2030)

Oven program: 25° C, hold for 5.0 minutes, then:

Ramp 1: 100° C at 8.0° C / min.; hold for 0.0 min

Ramp 2: 220^{o} C at 25^{o} C / min.; hold for 4.0 min

Gas Flows

Helium carrier gas flow program: 2.0 mL/min for entire run (23.18 min)

Sample Injection

Injection mode: split
Injection port temperature: 250^{0} C
Inlet pressure: 27.3 psi
Total flow: 39.3 mL/min
Split ratio: 17.3
Split flow: 34.6 mL/min
Gas saver flow: OFF

10.2.2 MS Conditions

Temperature of MSD transfer line: 250^{0} C

Temperature of MS Quad: 150^{0} C

Temperature of MS Source: 230^{0} C

Solvent Delay: 3.0 minutes

Scanning Parameters: 29-270 amu until 10 min, scan rate = 5.52 scans/sec; then 35-270 amu, scan rate = 3.1 scans/sec. Threshold = 150. Sampling rate = 2. EM offset-variable to achieve response of 200K area counts (+/- 25K) for the internal standard bromochloromethane.

10.2.3 Daily GC/MS Performance Check

10.2.3.1 The first analysis of the day is typically a tune evaluation. The GC/MS system is checked to confirm that acceptable performance criteria for bromofluorobenzene (BFB), which is in surrogate mixture, are achieved. These criteria must be met prior to analyzing further standards, blanks and samples.

10.2.3.2 A maximum injection of 50 ng must successfully meet the BFB spectrum criteria in Table 5.

10.2.3.3 If the spectrum of BFB does not meet the above stated criteria, the analysis must be repeated. If the spectrum of BFB still does not meet these criteria, the GC/MS instrument must be re-tuned.

10.2.3.4 The Daily GC/MS Performance Check must be analyzed every 24 hours or less.

10.2.4 Initial Calibration

10.2.4.1 Analyze a minimum of five different levels by analyzing various volumes of the secondary standards prepared in Table 3 (Table A-3 for sulfide/mercaptan analysis). The lowest standard will be at or below the reporting limit. If the response is not linear at the lowest level for the higher molecular weight compounds, this point must not be included in the calibration curve for these compounds. As a result, the analysis of more than five levels may be required in order to ensure a minimum of five calibration points for each analyte.

Table 4 lists the calibration standard levels and the volumes of the secondary standards needed to achieve these levels.

10.2.4.2 The true value of each of these calibration points is determined by applying a dilution factor that is based on the volume of sample extracted from the canister for each calibration point. Assuming that a volume of 250 mL will be the maximum volume extracted from the samples; this will be the "1X" volume. A dilution factor can be calculated using Equation 2.

Equation 2: Calculation of Instrument Dilution Factor

$$\mathbf{DF = V_{1X} / V_{actual}}$$

where:

DF = dilution factor
V_{1X} = maximum volume sampled, mL
V_{actual} = actual volume sampled for samples and standards

10.2.4.3 Analyze each calibration standard according to the procedures specified in Section 10. The true value of each calibration point is determined by dividing the concentration of the canister by the dilution factor determined using Equation 2.

10.2.4.4 Tabulate the area response of the characteristic ions against the amount for each analyte and internal standard and calculate relative response factors (RRF) for each compound using Equation 3. Perform this calculation for each calibration standard.

Equation 3: Relative Response Factor for Individual Target Analytes

$$\mathbf{RRF = [(A_{EC}) * (C_i)] / [(A_{EI}) * (C_c)]}$$

where:

RRF = relative response factor
A_{EC} = area count of the extracted ion for the analyte of interest
C_i= amount of internal standard (ppbV)
A_{EI} = area count of the extracted ion for the associated internal standard

C_c = amount of analyte of interest (ppbV)

Table 7 lists all TO-15 analytes, internal standards and the associated quantitation ion.

Table 8 lists the internal standards and the associated TO-15 analytes.

10.2.4.5 Calculate the average response factor for each of the target analytes by the following equation (AVG_x = SUM(RFs) / total # of RFs).

10.2.4.6 Calculate the percent relative standard deviation (%RSD) of the response factors over the secondary range of the curve for each of the target analytes using Equation 4.

Equation 4: Percent Relative Standard Deviation

$$\%RSD = [(SD_n - 1) / (AVG_x)] * 100]$$

where:

%RSD = percent relative standard deviation
SD_n -1 = standard deviation (n-1 degrees of freedom)
AVG_x = average response factor from the initial calibration curve

This task can also be accomplished using the quantitation software provided by the instrument manufacturer.

10.2.4.7 If the %RSD is <30 for each analyte, linearity can be assumed for the associated target analyte and sample analysis may proceed.

If the %RSD is >30 for any analyte, the integrations must be evaluated and the calculations verified. If a %RSD <30 cannot be achieved, it is acceptable for two (2) of the analytes to be above 30%, but below 40% RSD (applies to analytes flagged with a “C” on the Enviroquant initial calibration summary table).

Alpha may use the following modified acceptance criteria only for projects that have documentation and approval within the QAPP by the quality assurance project planners, and also for analytes not listed in EPA Method TO-15:

10.2.4.8 If the %RSD is >30 for any analyte, the integrations must be evaluated and the calculations verified. If a %RSD <30 cannot be achieved, it is acceptable for 10% of the total analytes to be above 30%, but below 50% RSD. Before acceptance of such a Calibration Curve, it must be confirmed with the approval of the Section Supervisor and/or the Project Manager that these analytes are typically and historically "trouble" analytes or "poor performers" (typically compounds listed in Table 3B), and that all Client and Project Data Quality Objectives (DQOs) will still be met when analyzing samples using this calibration. Refer to Appendices D - F for agency –specific criteria regarding initial calibration acceptance criteria.

Calibration points may be removed from the calibration curve to meet the 30% RSD criteria, so long as five consecutive points remain in the calibration curve, and the following procedure is followed:

- Remove high level calibration points
- Remove low-level calibration points; reporting limits will need to be elevated, however.

10.2.4.9 If calibration points in the mid-level range need to be removed due to a sequence error or instrument malfunction, the entire calibration level must be removed from the calibration curve. If the %RSD >30, a calibration curve is generated using the EnviroQuant quantitation software.

Correlation Coefficient calculation is performed by the Enviroquant software as follows;

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{[\, n\Sigma x^2 - (\Sigma x)^2 \,]\,[\, n\Sigma y^2 - (\Sigma y)^2 \,]}}$$

Where:

r = Correlation Coefficient

n = number of standards measured

x = true concentration of the standard

y = observed concentration of the standard

The correlation coefficient (linear) for the calibration curve must be greater than 0.995. If these criteria cannot be met, prepare a new set of calibration standards and recalibrate the instrument. NOTE: Quadratic calibration in any form is not acceptable.

Authorization from the department supervisor is required prior to using linear regression calibration. Linear regression is only allowed if certain criteria listed below are met:

- The minimum number of points for a linear regression curve is five points.
- The curve must be plotted and printed and turned in with the raw data.
- A calibration standard must be analyzed at the low point of the curve. Recovery of the low point standard must be 60-140% using the linear regression curve.

  The recovery of the compound for the continuing calibration / LCS must be within 70-130%.

10.2.4.10 The reference spectra for all target analytes are reviewed for both assignments and purity for all instruments. In addition, this process of reviewing all spectra continues whenever a new calibration is completed.

Reference spectra should be updated with each initial calibration performed with the midpoint standard of the calibration.

10.2.4.11 Internal Standard Criteria for Initial Calibration Levels and ICV.

The mean response for each internal standard compound is calculated over the initial calibration range. The area response at each calibration level must be within 60-140% of the midpoint area response over the initial calibration range for each internal standard. If recovery is outside the range, re-analyze calibration level. This criteria must be met prior to sample analysis.

All of these criteria must be met prior to sample analysis.

10.3 Equipment Operation and Sample Processing

10.3.1 GC/MS ANALYSIS

10.3.1.1 The Entech 7200 or 7200A Concentrator is programmed to the specific analytical conditions listed in Table 6 (Entech method Alpha_TO15.CTD) and the GC/MS parameters are set to those listed in Sections 10.3.1 and 10.3.2. (Enviroquant method TO15-SFS.M (SIM and full scan) or TO15_FS_35C.M (full scan only, for sulfide & mercaptan analysis in App. A)).

10.3.1.2 The BFB spectrum is evaluated by analyzing a Laboratory Method Blank and adding 100 mL of the BFB/surrogate mix.

10.3.1.3 A continuing calibration and/or a laboratory control spike is analyzed. See sect. 9.2 for acceptable criteria, and refer to Appendices D - F for agency – specific criteria on continuing calibration and laboratory control spike criteria.

10.3.1.4 A Laboratory Method Blank is analyzed. The Laboratory Method Blank consists of the analysis of 250 mL from a canister of humidified nitrogen. The method blank must be free of target analyte contamination at or above the reporting limit.

10.3.1.5 A 250-mL aliquot of sample is preconcentrated on the Entech 7200 or 7200A concentrator and injected onto the GC column. For soil vapor samples, or other samples that may contain elevated levels, the aliquot amount must be determined using the results from a pre-screening analysis. Sample concentrations are determined using the following equation:

$$\text{ppbV} = [(A_{EC}) * (C_i)] / [(A_{EI}) * (RRF)]$$

10.3.1.6 Instrument Dilutions and Sub-Atmospheric Sample dilutions

10.3.1.6.1 For dilutions, smaller sample volumes (<250 mL) are analyzed. The smallest volume that can be analyzed with accuracy using the Entech concentrator is 10 mL. The dilution factor is accounted for by entering the volume analyzed in the sample calculation discussed in Section 10.2.2.2 (Equation 2).

10.3.1.6.2 Samples that arrive at the laboratory with pressures below -15 inches Hg should be pressurized with nitrogen to greater than -15 inches Hg, as discussed in Section 6.4. This pressurization results in a dilution factor. The dilution factor is calculated using Equation 6, and the canister dilution spreadsheet (Form No.: 117-05). Attach a green tag to the canister with the pressurization information (initial pressure and final pressure) recorded on the tag.

Equation 6: Dilution Factor for Pressurization of Subatmospheric Samples: Three Steps

Step 1: Calculate the volume in the canister prior to pressurization (Assume a 2.7-liter canister is used).

$$\mathbf{V_{ci} = 2.7 * P_I / 14.696}$$

Step 2: Calculate the volume in the canister after pressurization.

$$\mathbf{V_{cf} = 2.7 * P_F / 14.696}$$

Step 3: Calculate the dilution factor.

$$\mathbf{DF = V_{cf} / V_{ci}}$$

where:

V_{ci}= volume of air in canister prior to pressurization, L
P_I = pressure reading of canister prior to pressurization (psia)
V_{cf} = volume of air in canister after pressurization, L
P_F = pressure reading of canister after pressurization (psia)
DF = dilution factor
14.696 = atmospheric pressure (psia)

10.3.1.6.3 If samples require larger dilutions than pressurization and instrument dilutions, a syringe dilution into an additional canister or Tedlar bag (typically used only for App. A analytes) with a known volume of nitrogen is required.

10.3.1.6.4 Fit a VCO® adapter with a septa to the pressurized sample canister. With a gastight syringe remove appropriate sample size for dilution. Allow sample to flow through syringe for 1 – 2 seconds to flush syringe prior to volumizing. Inject the sample aliquot into a Tedlar bag. If using an evacuated canister, connect the canister to an injection port tee (see Figure 3) attached to the dynamic diluter. Inject the aliquot of sample while a steady stream of Nitrogen is flowing into the dilution canister. Pressurize this canister to 30 psia. Attach a green tag to the canister with dilution information recorded on the tag. Use the dilution calculation worksheet (Form No.: 117-05) to calculate resulting dilutions.

10.3.2 Qualitative Identifications

10.3.2.1 An analyst competent in the interpretation of mass spectra must identify the target analytes by comparison of the sample mass spectrum to the mass spectrum of the standard. Two criteria must be satisfied to verify the identification: (1) elution of the component in the sample at the same GC relative retention time (RRT) as the component in the standard, and (2) agreement of the sample component and standard component mass spectra.

10.3.2.2 For establishing correspondence of the GC RRT, the RRT of the component in the sample must compare within ± 0.06 RRT units of the RRT of the component in the standard. If co-elution of interfering components prohibits accurate assignment of the sample component RRT from the total ion chromatogram, the RRT must be assigned using extracted ion current profiles for the ion unique to the component of interest.

10.3.2.3 For comparison of the standard and sample component mass spectra, mass spectra of standards obtained on the GC/MS under the same instrument conditions are required. Reference spectra should be updated for each initial calibration performed, using the mid-level standard. Once obtained, these standard spectra may be used for identification and reference purposes.

10.3.2.4 The requirements for qualitative verification by comparison of mass spectra are as follows:

- All ions present in the standard mass spectra at a relative intensity greater than 10% (most abundant ion in the spectrum equals 100%) must be present in the sample spectrum.
- The relative intensities of ions specified must agree within ± 20% between the standard and sample spectra.
- Ions greater than 10% in the sample spectrum must be considered and accounted for by the analyst making the comparison.

Table 7 lists the primary and secondary ions for all analytes.

10.3.2.5 Manual integrations: for peaks that are observed to be not integrated correctly by the quantitation software, manual integrations must be performed. Please refer to the manual integration SOP for further instruction on how to properly perform and document manual integrations (Alpha SOP # 1731).

10.3.2.6 **Tentatively identified compounds (TICs)-**A library search may be performed for non-target sample components for the purpose of tentative identification, as requested by the client. Mass spectra are compared to the National Institute of Standards and Technology Mass Spectral Library (2002 version), and a qualitative match is determined by the analyst. Computer generated library search routines must not use normalization routines that would misrepresent the library or unknown spectra when compared to each other. Refer to Appendices D - F for agency –specific criteria on TIC reporting.

10.3.2.7 Guidelines for making tentative identification:

- Relative intensities of major ions in the reference spectrum (ions greater than 20% of the most abundant ion) must be present in the sample spectrum.
- The relative intensities of the major ions must agree within ± 30%.
- Molecular ions present in the reference spectrum must be present in the sample spectrum.
- Ions present in the sample spectrum but not in the reference spectrum must be reviewed for possible background contamination or presence of coeluting compounds.
- If, in the technical judgment of the mass spectral interpretation specialist, no valid tentative identification can be made, the compound will be reported as "Unknown". The mass spectral interpretation specialist should give additional classification of the unknown compound, if possible (i.e., unknown aromatic, unknown hydrocarbon, unknown acid, unknown chlorinated compound)..

10.4 Continuing Calibration

10.4.1 Calibration Verification

10.4.1.1 The initial calibration must be verified through the analysis of an Initial Calibration Verification (ICV) sample. (The ICV may also be used to satisfy LCS requirements.) This analysis must be performed every time an initial calibration is performed.

10.4.1.2 The ICV must be prepared using a purchased gaseous standard (from a different lot # or separate vendor) with the components of interest in an evacuated FSL canister. Follow the standard preparation procedure for the calibration standards outlined in Section 8.0. The standard must be prepared at or below the midpoint of the calibration curve.

See section 10.4.2.6 for acceptable criteria and Section 12 for corrective actions.

10.4.2 Continuing Calibration

10.4.2.1 A continuing calibration check must be performed daily prior to sample analysis. The continuing calibration standard must be one of the initial calibration levels.

10.4.2.2 Analyze a calibration standard that is at the midpoint of the calibration curve.

10.4.2.3 The LCS standard may be utilized as the continuing calibration check, provided that all target analytes of interest are present in the LCS standard.. Refer to Appendices D - F for agency –specific criteria on LCS criteria.

10.4.2.4 Evaluate continuing calibration for internal standard recoveries. Recoveries must be between 60-140%. If not, the CCV will be re-analyzed.

10.4.2.5 Calculate the percent difference (%D) of the continuing calibration response factor from the initial calibration average response factor using Equation 5.

Equation 5: Percent Difference

$$\% D = [(C_{found})-(C_{true}) / (C_{true})] * 100$$

where:

%D = percent difference

C_{found} = amount of the analyte detected in the standard (ppbV)
C_{true} = true amount of the analyte in the standard (ppbV)

This task can also be accomplished using the quantitation software provided by the instrument manufacturer.

10.4.2.6 Acceptance Criteria

The acceptance criteria is less than 30% RSD for any analyte, with an allowance of two analytes to be greater than 30%, but less than 40%.

Alpha may use the following modified acceptance criteria only for projects that have documentation and approval within the QAPP by the quality assurance project planners, and also for analytes not listed in EPA Method TO-15:

If the %RSD is <30 for each analyte, linearity can be assumed for the associated target analyte and sample analysis may proceed.

10.4.2.7 If the %RSD is >30 for any analyte, the integrations must be evaluated and the calculations verified. If a %RSD <30 cannot be achieved, it is acceptable for 10% of the total analytes to be above 30%, but below 50% RSD. Before acceptance of such a Calibration Curve, it must be confirmed with the approval of the Section Supervisor and/or the Project Manager that these analytes are typically and historically "trouble" analytes or "poor performers" (typically compounds listed in Table 3B), and that all Client and Project Data Quality Objectives (DQOs) will still be met when analyzing samples using this calibration. . Refer to Appendices D - F for agency –specific criteria on initial calibration acceptance criteria.

10.4.2.8 Refer to Sect. 12 for additional procedures regarding continuing calibration acceptance criteria and corrective actions if criteria are not met.

10.5 Preventive Maintenance

Mass flow controllers should be checked annually for flowrate accuracy using a BIOS cell or other primary flow measurement device.

Ion source cleaning – typically prior to initial calibration.

Electron Multiplier (EM)-changed when the voltage setting required to achieve adequate response approaches 1900.

Rough pump oil changed annually.

Transfer lines, concentrator traps, and the GC guard column should be changed semi-annually, or when system repeatedly fails initial calibration.

11. Data Evaluation, Calculations and Reporting

11.1 Calculations

11.1.1 Individual Target Analytes: The average response factor from the initial calibration is used to calculate the amount of analyte detected in the sample analyses. Standards are prepared on a ppbV basis, so if no dilution is performed, values can be reported from the quantitation report without any calculations. Dilution factors are calculated using Equation 2. Equation 7 shows the conversion of ppbV to $\mu g/m^3$.

Equation 7: Conversion of ppbV to $\mu g/m^3$

$$\mu g/m^3 = (ppbV) * MW / 24.45$$

where:

24.45 = molar gas constant (g/g-mole)
MW = molecular weight of the compound of interest (Table 1 and 2 lists the molecular weights of the target analytes)

11.1.2 TICS: An estimated amount for the TIC is calculated using the total area of the TIC, the total area of the internal standard assigned by the quantitation software, and a response factor of 1.000 (Equation 8). If the internal standard assigned by the quantitation software exhibits significant interference from other analytes, the next closest eluting internal standard will be utilized. Refer to Appendices D – F for agency-specific criteria on reporting TICS.

Equation 8: Calculation of TIC Results in ppbV

$$\mathbf{ppbV = [(A_T) * (C_{IS})] / [(A_{IS\text{-}T}) * (1.000)]}$$

where:

A_T = total ion area of the TIC to be measured

C_{IS} = amount of the internal standard

$A_{IS\text{-}T}$ = total ion area of the closest eluting internal standard

The integration of target analytes and internal standards must be performed from valley to valley.

11.1.3 Percent Recovery

$$\% \text{ Recovery} = \frac{C_x}{C_t} \text{ X } 100$$

where:
C_x = measured concentration of compound
C_t = true concentration of compound

11.2 Data Package

11.2.1 Canister Cleaning Information

A copy of the data for the batch certification analysis associated with the FSL canisters must be on file. The raw data must include a sample chromatogram, quantitation report, and spectra of all positive results.

11.2.2 BFB Tune Checks

Tune checks must be included for all days of analysis, including initial calibration. Raw data must include the chromatogram, mass spectra, and summary of relative abundances of the BFB ions.

11.2.3 Calibration Data

- Initial calibration summary (including average response factors, %RSDs, and copies of calibration curves, if appropriate) for target analytes and all calibration chromatograms must be on file.
- Continuing calibration summaries (including %Ds) for individual analytes.
- Chromatograms and quantitation reports associated with all standards used, in the initial and continuing calibrations.

11.2.4 QA/QC

- Internal standard responses and % recoveries vs. the continuing calibration.
- Quantitation report and chromatogram for laboratory control spike (and laboratory control spike duplicate, if requested).

- Quantitation reports, chromatograms, and spectra of positive results for all blanks.
- Copy of the instrument runlog.

11.2.5 Sample Data

- Quantitation reports, chromatograms, spectra of positive results, negative proofs, and pre- and post-manual integrations for all LCSs, samples, and duplicates.
- A copy of the canister dilution worksheet, Form No.: 117-05 (if any canister pressurizations or canister dilutions are performed).

12. Contingencies for Handling Out-of-Control Data or Unacceptable Data

The laboratory must maintain records to document the quality of data that is generated. Ongoing data quality checks are compared with established performance criteria to determine if the results of analyses meet the performance characteristics of the method. When results indicate atypical method performance, a calibration verification standard is used to confirm the measurements were performed in an in-control mode of operation.

Holding time exceedence and/or container damage is noted on the Sample Delivery Group form.

Perform routine preventative maintenance following manufacturer's specification. Record all maintenance in the instrument logbook.

Review of standards, blanks and standard response for acceptable performance occurs for each batch of samples. Record any trends or unusual performance on a nonconformance action form. The method blank must be free of target analyte contamination at or above the reporting limit. If it is not, the system must be evaluated for possible sources of contamination. Once the source is determined and eliminated, the method blank must be reanalyzed.

If the ICV, CCV, LCS or LCSD recovery of any parameter falls outside the designated acceptance range, the laboratory performance for that parameter is judged to be out of control, and the problem must be immediately identified and corrected. The analytical result for that parameter in the unspiked samples is suspect and is only reported for regulatory compliance purposes with the appropriate Narratives. Immediate corrective action includes reanalyzing all affected samples (provided sufficient volume of sample remains) by using any retained sample before the expiration of the holding time. If sufficient volume is not available, Alpha will narrate accordingly. Analytes that fail ICV, CCV and LCS criteria due to elevated recoveries may be reported, provided there are no detections in the associated samples.

Samples exhibiting internal standard recovery failures must be re-analyzed at the same dilution level if instrument malfunction is suspected to be the cause, or at a lesser dilution if sample matrix or concentration levels of target and/or non-target analytes are suspected of being the cause. If recovery failures are observed upon re-analysis, narrate bias accordingly (negative if high recovery, positive if low recovery).

When applicable criteria is not met (ICV, CCV, LCS, IS), Alpha will narrate bias which will be included in the opening narrative of the report.

13. Method Performance

13.1 Method Detection Limit Study (MDL) / Limit of Detection Study (LOD) / Limit of Quantitation (LOQ)

The laboratory follows the procedure to determine the MDL, LOD, and/or LOQ as outlined in Alpha SOP # 1732. These studies performed by the laboratory are maintained on file for review.

13.2 Demonstration of Capability Studies

Refer to Alpha SOP # 1739 for further information regarding IDC/DOC Generation.

13.2.1 Initial (IDC)

The analyst must make an initial, one-time, demonstration of the ability to generate acceptable accuracy and precision with this method, prior to the processing of any samples.

13.2.2 Continuing (DOC)

The analyst must make a continuing, annual, demonstration of the ability to generate acceptable accuracy and precision with this method.

14. Pollution Prevention and Waste Management

Refer to Alpha's Chemical Hygiene Plan and Waste Management and Disposal SOP for further pollution prevention and waste management information.

15. Referenced Documents

Chemical Hygiene Plan

SOP # 1732 MDL/LOD/LOQ Generation

SOP # 1739 IDC/DOC Generation

SOP # 1797 Hazardous Waste & Sample Disposal

SOP # 1731 Manual Integration

Form 117-05: Canister Dilution Worksheet Template

Form 117-09: Instrument Run Log

Form 117-11: Primary Standard Preparation Log

Form 12925: Secondary Standard Preparation Log

16. Attachments

Table 1	TO-15 Tedlar® Bag Stock Standard Preparation for LCS
Table 2A	TO-14 Primary Mix #1 & TO-15 Mix #2 Stock Standard Cylinder
Table 2B	TO-15 Custom Mix #3 Stock Standard Cylinder
Table 2C	TO-15 Custom Mix #4 Stock Standard Cylinder
Table 2D	TO-15 Custom Mix #5 Stock Standard Cylinder
Table 3A	Summary of Working Standard Preparation
Table 3B	Preparation of Calibration Standards for Low Vapor Pressure Compounds

DEFINITIONS

Absolute canister pressure - Pg + Pa, where Pg = gauge pressure in the canister (psig) and Pa = barometric pressure.

Absolute pressure - Pressure measured with reference to absolute zero pressure (as opposed to atmospheric pressure), usually expressed as kPA, mm Hg, or psia (pounds per square inch absolute).

Cryogen - The refrigerant used to obtain very low temperatures in the cryogenic trap of the analytical system. A typical cryogen is liquid nitrogen (bp = -196^{0}C).

Gauge pressure - Pressure measured above atmospheric pressure (as opposed to absolute pressure). Zero gauge is equal to ambient atmospheric (barometric) pressure. Units = psig (pounds per square inch gauge).

ppmV – parts per million on a volume basis.

ppbV – parts per billion on a volume basis

psia – pounds per square inch absolute

Relative retention time (RRT)– retention time (RT) ratio of the target analyte and the internal standard used to quantitate (RT target / RT internal standard).

Table 1

TO-15 Tedlar® Bag Stock Standard Preparation- LCS/ICV Standard

ICV / LCS Standard				
COMPOUND (liquids)	**MOL WGT**	**Density ug/uL**	**uL injected***	**FINAL ppmV**
Acetone	58.1	791	12.0	200
Isopropyl alcohol	60.1	785	4.8	76.7

All neat chemicals are injected into a Tedlar® bag containing 20 Liters of zero air or UHP nitrogen.

See Table A-1 & Table A-4 for sulfide/mercaptan stock standard preparation

Table 2A

TO-15 Purchased Primary Standard Mix

TO-14 Primary Standard Mix #1

COMPOUND	MOL WGT	Conc. ppmV
dichlorodifluoromethane	120.92	1.0
chloromethane	50.49	1.0
Freon-114	170.92	1.0
vinyl chloride	62.5	1.0
bromomethane	94.94	1.0
chloroethane	64.52	1.0
trichlorofluoromethane	137.37	1.0
1,1-dichloroethene	96.94	1.0
methylene chloride	84.93	1.0
Freon-113	187.38	1.0
trans-1,2-dichloroethene	98.96	1.0
1,1-dichloroethane	98.96	1.0
cis-1,2-dichloroethene	96.94	1.0
chloroform	119.38	1.0
1,2-dichloroethane	98.96	1.0
1,1,1-trichloroethane	133.41	1.0
benzene	78.11	1.0
carbon tetrachloride	153.82	1.0
1,2-dichloropropane	113	1.0
trichloroethene	131.38	1.0
cis-1,3-dichloropropene	110.97	1.0
trans-1,3-dichloropropene	110.97	1.0
1,1,2-trichloroethane	133.41	1.0
toluene	92.14	1.0
1,2-dibromoethane	187.87	1.0
tetrachloroethene	165.83	1.0
chlorobenzene	112.56	1.0
ethylbenzene	106.17	1.0
m-xylene	106.17	1.0
p-xylene	106.17	1.0
styrene	104.15	1.0
1,1,2,2-tetrachloroethane	167.85	1.0
o-xylene	106.17	1.0
1,3,5-trimethylbenzene	120.2	1.0
1,2,4-trimethylbenzene	120.2	1.0
1,3-dichlorobenzene	147.0	1.0
1,4-dichlorobenzene	147.0	1.0
1,2-dichlorobenzene	147.0	1.0
1,2,4-trichlorobenzene	181.45	1.0
hexachlorobutadiene	260.76	1.0

TO-15 Primary Standard Mix #2

COMPOUND	MOL WGT	Conc. ppmV
Propylene	42.08	1.0
1,3-butadiene	54.09	1.0
Vinyl bromide	106.96	1.0
Acetone	58.08	1.0
Isopropyl alcohol	60.1	1.0
Carbon disulfide	76.14	1.0
3-chloropropene	76.53	1.0
Trans-1,2-dichloroethene	96.94	1.0
Methyl-tert butyl ether	88.15	1.0
Vinyl acetate	86.09	1.0
2-butanone (MEK)	72.11	1.0
Hexane	86.18	1.0
Ethyl acetate	88.11	1.0
Tetrahydrofuran	72.11	1.0
Cyclohexane	84.16	1.0
Bromodichloromethane	163.83	1.0
1,4-dioxane	88.11	1.0
2,2,4-trimethylpentane	114.23	1.0
Heptane	100.21	1.0
4-methyl-2-pentanone (MIBK)	100.16	1.0
2-hexanone	100.16	1.0
Dibromochloromethane	208.29	1.0
Bromoform	252.75	1.0
Benzyl chloride	126.59	1.0
4-ethyl toluene	120.2	1.0

Table 2B

TO-15 Purchased Custom Mix #3

TO-15 Custom Standard Mix					
COMPOUND	**MOL WGT**	**Conc. ppmV**	**COMPOUND**	**MOL WGT**	**Conc. ppmV**
Propane	44.10	1.0	n-Octane	114.23	1.0
Chlorodifluoromethane	86.47	1.0	1,1,1,2-Tetrachloroethane	167.85	1.0
Methanol	32.04	5.0	1,2,3-Trichloropropane	147.43	1.0
n-Butane	58.12	1.0	Nonane	128.26	1.0
Dichlorofluoromethane	102.92	1.0	Isopropylbenzene	120.19	1.0
Ethanol	46.07	5.0	Bromobenzene	157.01	1.0
Acetonitrile	41.05	1.0	2-Chlorotoluene	126.58	1.0
Acrolein	56.10	1.0	n-Propylbenzene	120.19	1.0
n-Pentane	72.20	1.0	4-Chlorotoluene	126.58	1.0
Acrylonitrile	53.10	1.0	tert-Butylbenzene	134.20	1.0
Ethyl Ether	74.12	1.0	n-Decane	142.28	1.0
tert-Butyl Alcohol	74.12	1.0	sec-Butylbenzene	134.20	1.0
2,2-Dichloropropane	112.99	1.0	p-Isopropyltoluene	134.22	1.0
Di-Isopropyl Ether	102.17	1.0	n-Butylbenzene	134.20	1.0
Tert-Butyl Ethyl Ether	102.20	1.0	1,2-Dibromo-3-chloropropane	236.33	1.0
1,1-Dichloropropene	110.97	1.0	n-Undecane	156.31	1.0
Tert Amyl Methyl Ether	102.17	1.0	Naphthalene	128.17	1.0
Dibromomethane	173.83	1.0	n-Dodecane	170.33	1.0
1,3-Dichloropropane	112.99	1.0	1,2,3-Trichlorobenzene	181.45	1.0
n-Butyl Acetate	116.16	1.0			

All mixes currently purchased fromPraxair (formerly Linde and Spectra Gases)

Table 2C

TO-15 / PIANO Custom Mix #4

COMPOUND (liquids)	Boiling Pt, deg C	Molecular Weight	Density ug/uL	uL injected*	FINAL ppmV
1,1-difluoroethane (gas)	-24.7	66.05	NA	10 mL	5.0
1-ethyl-1-methylcyclopentane	121.55	112.21	785.4	11.9	1.0
Indan	177	118.18	965.0	10.2	1.0
Indene	182	116.16	996.0	9.7	1.0
1,2,3-trimethylbenzene	176	120.19	890.0	11.2	1.0
Acetaldehyde	20.2	44.05	785	23.3	5.0
Acetone	56.1	58.08	784.5	24.6	4.0
isopropyl alcohol	82.6	60.1	786	9.5	1.5
methyl methacrylate	101	100.1	940	8.8	1.0

Table 2D

TO-15 / PIANO Custom Mix #5

COMPOUND (liquids)	Boiling Pt, deg C	Molecular Weight	Density ug/uL	uL injected*	FINAL ppmV
Thiophene	83	84.14	1060	6.6	1.0
2-Ethylthiophene	133	112.19	990	9.4	1.0
2-methyllthiophene	114	98.17	1016	8.0	1.0
3-Methylthiophene	113	98.17	1017	8.0	1.0

* both mixes #4 and #5 prepared in 29.5 L high pressure cylinders, pressurized to 995 psia with UHP nitrogen. Total volume of standard is 1997 L. Two year expiration date.

Table 3A

Summary of Secondary Standards Preparation

Primary Standard	Primary Standard Conc. ppmV	Volume of Primary Standard Injected into canister	Primary Standard Transfer Method	Final Volume canister (L)	Final Concentration ppbV **
Secondary standards prepared using precision dilution system (Entech 4700)					
TO-15 Mixes #1 - #5	1.0	3000 mL	Pressure differential	30	100
TO-15 Mixes #1 - #5	1.0	300 mL	Pressure differential	51	10 ***
Secondary standards prepared via serial dilution					
100 ppbV ICAL mix	1.0	300 mL	Syringe Injection	30	1.0
100 ppbV ICAL mix	0.1 *	30 mL	Syringe Injection	30	0.1

All standards prepared using humidified nitrogen.

* This calibration standard is used for TO-15 SIM analysis only (see Appendix B).

** The following analytes have concentrations that are greater than the listed concentration

Methanol, acetylaldehyde, and ethanol – 5 times greater

m&p-xylene- 2 times greater

Isopropyl alcohol-2.5 times greater

*** 10 ppbV standards that are prepared at a pressure of 50 psia are split out into additional empty 15L canisters to reduce the pressure in the standard and allow for additional canisters to be prepared for continuing calibration usage.

Table 3B

Preparation of Calibration Standards for Low Vapor Pressure Compounds

COMPOUND (solids)	Vapor Pressure* (P), atm	Molecular Weight	Volume (V) extracted, mL	Gas Constant (R) (L atm/gm mol K)	T, °K	n**	Final Volume, L	mg	ug/m^3	ppbV
1-methylnaphthalene	7.11E-05	142.20	7.1	0.082057	298.1	2.44E-08	51	0.00347	115.7	10
1-methylnaphthalene	7.11E-05	142.00	42	0.082057	298.1	1.22E-07	30	0.0173255	577.5	100
2-methylnaphthalene	8.96E-05	142.00	5.8	0.082057	298.1	2.491E-08	51	0.0035373	117.9	10.2
2-methylnaphthalene	8.96E-05	142.00	34	0.082057	298.1	1.246E-07	30	0.0176867	589.6	101.6
benzothiophene	7.70E-05	134.20	6.5	0.082057	291.5	2.446E-08	51	0.0032824	109.4	10.0
benzothiophene	7.70E-05	134.20	38	0.082057	291.5	1.223E-07	30	0.016412	547.1	100

Approximately 5.0 g of solid material was allowed to stand in a 250 mL jar w/ septa cap for 30 min prior to removal of vapor phase aliquot. The aliquot was then spiked directly into secondary standard.

All vapor pressure values from Lange's Handbook of Chemistry & Physics

Table 4

Calibration Standard Levels

Calibration Level	Amount (ppbV)	Volume / Secondary Standard
1	0.20	50 mL of 1.0 ppbV sec. standard
2	0.50	125 mL of 1.0 ppbV sec. standard
3	1.0	250 mL of 1.0 ppbV sec. standard
4	5.0	125 mL of 10 ppbV sec. standard
5	10	250 mL of 10 ppbV sec. standard
6	20	50 mL of 100 ppbV sec. standard
7	50	125 mL of 100 ppbV sec. standard
8	100	250 mL of 100 ppbV sec. standard

Table 5

BFB Key Ions and Abundance Criteria

Mass	Ion Abundance Criteria
50	8.0-40.0 percent of the base peak
75	30.0-66.0 percent of the base peak
95	Base peak, 100 percent relative abundance
96	5.0-9.0 percent of the base peak
173	Less than 2.0% of mass 174
174	50.0 to 120.0% of mass 95
175	4.0-9.0 percent of mass 174
176	Greater than 93.0 percent but less than 101.0 percent of mass 174
177	5.0-9.0 percent of mass 176

Table 6

ENTECH 7016D/ 7200 or 7200A Operating Parameters

Module 1 (Cold Trap)

Parameter	Setting
Trapping Temperature	-40° C
Internal standard / surrogate volume	100 mL
Internal standard / surrogate flow rate	100 mL / min
Nominal Sample volume (may vary depending on sample concentrations)	250 mL
Sample flow rate, mL / min	100 mL / min
Preheat Temperature	10° C
Desorb Temperature	10° C
Bake Temperature	220° C
Bake Time	10 min
Module 1 to Module 2 transfer volume / rate	20 cc @ 5.0 cc/min

Module 2 (Tenax trap)

Parameter	Setting
Trapping Temperature	-65° C to -75° C
Desorb Temperature	220° C
Bake Temperature	220° C
Module 2 to Module 3 desorb time	3.5 min

Module 3 (Cryofocusser)

Parameter	Setting
Cryofocusing Temperature	-130° C to -190° C
Desorb Temperature	Approx. 90° C
Module 3 to GC desorb time	3.0-3.5 min
Bake temperature / event	Approx. 90° C / event 3
Delay time	13-17 min

Table 7
Quantitation and Secondary Ions for TO-15 Analytes and Internal Standards

Compound	Quant. Ion	Sec. Ion(s)
bromochloromethane	49	130
chlorodifluoromethane	51	67
propylene	41	39, 42
propane	29	43,39
dichlorodifluoromethane	85	87
chloromethane	50	52
Freon-114	85	87, 135
methanol	31	32,29
vinyl chloride	62	64,
1,3-butadiene	54	39
butane	43	41,58
bromomethane	94	96
chloroethane	64	66
dichlorofluoromethane	67	69, 47
ethanol	31	45
acetonitrile	41	40
vinyl bromide	106	108
acrolein	56	55,29
acetone	43	58
trichlorofluoromethane	101	103
isopropyl alcohol	45	59
acrylonitrile	53	52,51
pentane	43	57,72
ethyl ether	31	59,45
1,1-dichloroethene	61	96, 63
Tertiary butyl Alcohol	59	41, 43
methylene chloride	49	84
3-chloropropene	41	39, 76
carbon disulfide	76	44
Freon 113	101	85, 151
trans-1,2-dichloroethene	61	96, 98
1,1-dichloroethane	63	65
MTBE	73	57, 43
vinyl acetate	43	86
2-butanone	43	72
cis-1,2-dichloroethene	61	96, 98
chloroform	83	85, 47
1,2-dichloroethane	62	49, 63, 64
acetaldehyde	29	43, 44
1,4-difluorobenzene	114	63
n-hexane	57	43, 86
diisopropyl ether	87	45, 59
ethyl acetate	61	43, 70
2,2-dichloropropane	77	41, 97
tetrahydrofuran	42	71, 72
tert-butyl ethyl ether	59	87, 57
1,2-dichloroethane-D4	65	67, 102
1,1,1-trichloroethane	97	61, 119
1,1-dichloropropene	75	39,110
benzene	78	52
carbon tetrachloride	117	119, 82
cyclohexane	56	84, 41
tert-amyl methyl ether	73	43, 87
dibromomethane	93	95, 174
1,2-dichloropropane	63	39, 62
bromodichloromethane	83	85, 129
trichloroethene	130	132, 97
1,4-dioxane	88	58
2,2,4-trimethylpentane	57	41, 99
n-heptane	43	57, 100
cis-1,3-dichloropropene	75	39, 77
4-methyl-2-pentanone	43	58, 100
methyl methacrylate	41	69, 100
trans-1,3-dichloropropene	75	39, 77
1,1,2-trichloroethane	97	61, 83
Thiophene	84	45, 58
chlorobenzene-D5	54	82, 117
toluene	91	92
toluene-D8	98	100
1,3-dichloropropane	76	41,49
2-hexanone	43	58, 100
dibromochloromethane	129	127, 131
1,2-dibromoethane	107	109
butyl acetate	73	43, 56
octane	85	43, 57, 114
tetrachloroethene	166	94, 131
1,1,1,2-tetrachloroethane	131	95, 133
chlorobenzene	112	77, 114
ethylbenzene	91	106
m+p-xylene	91	106
bromoform	173	171, 175
styrene	104	103, 78
1,1,2,2-tetrachloroethane	83	85
o-xylene	91	106
1,2,3-trichloropropane	75	39, 110
nonane	43	57, 128
bromofluorobenzene	95	75, 174
isopropylbenzene	105	120
bromobenzene	77	156
2-chlorotoluene	126	91
n-propylbenzene	120	91
4-chlorotoluene	91	126
4-ethyl toluene	105	91, 120
1,3,5-trimethylbenzene	105	91, 120
tert-butlybenzene	119	134
1,2,4-trimethylbenzene	105	91, 120
decane	57	43, 142
benzyl chloride	91	126
1,3-dichlorobenzene	146	75, 111
1,4-dichlorobenzene	146	75, 111
sec-butylbenzene	105	134
p-isopropyltoluene	119	134
1,2-dichlorobenzene	146	75, 111
n-butylbenzene	91	134
1,2-dibromo-3-chloropropane	75	39, 157
undecane	57	43, 71, 156
dodecane	57	43
1,2,4-trichlorobenzene	180	109, 145
naphthalene	128	102
1,2,3-trichlorobenzene	180	109, 145
hexachlorobutadiene	225	118, 260
2-methylthiophene	97	45, 98
3-methylthiophene	97	45, 98
2-ethylthiophene	97	45, 112
1,2,3-trimethylbenzene	105	120
indan	117	91, 118
indene	115	89, 116
1,2,4,5-tetramethylbenzene	119	91, 134
benzothiophene	134	63, 89
2-methylnaphthalene	142	115, 141
1-methylnaphthalene	142	115, 141

Table 8

Internal Standards and the Associated Target Analytes

bromochloromethane		1,4-difluorobenzene	chlorobenzene-D5	
chlorodifluoromethane	trans-1,2-dichloroethene	hexane	toluene	decane
propylene	1,1-dichloroethane	diisopropyl ether	toluene-D8	benzyl chloride
propane	MTBE	tert-butyl ethyl ether	1,3-dichloropropane	1,3-dichlorobenzene
dichlorodifluoromethane	vinyl acetate	1,2-dichloroethane-D4	2-hexanone	1,4-dichlorobenzene
chloromethane	2-butanone	1,1,1-trichloroethane	dibromochloromethane	sec-butylbenzene
Freon-114	cis-1,2-dichloroethene	1,1-dichloropropene	1,2-dibromoethane	p-isopropyltoluene
methanol	chloroform	benzene	butyl acetate	1,2-dichlorobenzene
vinyl chloride	1,2-dichloroethane	carbon tetrachloride	Octane	n-butylbenzene
1,3-butadiene	trans-1,2-dichloroethene	cyclohexane	tetrachloroethene	1,2-dibromo-3-chloropropane
butane	1,1-dichloroethane	tert-amyl methyl ether	1,1,1,2-tetrachloroethane	undecane
bromomethane	acetaldehyde	dibromomethane	Chlorobenzene	dodecane
chloroethane	ethyl acetate	1,2-dichloropropane	Ethylbenzene	1,2,4-trichlorobenzene
dichlorofluoromethane	2,2-dichloropropane	bromodichloromethane	m+p-xylene	naphthalene
ethanol	tetrahydrofuran	trichloroethene	Bromoform	1,2,3-trichlorobenzene
acetonitrile		1,4-dioxane	Styrene	hexachlorobutadiene
vinyl bromide		2,2,4-trimethylpentane	1,1,2,2-tetrachloroethane	2-methylthiophene
acrolein		heptane	o-xylene	3-methylthiophene
acetone		cis-1,3-dichloropropene	1,2,3-trichloropropane	2-ethylthiophene
trichlorofluoromethane		4-methyl-2-pentanone	Nonane	1,2,3-trimethylbenzene
isopropyl alcohol		methyl methacrylate	bromofluorobenzene	indan
acrylonitrile		trans-1,3-dichloropropene	isopropylbenzene	indene
pentane		1,1,2-trichloroethane	bromobenzene	1,2,4,5-tetramethylbenzene
ethyl ether		thiophene	2-chlorotoluene	benzothiophene
1,1-dichloroethene			n-propylbenzene	2-methylnaphthalene
Tertiary butyl Alcohol			4-chlorotoluene	1-methylnaphthalene
methylene chloride			4-ethyl toluene	
3-chloropropene			1,3,5-trimethylbenzene	
carbon disulfide			tert-butlybenzene	
Freon 113			1,2,4-trimethylbenzene	

Table 9A

TO-15 Target Analytes and Reporting Limits
Standard List

COMPOUND	CAS #	Standard Reporting Limit, ppbV	Standard Reporting Limit, ug/m^3
1,1,1-trichloroethane	71-55-6	0.2	1.09
1,1,2,2-tetrachloroethane	79-34-5	0.2	1.37
1,1,2-trichloroethane	79-00-5	0.2	1.09
1,1-dichloroethane	75-34-3	0.2	0.81
1,1-dichloroethene	75-35-5	0.2	0.79
1,2,4-trichlorobenzene	120-82-1	0.2	1.48
1,2,4-trimethylbenzene	95-63-6	0.2	0.98
1,2-dibromoethane	106-93-4	0.2	1.54
1,2-dichlorobenzene	95-50-1	0.2	1.2
1,2-dichloroethane	107-06-2	0.2	0.81
1,2-dichloropropane	78-87-5	0.2	0.92
1,3,5-trimethylbenzene	108-67-8	0.2	0.98
1,3-butadiene	106-99-0	0.2	0.44
1,3-dichlorobenzene	541-73-1	0.2	1.2
1,4-dichlorobenzene	106-46-7	0.2	1.2
1,4-dioxane	123-91-1	0.2	0.72
2,2,4-trimethylpentane	540-84-1	0.2	0.93
2-butanone	78-93-3	0.5	1.48
2-hexanone	591-78-6	0.2	0.82
3-chloropropene	107-05-1	0.2	0.63
4-Ethyltoluene	622-96-8	0.2	0.98
Acetone	67-64-1	1.0	2.38
benzene	71-43-2	0.2	0.64
Benzyl Chloride	100-44-7	0.2	1.03
bromodichloromethane	75-27-4	0.2	1.34
bromoform	75-25-2	0.2	2.07
bromomethane	74-83-9	0.2	0.78
carbon disulfide	75-15-0	0.2	0.62
carbon tetrachloride	56-23-5	0.2	1.26
chlorobenzene	108-90-7	0.2	0.92
chloroethane	75-00-3	0.2	0.53
chloroform	67-66-3	0.2	0.98
chloromethane	74-87-3	0.2	0.41
cis-1,2-dichloroethene	156-59-2	0.2	0.79
cis-1,3-dichloropropene	10061-01-5	0.2	0.91
cyclohexane	110-82-7	0.2	0.69
dibromochloromethane	124-48-1	0.2	1.7
dichlorodifluoromethane	75-71-8	0.2	0.99
ethanol	64-17-5	2.5	4.71
ethyl acetate	141-78-6	0.5	1.8
ethylbenzene	100-41-4	0.2	0.87
Freon-113	76-13-1	0.2	1.53
Freon-114	76-14-2	0.2	1.4
hexachlorobutadiene	87-68-3	0.2	2.13
hexane	110-54-3	0.2	0.7
isopropyl alcohol	67-63-0	0.5	1.23
methylene chloride	75-09-2	0.5	1.74
MIBK	108-10-1	0.5	2.1
MTBE	1634-04-4	0.2	0.72
m+p-xylene	108-38-3 106-42-3	0.4	1.74
n-heptane	142-82-5	0.2	0.82
o-xylene	95-47-6	0.2	0.87
propylene	115-7-1	0.5	0.85
styrene	100-42-5	0.2	0.85
tetrachloroethene	127-18-4	0.2	1.36
tetrahydrofuran	109-99-9	0.5	1.48
toluene	108-88-3	0.2	0.75
trans-1,2-dichloroethene	156-60-5	0.2	0.79
trans-1,3-dichloropropene	10061-02-6	0.2	0.91
trichloroethene	79-01-6	0.2	1.07
trichlorofluoromethane	75-69-4	0.2	1.12
vinyl acetate	108-05-4	0.5	1.75
vinyl bromide	593-60-2	0.2	0.87
vinyl chloride	75-01-4	0.2	0.51

Table 9B

TO-15 Target Analytes and Reporting Limits
Additional Analytes

COMPOUND	CAS #	Standard Reporting Limit, ppbV	Standard Reporting Limit, ug/m^3
AP-42 Analytes			
acrolein	107-02-8	0.50	1.15
acrylonitrile	107-13-1	0.50	1.08
butane	106-97-8	0.20	0.48
Chlorodifluoromethane	75-45-6	0.20	0.71
Dichlorofluoromethane	75-71-8	0.20	0.84
n-Pentane	109-66-0	0.20	0.59
Propane	74-98-6	0.50	0.90
MADEP MCP 8260 Analytes			
1,1,1,2-tetrachloroethene	630-20-6	0.20	1.37
1,1-dichloropropene	563-58-6	0.20	0.91
1,2,3-trichlorobenzene	87-61-6	0.20	1.48
1,2,3-Trichloropropane	96-18-4	0.20	1.20
1,3-dichloropropane	142-28-9	0.20	0.92
2,2-dichloropropane	594-20-7	0.20	0.92
2-chlorotoluene	95-49-8	0.20	1.03
4-chlorotoluene	106-43-4	0.20	1.03
bromobenzene	108-86-1	0.20	1.28
1,2-dibromo-3-chloropropane	96-12-8	0.20	1.93
dibromomethane	74-95-3	0.20	1.42
diisopropyl ether	108-20-3	0.20	0.84
isopropylbenzene	98-82-8	0.20	0.98
isopropyltoluene	99-87-6	0.20	1.10
naphthalene	91-20-3	0.20	1.05
n-butylbenzene	104-51-8	0.20	1.10
n-propylbenzene	103-65-1	0.20	0.98
sec-butylbenzene	135-98-8	0.20	1.10
tert-amyl methyl ether	994-05-8	0.20	0.84
tert-Butyl ethyl ether	637-92-3	0.20	0.84
tert-butylbenzene	98-06-6	0.20	1.10

COMPOUND	CAS #	Standard Reporting Limit, ppbV	Standard Reporting Limit, ug/m^3
NYDEC Petroleum Indicator Compounds			
nonane	111-84-2	0.20	1.05
octane	111-65-9	0.20	0.93
undecane	1120-21-4	0.20	1.28
decane	124-18-5	0.20	1.16
dodecane	112-40-3	0.20	1.39
indene	95-13-6	0.20	0.95
Indan	496-11-7	0.20	0.97
thiophene	110-02-1	0.20	0.69
2-methylthiophene	554-13-3	0.20	0.80
3-methylthiophene	616-44-4	0.20	0.80
2-ethyl thiophene	872-55-9	0.20	0.92
benzothiophene	934-80-5	0.50	2.74
1,2,3-trimethylbenzene	526-73-8	0.20	0.98
1,2,4,5-tetramethylbenzene	95-93-2	0.20	1.10
2-methylnaphthalene	91-57-6	1.0	5.8
1-methylnaphthalene	90-12-0	1.0	5.8
Project Specific Analytes			
acetaldehyde	75-07-0	2.5	4.51
Acetonitrile	75-05-8	0.20	0.34
butyl acetate	123-86-4	0.50	2.38
ethyl ether	60-29-7	0.20	0.61
methanol	67-56-1	5.0	6.55
tert-butyl alcohol	75-65-0	0.50	1.51
Methyl methacrylate	80-62-6	0.50	2.05
All reporting limits are subject to change.			

Appendix A

Cold Trap Dehydration technique (CTD) for Analysis of Sulfides and Mercaptans by EPA TO-15

Target analytes:

Compound	CAS#	Reporting Limit, ppbV
Hydrogen sulfide	7783-06-4	2.0
Carbonyl sulfide	463-58-1	2.0
Methyl mercaptan	74-93-1	2.0
Ethyl mercaptan	75-08-1	0.5
Dimethyl sulfide	75-18-3	0.5
carbon disulfide	75-15-0	0.5
Isopropyl Mercaptan	75-33-2	0.5
tert-Butyl Mercaptan	75-66-1	0.5
n-Propyl Mercaptan	107-03-9	0.5
Ethyl Methyl Sulfide	624-89-5	0.5

Compound	CAS#	Reporting Limit, ppbV
Thiophene	110-02-1	0.5
Isobutyl Mercaptan	513-44-0	0.5
diethyl sulfide	352-93-2	0.5
Butyl Mercaptan	109-75-5	2.0
dimethyl disulfide	624-92-0	0.5
3-Methylthiophene	616-44-4	0.5
Tetrahydrothiophene	110-01-0	0.5
2-Ethylthiophene	872-55-9	0.5
2,5-Dimethylthiophene	638-02-8	0.5
Diethyl Disulfide	110-81-6	0.5
All reporting limits are subject to change.		

The cold trap dehydration method requires a blank trap (i.e. no trapping material) be installed in module 1 of the Entech 7200 or 7200A concentrator. This trap is cooled and a 250 mL aliquot of sample is allowed to pass through this trap and then directly onto the Tenax trap in module 2, which is also cooled (see Table A-5 for setpoints). The sample is then transferred to module 3 (cryofocusser) via ballistic heating. All requirements stated in this SOP must be applied to any TO15-Sulfide/Mercaptan analysis conducted in the laboratory.

SOP modifications:

Standard preparation and calibration procedures for these analytes are listed in Table A-1 through A-5. Quantitation parameters are listed in Table A-8. Table A-7 lists modified GC conditions.

Section 9.2.5 and 9.5.3.1: Use the Entech method alpha_H2S&SULF.CTD in place of the alpha_TO15.MPT method.

A second source laboratory check standard (LCS) is not readily available for these analytes. An LCS standard is prepared at a different concentration than the initial calibration standards using the same stock standard.

Table A-1

Sulfide/Mercaptan Primary Standard Mix #1

COMPOUND	CAS#	Molecular Weight	Concentration, ppmV
hydrogen sulfide	7783-06-4	34.08	5.0
Carbonyl sulfide	463-58-1	60.08	5.0
Methyl mercaptan	74-93-1	48.11	5.0
ethyl mercaptan	75-08-1	62.14	1.0
dimethyl sulfide	75-18-3	62.14	1.0
carbon disulfide	75-15-0	76.1	1.0
Isopropyl Mercaptan	75-33-2	76.2	1.0
tert-Butyl Mercaptan	75-66-1	90.19	1.0
n-Propyl Mercaptan	107-03-9	76.16	1.0
Ethyl Methyl Sulfide	624-89-5	76.16	1.0
Thiophene	110-02-1	84.1	1.0
Isobutyl Mercaptan	513-44-0	90.19	1.0
diethyl sulfide	352-93-2	90.2	1.0
Butyl Mercaptan	109-79-5	90.19	4.0
3-Methylthiophene	616-44-4	98.17	1.0
Tetrahydrothiophene	110-01-0	88.17	1.0
2-Ethylthiophene	872-55-9	112.19	1.0
2,5-Dimethylthiophene	638-02-8	112.19	1.0

Table A-2

Sulfide/Mercaptan Primary Standard Mix #2

COMPOUND	CAS#	Molecular Weight	Concentration, ppmV
dimethyl disulfide	624-92-0	94.2	1.0

Table A-3

Sulfide/Mercaptan Primary Standard Mix #3

COMPOUND	CAS#	Molecular Weight	Concentration, ppmV
Diethyl Disulfide	110-81-6	122.25	1.0

Table A-4

Summary of Secondary Standards Preparation for Sulfides and Mercaptan Analysis

Primary Standard	Primary Standard Conc. ppmV	Volume of Primary Standard Injected into Tedlar® Bag	Primary Standard Transfer Data	Final Volume Tedlar® Bag (L)	Final Concentration ppbV
Secondary standards prepared using gas-tight syringes					
Tedlar® bag primary standard-Low	1- 5ppmV	20 mL	Syringe Injection	4.0	5.0 / 20.0 / 20
Tedlar® bag primary standard-High	1- 5ppmV	400 mL	Syringe Injection	4.0	100 / 400 / 500
Tedlar® bag primary standard-LCS	1- 5ppmV	40 mL	Syringe Injection	4.0	10 / 40 / 50

Table A-5

Calibration Standard Levels

Calibration Level	Amount (ppbV)	Volume / Secondary Standard
1	0.50	25 mL of 5.0 ppbV sec. standard
2	1.0	50 mL of 5.0 ppbV sec. standard
3	5.0	250 mL of 5.0 ppbV sec. standard
4	10	25 mL of 100 ppbV sec. standard
5	20	50 mL of 100 ppbV sec. standard
6	50	125 mL of 100 ppbV sec. standard
7	80	200 mL of 100 ppbV sec. standard
8	100	250 mL of 100 ppbV sec. standard

Table A-6

ENTECH & 7016D/7200 or 7200A Operating Parameters for CTD Method

Module 1 (Blank Trap)	
Parameter	**Setting**
Trapping Temperature	-20° C
Internal standard volume	100 mL
Internal standard flow rate	60 mL / min
Sample volume (may vary depending on sample concentrations)	250 mL
Sample flow rate	100 mL / min
Preheat Temperature	10° C
Desorb Temperature	10° C
Bake Temperature	220° C
Bake Time	10 min.
Module 2 (Tenax trap)	
Parameter	**Setting**
Trapping Temperature	-70° C
Desorb Temperature	180° C
Bake Temperature	220° C
Module 2 to Module 3 desorb time	3.5 min
Module 3 (Cryofocusser)	
Parameter	**Setting**
Cryofocusing Temperature	-130° C
Desorb Temperature	Approx. 70° C
Module 3 to GC desorb time	2 min
Bake temperature / event	Approx. 90° C / event 3
Delay time	10 min

Table A-7

Internal Standard (IS) Assignments and Quantitation Ions for Sulfides & Mercaptans

Compound	Quant Ion	Sec. Ion(s)
Bromochloromethane (IS)	49	130
Hydrogen sulfide	34	33, 36
Carbonyl sulfide	60	62, 32
Methyl mercaptan	47	48, 45
ethyl mercaptan	62	47, 29
dimethyl sulfide	62	45, 47
carbon disulfide	76	44, 78
Isopropyl Mercaptan	43	41, 76
tert-Butyl Mercaptan	41	57, 90
n-Propyl Mercaptan	76	47, 43
Ethyl Methyl Sulfide	61	76, 48

Compound	Quant Ion	Sec. Ion(s)
1,4-difluorobenzene (IS)	114	63
Thiophene	84	58, 45
Isobutyl Mercaptan	41	56, 90
diethyl sulfide	75	90, 47
Butyl Mercaptan	56	41, 90
dimethyl disulfide	94	79, 45

Compound	Quant Ion	Sec. Ion(s)
Chlorobenzene-D5 (IS)	54	82, 117
3-Methylthiophene	97	98, 45
Tetrahydrothiophene	60	88, 45
2-Ethylthiophene	97	112, 45
2,5-Dimethylthiophene	111	112,97
Diethyl Disulfide	122	66, 94

Appendix B

Data Acquistion Parameters and Analysis Modifications for Conducting SIM Analysis

SIM analysis is conducted when full scan sensitivity does not meet the data quality objectives (DQO) of the project and/or regulatory criteria. The acquisition method used to acquire full scan data simultaneously acquires SIM data using the SIM ions and windows specified in Table B-1. The following modifications to the full scan SOP must be done to generate data using the SIM signal:

- SIM level calibration standards must be analyzed w/ the full scan curve (0.02,0.05, and 0.1 ppbV)
- A calibration curve is generated using the SIM signal utilizing the lower level calibration standards and must meet the same criteria as the full scan calibration criteria.
- The continuing calibration /LCS should be analyzed at a lower concentration (5.0 ppbV). If a separate continuing calibration run is needed, the continuing calibration level of 10 ppbV may be utilized. Laboratory Method Blanks must be evaluated for the SIM reporting limit as listed in Table B-2.

The SIM signal only acquires data for a limited target analyte list. These target analytes and reporting limits are listed in Table B-2. Additional ions have been added to allow for more analytes to be added, if requested by client. All requirements stated in this SOP must be applied to any TO15-SIM analysis conducted in the laboratory.

Table B-1

Calibration Standard Levels for SIM Analysis

Calibration Level	Amount (ppbV)	Volume / Secondary Standard
1	0.02	50 mL of 0.10 ppbV sec. standard
2	0.05	125 mL of 0.1 ppbV sec. standard
3	0.10	250 mL of 0.1 ppbV sec. standard
4	0.20	50 mL of 1.0 ppbV sec. standard
5	0.50	125 mL of 1.0 ppbV sec. standard
6	1.0	250 mL of 1.0 ppbV sec. standard
7	5.0	125 mL of 10 ppbV sec. standard
8	10	250 mL of 10 ppbV sec. standard
9	20	50 mL of 100 ppbV sec. standard
10	50	125 mL of 100 ppbV sec. standard

Table B-2

Seletive Ion Monitoring (SIM) Groupings

Group #	**1**	**2**		**3**	**5**	**6**	**7**		**8**	**9**		**10**		**11**	**12**
Group Start Time, min	**0**	**5.9**		**8.75**	**10.1**	**10.9**	**11.6**		**13.8**	**14.6**		**16.6**		**18.8**	**20.5**
Dwell time, sec	**25**	**10**		**25**	**25**	**25**	**15**		**25**	**15**		**3**		**5**	**25**
Cycles/sec (calc)	**2**	**2.5**		**3.3**	**2.1**	**2.3**	**1.8**		**5.7**	**2.2**		**7**		**7**	**2.3**
Analyte Range, Compound #	**C2-C7**	**C8-C20**		**C21-C26**	**C27-C29, BCM (IS)**	**C30-C34**	**C35-C44, 1,4-DFB (IS)**		**C45-C46**	**C47-C55**		**C56-C67, CHB-D5 (IS)**		**C68-C76**	**C77-C80**
Ions	29	29	63	43	41	42	39	85	39	39	92	39	106	39	43
	31	31	64	57	43	49	41	87	43	41	94	43	110	43	57
	32	39	66	61	45	51	43	88	58	43	97	45	112	57	63
	39	40	67	63	47	57	45	93	75	45	98	54	114	71	89
	41	41	69	65	49	59	52	95	77	49	100	57	117	75	102
	42	43	72	72	57	62	56	97	100	56	107	75	120	89	109
	43	44	76	73	59	63	57	99		57	109	77	126	91	115
	44	45	84	86	61	64	58	100		58	114	78	128	105	118
	50	47	85	96	70	65	62	110		61	127	82	131	111	128
	51	49	94	98	77	67	63	114		73	129	83	133	115	134
	52	51	96	117	83	71	69	117		75	131	85	156	116	141
	54	52	101	198	85	72	73	119		76	166	91	171	117	142
	58	53	103		86	87	75	129		77		95	173	118	145
	62	55	106		87	97	78	130		83		97	174	119	180
	64	56	108		96	102	82	132		85		103	175	120	225
	67	57	151		97	119	83	174		91		104		126	260
	85	58			98		84					105		134	
	87	59			130									142	
	135	61												146	
														156	
														157	

Table B-3

TO15-SIM Target Analytes and Reporting Limits

COMPOUND	CAS #	SIM Reporting Limit, ppbV	SIM Reporting Limit, ug/m^3
1,1,1-trichloroethane	71-55-6	0.02	0.109
1,1,2,2-tetrachloroethane	79-34-5	0.02	0.137
1,1,2-trichloroethane	79-00-5	0.02	0.109
1,1-dichloroethane	75-34-3	0.02	0.081
1,1-dichloroethene	75-35-5	0.02	0.079
1,2,4-trimethylbenzene	95-63-6	0.02	0.098
1,2-dibromoethane	106-93-4	0.02	0.154
1,2-dichlorobenzene	95-50-1	0.02	0.12
1,2-dichloroethane	107-06-2	0.02	0.081
1,2-dichloropropane	78-87-5	0.02	0.092
1,2-dibromo-3-chloropropane	96-12-8	0.02	0.193
1,3,5-trimethylbenzene	108-67-8	0.02	0.098
1,3-butadiene	106-99-0	0.02	0.044
1,3-dichlorobenzene	541-73-1	0.02	0.12
1,4-dichlorobenzene	106-46-7	0.02	0.12
1,4-dioxane	123-91-1	0.10	0.36
2-hexanone	591-78-6	0.20	0.82
2,2,4-trimethylpentane	540-84-1	0.20	0.93
3-chloropropene	107-05-1	0.20	0.63
4-Ethyltoluene	622-96-8	0.02	0.098
benzene	71-43-2	0.10	0.223
benzyl chloride	100-44-7	0.20	1.03
bromodichloromethane	75-27-4	0.02	0.134
bromoform	75-25-2	0.02	0.207
bromomethane	74-83-9	0.02	0.078
carbon disulfide	75-15-0	0.20	0.62

COMPOUND	CAS #	SIM Reporting Limit, ppbV	SIM Reporting Limit, ug/m^3
hexachlorobutadiene	87-68-3	0.05	533
hexane	110-54-3	0.20	0.7
heptane	142-82-5	0.20	0.82
isopropyl alcohol	67-63-0	0.50	1.23
methylene chloride	75-09-2	0.50	1.74
MTBE	1634-04-4	0.02	0.072
m+p-xylene	108-38-3 106-42-3	0.04	0.174
o-xylene	95-47-6	0.02	0.087
propylene	115-7-1	0.50	0.85
styrene	100-42-5	0.02	0.085
tetrachloroethene	127-18-4	0.02	0.136
tetrahydrofuran	109-99-9	0.5	1.48
toluene	108-88-3	0.05	0.188
trans-1,2-dichloroethene	156-60-5	0.02	0.079
trans-1,3-dichloropropene	10061-02-6	0.02	0.091
trichlorofluoromethane	75-69-4	0.05	0.280
trichloroethene	79-01-6	0.02	0.107
1,2,4-trichlorobenzene	120-82-1	0.05	0.371
vinyl acetate	108-05-4	1.00	3.50
vinyl bromide	593-60-2	0.20	0.87
vinyl chloride	75-01-4	0.02	0.051

CT RSR Additional Analytes

COMPOUND	CAS #	SIM Reporting Limit, ppbV	SIM Reporting Limit, ug/m^3
1,1,1,2-tetrachloroethane	630-20-6	0.02	0.137
acrylonitrile	107-13-1	0.50	1.08
isopropyltoluene	99-87-6	0.20	1.1
n-butylbenzene	104-51-8	0.20	1.1

carbon tetrachloride	56-23-5	0.02	0.126
chlorobenzene	108-90-7	0.10	0.460
chloroethane	75-00-3	0.10	0.265
chloroform	67-66-3	0.02	0.098
chloromethane	74-87-3	0.20	0.41
cis-1,2-dichloroethene	156-59-2	0.02	0.079
cis-1,3-dichloropropene	10061-01-5	0.02	0.091
cyclohexane	110-82-7	0.2	0.69
dibromochloromethane	124-48-1	0.02	0.17
dichlorodifluoromethane	75-71-8	0.20	0.99
ethanol	64-17-5	5.0	9.42
ethyl acetate	141-78-6	0.50	1.8
ethylbenzene	100-41-4	0.02	0.087
Freon-113	76-13-1	0.05	0.383
Freon-114	76-14-2	0.05	0.349

sec-butylbenzene	135-98-8	0.20	1.1
tert-butylbenzene	98-06-6	0.20	1.1
isopropylbenzene	98-82-8	0.20	0.98
2-butanone (MEK)	78-93-3	0.50	1.48
Acetone	67-64-1	1.00	2.35
4-methyl-2-pentanone (MIBK)	108-10-1	0.50	2.05
Project & State Specific Analytes			
1,2,3-trichlorobenzene	87-61-6	0.05	0.371
1,2,3-Trichloropropane	96-18-4	0.02	0.12
acrolein	107-02-8	0.05	0.115
bromobenzene	108-86-1	0.20	1.28
Dibromomethane	74-95-3	0.20	1.42
Naphthalene	91-20-3	0.05	0.262
tertiary butyl alcohol	75-65-0	0.50	1.51

All reporting limits are subject to change.

Appendix C

Modifications to Data Review and Case Narrative to Comply with MADEP MCP TO-15 Method

This addendum addresses modifications to this SOP required to be in compliance with the MADEP MCP TO-15 method, specifically “Quality Control Requirements and Performance Standards for the ***Analysis of Volatile Organic Compounds in Air Samples (TO-15) by Gas Chromatography/Mass Spectrometry (GC/MS)*** in Support of Response Actions under the Massachusetts Contingency Plan (MCP)” Revision No. 0, Section IX B.

1) For duplicate analyses, the 25% RPD criteria stated in Sect. 9.6 of this SOP does not need to be applied to concentrations less than 5X the reporting limit.

2) Samples cannot be analyzed if any of the target analytes if the LCS recovery criteria stated in sect. 9.2 of this SOP is below 70% recovery. For compounds listed as difficult analytes (hexachlorobutadiene, 1,2,4-trichlorobenzene, naphthalene, acetone, and 1,4-dioxane), LCS recovery cannot be less than 50%.

3) Any analyte exceeding %RSD criteria of 30% during initial calibration that is a not listed in the MCP TO-15 method, but may still be reported to the client, must be noted in the case narrative.

Appendix E

Modifications to Data Review and Case Narrative to Comply with 2014 NJDEP Technical Guidance for EPA Method TO-15

This addendum addresses modifications to this SOP required to be in compliance with the NJDEP 2014 Technical Guidance, **"NJDEP Site Remediation Program, Data of Known Quality Protocol, Version 1, April 2014**". This guidance is to be used when analyzing samples via the EPA Method TO-15.

1) Per the Data of Know Quality Protocols Technical Guidance, surrogates are not required to be reported via EPA Method TO-15.

2) A target analyte list and reporting limits are specified in Table E-1, per the Analytical Laboratory Data Generation, Assessment and Usability Technical Guidance.

3) For the analytes ethanol and isopropyl alcohol, results are allowed to be reported outside the calibration range of the instrument, per the Analytical Laboratory Data Generation, Assessment and Usability Technical Guidance. Results reported that exceed the calibration range will be designated with an "E" qualifier.

4) **Laboratory Control Sample (LCS) criteria -** Must contain all target analytes, recovery range is 70-130%. Exceptions for difficult analytes (hexachlorobutadiene, 1,2,4-trichlorobenzene, naphthalene, acetone, dichlorodifluoromethane, and 1,4-dioxane) must exhibit percent recoveries between 40-160%. In addition, the CCAL analysis cannot be reported as the LCS even if it meets LCS requirements. The LCS must be a separate analysis, analyzed after a passing CCAL standard.

5) **Duplicate analyses** - The 25% RPD criteria stated in Sect. 9.6 of this SOP does not need to be applied to concentrations less than 5X the reporting limit.

6) **Tentatively Identified Compounds (TICs)** – up to 15 TICs must be reported, if present. If a reduced target analyte list is requested by client, TICs are not reported.

Table E-1

NJDEP 2014 Target Analytes and Reporting Limits via EPA Method TO-15

Required Compound Name	CAS Number	Molecular Weight	Reporting Limit ppbV	Reporting Limit ug/m^3
Acetone	67-64-1	58.08	5.0	12
Allyl chloride	107-05-1	76.53	0.2	0.6
Benzene	71-43-2	78.11	0.2	0.6
Bromodichloromethane	75-27-4	163.8	0.2	1
Bromoform	75-25-2	252.8	0.2	2
Bromomethane	74-83-9	94.94	0.2	0.8
1,3-Butadiene	106-99-0	54.09	0.2	0.4
Chlorobenzene	108-90-7	112.6	0.2	0.9
Chloroethane	75-00-3	64.52	0.5	1
Chloroform	67-66-3	119.4	0.2	1
Chloromethane	74-87-3	50.49	0.5	1
Carbon disulfide	75-15-0	76.14	0.5	2
Carbon tetrachloride	56-23-5	153.8	0.2	1
2-Chlorotoluene	95-49-8	126.6	0.2	1
Cyclohexane	110-82-7	84.16	0.2	0.7
Dibromochloromethane	124-48-1	208.3	0.2	2
1,2-Dibromoethane	106-93-4	187.9	0.2	2
1,2-Dichlorobenzene	95-50-1	147.0	0.2	1
1,3-Dichlorobenzene	541-73-1	147.0	0.2	1
1,4-Dichlorobenzene	106-46-7	147.0	0.2	1
Dichlorodifluoromethane	75-71-8	120.9	0.5	2
1,1-Dichloroethane	75-34-3	98.96	0.2	0.8
1,2-Dichloroethane	107-06-2	98.96	0.2	0.8
1,1-Dichloroethene	75-35-4	96.94	0.2	0.8
1,2-Dichloroethene (cis)	156-59-2	96.94	0.2	0.8
1,2-Dichloroethene (trans)	156-60-5	96.94	0.2	0.8
1,2-Dichloropropane	78-87-5	113.0	0.2	0.9
1,3-Dichloropropene (cis)	10061-01-5	111.0	0.2	0.9
1,3-Dichloropropene (trans)	10061-02-6	111.0	0.2	0.9
1,2-Dichlorotetrafluoroethane	76-14-2	170.9	0.2	1
1,4-Dioxane	123-91-1	88.12	5	18
Ethanol	64-17-5	46.07	5	9
Ethylbenzene	100-41-4	106.2	0.2	0.9
4-Ethyltoluene	622-96-8	120.2	0.2	1
n-Heptane	142-82-5	100.2	0.2	0.8
1,3-Hexachlorobutadiene	87-68-3	260.8	0.2	2
n-Hexane	110-54-3	86.17	0.2	0.7
Isopropanol	67-63-0	60.10	5	12

Table E-1 continued

Required Compound Name	CAS Number	Molecular Weight	Reporting Limit ppbV	Reporting Limit ug/m^3
Methylene chloride	75-09-2	84.94	0.5	2
Methyl ethyl ketone	78-93-3	72.11	0.5	1
Methyl isobutyl ketone	108-10-1	100.2	0.5	2
Methyl methacrylate	80-62-6	100.1	0.5	2
Methyl tert-butyl ether	1634-04-4	88.15	0.2	0.7
Styrene	100-42-5	104.1	0.2	0.9
Tert-butyl alcohol	75-65-0	74.12	5	15
1,1,2,2-Tetrachloroethane	79-34-5	167.9	0.2	1
Tetrachloroethene	127-18-4	165.8	0.2	1
Tetrahydrofuran	109-99-9	72.11	5	15
Toluene	108-88-3	92.14	0.2	0.8
1,2,4-Trichlorobenzene	120-82-1	181.5	0.5	4
1,1,1-Trichloroethane	71-55-6	133.4	0.2	1
1,1,2-Trichloroethane	79-00-5	133.4	0.2	1
Trichloroethene	79-01-6	131.4	0.2	1
Trichlorofluoromethane	75-69-4	137.4	0.2	1
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	187.4	0.2	2
1,2,4-Trimethylbenzene	95-63-6	120.2	0.2	1
1,3,5-Trimethylbenzene	108-67-8	120.2	0.2	1
2,2,4-Trimethylpentane	540-84-1	114.2	0.2	0.9
Vinyl bromide	593-60-2	106.9	0.2	0.9
Vinyl chloride	75-01-4	62.50	0.2	0.5
Xylenes (m&p)	179601-23-1	106.2	0.5	2
Xylenes (o)	95-47-6	106.2	0.2	0.9
Naphthalene (reported on request)	91-20-3	128.2	0.2	1

All reporting limits are subject to change.

Appendix F

Modifications to EPA TO-15 SOP to comply with Ohio EPA Voluntary Action Program (VAP) Requirements

This Appendix defines requirements that are necessary to perform TO-15 analysis for any samples submitted via the VAP Program. No deviations from the SOP are allowed under the VAP program.

1) Sec. 3 caveat – reporting limits defined in this SOP are subject to change.

2) Sec. 7 caveat – Equipment and supplies are subject to change.

3) Initial calibration acceptance – %RSD criteria must be as defined in the EPA TO-15 method; only 2 analytes allowed greater than 30% RSD, and must be less than 40%.

4) The Laboratory check standard (LCS) may not be used as the continuing calibration verification (CCV). A CCV and LCS must be analyzed prior to samples.

5) Tentatively Identified Compounds (TICs) may not be reported as certified values.

6) CCV-10% rule not allowed. All analytes reported must be +/- 30% D. (Criteria in sections 10.4.2.6 and 2.1 do not apply to VAP samples.) All analytes in the CCV must be less than 30% RSD for VAP samples (criteria in Section 2.1, 10.4.2.6 and 10.4.2.7 do not apply.)

7) 10% Duplicate criteria not allowed. All duplicate %RPD results must be below 25%.

8) For Ohio projects, only the analytes listed in Table F-1 or as explained in the footnote to Table F-1 will be reported as certified data.

9) Affidavits are required with each report or for a series of reports generated for a particular project.

10) Surrogates are not required and will not be added to Ohio VAP samples.

11) The analysis of a Laboratory Control Sample Duplicate (LCSD) is not required and will not be analyzed for Ohio VAP samples.

12) The LCS is evaluated at +/- 30. Criteria in section 2.1 does not apply to VAP samples.

13) Corrective actions for the method blank are required if it contains analyte concentrations at or above the RL for reportable analytes.

Table F-1

Ohio EPA VAP Program Target Analyte List *		
chloromethane	1,2-dichloropropane	1,1-Dichloropropene
vinyl chloride	1,4-dioxane	1,2,3-Trichloropropane
1,3-butadiene	trichloroethene	1,2,4-Trimethylbenzene
acetaldehyde	2,2,4-trimethylpentane	1,2-Dichlorobenzene
bromomethane	cis-1,3-dichloropropene	1,3,5-Trimethylbenzene
chloroethane	4-methyl-2-pentanone	1,3-Dichlorobenzene
vinyl bromide	1,1,2-trichloroethane	1,3-Dichloropropane
acrolein	toluene	Acetone
acetonitrile	1,2-dibromoethane	Bromodichloromethane
acrylonitrile	tetrachloroethene	Butyl acetate
1,1-dichloroethene	chlorobenzene	cis-1,2-Dichloroethene
methylene chloride	ethylbenzene	Cyclohexane
3-chloropropene	m+p-xylene	Dibromochloromethane
carbon disulfide	bromoform	Dibromomethane
1,1-dichloroethane	styrene	Dichlorodifluoromethane
MTBE	1,1,2,2-tetrachloroethane	Ethyl acetate
vinyl acetate	o-xylene	Ethyl ether
2-butanone	isopropylbenzene	Methyl alcohol (methanol)
chloroform	Benzyl Chloride	Methyl Methacrylate
1,2-dichloroethane	1,4-dichlorobenzene	Naphthalene
hexane	1,2-dibromo-3-chloropropane	Tetrahydrofuran
1,1,1-trichloroethane	1,2,4-trichlorobenzene	trans-1,2-Dichloroethene
benzene	hexachlorobutadiene	trans-1,3-Dichloropropene
carbon tetrachloride	1,1,1,2-Tetrachloroethane	Trichlorofluoromethane

***** The analytes appearing in this table are subject to change, however, any changes will not include identification of compounds that are not included in the TO-15 method referenced at the beginning of this document. However, it is acceptable to analyze and report, as certified data, compound(s) not included in the TO-15 method referenced at the beginning of this document if the compound(s) appear on the current and valid certificate issued by VAP on the date of analysis and if the laboratory has followed all applicable VAP approved documents.

APPENDIX B
Project Specific Health and Safety Plan

HALEY & ALDRICH, INC.
SITE-SPECIFIC SAFETY PLAN

FOR

Oerlikon Metco Site

1101 Prospect Avenue

Westbury, NY

Project/File No. 0127841-008

Gensuite EZ Scan®
MAN - General

Prepared By: Emma Loubsky-Lonergan **Date: 3/6/2024**

Approvals: The following signatures constitute approval of this Health & Safety Plan.

Local H&S Coordinator: Margaret B. Holt **Date: 3/6/2024**

Andrew J Nichols

Project Manager: Andrew Nichols **Date: 3/6/2024**

HASP Valid Through: December 2025

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Attachments

STOP WORK AUTHORITY

In accordance with Haley & Aldrich (Haley & Aldrich) Stop Work Authority Operating Procedure (OP1035), any individual has the right to refuse to perform work that he or she believes to be unsafe without fear of retaliation. He or she also has the authority, obligation, and responsibility to stop others from working in an unsafe manner.

STOP Work Authority is the stop work policy for all personnel and subcontractors on the Site. When work has been stopped due to an unsafe condition, Haley & Aldrich site management (e.g., Project Manager [PM], Site Health & Safety Officer [SHSO], etc.) and the Haley & Aldrich Senior Project Manager (SPM) will be notified immediately.

Reasons for issuing a stop work order include, but are not limited to:

- The belief/perception that injury to personnel or accident causing significant damage to property or equipment is imminent.
- An Haley & Aldrich subcontractor is in breach of site safety requirements and/or their own site HASP.
- Identifying a substandard condition (e.g., severe weather) or activity that creates an unacceptable safety risk as determined by a qualified person.

Work will not resume until the unsafe act has been stopped OR sufficient safety precautions have been taken to remove or mitigate the risk to an acceptable degree. Stop work orders will be documented as part of an on-site stop work log, on daily field reports to include the activity/activities stopped, the duration, person stopping work, person in-charge of stopped activity/activities, and the corrective action agreed to and/or taken. Once work has been stopped, only the Haley & Aldrich SPM or SHSO can give the order to resume work. Haley & Aldrich senior management is committed to support anyone who exercises his or her “Stop Work” authority.

ISSUANCE AND COMPLIANCE

This HASP has been prepared in accordance with Occupational Safety and Health Administration (OSHA) regulations (CFR 29, Parts 1904, 1910, and 1926) if such are applicable.

The specific requirements of this HASP include precautions for hazards that exist during this project and may be revised as new information is received or as site conditions change.

- This HASP must be signed by all Haley & Aldrich personnel involved in implementation of the SOW (Section 2 of this HASP).
- This HASP, or a current signed copy, must be retained at all times when Haley & Aldrich staff are present.
- Revisions to this HASP must be outlined within the contents of the HASP. If immediate or minor changes are necessary, the Field Safety Manager (FSM), Haley & Aldrich, SSO and/or Project Manager (PM) may use Attachment 1 (HASP Amendment Form), presented at the end of this HASP. Any revision to the HASP requires employees and subcontractors to be informed of the changes so that they understand the requirements of the change.
- Deviations from this HASP are permitted with approval from the Haley & Aldrich FSM, PM, or Senior Health & Safety Manager (SHSM). Unauthorized deviations may constitute a violation of Haley & Aldrich company procedures/policies and may result in disciplinary action.
- This HASP will be relied upon by Haley & Aldrich's subcontractors and visitors to the site. Haley & Aldrich's subcontractors must have their own HASP which will address hazards specific to their trade that is not included in this HASP. This HASP will be made available for review to Haley & Aldrich's subcontractors and other interested parties (e.g. Facility personnel and regulatory agencies) to ensure that Haley & Aldrich has properly informed our subcontractors and others of the potential hazards associated with the implementation of the SOW to the extent that Haley &Aldrich is aware.

This site-specific HASP provides only site-specific descriptions and work procedures. General safety and health compliance programs in support of this HASP (e.g., injury reporting, medical surveillance, personal protective equipment (PPE) selection, etc.) are described in detail in the Haley &Aldrich Corporate Health and Safety Program Manual and within Haley & Aldrich's Standard Operating Procedures Both the manual and SOPs can be located on the Haley & Aldrich's Company Intranet. When appropriate, users of this HASP should always refer to these resources and incorporate to the extent possible. The manual and SOPs are available to clients and regulators upon request.

EMERGENCY EVENT PROCEDURES

1 - ASSESS THE SCENE

- STOP WORK
- Review the situation and ascertain if it's safe to enter the area.
- Evacuate the site if the conditions are unsafe.

2 - EVALUATE THE EMERGENCY

- **Call 911, or designated emergency number, if required.**
- **Provide first aid for the victim if qualified and safe to do so.**
  - First aid will be addressed using the onsite first aid kit. *
    - If providing first aid, remember to use proper first aid universal precautions if blood or bodily fluids are present.
- **If exposure to hazardous substance is suspected, immediately vacate the contaminated area.**
  - Remove any contaminated clothing and/or equipment.
  - Wash any affected dermal/ocular area(s) with water for at least 15 minutes.
  - Seek immediate medical assistance if any exposure symptoms are present.

** Note: Haley & Aldrich employees are not required or expected to administer first aid / CPR to any Haley & Aldrich staff member, Contractor, or Civilian personnel at any time; it is Haley & Aldrich´s position that those who do are doing so on their own behalf and not as a function of their job.*

3 - SECURE THE AREA

- **Cordon off the incident area, if possible.**
  - Notify any security personnel, if required.
  - Escort all non-essential personnel out of the area, if able.

4 - REPORT ON-SITE ACCIDENTS / INCIDENTS TO PM / SSO

- **Notify the PM and SSO as soon as it is safe to do so.**
  - Assist PM and SSO in completing any additional tasks, as required.

5 - INVESTIGATE / REPORT THE INCIDENT

- **Record details of the incident for input to the Gensuite.**
  - Complete any additional forms as requested by the PM and SSO.

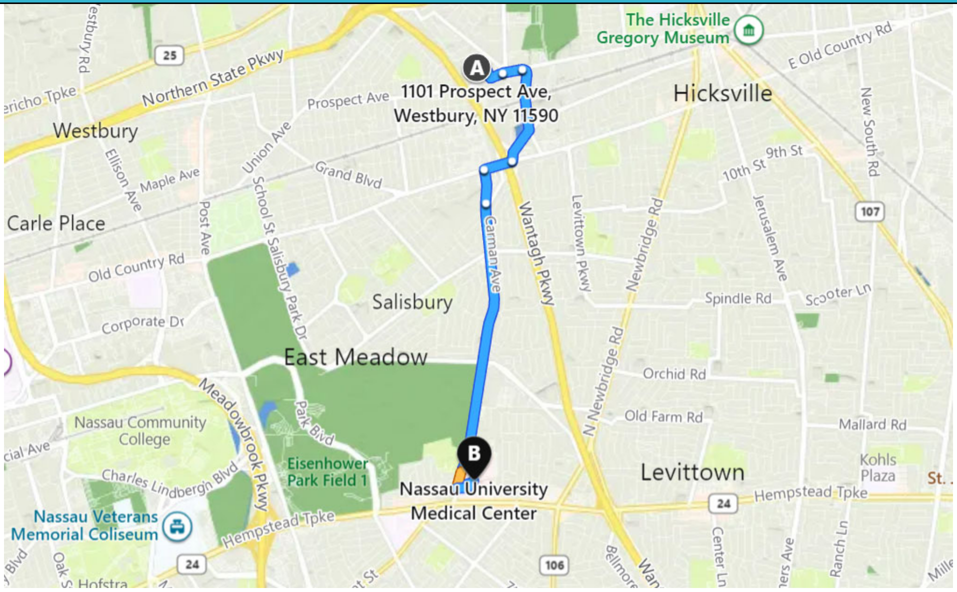
6 - TAKE CORRECTIVE ACTION

- **Implement corrective actions per the PM following root cause analysis.**
  - Complete Lessons Learned form.

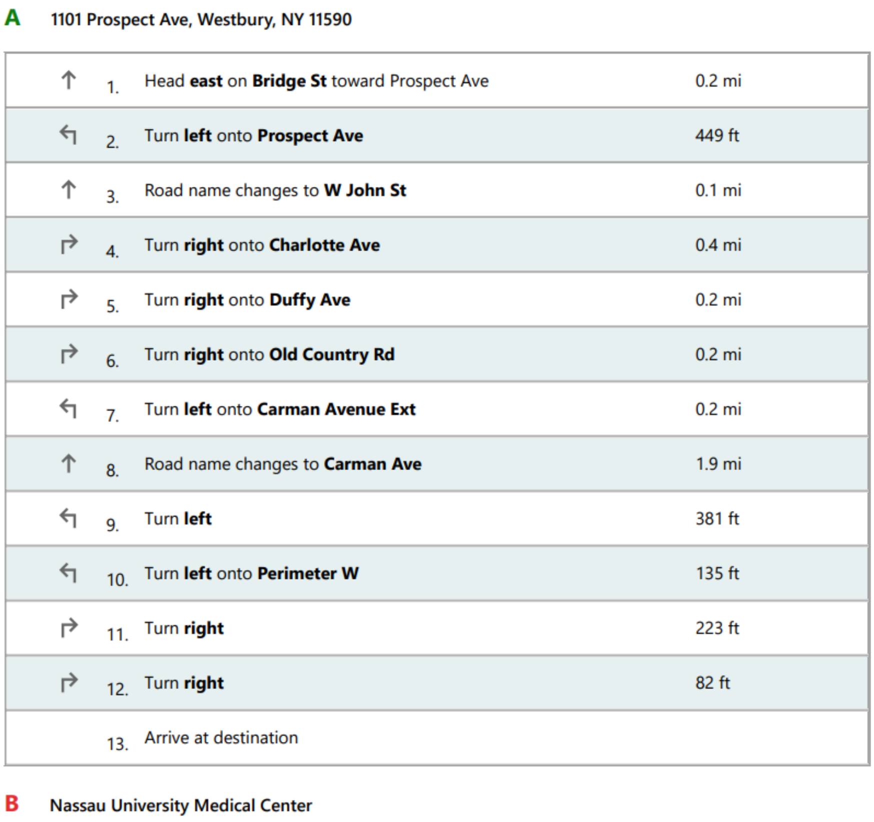
PROJECT INFORMATION AND CONTACTS

Project Name: Oerlikon Metco Site	**Haley & Aldrich File No.:** 0127841-008
Location: 1101 Prospect Avenue, Westbury, NY	
Client/Site Contact: Phone Number:	Jim Kourkoumelis 516.338.2417
Haley & Aldrich Field Representative: Phone Number: Emergency Phone Number:	TBD Enter Phone Number Enter Phone Number
Haley & Aldrich Project Manager: Phone Number: Emergency Phone Number:	**Andrew Nichols** 585.321.4220 617.650.2373
Local H&S Coordinator: Phone Number: Emergency Phone Number:	Margaret Holt 585.321.4214 585.721.2426
Subcontractor Project Manager: Phone Number:	TBD
Nearest Hospital: Address: (see map on next page) Phone Number:	Nassau University Medical Center 2201 Hempstead Turnpike East Meadow, NY 11554 516-572-0123
Nearest Occ. Health Clinic: **http://www.talispoint.com/liberty/ext/** Address: (see map on next page) Phone Number:	CityMD Urgent Care 235 Glen Cove Rd. Carle Place, NY 11514 516.877.2273
Liberty Mutual Claim Policy	**WC6Z11254100033**
Emergency Response Number:	**911**
WORKCARE:	888-449-7787
Other Ambulance, Fire, Police, or Environmental Emergency Resources:	

DIRECTIONS TO THE NEAREST HOSPITAL



Directions to the Nearest Hospital:



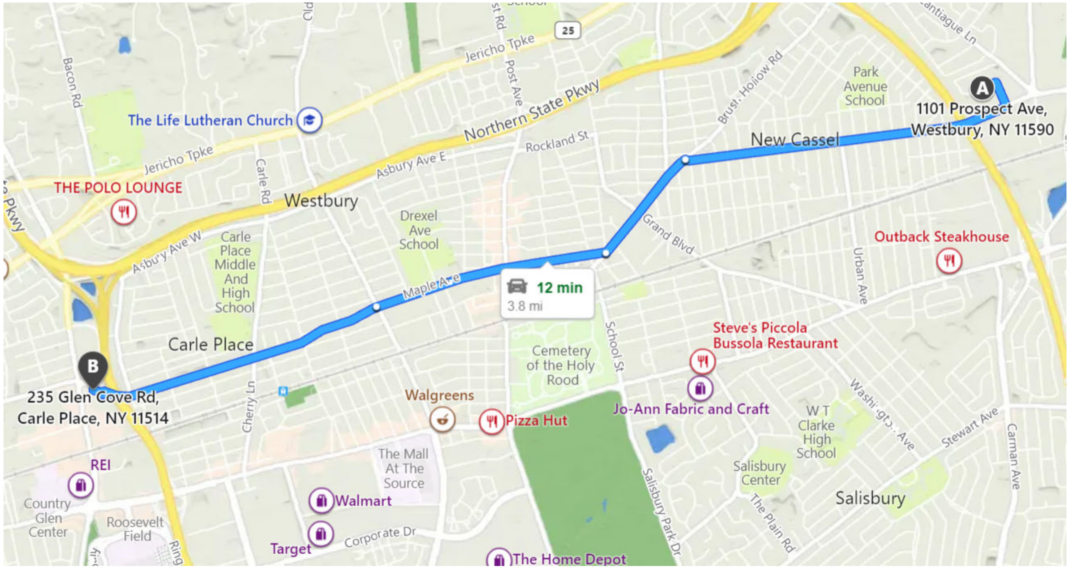
A 1101 Prospect Ave, Westbury, NY 11590

↑	1.	Head **east** on **Bridge St** toward Prospect Ave	0.2 mi
↰	2.	Turn **left** onto **Prospect Ave**	449 ft
↑	3.	Road name changes to **W John St**	0.1 mi
↱	4.	Turn **right** onto **Charlotte Ave**	0.4 mi
↱	5.	Turn **right** onto **Duffy Ave**	0.2 mi
↱	6.	Turn **right** onto **Old Country Rd**	0.2 mi
↰	7.	Turn **left** onto **Carman Avenue Ext**	0.2 mi
↑	8.	Road name changes to **Carman Ave**	1.9 mi
↰	9.	Turn **left**	381 ft
↰	10.	Turn **left** onto **Perimeter W**	135 ft
↱	11.	Turn **right**	223 ft
↱	12.	Turn **right**	82 ft
	13.	Arrive at destination	

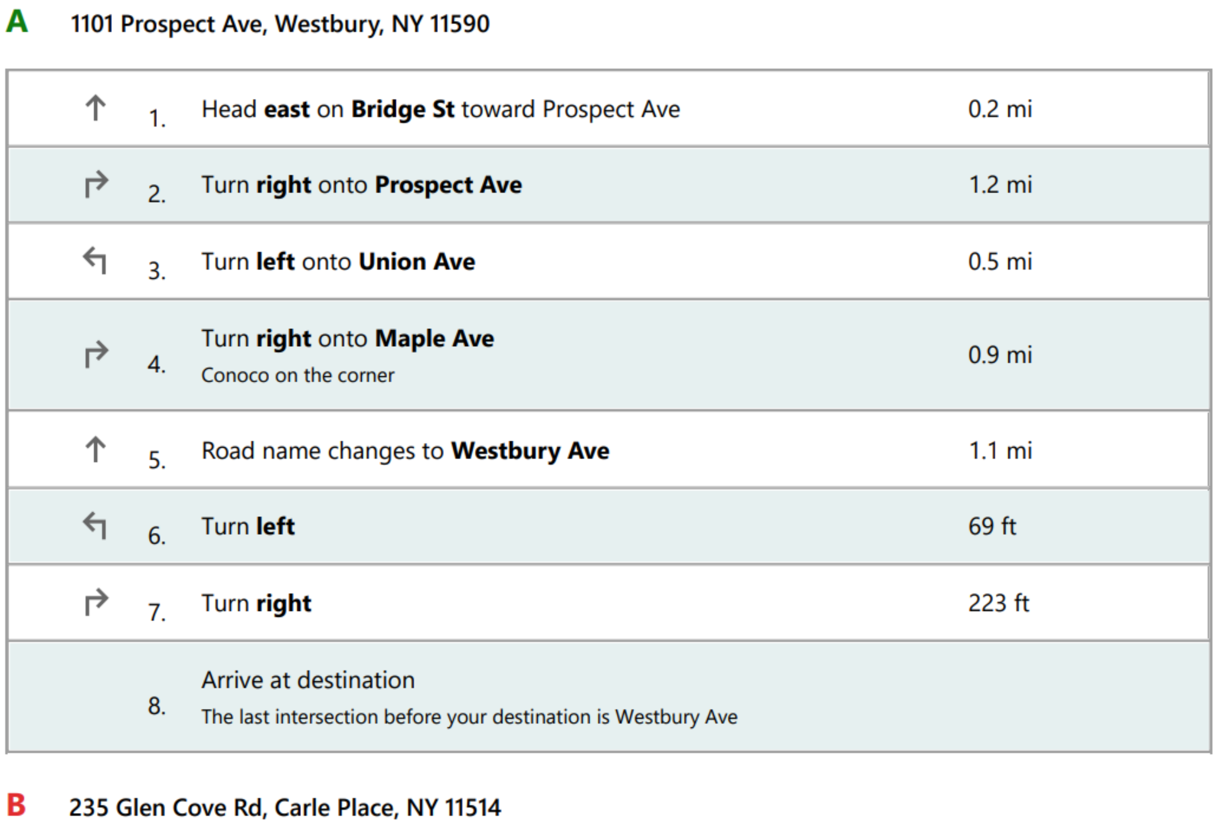
B Nassau University Medical Center

DIRECTIONS TO THE NEAREST URGENT CARE

[Liberty Mutual Medical Location Directory]



Directions to the Nearest Occupational Clinic:



A 1101 Prospect Ave, Westbury, NY 11590

↑	1.	Head **east** on **Bridge St** toward Prospect Ave	0.2 mi
↱	2.	Turn **right** onto **Prospect Ave**	1.2 mi
↰	3.	Turn **left** onto **Union Ave**	0.5 mi
↱	4.	Turn **right** onto **Maple Ave** Conoco on the corner	0.9 mi
↑	5.	Road name changes to **Westbury Ave**	1.1 mi
↰	6.	Turn **left**	69 ft
↱	7.	Turn **right**	223 ft
	8.	Arrive at destination The last intersection before your destination is Westbury Ave	

B 235 Glen Cove Rd, Carle Place, NY 11514

1. WORK SCOPE

This Site-Specific Health and Safety Plan addresses the health and safety practices and procedures that will be exercised by all Haley & Aldrich employees participating in all work on the Project Site. This plan is based on an assessment of the site-specific health and safety risks available to Haley & Aldrich and Haley & Aldrich's experience with other similar project sites. The scope of work includes the following:

Media	Sample Type and Depth	Location Identification	Laboratory Analysis[1]
Soil	**PFAS Source Area** *Advance seven (7) soil borings to approximately 60 ft bgs* • Grab soil samples will be collected every ten (10) ft bgs	HA-201, HA-202, HA-203, HA-204, HA-205, HA-206, HA-207	PFAS (40 Target Compounds)
	Additional On-Site *Advance five (5) soil borings to approximately 200 ft bgs* • Soils will be characterized by field geologist; soil grab samples will not be collected or analyzed.	HA-301, HA-302, HA-303, HA-304, HA-305	No soil samples collected
	Additional Off-Site *Advance one (1) soil boring to approximately 200 ft bgs* • Soils will be characterized by field geologist; soil grab samples will not be collected or analyzed.	HA-306, HA-307, HA-308, HA-309	No soil samples collected
Groundwater	*Conversion of "Additional On-Site" and "Additional Off-Site" soil borings into permanent multi-level monitoring wells.* • Well screening intervals of 75, 125 and 175 ft bgs • Develop and sample wells • Collect groundwater samples from each well screening interval	MW-301A/B/C, MW-302 A/B/C, MW-303 A/B/C, MW-304 A/B/C, MW-305 A/B/C, MW-306 A/B/C, MW-307 A/B/C, MW-308 A/B/C, MW-309 A/B/C	PFAS (40 Target Compounds)
Indoor Air/ Sub-Slab Vapor	• One (1) outdoor air sample • Two (2) indoor air samples co-located with existing sub-slab points in the machine shop • Two (2) sub-slab air samples (HA105B, HA5) • Samples to be collected over 8-hour period	HA105B, HA5	VOCs via EPA TO-15/TO-15 SIM

	- Inventory of materials stored adjacent to sampling points		

Project Task Breakdown

Task No.	Task Description	Employee(s) Assigned	Work Date(s) or Duration
1	Soil Boring Oversight/ Soil Sampling	TBD	TBD
2	Well Installation/Development Oversight	TBD	TBD
3	Groundwater Sampling	TBD	TBD
4	Indoor Air/ Sub-Slab Vapor Sampling	TBD	TBD

Projected Start Date: TBD

Projected Completion Date: TBD

Subcontractor(s) Tasks

Firm Name	Work Activity	Work Date(s) or Duration
TBD	Soil Borings	TBD
TBD	Well Installation/Development	TBD
TBD	Utility Clearance	TBD

Projected Start Date: TBD

Projected Completion Date: TBD

2. SITE OVERVIEW / DESCRIPTION

Site Classification

Industrial

Site Description

The Site is located at 1101 Prospect Avenue in Westbury, Town of North Hempstead, Nassau County, New York. The area is generally characterized as suburban with mixed use industrial, commercial, and residential properties. The site is bordered to the north and east by a private drive and Bridge Street beyond which are the Nassau County Board of Cooperative Education Services buildings; to the south by Prospect Avenue, beyond which is the Nassau County Department of Public Works; and to the west by undeveloped land and the Wantagh State Parkway. The site is 6.88 acres and developed with an approximately 170,000 square foot (approximately 15,800 square meters) one/two-story brick building constructed between 1954 and 1999. The Site is generally flat at an elevation of approximately 138 feet above mean sea level (NAVD 88). The Site gently slopes towards the south. The Site is located on the western side of Long Island and centrally located between Long Island Sound (approximately 10 miles to the north) and the Atlantic Ocean (approximately 12 miles to the south).

Background and Historic Site Usage

The building on the Site was originally constructed in 1954 and is currently used by Oerlikon Metco (formerly Sulzer Metco), a manufacturer of metal and ceramic powders for use in the thermal spray coating industry as well as thermal spray guns and parts. Site operations include swaging and drawing (the compression and stretching of wire that has been filled with metal powder pellets), blending of metallic or ceramic powders with lacquer or glue, laboratory testing, research and development, thermal spray application development, thermal spray coating operations, and corporate functions.

Multiple subsurface investigation activities were conducted at the site under the NYSDEC State Superfund Program (Site No. 130178) between the 1990s and 2014. These investigations generally identified CVOC contamination in sub-slab vapor and shallow soil vapor beneath and immediately adjacent to the Site building. In December 2014, the Site was entered into the NYSDEC Brownfield Cleanup Program (BCP) as Site No. C130178. Under the BCP, Haley & Aldrich, on behalf of Oerlikon Metco completed remedial investigation activities, and eventually submitted a Revised Remedial Action Work Plan with Alternatives Analysis to the NYSDEC on 2 July 2018. The Remedial Action Work Plan recommended a site remedy to address CVOC contamination in sub-slab vapor and shallow soil vapor. The recommended remedy was not implemented.

Following the identification of elevated concentrations of PFAS in site groundwater during subsurface investigation activities conducted by Haley & Aldrich on behalf of Oerlikon Metco between 2018 and 2019, PFAS was added as a Contaminant of Concern (CoC) at the Site. In December 2022, the Site was removed from the BCP, and subsequently listed as a Class 02 New York State Superfund Site (No. 130178) due to the presence of elevated concentrations of PCE in soil vapor beneath the Site building slab, and for the detection of elevated concentrations of PFAS in groundwater upgradient from public water supply well(s). On 7 October 2023, NYSDEC issued Order on Consent Index No.: CO1-20230807-157 to Oerlikon Metco ordering the preparation of an initial Remedial Investigation Work Plan to assess Site PFAS contamination.

Site Status

Active

Manufacture of metal and ceramic powders for use in the thermal spray coating industry as well as thermal spray guns and parts. Site operations include swaging and drawing (the compression and stretching of wire that has been filled with metal powder pellets), blending of metallic or ceramic powders with lacquer or glue, laboratory testing, research and development, thermal spray application development, thermal spray coating operations, and corporate functions.

Site Plan

Is a site plan or sketch available? Yes

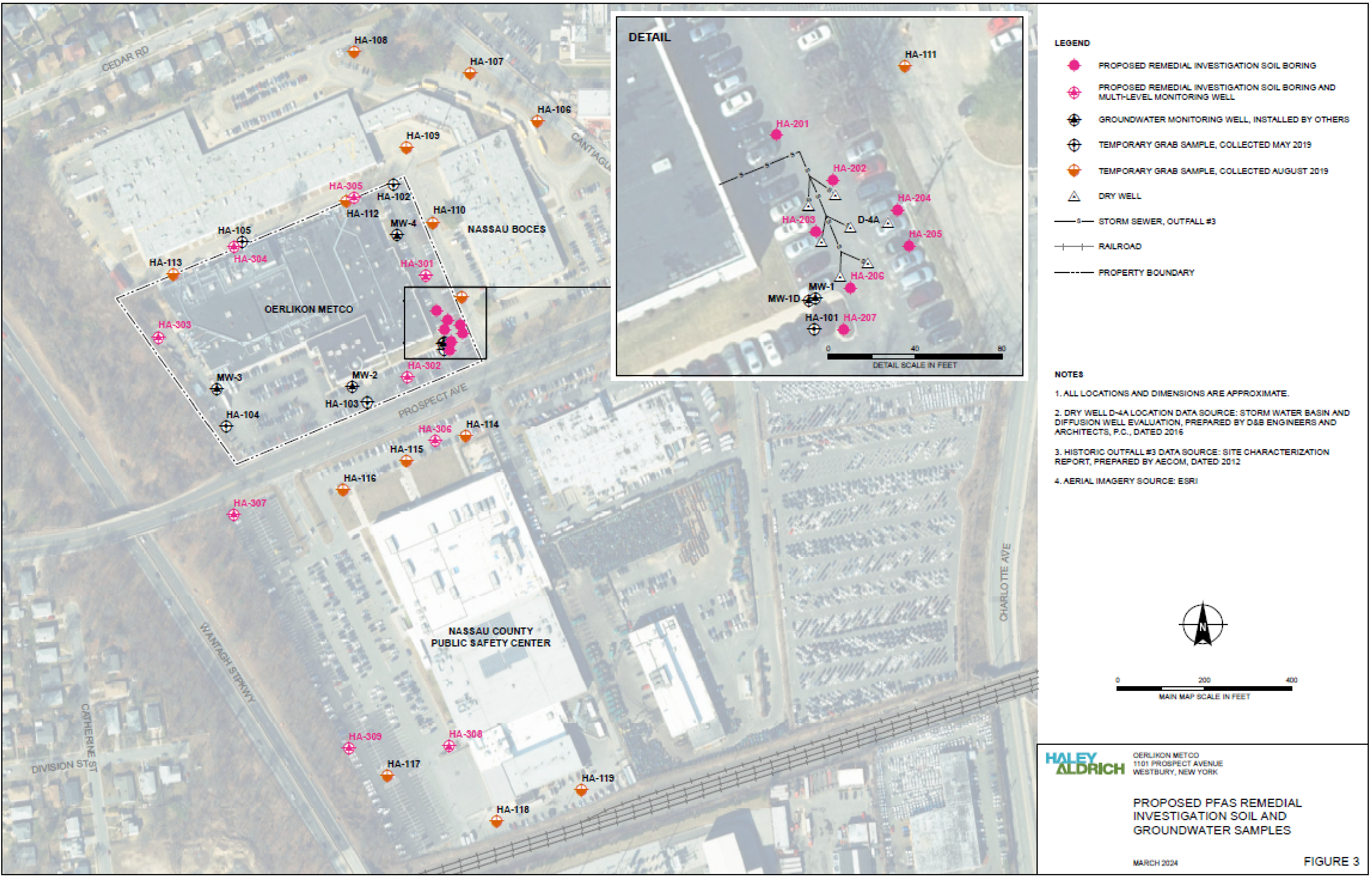
Work Areas

List and identify each specific work areas(s) on the job site and indicate its location(s) on the site plan:

Parking Lot of Oerlikon Metco Facility

Parking Lot of Nassau County Public Safety Center

Site Plan



NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. DRY WELL D-4A LOCATION DATA SOURCE: STORM WATER BASIN AND DIFFUSION WELL EVALUATION, PREPARED BY D&B ENGINEERS AND ARCHITECTS, P.C., DATED 2016
3. HISTORIC OUTFALL #3 DATA SOURCE: SITE CHARACTERIZATION REPORT, PREPARED BY AECOM, DATED 2012
4. AERIAL IMAGERY SOURCE: ESRI

OERLIKON METCO
1101 PROSPECT AVENUE
WESTBURY, NEW YORK

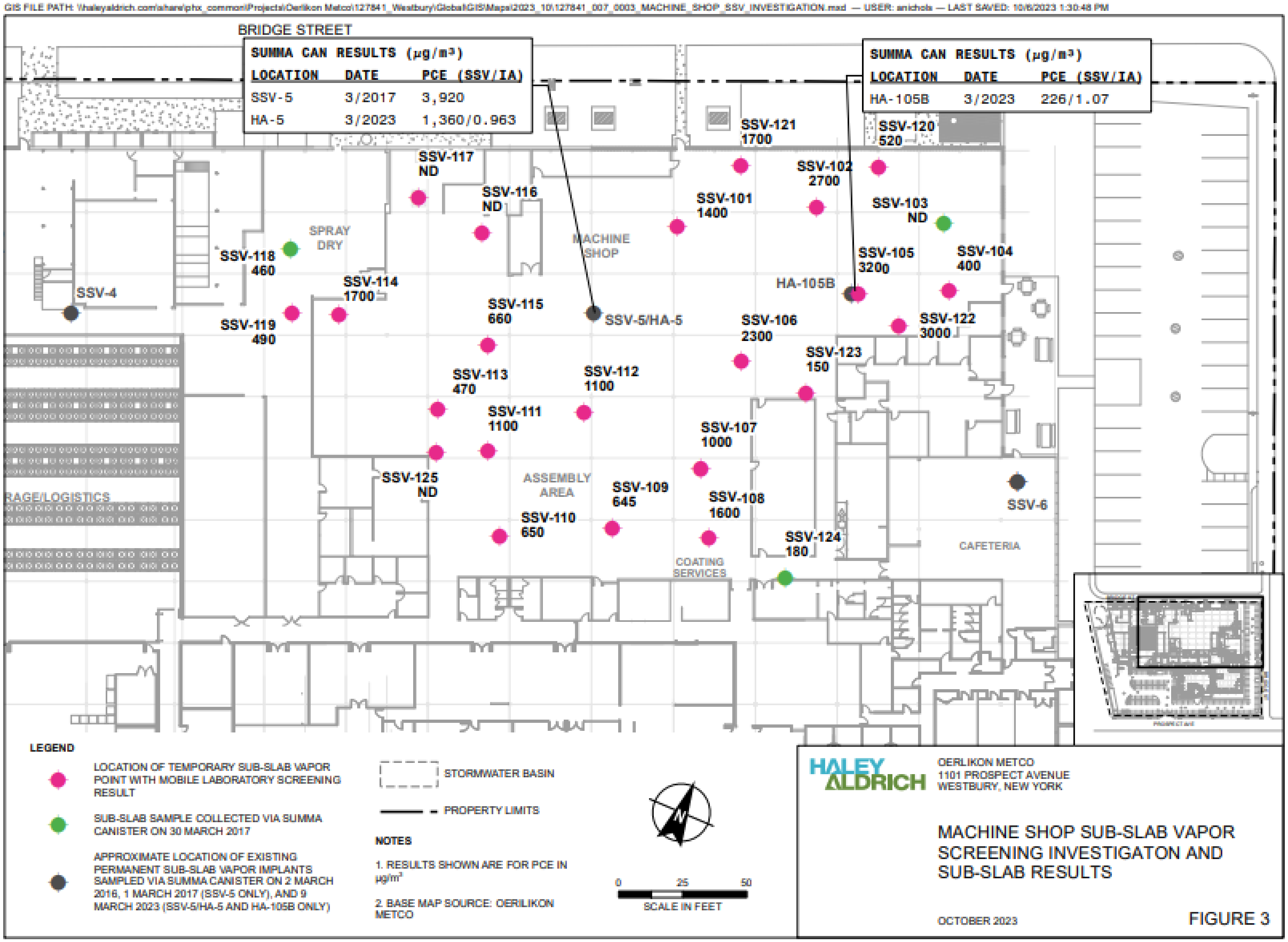
PROPOSED PFAS REMEDIAL INVESTIGATION SOIL AND GROUNDWATER SAMPLES

MARCH 2024

FIGURE 3

Note: This HASP has been developed for Haley & Aldrich purposes only and is not for use by others.

GIS FILE PATH: \\haleyaldrich.com\share\phx_common\Projects\Oerlikon Metco\127841_Westbury\Global\GIS\Maps\2023_10\127841_007_0003_MACHINE_SHOP_SSV_INVESTIGATION.mxd — USER: anichols — LAST SAVED: 10/6/2023 1:30:48 PM



SUMMA CAN RESULTS (µg/m³)

LOCATION	DATE	PCE (SSV/IA)
SSV-5	3/2017	3,920
HA-5	3/2023	1,360/0.963

SUMMA CAN RESULTS (µg/m³)

LOCATION	DATE	PCE (SSV/IA)
HA-105B	3/2023	226/1.07

LEGEND

●	LOCATION OF TEMPORARY SUB-SLAB VAPOR POINT WITH MOBILE LABORATORY SCREENING RESULT
●	SUB-SLAB SAMPLE COLLECTED VIA SUMMA CANISTER ON 30 MARCH 2017
●	APPROXIMATE LOCATION OF EXISTING PERMANENT SUB-SLAB VAPOR IMPLANTS SAMPLED VIA SUMMA CANISTER ON 2 MARCH 2016, 1 MARCH 2017 (SSV-5 ONLY), AND 9 MARCH 2023 (SSV-5/HA-5 AND HA-105B ONLY)
▭	STORMWATER BASIN
— -	PROPERTY LIMITS

NOTES

1. RESULTS SHOWN ARE FOR PCE IN µg/m³
2. BASE MAP SOURCE: OERLIKON METCO

0 25 50
SCALE IN FEET

OERLIKON METCO
1101 PROSPECT AVENUE
WESTBURY, NEW YORK

MACHINE SHOP SUB-SLAB VAPOR SCREENING INVESTIGATON AND SUB-SLAB RESULTS

OCTOBER 2023

FIGURE 3

3. HAZARD ASSESSMENT

Indicate all hazards that may be present at the site and for each task. If any of these potential hazards are checked, it is the Project Manager's responsibility to determine how to eliminate / minimize the hazard to protect onsite personnel.

Site Chemical Hazards

Is this Site impacted with chemical contamination? Yes

Source of information about contaminants: Previous Investigation

Contaminant of Concern	Location/Media	Concentration	Units
Tetrachloroethylene	**Soil Vapor**	**3920**	**ug/m3**
Volatile Organic Compounds (VOCs)	**Soil Vapor/ Indoor Air**	**Various Concentrations (ND-328)**	**ug/m3**
PFAS	**Water**	**6.7**	**ppt**

Tetrachloroethylene: is a colorless liquid with a sharp sweet odor. Tetrachloroethylene vapor is heavier than air and will be found in low lying areas.

VOCs: include all organic compounds (substances made up of predominantly carbon and hydrogen) with boiling temperatures in the range of 50-260 degrees C, excluding pesticides. This means that they are likely to be present as a vapor or gas in normal ambient temperatures. Substances which are included in the VOC category include aliphatic hydrocarbons (such as hexane), aldehydes, aromatic hydrocarbons (such as benzene, toluene, and the xylenes or BTEX), and oxygenated compounds (such as acetone and similar ketones). The term VOC often is used in a legal or regulatory context and in such cases the precise definition is a matter of law.

VOCs are released from oil and gasoline refining, storage and combustion as well as from a wide range of industrial processes. Processes involving fuels, solvents, paints or the use of chemicals are the most significant sources. VOCs may also be emitted from cleaning products, degreasing products, fabrics, carpets, plastic products, glues, printed material, varnishes, wax, disinfectants, and cosmetics.

Typically, VOCs are present in gas or vapor and will enter the body by breathing contaminated air. Higher concentrations of VOCs may occur in areas of poor ventilation. Scientific studies have shown that exposure to some PFAS in the environment may be linked to harmful health effects in humans and animals.

PFAS: PFAS are widely used, long lasting chemicals, components of which break down very slowly over time. PFAS are found in water, air, fish, and soil at locations across the nation and the globe. There are thousands of PFAS chemicals, and they are found in many different consumer, commercial, and industrial products. This makes it challenging to study and assess the potential human health and environmental risks.

Site Hazards Checklist

Weather

Cold Temperatures	Lightning Storms	Hot Temperatures	High Winds

Cold Temperatures

Cold stress may occur at any time work is being performed at low ambient temperatures and high velocity winds. Because cold stress is common and has potentially serious illnesses associated with outdoor work during cold seasons, regular monitoring and other preventative measures are vital.

Refer to OP1003-Cold Stress for additional information and mitigation controls.

Lightning Storms

Where the threat of electrical storms and the hazard of lightning exist staff shall ensure site procedures exist to: (1) detect when lightning is in the near vicinity and when there is a potential for lightning and (2) to notify appropriate site personnel of these conditions and (3) implement protocols to stop work and seek shelter.

The 30-30 Rule states that if time between seeing the lightning and hearing the thunder is less than 30 seconds, you are in danger and must seek shelter. You must also stay indoors for more than 30 minutes after hearing the last clap of thunder.

Hot Temperatures

Heat stress may occur at any time work is being performed at elevated ambient temperatures. Because heat stress is one of the most common and potentially serious illnesses associated with outdoor work during hot seasons, regular monitoring and other preventative measures are vital. Site workers must learn to recognize and treat the various forms of heat stress. The best approach is preventative heat stress management.

H&A employees and their subcontractors should be aware of potential health effects and/or physical hazards of working when there are hot temperatures or a high heat index. Refer OP1015-Heat Stress for a discussion on hot weather hazards.

High Winds

While high winds are commonly associated with severe thunderstorms and hurricanes they may also occur as a result of differences in air pressures, such as when a cold front passes across the area. They can cause downed trees and power lines, and flying debris (such as dust or larger debris), which adds additional risks and could lead to power outages, transportation disruptions, damage to buildings and vehicles, and serious injury.

Wind Advisory are issued for sustained winds 25 to 39 mph and/or gusts to 57 mph. High Wind warnings are issued by the National Weather Service when high wind speeds may pose a hazard or is life threatening. The criteria for this warning will varies by state. The Beaufort Wind Scale is a helpful tool to when dealing with high winds.

Biological			
Small Mammals	Wildlife Droppings	Mosquitoes	Choose an item.
Choose an item.	Choose an item.	Choose an item.	Choose an item.

Small Mammals

Rodents, are the most abundant order of mammals. There are hundreds of species of rats; the most common are the black and brown rat. Other rodents you may encounter are mice, beavers, squirrels, guinea pigs, capybaras and coypu.

The Brown Rat has small ears, blunt nose, and short hair. It is approximately 14-18” long (with tail). They frequently infest garbage/rubbish, slaughterhouses, domestic dwellings, warehouses, and supermarkets. They also frequent any space with an easy meal and potential nesting sites. The Black Rat is identified by its tail, that is always longer than the length from the head to the body. It is also slimmer and more agile than the Brown rat. Its size varies according to its environment and food supply.

The House Mouse has the amazing ability to adapt and can frequently be found in human dwellings. In buildings, mice will live anywhere and difficult to keep out. Mice are omnivorous, they will eat anything. Rats and mice often become a serious problem in cold winter months when they seek food and warmth inside buildings. They may suddenly appear in large numbers when excavation work disturbs their in-ground nesting locations or their food source is changed.

Some major problems caused by rats and mice are contaminating the food they eat with urine and excrement. Gnawing into materials such as paper, wood, or upholstery, to use as nest material. Also gnawing plastic, cement, soft metals such as lead and aluminum, and wiring, which may cause a fire hazard. Occasionally biting people and may kill small animals. They, or the parasites they carry, like fleas, mites and worms, spread many diseases such as salmonella, trichinosis, rat bite fever, hantavirus, Weil's disease, and bubonic plague. They damage ornamental plants by burrowing among the roots or feeding on new growth. They also eat garden vegetables, such as corn and squash. These rodents have been a problem for centuries, because of their incredible ability to survive and are so difficult to eliminate. In addition, they are extremely compatible with human behavior and needs.

Avoid contact with rodents, if possible. Avoid contact with rodent excrement. Do not eat food or water that may have encountered rodent excrement. If exposed, wash hands and avoid touching your face with your hands.

Wildlife Droppings

Project sites involving abandoned buildings may bring staff into contact with animal droppings. There are many diseases that one can be exposed to from a variety of animals.

Mice and Rats
Hantavirus is transmitted to humans from dried droppings, urine, or saliva of mice and rats. The disease begins as a flu-like illness with fever, chills, and muscle aches, but can rapidly progress to a life-threatening condition marked by respiratory failure as fluids fill the lungs. Persons working in infested buildings are at increased risk to this disease, particularly during dusty clean-up activities.

Birds and Bats
Large populations of roosting birds may present a disease risk. The most serious health risks arise from disease organisms that grow in the nutrient-rich accumulations of bird droppings, feathers and debris under a roost, particularly if roosts have been active for years.

Histoplasmosis and Cryptococcosis are the most common fungal diseases associated with bird and bat dropping. Infection occurs when spores, carried by the air, are inhaled, especially after a roost has been disturbed. The active and inactive roosts of blackbirds, starlings and cowbirds have also been found to be heavily contaminated with fungus spores. Most infections are mild and produce either no symptoms or a minor influenza-like illness. Occasionally the disease can cause high fever, blood abnormalities, pneumonia and even death.

Do not touch droppings with unprotected hands. Avoid disturbing the droppings and generating dust. Employee work practices and dust control measures that eliminate or reduce dust generation during removal of manure from a building will also reduce risks of infection and development of disease. Use an industrial vacuum cleaner with a high-efficiency (HEPA) filter to bag contaminated material.

Mosquitos

Work outdoors with temperatures above freezing will likely bring staff into contact with mosquitos. There are a variety of mosquito species that can transmit a range of diseases. Birds act as reservoirs for the viruses that can be collected by the mosquito and transmitted to a person. Majority of mosquitos are mainly a nuisance but staff need to take appropriate precautions to minimize the potential transmission of a virus that can result in one of the following diseases: West Nile, Eastern Equine Encephalitides and Western Encephalitides. Knowing some key steps that can minimize the risk of mosquito bites is, therefore, important in reducing the risks. Workers working outdoors should be aware that the use of PPE techniques is essential to preventing mosquito bites especially when working at sites where mosquitoes may be active and biting.

Use repellents containing DEET, picaridin, IR3535, and some oil of lemon eucalyptus and para-menthane-diol products provide longer-lasting protection. To optimize safety and effectiveness, repellents should be used according to the label instructions. Cover as much of your skin as possible by wearing shirts with long-sleeves, long pants, and socks whenever possible. Avoid use of perfumes and colognes when working outdoors during peak times when mosquitoes may be active; mosquitoes may be more attracted to individuals wearing perfumes and colognes.

Click + to Add Additional Hazard Language

Click + to Add Additional Hazard Language

Location/Terrain			
Public Rd/Right of Way	Slip/Trip/Falls	SIMOPS	Choose an item.

Public Right of Way

H&A staff and their subcontractors conducting work on public roads and/or right of ways can be exposed to vehicular traffic and expose the public to the hazards of the job site. Where a hazard exists to site workers because of traffic or haulage conditions at work sites that encroach public streets or highways, a system of traffic controls in conformance with the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), or state program, is required. A Temporary Traffic Control Plan (TCP) describes traffic controls to be used for facilitating vehicle and pedestrian traffic through a temporary traffic control zone TCPs are required to provide for worker protection and safe passage of traffic through and around job sites with as little inconvenience and delay as possible.

The plan may range in scope from being very detailed, to merely referencing typical drawings contained in the MUTCD. The degree of detail in the TCP depends entirely on the complexity of the situation, and TCP's should be prepared by persons knowledgeable about the fundamental principles of temporary traffic control and the work activities to be performed.

H&A Project Managers or their subcontractors need to establish appropriate control measures and obtain any permits when project work is on or encroaches public roadways. You may need flaggers or police details. Cease work and notify the field supervisor immediately if any conditions are such that safety is jeopardized. Utilize protective vehicles whenever appropriate or position equipment so in between the work and oncoming traffic.

Slips, Trips & Falls

Slip and trip injuries are the most frequent injuries to workers. Statistics show most falls happen on the same level resulting from slips and trips. Both slips and trips result from unintended or unexpected change in the contact between the feet and the ground or walking surface. Good housekeeping, quality of walking surfaces (flooring), awareness of surroundings, selection of proper footwear, and appropriate pace of walking are critical for preventing fall accidents.

Site workers will be walking on a variety of irregular surfaces, that may affect their balance. Extra care must be taken to walk cautiously near rivers because the bottom of the riverbed maybe slick and may not be visible. Rocks, gradient changes, sandy bottoms, and debris may be present but not observable.

Take your time and pay attention to where you are going. Adjust your stride to a pace that is suitable for the walking surface and the tasks you are doing. Check the work area to identify hazards - beware of trip hazards such as wet floors, slippery floors, and uneven surfaces or terrain. Establish and utilize a pathway free of slip and trip hazards. Choose a safer walking route. Carry loads you can see over. Keep work areas clean and free of clutter. Communicate hazards to on-site personnel and remove hazards as appropriate.

SIMOPS

SIMOPS are described as the potential class of activities which could bring about an undesired event or set of circumstances, e.g., safety, environment, damage to assets, schedule, commercial, financial, etc. SIMOPS are defined as performing two or more operations concurrently.

SIMOPS should be identified at an early stage before operations commence to understand issues such as schedule and physical clashes, maintenance activities, failure impacts, interferences between vessels, contracts and third part interfaces and environmental impacts.

Coordinate project with site activities. Identify and understand the hazards associated with the host and client's activities. Integrate site emergency response protocols where appropriate and communicate to all project staff. Integrate site communication protocols and communicate to all project staff.

Click + to Add Additional Hazard Language

Miscellaneous			
Other	Choose an item.	Choose an item.	Choose an item.
Work will be conducted inside an operating business with storage of materials that may obstruct workspace or generate VOCs in air space. Clear space for subslab sampling to allow adequate safe work space. Bring portable lighting if needed to illuminate work space.			

Task Hazard Summary

Task 1/2 – Drilling

Drilling is conducted for a range of services that can include but are not limited to: soil characterization, environmental investigation, well installation, and ore exploration. Familiarity with basic drilling safety is an essential component of all drilling projects. Potential hazards related to drilling operations include, but are not limited to encountering underground or overhead utilities, traffic and heavy equipment, hoisting heavy tools, steel impacts, open rotation entanglement, and the planned or unexpected encountering of toxic or hazardous substances. While staff members do not operate drilling equipment, they may work in close proximity to operating drilling equipment and may be exposed to many of the same hazards as the drilling subcontractor. It is imperative that staff are aware of emergency stops and establish communication protocols with the drillers prior to the start of work.

See OP 1002 Drilling Safety for more information.

Task 1 – Soil Sampling

Soil sampling by H&A staff on active construction sites can be conducted in conjunction with a wide range activities such as building construction, earthwork and soil management related activities. These activities can include, but are not limited to: drill spoil characterization and management during building foundation element installation, characterization of excavated soils for management/disposal/reuse during earthwork activities, and as part of environmental remedial activities such as delineation and confirmation sampling. Familiarity with basic heavy construction safety, site conditions (geotechnical and environmental), and potential soil contaminants are essential components of soil sampling performed on active sites. Potential hazards related to soil sampling at construction sites include, but are not limited to: encountering site vehicle traffic and heavy equipment operations, manual lifting, generated waste, contact or exposure to impacted soil, and encountering unknown toxic or hazardous substances. Although soil sampling is commonly performed within active excavations, from stockpiles, or within trench excavations, sampling locations and situations will vary depending on site conditions. Care should be taken while entering and exiting excavations or trenches, and when accessing (climbing up or down) soil stockpiles, ensuring that the sampling area is not being actively accessed by construction equipment. Care should also be taken with handling of potentially environmentally impacted soil during sampling, with appropriate PPE identified and used. At no time during classification activities are personnel to reach for debris near machinery that is in operation, place any samples in their mouth, or come in contact with the soils without the use of gloves. Staff will have to carry and use a variety of sampling tools, equipment, containers, and potentially heavy sample bags. It is imperative that staff are aware of emergency / communication protocols with the Contractor prior to the start of work.

Task 1/2 - Underground Utility Clearance

Ground disturbance activities such as excavating or drilling have the potential to contact underground utilities and may be considered a hazardous activity and a permit to work may be required. Once the H&A Project Manager has identified the work zone and the areas designated for ground disturbance the PM or designee is required to delineate the area with either white paint or flags so that the appropriate agencies know which area to check for their respective utilities. Haley & Aldrich staff members must ensure that permission has been gained from the property owner to access the property prior to site entry and before marking any proposed exploration or drilling locations.

The Project Manager shall verify that the proposed dig or drill zones are adequately marked or staked prior to the locators site visit, and that the appropriate Line Location Organization/ Contractor has been notified (a minimum of 72 business hours in advance) of all planned ground disturbance activities and a request for line location has been registered with the applicable One Call or dial Before You Dig organization when applicable. Personnel that are required to mark the area need to identify and understand the hazards associated with the project area which can range from a public roadway to a greenspace in a remote location.

See OP1020 Work Near Utilities.

Task 3 – Water Sampling

Environmental water sampling could include activities such as groundwater sampling from permanent or temporary wells, or surface water sampling from streams, rivers, lakes, ponds, lagoons, and surface impoundments.

Sampling tasks could involve uncapping, purging (pumping water out of the well), and sampling, and/or monitoring, new or existing monitoring wells. A mechanical pump may be used to purge the wells and can be hand-, gas-, or electric-operated. Water samples taken from the wells are then placed in containers and shipped to an analytical laboratory for analysis. The physical hazards of these operations are primarily associated with the collection methods and procedures used.

When sampling bodies of water containing known or suspected hazardous substances, adequate precautions must be taken to ensure the safety of sampling personnel. The sampling team member collecting the sample should not get too close to the edge, where ground failure or slips, trips or falls may cause him/her to lose his/her balance. The person performing the sampling should have fall restraint or protection for the task. When conducting sampling from a boat in an impoundment or flowing waters, appropriate vessel safety procedures should be followed. Avoid lifting heavy coolers with back muscles; instead, use ergonomic lifting techniques, team lift or mechanical lifts. Wear proper gloves, such as when handling sample containers to avoid contacting any materials that may have spilled out of the sample containers.

Inhalation and absorption of COCs are the primary routes of entry associated with water sampling, due to the manipulation of sample media and equipment, manual transfer of media into sample containers, and proximity of operations to the breathing zone. During this project, several different groundwater sampling methodologies may be used based on equipment accessibility and the types of materials to be sampled. These sampling methods may include hand or mechanical bailing. The primary hazards associated with these specific sampling procedures are not potentially serious; however, other operations in the area or the conditions under which samples must be collected may present chemical and physical hazards. The hazards directly associated with groundwater sampling procedures are generally limited to strains or sprains from hand bailing, and potential eye hazards. Exposure to water containing COCs is also possible. All tools and equipment that will be used at the site must be intrinsically safe (electronics and electrical equipment) and non-sparking or explosion-proof (hand tools).

Task 4 – Air Sampling

Air sampling is conducted to monitor levels of air contaminants. Air is the most transient environmental medium and subject to extreme spatial and temporal heterogeneity. Air sampling matrices include: Ambient (outdoor) air, indoor air, point sources (stacks, exhausts, and other emission sources), fugitive emissions (sources of air pollutants other than stacks or vents), and monitor and evaluate remediation processes. Samples can be collected in tedlar bags, sorbent tubes, or summa canisters.

Safety precautions during air sampling include a review of possible environmental hazards before entering the site and the use of proper clothing and equipment. Workers performing stack sampling and air monitoring during emergency situations may be exposed to hazardous levels of air pollutants. Therefore, the JHA must specify what kind of real-time air monitoring will be performed, the action levels for the use of respirators, and the types of respirators to be worn if action levels are exceeded. Safety must always be considered to ensure that the chosen field measurement instrument is compatible with the potential hazard. For example, some instruments are capable of detecting explosive hazards, but not all are safe for operations under these conditions. If the atmospheric concentration is potentially greater than 25% of the lower explosive limit, the meter itself must be certified safe for operation (FM, UL or MSHA certified). Operators should be thoroughly familiar with the instrument and operating instructions before use. Always read or review the manual prior to using an instrument in the field.

Safety concerns are of critical importance in performing sampling at heights due to the possibility of, falling, dropping equipment on workers below, and possibly weather related hazards such as ice, snow, and rain if sampling outdoors.

Gases used to calibrate and operate some instruments come in pressurized cylinders and many are flammable. Proper care should be taken when handling these materials. Light sources from some instruments can cause eye damage when viewed directly.

Task 4 – Soil Vapor

Soil gas sampling is employed as an indirect indicator of contamination in soil or groundwater particularly over and around landfill waste sites, or groundwater plumes. Soil gas sampling points can be installed manually using a slam bar or power driven mechanical devices (e.g., demolition hammer or Geoprobe) may be used based on site conditions (i.e., pavement, frozen ground, very dense clays, etc.). Soil gas samples can be drawn through the probe itself, or through Teflon tubing inserted through the probe and attached to the probe point. Samples are collected and analyzed as described below. Other field air monitoring devices, such as the Combustible Gas Indicator (CGI) and the Organic Vapor Analyzer (OVA), can also be used, depending on specific site conditions.

Because the sample is being drawn from underground, and no contamination is introduced into the breathing zone, soil gas sampling usually occurs in Level D. Nevertheless, ambient air should be constantly monitored to obtain background and breathing zone readings during the sampling procedure in the event the seal around the sampling point is breached. As long as the levels in ambient air do not rise above background, no upgrade of the level of protection is needed. Also, an underground utility search must be performed prior to sampling.

Task Physical Hazards Checklist

Potential Task Hazards	Task 1 Soil Borings/Soil Sampling	Task 2 Well Installation/Development	Task 3 Water Sampling	Task 4 Indoor Air/Soil Vapor Sampling
Ergonomics	☒	☒	☒	☒
Energized Equipment	☒	☒	☐	☐
Ground Disturbance	☒	☒	☐	☐
Hand/Power Tools	☒	☒	☐	☐
Heavy Equipment	☒	☒	☐	☒
Line of Fire	☒	☒	☐	☐
Manual Lifting	☒	☒	☒	☒
Noise	☒	☒	☐	☒
Overhead Utilities	☒	☒	☐	☐
Repetitive Motion	☒	☒	☒	☐
Rotating Equipment	☒	☒	☐	☐
Traffic	☒	☒	☒	☒
Underground Utilities	☒	☒	☐	☐
Slippery Surfaces	☒	☒	☒	☒

Other: Specify	☐	☐	☐	☐

Summary of Physical Hazards & Controls

Ergonomics

Most Work-related Musculoskeletal Disorders (WMSDs) are caused by Ergonomic Stressors. Ergonomic Stressors are caused by poor workplace practices and/or insufficient design, which may present ergonomic risk factors. These stressors include, but not limited to, repetition, force, extreme postures, static postures, quick motions, contact pressure, vibration, and cold temperatures.

WMSDs are injuries to the musculoskeletal system, which involves bones, muscles, tendons, ligaments, and other tissues in the system. Symptoms may include numbness, tightness, tingling, swelling, pain, stiffness, fatigue, and/or redness. WMSD are usually caused by one or more Ergonomic Stressors. There may be individual differences in susceptibility and symptoms among employees performing similar tasks. Any symptoms are to be taken seriously and reported immediately.

See OP1053 Ergonomics for more information.

Controls

- Ensure workstations are ergonomically correct so bad posture is not required to complete tasks.
- Take periodic breaks over the course of the day.
- Stretch during break times.
- Break up tasks that require repetitive motion.
- Contact Corporate H&S with any ergonomic concerns

Energized Equipment

Energy sources including electrical, mechanical, hydraulic, pneumatic, or other sources in machines and equipment can be hazardous to workers. During servicing and maintenance of machines and equipment, the unexpected startup or release of stored energy can result in serious injury or death to workers.

Staff members that are required to work on energized equipment must first ensure that the source of energy is isolated and/or de-energized. In addition, any stored energy must also be released. Staff must ensure that the process to de-energize and isolate energy sources is documented and communicated to those who are working on the equipment. Staff must be trained on and understand the procedure.

See OP 1032 Control of Hazardous Energy for more information.

Controls

- Document process to de-energize or isolate energy sources.
- Ensure staff are appropriately trained to conduct work requiring LOTO.
- Affix log or tag to equipment to ensure improper start-up or release of energy.
- Execute an Energy Isolation Permit.

Hand and Power Tools

Hand and power tools can expose staff to a wide range of hazards depending upon the tool used. Hazards can include but are not limited to: falling, flying, abrasive, and splashing objects, or harmful dusts, fumes, mists, vapors, or gases.

Serious accidents often occur before steps are taken to evaluate and avoid or eliminate tool-related hazards. Staff must recognize the hazards associated with the different types of tools and the safety precautions necessary to prevent those hazards.

See OP 1026 Hand and Power Tools for more information.

Controls

- Keep all tools in good condition with regular maintenance.
- Use the right tool for the job. Do not use a tool for a task which it was not designed for.
- Examine each tool for damage before use and do not use damaged tools.
- For tools that are damaged or defective, red tag the tool and take out of service.
- Operate tools per the manufacturers' instructions.
- Use the appropriate personal protective equipment.
- All electrically powered tools will be connected through a ground fault circuit interrupter (GFCI).
- All personnel must be trained on the use of the tool they are utilizing.

Manual Lifting/Moving

Most materials associated with investigation, remedial, or construction-related activities are moved by hand. The human body is subject to damage in the forms of back injury, muscle strains, and hernia if caution is not observed in the handling process.

Controls

- Under no circumstances should any one person lift more than 49 pounds unassisted.
- Always push, not pull, the object when possible.
- Size up the load before lifting. If it is heavy or clumsy, get a mechanical aid or help from a worker.
- Bend the knees; it is the single most important aspect of lifting.
- When performing the lift:
    - Place your feet close to the object and center yourself over the load.
    - Get a good handhold.
    - Lift straight up, smoothly and let your legs do the work, not your back!
    - Avoid overreaching or stretching to pick up or set down a load.
    - Do not twist or turn your body once you have made the lift.
    - Make sure beforehand that you have a clear path to carry the load.
    - Set the load down properly.

Noise

Working around heavy equipment (drill rigs, excavators, etc.) often creates excessive noise. The effects of noise include physical damage to the ear, pain, and temporary and/or permanent hearing loss. Workers can also be startled, annoyed, or distracted by noise during critical activities. Noise monitoring data that indicates that working within 25 feet of operating heavy equipment result in exposure to hazardous levels of noise (levels greater than 85 dBA).

See OP 1031 Hearing Conservation for additional information.

Controls

- Personnel are required to use hearing protection (earplugs or earmuffs) within 25 feet of any operating piece of heavy equipment.
- Limit the amount of time spent at a noise source.
- Move to a quiet area to gain relief from hazardous noise sources.
- Increase the distance from the noise source to reduce exposure.

Repetitive Motion

Repetitive Motion or Strain Injuries are injuries effecting muscles, nerves, and tendons by repetitive movement and overuse. Almost any kind of awkward or repetitive motion you make could lead to an injury over time. Actions like bending or twisting of the wrists, reaching for materials, working with your hands above shoulder level, or grasping objects can increase wear and tear on the body. The condition mostly effects the upper body.

Controls

- Arrange your work zone, supplies and tools as much as possible to avoid reaching, leaning, bending and twisting your waist or wrists.
- During rest breaks, use stretches to loosen up your body.
- Vary tasks if you can so that you are not making the same movement repeatedly over for a long period.

Slippery Surfaces

Both slips and trips result from unintended or unexpected change in the contact between the feet and ground or walking surface. Good housekeeping, quality of walking surfaces, selection of proper footwear, and appropriate pace of walking are critical for preventing fall accidents. Slips happen where there is too little friction or traction between the footwear and walking surface.

Common causes of slips are wet or oily surfaces, spills, weather hazards, loose unanchored rugs or mats and flooring or other walking surfaces that do not have same degree of traction in all areas.

Weather-related slips and falls become a serious hazard as winter conditions often make for wet or icy surfaces outdoors. Even wet organic material or mud can create hazardous walking conditions. Spills and leaks can also lead to slips and falls.

Controls

- Evaluate the work area to identify any conditions that may pose a slip hazard.

- Address any spills, drips or leaks immediately.
- Mark areas where slippery conditions exist.
- Select proper footwear or enhance traction with additional PPE.
- Where conditions are uncertain or environmental conditions result in slippery surfaces walk slowly, take small steps, and slide feet on wet or slippery surfaces.

Traffic

To ensure worker protection and the safe passage of traffic through and around job sites, Site Traffic Control procedures may need to be implemented on project sites. Job zone control and traffic management are necessary when Simultaneous Operations (SIMOPS) or third parties could be at risk of injury by entering the work zone, or when the work crew is at risk of injury by other operations.

Traffic patterns shall be evaluated. Conditions such as high pedestrian traffic, peak periods, daily deliveries or SIMOPS known, Heavy equipment traffic volume and light duty traffic volume shall be evaluated

Early identification and planning for site operations that require job zone control and traffic management, including SIMOPS, is the responsibility of the Project Manager and primary contractor manager. Traffic control plans shall be consistent with the Manual on Uniform Traffic Control Devices.

See OP1025 Signs, Signals, and Barricades and/or OP1043 Site Traffic Control for more information.

Controls

- Alternate walkways where possible.
- Use of the local police to direct traffic.
- Use of an air horn to alert drivers or other workers.
- Maintain good housekeeping and clean the area as work is completed.
- Use the ‘buddy’ or ‘watchperson’ system while performing work.
- Use a spotter for backing, tight maneuvers and bin/tank/equipment drop-offs.
- Use traffic control devices, field vehicles and barricades and avoid the use of caution tape.
- Park all vehicles (with wheels in a safe direction away from work) to block traffic with a flashing yellow light. Park so that access to the vehicle is away from oncoming traffic while working.
- When parking a vehicle and equipment, utilize a ‘first move forward’ driving practice.
- Work in an upright position, face traffic and make eye contact with drivers when possible.
- Minimize work time in traffic.
- Establish a ‘Stop Work’ hand signal.
- Personnel shall always wear high visibility vest

If public sites, such as public roads, bicycle paths or footpaths, are closed or rerouted, local and regulatory requirements shall be followed and traffic control permits shall be put in place. Proper traffic guiding equipment includes stop/slow paddle signs, flaggers, flashing lights and directional signs.

All personnel on-site should be aware of the plan of the day and the Traffic Control Plan should be communicated with all parties involved during the pre-shift meeting.

Enter any content that you want to repeat, including other content controls. You can also insert this control around table rows in order to repeat parts of a table.

Underground Utilities

Various forms of underground/overhead utility lines or conveyance pipes may be encountered during site activities. Prior to the start of intrusive operations, utility clearance is mandated, as well as obtaining authorization from all concerned public utility department offices. Should intrusive operations cause equipment to come into contact with utility lines, the SHSO, Project Manager, and Regional H&S Manager shall be notified immediately. Work will be suspended until the client and applicable utility agency is contacted and the appropriate actions for the situation can be addressed.

See OP1020 Work Near Utilities for complete information.

Controls

- Obtain as-built drawings for the areas being investigated from the property owner;
- Visually review each proposed soil boring locations with the property owner or knowledgeable site representative;
- Perform a geophysical survey to locate utilities;
- Hire a private line locating firm to determine location of utility lines that are present at the property;
- Identifying a no-drill or dig zone;
- Hand dig or use vacuum excavation in the proposed ground disturbance locations if insufficient data is unavailable to accurately determine the location of the utility lines.

Congested Areas

Working in congested areas can expose both workers and the public to a wide range of hazards depending upon the specific activities taking place. Staff Members need to understand the work scope, work areas, equipment on-site, and internal traffic patterns to minimize or eliminate exposure potential.

Controls

- Provide barricades, fencing, warning signs/signals and adequate lighting to protect people while working in or around congested areas.
- Vehicles and heavy equipment with restricted views to the rear should have functioning back-up alarms that are audible above the surrounding noise levels. Whenever possible, use a signaler to assist heavy equipment operators and/or drivers in backing up or maneuvering in congested areas.
- Lay out traffic control patterns to eliminate excessive congestion.
- Workers in congested areas should always wear high visibility clothing.
- Be aware of Line of Fire hazards when performing work activities in congested areas.
- Hazards associated with SIMOPs should be discussed daily at Tailgate Safety Meetings.

Generated Waste

Activities on environmental sites may generate waste that requires regulated handling and disposal.

Excess sample solids, decontamination materials, poly sheeting, used PPE, etc. that are determined to be free of contamination through field or laboratory screening can usually be disposed into client-approved, on-site trash receptacles. Uncontaminated wash water may be discarded onto the ground surface away from surface water bodies in areas where infiltration can occur. Contaminated materials must be segregated into liquids or solids and drummed separately for off-site disposal.

Controls

- Manage waste properly through good work practices.
- Collect, store, containerize waste, and dispose of it properly.
- All wastes generated shall be containerized in an appropriate container (i.e. open or closed top 55-gallon drum, roll-off container, poly tote, cardboard box, etc.) as directed by the PM.
- Containers should be inspected for damages or defects
- Waste containers should be appropriately labeled indicating the contents, date the container was filled, owner of the material (including address) and any unique identification number, if necessary.
- Upon completion of filling the waste container, the container should be inspected for leaks and an appropriate seal.

Ground Disturbance

Ground disturbance is defined as any activity disturbing the ground. Ground disturbance activities include, but are not limited to, excavating, trenching, drilling (either mechanically or by hand), digging, plowing, grading, tunneling and pounding posts or stakes.

Because of the potential hazards associated with striking an underground utility or structure, the operating procedure for underground utility clearance shall be followed prior to performing any ground disturbance activities.

See OP1020 Working Near Utilities

Controls

Prior to performing ground disturbance activities, the following requirements should be applied:

- Confirm all approvals and agreements (as applicable) either verbal or written have been obtained.
- Request for line location has been registered with the applicable One-Call or Dial Before You Dig organization, when applicable.
    - Whenever possible, ground disturbance areas should be adequately marked or staked prior to the utility locators site visit.
- Notification to underground facility operator/owner(s) that may not be associated with any known public notification systems such as the One-Call Program regarding the intent to cause ground disturbance within the search zone.
- Notifications to landowners and/or tenant, where deemed reasonable and practicable.
- Proximity and Common Right of Way Agreements shall be checked if the line locator information is inconclusive.

Heavy Equipment

Staff must be careful and alert when working around heavy equipment, failure or breakage and limited visibility can lead to accidents and worker injury. Heavy equipment such as cranes, drills, haul trucks, or other can fail during operation increasing chances of worker injury. Equipment of this nature shall be visually inspected and checked for proper working order prior to commencement of field work. Those operating heavy equipment must meet all requirements to operate the equipment. Haley & Aldrich, Inc. staff that supervise projects or are associated with high risk projects that involve digging or drilling should use due diligence when working with a construction firm.

See OP1052 Heavy Equipment for additional information.

Controls

- Only approach equipment once you have confirmed contact with the operator (e.g., operator places the bucket on the ground).
- Always maintain visual contact with operators and keep out of the strike zone whenever possible.
- Always be alert to the position of the equipment around you.
- Always approach heavy equipment with an awareness of the swing radius and traffic routes of all equipment and never go beneath a hoisted load.
- Avoid fumes created by heavy equipment exhaust.

Overhead Utilities

When work is undertaken near overhead electrical lines, the distance maintained from those lines shall also meet the minimum distances for electrical hazards as defined in Table 1 below. Note: utilities other than overhead electrical utilities need to be considered when performing work.

Table 1 Minimal Radial Clearance Distances *

Normal System Voltage Kilovolts (kV)	Required Minimal Radial Clearance Distance (feet/meters)
0 – 50	**10/3.05**
51 – 100	**12/3.66**
101 – 200	**15/4.57**
201 – 300	**10/6.1**
301 – 500	**25/7.62**
501 – 750	**35/10.67**
750 - 1000	**45/13.72**

* For those locations where the utility has specified more stringent safe distances, those distances shall be observed.

Controls

- To prevent damage, guy wires shall be visibly marked and work barriers or spotters provided in those areas where work is being conducted.
    - When working around guy wires, the minimum radial clearance distances for electrical power shall be observed.

- The PM shall research and determine if the local, responsible utility or client has more restrictive requirements than those stated in Table 1.
- If equipment cannot be positioned in accordance with the requirements established in Table 1 the lines need to be de-energized.

Rotating Equipment

Exposure to rotating parts can occur when working near a drilling rig, or other similar equipment. All rotating parts should be covered with guards to prevent access by workers. When performing maintenance activities that require the rotating parts to be exposed, workers should not allow loose clothing, hands, or tools to approach the rotating parts. Energy isolation procedures must be followed, and guards must be replaced as soon as possible after completing the maintenance task.

Operation of drilling equipment also creates hazards associated with pinch points and rotating equipment. These are hazards where the body and extremities, especially the hands, can be caught in moving equipment and crushed.

Controls

- Evaluate work procedures to avoid placing the body and extremities in the path of rotating equipment and tools to avoid being struck by moving equipment, tools and machinery.
- Evaluate equipment and tool use to identify pinch points and develop procedures to avoid placing body parts in a position where they can be caught in moving equipment, tools and machinery.
- Follow energy isolation procedures if required
- Do not work near rotating equipment with long loose hair, loose clothing or jewelry.

Sharp Objects

Workers who handle sharp edged objects like sheets of steel or glass are at risk of cuts. Workers who handle sharp edged objects are also at risk of cuts. Injuries may occur to hands, fingers, or legs when they are in the way of the blade, when the blade slips, or if an open blade is handled unexpectedly. Other hazards at job sites include stepping on sharp objects (e.g. wooden boards with protruding nails, sharp work-tools, chisels, etc.) and colliding with sharp and/or protruding objects.

Controls

Always be alert when handling sharps. Never look away or become distracted while handling sharp objects. Use caution when working with tools; use right tool for the job. Keep tools sharp, dull blades are a safety hazard, requiring more force to make cuts which can lead to tool slippage. Wear appropriate PPE and do not handle sharp objects (i.e., broken glass) with bare hands. Use mechanical devices, when possible. Stay away from building debris; avoid handling site debris or placing your hand where you cannot see. Watch out for barbed wire and electrical fences; cover with a car mat or equivalent to cross or walk around; use the buddy system to avoid entanglement; wear gloves. Do not leave unprotected sharps unattended. Use protective shields, cases, styrofoam blocks, etc. Pass a sharp by handing it over carefully by the handle with the blade down or retracted. Fixed open blades are prohibited. Always cut away from the body, making several passes when cutting thicker materials. Make sure blades are fitted properly into the knife. Never cut items with a blade or other sharp object on your lap. Never try to catch a blade or cutting tool that is falling.

Underground Utilities

Various forms of underground/overhead utility lines or conveyance pipes may be encountered during site activities. Prior to the start of intrusive operations, utility clearance is mandated, as well as obtaining authorization from all concerned public utility department offices. Should intrusive operations cause equipment to come into contact with utility lines, the SHSO, Project Manager, and Regional H&S Manager shall be notified immediately. Work will be suspended until the client and applicable utility agency is contacted and the appropriate actions for the situation can be addressed.

See OP1020 Work Near Utilities for complete information.

Controls

- Obtain as-built drawings for the areas being investigated from the property owner;
- Visually review each proposed soil boring locations with the property owner or knowledgeable site representative;
- Perform a geophysical survey to locate utilities;
- Hire a private line locating firm to determine location of utility lines that are present at the property;
- Identifying a no-drill or dig zone;
- Hand dig or use vacuum excavation in the proposed ground disturbance locations if insufficient data is unavailable to accurately determine the location of the utility lines.

4. PROTECTIVE MEASURES

The personal protective equipment and safety equipment (if listed) is specific to the associated task. The required PPE and equipment listed must be onsite during the task being performed. Work shall not commence unless the required PPE or Safety Equipment is present.

Required Safety & Personal Protective Equipment

Required Personal Protective Equipment (PPE)	**Task 1**	**Task 2**	**Task 3**	**Task 4**
	Soil Boring/Soil Sampling	Well Installation/Development	Water Sampling	Indoor Air/ Soil Vapor Sampling
Hard hat	☒	☒	☐	☐
Safety Glasses	☒	☒	☒	☒
Safety Toed Shoes	☒	☒	☒	☒
Class 2 Safety Vest	☒	☒	☒	☒
Hearing Protection	☒	☒	☐	☐
Nitrile Gloves	☒	☒	☒	☒
Cut Resistant Gloves ANSI A2 – PFAS free	☒	☒	☒	☒
Level of protection required	D	D	D	Select
Required Safety Equipment				
Fire Extinguisher	☒	☒	☐	☐
First Aid Kit	☒	☒	☒	☒
Safety Cones	☒	☒	☒	☒
Choose an item.	☐	☐	☐	☐

5. TRAINING REQUIREMENTS

The table below lists the training requirements staff must have respective to their assigned tasks and that are required to access the Site.

Site Specific Training Requirements

HAZWOPER - 40 Hour (Initial)

HAZWOPER - 8 Hour (Annual Refresher)

First Aid/CPR

Task Specific Training Requirements

Required Training Type	**Task 1**	**Task 2**	**Task 3**	**Task 4**
	Soil Boring/Sampling	Well Installation/ Development	Water Sampling	Indoor Air/Soil Vapor Sampling
Site access training	☒	☒	☒	☒

6. AIR MONITORING PLAN AND EQUIPMENT

Exposures to airborne substances shall be fully characterized throughout project operations to ensure that exposure controls are effectively selected and modified as needed.

Is air/exposure monitoring required at this work site for personal protection? Yes

Is perimeter monitoring required for community protection? No

Air monitoring plan not applicable Yes

Air Monitoring/Screening Equipment Requirements

Photo-Ionization Detector (PID) 10.6eV

The required equipment listed above must be on site. Work shall not commence unless the equipment is present and in working order.

Monitoring Plans

Perform air monitoring during drilling operations and core logging/screening, and prior to soil and groundwater sampling, pulling of temporary wells.

Parameter/ Contaminant	Equipment	Action Level	Response Activity
VOCs	PID 10.6 eV	< 10 ppm	Continue work and monitoring.
		>10 ppm for 5 minutes	Clear Instrument and Re-Monitor the Area. Implement PPE upgrades
		>10 ppm for >5 minutes	Evacuate the area and call the RHSM and/or PM for further guidance. Implement engineering controls.

Zone Location and Monitoring Interval
Breathing zone and edge of Exclusion Zone.

***If chemical does not have an action level use TLV or REL, whichever is lowest, to be used as an action level. If TLV or REL are the same as PEL, cut the PEL in half for an action level.**

7. DECONTAMINATION & DISPOSAL METHODS

All possible and necessary steps shall be taken to reduce or minimize contact with chemicals and contaminated/impacted materials while performing field activities (e.g., avoid sitting or leaning on, walking through, dragging equipment through or over, tracking, or splashing potential or known contaminated/impacted materials.)

Personal Hygiene Safeguards

The following minimum personal hygiene safeguards shall be adhered to:

1. No smoking or tobacco products in any project work areas.
2. No eating or drinking in the exclusion zone.
3. It is required that personnel present on site wash hands before eating, smoking, taking medication, chewing gum/tobacco, using the restroom, or applying cosmetics and before leaving the site for the day.

It is recommended that personnel present on site shower or bathe at home at the end of each day of working on the site.

Decontamination Supplies

All decontamination should be conducted at the project site in designated zones or as dictated by Client requirements. Decontamination should not be performed on Haley & Aldrich owned or leased premises.

☐ Acetone	☒ Distilled Water	☒ Polyethylene Sheeting
☒ Alconox Soap	☒ Drums	☒ Pressure/Steam Cleaner
☒ Brushes	☐ Hexane	☐ Tap Water
☒ Disposal Bags	☐ Methanol	☐ Wash tubs
☒ 5 Gallon Buckets	☒ Paper Towels	☐ Other: Specify

Location of Decontamination Station

At each soil boring location or well in the field.

Standard Personal Decontamination Procedures

Outer gloves and boots should be decontaminated periodically as necessary and at the end of the day. Brush off solids with a hard brush and clean with soap and water or other appropriate cleaner whenever possible. Remove inner gloves carefully by turning them inside out during removal. Wash hands and forearms frequently. It is good practice to wear work-designated clothing while on-site which can be removed as soon as possible. Non-disposable overalls and outer work clothing should be bagged onsite prior to laundering. If gross contamination is encountered on-site contact the Project Manager and Field Safety Manager to discuss proper decontamination procedures.

The steps required for decontamination will depend upon the degree and type of contamination but will generally follow the sequence below.

1. Remove and wipe clean hard hat
2. Rinse boots and gloves of gross contamination
3. Scrub boots and gloves clean
4. Rinse boots and gloves
5. Remove outer boots (if applicable)
6. Remove outer gloves (if applicable)
7. Remove Tyvek coverall (if applicable)
8. Remove respirator, wipe clean and store (if applicable)
9. Remove inner gloves (if outer gloves were used)

PPE that is not grossly contaminated can be bagged and disposed in regular trash receptacles.

Small Equipment Decontamination

Pretreatment of heavily contaminated equipment may be conducted as necessary:

1. Remove gross contamination using a brush or wiping with a paper towel
2. Soak in a solution of Alconox and water (if possible)
3. Wipe off excess contamination with a paper towel

Standard decontamination procedure:

4. Wash using a solution of Alconox and water
5. Rinse with potable water
6. Rinse with methanol (or equivalent)
7. Rinse with distilled/deionized water

Inspect the equipment for any remaining contamination and repeat as necessary.

Disposal Methods

Procedures for disposal of contaminated materials, decontamination waste, and single use personal protective equipment shall meet applicable client, locate, State, and Federal requirements.

Disposal of Single Use Personal Protective Equipment

PPE that is not grossly contaminated can be bagged and disposed in regular trash receptacles. PPE that is grossly contaminated must be bagged (sealed and field personnel should communicate with the Project Manager to determine proper disposal.

8. SITE CONTROL

The overall purpose of site control is to minimize potential contamination of workers, protect the public from the site's hazards, and prevent vandalism. Site control is especially important in emergency situations. The degree of site control necessary depends on site characteristics, site size, and the surrounding community. The following information identifies the elements used to control the activities and movements of people and equipment at the project site.

Communication
Internal Haley & Aldrich site personnel will communicate with other Haley & Aldrich staff member and/or subcontractors or contractors with: Cellular Phones Adhere to site emergency communications (initial orientation)
External H&S site personnel will use the following means to communicate with off-site personnel or emergency services. Cellular Phones
Visitors
Project Site Will visitors be required to check-in prior to accessing the project site? Yes
Visitor Access Authorized visitors that require access to the project site need to be provided with known information with respect to the site operations and hazards as applicable to the purpose of their site visit. Authorized visitors must have the required PPE and appropriate training to access the project site. The field staff is responsible for facilitating authorized visitor access.
Zoning
Work Zone The work zone will be clearly delineated to ensure that the general public or unauthorized worker access is prevented. The following will be used: Cones Flagging Tape

9. SITE SPECIFIC EMERGENCY RESPONSE PLAN

The Emergency Response Plan addresses potential emergencies at this site, procedures for responding to these emergencies, roles, responsibilities during emergency response, and training. This section also describes the provisions this project has made to coordinate its emergency response with other contractors onsite and with offsite emergency response organizations (as applicable).

During the development of this emergency response plan, local, state, and federal agency disaster, fire, and emergency response organizations were consulted (if required) to ensure that this plan is compatible and integrated with plans of those organizations. Documentation of the dates of these consultations are the names of individuals contacted is kept on file and available upon request.

The site has been evaluated for potential emergency occurrences, based on site hazards, and the major categories of emergencies that could occur during project work are:

- Fire(s)/Combustion
- Hazardous Material Event
- Medical Emergency
- Natural Disaster

A detailed list of emergency types and response actions are summarized in Table X below. Prior to the start of work, the SSO will update the table with any additional site-specific information regarding evacuations, muster points, or additional emergency procedures. The SSO will establish evacuation routes and assembly areas for the Site. All personnel entering the Site will be informed of these routes and assembly areas.

Pre-Emergency Planning

Before the start of field activities, the Project Manager will ensure preparation has been made in anticipation of emergencies. Preparatory actions include the following:

Meeting with the subcontractor/and or client concerning the emergency procedures in the event a person is injured. Appropriate actions for specific scenarios will be reviewed. These scenarios will be discussed, and responses determined before the sampling event commences. A form of emergency communication (i.e.; Cell phone, Air horn, etc.) between the Project Manager and subcontractor and/or client will be agreed on before the work commences.

A training session (i.e., “safety meeting”) given by the Project Manager or their designee informing all field personnel of emergency procedures, locations of emergency equipment and their use, and proper evacuation procedures.

Ensuring field personnel are aware of the existence of the emergency response HASP and ensuring a copy of the HASP accompanies the field team(s).

Onsite Emergency Response Equipment

Emergency procedures may require specialized equipment to facilitate work rescue, contamination control and reduction or post-emergency cleanup. Emergency response equipment stocked

Table 9.1 Emergency Equipment and Emergency PPE			
Emergency Equipment	**Specific Type**	**Quantity Stocked**	**Location Stored**
First Aid Kit	Field	1	Vehicle
Emergency PPE	**Specific Type**	**Quantity Stocked**	**Location Stored**
Gloves - "Nitrile"	Nitrile	100	At work site
Gloves - "Cut resistant"	Cut resistant and PFAS free	1	On person

EVACUATION ALARM
Verbal Communication and building alarms (Site Personnel are adjacent in work zone)
EVACUATION ROUTES
Will be given a map after site specific training
EVACUATION MUSTER POINT(S)/ SHELTER AREA(S)
Will be given a locations after site specific training
EVACUTION RESPONSE DRILLS
The Site relies on outside emergency responders and a drill is not required.

Table 9-2 – Emergency Planning

Emergency Type	Notification	Response Action	Evacuation Plan/Route
Chemical Exposure	Report event to SSO immediately	Refer to Safety Data Sheet for required actions	Remove personnel from work zone
Fire - Small	Notify SSO and contact 911	Use fire extinguisher if safe and qualified to do so	Mobilize to *Muster Point*
Fire – Large/Explosion	Notify SSO and contact 911	Evacuate immediately	Mobilize to *Muster Point*
Hazardous Material – Spill/Release	Notify SSO; SSO will contact PM to determine if additional agency notification is	If practicable don PPE and use spill kit and applicable procedures to contain the release	See Evacuation Map for route, move at least 100 ft upwind of spill location
Medical – Bloodborne Pathogen	Notify SSO	If qualified dispose in container or call client or city to notify for further instruction.	None Anticipated
Medical – First Aid	Notify SSO	If qualified perform first aid duties	None Anticipated
Medical – Trauma	If life threatening or transport is required call 911, immediately	Wait at site entrance for ambulance	Noe Anticipated
Security Threat	Notify SSO who will call 911 as warranted	Keep all valuables out of site and work zones delineated.	None Anticipated
Weather – Earthquake/Tsunami's	STOP WORK and evacuate Site upon any earthquake	Turn off equipment and evacuate as soon as is safe to do so	Mobilize to *Shelter Location*
Weather – Lightning Storm	STOP WORK	Work may resume 30 minutes after the last observed lightning.	None Anticipated
Weather – Tornadoes/Hurricanes	Monitor weather conditions STOP WORK and evacuate the site	Evacuate to shelter location or shelter in place immediately	Mobilize to *Shelter Location*
<u>MUSTER POINT</u> Personal Vehicle		*<u>SHELTER LOCATION</u>* Personal Vehicle	
In case of site emergencies, site personnel shall be evacuated per this table and will not participate in emergency response activities. Site emergencies shall be reported to local, state, and federal governmental agencies as required.			

10. HASP ACKNOWLEDGEMENT FORM

All Haley & Aldrich employees onsite must sign this form prior to entering the site.

I hereby acknowledge receipt of, and briefing on, this HASP prior to the start of on-site work. I declare that I understand and agree to follow the provisions, processes, and procedures set forth herein at all times while working on this site.

Printed Name	Signature	Date

ATTACHMENT A
HASP AMENDMENT FORM

HASP AMENDMENT FORM

This form is to be used whenever there is an immediate change in the project scope that will require an amendment to the HASP. For project scope changes associated with "add-on" tasks, the changes must be made in the body of the HASP. Before changes can be made, a review of the potential hazards must be initiated by the Haley & Aldrich Project Manager.

This original form must remain on site with the original HASP. If additional copies of this HASP have been distributed, it is the Project Manager's responsibility to forward a signed copy of this amendment to those who have copies.

Amendment No.	
Site Name	
Work Assignment No.	
Date	
Type of Amendment	
Reason for Amendment	
Alternate Safeguard Procedures	
Required Changes in PPE	

Project Manager Name (Print)　　Project Manager Signature　　Date

Health & Safety Approver Name (Print)　　Health & Safety Approver Signature　　Date

ATTACHMENT B
TRAINING REQUIREMENTS

TRAINING REQUIREMENTS

Health and Safety Training Requirements

Personnel will not be permitted to supervise or participate in field activities until they have been trained to a level required by their job function and responsibility. Haley & Aldrich staff members, contractors, subcontractors, and consultants who have the potential to be exposed to contaminated materials or physical hazards must complete the training described in the following sections.

The Haley & Aldrich Project Manager/FSM will be responsible for maintaining and providing to the client/site manager documentation of Haley & Aldrich staff members' compliance with required training as requested. Records shall be maintained per OSHA requirements.

40-Hour Health and Safety Training

The 40-Hour Health and Safety Training course provides instruction on the nature of hazardous waste work, protective measures, proper use of personal protective equipment, recognition of signs and symptoms which might indicate exposure to hazardous substances, and decontamination procedures. It is required for all personnel working on-site, such as equipment operators, general laborers, and supervisors, who may be potentially exposed to hazardous substances, health hazards, or safety hazards consistent with 29 CFR 1910.120.

8-hour Annual Refresher Training

Personnel who complete the 40-hour health and safety training are subsequently required to attend an annual 8-hour refresher course to remain current in their training. When required, site personnel must be able to show proof of completion (i.e., certification) at an 8-hour refresher training course within the past 12 months.

8-Hour Supervisor Training

On-site managers and supervisors directly responsible for, or who supervise staff members engaged in hazardous waste operations, should have eight additional hours of Supervisor training in accordance with 29 CFR 1910.120. Supervisor Training includes, but is not limited to, accident reporting/investigation, regulatory compliance, work practice observations, auditing, and emergency response procedures.

Additional Training for Specific Projects

Haley & Aldrich personnel will ensure their personnel have received additional training on specific instrumentation, equipment, confined space entry, construction hazards, etc., as necessary to perform their duties. This specialized training will be provided to personnel before engaging in the specific work activities including:

- Client specific training or orientation
- Competent person excavations
- Confined space entry (entrant, supervisor, and attendant)
- Heavy equipment including aerial lifts and forklifts
- First aid/ CPR
- Use of fall protection
- Use of nuclear density gauges
- Asbestos awareness

ATTACHMENT C

ROLES AND RESPONSIBILITIES

SITE ROLES AND RESPONSIBILITIES

Haley & Aldrich Personnel

Field Safety Manager (FSM)

The Haley & Aldrich FSM is a full-time Haley & Aldrich staff member, trained as a safety and health professional, who is responsible for the interpretation and approval of this Safety Plan. Modifications to this Safety Plan cannot be undertaken by the PM or the SSO without the approval of the FSM.

Specific duties of the FSM include:

- Approving and amending the Safety Plan for this project
- Advising the PM and SHSOs on matter relating to health and safety
- Recommending appropriate personal protective equipment (PPE) and air monitoring instrumentation
- Maintaining regular contact with the PM and SSO to evaluate the conditions at the property and new information which might require modifications to the HASP and
- Reviewing and approving JSAs developed for the site-specific hazards.

Project Manager (PM)

The Haley & Aldrich PM is responsible for ensuring that the requirements of this HASP are implemented at that project location. Some of the PM´s specific responsibilities include:

- Assuring that all personnel to whom this HASP applies have received a copy of it;
- Providing the FSM with updated information regarding environmental conditions at the site and the scope of site work;
- Providing adequate authority and resources to the on-site SHSO to allow for the successful implementation of all necessary safety procedures;
- Supporting the decisions made by the SHSO;
- Maintaining regular communications with the SHSO and, if necessary, the FSM;
- Coordinating the activities of all subcontractors and ensuring that they are aware of the pertinent health and safety requirements for this project;
- Providing project scheduling and planning activities; and
- Providing guidance to field personnel in the development of appropriate Job Safety Analysis (JSA) relative to the site conditions and hazard assessment.

Site Health & Safety Officer (SHSO)

The SHSO is responsible for field implementation of this HASP and enforcement of safety rules and regulations. SHSO functions may include some or all of the following:

- Act as Haley & Aldrich´s liaison for health and safety issues with client, staff, subcontractors, and agencies.
- Verify that utility clearance has been performed by Haley & Aldrich subcontractors.
- Oversee day-to-day implementation of the Safety Plan by Haley & Aldrich personnel on site.

- Interact with subcontractor project personnel on health and safety matters.
- Verify use of required PPE as outlined in the safety plan.
- Inspect and maintain Haley & Aldrich safety equipment, including calibration of air monitoring instrumentation used by Haley & Aldrich.
- Perform changes to HASP and document in Appendix A of the HASP as needed and notify appropriate persons of changes.
- Investigate and report on-site accidents and incidents involving Haley & Aldrich and its subcontractors.
- Verify that site personnel are familiar with site safety requirements (e.g., the hospital route and emergency contact numbers).
- Report accidents, injuries, and near misses to the Haley & Aldrich PM and FSM as needed.

The SHSO will conduct initial site safety orientations with site personnel (including subcontractors) and conduct toolbox and safety meetings thereafter with Haley & Aldrich employees and Haley & Aldrich subcontractors at regular intervals and in accordance with Haley & Aldrich policy and contractual obligations. The SHSO will track the attendance of site personnel at Haley & Aldrich orientations, toolbox talks, and safety meetings.

Field Personnel

Haley & Aldrich personnel are responsible for following the health and safety procedures specified in this HASP and for performing their work in a safe and responsible manner. Some of the specific responsibilities of the field personnel are as follows:

- Reading the HASP in its entirety prior to the start of on-site work;
- Submitting a completed Safety Plan Acceptance Form and documentation of medical surveillance and training to the SHSO prior to the start of work;
- Attending the pre-entry briefing prior to beginning on-site work;
- Bringing forth any questions or concerns regarding the content of the Safety Plan to the PM or the SHSO prior to the start of work;
- Stopping work when it is not believed it can be performed safely;
- Reporting all accidents, injuries and illnesses, regardless of their severity, to the SHSO;
- Complying with the requirements of this safety plan and the requests of the SHSO; and
- Reviewing the established JSAs for the site-specific hazards on a daily basis and prior to each shift change, if applicable.

Visitors

Authorized visitors (e.g., Client Representatives, Regulators, Haley & Aldrich management staff, etc.) requiring entry to any work location on the site will be briefed by the Site Supervisor on the hazards present at that location. Visitors will be escorted at all times at the work location and will be responsible for compliance with their employer´s health and safety policies. In addition, this safety plan specifies the minimum acceptable qualifications, training and personal protective equipment which are required for entry to any controlled work area; visitors must comply with these requirements at all times. Unauthorized visitors, and visitors not meeting the specified qualifications, will not be permitted within established controlled work areas.

SUBCONTRACTOR PERSONNEL

Subcontractor Site Representative

Each contractor and subcontractor shall designate a Contractor Site Representative. The Contractor Site Representative will interface directly with Insert Staff Name Here, the Subcontractor Site Safety Manager, with regards to all areas that relate to this safety plan and safety performance of work conducted by the contractor and/or subcontractor workforce. Contractor Site Representatives for this site are listed in the Contact Summary Table at the beginning of the Safety Plan.

Subcontractor Site Safety Manager

Each contractor / subcontractor will provide a qualified representative who will act as their Site Safety Manager (Sub-SSM). This person will be responsible for the planning, coordination, and safe execution of subcontractor tasks, including preparation of job hazard analyses (JHA), performing daily safety planning, and coordinating directly with the Haley & Aldrich SHSO for other site safety activities. This person will play a lead role in safety planning for Subcontractor tasks, and in ensuring that all their employees and lower tier subcontractors are in adherence with applicable local, state, and/or federal regulations, and/or industry and project specific safety standards or best management practices.

General contractors / subcontractors are responsible for preparing a site-specific HASP and/or other task specific safety documents (e.g., JHAs), which are, at a minimum, in compliance with local, state, and/or federal other regulations, and/or industry and project specific safety standards or best management practices. The contractor(s)/subcontractor(s) safety documentation will be at least as stringent as the health and safety requirements of the Haley & Aldrich Project specific HASP.

Safety requirements include, but are not limited to: legal requirements, contractual obligations and industry best practices. Contractors/subcontractors will identify a site safety representative during times when contractor/subcontractor personnel are on the Site. All contractor/subcontractor personnel will undergo a field safety orientation conducted by the Haley & Aldrich SHSO and/or PM prior to commencing site work activities. All contractors / subcontractors will participate in Haley & Aldrich site safety meetings and their personnel will be subject to training and monitoring requirements identified in this Safety Plan. If the contractors / subcontractors means and methods deviate from the scope of work described in Section 1 of this Safety Plan, the alternate means and methods must be submitted, reviewed and approved by the Haley & Aldrich SHSO and/or PM prior to the commencement of the work task. Once approved by the Haley & Aldrich SHSO and/or PM, the alternate means and methods submittal will be attached to this Safety Plan as an Addendum.

ATTACHMENT D
JOB SAFETY ANALYSES

Safety
in everything we do

OERLIKON METCO SITE

KEY TASK ENTER TASK NUMBER.**:** ENTER TASK NAME.

Subtask Category	Potential Hazards	Controls
Mobilizing to soil boring and well locations and soil vapor/ air sampling locations	Driving/Vehicle Safety	• Avoid distracted driving, drive for weather conditions
Drilling	Utility locators and underground hazards	• Clear utilities per the operating procedure
Drilling	Weather-related hazards	• Wear appropriate layers • Take frequent breaks to warm up or cool down • Utilize Alertmedia app to be aware of site specific weather hazards • Review emergency procedures with site staff
Drilling	Heavy equipment	• Maintain appropriate radius away from drilling rig • Wear PPE
Drilling	Noise reduction	• Wear hearing protection
Drilling	Lifting	• Utilize buddy system when lifting • Lift with the legs not the back
All field activities	Slips, Trips, and Falls	• Utilize appropriate caution when traversing site • Wear appropriate footwear • Watch foot placement
Soil/Water Sampling	Chemical hazards	• Known presence of chlorinated and non-chlorinated solvents, use PID and assigned action levels based on results.
Air Sampling	General hazards associated with work in	• Site contact/escort, building orientation, understand emergency procedures.

	active manufacturing operation	- Locate vapor points in low traffic area, mark work space with cones or other obvious markings.
Air Sampling	Chemical hazards	- Known presence of chlorinated solvents, use PID and assigned action levels based on results.

ATTACHMENT E
PROJECT SITE FORMS

ATTACHMENT F
SITE-SPECIFIC OPERATING PROCEDURES

APPENDIX C

Community Air Monitoring Plan

Appendix 1A
New York State Department of Health
Generic Community Air Monitoring Plan

Overview

A Community Air Monitoring Plan (CAMP) requires real-time monitoring for volatile organic compounds (VOCs) and particulates (i.e., dust) at the downwind perimeter of each designated work area when certain activities are in progress at contaminated sites. The CAMP is not intended for use in establishing action levels for worker respiratory protection. Rather, its intent is to provide a measure of protection for the downwind community (i.e., off-site receptors including residences and businesses and on-site workers not directly involved with the subject work activities) from potential airborne contaminant releases as a direct result of investigative and remedial work activities. The action levels specified herein require increased monitoring, corrective actions to abate emissions, and/or work shutdown. Additionally, the CAMP helps to confirm that work activities did not spread contamination off-site through the air.

The generic CAMP presented below will be sufficient to cover many, if not most, sites. Specific requirements should be reviewed for each situation in consultation with NYSDOH to ensure proper applicability. In some cases, a separate site-specific CAMP or supplement may be required. Depending upon the nature of contamination, chemical- specific monitoring with appropriately-sensitive methods may be required. Depending upon the proximity of potentially exposed individuals, more stringent monitoring or response levels than those presented below may be required. Special requirements will be necessary for work within 20 feet of potentially exposed individuals or structures and for indoor work with co-located residences or facilities. These requirements should be determined in consultation with NYSDOH.

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

Community Air Monitoring Plan

Depending upon the nature of known or potential contaminants at each site, real-time air monitoring for VOCs and/or particulate levels at the perimeter of the exclusion zone or work area will be necessary. Most sites will involve VOC and particulate monitoring; sites known to be contaminated with heavy metals alone may only require particulate monitoring. If radiological contamination is a concern, additional monitoring requirements may be necessary per consultation with appropriate DEC/NYSDOH staff.

> **Continuous monitoring** will be required for all ground intrusive activities and during the demolition of contaminated or potentially contaminated structures. Ground intrusive activities include, but are not limited to, soil/waste excavation and handling, test pitting or trenching, and the installation of soil borings or monitoring wells.
>
> **Periodic monitoring** for VOCs will be required during non-intrusive activities such as the collection of soil and sediment samples or the collection of groundwater samples from existing monitoring wells. “Periodic” monitoring during sample collection might reasonably consist of taking a reading upon arrival at a sample location, monitoring while opening a well cap or

overturning soil, monitoring during well baling/purging, and taking a reading prior to leaving a sample location. In some instances, depending upon the proximity of potentially exposed individuals, continuous monitoring may be required during sampling activities. Examples of such situations include groundwater sampling at wells on the curb of a busy urban street, in the midst of a public park, or adjacent to a school or residence.

VOC Monitoring, Response Levels, and Actions

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

1. If the ambient air concentration of total organic vapors at the downwind perimeter of the work area or exclusion zone exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities can resume with continued monitoring.

2. If total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities must be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities can resume provided that the total organic vapor level 200 feet downwind of the exclusion zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less - but in no case less than 20 feet, is below 5 ppm over background for the 15-minute average.

3. If the organic vapor level is above 25 ppm at the perimeter of the work area, activities must be shutdown.

4. All 15-minute readings must be recorded and be available for State (DEC and NYSDOH) personnel to review. Instantaneous readings, if any, used for decision purposes should also be recorded.

Particulate Monitoring, Response Levels, and Actions

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

1. If the downwind PM-10 particulate level is 100 micrograms per cubic meter (mcg/m^3) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques must be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 mcg/m^3 above the upwind level and provided that no visible dust is migrating from the work area.

2. If, after implementation of dust suppression techniques, downwind PM-10 particulate levels are greater than 150 mcg/m^3 above the upwind level, work must be stopped and a re-evaluation of activities initiated. Work can resume provided that dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 mcg/m^3 of the upwind level and in preventing visible dust migration.

3. All readings must be recorded and be available for State (DEC and NYSDOH) and County Health personnel to review.

December 2009

Appendix 1B
Fugitive Dust and Particulate Monitoring

A program for suppressing fugitive dust and particulate matter monitoring at hazardous waste sites is a responsibility on the remedial party performing the work. These procedures must be incorporated into appropriate intrusive work plans. The following fugitive dust suppression and particulate monitoring program should be employed at sites during construction and other intrusive activities which warrant its use:

1. Reasonable fugitive dust suppression techniques must be employed during all site activities which may generate fugitive dust.

2. Particulate monitoring must be employed during the handling of waste or contaminated soil or when activities on site may generate fugitive dust from exposed waste or contaminated soil. Remedial activities may also include the excavation, grading, or placement of clean fill. These control measures should not be considered necessary for these activities.

3. Particulate monitoring must be performed using real-time particulate monitors and shall monitor particulate matter less than ten microns (PM10) with the following minimum performance standards:

(a) Objects to be measured: Dust, mists or aerosols;
(b) Measurement Ranges: 0.001 to 400 mg/m3 (1 to 400,000 :ug/m3);
(c) Precision (2-sigma) at constant temperature: +/- 10 :g/m3 for one second averaging; and +/- 1.5 g/m3 for sixty second averaging;
(d) Accuracy: +/- 5% of reading +/- precision (Referred to gravimetric calibration with SAE fine test dust (mmd= 2 to 3 :m, g= 2.5, as aerosolized);
(e) Resolution: 0.1% of reading or 1g/m3, whichever is larger;
(f) Particle Size Range of Maximum Response: 0.1-10;
(g) Total Number of Data Points in Memory: 10,000;
(h) Logged Data: Each data point with average concentration, time/date and data point number
(i) Run Summary: overall average, maximum concentrations, time/date of maximum, total number of logged points, start time/date, total elapsed time (run duration), STEL concentration and time/date occurrence, averaging (logging) period, calibration factor, and tag number;
(j) Alarm Averaging Time (user selectable): real-time (1-60 seconds) or STEL (15 minutes), alarms required;
(k) Operating Time: 48 hours (fully charged NiCd battery); continuously with charger;
(l) Operating Temperature: -10 to 50^{o} C (14 to 122^{o} F);
(m) Particulate levels will be monitored upwind and immediately downwind at the working site and integrated over a period not to exceed 15 minutes.

4. In order to ensure the validity of the fugitive dust measurements performed, there must be appropriate Quality Assurance/Quality Control (QA/QC). It is the responsibility of the remedial party to adequately supplement QA/QC Plans to include the following critical features: periodic instrument calibration, operator training, daily instrument performance (span) checks, and a record keeping plan.

5. The action level will be established at 150 ug/m3 (15 minutes average). While conservative,

this short-term interval will provide a real-time assessment of on-site air quality to assure both health and safety. If particulate levels are detected in excess of 150 ug/m3, the upwind background level must be confirmed immediately. If the working site particulate measurement is greater than 100 ug/m3 above the background level, additional dust suppression techniques must be implemented to reduce the generation of fugitive dust and corrective action taken to protect site personnel and reduce the potential for contaminant migration. Corrective measures may include increasing the level of personal protection for on-site personnel and implementing additional dust suppression techniques (see paragraph 7). Should the action level of 150 ug/m3 continue to be exceeded work must stop and DER must be notified as provided in the site design or remedial work plan. The notification shall include a description of the control measures implemented to prevent further exceedances.

6. It must be recognized that the generation of dust from waste or contaminated soil that migrates off-site, has the potential for transporting contaminants off-site. There may be situations when dust is being generated and leaving the site and the monitoring equipment does not measure PM10 at or above the action level. Since this situation has the potential to allow for the migration of contaminants off-site, it is unacceptable. While it is not practical to quantify total suspended particulates on a real-time basis, it is appropriate to rely on visual observation. If dust is observed leaving the working site, additional dust suppression techniques must be employed. Activities that have a high dusting potential--such as solidification and treatment involving materials like kiln dust and lime--will require the need for special measures to be considered.

7. The following techniques have been shown to be effective for the controlling of the generation and migration of dust during construction activities:

(a) Applying water on haul roads;
(b) Wetting equipment and excavation faces;
(c) Spraying water on buckets during excavation and dumping;
(d) Hauling materials in properly tarped or watertight containers;
(e) Restricting vehicle speeds to 10 mph;
(f) Covering excavated areas and material after excavation activity ceases; and
(g) Reducing the excavation size and/or number of excavations.

Experience has shown that the chance of exceeding the 150ug/m3 action level is remote when the above-mentioned techniques are used. When techniques involving water application are used, care must be taken not to use excess water, which can result in unacceptably wet conditions. Using atomizing sprays will prevent overly wet conditions, conserve water, and provide an effective means of suppressing the fugitive dust.

8. The evaluation of weather conditions is necessary for proper fugitive dust control. When extreme wind conditions make dust control ineffective, as a last resort remedial actions may need to be suspended. There may be situations that require fugitive dust suppression and particulate monitoring requirements with action levels more stringent than those provided above. Under some circumstances, the contaminant concentration and/or toxicity may require additional monitoring to protect site personnel and the public. Additional integrated sampling and chemical analysis of the dust may also be in order. This must be evaluated when a health and safety plan is developed and when appropriate suppression and monitoring requirements are established for protection of health and the environment.