QUEENS ANIMAL SHELTER AND CARE CENTER

151 WOODWARD AVENUE

QUEENS, NEW YORK

Remedial Investigation Work Plan

BCP Site No.: C241230
AKRF Project Number: 180291

Prepared for:

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1.0 INTRODUCTION

This Remedial Investigation Work Plan (RIWP) has been prepared by AKRF, Inc. (AKRF) on behalf of Animal Care and Control of New York City, Inc. (ACC or the Requestor) for the property located at 151 Woodward Avenue in Queens, New York (the Site). The Requestor is currently applying to investigate and remediate the Site under the New York State Department of Environmental Conservation (NYSDEC) Brownfield Cleanup Program (BCP). The legal definition of the Site is Queens Borough Tax Block 3376, Lots 1 and 7. The approximately 0.986- acre Site is bound to the north by a two-story commercial building, to the east by Troutman Street, to the south by Woodward Avenue, and to the west by Flushing Avenue. Currently, the Site is occupied by Aalba Auto Salvage, Inc., an auto wrecking yard and used auto parts facility, and Tire Wheel and Glass Depot, a tire and auto glass shop. A Site Location Plan is provided as Figure 1.

A Phase II Environmental Site Investigation (Phase II) was performed by Soil Mechanics, and summarized in a Phase II Report dated December 2008. Phase I and Phase II Environmental Site Assessments (ESAs) were conducted by Environmental Studies Corporation (ESC) in May and June 2018, respectively, and a Supplemental Subsurface (Phase II) Investigation Report dated September 2018 was prepared by AKRF, Inc. (AKRF). Laboratory results from the Phase II investigations identified volatile organic compounds (VOCs), poly-aromatic hydrocarbons (PAHs), heavy metals, and polychlorinated biphenyl (PCB) above NYSDEC Part 375 Commercial Use Soil Cleanup Objectives (CSCOs) in soil. Metals and Methyl tert-butyl ether (MTBE) were detected in groundwater above NYSDEC Technical and Operational Guidance Series (TOGS) Ambient Water Quality Standards (AWQS) and/or Guidance Values. The compounds cis-1,2-dichloroethylene and trichloroethylene (TCE) were detected at elevated concentrations in soil vapor beneath the Site. The soil, soil vapor, and groundwater contamination appear to be related to current and historic industrial operations at the Site.

This RIWP has been prepared in accordance with DER-10 Technical Guidance for Site Investigation and Remediation dated May 2010 (DER-10) to delineate the vertical and horizontal contamination identified in the previous subsurface investigations. The RIWP describes the procedures to be used to define the nature and extent of contamination in on-site soil, groundwater, and soil vapor. The data compiled from the Remedial Investigation (RI) and the previous Phase II investigations will be used to prepare a Remedial Action Work Plan (RAWP). All work will be completed in accordance with this RIWP, which includes a Quality Assurance Project Plan (QAPP) (Appendix A) and a Health and Safety Plan (HASP) (Appendix B). The Community Air Monitoring Plan (CAMP) detailed in the HASP will be implemented during all subsurface disturbance activities at the Site, including, but not limited to, soil boring advancement, soil sampling, monitoring well installation and development, groundwater and soil vapor sampling, and backfilling of boreholes.

2.0 SITE DESCRIPTION AND HISTORY

2.1 Site Description and Surrounding Land Use

The approximately 0.986- acre Site is located at 151 Woodward Avenue, in the Ridgewood neighborhood of Queens, New York. The Site contains two permanent structures: a one-story masonry and wood frame garage used for storage, vehicle dismantling, and repairs; and a one-story masonry and steel frame garage building with a mezzanine level. Exterior portions of the Site contain several steel shipping containers, racks and shelving for auto parts, and open areas for storage of cars and car parts. Some of the shipping containers have been modified to house temporary office spaces on the Site. A Site Plan that shows the Site usage is provided as Figure 2.

The Site is bounded to the north by a shelving warehouse and distribution facility; to the east by Troutman Street, followed by a parking lot, unspecified storage, and multi-family residential buildings; to the south by Woodward Avenue, followed by residential and commercial buildings and a gasoline station; and to the west by Flushing Avenue, followed by mixed-use buildings with street-level commercial uses (auto repair/tire shop and deli) and an auto storage/junk yard. The surrounding area is primarily industrial, commercial, and residential in use.

2.2 Site Geology, Hydrogeology, and Subsurface Characteristics

Based on the U.S. Geological Survey (USGS), Brooklyn, New York 2013 Quadrangle map, the elevation of the Site is between approximately 34 and 40 feet above the North American Datum of 1988 (an approximation of mean sea level). The Site surface topography slopes down approximately 15 feet from the Site ramp along Troutman Street towards Flushing Avenue. Regional surface topography generally slopes downward to the north. Subsurface materials as described in the Supplemental Subsurface (Phase II) Investigation consisted of historic fill (comprising sand, silt, brick, gravel, glass, asphalt, and concrete) from the surface down to approximately 3 to 5 feet below grade across the Site. The fill material was generally underlain by apparent native material consisting of sand and silt layers with a minor gravel component to the boring terminus at 30 feet below grade.

During the September 2018 Supplemental Subsurface (Phase II) Investigation, groundwater was encountered between approximately 19 to 23 feet below grade surface (bgs) in temporary well points across the Site. Based on USGS mapping and local topography, groundwater is anticipated to flow in a northeasterly direction toward Newtown Creek, which is located approximately 1,600 feet northeast of the Site; however, actual groundwater flow direction can be affected by many factors, including subsurface openings or obstructions such as subway tunnels, basements, utilities, and other factors beyond the scope of this assessment. Groundwater is not used as a source of potable water at the Site.

2.3 Nearby Areas of Public Concern

A review of the existing uses within the surrounding area identified one school and several residential buildings within an approximately 3,000-foot radius of the Site. A Citizen Participation Plan (CPP) will be prepared upon execution of a Brownfield Cleanup Agreement (BCA), which is anticipated in March 2019.

2.4 Site History

Historic records indicated that the Site has been used for automotive, residential, and commercial purposes since at least 1902. Historical Sanborn maps identified the Site as a being mixed-use commercial (retail) and residential in 1902. By 1914, the Site was used solely for retail purposes.

By 1939, the Site was identified as being used as a restaurant. New York City Department of Buildings (DOB) records indicated that permits were filed in 1960 to allow the Site to be redeveloped into as an automobile garage, and in 1962 the city directory lists the Site as an automobile wrecking corporation. City directories indicate that automobile wrecking businesses occupied the Site from 1962 to 2005. The Site is currently operating as an auto wrecking yard and used auto parts facility, and a tire and auto glass shop.

3.0 PREVIOUS INVESTIGATIONS

3.1 Phase II Environmental Site Investigation, Soil Mechanics – December 2008

Based on the results of a May 2007 Phase I ESA (not provided for review), Soil Mechanics conducted a subsurface investigation at the Site on behalf of 5915 Holding Corp. (one of the property owners). The scope of work included the advancement of eight soil borings, installation of three temporary groundwater wells, and collection and analysis of eight soil samples and three groundwater samples. Findings of the investigation included:

- Numerous VOCs were detected in soil above their respective NYSDEC Unrestricted Soil Cleanup Objectives (UUSCOs). The detected semivolatile organic compounds (SVOCs) primarily included PAHs, which are commonly found in fill material in New York City. The metals chromium, cadmium, mercury, and lead were detected above their respective UUSCOs, but below the Restricted Commercial Use Soil Cleanup Objectives (CSCOs), in several samples.
- The VOC MTBE was detected above its NYSDEC Class GA Ambient Water Quality Standards (AWQS) and Guidance Value of 10 micrograms per liter (µg/L) in all three groundwater samples at concentrations ranging from 111 µg/L to 1,557 µg/L. The metals arsenic, barium, chromium, mercury, and lead were detected above their respective AWQS and/or Guidance Values in the groundwater samples.

3.2 Phase I Environmental Site Assessment, ESC – May 2018

A Phase I ESA of the Site was prepared by Environmental Studies Corporation (ESC) in May 2018 on behalf of The Requestor. The Phase I ESA was performed in conformance with ASTM Standard E1527-13, *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Practice*. The report identified the following Recognized Environmental Conditions (RECs):

- The presence of contaminants in excess of regulatory standards and guidelines found in soil and groundwater samples collected at the Site in 2008.
- The potential for additional contaminated soil and groundwater at the Site from current and historic automobile maintenance, wrecking, and salvage operations.
- The potential for a vapor encroachment condition to current and future buildings at the Site from current and historic operations.
- The possible presence of one or more out-of-service petroleum underground storage tanks (USTs) that have not been closed or removed in accordance with applicable regulations.
- The potential for groundwater contamination from off-site sources in the immediate vicinity of the Site.

3.3 Phase II Environmental Site Investigation, ESC – June 2018

Based on the results of the May 2018 Phase I ESA, ESC conducted a subsurface investigation at the Site on behalf of The Requestor. The scope of work included a geophysical survey, the advancement of six soil borings, installation of two temporary groundwater wells, and collection of analysis of six soil samples, two groundwater samples, and two soil vapor samples. Findings of the investigation included:

- A geophysical survey identified the presence of an oil-water separator tank in the Tire Wheel and Glass Depot building located on Flushing Avenue. The report did not indicate the location of the tank.
- Petroleum-related VOCs were detected in several soil samples above their respective UUSCOs, including: 1,2,4-trimethylbenzene, ethylbenzene, toluene, total xylenes, and 2-butanone.
- PAHs including benzo(a)pyrene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene were detected above their respective UUSCOs in soil samples. Benzo(a)pyrene was also detected above its CSCO in one soil sample (B-3 12 FT).
- The metals lead and mercury were detected above the UUSCOs, but below the CSCOs, in several soil samples.
- The VOC MTBE was detected in both groundwater samples at concentrations of 260 µg/L and 240 µg/L, both exceeding its AWQS and Guidance Value of 10 µg/L. Two SVOCs including diethyl phthalate and 2,6-dinitrotoluene were detected above their respective AWQS and/or Guidance Value.
- Several petroleum related compounds were detected in the two soil vapor samples collected at the Site. In addition, TCE was detected at a concentration of 170 micrograms per cubic meter (µg/m^3) and cis-1,2-dichloroethylene was detected at a concentration of 90 µg/m^3 in sample SV-1.

3.4 Supplemental Phase II Environmental Site Investigation, AKRF – September 2018

AKRF conducted a Supplemental Subsurface (Phase II) Investigation to further investigate whether current and historic uses at the Site had adversely affected the Site’s subsurface. The scope of the investigation was based on the findings of the Phase I and Phase II ESA conducted at the Site by ESC in May and June 2018, respectively. Field activities included the advancement of seven soil borings with collection and analysis of nine soil samples; and the installation of three temporary groundwater monitoring wells with the collection and analysis of three groundwater samples. Findings of the investigation included:

- The VOCs acetone, benzene, ethylbenzene, toluene, and total xylenes were detected in soil above their respective UUSCOs, but below their respective CSCOs in up to five shallow soil samples. The VOCs m,p-xylenes and MTBE were detected in groundwater at concentrations above their AWQSs and/or Guidance Values of 5 µg/L and 10 µg/L, respectively. MTBE was detected in both groundwater samples at concentrations of 260 µg/L and 240 µg/L.
- Two SVOCs were detected above their respective CSCOs in two soil samples: benzo(a)pyrene was detected above CSCO of 1 mg/kg in two samples samples at concentrations of 4.2 mg/kg and 1.3 mg/kg, respectively, and dibenz(a,h)anthracene was detected above its CSCO of 0.56 mg/kg in one soil sample at a concentration of 1 mg/kg. The detected concentration of phenol (5.5 µg/L) in one ground water sample exceeded the AWQS of 1.0 µg/L.

- Two metals were detected in two soil samples above CSCOs. Mercury was detected in one sample at a concentration of 3.3 mg/kg, above the CSCO of 2.8 mg/kg; and copper was detected in another sample at a concentration of 391 mg/kg, above the CSCO of 270 mg/kg. Arsenic, barium, chromium, iron, lead, magnesium, manganese, mercury and selenium were detected above their respective AWQS and/or Guidance Values.
- Total PCBs were detected in one soil sample at 8.7 mg/kg, above the total PCB CSCO of 1 mg/kg.

The petroleum-related VOCs and SVOCs detected in the shallow soil/fill and in groundwater samples are likely related to current and historic automobile uses as the Site. The detection of total PCBs, which exceeded the UUSCO and CSCO in one soil sample, is likely related to historic industrial uses at the Site. SVOC detections that exceeded the UUSCOs and/or CSCOs in the soil samples were mostly PAHs and are likely related to the presence of historic fill. Detections of metals that exceeded the UUSCOs and/or CSCOs in shallow soil samples are also likely related to the presence of historic fill at the Site. Iron and manganese are earthen metals that are expected to be present within the aquifer, and are generally not attributable to a Site-related discharge. Maps showing exceedances of soil and groundwater standards and/or guidance values are included as Figures 3 and 4, respectively.

4.0 FIELD PROGRAM

The RI field program will focus on collecting soil, groundwater, and soil vapor data to supplement the existing data, determine the nature and extent of Site contamination, and to assist with determining the appropriate remedial action.

4.1 Field Program Summary

The field sampling scope of work consists of: the advancement of 14 soil borings with continuous soil sampling and laboratory analysis of up to 4 soil samples per boring, the installation of 10 permanent groundwater monitoring wells with the collection and analysis of 10 groundwater samples, collection of one sludge sample from the concrete surface, and the installation of 7 soil vapor points with the collection and analysis of 7 soil vapor samples during the RI. In addition, 11 soil borings will be advanced to collect soil pre-characterization soil samples and emerging contaminants. The waste class and emerging contaminants sampling will be performed after building demolition as part of the remedial action, during the summer of 2019. The proposed sample locations are shown on Figure 2. The following sections describe the methods that will be used to complete the scope of work.

The rationale for the proposed sample locations is as follows:

Table 1
Sample Locations and Rationale

Sampling Location	Location	Rationale For Sampling Location
RI-SB-01/MW-01	Northwestern portion of the Site	To assess soil and groundwater quality in the down-gradient of the vehicle salvage bays/northwestern portion of the Site
RI-SB-02/MW-02	Northeastern portion of the Site	To assess soil and groundwater quality in the down-gradient of the Tire Depot/northeastern portion of the Site

Sampling Location	Location	Rationale For Sampling Location
RI-SB-03/MW-03	Western portion of the Site	To assess soil and groundwater quality within the Vehicle Salvage Bay/western portion of the Site
RI-SB-04/MW-04	Center of the Site	To assess soil and groundwater quality in center of the Site
RI-SB-05/MW-05	Eastern portion of the Site	To assess soil and groundwater quality in the eastern portion of the Site
RI-SB-06/MW-06	Center of the Site	To assess soil and groundwater quality in the center of the Site
RI-SB-07/MW-07	Eastern portion of the Site	To assess soil and groundwater quality in the eastern portion of the Site
RI-SB-08/MW-08	Southwestern portion of the Site	To assess soil and groundwater quality in the southwestern portion of the Site
RI-SB-09/MW-09	Southern portion of the Site	To assess soil and groundwater quality in the southern portion of the Site
RI-SB-10/MW-10	Southeastern portion of the Site	To assess soil and groundwater quality in the up-gradient/southeastern portion of the Site
RI-SB-11	Central portion of the Site, near auto rack storage	To assess soil quality in the central portion of the Site
RI-SB-12	Western portion of the Site, in parts storage building	To assess soil quality in western portion of the Site
RI-SB-13	Southeastern portion of the Site, adjacent to auto rack storage	To assess soil quality in southeastern portion of the Site
RI-SB-14	Southwestern portion of the Site, in parts storage building	To assess soil quality in southwestern portion of the Site
RI-SL-01	Northwestern portion of the Site, in vehicle salvage bays	To assess the sludge on top of the ground surface in northwestern portion of the Site
RI-SV-01	Northwestern portion of the Site	To assess soil vapor quality, evaluate potential for off-site exposures, and to complete significant threat determination
RI-SV-02	Northeastern portion of the Site	To assess soil vapor quality, evaluate potential for off-site exposures, and to complete significant threat determination
RI-SV-03	Western portion of the Site	To assess soil vapor quality, evaluate potential for off-site exposures, and to complete significant threat determination
RI-SV-04	Center of the Site	To assess soil vapor quality, and to complete significant threat determination
RI-SV-05	Eastern portion of the Site, along the Site boundary	To assess soil vapor quality, evaluate potential for off-site exposures, and to complete significant threat determination

Sampling Location	Location	Rationale For Sampling Location
RI-SV-06	Southwestern portion of the Site	To assess soil vapor quality, evaluate potential for off-site exposures, and to complete significant threat determination
RI-SV-07	Southern portion of the Site	To assess soil vapor quality, evaluate potential for off-site exposures, and to complete significant threat determination
WC-SB-01	Northwestern portion of the Site	For waste characterization and to assess soil for the presence of 1,4-dioxane and perfluorinated alkylated substances (PFAS).
WC-SB-02	Northeastern portion of the Site	For waste characterization and to assess soil for the presence of 1,4-dioxane and PFAS.
WC-SB-03	Western portion of the Site	For waste characterization and to assess soil for the presence of 1,4-dioxane and PFAS.
WC-SB-04	Center of the Site	For waste characterization and to assess soil for the presence of 1,4-dioxane and PFAS.
WC-SB-05	Eastern portion of the Site	For waste characterization and to assess soil for the presence of 1,4-dioxane and PFAS.
WC-SB-06	Center of the Site	For waste characterization and to assess soil for the presence of 1,4-dioxane and PFAS.
WC-SB-07	Eastern portion of the Site	For waste characterization and to assess soil for the presence of 1,4-dioxane and PFAS.
WC-SB-08	Southwestern portion of the Site	For waste characterization and to assess soil for the presence of 1,4-dioxane and PFAS.
WC-SB-09	Southwestern portion of the Site	For waste characterization and to assess soil for the presence of 1,4-dioxane and PFAS.
WC-SB-10	Southeastern portion of the Site	For waste characterization and to assess soil for the presence of 1,4-dioxane and PFAS.
WC-SB-11	Southeastern portion of the Site	For waste characterization and to assess soil for the presence of 1,4-dioxane and PFAS.

4.2 Soil Sampling

A Geoprobe drill rig with Hollow Stem Augers (HSA) will be used to advance 25 soil borings (RI-SB-1 through RI-SB-14 and WC-SB-01 through WC-SB-11) at the approximate locations shown on Figure 2 to assess soil quality throughout the Site. At borings RI-SB-01 through RI-SB-14, soil samples will be collected continuously until the groundwater interface. At borings WC-SB-01 through WC-SB-11, soil samples will be collected continuously until the groundwater interface (between approximately 3 and 23 feet below existing grade across the Site). Soil cores will be collected in five-foot long, two-inch diameter, stainless steel macrocore piston rod samplers fitted with dedicated, internal acetate liners. Soil cores will be inspected by AKRF field personnel for evidence of contamination (e.g., odors, staining), screened for the presence of VOCs with a photoionization detector (PID) equipped with a 10.6 electron volt (eV) lamp, and logged using the modified Burmister soil classification system. The PID will be calibrated in accordance with manufacturer's recommendations prior to sampling.

> At borings RI-SB-01 through RI-SB-14, up to four soil samples from each soil boring will be submitted for laboratory analysis. One soil sample will be collected from the interval beneath the site-wide concrete cap (approximately 2 feet below existing grade surface), a second sample will be collected from the proposed new building foundation depth (between approximately 4 and 12 feet below existing grade surface across the Site), and a third sample will be collected from the 2-foot interval directly above the groundwater interface in soil borings that will be converted into groundwater monitoring wells. Groundwater is expected to be encountered at approximately 19 to 23 feet below existing grade. The site is currently covered by impervious materials (buildings and pavement) without any exposed soil; therefore, surface soil samples will not be collected during the RI.
>
> At borings WC-SB-01 through WC-SB-11, 3 to 4 soil samples will be submitted for laboratory analysis from each soil boring. One soil sample will be collected from the interval beneath the site-wide concrete cap (approximately 2 feet below existing grade surface). A second sample will be collected between approximately 2 and 8 feet below existing grade surface across the Site, and a third sample will be collected between approximately 8 and 15 feet bgs. In five of the borings, a fourth sample will be collected from the interval immediately above the water table, which was encountered between 19 and 23 feet bgs during the Supplemental Phase II Investigation.

If field evidence of contamination (visual, olfactory, or elevated PID reading) is observed, an additional soil sample per soil boring will be collected from the interval exhibiting the highest level of contamination. All sampling equipment (e.g., drilling rods and casing and probe rods) will be either dedicated, or decontaminated between each soil boring location.

Soil samples slated for laboratory analysis will be labeled and placed in laboratory-supplied containers and shipped to a NYSDOH Environmental Laboratory Approval Program (ELAP)-certified laboratory via courier with appropriate chain of custody documentation in accordance with appropriate USEPA protocols. The samples from RI-SB-01 through RI-SB-14 will be analyzed for VOCs by EPA Method 8260, SVOCs by EPA Method 8270, PCBs by EPA Method 8082, pesticides by EPA Method 8081, and the total analyte list (TAL) of metals by EPA Method 6000/7000 series plus hexavalent chromium by EPA Method 7196A and cyanide by EPA Method 9012B using Category B deliverables. The grab samples from WC-SB-01 through WC-SB-11 will be analyzed for 1,4-dioxane by EPA Method 8270D selected ion monitoring (SIM), PFAS by EPA Method 537 (modified), VOCs plus 10 tentatively identified compounds (TICs) by EPA Method 8260. The five-point composite samples will be analyzed for: SVOCs plus 20 TICs by EPA Method 8270; TAL metals and trivalent chromium; Toxicity Characteristic Leaching Procedure (TCLP) eight Resource Conservation and Recovery Act (RCRA) metals plus copper, nickel, and zinc; PCBs by EPA Method 8082; pesticides by EPA Method 8081; total cyanide; total petroleum hydrocarbons (TPH) by EPA Method 8015 for diesel range organics (DRO) and gasoline range organics (GRO); extractable petroleum hydrocarbon (EPH); hexavalent chromium; and ignitability, corrosivity, and reactivity using Category A deliverables. A standard turnaround time will be requested from the laboratory.

For RI-SB-01 through RI-SB-14, one blind duplicate, field blank, trip blank, and matrix spike/matrix spike duplicate (MS/MSD) will be collected for quality control/quality assurance (QA/QC) purposes for every 20 field samples collected. It is anticipated that four field blanks, four blind duplicate, four matrix spike/matrix spike duplicates (MS/MSD), and four trip blanks will be required during the soil portion of the field investigation. The QA/QC samples, with the exception of trip blanks, will be analyzed for all of the previously listed testing parameters. Trip blanks will be analyzed for VOCs only. The data will be reviewed by a third-party validator, and a Data

Usability Summary Report (DUSR) will be prepared to document the usability and validity of the data. The soil boring locations will be surveyed using the Global Positioning System (GPS).

After each boring is completed, the soil boring holes will be filled with on-site materials (if not noticeably contaminated) to 24-inches below the surface and patched with concrete to match existing surface conditions. If necessary (soils exhibit evidence of contamination), soil cuttings will be containerized in properly labeled Department of Transportation (DOT) approved 55-gallon drums for future off-site disposal at a permitted facility. All boreholes that require drill-cutting disposal would be filled with bentonite chips (hydrated) and concrete capping. Disposable sampling equipment, including spoons, gloves, bags, paper towels, etc. that come in contact with environmental media will be double bagged and disposed of as municipal trash in a facility trash dumpster as non-hazardous refuse.

4.3 Monitoring Well Installation and Development

Ten soil boring locations will be converted into 2-inch diameter permanent monitoring wells (RI-MW-01 through RI-MW-10) as shown on Figure 2. The monitoring wells will be installed up to 30 feet into the groundwater table, expected to be encountered at approximately 19 to 23 feet bgs. Procedures for field screening and soil sample collection will be consistent with those described in Section 4.2 and in the QAPP (Appendix A). Monitoring well construction will consist of 10 feet of 0.020-inch slotted polyvinyl chloride (PVC) screen installed approximately 5 feet into the water table; solid PVC riser will be placed to ground surface. A No. 2 Morie sandpack will be installed to two feet above the well screen. The annular space around the solid well riser will be sealed with bentonite and the well will be completed with Site soil to approximately one-foot bgs if there is no evidence of contamination (visual, olfactory, and/or PID detections) in the boring. If contamination is noted, annular space will be filled with No. 2 Morie sand to approximately one-foot bgs. The wells will be finished with a locking plug and flush-mounted protective locking well cover. The proposed monitoring well locations are shown on Figure 2.

Following installation, each well will be developed via pumping and surging to remove any accumulated fines and establish a hydraulic connection with the surrounding aquifer. Development will continue until turbidity within the well is less than 50 nephelometric turbidity units (NTUs) for three successive readings and until water quality indicators have stabilized to within 10% for pH, temperature, and specific conductivity for three successive readings. In the event 50 NTUs cannot achieved, the wells will be developed until at least three well volumes have been purged from the well. Well development details will be noted on logs. Purge water needing to be managed will be containerized in properly labeled DOT approved 55-gallon drums for future off-site disposal at a state-permitted facility.

4.4 Groundwater Elevation Survey

The monitoring wells will be surveyed by a New York State-licensed surveyor to determine their accurate location and elevation. Two elevation measurements will be taken at each well location: the at-grade elevation; and the elevation of the top of PVC casing (north side at marking), to facilitate preparation of a groundwater elevation contour map to establish the direction of groundwater flow. The elevation datum for the sampling points will be based on NVAD 88 Elevation Datum with the horizontal datum being based on NYS Plane Coordinates Long Island Zone.

4.5 Groundwater Sampling

In accordance with USEPA low-flow sampling protocols, the wells will be sampled one to two weeks following their development. Prior to sampling, an electronic interface meter will be used to measure water levels and thickness of separate phase product, if any. The purge water will be monitored for turbidity and water quality indicators (i.e., pH, dissolved oxygen, oxidation-reduction potential, temperature, and specific conductivity) with measurements collected approximately every five minutes. The criteria for stabilization will be three successive readings within ±10% for pH, temperature, and specific conductivity. Purge water needing to be managed on-site will be containerized in properly labeled, Department of Transportation (DOT)-approved 55-gallon drums for off-site disposal at a permitted facility.

Groundwater samples slated for laboratory analysis will be placed in laboratory-supplied containers and shipped in accordance with appropriate EPA protocols to a NYSDOH ELAP-certified laboratory. The samples will be analyzed for Target Compound List (TCL) VOCs by EPA Method 8260, TCL SVOCs by EPA Method 8270, PCBs by EPA Method 8082, pesticides by EPA Method 8081, 1,4-dioxane by EPA Method 8270D SIM, PFAS by EPA Method 537 (modified), and TAL Metals (total and dissolved) by EPA Method 6000/7000 series, using Category B deliverables. All dissolved metals samples will be field filtered. A standard turnaround time will be requested from the laboratory.

One blind duplicate, one field blank, one equipment rinsate blank, one trip blank, and one MS/MSD sample will be collected for QA/QC purposes. The QA/QC samples, with the exception of the trip blank, will be analyzed for TCL VOCs, TCL SVOCs, PCBs, pesticides, and TAL Metals EPA Method 6000/7000 series. The trip blank will be analyzed for VOCs only. The data will be reviewed by a third-party validator, and a DUSR will be prepared to document the usability and validity of the data.

4.6 Soil Vapor Sampling

Soil vapor sampling will be performed in accordance with the guidelines provided in the NYSDOH document entitled, “Guidance for Evaluating Soil Vapor Intrusion in the State of New York, October 2006.” Seven soil vapor samples will be collected from seven temporary monitoring points installed between 5 and 12 feet below surface grade (depending upon the location) as shown on Figure 2. Each soil vapor probe location will be surveyed using GPS to determine their accurate location.

All soil vapor monitoring points will be installed by advancing an expendable drive point using a drill rig to the specified depth below grade. At each monitoring point, a 6-inch stainless steel screen implant, connected to Teflon tubing will be installed by hand or through the drilling rods and threaded into the drive point. The sampling tubing will extend from the end of the screen to above grade. The push probe rods will then be removed and the boring will be backfilled with clean silica sand to 3 to 6 inches above the screen. Hydrated bentonite will be used to fill the remaining void around the sampling tubing to the ground surface.

The soil vapor samples will be collected over a 2-hour time period from each monitoring point using a 6-liter (6L), batch-certified SUMMA canister equipped with a vacuum gauge and flow regulator set at a maximum rate of 0.2 liters per minute. Prior to sample collection, the sampling points will be purged of three sample volumes using a peristaltic pump. During purging, an inverted 5-gallon bucket will be placed over the sampling point and helium gas will be introduced through a small hole in the bucket to saturate the atmosphere around the sample port with helium gas. Purged vapors will be collected into a Tedlar bag and field-screened for organic vapors using a PID. The purged air will also be monitored using a portable helium detector to check for short-circuiting of ambient air into the vapor sampling point. If the purged soil vapor contains greater than 10% helium, additional bentonite will used to enhance the surface seal, and the point will be retested.

Following purging, a soil vapor sample will be collected using the vacuum from the SUMMA canister. Immediately after opening the flow control valve equipped with a 2-hour regulator, the initial SUMMA canister vacuum (inches of mercury) will be noted. After two hours, the flow controller valve will be closed, the final vacuum noted, and the canister placed in a shipping carton for delivery to the laboratory.

All samples will be analyzed for VOCs according to USEPA Method TO-15 by a NYSDOH ELAP-certified laboratory with Category B deliverables. Samples will be shipped to the laboratory with appropriate chain of custody documentation. No sample preservation is required for soil vapor samples. The data will be reviewed by a third-party validator and a DUSR will be prepared to document the suitability of using the data.

4.7 Quality Assurance / Quality Control (QA/QC)

Additional analysis will be included for quality control measures, as required by the Category B sampling techniques. The QA/QC samples for soil and groundwater will include up to four field blanks, trip blanks, MS/MSD samples, and blind duplicate samples at a frequency of one sample per 20 field samples per media. Equipment rinsate blanks will also be collected for groundwater samples at a frequency of one sample per 20 field samples per media. The field blanks, equipment rinsate blanks, blind duplicates, and MS/MSD samples will be analyzed for VOCs by EPA Method 8260, SVOCs by EPA Method 8270, PCBs by EPA Method 8082, pesticides by EPA Method 8081, and the total analyte list (TAL) of metals by EPA Method 6000/7000 series plus hexavalent chromium by EPA Method 7196A and cyanide by EPA Method 9012B (hexavalent chromium and cyanide for soil only) using Category B deliverables. One laboratory-prepared trip blank will be submitted for analysis of VOCs only to determine the potential for cross-contamination. The QAPP (Appendix A) describes the QA/QC protocols and procedures that will be followed during implementation of the RIWP.

4.8 Decontamination Procedures

All non-dedicated sampling equipment (e.g., submersible pumps and oil/water interface probe) will be decontaminated between drilling and sampling locations using the following procedure:

1. Scrub equipment with a bristle brush using a tap water/Simple Green® solution.
2. Rinse with tap water.
3. Scrub again with a bristle brush using a tap water/Simple Green® solution.
4. Rinse with tap water.
5. Rinse with distilled water.
6. Air-dry the equipment.

4.9 Management of Investigation-Derived Waste (IDW)

IDW that does not exhibit of evidence of contamination (e.g., staining, presence of ash, oily sheens, odors, etc.) will be used to fill in the corresponding soil boring hole. Soil and groundwater IDW exhibiting evidence of contamination will be containerized in DOT-approved 55-gallon drums. The drums will be sealed at the end of each work day and labeled with the date, the well or boring number(s), the type of waste (i.e., drill cuttings, decontamination fluids, development water, or purge water) and the name of an AKRF point-of-contact. All drums will be labeled "pending analysis" until laboratory data is available. All IDW will be disposed of or treated according to applicable local, state, and federal regulations.

5.0 REPORTING REQUIREMENTS

5.1 Remedial Investigation Report (RIR)

Upon completion of all field work and receipt of laboratory analytical results, an RIR will be prepared that will: document field activities; present field and laboratory data; evaluate exposure pathways in an exposure assessment; and discuss conclusions and recommendations drawn from the results of the investigation. Soil, groundwater, and soil vapor sampling results will be presented in the text, and on figures and tables with comparisons to applicable standards, criteria and guidance (SCGs) for each media.

5.1.1 Description of Field Activities

This section of the RIR will describe the field methods used to characterize the Site conditions, including: sampling techniques; field screening equipment; drilling and excavation equipment; monitoring well installation procedures; and management of IDW.

5.1.2 Soil Boring Assessment

The RIR will include a section that presents field and laboratory data for soil results. The section will include a description of soil characteristics and figures will be provided that illustrate soil boring locations. Field and laboratory analytical results will be presented in the body of the report, summarized in tables and figures, and the detected concentrations will be compared to regulatory standards. Soil boring logs and laboratory analytical reports will be provided as attachments. Category B deliverables will be provided by the laboratory and a third-party DUSR will be prepared.

5.1.3 Groundwater Assessment

The RIR will include a section that presents field and laboratory data from the groundwater monitoring results. The section will include a description of groundwater characteristics and figures will be provided that illustrate monitoring well locations. Well survey data and water level measurements will be used to create a groundwater elevation contour map and determine inferred groundwater flow direction. Field and laboratory analytical results will be presented and compared with regulatory standards and/or guidance values. Well construction, well development, and low-flow groundwater sampling logs and laboratory analytical reports will be provided as attachments. Category B deliverables will be provided by the laboratory and a third-party DUSR will be prepared.

5.1.4 Soil Vapor Assessment

The RIR will include a section that presents field and laboratory data from the soil vapor results. The section will include a description of soil vapor characteristics and will provide a summary of soil vapor sample analytical data. Figures will be provided that illustrate the soil vapor point locations. Field and laboratory analytical results will be presented and compared with regulatory standards and/or guidance values. Soil vapor logs and laboratory analytical reports will be provided as attachments. Category B deliverables will be provided by the laboratory and a third-party DUSR will be prepared.

5.1.5 Qualitative Human Health Exposure Assessment

A Qualitative Human Health Exposure Assessment will be performed in accordance with DER-10 Section 3.3. The assessment will be included in the RIR.

6.0 SCHEDULE OF WORK

The following tentative schedule has been developed for the project. This schedule is subject to change.

Activity	**Time To Complete**
Submittal of BCP Application and Draft Remedial Investigation Work Plan (RIWP)	November 2018
30-day Completeness Review	December 2018
Remedial Investigation	December 2018
30-day Public Notice/Public Comment Period is Initiated	January 2019
BCA Execution	April 8, 2019
Submittal and Approval of Citizen Participation Plan	April 2019
Submittal of Final RIWP	May 2019
Draft Remedial Investigation Report (RIR) and Draft Remedial Action Work Plan (RAWP) Submitted to NYSDEC	May 2019
45-day Public Comment Period for RIR and RAWP is Initiated	June 2019
Public Comment Period for RIR and RAWP Ends	July 2019
Final RIR and RAWP Submitted/DEC Approves and Issues Decision Document	August 2019
Issue Remedial/Construction Notice Fact Sheet	End of September 2019
Begin Redevelopment (Construction) with Implementation of RAWP	October 2019
Execution of Environmental Easement (if required)	May 2020
Draft Site Management Plan (SMP) Submitted to NYSDEC	July 2020
Draft Final Engineering Report and Fact Sheet	September 2020
Certificate of Completion and Fact Sheet	December 2020
Completion of Building	December 2021

7.0 CERTIFICATION

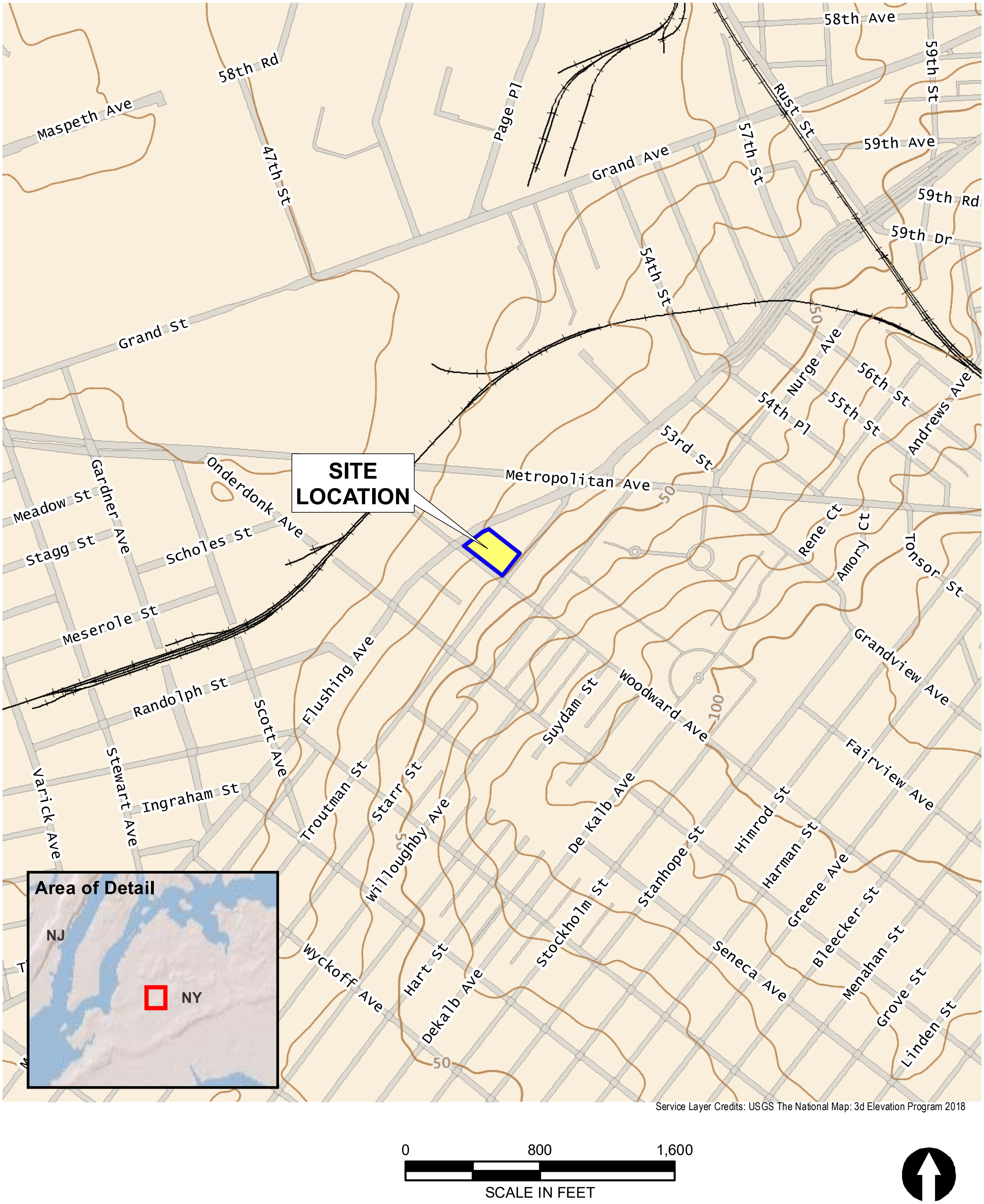
I, Deborah Shapiro, QEP, certify that I am currently a Qualified Environmental Professional as defined in 6 NYCRR Part 375 and that this Supplemental Remedial Investigation Work Plan was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10).

Deborah Shapiro, QEP	D. Shapiro	May 23, 2019
Name	***Signature***	***Date***

8.0 REFERENCES

- U.S. Geological Survey; Quadrangle Map – Brooklyn, New York; 7.5 Minute Series (Topographic); Scale 1:24,000; 2013.
- U.S. Geological Survey; Bedrock and Engineering Geologic Maps of New York County and Parts of Kings and Queens Counties, New York, and Parts of Bergen and Hudson Counties, New Jersey. Sheet 3 – Bedrock Contours and Outcrops. Scale 1:24,000. 1990.
- Phase I Environmental Site Assessment (ESA), 151 Woodward Avenue (A.K,A. 151-161 Woodward Avenue, 19-02 through 19-08 Flushing Avenue & 19-01 Troutman Street, Queens, N.Y. 11385, Block 3376, Lot #'s 1 & 7), Environmental Studies Corporation, May 2018Phase II Work Plan (Short Form) for 1888 Bathgate Avenue, Bronx, New York – Block 2924, Lots 7, 10, 25, 30, and 34, ALC Environmental, May 2016.
- Phase II Environmental Site Investigation Report, 151 Woodward Avenue, Queens, N.Y. 11385, Block 3376, Lot #'s 1 & 7), Soil Mechanics, December 2008 Geotechnical Investigation Report for Two Proposed Nine-Story Mixed-Use Buildings, 3rd Avenue and Bathgate Avenue, Bronx, New York, SESI Consulting Engineers D.P.C., August 2016.
- Phase II Environmental Site Investigation Report, 151 Woodward Avenue (A.K,A. 151-161 Woodward Avenue, 19-02 through 19-08 Flushing Avenue & 19-01 Troutman Street, Queens, N.Y. 11385, Block 3376, Lot #'s 1 & 7), Environmental Studies Corporation, June 2018
- Supplemental Subsurface (Phase II) Environmental Site Investigation Report, 151 Woodward Avenue, Queens, N.Y. 11385, Block 3376, Lot #'s 1 & 7), AKRF, Inc., September 2018
- 6 NYCRR Section 375-6: Remedial Program Soil Cleanup Objectives (SCOs), December 14, 2006.
- NYSDEC Division of Water Technical and Operational Guidance Series 1.1.1 Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations, March 1998.
- NYSDOH Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York, October 2006; updated September 2013 for change of AGV for PCE; updated in August 2015 and May 2017.

FIGURES



Service Layer Credits: USGS The National Map: 3d Elevation Program 2018

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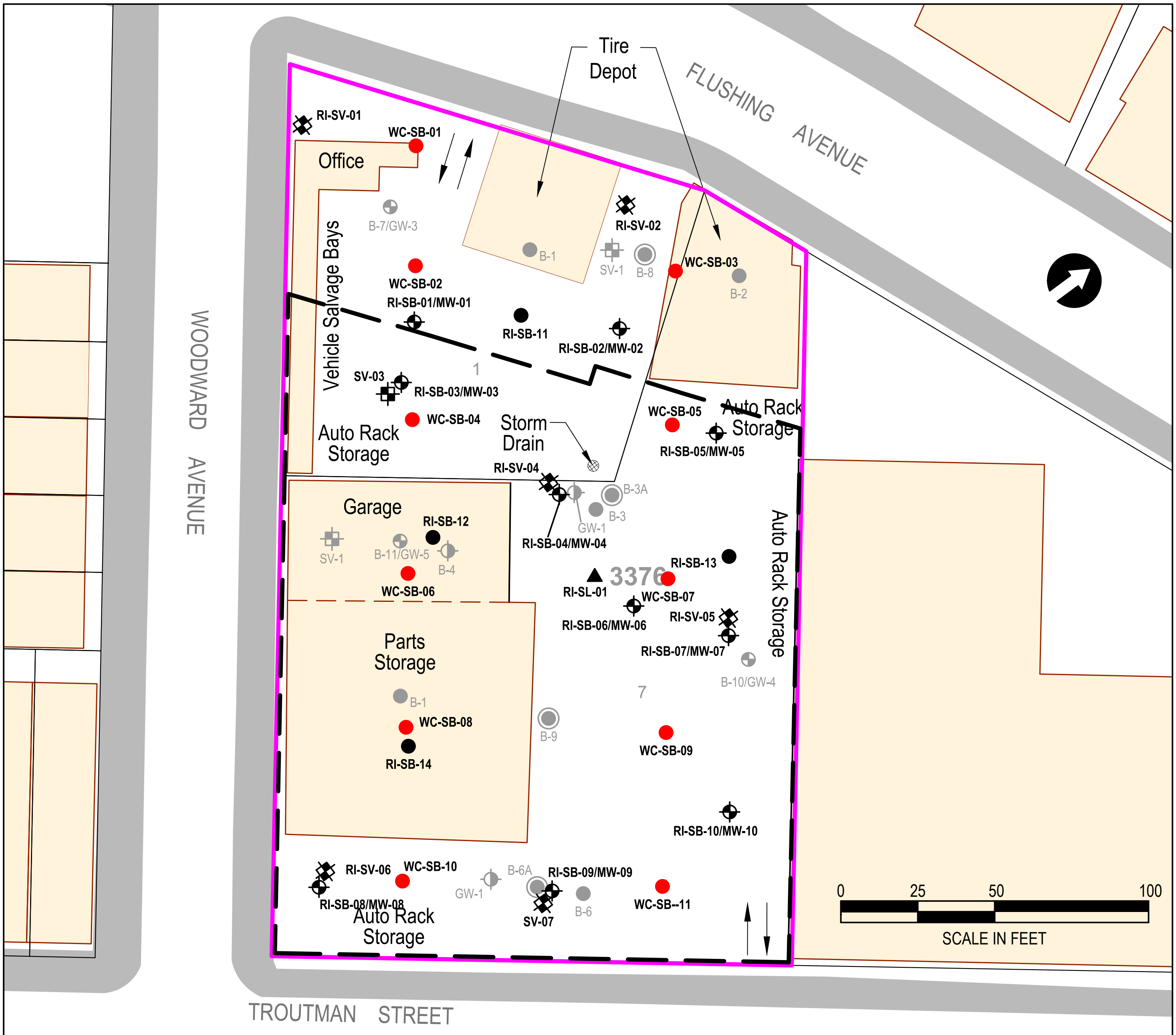
Queens Animal Shelter
151 Woodward Avenue
Queens, New York

SITE LOCATION

DATE	**9/3/2018**
PROJECT NO.	**180291**
FIGURE	**1**



LEGEND

- PROJECT SITE BOUNDARY
- 7 LOT BOUNDARY AND TAX LOT NUMBER
- 3376 TAX BLOCK NUMBER
- BUILDING
- PROPOSED NEW BUILDING OUTLINE
- PREVIOUS SOIL BORING (ENVIRONMENTAL CONSULTANTS CORPORATION - JUNE 2018)
- PREVIOUS SOIL VAPOR SAMPLE (ENVIRONMENTAL CONSULTANTS CORPORATION - JUNE 2018)
- PREVIOUS GROUNDWATER SAMPLE (ENVIRONMENTAL CONSULTANTS CORPORATION - JUNE 2018)
- AKRF SUPPLEMENTAL SOIL BORING LOCATION (SEPT 2018)
- AKRF SUPPLEMENTAL SOIL BORING AND TEMPORARY GROUNDWATER WELL LOCATION (SEPT 2018)
- ● RI SOIL BORING (MARCH 2019)
- RI SOIL BORING WITH MONITORING WELL (MARCH 2019)
- RI SOIL VAPOR POINT (MARCH 2019)
- ▲ RI SLUDGE SAMPLE LOCATION (MARCH 2019)
- ● SOIL PRE-CHARACTERIZATION BORING

Map Source:
NYCDCP (NYC Dept. of City Planning) GIS database

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Queens, New York

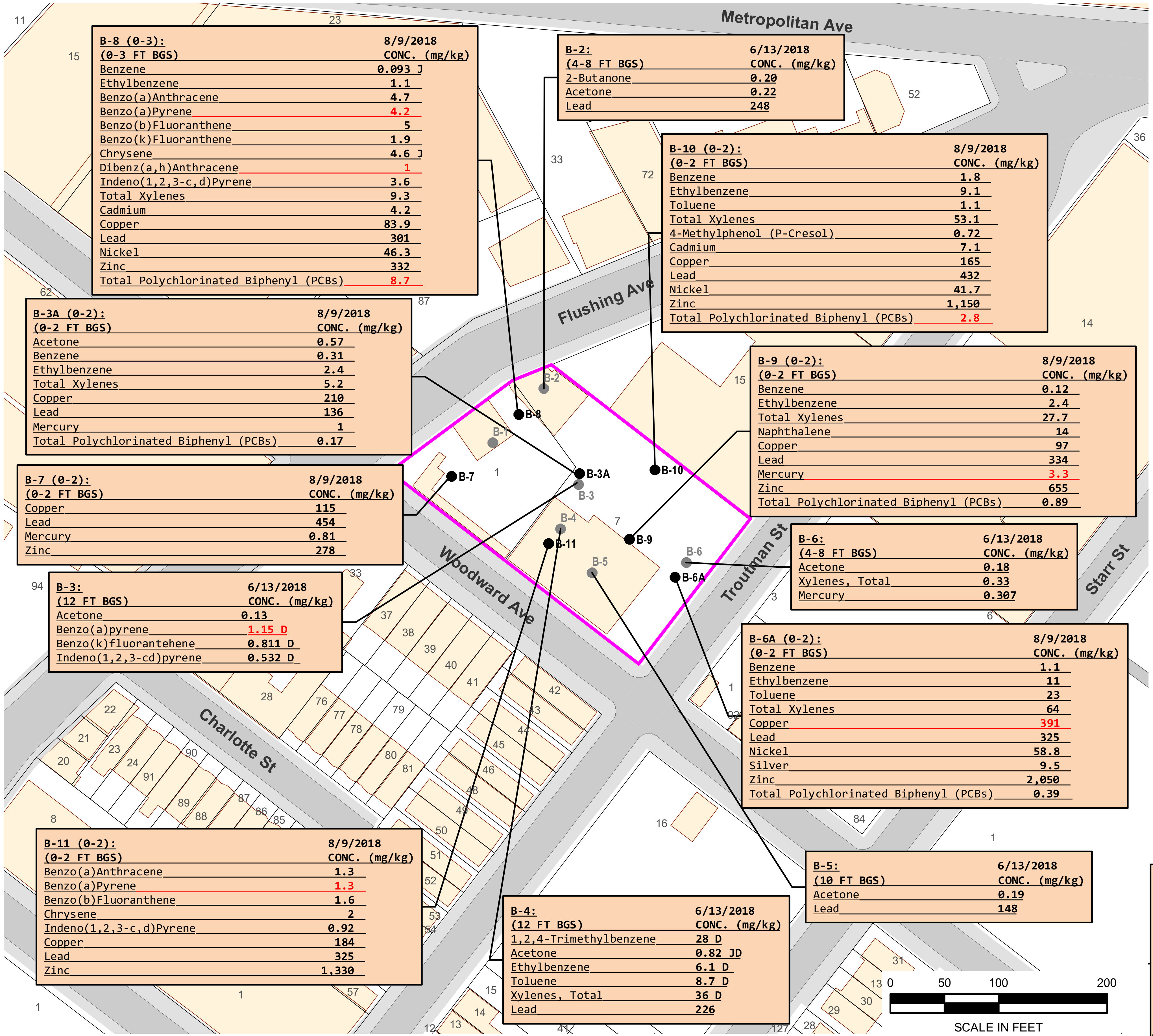
SITE PLAN AND PROPOSED SAMPLING LOCATIONS

DATE
5/6/2019

PROJECT NO.
180291

FIGURE
2

©2019 AKRF, Inc W:\Projects\180291 - QUEENS ANIMAL SHELTER\Technical\Hazmat\CAD\RIWP\180291 Fig 2 Site Plan and Sampling RIWP.dwg last save: jszalus 5/6/2019 2:01 PM



B-8 (0-3):	**8/9/2018**
(0-3 FT BGS)	**CONC. (mg/kg)**
Benzene	0.093 J
Ethylbenzene	1.1
Benzo(a)Anthracene	4.7
Benzo(a)Pyrene	4.2
Benzo(b)Fluoranthene	5
Benzo(k)Fluoranthene	1.9
Chrysene	4.6 J
Dibenz(a,h)Anthracene	1
Indeno(1,2,3-c,d)Pyrene	3.6
Total Xylenes	9.3
Cadmium	4.2
Copper	83.9
Lead	301
Nickel	46.3
Zinc	332
Total Polychlorinated Biphenyl (PCBs)	8.7

B-2:	**6/13/2018**
(4-8 FT BGS)	**CONC. (mg/kg)**
2-Butanone	0.20
Acetone	0.22
Lead	248

B-10 (0-2):	**8/9/2018**
(0-2 FT BGS)	**CONC. (mg/kg)**
Benzene	1.8
Ethylbenzene	9.1
Toluene	1.1
Total Xylenes	53.1
4-Methylphenol (P-Cresol)	0.72
Cadmium	7.1
Copper	165
Lead	432
Nickel	41.7
Zinc	1,150
Total Polychlorinated Biphenyl (PCBs)	2.8

B-3A (0-2):	**8/9/2018**
(0-2 FT BGS)	**CONC. (mg/kg)**
Acetone	0.57
Benzene	0.31
Ethylbenzene	2.4
Total Xylenes	5.2
Copper	210
Lead	136
Mercury	1
Total Polychlorinated Biphenyl (PCBs)	0.17

B-9 (0-2):	**8/9/2018**
(0-2 FT BGS)	**CONC. (mg/kg)**
Benzene	0.12
Ethylbenzene	2.4
Total Xylenes	27.7
Naphthalene	14
Copper	97
Lead	334
Mercury	3.3
Zinc	655
Total Polychlorinated Biphenyl (PCBs)	0.89

B-7 (0-2):	**8/9/2018**
(0-2 FT BGS)	**CONC. (mg/kg)**
Copper	115
Lead	454
Mercury	0.81
Zinc	278

B-6:	**6/13/2018**
(4-8 FT BGS)	**CONC. (mg/kg)**
Acetone	0.18
Xylenes, Total	0.33
Mercury	0.307

B-3:	**6/13/2018**
(12 FT BGS)	**CONC. (mg/kg)**
Acetone	0.13
Benzo(a)pyrene	1.15 D
Benzo(k)fluorantehene	0.811 D
Indeno(1,2,3-cd)pyrene	0.532 D

B-6A (0-2):	**8/9/2018**
(0-2 FT BGS)	**CONC. (mg/kg)**
Benzene	1.1
Ethylbenzene	11
Toluene	23
Total Xylenes	64
Copper	391
Lead	325
Nickel	58.8
Silver	9.5
Zinc	2,050
Total Polychlorinated Biphenyl (PCBs)	0.39

B-11 (0-2):	**8/9/2018**
(0-2 FT BGS)	**CONC. (mg/kg)**
Benzo(a)Anthracene	1.3
Benzo(a)Pyrene	1.3
Benzo(b)Fluoranthene	1.6
Chrysene	2
Indeno(1,2,3-c,d)Pyrene	0.92
Copper	184
Lead	325
Zinc	1,330

B-5:	**6/13/2018**
(10 FT BGS)	**CONC. (mg/kg)**
Acetone	0.19
Lead	148

B-4:	**6/13/2018**
(12 FT BGS)	**CONC. (mg/kg)**
1,2,4-Trimethylbenzene	28 D
Acetone	0.82 JD
Ethylbenzene	6.1 D
Toluene	8.7 D
Xylenes, Total	36 D
Lead	226

Map Source:
NYCDCP (NYC Dept. of City Planning) GIS database

LEGEND

▭	PROJECT SITE BOUNDARY
●	SOIL BORING LOCATION
●	PREVIOS SOIL BORING (ENVIRONMENTAL CONSULTANTS CORPORATION - JUNE 2018)
7	LOT BOUNDARY AND TAX LOT NUMBER
▭	BUILDING

	Part 375 Unrestricted Use (mg/kg)	Part 375 Commercial (mg/kg)
Volatile Organic Compounds		
1,2,4-Trimethylbenzene	3.6	190
Acetone	0.05	500
Benzene	0.06	44
Ethylbenzene	1	390
Toluene	0.7	500
Total Xylenes	0.26	500
Semivolatile Organic Compounds		
4-Methylphenol (P-Cresol)	0.33	500
Benzo(a)Anthracene	1	5.6
Benzo(a)Pyrene	1	1
Benzo(b)Fluoranthene	1	5.6
Benzo(k)Fluoranthene	0.8	56
Chrysene	1	56
Dibenz(a,h)Anthracene	0.33	0.56
Indeno(1,2,3-c,d)Pyrene	0.5	5.6
Naphthalene	12	500
Metals		
Cadmium	2.5	9.3
Copper	50	270
Lead	63	1,000
Mercury	0.18	2.8
Nickel	30	310
Silver	2	1,500
Zinc	109	10,000
PCBs		
Total Polychlorinated Biphenyl (PCBs)	0.1	1

SOIL

Part 375 Soil Cleanup Objectives:
Soil Clean-up Objectives listed in NYSDEC (New York State Department of Environmental Conservation) "Part 375" Regulations (6 NYCRR Part 375).

Exceedances of USCOs are highlighted in bold font.
Exceedances of USCOs and CSCOs are in red font.

mg/kg:milligrams per kilogram = parts per million (ppm)

J: The concentration given is an estimated value.
D: Analyte concentration obtained from dilution.

Sample ID
Sample Date
Concentration
Analyte/Compound

B-10 (0-2):	**8/9/2018**
(0-2 FT BGS)	**CONC. (mg/kg)**
Benzene	1.8
Ethylbenzene	9.1
Toluene	1.1
Total Xylenes	53.1
4-Methylphenol (P-Cresol)	0.72
Cadmium	7.1
Copper	165
Lead	432
Nickel	41.7
Zinc	1,150
Total Polychlorinated Biphenyl (PCBs)	2.8

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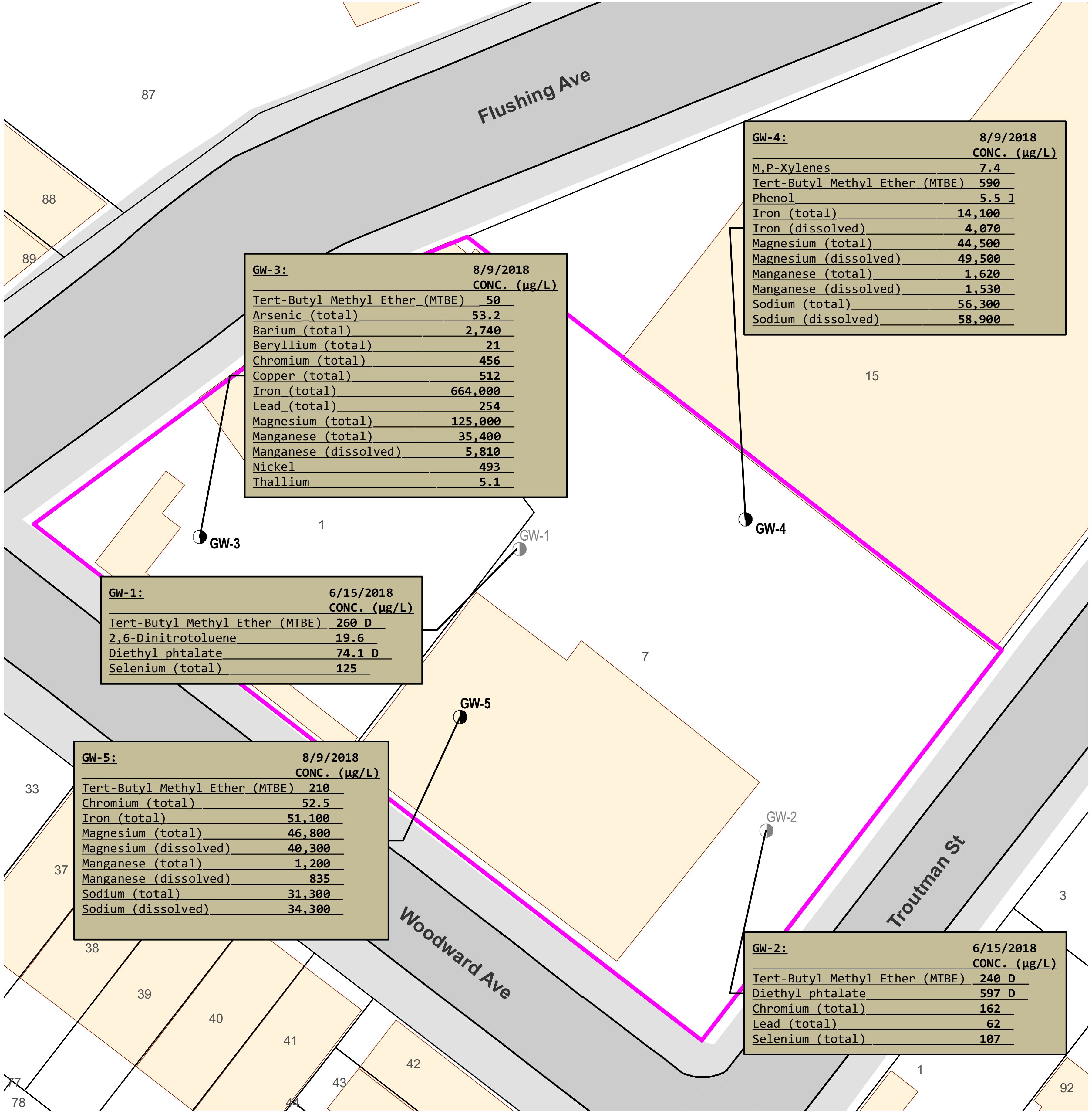
SOIL SAMPLE CONCENTRATIONS ABOVE NYSDEC UUSCOs and/or CSCOs

DATE
11/16/2018
PROJECT NO.
180291
FIGURE
3



GW-3:	**8/9/2018**
	CONC. (µg/L)
Tert-Butyl Methyl Ether (MTBE)	**50**
Arsenic (total)	**53.2**
Barium (total)	**2,740**
Beryllium (total)	**21**
Chromium (total)	**456**
Copper (total)	**512**
Iron (total)	**664,000**
Lead (total)	**254**
Magnesium (total)	**125,000**
Manganese (total)	**35,400**
Manganese (dissolved)	**5,810**
Nickel	**493**
Thallium	**5.1**

GW-4:	**8/9/2018**
	CONC. (µg/L)
M,P-Xylenes	**7.4**
Tert-Butyl Methyl Ether (MTBE)	**590**
Phenol	**5.5 J**
Iron (total)	**14,100**
Iron (dissolved)	**4,070**
Magnesium (total)	**44,500**
Magnesium (dissolved)	**49,500**
Manganese (total)	**1,620**
Manganese (dissolved)	**1,530**
Sodium (total)	**56,300**
Sodium (dissolved)	**58,900**

GW-1:	**6/15/2018**
	CONC. (µg/L)
Tert-Butyl Methyl Ether (MTBE)	**260 D**
2,6-Dinitrotoluene	**19.6**
Diethyl phthalate	**74.1 D**
Selenium (total)	**125**

GW-5:	**8/9/2018**
	CONC. (µg/L)
Tert-Butyl Methyl Ether (MTBE)	**210**
Chromium (total)	**52.5**
Iron (total)	**51,100**
Magnesium (total)	**46,800**
Magnesium (dissolved)	**40,300**
Manganese (total)	**1,200**
Manganese (dissolved)	**835**
Sodium (total)	**31,300**
Sodium (dissolved)	**34,300**

GW-2:	**6/15/2018**
	CONC. (µg/L)
Tert-Butyl Methyl Ether (MTBE)	**240 D**
Diethyl phtalate	**597 D**
Chromium (total)	**162**
Lead (total)	**62**
Selenium (total)	**107**

Map Source:
NYCDCP (NYC Dept. of City Planning) GIS database

LEGEND

🟪	PROJECT SITE BOUNDARY
◑	PREVIOS GROUNDWATER SAMPLE (ENVIRONMENTAL CONSULTANTS CORPORATION - JUNE 2018)
◑	GROUNDWATER SAMPLE LOCATION
7	LOT BOUNDARY AND TAX LOT
🟧	BUILDING

	NYSDEC TOGS Class GA AWQS (µg/L)
Metals	
Arsenic	25
Barium	1,000
Beryllium	3
Chromium, Total	50
Copper	200
Iron	300
Lead	25
Magnesium	35,000
Manganese	300
Nickel	100
Selenium	10
Sodium	20,000
Thallium	0.5
Semivolatile Organic Compounds	
2,6-Dinitrotoluene	5
Diethyl Phthalate	50
Phenol	1
Volatile Organic Compounds	
M,P-Xylenes	5
Tert-Butyl Methyl Ether	10

NYSDEC TOGS Class GA Ambient Water Quality Standard (AWQS):
New York State Department of Environmental Conservation (NYSDEC)
Technical and Operational Guidance Series (TOGS) (1.1.1):
Class GA Ambient Water Quality Standards and Guidance Values (AWQS)

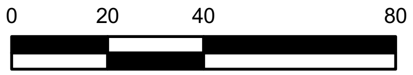
ug/L : micrograms per Liter = parts per billion (ppb)

Exceedances of NYSDEC NYSDEC TOGS are shown in bold font.

J: The concentration given is an estimated value.
D : Analyte concentration obtained from dilution.

GW-3:	**8/9/2018**
	CONC. (µg/L)
Tert-Butyl Methyl Ether (MTBE)	**50**
Arsenic (total)	**53.2**
Barium (total)	**2,740**
Beryllium (total)	**21**
Chromium (total)	**456**
Copper (total)	**512**
Iron (total)	**664,000**
Lead (total)	**254**
Magnesium (total)	**125,000**
Manganese (total)	**35,400**
Manganese (dissolved)	**5,810**
Nickel	**493**
Thallium	**5.1**

Sample Date
Sample ID
Analyte/Compound
Concentration



SCALE IN FEET

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GROUNDWATER SAMPLE CONCENTRATIONS ABOVE NYSDEC TOGS

DATE
11/16/2018

PROJECT NO.
180291

FIGURE
4

©2018 AKRF W:\Projects\180291 - QUEENS ANIMAL SHELTER\Technical\GIS and Graphics\Hazmat\Fig7_GWExceedances BCP.mxd11/16/2018 11:32:11 AM dcolombini

APPENDIX A

QUALITY ASSURANCE PROJECT PLAN

QUEENS ANIMAL SHELTER AND CARE CENTER

151 WOODWARD AVENUE

QUEENS, NEW YORK

Quality Assurance Project Plan

BCP Site No.: C241230
AKRF Project Number: 180291

Prepared for:
Animal Care and Control of New York City
11 Park Place, Suite 805
New York, NY 10007

Prepared by:

AKRF, Inc.
440 Park Avenue South, 7th Floor
New York, NY 10016
212-696-0670

MAY 2019

TABLE OF CONTENTS

FIGURES

APPENDIX

TITLE AND APPROVAL PAGE

Title: Remedial Investigation Work Plan – 151 Woodward Avenue Quality Assurance Project Plan (QAPP)
Project Name/Property Name: Remedial Investigation/Queens Animal Shelter and Care Center
Property/Site Location: 151 Woodward Avenue, Queens, NY 11385

Date: 5/9/2019
Agreement Number: C241230-03-191

Animal Care of Control of New York City, Inc.
Brownfield Cleanup Program Volunteer

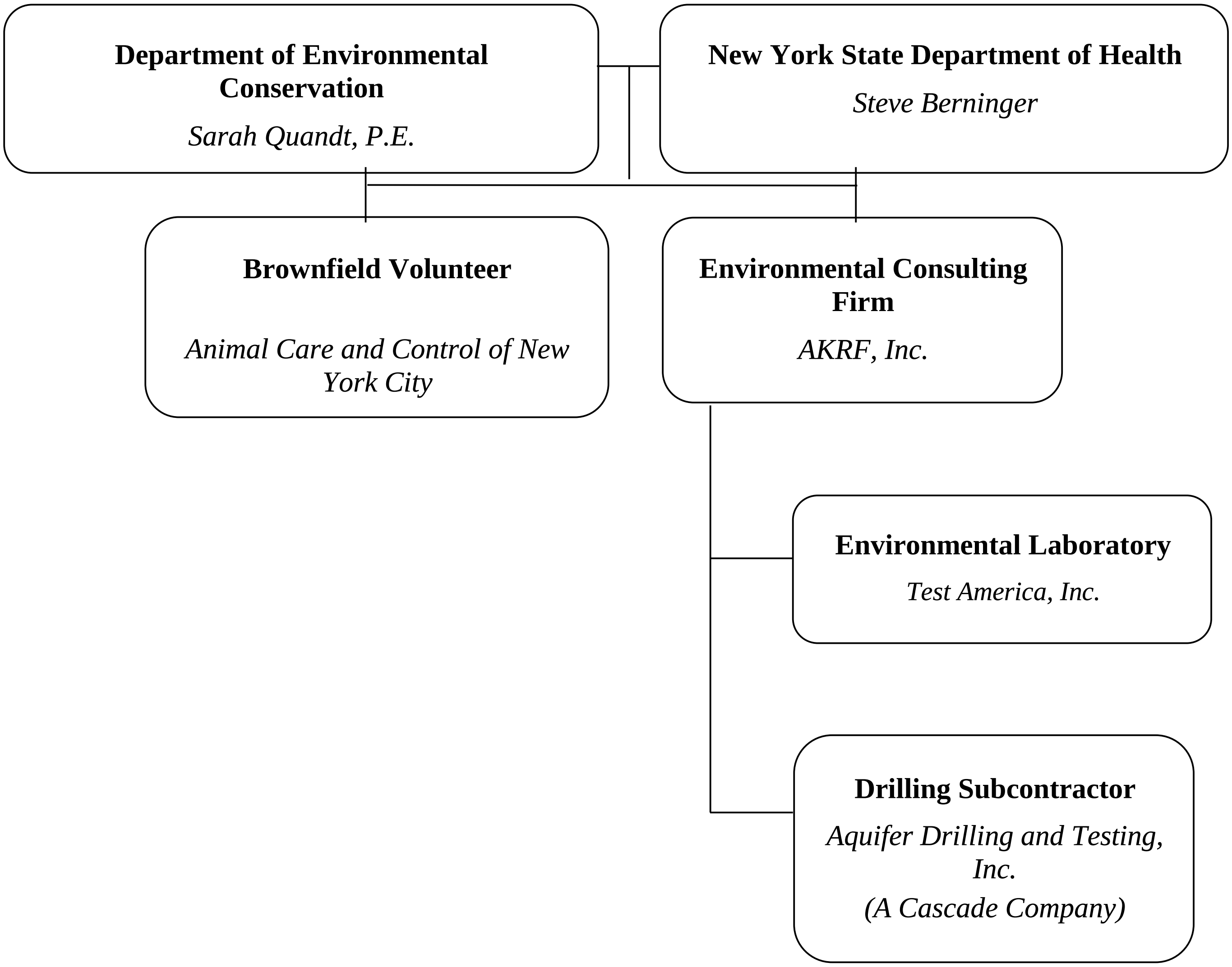
Deborah Shapiro, QEP
AKRF, Inc.
440 Park Avenue South, 7th Floor, New York, NY 10016
646-388-9544, dshapiro@akrf.com
Preparer's Name and Organizational Affiliation
Preparer's Address, Telephone Number, and E-mail Address

23 May 2019
Preparation Date (Day/Month/Year)

Environmental Consultant Quality Assurance Officer (QAO)

J. Patrick Diggins/AKRF, Inc.
Printed Name/Organization/Date

1.0 PROJECT ORGANIZATION CHART



2.0 PERSONNEL RESPONSIBILITIES

Name	**Title**	**Organization**	**Telephone Number**	**Responsibilities**
Sarah Quandt, P.E.	BCP Manager	NYSDEC	518-402-9767	Review all technical and schedule aspects of the project. Communicate regularly with AKRF and NYSDOH to ensure project in compliance with project work plans.
Deborah Shapiro, QEP	Project Director	AKRF, Inc.	646-388-9544	General oversight of all aspects of the project. Communicate regularly with all members of the AKRF project team to ensure a smooth flow of information between involved parties.
J. Patrick Diggins	Project Manager	AKRF, Inc.	646-388-9784	Coordinate the implementation of all aspects of the technical scope, and communicate with NYSDEC. Interpretation of laboratory results and preparation of report.
Michelle Lapin	Quality Assurance Officer	AKRF, Inc.	646-388-9520	Interpretation of laboratory results and coordination with project team.
Carl Ambruster	Laboratory QA/QC Director	TestAmerica, Inc.	(347) 507-0579	Responsible for enforcing all quality control requirements and checks in the laboratory and ensuring adherence to laboratory protocols. Conduct a final check on the analytical calculations and sign off on the laboratory reports.
Jim Todaro	Laboratory QA/QC Director	Alpha Analytical Laboratories	(800) 624-9220	Responsible for enforcing all quality control requirements and checks in the laboratory and ensuring adherence to laboratory protocols. Conduct a final check on the analytical calculations and sign off on the laboratory reports.
Lori Beyer	DUSR Preparer	Lab Validation Corp.	631-454-6100	Responsible for third-party data validation and DUSR preparation.
Jacob Menken	Field Team Leader	AKRF, Inc.	914-922-2373	Oversee installation of soil borings, monitoring wells, and soil vapor probes; Collect soil samples, groundwater samples, and sub-slab vapor samples.

Resumes of key personnel are provided as Appendix A.

3.0 PROBLEM DEFINITION/PROJECT DESCRIPTION

3.1 Problem Definition

Historic records indicated that the Site has been used for industrial, automotive, residential, and commercial purposes since at least 1902. Historical Sanborn maps identified the Site as a being mixed-use commercial (retail) and residential in 1902. By 1914, the Site was used solely for retail purposes. By 1939, the Site was identified as being used as a restaurant. New York City Department of Buildings (DOB) records indicated that permits were filed in 1960 to allow the Site to be redeveloped into as an automobile garage, and in 1962 the city directory lists the Site as an automobile wrecking corporation. City directories indicate that automobile wrecking businesses occupied the Site from 1962 to 2005. An inspection of the Site, during the Supplemental Phase II investigation, indicated that automobile wrecking continues to the present. Automotive uses may have led to contamination at the Site.

Based on an evaluation of the available data and information from a Supplemental Subsurface (Phase II) Investigation conducted by AKRF, Inc. in August 2018, on-site soil is contaminated with certain volatile organic compounds (VOCs), poly-aromatic hydrocarbons (PAHs) [a class of semi-volatile organic compounds (SVOCs)], metals, and total polychlorinated biphenyls (PCBs), which were detected above the New York State Department of Environmental Conservation (NYSDEC) 6 New York City Rules and Regulations (NYCRR) Part 375 Unrestricted Use Soil Cleanup Objectives (USCOs). In addition, total PCBs, two PAHs (benzo(a)pyrene and dibenzo(a,h)anthracene), and two metals (copper and mercury) were also detected in soil at concentrations above the Commercial Use Soil Cleanup Objectives (CSCOs). Methyl-tert butyl ether (MTBE), PAHs, and metals were detected in the groundwater samples at concentrations above the NYSDEC Class GA Ambient Water Quality Standards (AWQS) and Guidance Values. Trichloroethene (TCE) was detected at a concentration of 170 micrograms per cubic meter ($\mu g/m^3$) and cis-1,2-dichloroethylene was detected at a concentration of 90 $\mu g/m^3$ in sample SV-1.

As a result of the soil, soil vapor, and groundwater contamination identified during previous investigations, the environmental questions being asked are:

1. Are there contaminants in the soil and/or groundwater that exceed NYSDEC criteria and may impact human health and the environment?
2. Are there VOCs in the soil vapor at the Site that may impact indoor air quality during future use of the Site.

3.2 Project Description

3.2.1 Site Location and Description

The approximately 0.986-acre Site is located at 151 Woodward Avenue, in the Ridgewood neighborhood of Queens, New York. The Site contains two permanent structures: a one-story masonry and wood frame garage used for storage, vehicle dismantling, and repairs; and a one-story masonry and steel frame garage building with a mezzanine level. Exterior portions of the Site contain several steel shipping containers, racks and shelving for auto parts, and open areas for storage of cars and car parts. Some of the shipping containers have been modified to house temporary office spaces on the Site. The surrounding area is primarily developed with commercial and residential properties. The Site location is provided as Figure 1 and a Site Plan that shows the surrounding land usage is provided as Figure 2.

Based on the U.S. Geological Survey (USGS), Brooklyn, New York 2013 Quadrangle map, the Site between approximately 34 and 40 feet above the North American Datum of 1988 (an approximation of mean sea level). The Site surface topography slopes down approximately 6 feet from Troutman Street towards Flushing Avenue. Regional surface topography slopes downward to the northwest.

During the Supplemental Subsurface (Phase II) Investigation, groundwater was encountered between approximately 19 to 23 feet below grade surface (bgs) in temporary well points across the Site. Based on USGS mapping and local topography, groundwater is anticipated to flow in a northeasterly direction toward Newtown Creek, which is located approximately 1,600 feet northeast of the Site; however, actual groundwater flow direction can be affected by many factors, including subsurface openings or obstructions such as subway tunnels, basements, utilities, and other factors beyond the scope of this assessment. Groundwater is not used as a source of potable water at the Site. Subsurface materials as described in the Supplemental Subsurface (Phase II) Investigation consisted of historic fill (comprising sand, silt, brick, gravel, glass, asphalt, and concrete) from the surface down to approximately 3 to 5 feet below grade across the Site. The fill material was generally underlain by apparent native material consisting of sand and silt layers with a minor gravel component to the boring terminus at 30 feet below grade.

Proposed RI soil, groundwater, and soil vapor sample locations are shown on Figure 3. AKRF and their subcontractors will be responsible for installing the soil borings, groundwater monitoring wells, and soil vapor sampling points. AKRF will collect soil, groundwater, soil vapor, and ambient air samples and submit them for laboratory analysis for the contaminants of concern. The RI field sampling scope of work consists of: the advancement of 14 soil borings with continuous soil sampling and laboratory analysis of 2 to 4 soil samples per boring; the installation of 10 permanent groundwater monitoring wells with the collection and analysis of 10 groundwater samples; and the installation of 7 soil vapor points, with the collection and analysis of 7 soil vapor samples. The emerging contaminants soil sampling scope will be performed during the soil pre-characterization sampling, and will consist of the advancement of 11 soil borings with continuous soil sampling and laboratory analysis of 2 to 3 soil samples per boring.

3.2.2 Site History

Historic records indicated that the Site has been used for automotive, residential, and commercial purposes since at least 1902. Historical Sanborn maps identified the Site as a being mixed-use commercial (retail) and residential in 1902. By 1914, the Site was used solely for retail purposes. By 1939, the Site was identified as being used as a restaurant. New York City Department of Buildings (DOB) records indicated that permits were filed in 1960 to allow the Site to be redeveloped into as an automobile garage, and in 1962 the city directory lists the Site as an automobile wrecking corporation. City directories indicate that automobile wrecking businesses occupied the Site from 1962 to 2005. An inspection of the Site, during the Supplemental Phase II investigation, indicated that automobile wrecking continues to the present.

3.3 Project Decision Statements

To assess the contaminant pathway for potential contaminants of concern, it is necessary to acquire soil and groundwater samples for analysis of VOCs, SVOCs, pesticides, PCBs, and metals; and soil vapor samples for analysis of VOCs. The primary concern is to identify potential impacts to the environment that may affect human health. Soil and groundwater analytical results will be evaluated against NYSDEC criteria listed in Part 375: “Restricted Commercial” and for “Protection of Groundwater” and Part 703.5: “Water Quality Standards Surface Water and Groundwater”. If an analyte(s) in the collected groundwater exceeds criteria listed in Part 703.5, then the exceedance will be evaluated against potential human health and safety protection as well as discharge requirements for the collected groundwater. Based on these assessments, it may be necessary to develop a construction health and safety plan (CHASP) for mitigating potential exposure for any activities that may encounter contaminated media.

Due to the presence of potential sources of petroleum hydrocarbons or solvents at or near the Site, there is the possibility that VOCs may exist in the soil vapor that may impact future indoor air quality. These VOCs may also be present in groundwater at the Site. An evaluation of potential vapor intrusion impacts needs to be performed using soil vapor samples. The type and magnitude of any elevated soil vapor concentrations will be evaluated as to potential impacts to indoor air quality of future Site structures.

4.0 PROJECT QUALITY OBJECTIVES

The overall project objectives for the RI and pre-characterization sampling include:

- Determine whether soil, groundwater, and/or soil vapor at the Site poses a risk to human health and safety by exposure to hazardous substances;
- Determine whether collected groundwater from any Site activities (if any) will require treatment prior to disposal;
- Investigate the potential for off-site impacts; and
- Determine the potential for vapor intrusion into future structures from soil vapors.

To meet these objectives, soil samples will be analyzed for regulated hazardous substances including VOCs by EPA Method 8260, SVOCs by EPA Method 8270, PCBs by EPA Method 8082, pesticides by EPA Method 8081, 1,4-dioxane by EPA Method 8270D SIM, perfluorinated alkylated substances (PFAS) by EPA Method 537 (modified), and the total analyte list (TAL) of metals by EPA Method 6000/7000 series plus hexavalent chromium by EPA Method 7196A and cyanide by EPA Method 9012B using Category B deliverables. Groundwater samples will be analyzed for target compound list (TCL) VOCs, TCL SVOCs, PCBs, pesticides, 1,4-dioxane by EPA Method 8270D SIM, PFAS by EPA Method 537 (modified), and TAL Metals EPA Method 6000/7000 series. Soil vapor samples will be analyzed for VOCs by EPA Method TO-15.

Who will use the data?

The collected data will be used by NYSDEC, New York State Department of Health (NYSDOH), the Volunteer, and AKRF to be implemented to determine what remedial location will be necessary to redevelop the Site.

What types of data are needed?

- Soil samples will be collected from soil borings and analyzed by a NYSDOH Environmental Laboratory Approval Program (ELAP)-certified laboratory for VOCs by EPA Method 8260, SVOCs by EPA Method 8270, PCBs by EPA Method 8082, pesticides by EPA Method 8081, 1,4-dioxane by EPA Method 8270D SIM, PFAS by EPA Method 537 (modified), and the total analyte list (TAL) of metals by EPA Method 6000/7000 series plus hexavalent chromium by EPA Method 7196A and cyanide by EPA Method 9012B using Category B deliverables.
- Groundwater samples will be collected from monitoring wells using low-flow groundwater sampling techniques and analyzed by a NYSDOH ELAP-certified laboratory for TCL VOCs by EPA Method 8260, TCL SVOCs by EPA Method 8270, PCBs by EPA Method 8082, pesticides by EPA Method 8081, 1,4-dioxane by EPA Method 8270D SIM, PFAS by EPA Method 537 (modified), and TAL metals using EPA Method 6000/7000 series using Category B deliverables.
- Soil vapor samples will be collected in Summa canisters and analyzed for VOCs by Method TO-15 using Category B deliverables.
- Groundwater elevation measurements will be taken from the newly installed monitoring wells to determine the inferred groundwater flow direction.

How much data are needed?

- Two to 4 soil samples from 14 RI soil borings will be collected and analyzed.
- Up to 4 soil samples from 11 soil pre-characterization borings will be collected and analyzed.
- Ten groundwater samples will be collected and analyzed.

- Seven soil vapor samples will be collected.
- For soil - field blanks, blind duplicates, matrix spike/matrix spike duplicates, and trip blanks will be collected and analyzed at a sample frequency of one sample per 20 field samples per media.
- For groundwater samples - field blanks, equipment rinsate blanks, blind duplicates, matrix spike/matrix spike duplicates, and trip blanks will be collected and analyzed at a sample frequency of one sample per 20 field samples per media.

Figure 3 shows the proposed soil, groundwater, and soil vapor sampling locations.

Where, when, and how should the data be collected/generated?

- During the RI, continuous soil samples will be recovered from the soil borings, which will be advanced to the groundwater interface. Two to four soil samples will be submitted for laboratory analysis from each soil boring. One soil sample will be collected from the interval beneath the site-wide concrete cap (approximately 2 feet below existing grade surface), a second sample will be collected from the proposed new building foundation depth (between approximately 4 and 12 feet below existing grade surface across the Site), and a third sample will be collected from the 2-foot interval directly above the groundwater interface in soil borings that will converted into groundwater monitoring wells. Groundwater is expected to be encountered at approximately 19 to 23 feet below existing grade. If field evidence of contamination [visual, olfactory, or elevated photoionization detector (PID) reading] is observed, an additional soil sample per soil boring will be collected from the interval exhibiting the highest level of contamination.
- During the soil pre-characterization sampling, continuous soil samples will be recovered from the soil borings, which will be advanced to the approximate development grade (between approximately 3 and 23 feet below existing grade across the Site). Up to four soil samples will be submitted for laboratory analysis of 1,4-dioxane and PFAS from each soil boring. One soil sample will be collected from the interval beneath the Site-wide cap (approximately 2 feet below existing grade surface), a second sample will be collected from an intermediate interval (between approximately 2 and 8 feet below existing grade surface across the Site, and a third sample will be collected from between 8 and 15 feet below existing grade surface. In five of the borings, a fourth sample will be collected from the interval immediately above the water table, which was encountered between 19 and 23 feet bgs during the Supplemental Phase II Investigation.
- Groundwater samples will be collected from 10 permanent monitoring wells to be installed as part of this investigation. Groundwater sampling will occur one to two weeks after well installation and development.
- Soil vapor samples will be collected in Summa canisters over a 2-hour sampling period.

Who will collect and generate the data?

AKRF, and their contractor, will be responsible for: advancing the soil borings and sampling the soil; installing, developing, and sampling the monitoring wells; and installing soil vapor points and sampling the soil vapor. All samples will be analyzed by TestAmerica, Inc. or Alpha Analytical Laboratories (subcontracted by AKRF), NYSDOH-certified laboratories. AKRF will be responsible for collecting, reviewing, assessing, and disseminating validated data. Third-party data validation and the preparation of a Data Summary Usability Report (DUSR) will be prepared by Ms. Lori Beyer of Lab Validation Corp. Ms. Beyer’s professional certification and resume are attached in Appendix A.

How will the data be reported?

The data will be reported in a Remedial Investigation Report (RIR) and as EQuIS-compatible electronic data deliverables (EDDs).

How will the data be archived?

All hard-copy data will be maintained at AKRF offices for a minimum of one year. Field logbooks and forms will be scanned and all electronic data will be archived on the AKRF corporate server.

5.0 PROJECT SCHEDULE/TIMELINE

Activities	**Organization**	**Dates (MM/DD/YY)**		**Deliverable**	**Deliverable Due Date**
		Anticipated Date(s) of Initiation	**Anticipated Date of Completion**		
Preparation of Work Plan and QAPP	AKRF, Inc.	11/1/18	11/21/18	Work Plan	11/15/18
Preparation of Health and Safety Plan	AKRF, Inc.	11/1/18	11/21/18	HASP	11/15/18
Laboratory Request	AKRF, Inc.	11/26/18	11/26/18	N/A	N/A
Procurement of Equipment	AKRF, Inc.	12/5/18	12/5/18	N/A	N/A
Field Reconnaissance/ Access	AKRF, Inc.	12/5/18	12/5/18	N/A	N/A
Collection of Field Samples	AKRF, Inc.	12/10/18	12/14/18	N/A	N/A
Laboratory Package Received	AKRF, Inc.	12/31/18	12/31/18	Unvalidated data package	12/31/18
Validation of Laboratory Results	L.A.B Validation Corp.	12/31/18	1/4/19	Validated data Package	1/4/19
Data Evaluation/ Preparation of Final Report	AKRF, Inc.	1/4/19	4/9/19	Final Report	4/9/19
Collection of Soil Pre-characterization Samples	AKRF, Inc.	6/24/19	6/28/19	N/A	N/A
Preparation of Soil Pre-characterization Report	AKRF, Inc.	7/15/19	7/19/19	Final Report	7/19/19

6.0 SAMPLING METHODS AND LOCATIONS

Samples will be collected from soil borings, monitoring wells, and soil vapor points at the Site to provide information on general conditions at the Site. AKRF will use a Geoprobe drill rig with Hollow Stem Augers (HSA) to advance soil borings RI-SB-01 through RI-SB-14 at the approximate locations shown on Figure 3. Soil cores will be collected in 5-foot long, 2-inch diameter dedicated acetate sleeves.

Soil samples will be inspected by AKRF field personnel for evidence of contamination (e.g., odors, staining) and field-screened for presence of volatile organics using a PID. Ten borings will be converted into 2-inch diameter permanent groundwater monitoring wells. The wells will be finished with a flush-mount locking well cover. The wells will be immediately developed and sampled one to two weeks after installation utilizing the low flow sampling methodology. In addition, one trip blank, one field blank, one blind duplicate, and one matrix spike/matrix spike duplicate will be collected at a frequency of one sample per 20 samples. The drill rig will be used to collect soil vapor samples from seven proposed locations to adequately evaluate soil vapor. Samples will be collected using 6-Liter (6L) stainless steel batch-certified Summa canisters.

Samples slated for laboratory analysis will be placed in laboratory-supplied containers and shipped in accordance with appropriate EPA protocols to a NYSDOH-certified laboratory certified in the appropriate fields of accreditation. All non-dedicated drilling and sampling equipment will be decontaminated between sampling locations. Soil and groundwater samples will be placed on ice and stored in a cooler at temperatures below 4ºC. Soil vapor samples will be placed in the laboratory-supplied containers immediately after sample collection.

The following table summarizes the sampling locations, analytical groups, number of samples, section reference for sampling SOP and rationale for sampling locations.

Matrix	Sampling Location	Depth (feet below grade)	Analytical Group	Rationale for Sampling Location
Soil/ Groundwater	RI-SB-01/MW-01	Beneath site-wide concrete cap (approx. 2 feet below grade), development grade (between approx.. 4 and 12 feet below grade), above water table (approx. 19 to 23 feet below grade), and the interval exhibiting the highest PID reading or visual evidence of contamination (if identified)	Soil: VOCs, SVOCs, Pesticides, PCBs, and Metals Groundwater: VOCs, SVOCs, PCBs, Pesticides, Metals, 1,4-Dioxane, and PFAS	To assess soil and groundwater quality in the down-gradient of the vehicle salvage bays/northwestern portion of the Site
Soil/ Groundwater	RI-SB-02/MW-02	Beneath site-wide concrete cap (approx. 2 feet below grade), development grade (between approx.. 4 and 12 feet below grade), above water table (approx. 19 to 23 feet below grade), and the interval exhibiting the highest PID reading or	Soil: VOCs, SVOCs, Pesticides, PCBs, and Metals Groundwater: VOCs, SVOCs, PCBs, Pesticides, Metals, 1,4-Dioxane, and PFAS	To assess soil and groundwater quality in the down-gradient of the Tire Depot/northeastern portion of the Site

Matrix	Sampling Location	Depth (feet below grade)	Analytical Group	Rationale for Sampling Location
		visual evidence of contamination (if identified)		
Soil/ Groundwater	RI-SB-03/MW-03	Beneath site-wide concrete cap (approx. 2 feet below grade), development grade (between approx. 4 and 12 feet below grade), above water table (approx. 19 to 23 feet below grade), and the interval exhibiting the highest PID reading or visual evidence of contamination (if identified)	Soil: VOCs, SVOCs, Pesticides, PCBs, and Metals Groundwater: VOCs, SVOCs, PCBs, Pesticides, Metals, 1,4-Dioxane, and PFAS	To assess soil and groundwater quality within the Vehicle Salvage Bay/western portion of the Site
Soil/ Groundwater	RI-SB-04/MW-04	Beneath site-wide concrete cap (approx. 2 feet below grade), development grade (between approx. 4 and 12 feet below grade), above water table (approx. 19 to 23 feet below grade), and the interval exhibiting the highest PID reading or visual evidence of contamination (if identified)	Soil: VOCs, SVOCs, Pesticides, PCBs, and Metals Groundwater: VOCs, SVOCs, PCBs, Pesticides, Metals, 1,4-Dioxane, and PFAS	To assess soil and groundwater quality in center of the Site
Soil/ Groundwater	RI-SB-05/MW-05	Beneath site-wide concrete cap (approx. 2 feet below grade), development grade (between approx. 4 and 12 feet below grade), above water table (approx. 19 to 23 feet below grade), and the interval exhibiting the highest PID reading or visual evidence of contamination (if identified)	Soil: VOCs, SVOCs, Pesticides, PCBs, and Metals Groundwater: VOCs, SVOCs, PCBs, Pesticides, Metals, 1,4-Dioxane, and PFAS	To assess soil and groundwater quality in the eastern portion of the Site
Soil/ Groundwater	RI-SB-06/MW-06	Beneath site-wide concrete cap (approx. 2 feet below grade), development grade (between approx. 4 and 12 feet below grade), above water table (approx. 19 to 23 feet	Soil: VOCs, SVOCs, Pesticides, PCBs, and Metals Groundwater: VOCs, SVOCs, PCBs, Pesticides, Metals, 1,4-Dioxane, and PFAS	To assess soil and groundwater quality in the center of the Site

Matrix	Sampling Location	Depth (feet below grade)	Analytical Group	Rationale for Sampling Location
		below grade), and the interval exhibiting the highest PID reading or visual evidence of contamination (if identified)		
Soil/ Groundwater	RI-SB-07/MW-07	Beneath site-wide concrete cap (approx. 2 feet below grade), development grade (between approx. 4 and 12 feet below grade), above water table (approx. 19 to 23 feet below grade), and the interval exhibiting the highest PID reading or visual evidence of contamination (if identified)	Soil: VOCs, SVOCs, Pesticides, PCBs, and Metals Groundwater: VOCs, SVOCs, PCBs, Pesticides, Metals, 1,4-Dioxane, and PFAS	To assess soil and groundwater quality in the eastern portion of the Site
Soil/ Groundwater	RI-SB-08/MW-08	Beneath site-wide concrete cap (approx. 2 feet below grade), development grade (between approx. 4 and 12 feet below grade), above water table (approx. 19 to 23 feet below grade), and the interval exhibiting the highest PID reading or visual evidence of contamination (if identified)	Soil: VOCs, SVOCs, Pesticides, PCBs, and Metals Groundwater: VOCs, SVOCs, PCBs, Pesticides, Metals, 1,4-Dioxane, and PFAS	To assess soil and groundwater quality in the southwestern portion of the Site
Soil/ Groundwater	RI-SB-09/MW-09	Beneath site-wide concrete cap (approx. 2 feet below grade), development grade (between approx. 4 and 12 feet below grade), above water table (approx. 19 to 23 feet below grade), and the interval exhibiting the highest PID reading or visual evidence of contamination (if identified)	Soil: VOCs, SVOCs, Pesticides, PCBs, and Metals Groundwater: VOCs, SVOCs, PCBs, Pesticides, Metals, 1,4-Dioxane, and PFAS	To assess soil and groundwater quality in the southern portion of the Site
Soil/ Groundwater	RI-SB-10/MW-10	Beneath site-wide concrete cap (approx. 2 feet below grade), development grade (between approx. 4 and	Soil: VOCs, SVOCs, Pesticides, PCBs, and Metals Groundwater: VOCs, SVOCs,	To assess soil and groundwater quality in the up-gradient/southeastern portion of the Site

Matrix	Sampling Location	Depth (feet below grade)	Analytical Group	Rationale for Sampling Location
		12 feet below grade), above water table (approx. 19 to 23 feet below grade), and the interval exhibiting the highest PID reading or visual evidence of contamination (if identified)	PCBs, Pesticides, Metals, 1,4-Dioxane, and PFAS	
Soil	RI-SB-11	Beneath site-wide concrete cap (approx. 2 feet below grade), development grade (between approx. 4 and 12 feet below grade), and the interval exhibiting the highest PID reading or visual evidence of contamination (if identified)	Soil: VOCs, SVOCs, Pesticides, PCBs and Metals	To assess soil quality in the central portion of the Site
Soil	RI-SB-12	Beneath site-wide concrete cap (approx. 2 feet below grade), development grade (between approx. 4 and 12 feet below grade), and the interval exhibiting the highest PID reading or visual evidence of contamination (if identified)	Soil: VOCs, SVOCs, Pesticides, PCBs and Metals	To assess soil quality in western portion of the Site
Soil	RI-SB-13	Beneath site-wide concrete cap (approx. 2 feet below grade), development grade (between approx. 4 and 12 feet below grade), and the interval exhibiting the highest PID reading or visual evidence of contamination (if identified)	Soil: VOCs, SVOCs, Pesticides, PCBs and Metals	To assess soil quality in southeastern portion of the Site
Soil	RI-SB-14	Beneath site-wide concrete cap (approx. 2 feet below grade), development grade (between approx. 4 and 12 feet below grade), and the interval exhibiting the highest PID reading or visual evidence of contamination (if identified)	Soil: VOCs, SVOCs, Pesticides, PCBs and Metals	To assess soil quality in southwestern portion of the Site

Matrix	Sampling Location	Depth (feet below grade)	Analytical Group	Rationale for Sampling Location
Sludge	RI-SL-01	NA (Surface)	Soil: VOCs, SVOCs, Pesticides, PCBs and Metals	To assess the sludge on top of the ground surface in northwestern portion of the Site
Soil Vapor	RI-SV-01	Development grade (between 4 and 12 feet below existing grade)	VOCs (TO-15)	To assess soil vapor quality, evaluate the potential for off-site exposures, and to complete the significant threat determination
Soil Vapor	RI-SV-02	Development grade (between 4 and 12 feet below existing grade)	VOCs (TO-15)	To assess soil vapor quality, evaluate the potential for off-site exposures, and to complete the significant threat determination
Soil Vapor	RI-SV-03	Development grade (between 4 and 12 feet below existing grade)	VOCs (TO-15)	To assess soil vapor quality, evaluate the potential for off-site exposures, and to complete the significant threat determination
Soil Vapor	RI-SV-05	Development grade (between 4 and 12 feet below existing grade)	VOCs (TO-15)	To assess soil vapor quality, evaluate the potential for off-site exposures, and to complete the significant threat determination
Soil Vapor	RI-SV-05	Development grade (between 4 and 12 feet below existing grade)	VOCs (TO-15)	To assess soil vapor quality, evaluate the potential for off-site exposures, and to complete the significant threat determination
Soil Vapor	RI-SV-06	Development grade (between 4 and 12 feet below existing grade)	VOCs (TO-15)	To assess soil vapor quality, evaluate the potential for off-site exposures, and to complete the significant threat
Soil Vapor	RI-SV-07	Development grade (between 4 and 12 feet below existing grade)	VOCs (TO-15)	To assess soil vapor quality, evaluate the potential for off-site exposures, and to complete the significant threat determination
Soil	WC-SB-01	Beneath the concrete cap (approx. 2 feet below grade), between approx. 2 and 8 feet below grade,	1,4-Dioxane and PFAS	To pre-characterize soil and assess soil for the

Matrix	Sampling Location	Depth (feet below grade)	Analytical Group	Rationale for Sampling Location
		between 8 and 15 feet below grade, and at the 2-foot interval immediately above the groundwater interface		presence of 1,4-dioxane and PFAS
Soil	WC-SB-02	Beneath the concrete cap (approx. 2 feet below grade), between approx. 2 and 8 feet below grade, and between 8 and 15 feet below grade	1,4-Dioxane and PFAS	To pre-characterize soil and assess soil for the presence of 1,4-dioxane and PFAS
Soil	WC-SB-03	Beneath the concrete cap (approx. 2 feet below grade), between approx. 2 and 8 feet below grade, and between 8 and 15 feet below grade	1,4-Dioxane and PFAS	To pre-characterize soil and assess soil for the presence of 1,4-dioxane and PFAS
Soil	WC-SB-04	Beneath the concrete cap (approx. 2 feet below grade), between approx. 2 and 8 feet below grade, between 8 and 15 feet below grade, and at the 2-foot interval immediately above the groundwater interface	1,4-Dioxane and PFAS	To pre-characterize soil and assess soil for the presence of 1,4-dioxane and PFAS
Soil	WC-SB-05	Beneath the concrete cap (approx. 2 feet below grade), between approx. 2 and 8 feet below grade, and between 8 and 15 feet below grade	1,4-Dioxane and PFAS	To pre-characterize soil and assess soil for the presence of 1,4-dioxane and PFAS
Soil	WC-SB-06	Beneath the concrete cap (approx. 2 feet below grade), between approx. 2 and 8 feet below grade, and between 8 and 15 feet below grade	1,4-Dioxane and PFAS	To pre-characterize soil and assess soil for the presence of 1,4-dioxane and PFAS
Soil	WC-SB-07	Beneath the concrete cap (approx. 2 feet below grade), between approx. 2 and 8 feet below grade, between 8 and 15 feet below grade, and at the 2-foot interval immediately above the groundwater interface	1,4-Dioxane and PFAS	To pre-characterize soil and assess soil for the presence of 1,4-dioxane and PFAS
Soil	WC-SB-08	Beneath the concrete cap (approx. 2 feet below grade), between approx. 2 and 8 feet below grade, and between 8 and 15 feet below grade	1,4-Dioxane and PFAS	To pre-characterize soil and assess soil for the presence of 1,4-dioxane and PFAS

Matrix	Sampling Location	Depth (feet below grade)	Analytical Group	Rationale for Sampling Location
Soil	WC-SB-09	Beneath the concrete cap (approx. 2 feet below grade), between approx. 2 and 8 feet below grade, between 8 and 15 feet below grade, and at the 2-foot interval immediately above the groundwater interface	1,4-Dioxane and PFAS	To pre-characterize soil and assess soil for the presence of 1,4-dioxane and PFAS
Soil	WC-SB-10	Beneath the concrete cap (approx. 2 feet below grade), between approx. 2 and 8 feet below grade, between 8 and 15 feet below grade, and at the 2-foot interval immediately above the groundwater interface	1,4-Dioxane and PFAS	To pre-characterize soil and assess soil for the presence of 1,4-dioxane and PFAS
Soil	WC-SB-11	Beneath the concrete cap (approx. 2 feet below grade), between approx. 2 and 8 feet below grade, and the interval between 8 and 15 feet below grade	1,4-Dioxane and PFAS	To pre-characterize soil and assess soil for the presence of 1,4-dioxane and PFAS

6.1 Soil Boring Installation

The 25 proposed soil boring locations are depicted on Figure 3. Utility mark-outs are required by law and the drilling contractor is required to call Dig Safely New York at least two days prior to intrusive work. If there are any questions regarding locations of utilities in the sidewalk, the respective utility(s) will be contacted to clarify any concerns and/or the sampling location would be adjusted following consultation with NYSDEC.

Borings RI-SB-01 through RI-SB-14 will be advanced using a Geoprobe drill rig with Hollow Stem Augers (HSA) to the groundwater interface at the approximate locations shown on Figure 3. Borings WC-SB-01 through WC-SB-11 will be advanced using a Geoprobe drill rig to the proposed development grade (between 3 and 23 feet below existing grade surface). Groundwater is expected to be encountered at approximately 19 to 23 feet below grade. Soil will be inspected for evidence of contamination (e.g., odors, staining), screened for the presence of volatile organics with a PID equipped with a 10.6 electron volt (eV) lamp, and logged using the modified Burmister soil classification system. The PID will be calibrated prior to sampling in accordance with the manufacturer’s recommendations. NYSDEC will be contacted immediately if evidence of contamination is identified during the sampling activities. Each soil boring location will be surveyed using a Global Positioning System (GPS) handheld device to determine their accurate location. At each boring location, AKRF field personnel will record and document subsurface conditions.

6.2 Soil Sampling

Soil sampling will be part of this RI and soil pre-characterization to: (1) determine the nature and extent of potentially affected media; (2) determine whether potentially impacted soil may require special handling requirements relating to construction worker health and safety; and (3) determine the potential for a soil to soil vapor to indoor air pathway. Two to four soil samples from each boring will be submitted for laboratory analysis. Samples from soil borings will be analyzed for the following:

- VOCs by EPA Method 8260B;
- SVOCs by EPA Method 8270C;
- Pesticides by EPA Method 8081A;
- PCBs by EPA Method 8082;
- TAL Metals by EPA Method 6000/7000 series;
- Cyanide by EPA Method 9012B;
- Hexavalent Chromium by EPA Method 7196A;
- 1,4-dioxane by EPA Method 8270D SIM; and
- PFAS by EPA Method 537 (modified).

The PFAS list includes the following analytes: perfluorobutanesulfonic acid, perfluorohexanesulfonic acid, perfluoroheptanesulfonic acid, perfluorooctanessulfonic acid, perfluorodecanesulfonic acid, perfluorobutanoic acid, perfluoropentanoic acid, perfluorohexanoic acid, perfluoroheptanoic acid, perfluorooctanoic acid, perfluorononanoic acid, perfluorodecanoic acid, perfluoroundecanoic acid, perfluorododecanoic acid, perfluorotridecanoic acid, perfluorotetradecanoic acid, 6:2 fluorotelomer sulfonate, 8:2 fluorotelomer sulfonate, perfluroroctanesulfonamide, n-methyl perfluorooctanesulfonamidoacetic acid, and n-ethyl perfluorooctanesulfonamidoacetic acid. The laboratory's standard operating procedures (SOPs) for PFAS analyses are included as Appendix B.

During the RI, at each boring location, up to four soil samples will be collected from each boring. One soil sample will be collected from the interval beneath the site-wide concrete cap (approximately 2 feet below existing grade surface), a second sample will be collected from the proposed new building foundation depth (between approximately 4 and 12 feet below existing grade surface across the Site), and a third sample will be collected from the 2-foot interval directly above the groundwater interface in soil borings that will converted into groundwater monitoring wells. Groundwater is expected to be encountered at approximately 19 to 23 feet below existing grade. If field evidence of contamination [visual, olfactory, or elevated photoionization detector (PID) reading] is observed, an additional soil sample per soil boring will be collected from the interval exhibiting the highest level of contamination.

One field blank, one blind duplicate, and one matrix spike/matrix spike duplicate (MS/MSD) will be collected for quality control/quality assurance (QA/QC) purposes for analysis of all of the previously noted parameters and one laboratory-prepared trip blank will be submitted for analysis of VOCs to determine the potential for cross-contamination at a frequency of one sample per 20 samples. All samples will be analyzed by a NYSDOH-certified laboratory with Category B deliverables.

During the soil pre-characterization sampling, up to 4 samples will be collected from each boring. One soil sample will be collected from the interval beneath the site-wide concrete cap (approximately 2 feet below existing grade surface), one sample will be collected between approximately 2 and 8 feet below existing grade surface across the Site, and a third sample will be collected between 8 and 15 feet below grade surface. In five of the borings, a fourth sample will be collected from the interval immediately above the water table, which was encountered between 19 and 23 feet below grade during the Supplemental Phase II Investigation.

The pre-characterization soil samples will also be analyzed for parameters required by potential soil disposal facilities, including: VOCs plus 10 tentatively identified compounds (TICs) by EPA Method 8260, SVOCs plus 20 TICs by EPA Method 8270; TAL metals and trivalent chromium; Toxicity Characteristic Leaching Procedure (TCLP) eight Resource Conservation and Recovery Act (RCRA) metals plus copper, nickel, and zinc; PCBs by EPA Method 8082; pesticides by EPA Method 8081; total cyanide; total petroleum hydrocarbons (TPH) by EPA Method 8015 for diesel range organics (DRO) and gasoline range organics (GRO); extractable petroleum hydrocarbon (EPH); hexavalent chromium; and ignitability, corrosivity, and reactivity using Category A deliverables.

6.3 Monitoring Well Installation

A Geoprobe drill rig with Hollow Stem Augers (HSA) will be used to advance a steel core barrel from grade up to approximately 10 feet into the groundwater table, expected to be encountered at approximately 19 to 23 feet below grade. The wells will be constructed with 2-inch diameter polyvinyl chloride (PVC) casing with a 0.020-inch slotted well screen installed to 5 feet into the water table; solid PVC riser will be placed to ground surface. At each well, a No. 2 Morie sandpack will be installed around the well screen to a depth of 1 to 2 feet above the top of the screen and a bentonite seal will be installed to a depth of 1 to 2 feet above the sand pack. The remainder of the annular space will be filled with drill cuttings if not contaminated or Morie sand if drill cuttings cannot be used. The monitoring wells will be completed with a flush-to-grade manholes. A concrete apron will be set around the manhole to prevent drainage of surface runoff toward the well. The wells will be capped with a locking cap. The proposed well locations are provided on Figure 3. Following well installation, the wells will be developed according to the following procedure:

- Measure the depth to water using an oil/water interface probe and the total depth of the well using a weighted tape. Use these measurements to calculate the length of the water column. Calculate the volume of water in the well using 0.163 gallon per foot of water column as the conversion factors for a 2-inch diameter well.
- Develop the well using a check valve (Waterra-type) pump and a surge block and discharge the water to five-gallon buckets.
- Insert the surge block into the well, and allow it to sink to the bottom. Surge the screened zone in 3-foot intervals by lifting the block.
- Remove the block, insert the groundwater pump, and pump out groundwater. The type of pump used will depend on the type and size of the well. For 1-inch wells, a peristaltic pump or bladder pump will be required. For a 2-inch well (or larger) a submersible (Monsoon-type) pump or an inertial (Waterra-type) pump is appropriate. Record the initial water quality parameters (pH, specific conductivity, temperature, turbidity, DO, and salinity) in the field notebook and/or development log. Note any colors or odors.
- During development, collect periodic samples and analyze for turbidity and water quality indicators (pH, temperature, dissolved oxygen, reduction-oxidation potential, and specific conductivity) with measurements collected approximately every five minutes.
- Continue developing the well until turbidity is less than 50 nephelometric turbidity units (NTUs) for three successive readings and until water quality indicators have stabilized to within 10% for pH, temperature and specific conductivity for three successive readings, or if not possible, until at least three well volumes have been purged from the well.
- Once development is complete, transfer the water from the buckets to 55-gallon drums designated for well development water.

- Document the volume of water removed and any other observations made during well development in the field book or on field data sheets.
- Decontaminate the equipment prior to and following development at each well location as described in Section 6.6 of this QAPP.

Additionally, each well will be surveyed by a New York State licensed surveyor to determine their accurate location and elevation. A permanent marker (e.g., a sharpie) will be used to draw a thick line on the northern lip of the PVC casing – this will be the marker of what would be considered "Top of Casing" for surveying and measuring the depth to water/product and the total depth. Depth to groundwater will be measured to the nearest 1/100th of a foot.

6.4 Groundwater Sampling

One to two weeks after well installation and development, one groundwater sample will be collected from each of the wells in accordance with EPA low flow sampling techniques. The expected targeted purge rate will be around 500 mililiters per minute (ml/min) and water quality parameters will be monitored during purging. Prior to collecting any samples, each well will be screened for the presence of VOCs using a PID after removing the well cap. The depth to groundwater will then be measured in the wells using an electronic oil/water interface probe attached to a measuring tape accurate to 0.01 feet.

The groundwater samples will be analyzed for the following:

- VOCs by EPA Method 8260B;
- SVOCs by EPA Method 8270C;
- PCBs by EPA Method 8082;
- Pesticides by EPA Method 8081A;
- Total and Dissolved TAL Metals by EPA Method 6000/7000 series:
- 1,4-Dioxane by EPA Method 8270D SIM: and
- PFAS by EPA Method 537 (modified) (analytes listed in section 6.2).

One field blank, one blind duplicate, and one matrix spike/matrix spike duplicate (MS/MSD) will be collected for quality assurance/quality control (QA/QC) purposes for analysis of VOCs and SVOCs. One equipment blank will be collected per day, for sampling of PFAS. One laboratory-prepared trip blank will be submitted per shipment for analysis of VOCs to determine the potential for cross-contamination, or at a frequency of one sample per 20 samples. All samples will be analyzed by a NYSDOH certified laboratory with Category B deliverables. All metals samples will be field filtered.

Collection of Groundwater Samples for PFAS from Monitoring Wells Sample Protocol

Samples collected using this protocol are intended to be analyzed for perfluorooctanoic acid (PFOA) and other perfluorinated compounds by EPA Method 537 Modified (Low Level). The sampling procedure used will be consistent with the NYSDEC March 1991 Sampling Guidelines and Protocols (Revision 1.2 August 9, 2018) with the following materials limitations.

At this time acceptable materials for sampling include: stainless steel, high density polyethylene (HDPE), and polypropylene. Additional materials may be acceptable if proven not to contain PFAS. It should be noted that Grunfos pumps and some bladder pumps are known to contain PFAS materials (e.g. TeflonTM washers for Grunfos pumps and LDPE bladders for bladder pumps) and should not be used for PFAS sampling.

All sampling equipment components and sample containers will not come in contact with aluminum foil, low density polyethylene (LDPE), glass, or polytetrafluoroethylene (PTFE, Teflon^{TM}) materials including sample bottle cap liners with a PTFE layer. Standard two-step decontamination using detergent and clean water rinse will be performed for equipment that does come in contact with PFAS materials. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFAS materials will be avoided. Food and drink packaging materials and "plumbers thread seal tape," which contain PFAS, will be avoided during sampling. All clothing worn by sampling personnel will have been laundered multiple times. The sampler will wear nitrile gloves while filling and sealing the sample bottles.

Pre-cleaned sample bottles with closures, coolers, ice, sample labels and a chain of custody form will be provided by the laboratory, and the sampler will adhere to the following sampling protocol:

1. Fill two pre-cleaned 250 mL HDPE or polypropylene bottle with the sample.
2. Cap the bottles with an acceptable cap and liner closure system.
3. Label the sample bottles.
4. Fill out the chain of custody.
5. Place in a cooler maintained at 4 ± 2º Celsius.

One equipment blank, matrix spike and matrix spike duplicate, and field blank will be collected for every sample batch, not to exceed 20 samples. Category B electronic data deliverables will be requested from the laboratory.

6.5 Soil Vapor Sampling

One soil vapor sample will be collected from each of the seven temporary vapor monitoring points. The soil vapor samples will be collected from the proposed development grade acros the Site, which ranges between 5 and 12 feet below existing Site grade. Each soil vapor probe location will be surveyed using a GPS handheld device to determine their accurate location. The proposed soil vapor sampling locations are shown on Figure 3.

The soil vapor monitoring points will be installed with the Geoprobe® drill rig. A 6-inch stainless steel screen implant, connected to Teflon tubing will be installed through the drilling rods and threaded into the drive points. The sampling tubing will extend from the end of the screen to above grade. The push probe rods will then be removed and the borings will be backfilled with clean silica sand to 3 to 6 inches above the screen. Hydrated bentonite will be used to fill the remaining void around the sampling tubing to the ground surface.

The soil vapor samples will be collected over an approximately 2-hour time period using a 6L, batch-certified SUMMA canister equipped with a vacuum gauge and flow regulator set at a maximum of 0.2 liters per minute. Prior to sample collection, the sampling point will be purged of three sample volumes using a peristaltic pump. During purging, an inverted five-gallon bucket will be placed over the sampling point and helium gas will be introduced through a small hole in the bucket to saturate the atmosphere around the sample port with helium gas. Purged vapors will be collected into a Tedlar bag and field-screened for organic vapors using a PID and for helium using a portable helium detector to check for short-circuiting of ambient air into the vapor sampling point. If the purged soil vapor contains greater than 10% helium, additional bentonite will used to enhance the surface seal, and the point will be retested.

Following purging, a soil vapor sample will be collected using the vacuum from the SUMMA canister. Immediately after opening the flow control valve equipped with a two-hour regulator, the initial SUMMA canister vacuum (inches of mercury) will be noted. After approximately two hours, the flow controller valve will be closed, the final vacuum noted, and the canister placed in a shipping carton for delivery to the laboratory.

The soil vapor samples will be analyzed for VOCs according to EPA Method TO-15 by a NYSDOH-certified laboratory with Category B deliverables.

6.6 Decontamination of Sampling Equipment

All sampling equipment (augers, drilling rods, split spoon samplers, probe rods and pumps, etc.) will be either dedicated or decontaminated between sampling locations. The decontamination procedure will be as follows:

1. Scrub using tap water/Simple Green® mixture and bristle brush.
2. Rinse with tap water.
3. Scrub again with tap water/ Simple Green® and bristle brush.
4. Rinse with tap water.
5. Rinse with distilled water.
6. Air-dry the equipment, if possible.

Decontamination for Emerging Contaminants

Prior to sampling for emerging contaminants the sampler must also:

1. Have selected clothes that do not contain perfluorinated compounds (PFCs) (such as GORE-TEX® or other waterproofed items) and laundered them multiple times using detergent that does not contain PFCs.
2. Must be wearing nitrile gloves.
3. Obtained pre-cleaned sample bottles with closures, coolers, ice, sample labels and a chain of custody form provided by the laboratory.
4. Ensured that all sampling equipment components and sample containers have not come in contact with aluminum foil, low density polyethylene (LDPE), glass or polytetrafluoroethylene (PTFE, a.k.a. Teflon™) materials including sample bottle cap liners with a PTFE layer.
5. Rinse with PFC-free distilled water provided by the laboratory.
6. Air-dry the equipment, if possible.

6.7 Management of Investigation-Derived Waste (IDW)

IDW that does not exhibit evidence of contamination (e.g., staining, presence of ash, oily sheens, odors, etc.) will be discharged to the ground. IDW exhibiting evidence of contamination will be containerized in Department of Transportation (DOT)-approved 55-gallon drums. The drums will be sealed at the end of each work day and labeled with the date, the well or boring number(s), the type of waste (i.e., drill cuttings, decontamination fluids, development water, or purge water) and the name of an AKRF point-of-contact. All drums will be labeled "pending analysis" until laboratory data is available. All IDW will be disposed of or treated according to applicable local, state, and federal regulations.

7.0 ANALYTICAL METHODS AND REQUIREMENTS

TestAmerica, Inc. of Edison New Jersey, and/or Alpha Analytical Laboratories of Westborough, Massachusetts will perform analyses on soil, groundwater, and soil vapor.

Matrix	Analytical Group	Conc. Level	Frequency of Samples Per Location	Number of Duplicate, Field Blank, and Trip Blank Samples	Number of Matrix Spike and Matrix Spike Duplicate Samples	Analytical and Preparation Method	Sample Volume *	Containers	Preservation Requirement	Max. Hold Time
Soil	VOCs	Low	Up to 4	3	3	SW846 8260B	17 oz.	3 encores and % Solid	4 °C	2 days
Soil	SVOCs	Low	Up to 4	3	3	SW846 8270C	8 oz.	1, 8-oz Amber Glass	4 °C	14 days
Soil	PCBs	Low	Up to 4	3	3	SW846 8082	8 oz.	1, 8-oz Glass or Plastic	4 °C	14 days
Soil	Pesticides	Low	Up to 4	3	3	SW846 8081A	8 oz.	1, 8-oz Glass or Plastic	4 °C	14 days
Soil	Metals	Low	Up to 4	3	3	SW846 6010B	8 oz.	1, 8-oz Glass or Plastic	4°C	6 months
Soil	1,4-Dioxane	Low	Up to 4	1	1	SW846 8270SIM	1 L	Amber Jar	4°C	7 days
Soil	PFAS	Low	Up to 4	1	1	SW846 537 (modified)	275 mL	HDPE Plastic Jar	4°C	7 days
Groundwater	VOCs	Low	1	1	1	SW846 8260B	40 mL	40-ml VOAs	HCl, 4 °C	14 days
Groundwater	SVOCs	Low	1	1	1	SW846 8270C	1L	1L Amber Teflon-lined Glass	4°C	7 days
Groundwater	PCBs	Low	1	1	1	SW846 8082	1L	1L Amber Teflon-lined Glass	4°C	14 days

Matrix	**Analytical Group**	**Conc. Level**	**Frequency of Samples Per Location**	**Number of Duplicate, Field Blank, and Trip Blank Samples**	**Number of Matrix Spike and Matrix Spike Duplicate Samples**	**Analytical and Preparation Method**	**Sample Volume ***	**Containers**	**Preservation Requirement**	**Max. Hold Time**
Groundwater	Pesticides	Low	1	1	1	SW846 8081A	1L	1L Amber Teflon-lined Glass	4°C	14 days
Groundwater	Total and Dissolved Metals	Low	2	2	2	SW846 6010B	1 L	1L Amber Teflon-lined Glass	4°C	180 days
Groundwater	1,4-Dioxane	Low	1	1	1	SW846 8270SIM	1 L	Amber Jar	4°C	7 days
Groundwater	PFAS	Low	1	2	2	SW846 537 (modified)	275 mL	HDPE Plastic Jar	4°C	7 days
Soil Vapor	VOCs	Low	1	n/a	n/a	TO-15	6 L	6-L Summa Canister	None	30 days

* Minimum sample volumes required by the laboratory per sample. Additional volume may be requested as a contingency for dilutions, breakage, etc.

Laboratory Method Detection Limits (MDLs) for Emerging Contaminants

Analyte	MDL [nanograms per liter (ng/l)]
Perfluorooctanesulfonic acid	0.609
Perfluoroundecanoic acid	0.461
N-methyl perfluorooctanesulfonamidoacetic acid	0.272
Perfluoropentanoic acid	0.504
6:2 Fluorotelomer sulfonate	0.211
N-ethyl perfluorooctanesulfonamidoacetic acid	0.405
Perfluorohexanoic acid	0.535
Perfluorododecanoic acid	0.643
Perfluorooctanoic acid	0.500
Perfluorodecanoic acid	0.674
Perfluorodecanesulfonic acid	0.42
Perfluorohexanesulfonic acid	0.474
Perfluorobutanoic acid	0.406
Perfluorobutanesulfonic acid	0.413
Perfluoroheptanoic acid	0.404
Perfluoroheptanesulfonic acid	0.565
Perfluorononanoic acid	0.474
Perfluorotetradecanoic acid	1.07
8:2 Fluorotelomer sulfonate	0.316
Perfluorotridecanoic acid	0.341
Perfluroroctanesulfonamide	0.604
Total FAS	0.500
1,4-Dioxane (P-Dioxane)	33.9

The reporting limit for PFAS in groundwater and soil is 2 ng/l and 1 microgram per kilogram (µg/kg), respectively. The report limit for 1,4-Dioxane (Method 8270 SIM) for groundwater and soil is 0.35 micrograms per liter (µg/L) and 0.1 mg/kg, respectively.

8.0 FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION

Field Equipment (Parameter)	Calibration Activity	Maintenance Activity	Testing/ Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	SOP
Mini Rae 2000 or 3000 PID (Organic vapors)	Instrument calibration with isobutylene span gas	Charge battery Replace or clean sensor	Clean air reading Inspect for visual damage	Calibration – daily Maintenance as needed	As per operator's manual	Recalibrate Perform maintenance	Operation manual
Oil/water interface probe (Depth to GW and LNAPL or DNAPL)	Calibrated by Manufacturer	Check battery and decontaminate between wells	Lower into well water to check alarm Inspect for visual damage	Between wells	Proper tone produced	Replace battery and/or decontaminate	Operation manual
Horiba U-52 water quality meter (conductivity, turbidity, pH, ORP, DO, temperature)	Verify calibration with auto-calibration solution for pH, DO, conductivity, turbidity, ORP	Charge battery	NA Inspect for visual damage	Calibrate at beginning of day After maintenance as required	Calibration does not drift	Recalibrate or replace	Operation model
MGD 2002 helium leak detector (helium)	Instrument calibration with helium span gas	Charge or replace battery	Clean air reading Inspect for visual damage	Calibration daily	As per operator's manual	Recalibrate, replace battery, replace instrument	Operation manual

Note: Equivalent equipment may also be used as available.

9.0 SAMPLE HANDLING SYSTEM

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Jacob Menken, AKRF
Sample Packaging (Personnel/Organization): Jacob Menken, AKRF
Coordination of Shipment (Personnel/Organization): Jacob Menken, AKRF
Type of Shipment/Carrier: Courier or overnight delivery services
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): TestAmerica or Alpha Laboratories Personnel
Sample Custody and Storage (Personnel/Organization): TestAmerica or Alpha Laboratories Personnel
Sample Preparation (Personnel/Organization): TestAmerica or Alpha Laboratories Personnel
Sample Determinative Analysis (Personnel/Organization): TestAmerica or Alpha Laboratories Personnel
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): Samples to be sent to TestAmerica or Alpha either by TestAmerica or Alpha Personnel courier the same day as the sampling or by overnight delivery services to laboratory for delivery the following morning. 1 day
Sample Extract/Digestate Storage (No. of days from extraction/digestion): As per analytical methodology; 30 days
SAMPLE DISPOSAL
Personnel/Organization: TestAmerica or Alpha Personnel
Number of Days from Analysis: Until analysis and QA/QC checks are completed; as per analytical methodology; 30 days

10.0 SAMPLE CUSTODY REQUIREMENTS

10.1 Sample Identification

All samples will be consistently identified in all field documentation, chain-of-custody documents and laboratory reports using an alpha-numeric code. The samples will be identified by a prefix of "SRI" to designate the type of investigation (SRI) followed by the soil boring or monitoring well number with sample depth interval in parenthesis (for soil samples only).

The blind duplicate samples will be labeled with a dummy sample location to ensure that they are submitted as blind samples to the laboratory. The dummy identification will consist of the sample type followed by a letter. Trip blanks will be identified as TRIP BLANK with the date of collection, and field and equipment rinsate blanks will be identified as FIELD BLANK with the date of collection.

The following table presents the sampling identification scheme.

Sample Description	Sample Designation
Soil sample collected from 0 to 2 feet at boring RI-SB-03 collected on December 10, 2018	RI-SB-03_0-2_20181210
Soil sample collected from 0 to 2 feet at boring WC-SB-03 collected on July 15, 2019.	WC-SB-03_0-3_20190715
Groundwater sample collected from monitoring well RI-MW-03 collected on December 10, 2018	RI-MW-03_20181210
MS/MSD duplicate groundwater sample from RI-MW-03 collected on December 10, 2018	RI-MW-03MS/MSD_20181210
Duplicate soil sample from 21 to 23 feet at RI-SB-03 collected on December 10, 2018	RI-SB-31_21-23_20181210
Duplicate groundwater sample at RI-MW-03 collected on December 10, 2018	RI-MW-03X_20191210
Soil vapor sample collected RI-SV-06 collected on December 10, 2018	RI-SV-06_20181210
Trip Blank submitted with samples collected on December 10, 2018	TRIP BLANK_20181210
Field Blank or Equipment Blank submitted with samples collected on December 10, 2018	FIELD BLANK_20181210

Following the labeling of each sample, the appropriate laboratory Chain-of-Custody (COC) form will be completed and will accompany the samples. Each person having custody of the samples will document receipt and relinquishment of such samples.

10.2 Sample Labeling and Shipping

All sample containers will be provided with labels containing the following information:

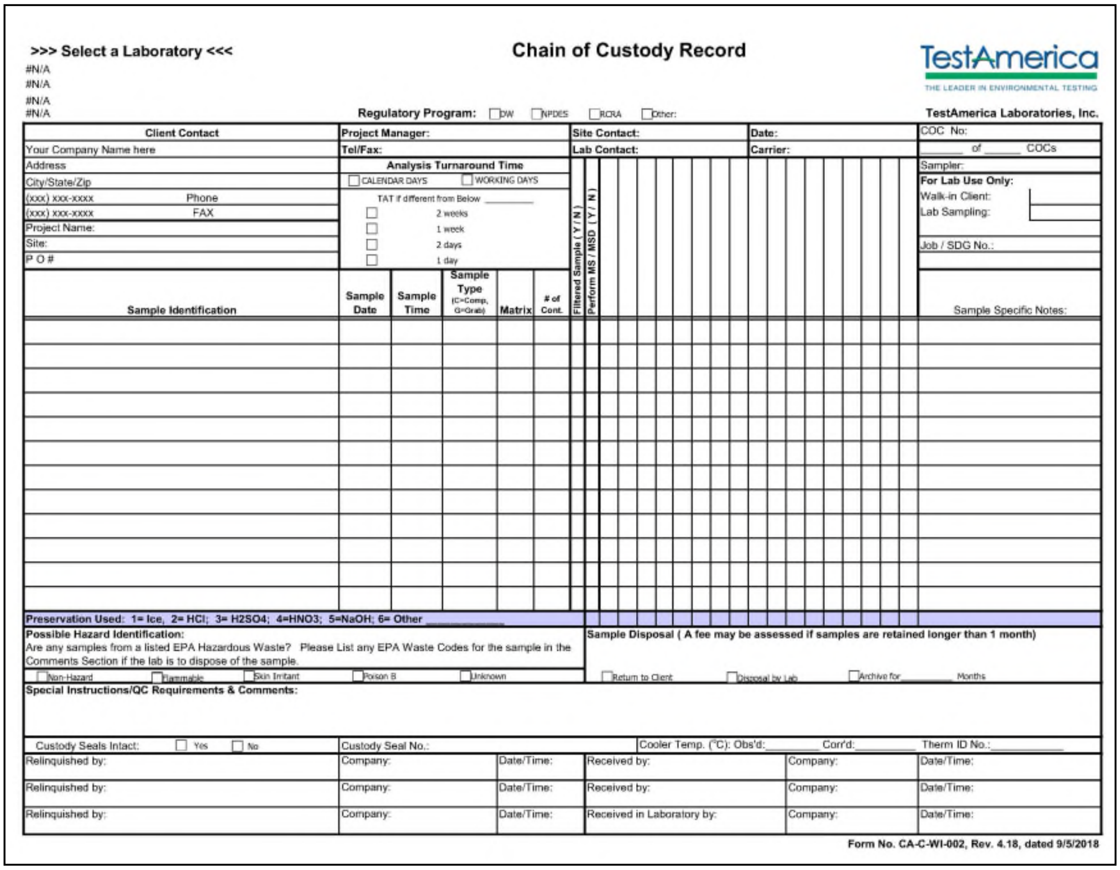
- Project identification
- Sample identification
- Date and time of collection

- Analysis(es) to be performed
- Sampler's initials

Once the samples are collected and labeled, they will be placed in a container and maintained in a secure environment until transported to the laboratory. The soil and groundwater samples will be prepared for shipment by placing each sample in a sealable plastic bag, then wrapping each container in bubble wrap to prevent breakage, adding freezer packs and/or fresh ice in sealable plastic bags and the COC form. Samples will be transported by a laboratory courier or, if necessary, shipped via FedEx. Freezer packs and/or blue ice cannot be used for transport of PFAS samples.

10.3 Sample Custody

Field personnel will be responsible for maintaining the sample containers in a secured location until they are picked up and/or sent to the laboratory. The record of possession of samples from the time they are obtained in the field to the time they are delivered to the laboratory or shipped off-site will be documented on COC forms. The COC forms will contain the following information: project name; names of sampling personnel; sample number; date and time of collection and matrix; signatures of individuals involved in sample transfer; and the dates and times of transfers. Blanks and example COCs for soil and groundwater and air are provided on the following pages.



>>> Select a Laboratory <<<
#N/A
#N/A
#N/A
#N/A

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☐ Other:

TestAmerica Laboratories, Inc.

Client Contact	**Project Manager:**	**Site Contact:**	**Date:**	COC No:
Your Company Name here	**Tel/Fax:**	**Lab Contact:**	**Carrier:**	______ of ______ COCs
Address	**Analysis Turnaround Time**			Sampler:
City/State/Zip	☐ CALENDAR DAYS ☐ WORKING DAYS			**For Lab Use Only:**
(xxx) xxx-xxxx Phone	TAT if different from Below ________			Walk-in Client:
(xxx) xxx-xxxx FAX	☐ 2 weeks			Lab Sampling:
Project Name:	☐ 1 week			
Site:	☐ 2 days			Job / SDG No.:
P O #	☐ 1 day			

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	# of Cont.	Filtered Sample (Y / N)	Perform MS / MSD (Y / N)	Sample Specific Notes:

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other ____________

Possible Hazard Identification:
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

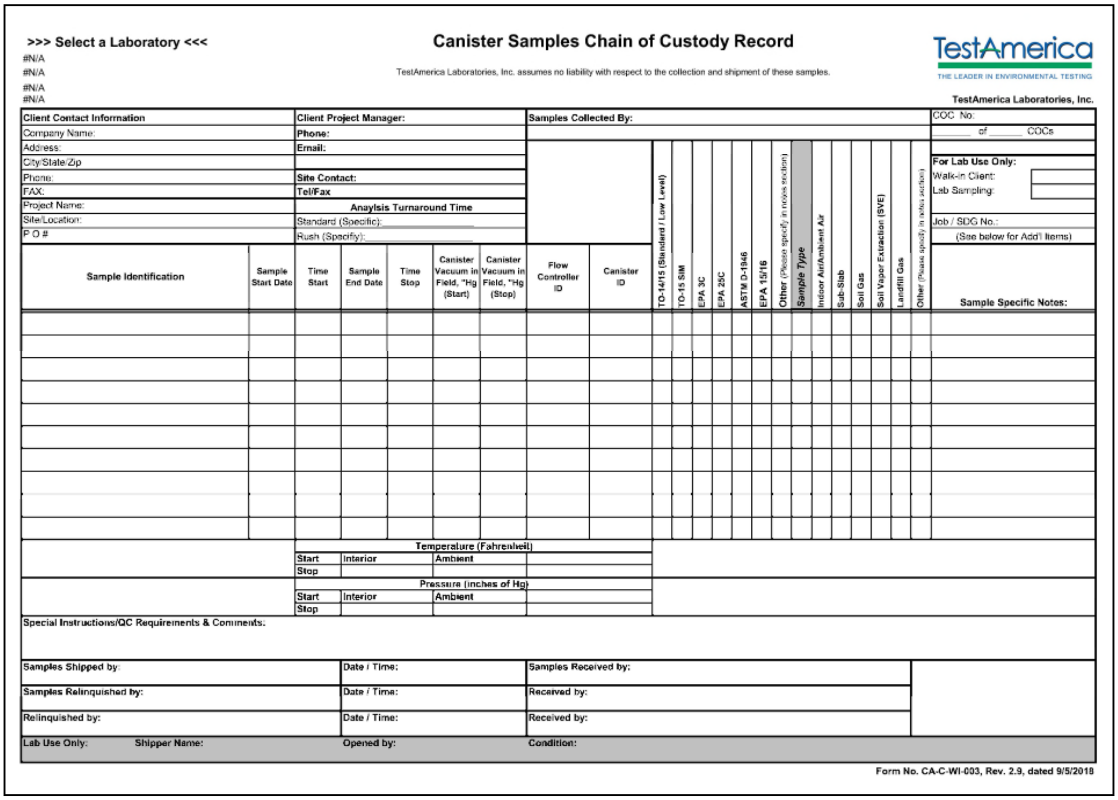
Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return to Client ☐ Disposal by Lab ☐ Archive for________ Months

Special Instructions/QC Requirements & Comments:

Custody Seals Intact: ☐ Yes ☐ No
Custody Seal No.:
Cooler Temp. (°C): Obs'd:________ Corr'd:________ Therm ID No.:__________

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time:

Form No. CA-C-WI-002, Rev. 4.18, dated 9/5/2018



>>> Select a Laboratory <<<
#N/A
#N/A
#N/A
#N/A

Canister Samples Chain of Custody Record

TestAmerica Laboratories, Inc. assumes no liability with respect to the collection and shipment of these samples.

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

TestAmerica Laboratories, Inc.

Client Contact Information	**Client Project Manager:**	**Samples Collected By:**	COC No:
Company Name:	**Phone:**		______ of ______ COCs
Address:	**Email:**		
City/State/Zip			**For Lab Use Only:**
Phone:	**Site Contact:**		Walk-in Client:
FAX:	**Tel/Fax**		Lab Sampling:
Project Name:	**Anaylsis Turnaround Time**		
Site/Location:	Standard (Specific):__________		Job / SDG No.:
P O #	Rush (Specify):__________		(See below for Add'l Items)

Sample Identification	Sample Start Date	Time Start	Sample End Date	Time Stop	Canister Vacuum in Field, "Hg (Start)	Canister Vacuum in Field, "Hg (Stop)	Flow Controller ID	Canister ID	TO-14/15 (Standard / Low Level)	TO-15 SIM	EPA 3C	EPA 25C	ASTM D-1946	EPA 15/16	Other (Please specify in notes section)	Sample Type	Indoor Air/Ambient Air	Sub-Slab	Soil Gas	Soil Vapor Extraction (SVE)	Landfill Gas	Other (Please specify in notes section)	Sample Specific Notes:

Temperature (Fahrenheit)

Start	**Interior**	**Ambient**
Stop		

Pressure (inches of Hg)

Start	**Interior**	**Ambient**
Stop		

Special Instructions/QC Requirements & Comments:

Samples Shipped by:	**Date / Time:**	**Samples Received by:**
Samples Relinquished by:	**Date / Time:**	**Received by:**
Relinquished by:	**Date / Time:**	**Received by:**

Lab Use Only: **Shipper Name:** **Opened by:** **Condition:**

Form No. CA-C-WI-003, Rev. 2.9, dated 9/5/2018

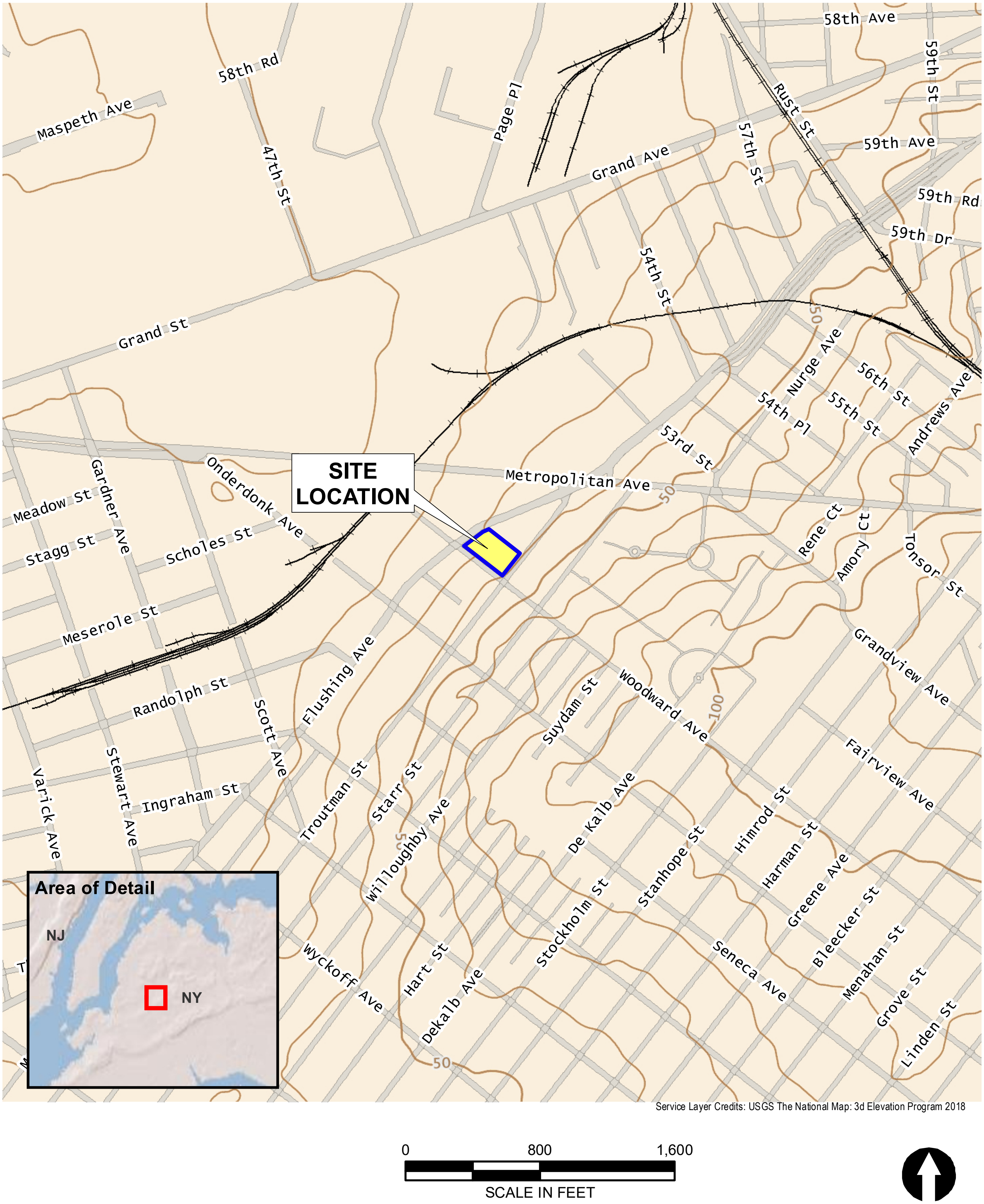
Upon receipt at the laboratory, the condition of each sample will be checked to ensure that the sample integrity has not been compromised. Any discrepancy between the samples and the chain-of-custody information, any broken or leaking sample bottles, or any other abnormal situations will be reported by the laboratory project manager to the AKRF Project Manager. If required, corrective action options will be discussed and implemented. Notations of the problem and resolution will be made in the laboratory analytical report.

Once samples are in the custody of the laboratory, sample integrity will be maintained. Each sample batch will be assigned a unique project number by the laboratory and each sample will be assigned a unique laboratory identification number. When samples are required for preparation and/or analysis, the sample custodian or designee will distribute the samples to the appropriate analysts. An internal chain-of-custody form will be signed by the individual to whom the samples are relinquished to track the samples internally.

11.0 DATA MANAGEMENT AND DOCUMENTATION

Field Sample Collection Documents and Records	Analytical Laboratory Documents and Records	Data Assessment Documents and Records	Project File
• Field books • Boring logs • Well construction diagrams • Chain-of-Custody (COC) forms • Well Development Forms • Well Sampling Forms • Photos • Air Sampling Logs • Soil Vapor Sampling Logs	• Sample receipt logs • Internal and external COC forms • Equipment calibration logs • Sample preparation worksheets/logs • Sample analysis worksheets/run logs • Corrective action documentation	• Data validation report • Field inspection forms • Corrective action documentation • Electronic Data Deliverables (EDD) compatible with EQuIS.	• Project files will be stored for one year in AKRF main office • Project files will be stored for seven years by the City of New York • After minimum of one year, hard copy files archived off-site • EDDs archived on AKRF corporate server

FIGURES



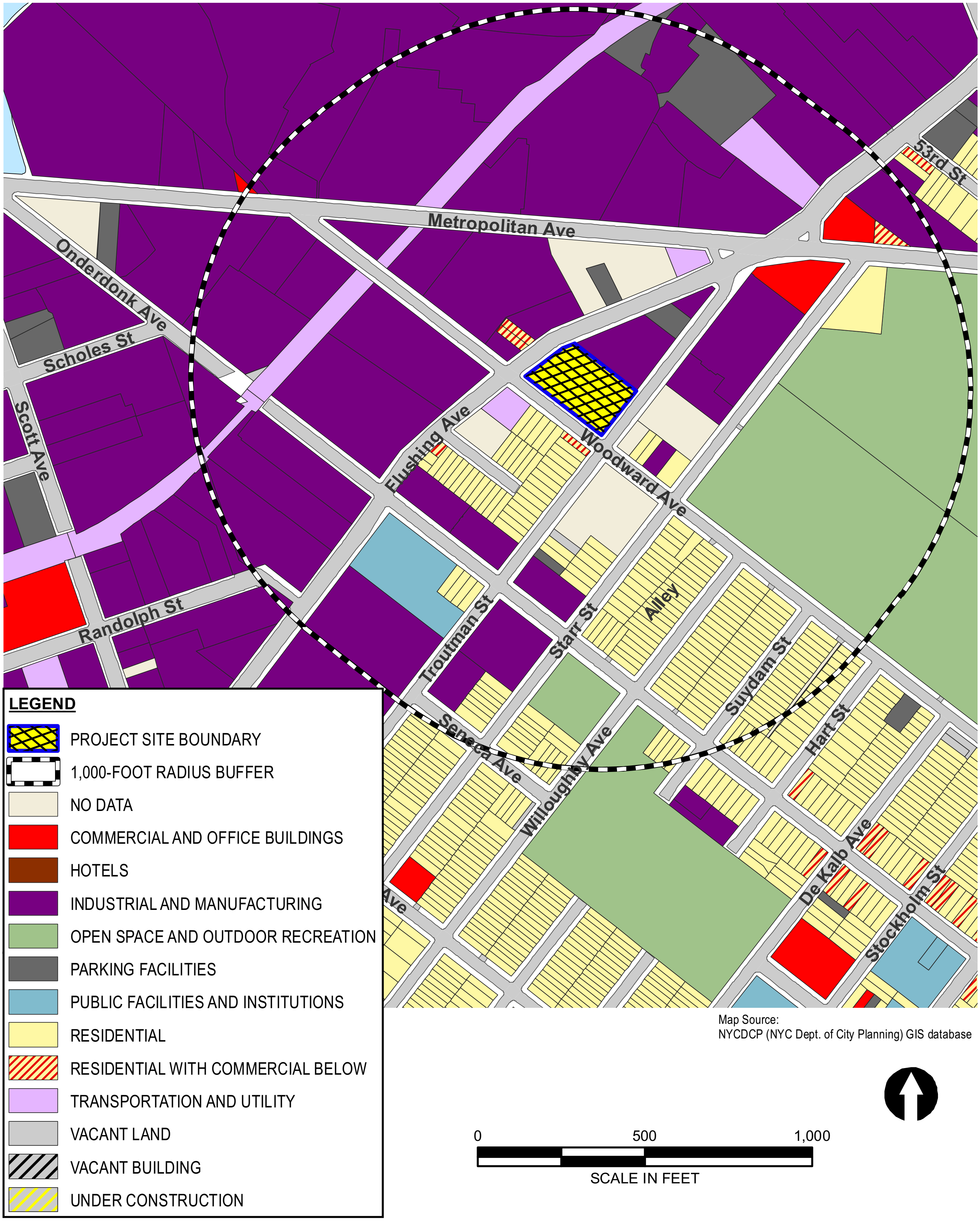
Service Layer Credits: USGS The National Map: 3d Elevation Program 2018

AKRF
440 Park Avenue South, New York, NY 10016

Queens Animal Shelter
151 Woodward Avenue
Queens, New York

SITE LOCATION

DATE
9/3/2018
PROJECT NO.
180291
FIGURE
1



Map Source:
NYCDCP (NYC Dept. of City Planning) GIS database

©2018 AKRF W:\Projects\180291 - QUEENS ANIMAL SHELTER\Technical\GIS and Graphics\Hazmat\180291 Fig 4 Existing Land Use map BCP.mxd 11/16/2018 10:42:32 AM dcolombini

AKRF
440 Park Avenue South, New York, NY 10016

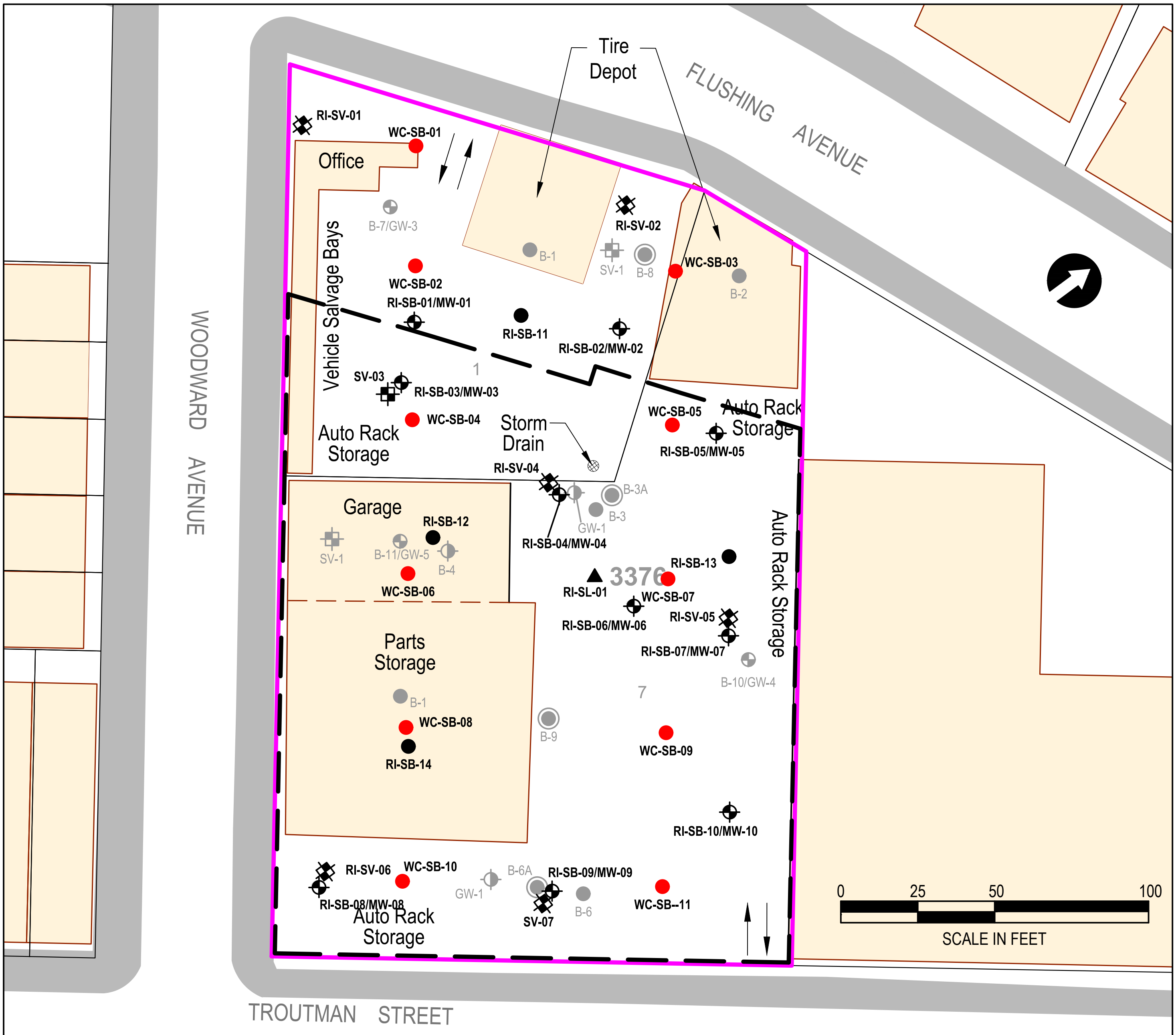
Queens Animal Shelter
151 Woodward Avenue
Queens, New York

EXISTING LAND USE

DATE
11/16/2018

PROJECT NO.
180291

FIGURE
2



LEGEND

▭	PROJECT SITE BOUNDARY
7	LOT BOUNDARY AND TAX LOT NUMBER
3376	TAX BLOCK NUMBER
▭	BUILDING
— —	PROPOSED NEW BUILDING OUTLINE
●	PREVIOUS SOIL BORING (ENVIRONMENTAL CONSULTANTS CORPORATION - JUNE 2018)
⊕	PREVIOUS SOIL VAPOR SAMPLE (ENVIRONMENTAL CONSULTANTS CORPORATION - JUNE 2018)
⊕	PREVIOUS GROUNDWATER SAMPLE (ENVIRONMENTAL CONSULTANTS CORPORATION - JUNE 2018)
◉	AKRF SUPPLEMENTAL SOIL BORING LOCATION (SEPT 2018)
⊕	AKRF SUPPLEMENTAL SOIL BORING AND TEMPORARY GROUNDWATER WELL LOCATION (SEPT 2018)
●	RI SOIL BORING (MARCH 2019)
⊕	RI SOIL BORING WITH MONITORING WELL (MARCH 2019)
⊠	RI SOIL VAPOR POINT (MARCH 2019)
▲	RI SLUDGE SAMPLE LOCATION (MARCH 2019)
●	SOIL PRE-CHARACTERIZATION BORING

Map Source:
NYCDCP (NYC Dept. of City Planning) GIS database

AKRF
440 Park Avenue South, New York, NY 10016

Queens Animal Shelter and Care Center
151 Woodward Avenue
Queens, New York

SITE PLAN AND PROPOSED SAMPLING LOCATIONS

DATE
5/6/2019
PROJECT NO.
180291
FIGURE
3

APPENDIX A
RESUMES OF KEY PERSONNEL

DEBORAH SHAPIRO, QEP

VICE PRESIDENT

Deborah Shapiro is a Vice President in the Site Assessment and Remediation Department. Ms. Shapiro supervises project teams and manages all aspects of assessment and remediation projects across the New York Metropolitan Area. Ms. Shapiro works with developers, non-profit organizations, architects, local community groups, local businesses, and government agencies. Her projects fall under the regulatory oversight of NYSDEC, NYCDEP, and NYCOER including the New York State Brownfield Cleanup Program (BCP), New York City Voluntary Cleanup Program (VCP), NYSDEC petroleum spills program, RCRA/UIC closures, and NYCOER's E-designation program. Ms. Shapiro has also assisted commercial and industrial property owners with maintaining the integrity of their portfolios by providing compliance related cleanup and chemical storage management services. Ms. Shapiro has also been a moderator and panelist at numerous conferences.

Ms. Shapiro manages all aspects of redevelopment projects from the initial Phase I ESA, Phase II, and remediation through post-remedial site management. In addition, her experience includes groundwater investigations, monitoring, and sampling programs; Brownfield and hazardous waste site investigations; In-Situ Chemical Oxidation; underground storage tank studies, including soil contamination delineation, classification, removal and disposal; waste characterization sampling; exposure assessments; on-going remedial action (especially AS/SVE), and permitting.

BACKGROUND

Education

M.S., Environmental Science, American University, 2001
B.A., Environmental Studies, American University, 1998

Professional Licenses/Certifications

Qualified Environmental Professional
Health and Safety Operations at Hazardous Materials Sites 29 CFR 1910.120

OSHA 8 Hour HAZWOPER Supervisor

OSHA 10 Hour Occupational Construction Safety and Health

CPR

Professional Memberships

Past President, New York City Brownfield Partnership
Board Member, Residents for a More Beautiful Port Washington
Member, Institute of Professional Environmental Practitioners (IPEP)

Awards

Big Apple Brownfield Award recipient as part of the Elton Crossing redevelopment team 2017
Big Apple Brownfield Award recipient as part of the Courtlandt Crescent redevelopment team 2013
Big Apple Brownfield Award recipient as part of the Via Verde redevelopment team 2012
Big Apple Brownfield Award recipient as part of the Cornerstone B1 (LaTerraza) redevelopment team 2011

Years of Experience

Year started in company: 2013
Year started in industry: 1998

Relevant Experience

Elton Crossing, Bronx, NY

AKRF provided environmental consulting services in connection with the purchase and redevelopment of the Elton Crossing site at 899 Elton Avenue in the Bronx, NY. The work initially involved the preparation of a Phase II subsurface investigation including soil and soil vapor testing to determine if the site would be eligible for the New York State Brownfield Cleanup Program (NYSBCP). Upon completion of the investigation, AKRF prepared a NYCBCP Application and the site was accepted into the NYSBCP. AKRF managed all aspects of the brownfield cleanup including; development of Investigation Work Plans, performing Remedial Investigations and Reports, preparation of Phase I ESAs, preparation of a Citizen Participation Plan, distribution of public notices, preparation and implementation of a Remedial Action Work Plan (RAWP), design of a sub-slab depressurization system, preparation of the Final Engineering Report and Site Management Plan, and sampling and management of soil disposal. AKRF is in the midst of implementing the Site Management Plan. As project manager, Ms. Shapiro was responsible for managing all technical components of the project, communication with NYSDEC and the Client, and managing the budget.

Second Farms, Bronx, NY

AKRF, Inc. was initially contracted by the New York City Office of Environmental Remediation (NYCOER) to conduct a subsurface investigation of a 1.12-acre parcel in the Bronx, New York under the United States Environmental Protection Agency (USEPA) Brownfield Assessment Grant program. The investigation included a geophysical survey and utility mark-outs, and the collection and analysis of soil, groundwater, soil vapor, indoor air and ambient air samples. AKRF continued working on the project for the developer by preparing a Remedial Action Plan and Environmental Assessment Statement. AKRF is in the midst of implementing the remedy.As project manager, Ms. Shapiro was responsible for managing all technical components of the project, communication with OER, NYCDEP, and the Client, and managing the budget.

Bradhurst Cornerstone II Residences, Manhattan, NY

AKRF, Inc. prepared a Part 58 Environmental Assessment and a City Environmental Quality Review Environmental Assessment Statement for the Bradhurst Cornerstone II Apartments project. Issues of concern for the environmental review included the identification of project commitments for certain of the four sites related to historic resources, hazardous materials, air quality, and building attenuation. As part of the mitigation of hazardous materials, AKRF conducted a Phase II investigation, and prepared a Remedial Action Plan and Construction Health and Safety Plan. As project manager, Ms. Shapiro was responsible for managing all technical components of the hazardous materials portion of the project, communication with the regulatory agency and the Client, and managing the budget.

Lambert Houses, Bronx, NY

AKRF performed an EIS of the Lambert Houses affordable housing complex located in the West Farms section of the Bronx, NY. Lambert Houses consisted of multi-story apartment buildings, parking garage, and a multi-tenant retail/commercial building alongside the elevated NYC subway. AKRF also conducted a Phase I ESA with a vapor intrusion screen of the Property to satisfy HUD's vapor intrusion requirements. The Phase I and vapor intrusion screens were prepared in accordance with ASTM E1527-05, ASTM E2600, and EPA's All Appropriate Inquiry (AAI) rule. After completion of the EIS, an E designation for hazardous materials was placed on the Site. A Subsurface Investigation was conducted and a Remedial Action Work Plan was prepared under OER oversight. The Site was subsequently entered in the NYC Voluntary Cleanup Program. AKRF is in the midst of implementing the RAWP, which included remediation of a hydraulic oil spill. As project manager, Ms. Shapiro was responsible for managing all technical components of the hazardous materials portion of the project, communication with the regulatory agency and the Client, and managing the budget.

Brook 156, Bronx, NY

AKRF was retained to provide environmental consulting services in connection with the purchase and development of the Site. AKRF prepared a Phase I Environmental Site Assessment (ESA) of the NYC-owned former gasoline service station and a former railroad. A Tier 1 Vapor Encroachment Screening was also conducted to satisfy HUD's vapor intrusion requirements. AKRF prepared a Remedial Investigation Work Plan (RIWP) and conducted a Remedial Investigation (RI) at the site, which included the collection and analysis of soil, soil vapor, and groundwater. The results of the RI, which were documented in a Remedial Investigation Report (RIR), were used to prepare a New York City Brownfield Cleanup Program (NYCBCP) application. The site was accepted into the New York State Brownfield Cleanup Program (NYSBCP). AKRF prepared a Citizen Participation Plan (CPP), distributed public notices, and conducted multiple Remedial Investigations to further investigate soil, soil vapor, and groundwater at the site prior to redevelopment. The results of the investigations were used to prepare a Remedial Action Work Plan (RAWP), which is undergoing review and approval by NYSDEC. The proposed remedy includes excavation of soil, design and installation of a soil vapor extraction system and sub-slab depressurization system, contingent groundwater treatment program, and installation of a vapor barrier and composite cover system. As project manager, Ms. Shapiro is responsible for managing all technical components of the project, communication with NYSDEC and the Client, and managing the budget.

20568 On-Call Environmental Consulting Services (Various Locations), New York City Mayor's Office of Environmental Remediation (OER) (administered by NYCEDC)

Ms. Shapiro is managing an on-call contract with the OER for brownfields environmental assessment and remediation. The work has included conducting Phase I environmental site assessments (ESAs) and multi-media sampling of soil, groundwater, and soil vapor for various sites funded by EPA grants. The work plans and investigation reports were completed in accordance with OER and EPA requirements. AKRF also implemented a remedial plan for capping a park site in Staten Island. In addition, AKRF provided support to OER and an affordable housing developer to expedite an application for entry into the New York State Department of Environmental Conservation (NYSDEC) Brownfield Cleanup Program (BCP), as well as preparation and implementation of the remedial investigation and remedial plan.

Atlantic Chestnut, Brooklyn, NY

AKRF was retained to provide environmental consulting services in connection with the purchase and redevelopment of former burned manufacturing buildings encompassing an entire city block in Brooklyn, New York. As part of due diligence, AKRF prepared a Phase I Environmental Site Assessment (ESA) Report for the property. After acquisition, the property was divided into three separate sites (3264 Fulton Street, 235 Chestnut Street, and 3301 Atlantic Avenue). AKRF prepared a Subsurface (Phase II) Investigation Work Plans and conducted Phase IIs at each of the sites, which included the collection and analysis of soil, soil vapor, and groundwater samples. Based on the results of the Phase IIs, which were documented in Subsurface (Phase II) Reports, New York State Brownfield Cleanup Program (NYSBCP) applications were prepared for each of the sites. After acceptance into the NYSBCP, AKRF prepared Citizen Participation Plans (CPPs) and distributed public notices. AKRF prepared Remedial Investigation (RI) Work Plans (RIWPs) and implemented numerous Remediation Investigations for each of the sites to further investigate contaminated media at the site prior to redevelopment, and prepared the RI Reports (RIRs). AKRF is in the midst of preparing Interim Remedial Work Plans for each Site, which include installation of a Soil Vapor Extraction to prevent the off-site migration of contaminants. As project manager, Ms. Shapiro was responsible for managing all technical components of the project, communication with NYSDEC and the Client, and managing the budget.

J. PATRICK DIGGINS, P.G.

Technical Director

J. Patrick Diggins has 10 years of environmental consulting experience primarily in environmental investigations, and remediation planning and oversight. His experience includes implementing Phase I Environmental Site Assessments, Subsurface (Phase II) Investigations and/or Remedial Investigations; developing and managing remedial action programs including soil excavation, remediation system design and installation, regulatory reporting, and post-remedial site management. Several of his New York City (NYC) projects have been successfully remediated under either the New York State Department of Environmental Conservation (NYSDEC) Brownfield or NYC Office of Environmental Remediation (OER) Voluntary Cleanup Program (VCP). Prior to his work in New York City, he gained experience in the New England region implementing large-scale environmental investigation and groundwater remediation projects.

BACKGROUND

Education

M.S. Hydrogeology, University of Massachusetts - Amherst, 2009
B.S Geology, Beloit College, 2005

Years of Experience

Date started at AKRF: January 2016
Prior industry experience: Langan Engineering and Environmental Services – Oct. 2011 to Dec. 2015 (4 years)
Environmental Resources Management – September 2008 to October 2011 (3 years)

Certifications

New York State Certified Professional Geologist (August 2017)

RELEVANT EXPERIENCE

110-10 Astoria Boulevard (419Q), Queens, NY

The property is a future public school, and is enrolled in New York City Mayor's Office of Environmental Remediation (NYC OER) E-Designation program. AKRF is representing the New York City School Construction Authority (NYC SCA) and has performed the remedial investigation; developed remedial work plans for approval by the NYC OER, and is currently overseeing the implementation of remedial actions. For this project, Mr. Diggins is acting as project manager, overseeing field personnel and reviewing daily reports.

11 Greene Street, New York, NY

The property is a New York City Mayor's Office of Environmental Remediation (NYC OER) Voluntary Cleanup Program (VCP) site. AKRF performed the remedial investigation; developed remedial work plans for approval by the NYC OER, and is currently overseeing the implementation of remedial actions. For this project, Mr. Diggins is acting as project manager, overseeing field personnel and reviewing daily reports.

74-16 Grand Avenue, Queens, New York

AKRF was tasked with completion of Phase I Environmental Site Assessment (ESA) and implementation of a Subsurface (Phase II) Investigation. Mr. Diggins acted as project manager, overseeing field personnel implementing the Phase I ESA site reconnaissance and the subsurface investigation, as well as completing reports for delivery to the client.

DOT Relocation Site, Long Island City, New York

AKRF was tasked with completion of Phase I Environmental Site Assessment (ESA) and implementation of a Subsurface (Phase II) Investigation. Mr. Diggins acted as project manager, overseeing field personnel implementing the Phase I ESA site reconnaissance and the subsurface investigation, as well as completing reports for delivery to the client. AKRF is now assisting the client with entering the proposed site redevelopment project into the New York State Brownfield Cleanup Program. Mr. Diggins completed the application for submittal and is working with colleagues to begin design of remedial elements.

29-39 East Fordham Road, Bronx, NY

The property has undergone remediation of a petroleum spill that originated in the facility basement. AKRF performed the spill investigation, developed remedial work plans for approval by the New York State Department of Environmental Conservation (NYSDEC), and oversaw the implementation of remedial actions. For this project, Mr. Diggins acted as project manager overseeing field personnel and guiding the client over the regulatory hurdles.

East Side Coastal Resiliency, East River Waterfront/Lower Manhattan, New York

Mr. Diggins prepared cost estimates for construction of coastal resiliency structures in potentially contaminated areas of the East River waterfront, on behalf of NYC Department of Design and Construction (DDC). He evaluated field and laboratory data to assist the project manager in the report preparation, and represented AKRF at meetings with city officials.

JACOB MENKEN, M.SC.

PROFESSIONAL I GEOLOGIST

Mr. Menken has a Master of Science in Geology, Bachelor of Arts in Geology, and Bachelor of Science in Environmental Science from the University of Vermont. He is familiar with the following professional techniques: powder and single crystal x-ray diffraction; field geology; remote sensing of natural resources using airborne and satellite imagery; geophysical survey using ground penetrating radar, electromagnetic induction and seismic refraction; optical and hand sample identification of minerals; aseptic laboratory techniques; and stable isotope geochemistry. Mr. Menken's familiarity with hardware includes the following: Crystallography: APEX II Single Crystal X-Ray Diffractometer, Rigaku Powder X- Ray Diffractometer; Geophysical: Ground Penetrating Radar: GSSI SIR 3000 with 400 and 200MHz antennas, Electromagnetic Induction: SSI Profiler EMP-400; Stable Isotope: VG/Fisons SIRA Series II Stable Isotope Ratio Mass Spectrometer Honeywell Photoionization Detector; HACH Portable Water Quality Meter. Mr. Menken is familiar with the following software: X-Ray Crystallography: PDXL, Standard Measurement, APEX 2, ATOMS; Statistical Software: R, SPSS, Geophysical, Geogiga Pro, GSSI Radan 7, GSSI Profiler; Microsoft Office Suite, Adobe Creative Suite; Geospatial: ENVI 5.0, 4.0 and Classic ArcGIS.

BACKGROUND

Education

M.S., Geology, University of Vermont, 2014

B.A., Geology, University of Vermont, 2012

B.S., Environmental Science, University of Vermont, 2012

Certifications

OSHA 40-Hour Health & Safety Training for Hazardous Waste Operations, May 2011

OSHA 8-Hour Health & Safety Training for Hazardous Waste Operations, September, 2016

OSHA 10-Hour Health & Safety Training for Hazardous Waste Operations, August, 2016

University of Vermont Radiological Safety Training

American Heart Association CPR

Professional Memberships

Mineralogical Society of America

Mineralogical Society of Canada

Geological Society of America

The Society of Sigma Gamma Epsilon, Eta Kappa, National Honor Society in the Earth Sciences

Burlington Gem and Mineral Club

Years of Experience

Year started in company: 2016

Year started in industry: 2012

RELEVANT EXPERIENCE - AKRF

112 Atlantic Ave, Brooklyn, NY 11201 – Construction Oversite and Community Air Monitoring

AKRF provided community air monitoring on this site for dust and volatile organic compounds (VOCs) in accordance with existing community air quality standards. Additionally, AKRF provided onsite oversite to ensure additional discovered soil contamination was left in place for determination of the extent of soil. AKRF was also responsible for logging any incoming or outgoing soil or fill laden trucks. For this project Mr. Menken provided on-site monitoring.

32 N. Main Street, New City, NY – Groundwater Sampling/Inspections and Wastewater Drum Disposal

Mr. Menken oversees the disposal of wastewater drums by a contractor. Mr. Menken ensures that the contractor completed the appropriate task and the appropriate drums were removed from the site. Additionally, Mr. Menken performs quarterly groundwater sampling as well as annual SSDS and site cover inspections.

Gedney Way Landfill, White Plains, NY – Annual Groundwater Sampling and Quarterly Well Survey

Mr. Menken performs the annual groundwater sampling as well as site cover inspections at the City of White Plains Department of Public Works Gedney Way Landfill. Additionally, Mr. Menken performs the quarterly well survey for all wells present.

Home Depot, 75-09 Woodhaven Boulevard, Glendale, NY – Groundwater and Soil Vapor Sampling, Monthly Sub-Slab Depressurization System Monitoring and SVE System Expansion

Mr. Menken maintains the Sub-Slab Depressurization System (SSDS) at the Home Depot in Rego Park, Queens. Mr. Menken is responsible for the soil vapor extraction of the system on-site including ensuring the SSDS was operational and SSDS/SVE operation was within accepted values for the site. Additionally, Mr. Menken performs annual/quarterly groundwater and soil vapor sampling at locations on site as well as assisted with the installation of additional SVE legs to the existing SVE system.

2350 5th Avenue, Manhattan, NY – Groundwater Sampling and Monthly Sub-Slab Depressurization System Monitoring and Maintenance

Mr. Menken maintains the Sub-Slab Depressurization System (SSDS) at the site in Harlem, New York. Mr. Menken is responsible for the soil vapor extraction of the system on-site including ensuring the SSDS was operational and SSDS/SVE operation was within accepted values for the site. Additionally, Mr. Menken performs annual/quarterly groundwater and soil vapor sampling at locations on site.

34 Berry Street, Williamsburg, NY – Groundwater Sampling and Quarterly Inspections

AKRF was retained to prepare close-out documentation for this former industrial/warehouse facility in Williamsburg, which was remediated under the New York City Office of Environmental Remediation (OER) E-designation and NYSDEC Spills programs. The closure report, which was based on documentation provided by the environmental contractor, was prepared on an expedited basis so that the developer could obtain a Certificate of Occupancy in time for the scheduled opening of the new building. AKRF is currently providing on-going remediation monitoring services to fulfill NYSDEC Spill closure requirements. For this project, Mr. Menken performed monthly/quarterly groundwater monitoring.

11 Greene Street, Manhattan, NY 10013 – Construction Oversite and Community Air Monitoring

AKRF is overseeing implementation of the approved RAWP and Site Management Plan (SMP) for this OER site in Manhattan. AKRF serves as the on-site contact who conducts waste characterization sampling, oversees soil management and conducts community air monitoring and completes daily reports for submittal to the AKRF and NYCDEP project managers. For this project Mr. Menken provided on-site monitoring.

SCA City Wide Portable Water Lead Sampling – Drinking Water Sampling

As part of an on-call contract with the SCA, AKRF provided water sampling services at various public schools in New York City. AKRF sampled potable water fixtures for lead concentration at public schools in all five boroughs. Work was performed at night or when school was not in session and coordinated with the SCA, custodial engineers and various contractors.

Staten Island Wheel, Staten Island, New York 10301 – Construction Oversite and Community Air Monitoring

AKRF is overseeing implementation of the approved RAWP and Site Management Plan (SMP) for this site in the Staten Island. AKRF serves as the on-site contact who conducts waste characterization sampling, oversees soil management, conducts community air monitoring, and prepares daily reports for submittal to the AKRF. For this project Mr. Menken provided on-site monitoring.

Adelaar/Concord Resort, 219 Concord Road, Monticello, New York 12751 – Construction Oversite and Community Air Monitoring

AKRF is overseeing implementation of the NYSDEC-approved RAWP and Site Management Plan (SMP) for this BCP site in the Catskills. AKRF serves as the on-site contact who conducts waste characterization sampling, oversees soil management and conducts community air monitoring for submittal to the AKRF and NYSDEC project managers. For this project Mr. Menken provided on-site monitoring.

Avalon Bay-Yonkers Buildings #1, #2, #3, 79 Alexander, Yonkers, New York – Construction Oversite, Monitoring Well Abandonment, Waste Classification and Remedial Investigation.

AKRF is overseeing implementation of the approved RAWP and Site Management Plan (SMP) for this site in the Yonkers. AKRF serves as the on-site contact who conducts waste characterization sampling, oversees soil management, conducts community air monitoring, and prepares daily reports for submittal to the AKRF. For this project Mr. Menken provided on-site monitoring, SSDS and vapor barrier inspections, monitoring well abandonment, soil waste classification and additional remediation investigations.

Cayuga Indian Nation of New York, Cayuga and Seneca Counties, New York Phase I's, Phase I Updates and Phase II:

Mr. Menken performed several Phase I site inspections of various properties for the Cayuga Indian Nation of New York including a gas station, farm field and casino. Additionally, Mr. Menken performed a Phase II site investigation of an existing gas station. Mr. Menken also submitted FOIL requests to various city, county and state agencies as part of a records search.

PRIOR EXPERIENCE

Tutor/Writing Consultant, Burlington, VT (2014 - 2016)

Prior to joining AKRF, Mr. Menken served as a Tutor/Writing Consultant.

- Private in-person or virtual tutoring sessions for graduate, undergraduate and high school students.
- Tutored topics included high school STEM; university-level geology and environmental science; and SAT, ACT and GRE test preparation.
- Assisted in the writing, editing and publishing of professional and scholarly works and college application essays.
- Students placed at top U.S. educational institutions such as Cornell University, Virginia Polytechnic Institute and State University, New York University and University of Vermont.

University of Vermont - Department of Geology, Burlington, VT (8/2012 - 10/2014)

Prior to joining AKRF, Mr. Menken served as a Graduate Teaching Fellow/Assistant at the University of Vermont.

- Thesis Topic: Determining the effect of step-wise thermal treatment on the cation exchange and disordering within Fe^{2+}, Fe^{3+}, and Mg^{2+} rich tourmaline samples using Single Crystal X-Ray Diffraction.
- Assisted in New York and Vermont field geology and geophysical projects with university faculty, staff and graduate students.
- Duties included:
  - Sample preparation and analysis of samples analyzed by the X-Ray Diffraction equipment
  - Maintenance of the scientific equipment and other technical equipment
  - Consultation on research projects requiring non-destructive geochemical analysis
  - Generation of scientific and technical reports from collected data

Vermont Space Grant Consortium VT-NASA EPSCoR/Vermont State Climate Office, Burlington, VT (6/2013 - 9/2013)

Prior to joining AKRF, Mr. Menken served as a Graduate Research Assistant.

- Performed statistical analysis on impounded and open water wetlands from data collected from MODIS and NAIP imagery to determine statistical difference between different wetlands on satellite images.
- Statistical tests include clustering around medoids, analysis of variation, principle component analysis, standard deviation, propagation of error and liner regression.
- Research funded by Vermont State Climatologist, National Aeronautics and Space Administration and National Science Foundation, Experimental Program to Stimulate Competitive Research.

EPSCoR Streams Project/National Science Foundation, Burlington, VT (5/2011 - 8/2011)

Prior to joining AKRF, Mr. Menken served as a Streams Project Intern for research experience for undergraduate student.

- Determined the effect of the acidification of mountain streams on the growth and survival of bio-indicator species.
- Conducted an independent research project using multiple controls, replicates and quantitative statistical analysis.
- Collected samples from the field, maintained experiment parameters and conditions, collected and analyzed data.

Westchester County Department of Parks, Recreation and Conservation, Katonah, NY (6/2010 - 8/2010)

Prior to joining AKRF, Mr. Menken served as Jack Robbins Biodiversity Intern.

- Studied and applied conservation and management practices for the threatened species using radio telemetry and ground survey of the Spotted Turtle (*Clemmys guttata*)
- Completed census and study of various populations of pond turtles, amphibians, mammals, fish, macro-invertebrates and birds on a suburban/rural farm
- Report on findings produced was published internally to guide future management strategies

CHRISTOPHER PUOPLO

FIELD TECHNICIAN

Christopher Puoplo is geologist in AKRF's Hazardous Materials Department. He has experience in groundwater sampling, air monitoring, water disinfection and sampling, lead in water sampling, SWPPP inspections, phase II subsurface investigations, sturgeon monitoring, crewing and driving a motorboat, and construction oversight.

BACKGROUND

Education

BS Geology, State University of New York, College at Oneonta, Oneonta, NY

Licenses/Certifications

40-Hour OSHA HAZWOPER Certified
10-Hour OSHA Construction Program Certified
DOL Asbestos Project Monitor, Air Technician, and Inspector Certified
SWPPP Certified
TWIC Certified

Years of experience

Year started in company: 2014
Year started in industry: 2014

RELEVANT EXPERIENCE

New York City School Construction Authority: On-Call Environmental Consulting

Under an on-call contract, AKRF provides the New York City School Construction Authority (NYCSCA) with hazardous materials consulting services. Mr. Puoplo performs environmental assessment tasks including lead in drinking water sampling and plumbing disinfection oversight tasks under the current on-call contract.

NY Wheel, Staten Island, NY

Working with the New York City Department of Small Business Services (SBS) as lead agency, AKRF conducted an environmental review for the forthcoming Empire Outlets and New York Observation Wheel (NY Wheel), a mixed-use development situated on a State Voluntary Cleanup Program (VCP) site managed by the New York City Economic Development Corporation (EDC), on the northern Staten Island waterfront. The approximately 60-story NY Wheel will be one of the world's tallest Ferris wheels, while Empire Outlets will be New York City's first outlet mall. The combined project is the largest investment in the borough since the construction of the Verrazano-Narrows Bridge in the 1960s.

AKRF is also providing hazardous materials services and civil engineering services to New York Wheel LLC during construction on the NY Wheel site. Mr. Puoplo has performed construction oversight to ensure compliance with the SMP.

87 Gedney Way, White Plains NY – Groundwater Sampling

AKRF was hired by the City of White Plains' Department of Public Works (DPW) to prepare a Site Investigation Work Plan (SIWP) of the 22.7-acre Gedney Way Leaf and Yard Waste Compost Facility. AKRF completed the SIWP and obtained NYSDEC approval on the plan. AKRF also collected of soil, groundwater, soil gas and surface water samples. Closure activities have been completed and New York State Department of Environmental Conservation (NYSDEC) closure approval is pending. As part of ongoing monitoring, Mr. Puoplo screened wells for methane, measured depth to groundwater, and collected groundwater samples from the site.

Rego Park Home Depot, Queens, NY

Solvent contamination was encountered during retail development of a former industrial property in Rego Park, Queens, New York. The site work included an extensive investigation and a multi-phase remediation performed under the NYSDEC Voluntary Cleanup Program (VCP). Remediation included removal of aboveground and underground storage tanks (ASTs and USTs) and hotspot soil removal. An AS/SVE groundwater remediation system designed by AKRF was installed as part of the building construction. Mr. Puoplo performed quarterly groundwater monitoring.

Storage Deluxe, Various Locations, NY

AKRF assists Storage Deluxe with the ongoing expansion of their self-storage facilities primarily in the five boroughs of New York City and Westchester County. AKRF provides environmental due diligence services related to their property transactions, including Phase I Environmental Site Assessments (ESAs), Phase II investigations, and geophysical surveys, remediation, as well as consulting on petroleum bulk storage tank management. Mr. Puoplo has assisted Storage Deluxe with asbestos surveys at various properties.

34 Berry Street, Williamsburg, NY

AKRF was retained to prepare close-out documentation for this former industrial/warehouse facility in Williamsburg, which was remediated under the New York City Office of Environmental Remediation (OER) E-designation and NYSDEC Spills programs. The closure report, which was based on documentation provided by the environmental contractor, was prepared on an expedited basis so that the developer could obtain a Certificate of Occupancy in time for the scheduled opening of the new building. AKRF is currently providing on-going remediation monitoring services to fulfill NYSDEC Spill closure requirements. For this project, Mr. Puoplo performed monthly/quarterly groundwater monitoring.

Crestwood 300-308 Columbus Avenue, Tuckahoe, NY – Environmental Monitoring

Investigation and remediation of the former gasoline filling station is being conducted under the New York State Brownfield Cleanup Program (BCP). AKRF completed a Phase I Environmental Site Assessment, Phase II Subsurface Investigation, and prepared a Remedial Action Plan (RAP) to address subsurface contamination during site redevelopment. For this project, Mr. Puoplo served as an on-site environmental monitor who performed construction oversight and conducted work zone and community air monitoring.

Flushing Industrial Park, Flushing, NY

Investigation and remediation of former garage and filling station is being conducted under the New York State BCP. AKFR conducted a remedial investigation, and prepared and executed a Remedial Action Work Plan (RAWP). For this project, Mr. Puoplo served as a lead on-site environmental monitor who performed construction oversight and conducted work zone and community air monitoring.

Extell Construction Oversight, Manhattan, NY

Environmental investigation and remediation of this Site is being conducted under the New York City Voluntary Cleanup Program (VCP) managed by the New York City Mayer's Office of Environmental Remediation (OER).

The Site is also subject to environmental review by the NYSDEC. For this project, Mr. Puoplo performed post-remediation groundwater sampling at the site.

The Crossing at Jamaica Station, Jamaica, NY

AKRF was retained to prepare close-out documentation for this former industrial/warehouse facility in Williamsburg, which was remediated under the New York City Office of Environmental Remediation (OER) E-designation and NYSDEC Spills programs. The closure report, which was based on documentation provided by the environmental contractor, was prepared on an expedited basis so that the developer could obtain a Certificate of Occupancy in time for the scheduled opening of the new building. For this project, Mr. Puoplo performed monthly/quarterly groundwater monitoring.

Tappan Zee Bridge, Tarrytown, NY

AKRF was retained to perform a sturgeon monitoring program with near field monitoring during construction activities at the Tappan Zee Bridge project. For this project, Mr. Puoplo performed sturgeon monitoring and near field data collection, as well as crewing and driving a motor boat.

29-39 East Fordham Road, Fordham, NY

AKRF was retained to perform a phase II subsurface investigation, create and implement a remedial action work plan for this commercial building in Fordham which had an aboveground oil storage tank spill, which was remediated under the NYSDEC Spills programs. The spill is still open today. For this project, Mr. Puoplo acted as the primary field person for construction oversight during soil remediation, installation of groundwater monitoring wells, and concrete restoration.

Adelaar Resort (Formerly known as Concord Resort), Thompson, NY

Developed over several years and phases, the Adelaar Resort project will redevelop the historic Concord Resort into a variety of amenities, uses, and experiences. The Adelaar Resort will include a Resort Core with casino hotels and conference facilities, an entertainment village, a family resort area, and a residential village encompassing a total area of over 1,500 acres. AKRF was retained for engineering and remediation oversight. For this project, Mr. Puoplo conducted construction oversight, community and work zone air monitoring during remediation activities, collected soil samples, and performed stormwater pollution prevention plan (SWPPP) inspections. All activities done in accordance with the RAWP, SMP, and SWPPP.

Marymount School, Manhattan, NY

AKRF was retained to perform a phase I environmental site assessment (ESA) and phase II subsurface investigation to be submitted to the NYSDEC for the athletic field at Marymount School in Manhattan, NY prior to redevelopment of the field. For this project, Mr. Puoplo performed the phase II subsurface investigation, which included soil boring oversight and logging, temporary monitoring well development, sampling, and subsequent abandonment, and installation and sampling of temporary soil vapor monitoring points.

Lori A. Beyer

SUMMARY: General Manager/Laboratory Director with a solid technical background combined with Management experience in environmental testing industry. Outstanding organizational, leadership, communication and technical skills. Customer focused, quality oriented professional with consistently high marks in customer/employee satisfaction.

EXPERIENCE:

1998-Present L.A.B. Validation Corporation, 14 West Point Drive, East Northport, NY
President

- Perform Data Validation activities relating to laboratory generated Organic and Inorganic Environmental Data.

1998-Present American Analytical Laboratories, LLC. 56 Toledo Street, Farmingdale, NY
Laboratory Director/Technical Director

- Plan, direct and control the operation, development and implementation of programs for the entire laboratory in order to meet AAL's financial and operational performance standards.
- Ensures that all operations are in compliance with AAL's QA manual and other appropriate regulatory requirements.
- Actively maintains a safe and healthy working environmental that is demanded by local laws/regulations.
- Monitors and manages group's performance with respect to data quality, on time delivery, safety, analyst development/goal achievement and any other key performance indices.
- Reviews work for accuracy and completeness prior to release of results to customers.

1996-1998 Nytest Environmental, Inc. (NEI) Port Washington, New York
General Manager

- Responsible for controlling the operation of an 18,000 square foot facility to meet NEI's financial and operational performance standards.
- Management of 65 FTEs including Sales and Operations
- Ensure that all operations are in compliance with NEI's QA procedures
- Ensures that productivity indicators, staffing levels and other cost factors are held within established guidelines
- Maintains a quantified model of laboratory's capacity and uses this model as the basis for controlling the flow of work into and through the lab so as to ensure that customer requirements and lab's revenue and contribution targets are achieved.

1994-1996 Nytest Environmental, Inc. (NEI) Port Washington, New York
Technical Project Manager

- Responsible for the coordination and implementation of environmental testing programs requirements between NEI and their customers
- Supervise Customer Service Department
- Assist in the development of major proposals
- Complete management of all Federal and State Contracts and assigned commercial contracts
- Provide technical assistance to the customer, including data validation and interpretation
- Review and implement Project specific QAPP's.

1995-1996 Nytest Environmental, Inc. (NEI) Port Washington, New York
Corporate QA/QC Officer

- Responsible for the implementation of QA practices as required in the NJDEP and EPA Contracts
- Primary contact for NJDEP QA/QC issues including SOP preparation, review and approval
- Responsible for review, verification and adherence to the Contract requirements and NEI QA Plan

1992-1994 Nytest Environmental, Inc. (NEI) Port Washington, New York
Data Review Manager

- Responsible for the accurate compilation, review and delivery of analytical data to the company's customers. Directly and effectively supervised a department of 22 personnel.
- Managed activities of the data processing software including method development, form creation, and production
- Implement new protocol requirements for report and data management formats
- Maintained control of data storage/archival areas as EPA/CLP document control officer

1987-1991 Nytest Environmental, Inc. (NEI) Port Washington, New York
Data Review Specialist

- Responsible for the review of GC, GC/MS, Metals and Wet Chemistry data in accordance with regulatory requirements
- Proficient with USEPA, NYSDEC, NJDEP and NEESA requirements
- Review data generated in accordance with SW846, NYSDEC ASP, EPA/CLP and 40 CFR Methodologies

1986-1987 Nytest Environmental, Inc (NEI) Port Washington, New York
GC/MS VOA Analyst

EDUCATION:

1982-1985 State University of New York at Stony Brook, New York; BS Biology/Biochemistry
1981-1982 University of Delaware; Biology/Chemistry
5/91 Rutgers University; Mass Spectral Data Interpretation Course, GC/MS Training
8/92 Westchester Community College; Organic Data Validation Course
9/93 Westchester Community College; Inorganic Data Validation Course

Form **W-9**
(Rev. December 2011)
Department of the Treasury
Internal Revenue Service

Request for Taxpayer Identification Number and Certification

Give Form to the requester. Do not send to the IRS.

Print or type
See **Specific Instructions** on page 2.

Name (as shown on your income tax return)
L.A.B VALIDATION CORP

Business name/disregarded entity name, if different from above

Check appropriate box for federal tax classification:
☐ Individual/sole proprietor ☐ C Corporation ☒ S Corporation ☐ Partnership ☐ Trust/estate

☐ Limited liability company. Enter the tax classification (C=C corporation, S=S corporation, P=partnership) ▶

☐ Other (see instructions) ▶

☐ Exempt payee

Address (number, street, and apt. or suite no.)
14 WEST POINT DRIVE

City, state, and ZIP code
EAST NORTHPORT, New York 11731

Requester's name and address (optional)

List account number(s) here (optional)

Part I Taxpayer Identification Number (TIN)

Enter your TIN in the appropriate box. The TIN provided must match the name given on the "Name" line to avoid backup withholding. For individuals, this is your social security number (SSN). However, for a resident alien, sole proprietor, or disregarded entity, see the Part I instructions on page 3. For other entities, it is your employer identification number (EIN). If you do not have a number, see *How to get a TIN* on page 3.

Note. If the account is in more than one name, see the chart on page 4 for guidelines on whose number to enter.

Social security number
☐☐☐ - ☐☐ - ☐☐☐☐

Employer identification number
58 - 2381714

Part II Certification

Under penalties of perjury, I certify that:

1. The number shown on this form is my correct taxpayer identification number (or I am waiting for a number to be issued to me), and
2. I am not subject to backup withholding because: (a) I am exempt from backup withholding, or (b) I have not been notified by the Internal Revenue Service (IRS) that I am subject to backup withholding as a result of a failure to report all interest or dividends, or (c) the IRS has notified me that I am no longer subject to backup withholding, and
3. I am a U.S. citizen or other U.S. person (defined below).

Certification instructions. You must cross out item 2 above if you have been notified by the IRS that you are currently subject to backup withholding because you have failed to report all interest and dividends on your tax return. For real estate transactions, item 2 does not apply. For mortgage interest paid, acquisition or abandonment of secured property, cancellation of debt, contributions to an individual retirement arrangement (IRA), and generally, payments other than interest and dividends, you are not required to sign the certification, but you must provide your correct TIN. See the instructions on page 4.

Sign Here Signature of U.S. person ▶ Lori A. Berger Date ▶ 01/18/13

General Instructions

Section references are to the Internal Revenue Code unless otherwise noted.

Purpose of Form

A person who is required to file an information return with the IRS must obtain your correct taxpayer identification number (TIN) to report, for example, income paid to you, real estate transactions, mortgage interest you paid, acquisition or abandonment of secured property, cancellation of debt, or contributions you made to an IRA.

Use Form W-9 only if you are a U.S. person (including a resident alien), to provide your correct TIN to the person requesting it (the requester) and, when applicable, to:

1. Certify that the TIN you are giving is correct (or you are waiting for a number to be issued),

2. Certify that you are not subject to backup withholding, or

3. Claim exemption from backup withholding if you are a U.S. exempt payee. If applicable, you are also certifying that as a U.S. person, your allocable share of any partnership income from a U.S. trade or business is not subject to the withholding tax on foreign partners' share of effectively connected income.

Note. If a requester gives you a form other than Form W-9 to request your TIN, you must use the requester's form if it is substantially similar to this Form W-9.

Definition of a U.S. person. For federal tax purposes, you are considered a U.S. person if you are:

- An individual who is a U.S. citizen or U.S. resident alien,
- A partnership, corporation, company, or association created or organized in the United States or under the laws of the United States,
- An estate (other than a foreign estate), or
- A domestic trust (as defined in Regulations section 301.7701-7).

Special rules for partnerships. Partnerships that conduct a trade or business in the United States are generally required to pay a withholding tax on any foreign partners' share of income from such business. Further, in certain cases where a Form W-9 has not been received, a partnership is required to presume that a partner is a foreign person, and pay the withholding tax. Therefore, if you are a U.S. person that is a partner in a partnership conducting a trade or business in the United States, provide Form W-9 to the partnership to establish your U.S. status and avoid withholding on your share of partnership income.

Westchester Community College
Professional Development Center

Awards this Certificate of Achievement To

LORI BEYER

for Successfully Completing

ORGANIC DATA VALIDATION COURSE (35 HOURS)

Dr. John Samuelian

Date AUGUST 1992

Assistant Dean
Professional Development Center

President

The Professional
Development Center

SUNY
WESTCHESTER COMMUNITY COLLEGE
Valhalla, New York 10595

Westchester Community College
Professional Development Center

Awards this Certificate of Achievement To

LORI BEYER

for Successfully Completing

INORGANIC DATA VALIDATION

Instructor: Dale Boshart

Date MARCH 1993

Assistant Dean
Professional Development Center

President

The Professional
Development Center

SUNY
WESTCHESTER COMMUNITY COLLEGE
Valhalla, New York 10595

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233

Thomas C. Jorling
Commissioner

July 8, 1992

Ms. Elaine Sall
Program Coordinator
Westchester Community College
Valhalla, NY 10595-1698

Dear Elaine,

Thank you for your letter of June 29, 1992. I have reviewed the course outline for organic data validation, qualifications for teachers and qualifications for students. The course that you propose to offer would be deemed equivalent to that which is offered by EPA. The individuals who successfully complete the course and pass the final written exam would be acceptable to perform the task of organic data validation for the Department of Environmental Conservation, Division of Hazardous Waste Remediation.

As we have discussed in our conversation of July 7, 1992, you will forward to me prior to the August course deadline, the differences between the EPA SOW/90 and the NYSDEC ASP 12/91. You stated these differences will be compiled by Mr. John Samulian.

I strongly encourage you to offer an inorganic data validation course. I anticipate the same list of candidates would be interested in an inorganic validation course as well, since most of the data to be validated consists of both organic and inorganic data.

Thank you for you efforts and please contact me if I can be of any further assistance.

Sincerely,

Maureen P. Serafini

Maureen P. Serafini
Environmental Chemist II
Division of Hazardous Waste
Remediation

The Professional Development Center
AT
WESTCHESTER COMMUNITY COLLEGE

914 285-6619

October 2, 1992

Ms. Lori Beyer
3 sparkill Drive
East Northport, NY 11731

Dear Ms. Beyer:

Congratulations upon successful completion of the Organic Data Validation course held August 17 - 21, 1992, through Westchester Community College, Professional Development Center. This course has been deemed by New York State Department of Environmental Conservation as equivalent to EPA's Organic Data Validation Course.

Enclosed is your Certificate. Holders of this Certificate are deemed competent to perform organic data validation for the New York State DEC Division of Hazardous Waste Remediation.

The Professional Development Center at Westchester Community College plans to continue to offer courses and seminars which will be valuable to environmental engineers, chemists and related personnel. Current plans include a TCLP seminar on November 17th and a conference on Environmental Monitoring Regulations on November 18th.

We look forward to seeing you again soon at another environmental program or event. Again, congratulations.

Very truly yours,

Passing Grade is 70%
Your Grade is 99%

Elaine Sall
Program Coordinator

ES/bf

SUNY
WESTCHESTER COMMUNITY COLLEGE
Valhalla, New York 10595

The Professional Development Center
AT
WESTCHESTER COMMUNITY COLLEGE

914 285-6619

June 21, 1993

Dear Ms. Beyer:

Enclosed is your graded final examination in the Inorganic Data Validation course you completed this past March. A score of 70% was required in order to receive a certificate of satisfactory completion. Persons holding this certificate are deemed acceptable to perform Inorganic Data Validation for the New York State Department of Environmental Conservation, Division of Hazardous Waste Remediation.

I am also enclosing a course evaluation for you to complete if you have not already done so. The information you provide will greatly aid us in structuring further courses. We wish to make these course offerings as relevant, targeted and comprehensive as possible. Your evaluation is vital to that end.

Congratulations on your achievement. I look forward to seeing you again at another professional conference or course. We will be co-sponsoring an environmental monitoring conference on October 21, 1993 with the New York Water Pollution Control Association, Lower Hudson Chapter, at IBM's Yorktown Heights, NY site. Information regarding this event will be going out in August.

Very truly yours,

Elaine Sall

Elaine Sall
Program Coordinator

ES/bf

Enclosures

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Personnel Resume

Carl Armbruster
QA Manager

Qualifications Summary

Mr. Armbruster has over 30 years of experience in the environmental laboratory and engineering industry that includes extensive technical, management/leadership experience in all aspects of the laboratory business. He is an action-oriented manager dedicated to ensuring the laboratory maintains a quality program that holds the highest credentials in PT scores, accreditations and customer satisfaction. His unique experience lends itself to working successfully with employees, managers and clients at all levels.

Professional Experience

Quality Assurance Manager – TestAmerica Edison - 2005 to Present

Mr. Armbruster is responsible for establishing and implementing the quality assurance program at the Edison facility; and for interfacing with the corporate Quality Assurance Director to ensure adherence with the overall Quality Management Plan. He is also responsible for monitoring implementation and compliance with NELAC and TestAmerica's QMP, conducting annual management system audits and data audits, as well as providing regulatory updates and technical support to the Laboratory Director, Operations Manager, Client Services and Sales department.

Project Manager/Assistant Technical Director – STL Edison --2000 to 2005

Laboratory Director − STL Whippany − 1998 to 2000

Account Manager − Clean Harbors Environmental Services − 1997 to 1998

Laboratory Manager − Waste Management Inc., and Chemical Waste Management Inc − 1988 to 1997

Environmental Scientist − ICF Technology − 1987 to 1988

Analytical Chemist − IT Corporation – 1985 to 1987

Analytical Chemist − Hess Environmental Laboratories – 1983 to 1985

Education

- MS in Biology – East Stroudsburg University, 1984
- BS in Environmental Studies - East Stroudsburg University, 1980

APPENDIX B
LABORATORY SOP FOR ANALYSES OF EMERGING CONTAMINANTS

PFAS Sampling Instructions for SDWA (Drinking Water) Compliance for EPA Method 537

Please read instructions entirely prior to sampling event.

It should be noted that there is considerable information available from the US EPA as well as a multitude of state regulatory agencies regarding the potential for PFAS cross-contamination during sampling. It is recommended that samplers consult the applicable regulatory guidance prior to sampling. The following instructions are drawn from "METHOD 537, Version 1.1, September 2009, EPA Document #: EPA/600/R-08/092".

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.

Each sample requires a set of containers to comply with the method as indicated below.

Container Count	Container Type	Preservative
2 Sampling Containers - Empty	275 mL container	Pre preserved with Trizma
Reagent Water for Field Blank use	275 mL container	Pre preserved with Trizma
1 Field Blank (FRB) Container - Empty	275 mL container	Unpreserved

**** Sampling container must be filled to the neck. For instructional purposes a black line has been drawn to illustrate the required fill level for each of the 2 Sample containers****

The Field blank**, for SDWA compliant samples only, must be included and handled** with each sample set at the sampling location. A sample set consists of samples collected from the same site at the same time.

Field Blank Instructions:

1. Locate the Reagent Water container from the bottle order. The Reagent Water container is prefilled with PFAS-free water and preserved with Trizma.
2. Locate the empty container labeled "Field Blank".
3. Open both containers and proceed to transfer contents of the "Reagent Water" container into the "Field Blank" container.

Both the empty Reagent Water container and the filled Field Blank container must be returned to the laboratory along with the samples taken.

Sampling Instructions:

1. Each sampling event requires 2 containers to be filled to the neck of the provided containers for each sampling location.
2. Before sampling, remove faucet aerator, run water for 5 min, slow water to flow of pencil to avoid splashing and fill sample containers to neck of container (as previously illustrated) and invert 5 times.
3. Do not overfill or rinse the container.
4. Close containers securely.
5. Ensure Chain-of-Custody and all labels on containers contain required information.
   Place sample, Field Blank and empty Reagent Blank containers in ice filled cooler and return to the laboratory. Samples should be kept at 4°C ±2. Samples must not exceed 10°C during first 48 hours after collection. Hold time is 14 days.

Please contact your project manager with additional questions or concerns.

Preparation of Selected Perfluorinated Alkyl Substances in Aqueous Phase by Solid Phase Extraction for Analysis via Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS)

Reference: EPA Method 537, Version 1.1, September 2009, EPA Document #: EPA/600/R-08/092

Department of Defense, Quality Systems Manual for Environmental Laboratories, Version 5.1, 2017

1. Scope and Application

Matrices: Matrices: Non-potable water, Soil

Definitions: Refer to Alpha Analytical Quality Manual.

1.1 This is a sample preparation method for the determination of selected perfluorinated alkyl substances (PFASs) in aqueous matrices Accuracy and precision data have been generated in reagent water, and finished ground and surface waters for the compounds listed in Alpha SOP# 23528 for 537-Isotope Dilution and SOP# 23511 for 537 standard analysis.

1.2 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.

1.3 This method is restricted to use by or under the supervision of analysts experienced in the operation of the necessary preparatory equipment. 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 A 250-mL water sample is fortified with surrogates and passed through a solid phase extraction (SPE) cartridge containing polystyrenedivinylbenzene (SDVB) to extract the method analytes and surrogates. The compounds are eluted from the solid phase with a small amount of methanol. The extract is concentrated to dryness with nitrogen in a heated water bath, and then adjusted to a 1-mL volume with 96:4% (vol/vol) methanol:water after adding the IS(s). A 3-µL injection is made 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 internal standard technique. Surrogate analytes are added to all Field and QC Samples to monitor the extraction efficiency of the method analytes.

2.2 Method Modifications from Reference

2.2.1 Section 10.3 modified for the implementation of non-portable water matrices.

3. Reporting Limits

Refer to analytical SOP for 537 analysis: SOP# 23511 for 537 standard analysis.

4. Interferences

4.1 All glassware must be meticulously cleaned. Wash glassware with detergent and tap water, rinse with tap water, followed by a reagent water rinse. Non-volumetric glassware can be heated in a muffle furnace at 400 °C for 2 hours or solvent rinsed. Volumetric glassware should be solvent rinsed and not be heated in an oven above 120 °C. Store clean glassware inverted or capped. Do not cover with aluminum foil because PFASs can be potentially transferred from the aluminum foil to the glassware.

4.1.1 **NOTE:** 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, IS and SUR 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 1/3 the RL for each method analyte) under the conditions of the analysis by analyzing laboratory reagent blanks as described in Section 9.2. **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. Under the LC conditions used during method development, matrix effects due to total organic carbon (TOC) were not observed.

4.4 Relatively large quantities of the preservative (Sect. 6.2.1) are added to sample bottles. The potential exists for trace-level organic contaminants in these reagents. Interferences from these sources should be monitored by analysis of laboratory reagent blanks (Sect. 9.2.1), particularly when new lots of reagents are acquired.

4.5 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

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.

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

6.1.1 Samples must be collected in three (3) 250-mL polypropylene bottles fitted with a polypropylene screw-cap.

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, taking care not to flush out the sample preservation reagent. Samples do not need to be collected headspace free.

6.1.5 After collecting the sample, cap the bottle and agitate by hand until preservative is dissolved. Keep the sample sealed from time of collection until extraction.

6.1.6 Field Reagent Blank (FRB)

6.1.6.1 A FRB must be handled along with each sample set. The sample set is composed of samples collected from the same sample site and at the same time. At the laboratory, fill the field blank sample bottle with reagent water and preservatives, seal, and ship to the sampling site along with the sample bottles. For each FRB shipped, an empty sample bottle (no preservatives) must also be shipped. At the sampling site, the sampler must open the shipped FRB and pour the preserved reagent water into the empty shipped sample bottle, seal and label this bottle as the FRB. The FRB is shipped back to the laboratory along with the samples and analyzed to ensure that PFASs were not introduced into the sample during sample collection/handling.

6.1.6.2 The same batch of preservative must be used for the FRBs as for the field samples.

6.1.6.3 The reagent water used for the FRBs must be initially analyzed for method analytes as a MB and must meet the MB criteria in Section 9.2.1 prior to use. This requirement will ensure samples are not being discarded due to contaminated reagent water rather than contamination during sampling.

6.2 Sample Preservation

6.2.1 For drinking water samples, the preservation reagent, listed in the table below, is added to each sample bottle as a solid prior to shipment to the field (or prior to sample collection).

Table 2

Compound	Amount	Purpose
Trizma	5.0 g/l	Buffering reagent and removes free chlorine

6.3 Sample Shipping

6.3.1 Samples must be chilled during shipment and must not exceed 10 °C during the first 48 hours after collection. Sample temperature must be confirmed to be at or below 10 °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 10° 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.

6.4 Sample Handling

6.4.1 Holding Times-Water samples should be extracted as soon as possible but must be extracted within 14 days. Extracts are stored at <10° C and analyzed within 28 days after extraction.

7. Equipment and Supplies

7.1 **SAMPLE CONTAINERS** – 250-mL polypropylene bottles fitted with polypropylene screw caps. Sample bottles must be discarded after use.

7.2 **POLYPROPYLENE BOTTLES** – 4-mL narrow-mouth polypropylene bottles.

7.3 **CENTRIFUGE TUBES** – 15-mL conical polypropylene tubes with polypropylene screw caps for storing standard solutions and for collection of the extracts.

7.4 **AUTOSAMPLER VIALS –** Polypropylene 0.3-mL autosampler vials with polypropylene caps.

7.4.1 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.

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

7.6 **AUTO PIPETS** – Suggested sizes include 5, 10, 25, 50, 100, 250, 500 and 1000-µL syringes.

7.7 **PLASTIC PIPETS** – Polypropylene or polyethylene disposable pipets.

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

7.9 **SOLID PHASE EXTRACTION (SPE) APPARATUS FOR USING CARTRIDGES**

7.9.1 **SPE CARTRIDGES** – 1g, 25-mL SPE cartridges containing styrenedivinylbenzene (SDVB) sorbent phase.

7.9.2 SPE CARTRIDGES – 500mg, 6-mL SPE cartridges containing graphitized polymer carbon

7.9.3 VACUUM EXTRACTION MANIFOLD – A manual vacuum manifold with Visiprep 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 (Sect. 9.2.1).

7.9.4 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 (Sect. 9.2.1) and LCS (Sect. 9.3) QC requirements. The PTFE transfer tubes may be used, but an MB must be run on each PFTE transfer tube and the QC requirements in Section 13.2.2 must be met. In the case of automated SPE, the removal of PTFE lines may not be feasible; therefore, MBs will need to be rotated among the ports and must meet the QC requirements of Sections 13.2.2 and 9.2.1.

7.10 EXTRACT CONCENTRATION SYSTEM – Extracts are concentrated by evaporation with nitrogen using a water bath set no higher than 65 °C.

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

8. Reagents and Standards

8.1 GASES, REAGENTS, AND SOLVENTS – Reagent grade or better chemicals should 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 1/3 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 20 mM AMMONIUM ACETATE/REAGENT WATER – To prepare 1 L, add 1.54 g ammonium acetate to 1 L of reagent water. This solution is prone to volatility losses and should be replaced at least every 48 hours.

8.1.5 TRIZMA PRESET CRYSTALS, pH 7.0 – Reagent grade. A premixed blend of Tris [Tris(hydroxymethyl)aminomethane] and Tris HCL [Tris(hydroxymethyl)aminomethane hydrochloride]. Alternatively, a mix of the two components with a weight ratio of 15.5/1 Tris HCL/Tris may be used. These blends are targeted to produce a pH near 7.0 at 25 °C in reagent water. Trizma functions as a buffer, and removes free chlorine in chlorinated finished waters (Sect. 6.2.1).

8.1.6 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).

8.2 STANDARD SOLUTIONS

8.2 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, IS and SUR 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. 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.

NOTE: Stock standards (Sect. 8.2.1, 8.2.3 and 8.2.5) are stored at ≤4 °C. Primary dilution standards (Sect. 8.2.2 and 8.2.4) are stored at room temperature to prevent adsorption of the method analytes onto the container surfaces that may occur when refrigerated. Storing the standards at room temperature will also minimize daily imprecision due to the potential of inadequate room temperature stabilization.

8.2.1 IS STOCK STANDARD SOLUTIONS - IS stock standard solutions are stable for at least 6 months when stored at 4 °C. The stock solution is purchased at a concentration range of 1-4 ng/µl.

8.2.2 INTERNAL STANDARD PRIMARY DILUTION (IS PDS) STANDARD (0.5-2 ng/µL) – Prepare the IS PDS at a concentration of 0.5-2 ng/µL. The IS PDS is prepared in 96:4% (vol/vol) methanol:water. The IS PDS is stable for at least two months when stored in polypropylene centrifuge tubes at room temperature.

Table 3

Internal Standard	Conc. of IS Stock (ng/uL)	Vol. of IS Stock (mL)	Final Vol. of IS PDS (mL)	Final Conc. of IS PDS (ng/µL)
^{13}C-PFOA	1	1.0	2.0	0.5
^{13}C-PFOS	3	1.0	2.0	1.5
D_3-NMeFOSAA	4	1.0	2.0	2.0

8.2.3 SUR STOCK STANDARD SOLUTIONS – SUR stock standard solutions are stable for at least 6 months when stored at 4 °C.

8.2.4 SURROGATE PRIMARY DILUTION STANDARD (SUR PDS) (0.5-2 ng/µL) – Prepare the SUR PDS at a concentration of 0.5-2 ng/µL. The SUR PDS is prepared in 96:4% (vol/vol) methanol:water. This solution is used to fortify all QC and Field Samples. The PDS is stable for one year when stored in polypropylene centrifuge tubes at room temperature.

Table 4

Surrogate	Conc. of SUR Stock (ng/µL)	Vol. of SUR Stock (mL)	Final Vol. of SUR PDS (,L)	Final Conc. of SUR PDS (ng/µL)
^{13}C-PFHxA	1.0	1.0	2.0	0.5
^{13}C-PFDA	1.0	1.0	2.0	0.5
d_5-NEtFOSAA	4.0	1.0	2.0	2.0

8.2.5 **ANALYTE STOCK STANDARD SOLUTION** – Analyte stock standards are stable for at least 6 months when stored at -15 °C. When using these stock standards to prepare a PDS, care must be taken to ensure that these standards are at room temperature and adequately vortexed.

Table 5

Analyte	Analyte Stock Solvent	Concentration (ug/mL)
PFHxA	100% methanol	1.0
PFHpA	100% methanol	1.0
PFOA	100% methanol	1.0
PFNA	100% methanol	1.0
PFDA	100% methanol	1.0
PFUnA	100% methanol	1.0
PFDoA	100% methanol	1.0
PFTrDA	100% methanol	1.0
PFTA	100% methanol	1.0
PFBS	100% methanol	1.0
PFHxS	100% methanol	1.0
PFOS	100% methanol	1.0
NEtFOSAA	100% methanol	1.0
NMeFOSAA	100% methanol	1.0

8.2.6 **LOW, MEDIUM AND HIGH LEVEL LCS** – The LCS's will be prepared at the following concentrations and rotated per batch; 2 ng/L, 40 ng/L, 500 ng/l. The analyte PDS contains all the method analytes of interest at various concentrations in methanol containing 4% water. The analyte PDS has been shown to be stable for 6 months when stored at room temperature.

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.

9.1 REPORTING LIMIT (RL) CONFIRMATION

9.1.1 Fortify, extract, and analyze seven replicate LCSs at 2 ng/l. These LCSs must contain all method preservatives described in Section 6.2.1. Calculate the mean measured concentration (Mean) and standard deviation for these replicates. Determine the Half Range for the prediction interval of results (HRPIR) using the equation below

$$HR_{PIR} = 3.963s$$

Where:

s = the standard deviation

3.963 = a constant value for seven replicates.

9.1.2 Confirm that the upper and lower limits for the Prediction Interval of Result (PIR = Mean ± HR_{PIR}) meet the upper and lower recovery limits as shown below

The Upper PIR Limit must be ≤150% recovery.

$$\frac{\text{Mean} + \text{HR}_{\text{PIR}}}{\text{Fortified Concentration}} \times 100\% \leq 150\%$$

The Lower PIR Limit must be ≥ 50% recovery.

$$\frac{\text{Mean} - \text{HR}_{\text{PIR}}}{\text{Fortified Concentration}} \times 100\% \geq 50\%$$

9.1.3 The RL is validated if both the Upper and Lower PIR Limits meet the criteria described above. If these criteria are not met, the RL has been set too low and must be determined again at a higher concentration.

9.2 Blank(s)

9.2.1 METHOD BLANK (MB) - 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. If more than 20 Field Samples are included in a batch, analyze an 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 1/3 of the RL. Blank contamination is estimated by extrapolation, if the concentration is below the lowest CAL standard. This extrapolation procedure is not allowed for sample results as it may not meet data quality objectives. 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. Because background contamination is a significant problem for several method analytes, it is highly recommended that the analyst maintain a historical record of MB data.

9.2.2 FIELD REAGENT BLANK (FRB) - The purpose of the FRB is to ensure that PFASs measured in the Field Samples were not inadvertently introduced into the sample during sample collection/handling. Analysis of the FRB is required only if a Field Sample contains a method analyte or analytes at or above the RL. The FRB is processed, extracted and analyzed in exactly the same manner as a Field Sample. If the method analyte(s) found in the Field Sample is present in the FRB at a concentration greater than 1/3 the RL, then all samples collected with that FRB are invalid and must be recollected and reanalyzed.

9.3 Laboratory Control Sample (LCS)

9.3.1 An LCS is required with each extraction batch. The fortified concentration of the LCS must be rotated between low, medium, and high concentrations from batch to batch.

9.3.2 The low concentration LCS must be as near as practical to, but no more than two times, the RL. Similarly, the high concentration LCS should be near the high end of the calibration range established during the initial calibration (Sect. 10.6 of SOP #23511).

9.3.3 Results of the low-level LCS analyses must be 50-150% of the true value. Results of the medium and high-level LCS analyses must be 70-130% of the true value. If the LCS 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.

9.3.4 It is the responsibility of the extraction chemist to view the previous extraction batch to determine the next spiking concentration. (Low → Medium → High)

9.4 Initial Calibration Verification (ICV)

Not Applicable

9.5 Continuing Calibration Verification (CCV)

Not Applicable

9.6 Matrix Spike

9.6.1 Analysis of an MS is required in each extraction batch and is used to determine that the sample matrix does not adversely affect method accuracy. Assessment of method precision is accomplished by analysis of a Field Duplicate (FD) (Sect. 9.7); however, infrequent occurrence of method analytes would hinder this assessment. If the occurrence of method analytes in the samples is infrequent, or if historical trends are unavailable, a second MS, or MSD, must be prepared, extracted, and analyzed from a duplicate of the Field Sample. Extraction batches that contain MSDs will not require the extraction of a field sample duplicate. If a variety of different sample matrices are analyzed regularly, for example, drinking water from groundwater and surface water sources, method performance should be established for each. Over time, MS data should be documented by the laboratory for all routine sample sources.

9.6.2 Within each extraction batch, a minimum of one Field Sample is fortified as an MS for every 20 Field Samples analyzed. The MS is prepared by spiking a sample with an appropriate amount of the Analyte Stock Standard (Sect. 8.2.5). Use historical data and rotate through the low, mid and high concentrations when selecting a fortifying concentration.

9.6.3 Analyte recoveries may exhibit matrix bias. For samples fortified at or above their native concentration, recoveries should range between 70-130%, except for lowlevel fortification near or at the RL (within a factor of 2-times the RL concentration) where 50-150% recoveries are acceptable. 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 CCVs, 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.

9.7 Laboratory Duplicate

9.7.1 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

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

9.7.3 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 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.

9.8 Method-specific Quality Control Samples

Not applicable

9.9 Method Sequence

MB

LCS

LCSD

MS

Duplicate or MSD

Field Samples (1-10)

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 (Sect. 9.2).

10.1.2 Some of the PFASs adsorb to surfaces, including polypropylene. Therefore, the aqueous sample bottles must be rinsed with the elution solvent (Sect 10.3.4) 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 (Sect. 10.3.4).

10.1.3 **NOTE:** 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.

10.2 Sample Preparation

10.2.1 Samples are preserved, collected and stored as presented in Section 6. All Field and QC Samples, including the MB, LCS and FRB, must contain the dechlorinating agent listed in Section 6.2.1. Determine sample volume. An indirect measurement may be done in one of two ways: by marking the level of the sample on the bottle or by weighing the sample and bottle to the nearest 10 g. After extraction, proceed to Section 10.5 for final volume determination. Some of the PFASs adsorb to surfaces, thus the sample volume may **NOT** be transferred to a graduated cylinder for volume measurement. The MB, LCS and FRB may be prepared by measuring 250 mL of reagent water with a polypropylene graduated cylinder or filling a 250-mL sample bottle to near the top.

10.2.2 Add 20 µL of the SUR PDS (Sect. 8.2.4) to each sample, cap and invert to mix for a final concentration of 10 ng/L for ^{13}C-PFHxA and ^{13}C-PFDA and 40 ng/L for d_5-NEtFOSAA.

10.2.3 In addition to the SUR(s) and dechlorination agent, if the sample is an LCS, MS, or MSD, add the necessary amount of analyte PDS (Sect. 8.2.5). Cap and invert each sample to mix.

10.3 Cartridge SPE Procedure

10.3.1 **CARTRIDGE CLEAN-UP AND CONDITIONING** – DO NOT allow cartridge packing material to go dry during any of the conditioning steps. Rinse each cartridge with 15 mL of methanol. Next, rinse each cartridge with 18 mL of reagent water, without allowing the water to drop below the top edge of the packing. If the cartridge goes dry during the conditioning phase, the conditioning must be started over. Add 4-5 mL of reagent water to each cartridge, attach the sample transfer tubes (Sect. 7.2.3), turn on the vacuum, and begin adding sample to the cartridge.

10.3.2 **SAMPLE EXTRACTON** – Adjust the vacuum so that the approximate flow rate is 10-15 mL/min. Do not allow the cartridge to go dry before all the sample has passed through.

10.3.3 **SAMPLE BOTTLE AND CARTRIDGE RINSE** – After the entire sample has passed through the cartridge, rinse the sample bottles with two 7.5-mL aliquots of reagent water and draw each aliquot through the sample transfer tubes and the cartridges. Draw air or nitrogen through the cartridge for 5 min at high vacuum (10-15 in. Hg).

NOTE: If empty plastic reservoirs are used in place of the sample transfer tubes to pass the samples through the cartridges, these reservoirs must be treated like the transfer tubes. After the entire sample has passed through the cartridge, the reservoirs must be rinsed to waste with reagent water.

10.3.4 **CLEAN-UP CARTRIDGE CONDITION** – Rinse each cartridge with 15 ml of methanol, drawing all methanol from the cartridge.

10.3.5 **SAMPLE BOTTLE AND CARTRIDGE ELUTION** – Turn off and release the vacuum. Lift the extraction manifold top and insert a rack with collection tubes into the extraction tank to collect the extracts as they are eluted from the cartridges. Remove the extraction cartridge and insert the clean-up cartridge into the manifold with the extraction cartridge stacked ontop. Rinse the sample bottles with 4 mL of methanol and elute the analytes from the inline cartridges by pulling the 4 mL of methanol through the sample transfer tubes and the cartridges. Use a low vacuum such that the solvent exits the cartridge in a dropwise fashion. Repeat sample bottle rinse and cartridge elution with a two more 4-mL aliquots of methanol.

NOTE: If empty plastic reservoirs are used in place of the sample transfer tubes to pass the samples through the cartridges, these reservoirs must be treated like the transfer tubes. After the reservoirs have been rinsed in Section 10.3.3, the elution solvent used to rinse the sample bottles must be swirled down the sides of the reservoirs while eluting the cartridge to ensure that any method analytes on the surface of the reservoirs are transferred to the extract.

10.4 Extract Concentration

10.4.1 Concentrate the extract to dryness under a gentle stream of nitrogen in a heated water bath (60-65 °C) to remove all the water/methanol mix. Add the appropriate amount of 96:4% (vol/vol) methanol:water solution and the IS PDS (Sect. 8.2.2) to the collection vial to bring the volume to 1 mL and vortex. Transfer a small aliquot with a plastic pipet (Sect. 7.6) to a polypropylene autosampler vial.

NOTE: It is recommended that the entire 1-mL aliquot not be transferred to the autosampler vial because the polypropylene autosampler caps do not reseal after injection. Therefore, do not store the extracts in the autosampler vials as evaporation losses can occur occasionally in these autosampler vials. Extracts can be stored in 15-mL centrifuge tubes (Sect. 7.3).

10.5 Sample Volume Determination

10.5.1 If the level of the sample was marked on the sample bottle, use a graduated cylinder to measure the volume of water required to fill the original sample bottle to the mark made prior to extraction. Determine to the nearest 10 mL. If using weight to determine volume, weigh the empty bottle to the nearest 10 g and determine the sample weight by subtraction of the empty bottle weight from the original sample weight (Sect. 10.2.1). 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 (Sect. 11.2).

10.6 Preventive Maintenance

Not applicable

11. Data Evaluation, Calculations and Reporting

Not applicable

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

Refer to Analytical SOPs: SOP ID 23528 537-Isotope Dilution, SOP ID 23511 for 537 Standard.

13. Method Performance

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

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

Refer to Alpha SOP ID 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

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

SOP ID 2124 Chemical Hygiene Plan – SOP 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

SOP ID 23528 537-Isotope Dilution

SOP ID 23511 for 537 Standard.

16. Attachments

None.

Determination of Selected Perfluorinated Alkyl Substances by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry Isotope Dilution (LC/MS/MS)

Reference: EPA Method 537, Version 1.1, September 2009, EPA Document #: EPA/600/R-08/09

EPA Method 537.1, Version 1, November 2018, EPA Document #: EPA/600/R-18/352

Department of Defense, Quality Systems Manual for Environmental Laboratories, Version 5.2, .2019

1. Scope and Application

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

Definitions: Refer to Alpha Analytical Quality Manual.

1.1 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 and soil Matrices. Accuracy and precision data have been generated in reagent water, and finished ground and surface waters for the compounds listed in Table 1.

1.2 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.

1.3 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 A 250-mL water sample is fortified with extracted internal standards (EIS) and passed through a solid phase extraction (WAX) cartridge containing a mixed mode, Weak Anion Exchange, reversed phase, water-wettable polymer to extract the method analytes and isotopically-labeled compounds. The compounds are eluted from the solid phase in two fractions with methanol followed by a small amount of 2% ammonium hydroxide in methanol solution. The extract is concentrated with nitrogen in a heated water bath, and then adjusted to a 1-mL volume with 80:20% (vol/vol) methanol:water. A 3 µl injection is made 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.

2.2 Method Modifications from Reference

None.

Table 1

Parameter	Acronym	CAS
PERFLUOROALKYL ETHER CARBOXYLIC ACIDS (PFECAs)		
Tetrafluoro-2-(heptafluoropropoxy)propanoic acid	HFPO-DA	62037-80-3
4,8-dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4
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
Perfluorotetradecanoic acid	PFTA *	376-06-7
Perfluorohexadecanoic acid	PFHxDA	67905-19-5
Perfluorooctadecanoic acid	PFODA	16517-11-6
PERFLUOROALKYLSULFONATES (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

*** also reportable via the standard 537 method**

Table 1 Cont.

Parameter	Acronym	CAS
CHLORO-PERFLUOROALKYLSULFONATE		
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid	9Cl-PF3ONS	756426-58-1
PERFLUOROOCTANESULFONAMIDES (FOSAs)		
Perfluorooctanesulfonamide	PFOSA	754-91-6
N-methylperfluoro-1-octanesulfonamide	NMeFOSA	31506-32-8
N-ethylperfluoro-1-octanesulfonamide	NEtFOSA	4151-50-2
TELOMER SULFONATES		
1H,1H,2H,2H-perfluorohexane sulfonate (4:2)	4:2FTS	27619-93-8
1H,1H,2H,2H-perfluorooctane sulfonate (6:2)	6:2FTS	27619-97-2
1H,1H,2H,2H-perfluorodecane sulfonate (8:2)	8:2FTS	39108-34-4
1H,1H,2H,2H-perfluorododecane sulfonate (10:2)	10:2FTS	120226-60-0
PERFLUOROOCTANESULFONAMIDOACETIC ACIDS		
N-methyl perfluorooctanesulfonamidoacetic acid	NMeFOSAA *	2355-31-9
N-ethyl perfluorooctanesulfonamidoacetic acid	NEtFOSAA *	2991-50-6
NATIVE PERFLUOROOCTANESULFONAMIDOETHANOLS (FOSEs)		
2-(N-methylperfluoro-1-octanesulfonamido)-ethanol	NMeFOSE	24448-09-7
2-(N-ethylperfluoro-1-octanesulfonamido)-ethanol	NEtFOSE	1691-99-2

*** also reportable via the standard 537 method**

3. Reporting Limits

The reporting limit for PFAS's is 2 ng/L for aqueous samples (20 ng/L for HFPO-DA) and 1 ng/g (10 ng/g for HFPO-DA) for soil samples.

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 1/3 the RL for each method analyte) under the conditions of the analysis by analyzing laboratory reagent blanks as described in Section 9.2. **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) 250-mL high density polyethylene (HDPE) container with an unlined plastic screw cap.

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 Field Reagent Blank (FRB)

6.1.6.1 A FRB must be handled along with each sample set. The sample set is composed of samples collected from the same sample site and at the same time. At the laboratory, fill the field blank sample bottle with reagent water and preservatives, seal, and ship to the sampling site along with the sample bottles. For each FRB shipped, an empty sample bottle (no preservatives) must also be shipped. At the sampling site, the sampler must open the shipped FRB and pour the reagent water into the empty shipped sample bottle, seal and label this bottle as the FRB. The FRB is shipped back to the laboratory along with the samples and analyzed to ensure that PFAS's were not introduced into the sample during sample collection/handling.

The reagent water used for the FRBs must be initially analyzed for method analytes as a MB and must meet the MB criteria in Section 9.2.1 prior to use. This requirement will ensure samples are not being discarded due to contaminated reagent water rather than contamination during sampling.

6.2 Sample Collection for Soil and Sediment samples.

Grab samples are collected in polypropylene containers. Sample containers and contact surfaces containing PTFE shall be avoided.

6.3 Sample Preservation

Not applicable.

6.4 Sample Shipping

Samples must be chilled during shipment and must not exceed 10 °C during the first 48 hours after collection. Sample temperature must be confirmed to be at or below 10 °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 10° 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.

6.5 Sample Handling

6.5.1 Holding Times

6.5.1.1 Water samples should be extracted as soon as possible but must be extracted within 14 days. Soil samples should be extracted within 28 days. Extracts are stored at < 10 ° C and analyzed within 28 days after extraction.

7. Equipment and Supplies

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

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

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

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

7.4.1 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.

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

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

7.7 PLASTIC PIPETS – Polypropylene or polyethylene disposable pipets.

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

7.9 SOLID PHASE EXTRACTION (SPE) APPARATUS FOR USING CARTRIDGES

7.9.1 SPE CARTRIDGES – 0.5 g SPE cartridges containing a reverse phase copolymer characterized by a weak anion exchanger (WAX) sorbent phase.

7.9.2 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 (Sect. 9.2.1).

7.9.3 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 (Sect. 9.2.1) and LCS (Sect. 9.3) QC requirements. The PTFE transfer tubes may be used, but an MB must be run on each PFTE transfer tube and the QC requirements in Section 13.2.2 must be met. In the case of automated SPE, the removal of PTFE lines may not be feasible; therefore, MBs will need to be rotated among the ports and must meet the QC requirements of Sections 13.2.2 and 9.2.1.

7.10 Extract Clean-up Cartridge – 250 mg 6ml SPE Cartridge containing graphitized polymer carbon

7.11 EXTRACT CONCENTRATION SYSTEM – Extracts are concentrated by evaporation with nitrogen using a water bath set no higher than 65 °C.

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

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

7.13.1 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.

NOTE: During the course of method development, it was discovered that while idle for more than one day, PFAS's built up in the PTFE solvent transfer lines. To prevent long delays in purging high levels of PFAS's from the LC solvent lines, they were replaced with PEEK tubing and the PTFE solvent frits were replaced with stainless steel frits. It is not possible to remove all PFAS background contamination, but these measures help to minimize their background levels.

7.13.2 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.

7.13.3 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.

7.13.4 ANALYTICAL COLUMN – An LC BEH C_{18} column (2.1 x 50 mm) packed with 1.7 µm d_p C_{18} solid phase particles was used. Any column that provides adequate resolution, peak shape, capacity, accuracy, and precision (Sect. 9) may be used.

8. Reagents and Standards

8.1 GASES, REAGENTS, AND SOLVENTS – Reagent grade or better chemicals should 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 1/3 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 Methanol/Water (80:20) – To prepare a 1 Liter bottle, mix 200 ml of REAGENT WATER with 800 ml of METHANOL.

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

8.1.9 Sodium Acetate ($NaOOCCH_3$, CAS#: 127-09-3) – High purity, demonstrated to be free of analytes and interferences.

8.1.10 25 mM Sodium Acetate Buffer – To prepare 250mls, dissolve .625 grams of sodium acetate into 100 mls of reagent water. Add 4 mls Acetic Acid and adjust the final volume to 250 mls with reagent water.

8.1.11 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).

8.1.12 ARGON – Used as collision gas in 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 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. 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.

NOTE: Stock standards and diluted stock standards are stored at ≤4 °C.

8.2.1 ISOTOPE DILUTION Extracted Internal Standard (ID EIS) STOCK SOLUTIONS - ID EIS stock standard solutions are stable for at least 6 months when stored at 4 °C. The stock solution is purchased at a concentration of 1000 ng/mL.

8.2.2 ISOTOPE DILUTION Extracted Internal Standard PRIMARY DILUTION STANDARD (ID EIS PDS) – Prepare the ID EIS PDS at a concentration of 500 ng/mL. The ID PDS is prepared in 80:20% (vol/vol) methanol:water. The ID PDS is stable for 6 months when stored at ≤4 °C.

Table 2

Isotope Labeled Standard	Conc. of EIS Stock (ng/mL)	Vol. of EIS Stock (mL)	Final Vol. of EIS PDS (mL)	Final Conc. of EIS PDS (ng/mL)
M4PFBA	1000	1.0	2.0	500
M5PFPeA	1000	1.0	2.0	500
M5PFHxA	1000	1.0	2.0	500
M4PFHpA	1000	1.0	2.0	500
M8PFOA	1000	1.0	2.0	500
M9PFNA	1000	1.0	2.0	500
M6PFDA	1000	1.0	2.0	500
M7PFUdA	1000	1.0	2.0	500
MPFDoA	1000	1.0	2.0	500
M2PFTeDA	1000	1.0	2.0	500
M2PFHxDA	50,000	.02	2.0	500
d3-N-MeFOSA	50,000	.02	2.0	500
d5-N-EtFOSA	50,000	.02	2.0	500
d7-N-MeFOSE	50,000	.02	2.0	500
d9-N-EtFOSE	50,000	.02	2.0	500
M8FOSA	1000	1.0	2.0	500
d3-N-MeFOSAA	1000	1.0	2.0	500
d5-N-EtFOSAA	1000	1.0	2.0	500
M3PFBS	929	1.0	2.0	464.5
M3PFHxS	946	1.0	2.0	473
M8PFOS	957	1.0	2.0	478.5
M2-4:2FTS	935	1.0	2.0	467.5
M2-6:2FTS	949	1.0	2.0	474.5
M2-8:2FTS	958	1.0	2.0	479
M3HFPO-DA	50,000	.4	2.0	10,000

8.2.3 ANALYTE STOCK STANDARD SOLUTION – Analyte stock standards are stable for at least 6 months when stored at 4 °C. When using these stock standards to prepare a PDS, care must be taken to ensure that these standards are at room temperature and adequately vortexed.

8.2.4 Analyte Secondary Spiking Standard Prepare the spiking solution of additional add on components for project specific requirements only. ANALYTE PRIMARY SPIKING STANDARD – Prepare the spiking standard at a concentration of 500 ng/mL in methanol. The spiking standard is stable for at least two months when stored in polypropylene centrifuge tubes at room temperature.

Table 3

Analyte	**Conc. of IS Stock (ng/mL)**	**Vol. of IS Stock (mL)**	**Final Vol. of IS PDS (mL)**	**Final Conc. of IS PDS (ng/mL)**
PFBA	2000	1	4	500
PFPeA	2000	1	4	500
PFHxA	2000	1	4	500
PFHpA	2000	1	4	500
PFOA	2000	1	4	500
PFNA	2000	1	4	500
PFDA	2000	1	4	500
PFUdA	2000	1	4	500
PFDoA	2000	1	4	500
PFTrDA	2000	1	4	500
PFTeDA	2000	1	4	500
FOSA	2000	1	4	500
N-MeFOSAA	2000	1	4	500
N-EtFOSAA	2000	1	4	500
L-PFBS	1770	1	4	442.5
L-PFPeS	1880	1	4	470
L-PFHxSK	1480	1	4	370
Br-PFHxSK	344	1	4	86
L-PFHpS	1900	1	4	475
L-PFOSK	1460	1	4	365
Br-PFOSK	391	1	4	97.75
L-PFNS	1920	1	4	480
L-PFDS	1930	1	4	482.5
4:2FTS	1870	1	4	467.5
6:2FTS	1900	1	4	475
8:2FTS	1920	1	4	480

8.2.5 Analyte Secondary Spiking Standard Prepare the spiking solution of additional add on components for project specific requirements only.

Table 4

Analyte	Conc. of IS Stock (ng/mL)	Vol. of IS Stock (mL)	Final Vol. of IS PDS (mL)	Final Conc. of IS PDS (ng/mL)
ADONA	2000	1	4	500
PFHxDA	2000	1	4	500
PFODA	2000	1	4	500
HFPO-DA	100,000	.4	4	10,000
9ClPF3ONS	50,000	0.04	4	500
11ClPF3OUdS	50,000	0.04	4	500

8.2.6 LOW, MEDIUM AND HIGH LEVEL LCS – The LCS's will be prepared at the following concentrations and rotated per batch; 2 ng/L, 40 ng/L, 500 ng/l for drinking waters. The analyte PDS contains all the method analytes of interest at various concentrations in methanol. The analyte PDS has been shown to be stable for six months when stored at ≤4 °C.

8.2.7 Isotope Dilution Labeled Recovery Stock Solutions (ID REC) – ID REC Stock solutions are stable for at least 6 months when stored at 4 °C. The stock solution is purchased at a concentration of 1000 ng/mL.

8.2.8 Isotope Dilution Labeled Recovery Primary Dilution Standard (ID REC PDS) - Prepare the ID REC PDS at a concentration of 500 ng/mL. The ID REC PDS is prepared in 80:20% (vol/vol) methanol:water. The ID REC PDS is stable for at least six months when stored in polypropylene centrifuge tubes at ≤4 °C.

Table 5

Analyte	Conc. of REC Stock (ng/mL)	Vol. of REC Stock (mL)	Final Vol. of REC PDS (mL)	Final Conc. of REC PDS (ng/mL)
M2PFOA	2000	1	4	500
M2PFDA	2000	1	4	500
M3PFBA	2000	1	4	500
M4PFOS	2000	1	4	500

8.2.9 CALIBRATION STANDARDS (CAL) –

Current Concentrations (ng/mL): 0.5, 1.0, 5.0, 10.0, 50.0, 125, 150, 250, 500

Prepare the CAL standards over the concentration range of interest from dilutions of the analyte PDS in methanol containing 20% reagent water. 20 µl of the EIS PDS and REC PDS are added to the CAL standards to give a constant concentration of 10 ng/ml. The lowest concentration CAL standard must be at or below the RL (2 ng/L), which may depend on system sensitivity. The CAL standards may also be used as CCVs (Sect. 9.8). To make calibration stock standards:

Table 6

Calibration Standard Concentration	Final Aqueous Cal STD Level Concentration	Final Soil Cal STD Level Concentration	24 compound stock added (ul)	PFHxDA Stock added (ul)	500 ng/ml PFHxDA dilution added (ul)	PFODA Stock added (ul)	500 ng/ml PFODA dilution added (ul)	ADONA, HFPO-DA, 11Cl-PF3OUdS, 9Cl-PF3ONS Stock added (ul)	500 ng/ml ADONA dilution added (ul)	Final Volume in MeOH/H_2O (82:20)
.5 ng/ml	2 ng/L	.25 ng/g	6.25		25		25		25	25 mls
1 ng/ml	4 ng/L	.5 ng/g	5		20		20		20	10 mls
5 ng/ml	20 ng/L	1 ng/g	25		100		100		100	10 mls
10 ng/ml	40 ng/L	5 ng/g	125	5		5		5		25 mls

50 ng/ml	200 ng/L	25 ng/g	250	10		10		10		10 mls
125 ng/ml	500 ng/L	62.5 ng/g	625	25		25		25		10 mls
150 ng/ml	600 ng/L	75 ng/g	750	30		30		30		10 mls
250 ng/ml	1000 ng/L	125 ng/g	625							5 mls
500 ng/ml	2000 ng/L	250 ng/g	1250							5 mls

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.

9.1 MINIMUM REPORTING LIMIT (MRL) CONFIRMATION

9.1.1 Fortify, extract, and analyze seven replicate LCSs at 2 ng/l. Calculate the mean measured concentration (*Mean*) and standard deviation for these replicates. Determine the Half Range for the prediction interval of results (HR_{PIR}) using the equation below

$$HR_{PIR} = 3.963s$$

Where:

s = the standard deviation
3.963 = a constant value for seven replicates.

9.1.2 Confirm that the upper and lower limits for the Prediction Interval of Result ($PIR = Mean \pm HR_{PIR}$) meet the upper and lower recovery limits as shown below

The Upper PIR Limit must be ≤150% recovery.

$$\frac{Mean + HR_{PIR}}{Fortified\ Concentration} \times 100\% \leq 150\%$$

The Lower PIR Limit must be ≥ 50% recovery.

$$\frac{Mean - HR_{PIR}}{Fortified\ Concentration} \times 100\% \geq 50\%$$

9.1.3 The RL is validated if both the Upper and Lower PIR Limits meet the criteria described above. If these criteria are not met, the RL has been set too low and must be determined again at a higher concentration.

9.2 Blank(s)

9.2.1 **METHOD BLANK (MB)** - 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. 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. Because background contamination is a significant problem for several method analytes, it is highly recommended that the analyst maintain a historical record of MB data.

9.2.2 **FIELD REAGENT BLANK (FRB)** - The purpose of the FRB is to ensure that PFAS's measured in the Field Samples were not inadvertently introduced into the sample during sample collection/handling. Analysis of the FRB is required only if a Field Sample contains a method analyte or analytes at or above the RL. The FRB is processed, extracted and analyzed in exactly the same manner as a Field Sample.

9.3 Laboratory Control Sample (LCS) and Laboratory Control Sample Duplicates (LCSD)

9.3.1 An LCS is required with each extraction batch. The fortified concentration of the LCS may be rotated between low, medium, and high concentrations from batch to batch. Default limits of 50-150% 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.

9.3.2 Where applicable, 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

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

9.3.3 **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.**

9.4 Labeled Recovery Standards (REC)

The analyst must monitor the peak areas of the REC(s) in all injections during each analysis day.

9.5 Extracted Internal Standards (EIS)

9.5.1 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.

9.5.2 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.

9.6 Matrix Spike (MS)

9.6.1 Analysis of an MS is required in each extraction batch and is used to determine that the sample matrix does not adversely affect method accuracy. Assessment of method precision is accomplished by analysis of a Field Duplicate (FD) (Sect. 9.6); however, infrequent occurrence of method analytes would hinder this assessment. If the occurrence of method analytes in the samples is infrequent, or if historical trends are unavailable, a second MS, or MSD, must be prepared, extracted, and analyzed from a duplicate of the Field Sample. Extraction batches that contain MSDs will not require the extraction of a field sample duplicate. If a variety of different sample matrices are analyzed regularly, for example, drinking water from groundwater and surface water sources, method performance should be established for each. Over time, MS data should be documented by the laboratory for all routine sample sources.

9.6.2 Within each extraction batch, a minimum of one Field Sample is fortified as an MS for every 20 Field Samples analyzed. The MS is prepared by spiking a sample with an appropriate amount of the Analyte Stock Standard (Sect. 8.2.3). Use historical data and rotate through the low, mid and high concentrations when selecting a fortifying concentration. Calculate the percent recovery (%*R*) for each analyte using the equation

$$\%R = \frac{(A - B)}{C} \times 100$$

Where:

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

9.6.3 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.

9.7 Laboratory Duplicate

9.7.1 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.

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

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

9.7.3 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.

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

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

9.7.5 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.

9.8 Initial Calibration Verification (ICV)

9.8.1 As part of the IDC (Sect. 13.2), and 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 ±

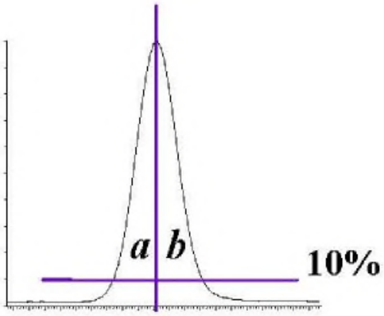
30% of the expected value. If measured analyte concentrations are not of acceptable accuracy, check the entire analytical procedureto locate and correct the problem.

9.9 Continuing Calibration Verification (CCV)

9.9.1 CCV Standards are analyzed at the beginning of each analysis batch, after every 10 Field Samples, and at the end of the analysis batch. See Section 10.7 for concentration requirements and acceptance criteria.

9.10 Method-specific Quality Control Samples

9.10.1 PEAK ASYMMETRY FACTOR – A peak asymmetry factor must be calculated using the equation below during the IDL and every time a calibration curve is generated. The peak asymmetry factor for the first two eluting peaks in a midlevel CAL standard (if only two analytes are being analyzed, both must be evaluated) must fall in the range of 0.8 to 1.5. Modifying the standard or extract composition to more aqueous content to prevent poor shape is not permitted. See guidance in Section 10.6.4.1 if the calculated peak asymmetry factors do not meet the criteria.



$$A_s = b / a$$

Where:

A_s = peak asymmetry factor
b = width of the back half of the peak measured (at 10% peak height) from the trailing edge of the peak to a line dropped perpendicularly from the peak apex
a = the width of the front half of the peak measured (at 10% peak height) from the leading edge of the peak to a line dropped perpendicularly from the apex.

9.11 Method Sequence

- CCV-LOW
- MB
- LCS
- LCSD
- MS
- Duplicate or MSD
- Field Samples (1-10)
- CCV-MID
- Field Samples (11-20)
- CCV-LOW

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 (Sect. 9.2).

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 (Sect 10.3.4) 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 (Sect. 10.3.4).

10.1.3 **NOTE:** 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.

10.2 Sample Preparation and Extraction of Aqueous Samples

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

The entire sample that is received must be sent through the SPE cartridge. In addition, the bottle must be solvent rinsed and this rinse must be sent through the SPE cartridge as well. The method blank (MB) and laboratory control sample (LCS) must be extracted in exactly the same manner (i.e., must include the bottle solvent rinse). It should be noted that a water rinse alone is not sufficient. This does not apply to samples with high concentrations of PFAS that are prepared using serial dilution and not SPE.

10.2.2 Determine sample volume. Weigh all samples to the nearest 1g. If visible sediment is present, centrifuge and decant into a new 250mL 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 250 mL of reagent water with a polypropylene graduated cylinder or filling a 250-mL sample bottle to near the top.

10.2.4 Adjust the QC and sample pH to 3 by adding acetic acid in water dropwise

10.2.5 Add 20 µL of the EIS PDS (Sect. 8.2.2) 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 (Sect. 8.2.3). Cap and invert each sample to mix.

10.3 Cartridge SPE Procedure

10.3.1 CARTRIDGE CLEAN-UP AND CONDITIONING – DO NOT allow cartridge packing material to go dry during any of the conditioning steps. Rinse each cartridge with 3 X 5 mL of 2% ammonium hydroxide in methanol, followed by 5mls of methanol. Next, rinse each cartridge with 5 mls of the 25 mM acetate buffer, followed by 15 mL of reagent water, without allowing the water to drop below the top edge of the packing. If the cartridge goes dry during the conditioning phase, the conditioning must be started over. Add 4-5 mL of reagent water to each cartridge, attach the sample transfer tubes (Sect. 7.9.3), turn on the vacuum, and begin adding sample to the cartridge.

10.3.2 SAMPLE EXTRACTON – Adjust the vacuum so that the approximate flow rate is approximately 4 mL/min. Do not allow the cartridge to go dry before all the sample has passed through.

10.3.3 SAMPLE BOTTLE AND CARTRIDGE RINSE – After the entire sample has passed through the cartridge, rinse the sample bottles with 4 ml reagent water followed by 4 ml 25 mM acetate buffer at pH 4 and draw the aliquot through the sample transfer tubes and the cartridges. Draw air or nitrogen through the cartridge for 5-10 min at high vacuum (10-15 in. Hg). **NOTE: If empty plastic reservoirs are used in place of the sample transfer tubes to pass the samples through the cartridges, these reservoirs must be treated like the transfer tubes. After the entire sample has passed through the cartridge, the reservoirs must be rinsed to waste with reagent water.**

10.3.4 SAMPLE BOTTLE AND CARTRIDGE ELUTION, Fraction 1 – Turn off and release the vacuum. Lift the extraction manifold top and insert a rack with collection tubes into the extraction tank to collect the extracts as they are eluted from the cartridges. Rinse the sample bottles with 12 mls of methanol and draw the aliquot through the sample transfer tubes and cartridges. Use a low vacuum such that the solvent exits the cartridge in a dropwise fashion.

SAMPLE BOTTLE AND CARTRIDGE ELUTION, Fraction 2 In a separate collection vial, rinse the sample bottles with 12 mL of 2% ammonium hydroxide in methanol and elute the analytes from the cartridges by pulling the 4 mL of methanol through the sample transfer tubes and the cartridges. Use a low vacuum such that the solvent exits the cartridge in a dropwise fashion. To the final extract, add 50 ul of acetic acid.

NOTE: If empty plastic reservoirs are used in place of the sample transfer tubes to pass the samples through the cartridges, these reservoirs must be treated like the transfer tubes. After the reservoirs have been rinsed in Section 10.3.3, the elution solvent used to rinse the sample bottles must be swirled down the sides of the reservoirs while eluting the cartridge to ensure that any method analytes on the surface of the reservoirs are transferred to the extract.

CLEAN-UP CARTRIDGE ELUTION, Elute the clean-up cartridge with 8 additional mls of methanol and draw the aliquot through the cartridge. Use a low vacuum such that the solvent exits the cartridge in a dropwise fashion.

10.3.5 Fractions 1 and 2 are to be combined during the concentration stage (section10.6)

10.4 Sample Prep and Extraction Protocol for Soils

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

10.4.2 Add 20 µL of the EIS PDS (Sect. 8.2.2) 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 (Sect. 8.2.3). Cap and invert each sample to mix.

10.4.4 To all samples, add 10 mls of methanol, cap, vortex for 25 seconds at 3000RPM and mix for 30 minutes using a shaker table of tumbler at 120RPM.

10.4.5 Following mixing, sonicate each sample for 30 minutes and let samples sit overnight (at least 2 hours is required for RUSH samples).

10.4.6 Centrifuge each sample at 3500RPM for 10 minutes.

10.4.7 Remove supernatant, and reserve for clean-up.

10.5 Extract Clean-up

10.5.1 CARTRIDGE CLEAN-UP AND CONDITIONING –. Rinse each cartridge with 15 mL of methanol and discard. If the cartridge goes dry during the conditioning phase, the conditioning must be started over. Attach the sample transfer tubes (Sect. 7.9.3), turn on the vacuum, and begin adding sample to the cartridge.

10.5.2 Adjust the vacuum so that the approximate flow rate is 1-2 mL/min. Do not allow the cartridge to go dry before all the sample has passed through.

10.5.3 SAMPLE BOTTLE AND CARTRIDGE RINSE – After the entire sample has passed through the cartridge, rinse the sample collection vial with two 1-mL aliquots of methanol and draw each aliquot through the cartridges. Draw air or nitrogen through the cartridge for 5 min at high vacuum (10-15 in. Hg).

10.5.4 If extracts are not to be immediately evaporated, cover collection tubes and store at ambient temperature till concentration.

10.6 Extract Concentration

10.6.1 Concentrate the extract to dryness under a gentle stream of nitrogen in a heated water bath (60-65 °C) to remove all the water/methanol mix. Add the appropriate amount of 80:20% (vol/vol) methanol:water solution and 20 µl of the ID REC PDS (Sect. 8.2.7) to the collection vial to bring the volume to 1 mL and vortex. Transfer two aliquots with a plastic pipet (Sect. 7.6) into 2 polypropylene autosampler vials.

NOTE: It is recommended that the entire 1-mL aliquot not be transferred to the autosampler vial because the polypropylene autosampler caps do not reseal after injection. Therefore, do not store the extracts in the autosampler vials as evaporation losses can occur occasionally in these autosampler vials. Extracts can be split between 2 X 700 µl vials (Sect. 7.4).

10.7 Sample Volume Determination

10.7.1 If the level of the sample was marked on the sample bottle, use a graduated cylinder to measure the volume of water required to fill the original sample bottle to the mark made prior to extraction. Determine to the nearest 10 mL.

10.7.2 If using weight to determine volume, weigh the empty bottle to the nearest 10 g and determine the sample weight by subtraction of the empty bottle weight from the original sample weight (Sect. 10.2.2). 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 (Sect. 11.2).

10.8 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.

10.8.1 ESI-MS/MS TUNE

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

10.8.1.2 Optimize the [M-H]- 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 (approximately 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.

10.8.1.3 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.

10.8.2 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.

Cautions: LC system components, as well as the mobile phase constituents, contain many of the method analytes in this method. Thus, these PFAS's will build up on the head of the LC column during mobile phase equilibration. To minimize the background PFAS peaks and to keep background levels constant, the time the LC column sits at initial conditions must be kept constant and as short as possible (while ensuring reproducible retention times). In addition, prior to daily use, flush the column with 100% methanol for at least 20 min before initiating a sequence. It may be necessary on some systems to flush other LC components such as wash syringes, sample needles or any other system components before daily use.

10.8.3 Inject a mid-level CAL standard under LC/MS conditions to obtain the retention times of each method analyte. If analyzing for PFTA, ensure that the LC conditions are adequate to prevent co-elution of PFTA and the mobile phase interferants. These interferants have the same precursor and products ions as PFTA, and under faster LC conditions may co-elute with PFTA. 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.

10.8.4 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.

10.8.4.1 If broad, split or fronting peaks are observed for the first two eluting chromatographic peaks (if only two analytes are being analyzed, both must be evaluated), change the initial mobile phase conditions to higher aqueous content until the peak asymmetry ratio for each peak is 0.8 – 1.5. The peak asymmetry factor is calculated as described in Section 9.9.1 on a mid-level CAL standard. The peak asymmetry factor must meet the above criteria for the first two eluting peaks during the IDL and every time a new calibration curve is generated. Modifying the standard or extract composition to more aqueous content to prevent poor shape is not permitted.

NOTE: PFHxS, PFOS, NMeFOSAA, and NEtFOSAA have multiple chromatographic peaks using the LC conditions in Table 5 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.

10.8.5 Prepare a set of CAL standards as described in Section 8.2.5. The lowest concentration CAL standard must be at or below the RL (2 ng/L), which may depend on system sensitivity.

10.8.6 The LC/MS/MS system is calibrated using the IS technique. 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.

10.8.7 **CALIBRATION ACCEPTANCE CRITERIA** – A linear fit is acceptable if the coefficient of determination (r^2) is greater than 0.99. When quantitated using the initial calibration curve, each calibration point, except the lowest point, for each analyte should calculate to be within 70-130% of its true value. The lowest CAL point should calculate to be within 50-150% of its true value. If these criteria cannot be met, the analyst will have difficulty meeting ongoing QC criteria. It is recommended that corrective action is taken to reanalyze the CAL standards, restrict the range of calibration, or select an alternate method of calibration (forcing the curve through zero is still required).

10.8.7.1 **CAUTION:** When acquiring MS/MS data, LC operating conditions must be carefully reproduced for each analysis to provide reproducible retention times. If this is not done, the correct ions will not be monitored at the appropriate times. As a precautionary measure, the chromatographic peaks in each window must not elute too close to the edge of the segment time window.

10.9 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.

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

10.9.2 Calculate the concentration of each analyte and EIS in the CCV. The calculated amount for each analyte for medium level CCVs must be within ± 30% of the true value with an allowance of 10% of the reported analytes to be greater than 30%, but less than 40%. The calculated amount for each EIS must be within ± 50% of the true value. The calculated amount for the lowest calibration point for each analyte must be within ± 50%. If these conditions do not exist, then all data for the problem analyte must be considered invalid, and remedial action should be taken (Sect. 10.7.4) 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% (150% for the low-level CCV) for a particular method analyte, and Field Sample extracts show no detection for that method analyte, non-detects may be reported without re-analysis.**

10.9.3 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 (Sect 10.6) and verification of sensitivity by analyzing a CCV at or below the RL (Sect 10.7).

10.10 EXTRACT ANALYSIS

10.10.1 Establish operating conditions equivalent to those summarized in Tables 6-8 of Section 16. Instrument conditions and columns should be optimized prior to the initiation of the IDC.

10.10.2 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 and completing the IDC 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.

10.10.3 Calibrate the system by either the analysis of a calibration curve (Sect. 10.6) or by confirming the initial calibration is still valid by analyzing a CCV as described in Section 10.7. If establishing an initial calibration, complete the IDC as described in Section 13.2.

10.10.4 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.

10.10.5 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.

10.10.6 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 insure 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.

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 7.

11.2 Calculate analyte concentrations using the multipoint calibration established in Section 10.6. 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 10.6 where:

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 5 due to the linear and branch isomers of these compounds (Sect. 10.6.4.1). 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 The IDC must be successfully performed prior to analyzing any Field Samples. Prior to conducting the IDC, the analyst must first generate an acceptable Initial Calibration following the procedure outlined in Section 10.6.

13.2.2 INITIAL DEMONSTRATION OF LOW SYSTEM BACKGROUND – Any time a new lot of SPE cartridges, solvents, centrifuge tubes, disposable pipets, and autosampler vials are used, it must be demonstrated that an MB is reasonably free of contamination and that the criteria in Section 9.2.1 are met. If an automated extraction system is used, an MB should be extracted on each port to ensure that all the valves and tubing are free from potential PFAS contamination.

13.2.3 INITIAL DEMONSTRATION OF PRECISION (IDP) – Prepare, extract, and analyze four to seven replicate LCSs fortified near the midrange of the initial calibration curve according to the procedure described in Section 10. Sample preservatives as described in Section 6.2.1 must be added to these samples. The relative standard deviation (RSD) of the results of the replicate analyses must be less than 20%.

13.2.4 INITIAL DEMONSTRATION OF ACCURACY (IDA) – Using the same set of replicate data generated for Section 13.2.3, calculate average recovery. The average recovery of the replicate values must be within ± 30% of the true value.

13.2.5 INITIAL DEMONSTRATION OF PEAK ASYMMETRY FACTOR – Peak asymmetry factors must be calculated using the equation in Section 9.10.1 for the first two eluting peaks (if only two analytes are being analyzed, both must be evaluated) in a mid-level CAL standard. The peak asymmetry factors must fall in the range of 0.8 to 1.5. See guidance in Section 10.6.4.1 if the calculated peak asymmetry factors do not meet the criteria.

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

13.2.7 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 7: LC Method Conditions

Time (min)	2 mM Ammonium Acetate (5:95 MeOH/H_2O)	100% Methanol
Initial	100.0	0.0
1.0	100.0	0.0
2.2	85.0	15.0
11	20.0	80.0
11.4	0.0	100.0
12.4	100.0	00.0
15.5	100.0	0.0
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 2-5 µL injection		

Table 8: ESI-MS Method Conditions

ESI Conditions	
Polarity	Negative ion
Capillary needle voltage	.5 kV
Cone Gas Flow	25 L/hr
Nitrogen desolvation gas	1000 L/hr
Desolvation gas temp.	500 ºC

Table 9: Method Analyte Source, Retention Times (RTs), and EIS References

#	Analyte	Transition	RT	IS	Type
1	M3PBA	216>171	2.65		REC
2	PFBA	213 > 169	2.65	2: M4PFBA	
3	M4PFBA	217 > 172	2.65	1: M3PBA	EIS
4	PFPeA	263 > 219	5.67	4: M5PFPEA	
5	M5PFPEA	268 > 223	5.66	1: M3PBA	EIS
6	PFBS	299 > 80	6.35	6: M3PFBS	
7	M3PFBS	302 > 80	6.35	29:M4PFOS	EIS
8	FtS 4:2	327 > 307	7.47	9: M2-4:2FTS	

#	Analyte	Transition	RT	IS	Type
9	M2-4:2FTS	329 > 81	7.47	29:M4PFOS	EIS
10	PFHxA	303 > 269	7.57	10: M5PFHxA	
11	M5PFHxA	318 > 273	7.57	19:M2PFOA	EIS
12	PFPeS	349 > 80	7.88	18: M3PFHxS	
13	PFHpA	363 > 319	8.80	14: M4PFHpA	
14	M4PFHpA	367 > 322	8.80	19:M2PFOA	EIS
15	L-PFHxS	399 > 80	8.94	18: M3PFHxS	
16	br-PFHxS	399 > 80	8.72	18: M3PFHxS	
17	PFHxS Total	399 > 80	8.94	18: M3PFHxS	
18	M3PFHxS	402 > 80	8.94	29:M4PFOS	EIS
19	MPFOA	415 > 370	9.7		REC
20	PFOA	413 > 369	9.7	23: M8PFOA	
21	br-PFOA	413 > 369	9.48	23: M8PFOA	
22	PFOA Total	413 > 369	9.7	23: M8PFOA	
23	M8PFOA	421 > 376	9.7	19: M2PFOA	EIS
24	FtS 6:2	427 > 407	9.66	25: M2-6:2FTS	
25	M2-6:2FTS	429 > 409	9.66	29:M4PFOS	EIS
26	PFHpS	449 > 80	9.78	33: M8PFOS	
27	PFNA	463 > 419	10.41	33: M8PFOS	
28	M9PFNA	472 > 427	10.41	19: M2PFOA	EIS
29	M4PFOS	501 > 80	10.45		REC
30	PFOS	499 > 80	10.45	33: M8PFOS	
31	br-PFOS	499 > 80	10.27	33: M8PFOS	
32	PFOS Total	499 > 80	10.45	33: M8PFOS	
33	M8PFOS	507 > 80	10.45	29: M4PFOS	EIS
34	FtS 8:2	527 > 507	10.99	38: M2-8:2FTS	
35	M2-8:2FTS	529 > 509	10.99	29:M4PFOS	EIS
36	M2PFDA	515 > 470	11.00		REC
37	PFDA	513 > 469	11.00	38: M6PFDA	
38	M6PFDA	519 > 474	11.00	36: M2PFDA	EIS
39	PFNS	549 > 80	11.02	33:M8PFOS	
40	NMeFOSAA	570 > 419	11.41	41: D3-NMeFOSAA	
41	d3-NMeFOSAA	573 > 419	11.41	36: M2PFDA	EIS
42	PFOSA	498 > 78	11.48	29: M8FOSA	
43	M8FOSA	506 > 78	11.48	19: M2PFOA	EIS
44	PFUnDA	563 > 519	11.51	41: M7-PFUDA	
45	M7-PFUDA	570 > 525	11.51	36: M2PFDA	EIS
46	PFDS	599 > 80	11.51	33:M8PFOS	
47	NEtFOSAA	584 > 419	11.68	48: d5-NEtFOSAA	

#	Analyte	Transition	RT	IS	Type
48	d5-NEtFOSAA	589 > 419	11.68	36: M2PFDA	EIS
49	PFDoA	613 > 569	11.96	50: MPFDOA	
50	MPFDOA	615 > 570	11.96	36: M2PFDA	EIS
51	PFTriA	663 > 619	12.34	50: MPFDOA	
52	PFTeA	713 > 669	12.6	53: M2PFTEDA	
53	M2PFTEDA	715 > 670	12.6	36: M2PFDA	EIS
54	M3HFPO-DA	329>285	7.97	19: M2PFOA	EIS
55	HFPO-DA	332>287	7.97	54: M3HFPO-DA	
56	ADONA	377>251	8.00	23: M8PFOA	
57	PFHxDA	813>769	13.20	59: M2PFHxDA	
58	PFODA	913>869	13.50	59: M2PFHxDA	
59	M2PFHxDA	815>770	13.20	36:M2PFDA	EIS
60	NEtFOSA	526>169	11.00	61: NMeFOSA	
61	NMeFOSA	512>169	10.50	63: d3-NMeFOSA	
62	d3-NMeFOSA	515>169	10.50	29: M4PFOS	EIS
63	d5-NEtFOSA	531>169	11.00	29: M4PFOS	EIS
64	NMeFOSE	556>122	11.25	66: d7-NMeFOSE	
65	NEtFOSE	570>136	10.75	67: d9-NEtFOSE	
66	d7-NMeFOSE	563>126	11.25	29: M4PFOS	EIS
67	d9-NEtFOSE	579>142	10.75	29: M4PFOS	EIS
68	FtS 10:2	627>607	11.50	25: M2-6:2FTS	
69	PFDoS	699>99	12.50	33: M8PFOS	

APPENDIX B

HEALTH AND SAFETY PLAN

QUEENS ANIMAL SHELTER AND CARE CENTER

151 WOODWARD AVENUE

QUEENS, NEW YORK

Health and Safety Plan

BCP Site No.: C241230
AKRF Project Number: 180291

Prepared for:

Animal Care and Control of New York City
11 Park Place, Suite 805
New York, NY 10007

Prepared by:

AKRF

440 Park Avenue South, 7th Floor
New York, NY 10016
212-696-0670

MAY 2019

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FIGURES

APPENDICES

1.0 INTRODUCTION

This environmental Health and Safety Plan (HASP) has been developed for implementation of the Remedial Investigation (RI) activities conducted by all personnel on-site, both AKRF employees and others, at the 151 Woodward Avenue site (the “Site”). The Site is located at 151 Woodward Avenue, in the Ridgewood neighborhood of Queens, New York. The legal definition of the Site is Tax Block 3376, Lots 1 and 7. A Site Location plan is provided as Figure 1. Currently, the Site is occupied by Aalba Auto Salvage, Inc., an auto wrecking yard and used auto parts facility, and Tire Wheel and Glass Depot. The Site contains two permanent structures: a one-story masonry and wood frame garage used for storage, vehicle dismantling, and repairs; and a one-story masonry and steel frame garage building with a mezzanine level. Exterior portions of the Site contain several steel shipping containers, racks and shelving for auto parts, and open areas for storage of cars and car parts. Some of the shipping containers have been modified to house temporary office spaces on the Site.

A Phase I Environmental Site Assessment (ESA) was conducted at the Site by Environmental Studies Corporation (ESC) in May 2018. The ESA indicated that the Site had been occupied by historic automobile maintenance, wrecking, and salvage operations. Site reconnaissance identified the potential for additional contaminated soil and groundwater at the Site from current and historic automobile maintenance, wrecking, and salvage operations as well as the presence of contaminants in excess of regulatory standards and guidelines found in soil and groundwater samples collected at the Site during previous investigations. These contaminates potentially allow a vapor encroachment condition to exist at current and future buildings at the Site from current and historic operations and may be indicative of potential for groundwater contamination from off-site sources in the immediate vicinity of the Site.

AKRF, Inc. conducted a Supplemental Subsurface (Phase II) Investigation at the Site in August 2018. The scope of the investigation was based on the May 2018 Phase I ESA and the June 2018 Phase II investigation prepared by ESC, and the December 2008 Phase II investigation prepared by Soil Mechanics. The Supplemental Phase II included a geophysical survey across accessible portions of the Site and the advancement of several soil borings with the collection and analysis of soil, groundwater, and soil vapor samples. The analytical results indicated that volatile organic compounds (VOCs), poly-aromatic hydrocarbons (PAHs), heavy metals, and PCB contamination were detected in soil samples at concentrations above the New York State Department of Environmental Conservation (NYSDEC) 6 New York City Rules and Regulations (NYCRR) Part 375 Unrestricted Use Soil Cleanup Objectives (UUSCOs) and/or Commercial Soil Cleanup Objectives (CSCOs). The VOC methyl tert-butyl ether (MTBE), two PAHs, and several metals were detected in groundwater samples above the NYSDEC Class GA Ambient Water Quality Standards (AWQS) and/or Guidance Values. Petroleum- and solvent-related VOCs were detected in soil vapor samples collected from the Site during the June 2018 Phase II. Cis-1,2-dichloroethene and TCE were detected in sample SV-1 at respective concentrations of 90 $\mu g/m^3$ and 170 $\mu g/m^3$. According to New York State Department of Health (NYSDOH) Soil Vapor/Indoor Air Matrix A, sub-slab soil vapor concentrations greater than 60 µg/m3 result in a “mitigate” action, even if the indoor air concentration is less than 0.2 $\mu g/m^3$. The detection of VOCs in the soil, groundwater and soil vapor samples is likely associated with the historic industrial uses at the Site.

This HASP does not discuss other routine health and safety issues common to general construction and excavation, including but not limited to slips, trips, falls, shoring, and other physical hazards. All AKRF employees are directed that all work must be performed in accordance with the Company's Generic HASP and all Occupation Safety and Health Administration (OSHA) applicable regulations for the work activities required for the project. All project personnel are furthermore directed that they are not permitted to enter Permit Required Confined Spaces (as defined by OSHA). For issues unrelated to contaminated materials, all non-AKRF employees are to be bound by all applicable OSHA regulations as well as any more stringent requirements specified by their employer in their corporate HASP or otherwise. AKRF is not responsible for providing oversight for issues unrelated to contaminated materials for non-employees. This oversight shall be the responsibility of the employer of that worker or other official designated by that employer.

2.0 HEALTH AND SAFETY GUIDELINES AND PROCEDURES

2.1 Hazard Evaluation

2.1.1 Hazards of Concern

Check all that apply		
(**X**) Organic Chemicals	(**X**) Inorganic Chemicals	( ) Radiological
( ) Biological	( ) Explosive/Flammable	( ) Oxygen Deficient Atm
(**X**) Heat Stress	(**X**) Cold Stress	( ) Carbon Monoxide
Comments: No personnel are permitted to enter permit confined spaces.		

2.1.2 Physical Characteristics

Check all that apply		
(**X**) Liquid	(**X**) Solid	(**X**) Sludge
(**X**) Vapors	( ) Unknown	( ) Other
Comments:		

2.1.3 Hazardous Materials

Check all that apply					
Chemicals	**Solids**	**Sludges**	**Solvents**	**Oils**	**Other**
( ) Acids	(**X**) Ash	( ) Paints	( ) Halogens	( ) Transformer	( ) Lab
( ) Caustics	( ) Asbestos	(**X**) Metals	(**X**) Petroleum	( ) Other DF	( ) Pharm
( ) Pesticides	( ) Tailings	( ) POTW	( ) Chlorinated solvents	(**X**) Motor or Hydraulic Oil	( ) Hospital
(**X**) Petroleum	(**X**) Other	(**X**)Other: VOCs & SVOCs		(**X**) Gasoline	( ) Rad
( ) Inks	Fill material			(**X**) Fuel Oil	( ) MGP
(**X**) PCBs					( ) Mold
(**X**) Metals					( ) Cyanide
(**X**)Other: VOCs & SVOCs					

2.1.4 Chemicals of Concern

Chemicals	**REL/PEL/STEL**	**Health Hazards**
Arsenic	REL = 0.002 mg/m^3 PEL = TWA 0.010 mg/m^3	Ulceration of nasal septum, dermatitis, gastrointestinal disturbances, peripheral neuropathy, resp irritation, hyperpigmentation of skin, potential occupational carcinogen
Barium	PEL = 0.5 mg/m^3 REL = 0.5 mg/m^3	Irritation eyes, skin, upper respiratory system; skin burns; gastroenteritis; muscle spasm; slow pulse, extrasystoles; hypokalemia.
Benzene	REL = TWA 0.1 ppm PEL = TWA 1 ppm	Irritation eyes, skin, nose, respiratory system; dizziness; headache, nausea, staggered gait; anorexia, lassitude (weakness, exhaustion); dermatitis; bone marrow depression.
Beryllium	REL = 0.0005 mg/m^3 PEL = TWA 0.002 mg/m^3	Berylliosis (chronic exposure): anorexia, weight loss, lassitude (weakness, exhaustion), chest pain, cough, clubbing of fingers, cyanosis, pulmonary insufficiency; irritation eyes; dermatitis; [potential occupational carcinogen].
Cadmium	PEL = TWA 0.005 mg/m^3	Pulmonary edema, dyspnea (breathing difficulty), cough, chest tightness, substernal (occurring beneath the sternum) pain; headache; chills, muscle aches; nausea, vomiting, diarrhea; anosmia (loss of the sense of smell), emphysema, proteinuria, mild anemia; [potential occupational carcinogen].
Chloroform	REL = 2 ppm PEL = 50 ppm	Irritation eyes, skin; dizziness, mental dullness, nausea, confusion; headache, lassitude (weakness, exhaustion); anesthesia; enlarged liver; [potential occupational carcinogen].
Chromium	TWA = 1 mg/mg^3	Irritation eyes, skin; lung fibrosis (histologic)
Chrysene	REL = TWA 0.1 mg/m^3 PEL = TWA 0.2 mg/m^3	Dermatitis, bronchitis, [potential occupational carcinogen].
Copper	REL = 1 mg/m^3 PEL = 1 mg/m^3	Irritation eyes, nose, pharynx; nasal septum perforation; metallic taste; dermatitis; in animals: lung, liver, kidney damage; anemia
Diethyl Phthalate	REL = TWA 5 mg/m^3	Irritation eyes, skin, nose, throat; headache, dizziness, nausea; lacrimation (discharge of tears); possible polyneuropathy, vestibular dysfunc; pain, numb, lassitude (weakness, exhaustion), spasms in arms & legs
Ethyl Benzene	REL = TWA 100 ppm PEL = TWA 100 ppm	Irritation eyes, skin, mucous membrane; headache; dermatitis; narcosis, coma.
Iron	REL = TWA 5 mg/m^3 PEL = TWA 10 mg/m^3	Benign pneumoconiosis with X-ray shadows indistinguishable from fibrotic pneumoconiosis (siderosis)
Lead	REL = 0.05 mg/m^3 PEL = 0.05 mg/m^3	Lassitude (weakness, exhaustion), insomnia; facial pallor; anorexia, weight loss, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremor; paralysis wrist, ankles; encephalopathy; kidney disease; irritation eyes; hypertension.
Manganese	REL = 1 mg/m^3 PEL = 0.2 mg/m^3	Manganism; asthenia, insomnia, mental confusion; metal fume fever: dry throat, cough, chest tightness, dyspnea (breathing difficulty), rales, flu-like fever; low-back pain; vomiting; malaise (vague feeling of discomfort); lassitude (weakness, exhaustion); kidney damage.
Methylene Chloride	PEL = TWA 25 ppm	Irritation eyes, skin; lassitude (weakness, exhaustion), drowsiness, dizziness; numb, tingle limbs; nausea.
Methyl Ethyl Ketone (2-Butanone)	REL = TWA 200 ppm PEL = TWA 200 ppm	Irritation eyes, skin, nose; headache; dizziness; vomiting; dermatitis.
Methyl tert-butyl ether (MTBE)	TLV = TWA 50 ppm	Headaches, nausea, dizziness, irritation of the nose or throat, and feelings of spaciness or confusion.
Mercury	REL = 0.1 mg/m^3 PEL = 0.05 mg/m^3	Irritation eyes, skin; cough, chest pain, dyspnea (breathing difficulty), bronchitis, pneumonitis; tremor, insomnia, irritability, indecision, headache, lassitude (weakness, exhaustion); stomatitis, salivation; gastrointestinal disturbance, anorexia, weight loss; proteinuria.

Chemicals	REL/PEL/STEL	Health Hazards
Naphthalene	REL = TWA 10 ppm PEL = TWA 10 ppm	Irritation eyes; headache, confusion, excitement, malaise (vague feeling of discomfort); nausea, vomiting, abdominal pain; irritation bladder; profuse sweating; jaundice; hematuria (blood in the urine), renal shutdown; dermatitis, optical neuritis, corneal damage.
Nickel	REL = TWA 0.015 mg/m^3 PEL = TWA 1 mg/m^3	Sensitization dermatitis, allergic asthma, pneumonitis; [potential occupational carcinogen].
Phenol	REL = TWA 5 ppm (19 mg/m^3) [skin] PEL = TWA 5 ppm (19 mg/m^3) [skin]	Irritation eyes, nose, throat; anorexia, weight loss; lassitude (weakness, exhaustion), muscle ache, pain; dark urine; cyanosis; liver, kidney damage; skin burns; dermatitis; ochronosis; tremor, convulsions, twitching
Polychorinated Biphenyls (PCBs)	REL = 0.001 mg/m^3 PEL = 0.5 mg/m^3 (skin)	Irritation eyes, chloracne; liver damage; reproductive effects; [potential occupational carcinogen].
Polycyclic Aromatic Hydrocarbons (PAHs)	PEL = 5 mg/m^3	Harmful effects to skin, bodily fluids, and ability to fight disease, reproductive problems; potential carcinogen.
Selenium	REL = TWA 0.2 mg/m^3 PEL = TWA 0.2 mg/m^3	Irritation eyes, skin, nose, throat; visual disturbance; headache; chills, fever; dyspnea (breathing difficulty), bronchitis; metallic taste, garlic breath, gastrointestinal disturbance; dermatitis; eye, skin burns
Silver	REL = TWA 0.01 mg/m^3 PEL = TWA 0.01 mg/m^3	Blue-gray eyes, nasal septum, throat, skin; irritation, ulceration skin; gastrointestinal disturbance.
Sodium	REL = 2 mg/m3 PEL = TWA 2 mg/m3	Irritation eyes, skin, mucous membrane; pneumonitis; eye, skin burns; temporary loss of hair
Toluene	PEL = TWA 200 ppm (750 mg/m^3)	Central nervous system depression, causing fatigue, headache, confusion, paresthesia, dizziness, and muscular incoordination, irritation of the eyes, mucous membranes, and upper respiratory tract.
Trichloroethylene (TCE)	PEL = TWA 100 ppm	Irritation eyes, skin; headache, visual disturbance, lassitude (weakness, exhaustion), dizziness, tremor, drowsiness, nausea, vomiting; dermatitis; cardiac arrhythmias, paresthesia; liver injury; [potential occupational carcinogen].
Xylenes	REL = TWA 435 mg/m^3 PEL = TWA 435 mg/m^3	Irritation eyes, skin, nose, throat; dizziness, excitement, drowsiness, incoordination, staggering gait; corneal vacuolization; anorexia, nausea, vomiting, abdominal pain; dermatitis
Zinc	REL = TWA 5 mg/m^3 PEL = TWA 5 mg/m^3	Metal fume fever: chills, muscle ache, nausea, fever, dry throat, cough; lassitude (weakness, exhaustion); metallic taste; headache; blurred vision; low back pain; vomiting; malaise (vague feeling of discomfort); chest tightness; dyspnea (breathing difficulty), rales, decreased pulmonary function.
Comments: REL = National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit PEL = OSHA Permissible Exposure Limit STEL = OSHA Short Term Exposure Limit		

2.2 Designated Personnel

AKRF will appoint one of its on-site personnel as the Site Safety Officer (SSO). This individual will be responsible for the implementation of the HASP. The SSO will work under the direction of a Qualified Environmental Professional (QEP) and will be experienced in the implementation of air monitoring and hazardous materials sampling programs. Health and safety training required for the SSO and all field personnel are outlined in Section 2.3 of this HASP.

2.3 Training

All personnel who enter the work area while intrusive activities are being performed will have completed a 40-hour training course that meets OSHA requirements of 29 CFR Part 1910, Occupational Safety and Health Standards. In addition, all personnel will have up-to-date 8-hour refresher training. The training will allow personnel to recognize and understand the potential hazards to health and safety. All field personnel must attend a training program, whose purpose is to:

- Make them aware of the potential hazards they may encounter;
- Provide the knowledge and skills necessary for them to perform the work with minimal risk to health and safety and make them aware of the purpose and limitations of safety equipment; and
- Ensure that they can safely avoid or escape from emergencies.

Each member of the field crew will be instructed in these objectives before he/she goes onto the Site. A Site safety meeting will be conducted at the start of the project. Additional meetings shall be conducted, as necessary, for new personnel working at the Site.

2.4 Medical Surveillance Program

All AKRF and subcontractor personnel performing field work involving subsurface disturbance at the Site are required to have passed a complete medical surveillance examination in accordance with 29 CFR 1910.120 (f). A physician’s medical release for work will be confirmed by the SSO before an employee can begin Site activities. The medical release shall consider the type of work to be performed and the required personal protective equipment (PPE). The medical examination will, at a minimum, be provided annually and upon termination of hazardous waste Site work.

2.5 Site Work Zones

During any activities involving subsurface disturbance, the work area must be divided into various zones to prevent the spread of contamination, ensure that proper protective equipment is donned, and provide an area for decontamination.

The Exclusion Zone is defined as the area where exposure to impacted media could be encountered. The Contamination Reduction Zone (CRZ) is the area where decontamination procedures take place and is located next to the Exclusion Zone. The Support is the zone area where support facilities such as vehicles, fire extinguisher, and first aid supplies are located. The emergency staging area (part of the Support Zone) is the area where all workers on-site would assemble in the event of an emergency. A summary of these areas is provided below. These zones may be changed by the SSO, depending on that day’s activities. All field personnel will be informed of the location of these zones before work begins.

Task	Exclusion Zone	CRZ	Support Zone
Subsurface Investigation	10 ft. from Drill Rig	25 ft. from Drill Rig	As Needed
Comments: Control measures such as “caution tape” and/or traffic cones will be placed around the perimeter of the work area when work is being done in a public area.			

2.6 Air Monitoring

The purpose of the air monitoring program is to identify any exposure of the field personnel to potential environmental hazards in the soil and groundwater. Results of the air monitoring will be used to determine the appropriate response action, if needed.

2.6.1 Volatile Organic Compounds and Particulates

A photoionization detection (PID) will be used to perform air monitoring during soil disturbance activities to determine airborne levels of total VOCs and a Dust Trak will be used to perform air monitoring during soil disturbance activities to determine airborne levels of particulate (dust). The air monitoring equipment will be calibrated prior to the start of work each day in accordance with the manufacturer's specifications.

2.6.2 Work Zone Air Monitoring

Real time air monitoring will be performed with the PID and Dust Trak. Measurements will be taken prior to commencement of work and continuously during the work, as outlined in the following table. Measurements will be made as close to the workers as practicable and at the breathing height of the workers. The SSO shall set up the equipment and confirm that it is working properly. His/her designee may oversee the air measurements during the day. The initial measurement for the day will be performed before the start of work and will establish the background level for that day. The final measurement for the day will be performed after the end of work. The action levels and required responses are listed in the following table:

Instrument	Action Level	Response Action
PID	Less than 5 ppm in breathing zone	Level D or D-Modified
	Between 5 ppm and 50 ppm	Level C
	More than 50 ppm	Stop work. Resume work when readings are less than 50 ppm.
Dust Trak	Less than 1.25 mg/m^3 above background in breathing zone	Level D or D-Modified
	Less than 1.25 mg/m^3 above background in breathing zone	Stop work. Resume work when readings are less than 1.25 mg/m^3.
mg/m^3 = micrograms per cubic meter ppm = parts per million		

2.7 Personal Protection Equipment

The personal protection equipment required for various kinds of site investigation tasks are based on 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response, Appendix B, "General Description and Discussion of the Levels of Protection and Protective Gear."

AKRF field personnel and other site personnel shall wear, at a minimum, Level D personal protective equipment. The protection will be based on the air monitoring described in Section 2.6.

LEVEL OF PROTECTION & PPE		**Excavation/ Sampling**
Level D (**X**) Steel Toe Shoes (**X**) Hard Hat (within 25 ft of drill rig) (**X**) Work Gloves	(**X**) Safety Glasses ( ) Face Shield (**X**) Ear Plugs (within 25 ft of drill rig) (**X**) Nitrile Gloves (**X**) Tyvek for drill rig operator if NAPL present	Yes
Level C ***(in addition to Level D)*** (**X**) Half-Face Respirator OR (**X**) Full Face Respirator ( ) Full-Face PAPR	( ) Particulate Cartridge ( ) Organic Cartridge (**X**) Dual Organic/ Particulate Cartridge	If PID > 5 ppm (breathing zone)
Comments: Cartridges to be changed out at least once per shift unless warranted beforehand (e.g., more difficult to breathe or any odors detected).		

2.8 General Work Practices

To protect the health and safety of the field personnel, field personnel will adhere to the guidelines listed below during activities involving subsurface disturbance:

- Eating, drinking, chewing gum or tobacco, and smoking are prohibited, except in designated areas on the Site. These areas will be designated by the SSO.
- Workers must wash their hands thoroughly on leaving the work area and before eating, drinking, or any other such activity.
- The workers should shower as soon as possible after leaving the Site. Contact with contaminated or suspected surfaces should be avoided.
- The buddy system should always be used; each buddy should watch for signs of fatigue, exposure, and heat/cold stress.

3.0 EMERGENCY PROCEDURES AND EMERGENCY RESPONSE PLAN

The field crew will be equipped with emergency equipment, such as a first aid kit and disposable eye washes. In the case of a medical emergency, the SSO will determine the nature of the emergency and he/she will have someone call for an ambulance, if needed. If the nature of the injury is not serious, i.e., the person can be moved without expert emergency medical personnel, he/she should be taken to a hospital by on-site personnel. Directions to the hospital are provided below, and a hospital route map is provided as Figure 2.

3.1 Hospital Directions

Hospital Name:	Wyckoff Heights Medical Center
Phone Number:	718-963-7391
Address/Location:	337-381 Stanhope St, Brooklyn, NY 11237
Directions:	1. Head south out of the Site and make a right on to Woodward Avenue towards Flushing Avenue. 2. Turn left onto Flushing Avenue. 3. Turn left onto St. Nicolas Avenue. 4. Turn right onto Stanhope Street. 5. Destination will be on the right.

3.2 Emergency Contacts

Company	Individual Name	Title	Contact Number
AKRF	Deborah Shapiro	Project Director	646-388-9529 (office)
	John Patrick Diggins	Project Manager	603-494-7090 (cell)
	Jacob Menken	SSO	914-552-7694 (cell)
	Chris Puoplo	SSO Alternate	914-419-7263 (cell)
Animal Care Centers of New York City	Jennifer Piibe	Client Representative	212-676-8558 (office)
NYSDEC	Sarah Quandt, PE	BCP Project Manager	TBD
Ambulance, Fire Department & Police Department	-	-	911
NYSDEC Spill Hotline	-	-	800-457-7362

4.0 APPROVAL & ACKNOWLEDGMENTS OF HASP

APPROVAL

Signed: ______________________________ Date: ______________________________

AKRF Project Manager

Signed: ______________________________ Date: ______________________________

AKRF Health and Safety Officer

Below is an affidavit that must be signed by all workers who enter the site. A copy of the HASP must be on-site at all times and will be kept by the SSO.

AFFIDAVIT

I,_________________________(name), of_______________________________(company name), have read the Health and Safety Plan (HASP) for the property located at 151 Woodward Avenue, Queens, New York. I agree to conduct all on-site work in accordance with the requirements set forth in this HASP and understand that failure to comply with this HASP could lead to my removal from the site.

Signed: ________________________ Company: ______________________ Date: _________
Signed: ________________________ Company: ______________________ Date: _________
Signed: ________________________ Company: ______________________ Date: _________
Signed: ________________________ Company: ______________________ Date: _________
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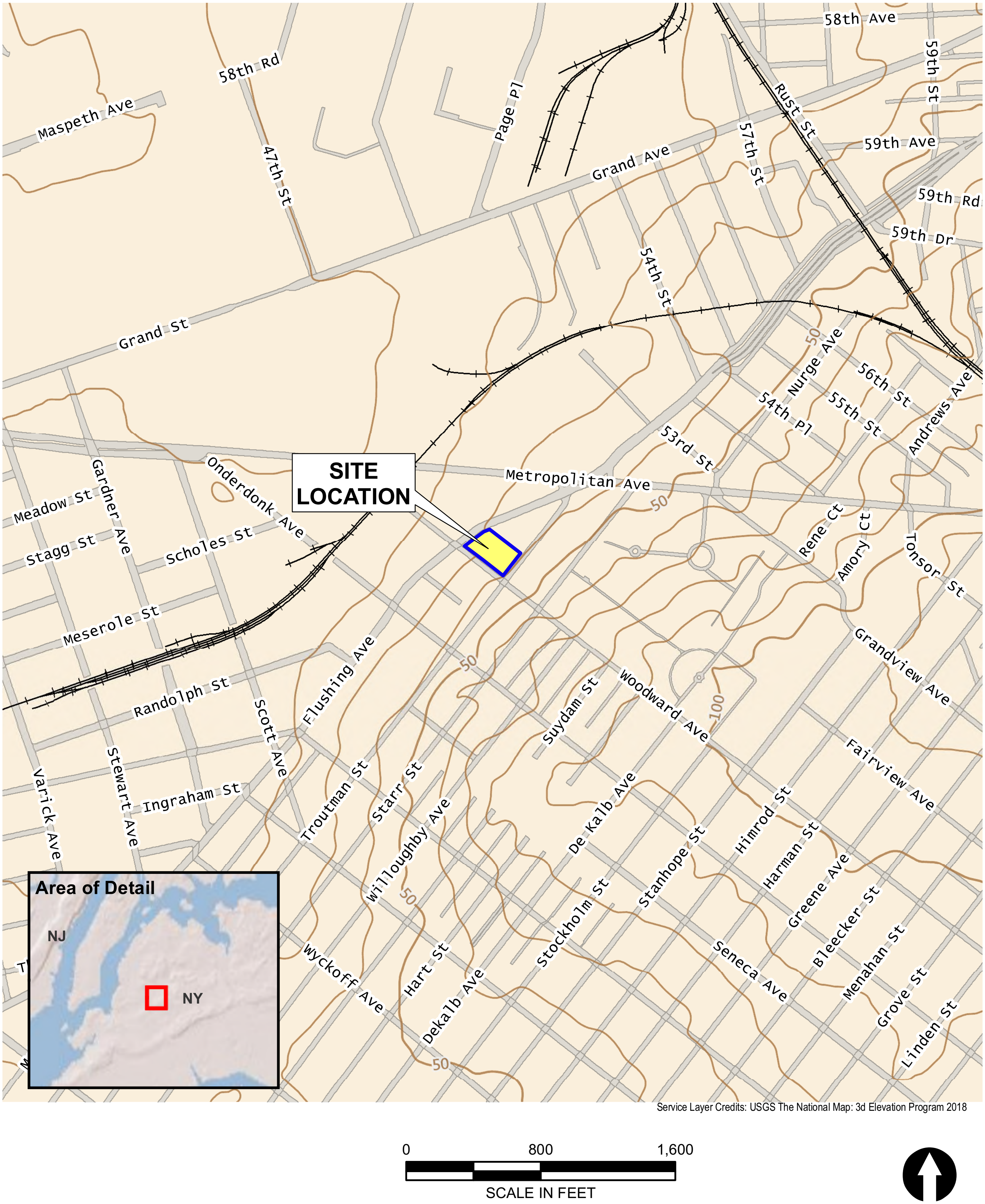
FIGURES



Service Layer Credits: USGS The National Map: 3d Elevation Program 2018

AKRF
440 Park Avenue South, New York, NY 10016

Queens Animal Shelter
151 Woodward Avenue
Queens, New York

SITE LOCATION

DATE
9/3/2018

PROJECT NO.
180291

FIGURE
1

Service Layer Credits: ESRC World Street Map 2018

LEGEND

🟨 PROJECT SITE BOUNDARY

━◀━ ROUTE TO HOSPITAL

✚ HOSPITAL LOCATION

Wyckoff Heights Medical Center
374 Stockholm St
Brooklyn, NY 11237
(718) 963-7272

0 600 1,200
SCALE IN FEET

AKRF
440 Park Avenue South, New York, NY 10016

Queens Animal Shelter
151 Woodward Avenue
Queens, New York

HOSPITAL ROUTE MAP

DATE	**10/15/2018**
PROJECT NO.	**180291**
FIGURE	**2**

APPENDIX A

POTENTIAL HEALTH EFFECTS FROM ON-SITE CONTAMINANTS

Polychlorinated Biphenyls - ToxFAQs™

This fact sheet answers the most frequently asked health questions (FAQs) about polychlorinated biphenyls. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Polychlorinated biphenyls (PCBs) are a mixture of individual chemicals which are no longer produced in the United States, but are still found in the environment. Health effects that have been associated with exposure to PCBs include acne-like skin conditions in adults and neurobehavioral and immunological changes in children. PCBs are known to cause cancer in animals. PCBs have been found in at least 500 of the 1,598 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA).

What are polychlorinated biphenyls?

Polychlorinated biphenyls are mixtures of up to 209 individual chlorinated compounds (known as congeners). There are no known natural sources of PCBs. PCBs are either oily liquids or solids that are colorless to light yellow. Some PCBs can exist as a vapor in air. PCBs have no known smell or taste. Many commercial PCB mixtures are known in the U.S. by the trade name Aroclor.

PCBs have been used as coolants and lubricants in transformers, capacitors, and other electrical equipment because they don't burn easily and are good insulators. The manufacture of PCBs was stopped in the U.S. in 1977 because of evidence they build up in the environment and can cause harmful health effects. Products made before 1977 that may contain PCBs include old fluorescent lighting fixtures and electrical devices containing PCB capacitors, and old microscope and hydraulic oils.

What happens to PCBs when they enter the environment?

- PCBs entered the air, water, and soil during their manufacture, use, and disposal; from accidental spills and leaks during their transport; and from leaks or fires in products containing PCBs.
- PCBs can still be released to the environment from hazardous waste sites; illegal or improper disposal of industrial wastes and consumer products; leaks from old electrical transformers containing PCBs; and burning of some wastes in incinerators.
- PCBs do not readily break down in the environment and thus may remain there for very long periods of time. PCBs can travel long distances in the air and be deposited in areas far away from where they were released. In water, a small amount of PCBs may remain dissolved, but most stick to organic particles and bottom sediments. PCBs also bind strongly to soil.
- PCBs are taken up by small organisms and fish in water. They are also taken up by other animals that eat these aquatic animals as food. PCBs accumulate in fish and marine mammals, reaching levels that may be many thousands of times higher than in water.

How might I be exposed to PCBs?

- Using old fluorescent lighting fixtures and electrical devices and appliances, such as television sets and refrigerators, that were made 30 or more years ago. These items may leak small amounts of PCBs into the air when they get hot during operation, and could be a source of skin exposure.
- Eating contaminated food. The main dietary sources of PCBs are fish (especially sportfish caught in contaminated lakes or rivers), meat, and dairy products.
- Breathing air near hazardous waste sites and drinking contaminated well water.
- In the workplace during repair and maintenance of PCB transformers; accidents, fires or spills involving transformers, fluorescent lights, and other old electrical devices; and disposal of PCB materials.

How can PCBs affect my health?

The most commonly observed health effects in people exposed to large amounts of PCBs are skin conditions such as acne and rashes. Studies in exposed workers have shown changes in blood and urine that may indicate liver damage. PCB exposures in the general population are not likely to result in skin and liver effects. Most of the studies of health effects of PCBs in the general population examined children of mothers who were exposed to PCBs.

Animals that ate food containing large amounts of PCBs for short periods of time had mild liver damage and some died. Animals that ate smaller amounts of PCBs in food over

Agency for Toxic Substances and Disease Registry
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several weeks or months developed various kinds of health effects, including anemia; acne-like skin conditions; and liver, stomach, and thyroid gland injuries. Other effects of PCBs in animals include changes in the immune system, behavioral alterations, and impaired reproduction. PCBs are not known to cause birth defects.

How likely are PCBs to cause cancer?

Few studies of workers indicate that PCBs were associated with certain kinds of cancer in humans, such as cancer of the liver and biliary tract. Rats that ate food containing high levels of PCBs for two years developed liver cancer. The Department of Health and Human Services (DHHS) has concluded that PCBs may reasonably be anticipated to be carcinogens. PCBs have been classified as probably carcinogenic, and carcinogenic to humans (group 1) by the Environmental Protection Agency (EPA) and International Agency for Research on Cancer (IARC), respectively.

How can PCBs affect children?

Women who were exposed to relatively high levels of PCBs in the workplace or ate large amounts of fish contaminated with PCBs had babies that weighed slightly less than babies from women who did not have these exposures. Babies born to women who ate PCB-contaminated fish also showed abnormal responses in tests of infant behavior. Some of these behaviors, such as problems with motor skills and a decrease in short-term memory, lasted for several years. Other studies suggest that the immune system was affected in children born to and nursed by mothers exposed to increased levels of PCBs. There are no reports of structural birth defects caused by exposure to PCBs or of health effects of PCBs in older children. The most likely way infants will be exposed to PCBs is from breast milk. Transplacental transfers of PCBs were also reported In most cases, the benefits of breast-feeding outweigh any risks from exposure to PCBs in mother's milk.

How can families reduce the risks of exposure to PCBs?

- You and your children may be exposed to PCBs by eating fish or wildlife caught from contaminated locations. Certain states, Native American tribes, and U.S. territories have issued advisories to warn people about PCB-contaminated fish and fish-eating wildlife. You can reduce your family's exposure to PCBs by obeying these advisories.
- Children should be told not play with old appliances, electrical equipment, or transformers, since they may contain PCBs.
- Children should be discouraged from playing in the dirt near hazardous waste sites and in areas where there was a transformer fire. Children should also be discouraged from eating dirt and putting dirty hands, toys or other objects in their mouths, and should wash hands frequently.
- If you are exposed to PCBs in the workplace it is possible to carry them home on your clothes, body, or tools. If this is the case, you should shower and change clothing before leaving work, and your work clothes should be kept separate from other clothes and laundered separately.

Is there a medical test to show whether I've been exposed to PCBs?

Tests exist to measure levels of PCBs in your blood, body fat, and breast milk, but these are not routinely conducted. Most people normally have low levels of PCBs in their body because nearly everyone has been environmentally exposed to PCBs. The tests can show if your PCB levels are elevated, which would indicate past exposure to above-normal levels of PCBs, but cannot determine when or how long you were exposed or whether you will develop health effects.

Has the federal government made recommendations to protect human health?

The EPA has set a limit of 0.0005 milligrams of PCBs per liter of drinking water (0.0005 mg/L). Discharges, spills or accidental releases of 1 pound or more of PCBs into the environment must be reported to the EPA. The Food and Drug Administration (FDA) requires that infant foods, eggs, milk and other dairy products, fish and shellfish, poultry and red meat contain no more than 0.2-3 parts of PCBs per million parts (0.2-3 ppm) of food. Many states have established fish and wildlife consumption advisories for PCBs.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Toxicological profile for polychlorinated biphenyls (PCBs). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636.

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Phenol - ToxFAQs™

CAS # 108-95-2

This fact sheet answers the most frequently asked health questions (FAQs) about phenol. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Phenol is both a manufactured chemical and a natural substance. Phenol is used as a disinfectant and is found in a number of consumer products. Skin exposure to high amounts can produce skin burns, liver damage, dark urine, irregular heart beat, and even death. Ingestion of concentrated phenol can produce internal burns. Phenol has been found in at least 595 of the 1,678 National Priority List (NPL) sites identified by the Environmental Protection Agency (EPA).

What is phenol?

Phenol is both a manufactured chemical and a natural substance. It is a colorless-to-white solid when pure. The commercial product is a liquid. Phenol has a distinct odor that is sickeningly sweet and tarry.

You can taste and smell phenol at levels lower than those that are associated with harmful effects. Phenol evaporates more slowly than water, and a moderate amount can form a solution with water.

Phenol is used primarily in the production of phenolic resins and in the manufacture of nylon and other synthetic fibers. It is also used in slimicides (chemicals that kill bacteria and fungi in slimes), as a disinfectant and antiseptic, and in medicinal preparations such as mouthwash and sore throat lozenges.

What happens to phenol when it enters the environment?

- Following small, single releases, phenol is rapidly removed from the air (generally, half is removed in less than a day).
- Phenol generally remains in the soil only about 2 to 5 days.
- Phenol can remain in water for a week or more.
- Larger or repeated releases of phenol can remain in the air, water, and soil for much longer periods of time.
- Phenol does not build up in fish, other animals, or plants.

How might I be exposed to phenol?

- You may be exposed to phenol if you live near landfills or hazardous waste sites that contain phenol or near facilities manufacturing phenol.
- You may be exposed to very low levels in your home because it is found in a number of consumer products, including mouthwashes and throat lozenges.
- You may be exposed to phenol if you undergo "chemical peels" to remove skin lesions with phenol-containing products or are treated for chronic pain or spasticity with injections of phenol.
- Low levels of phenol are found in some foods, including smoked summer sausage, fried chicken, mountain cheese, and some species of fish.
- Smoking or inhaling second hand smoke will expose you to phenol.
- Low levels of phenol can be present in air and drinking water.

How can phenol affect my health?

Most of the phenol that you may inhale or ingest will enter the bloodstream; less will enter if there is contact with the skin.

Short-term exposure to phenol in the air can cause respiratory irritation, headaches, and burning eyes. People who had skin exposure to high amounts of phenol had skin burns, liver damage, dark urine, irregular heart beat, and some died. Ingestion of high concentrations of phenol has resulted in internal burns and death.

In animals, breathing air with high levels of phenol resulted in irritation of the lungs. Repeated exposures induced muscle tremors and loss of coordination. Exposure to high concentrations of phenol in the air for several weeks caused paralysis and severe injury to the heart, liver, kidneys, and lungs, and in some cases, death. Some animals that drank water with very high concentrations of phenol suffered muscle tremors and loss of coordination.

Phenol can have beneficial effects when used medically as an antiseptic or anesthetic.

How likely is phenol to cause cancer?

The International Agency for Research on Cancer (IARC) and the EPA have determined that phenol is not classifiable as to its carcinogenicity to humans.

How can phenol affect children?

Vomiting and lethargy were the most frequent signs of toxicity observed in children who accidentally ingested phenol and were treated at a poison control center. We do not know whether children would be more sensitive than adults to the effects of phenol.

Phenol has caused minor birth defects and low birth weight in animals generally at exposure levels that also were toxic to the pregnant mothers.

How can families reduce the risks of exposure to phenol?

- Avoiding environmental tobacco smoke, which contains phenol, will reduce phenol exposures.
- Always store household products and over-the-counter medications that contain phenol in their original labeled containers out of the reach of children.

Is there a medical test to determine whether I've been exposed to phenol?

Phenol can be measured in blood and urine. A higher-than-normal concentration of phenol in the urine may suggest recent exposure to phenol or to substances that are converted to phenol in the body.

The detection of phenol and/or its metabolites in your urine cannot be used to predict the kind of health effects that might develop from that exposure.

Has the federal government made recommendations to protect human health?

The EPA has determined that exposure to phenol in drinking water at concentrations of 6 mg/L for up to 10 days is not expected to cause any adverse effects in a child.

The EPA has determined that lifetime exposure to 2 mg/L phenol in drinking water is not expected to cause any adverse effects.

The Occupational Safety and Health Administration (OSHA) has set a limit of 5 parts per million (ppm) of phenol in air to protect workers during 8-hour work shifts.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2008. Toxicological Profile for Phenol. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636.

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

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SELENIUM

CAS # 7782-49-2

Division of Toxicology ToxFAQs™ **September 2003**

This fact sheet answers the most frequently asked health questions (FAQs) about selenium. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: People may be exposed to low levels of selenium daily through food and water. Selenium is a trace mineral needed in small amounts for good health, but exposure to much higher levels can result in neurological effects and brittle hair and deformed nails. Occupational inhalation exposure to selenium vapors may cause dizziness, fatigue, irritation of mucous membranes, and respiratory effects. This substance has been found in at least 508 of the 1,636 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is selenium?

Selenium is a naturally occurring mineral element that is distributed widely in nature in most rocks and soils. In its pure form, it exists as metallic gray to black hexagonal crystals, but in nature it is usually combined with sulfide or with silver, copper, lead, and nickel minerals. Most processed selenium is used in the electronics industry, but it is also used: as a nutritional supplement; in the glass industry; as a component of pigments in plastics, paints, enamels, inks, and rubber; in the preparation of pharmaceuticals; as a nutritional feed additive for poultry and livestock; in pesticide formulations; in rubber production; as an ingredient in antidandruff shampoos; and as a constituent of fungicides. Radioactive selenium is used in diagnostic medicine.

What happens to selenium when it enters the environment?

❏ Selenium occurs naturally in the environment and can be released by both natural and manufacturing processes.
❏ Selenium dust can enter the air from burning coal and oil. This selenium dust will eventually settle over the land and water.
❏ It also enters water from rocks and soil, and from agricultural and industrial waste. Some selenium compounds will dissolve in water, and some will settle to the bottom as particles.
❏ Insoluble forms of selenium will remain in soil, but soluble forms are very mobile and may enter surface water from soils.
❏ Selenium may accumulate up the food chain.

How might I be exposed to selenium?

❏ The general population is exposed to very low levels of selenium in air, food, and water. The majority of the daily intake comes from food.
❏ People working in or living near industries where selenium is produced, processed, or converted into commercial products may be exposed to higher levels of selenium in the air.
❏ People living in the vicinity of hazardous waste sites or coal burning plants may also be exposed to higher levels of selenium.

How can selenium affect my health?

Selenium has both beneficial and harmful effects. Low doses of selenium are needed to maintain good health. However, exposure to high levels can cause adverse health effects. Short-term oral exposure to high concentrations of selenium may cause nausea, vomiting, and diarrhea. Chronic oral exposure to high concentrations of selenium compounds can produce a disease called selenosis. The major signs of selenosis are hair loss, nail brittleness, and neurological abnormalities (such as numbness and other odd sensations in the extremities).

Brief exposures to high levels of elemental selenium or selenium dioxide in air can result in respiratory tract irritation, bronchitis, difficulty breathing, and stomach pains. Longer-term exposure to either of these air-borne forms can cause respiratory irritation, bronchial spasms, and coughing. Levels of these forms of selenium that would be necessary to produce such effects are normally not seen outside of the workplace.

Animal studies have shown that very high amounts of selenium can affect sperm production and the female reproductive cycle. We do not know if similar effects would occur in humans.

How likely is selenium to cause cancer?

Studies of laboratory animals and people show that most selenium compounds probably do not cause cancer. In fact, studies in humans suggest that lower-than-normal selenium levels in the diet might increase the risk of cancer.

The International Agency for Research on Cancer (IARC) has determined that selenium and selenium compounds are not classifiable as to their carcinogenicity to humans.

The EPA has determined that one specific form of selenium, selenium sulfide, is a probable human carcinogen. Selenium sulfide is not present in foods and is a very different chemical from the organic and inorganic selenium compounds found in foods and in the environment.

How can selenium affect children?

It is likely that the health effects seen in children exposed to selenium will be similar to the effects seen in adults. However, one study found that children may be less susceptible to the health effects of selenium than adults.

Selenium compounds have not been shown to cause birth defects in humans or in other mammals.

How can families reduce the risk of exposure to selenium?

❏ Certain dietary supplements and shampoos contain selenium; these should be used according to the manufacturer's directions.

❏ Children living near waste sites that contain selenium or coal burning plants should be encouraged to wash their hands before eating and to avoid putting their unwashed hands in their mouths.

Is there a medical test to show whether I've been exposed to selenium?

Low levels of selenium are normally found in body tissues and urine. Blood and urine tests for selenium are most useful for people who have recently been exposed to high levels. Toenail clippings can be used to determine longer-term exposure. These tests are not usually available at your doctor's office, but your doctor can send the samples to a laboratory that can perform the tests. None of these tests, however, can predict whether you will experience any health effects.

Has the federal government made recommendations to protect human health?

The EPA restricts the amount of selenium allowed in public water supplies to 50 parts total selenium per billion parts of water (50 ppb).

The Occupational Safety and Health Administration (OSHA) sets a limit of 0.2 mg selenium/m^3 of workroom air for an 8-hour work shift.

ATSDR and the EPA have determined that 5 micrograms of selenium per kilogram of body weight taken daily would not be expected to cause any adverse health effects over a lifetime of such intake.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2003. Toxicological Profile for Selenium (Update) Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

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XYLENE

CAS # 1330-20-7

Division of Toxicology and Environmental Medicine ToxFAQs™ August 2007

This fact sheet answers the most frequently asked health questions (FAQs) about xylene. For more information, call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to xylene occurs in the workplace and when you use paint, gasoline, paint thinners and other products that contain it. People who breathe high levels may have dizziness, confusion, and a change in their sense of balance. Xylene has been found in at least 840 of the 1,684 National Priority List sites identified by the Environmental Protection Agency (EPA).

What is xylene?

There are three forms of xylene in which the methyl groups vary on the benzene ring: *meta*-xylene, *ortho*-xylene, and *para*-xylene (*m*-, *o*-, and *p*-xylene). These different forms are referred to as isomers.

Xylene is a colorless, sweet-smelling liquid that catches on fire easily. It occurs naturally in petroleum and coal tar. Chemical industries produce xylene from petroleum. It is one of the top 30 chemicals produced in the United States in terms of volume.

Xylene is used as a solvent and in the printing, rubber, and leather industries. It is also used as a cleaning agent, a thinner for paint, and in paints and varnishes. It is found in small amounts in airplane fuel and gasoline.

What happens to xylene when it enters the environment?

❏ Xylene evaporates quickly from the soil and surface water into the air.
❏ In the air, it is broken down by sunlight into other less harmful chemicals in a couple of days.
❏ It is broken down by microorganisms in soil and water.
❏ Only a small amount of it builds up in fish, shellfish, plants, and other animals living in xylene-contaminated water.

How might I be exposed to xylene?

❏ Using a variety of consumer products including gasoline, paint varnish, shellac, rust preventatives, and cigarette smoke. Xylene can be absorbed through the respiratory tract and through the skin.
❏ Ingesting xylene-contaminated food or water, although these levels are likely to be very low.
❏ Working in a job that involves the use of xylene such as painters, paint industry workers, biomedical laboratory workers, automobile garage workers, metal workers, and furniture refinishers.

How can xylene affect my health?

No health effects have been noted at the background levels that people are exposed to on a daily basis.

High levels of exposure for short or long periods can cause headaches, lack of muscle coordination, dizziness, confusion, and changes in one's sense of balance. Exposure of people to high levels of xylene for short periods can also cause irritation of the skin, eyes, nose, and throat; difficulty in breathing; problems with the lungs; delayed reaction time; memory difficulties; stomach discomfort; and possibly changes in the liver and kidneys. It can cause unconsciousness and even death at very high levels.

How likely is xylene to cause cancer?

Both the International Agency for Research on Cancer (IARC) and the EPA have found that there is insufficient information to determine whether or not xylene is carcinogenic.

How can xylene affect children?

The effects of xylene have not been studied in children, but it is likely that they would be similar to those seen in exposed adults. Although there is no direct evidence, children may be more sensitive to acute inhalation exposure than adults because their narrower airways would be more sensitive to swelling effects.

Studies of unborn animals indicate that high concentrations of xylene may cause increased numbers of deaths, and delayed growth and development. In many instances, these same concentrations also cause damage to the mothers. We do not know if xylene harms the unborn child if the mother is exposed to low levels of xylene during pregnancy

How can families reduce the risks of exposure to xylene?

❏ Exposure to xylene as solvents (in paints or gasoline) can be reduced if the products are used with adequate ventilation and if they are stored in tightly closed containers out of the reach of small children.
❏ Sometimes older children sniff household chemicals in attempt to get high. Talk with your children about the dangers of sniffing xylene.
❏ If products containing xylene are spilled on the skin, then the excess should be wiped off and the area cleaned with soap and water.

Is there a medical test to determine whether I've been exposed to xylene?

Laboratory tests can detect xylene or its breakdown products in exhaled air, blood, or urine. There is a high degree of agreement between the levels of exposure to xylene and the levels of xylene breakdown products in the urine. However, a urine sample must be provided very soon after exposure ends because xylene quickly leaves the body. These tests are not routinely available at your doctor's office because they require special equipment.

Has the federal government made recommendations to protect human health?

The EPA set a limit of 10 parts xylene per million parts drinking water (10 ppm).

The Occupational Safety and Health Administration (OSHA) has set limits of 100 parts xylene per million parts of workplace air (100 ppm) for 8 hour shifts and 40 hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for Xylene (Update). Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-800-232-4636, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Arsenic - ToxFAQs™

CAS # 7440-38-2

This fact sheet answers the most frequently asked health questions (FAQs) about arsenic. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to higher than average levels of arsenic occur mostly in the workplace, near hazardous waste sites, or in areas with high natural levels. At high levels, inorganic arsenic can cause death. Exposure to lower levels for a long time can cause a discoloration of the skin and the appearance of small corns or warts. Arsenic has been found in at least 1,149 of the 1,684 National Priority List (NPL) sites identified by the Environmental Protection Agency (EPA).

What is arsenic?

Arsenic is a naturally occurring element widely distributed in the earth's crust. In the environment, arsenic is combined with oxygen, chlorine, and sulfur to form inorganic arsenic compounds. Arsenic in animals and plants combines with carbon and hydrogen to form organic arsenic compounds.

Inorganic arsenic compounds are mainly used to preserve wood. Copper chromated arsenate (CCA) is used to make "pressure-treated" lumber. CCA is no longer used in the U.S. for residential uses; it is still used in industrial applications. Organic arsenic compounds are used as pesticides, primarily on cotton fields and orchards.

What happens to arsenic when it enters the environment?

- Arsenic occurs naturally in soil and minerals and may enter the air, water, and land from wind-blown dust and may get into water from runoff and leaching.
- Arsenic cannot be destroyed in the environment. It can only change its form.
- Rain and snow remove arsenic dust particles from the air.
- Many common arsenic compounds can dissolve in water. Most of the arsenic in water will ultimately end up in soil or sediment.
- Fish and shellfish can accumulate arsenic; most of this arsenic is in an organic form called arsenobetaine that is much less harmful.

How might I be exposed to arsenic?

- Ingesting small amounts present in your food and water or breathing air containing arsenic.
- Breathing sawdust or burning smoke from wood treated with arsenic.
- Living in areas with unusually high natural levels of arsenic in rock.
- Working in a job that involves arsenic production or use, such as copper or lead smelting, wood treating, or pesticide application.

How can arsenic affect my health?

Breathing high levels of inorganic arsenic can give you a sore throat or irritated lungs.

Ingesting very high levels of arsenic can result in death. Exposure to lower levels can cause nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels, and a sensation of "pins and needles" in hands and feet.

Ingesting or breathing low levels of inorganic arsenic for a long time can cause a darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso.

Skin contact with inorganic arsenic may cause redness and swelling.

Almost nothing is known regarding health effects of organic arsenic compounds in humans. Studies in animals show that some simple organic arsenic compounds are less toxic than inorganic forms. Ingestion of methyl and dimethyl compounds can cause diarrhea and damage to the kidneys.

How likely is arsenic to cause cancer?

Several studies have shown that ingestion of inorganic arsenic can increase the risk of skin cancer and cancer in the liver, bladder, and lungs. Inhalation of inorganic arsenic can cause increased risk of lung cancer. The Department of Health and Human Services (DHHS) and the EPA have determined that inorganic arsenic is a known human carcinogen. The International Agency for Research on Cancer (IARC) has determined that inorganic arsenic is carcinogenic to humans.

How can arsenic affect children?

There is some evidence that long-term exposure to arsenic in children may result in lower IQ scores. There is also some evidence that exposure to arsenic in the womb and early childhood may increase mortality in young adults.

There is some evidence that inhaled or ingested arsenic can injure pregnant women or their unborn babies, although the studies are not definitive. Studies in animals show that large doses of arsenic that cause illness in pregnant females, can also cause low birth weight, fetal malformations, and even fetal death. Arsenic can cross the placenta and has been found in fetal tissues. Arsenic is found at low levels in breast milk.

How can families reduce the risks of exposure to arsenic?

- If you use arsenic-treated wood in home projects, you should wear dust masks, gloves, and protective clothing to decrease exposure to sawdust.
- If you live in an area with high levels of arsenic in water or soil, you should use cleaner sources of water and limit contact with soil.
- If you work in a job that may expose you to arsenic, be aware that you may carry arsenic home on your clothing, skin, hair, or tools. Be sure to shower and change clothes before going home.

Is there a medical test to determine whether I've been exposed to arsenic?

There are tests available to measure arsenic in your blood, urine, hair, and fingernails. The urine test is the most reliable test for arsenic exposure within the last few days. Tests on hair and fingernails can measure exposure to high levels of arsenic over the past 6-12 months. These tests can determine if you have been exposed to above-average levels of arsenic. They cannot predict whether the arsenic levels in your body will affect your health.

Has the federal government made recommendations to protect human health?

The EPA has set limits on the amount of arsenic that industrial sources can release to the environment and has restricted or cancelled many of the uses of arsenic in pesticides. EPA has set a limit of 0.01 parts per million (ppm) for arsenic in drinking water.

The Occupational Safety and Health Administration (OSHA) has set a permissible exposure limit (PEL) of 10 micrograms of arsenic per cubic meter of workplace air (10 $\mu g/m^3$) for 8 hour shifts and 40 hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for Arsenic (Update). Atlanta, GA: U.S. Department of Health and Human Services. Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636

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AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

BARIUM

CAS # 7440-39-3

Division of Toxicology and Human Health Sciences ToxFAQs™ June 2013

This fact sheet answers the most frequently asked health questions (FAQs) about barium and barium compounds. For more information, call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because these substances may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to barium occurs mostly in the workplace or from drinking contaminated water. Ingesting drinking water containing levels of barium above the EPA drinking water guidelines for relatively short periods of time can cause gastrointestinal disturbances and muscle weakness. Ingesting high levels for a long time can damage the kidneys. Barium and barium compounds have been found in at least 798 of the 1,684 National Priority List sites identified by the Environmental Protection Agency (EPA).

What is barium?

Barium is a silvery-white metal which exists in nature only in ores containing mixtures of elements. It combines with other chemicals such as sulfur or carbon and oxygen to form barium compounds.

Barium compounds are used by the oil and gas industries to make drilling muds. Drilling muds make it easier to drill through rock by keeping the drill bit lubricated. They are also used to make paint, bricks, ceramics, glass, and rubber.

Barium sulfate is sometimes used by doctors to perform medical tests and to take x-rays of the gastrointestinal tract.

What happens to barium when it enters the environment?

- Barium gets into the air during the mining, refining, and production of barium compounds, and from the burning of coal and oil.
- The length of time that barium will last in air, land, water, or sediments depends on the form of barium released.
- Barium compounds, such as barium sulfate and barium carbonate, which do not dissolve well in water, can last a long time in the environment.
- Barium compounds, such as barium chloride, barium nitrate, or barium hydroxide, that dissolve easily in water usually do not last in these forms for a long time in the environment. The barium in these compounds that is dissolved in water quickly combines with sulfate or carbonate that are naturally found in water and become the longer lasting forms (barium sulfate and barium carbonate).
- Fish and aquatic organisms can accumulate barium.

How might I be exposed to barium?

- Ingesting small amounts present in your food and water or breathing air containing very low levels of barium.
- Living in areas with unusually high natural levels of barium in the drinking water.
- Working in a job that involves barium production or use.
- Living or working near waste sites where barium has been disposed of.

How can barium affect my health?

The health effects of the different barium compounds depend on how well the compound dissolves in water or in the stomach contents. Barium compounds that do not dissolve well, such as barium sulfate, are not generally harmful.

Barium has been found to potentially cause gastrointestinal disturbances and muscular weakness when people are exposed to it at levels above the EPA drinking water standards for relatively short periods of time. Some people who eat or drink amounts of barium above background levels found in food and water for a short period may experience vomiting, abdominal cramps, diarrhea, difficulties in breathing, increased or decreased blood pressure, numbness around the face, and muscle weakness. Eating or drinking very large amounts of barium compounds that easily dissolve can cause changes in heart rhythm or paralysis and possibly death. Animals that drank barium over long periods had damage to the kidneys, decreases in body weight, and some died.

How likely is barium to cause cancer?

The Department of Health and Human Services (DHHS) and the International Agency for Research on Cancer (IARC) have not classified barium as to its carcinogenicity. The EPA has determined that barium is not likely to be carcinogenic to humans following ingestion and that there is insufficient information to determine whether it will be carcinogenic to humans following inhalation exposure.

How can barium affect children?

We do not know whether children will be more or less sensitive than adults to barium toxicity. A study in rats that swallowed barium found a decrease in newborn body weight; we do not know if a similar effect would be seen in humans.

How can families reduce the risk of exposure to barium?

- ☐ The greatest potential source of barium exposure is through food and drinking water. However, the amount of barium in foods and drinking water are typically too low to be of concern.

Is there a medical test to determine whether I've been exposed to barium?

There is no routine medical test to determine whether you have been exposed to barium. Doctors can measure barium in body tissues and fluids, such as bones, blood, urine, and feces, using very complex instruments. These tests cannot be used to predict the extent of the exposure or potential health effects.

The geometric mean barium level measured in the U.S. general population aged 6 and older is reported by the Centers for Disease Control and Prevention (CDC) as 1.56 µg/g creatinine (measured in urine).

Has the federal government made recommendations to protect human health?

The EPA has set a limit of 2.0 milligrams of barium per liter of drinking water (2.0 mg/L), which is the same as 2 ppm.

The Occupational Safety and Health Administration (OSHA) has set Permissible Exposure Limits (PELs) of 0.5 milligrams of soluble barium compounds per cubic meter of workplace air (0.5 mg/m^3) for 8 hour shifts and 40 hour work weeks. The OSHA limits for barium sulfate dust are 15 mg/m^3 of total dust and 5 mg/m^3 for respirable fraction.

The National Institute for Occupational Safety and Health (NIOSH) has set Recommended Exposure Limits (RELs) of 0.5 mg/m^3 for soluble barium compounds. The NIOSH has set RELs of 10 mg/m^3 (total dust) for barium sulfate and 5 mg/m^3 (respirable fraction).

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for Barium and Compounds (*Update*). Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

http://www.cdc.gov/exposurereport/pdf/FourthReport_UpdatedTables_Sep2012.pdf

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30333. Phone: 1-800-232-4636, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Chromium - ToxFAQs™

CAS # 7440-47-3

This fact sheet answers the most frequently asked health questions (FAQs) about chromium. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to chromium occurs from ingesting contaminated food or drinking water or breathing contaminated workplace air. Chromium(VI) at high levels can damage the nose and cause cancer. Ingesting high levels of chromium(VI) may result in anemia or damage to the stomach or intestines. Chromium(III) is an essential nutrient. Chromium has been found in at least 1,127 of the 1,669 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA).

What is chromium?

Chromium is a naturally occurring element found in rocks, animals, plants, and soil. It can exist in several different forms. Depending on the form it takes, it can be a liquid, solid, or gas. The most common forms are chromium(0), chromium(III), and chromium(VI). No taste or odor is associated with chromium compounds.

The metal chromium, which is the chromium(0) form, is used for making steel. Chromium(VI) and chromium(III) are used for chrome plating, dyes and pigments, leather tanning, and wood preserving.

What happens to chromium when it enters the environment?

- Chromium can be found in air, soil, and water after release from the manufacture, use, and disposal of chromium-based products, and during the manufacturing process.
- Chromium does not usually remain in the atmosphere, but is deposited into the soil and water.
- Chromium can easily change from one form to another in water and soil, depending on the conditions present.
- Fish do not accumulate much chromium in their bodies from water.

How might I be exposed to chromium?

- Eating food containing chromium(III).
- Breathing contaminated workplace air or skin contact during use in the workplace.
- Drinking contaminated well water.
- Living near uncontrolled hazardous waste sites containing chromium or industries that use chromium.

How can chromium affect my health?

Chromium(III) is an essential nutrient that helps the body use sugar, protein, and fat.

Breathing high levels of chromium(VI) can cause irritation to the lining of the nose, nose ulcers, runny nose, and breathing problems, such as asthma, cough, shortness of breath, or wheezing. The concentrations of chromium in air that can cause these effects may be different for different types of chromium compounds, with effects occurring at much lower concentrations for chromium(VI) compared to chromium(III).

The main health problems seen in animals following ingestion of chromium(VI) compounds are irritation and ulcers in the stomach and small intestine and anemia. Chromium(III) compounds are much less toxic and do not appear to cause these problems.

Sperm damage and damage to the male reproductive system have also been seen in laboratory animals exposed to chromium(VI).

Skin contact with certain chromium(VI) compounds can cause skin ulcers. Some people are extremely sensitive tochromium(VI) or chromium(III). Allergic reactions consisting of severe redness and swelling of the skin have been noted.

How likely is chromium to cause cancer?

The Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), and the EPA have determined that chromium(VI) compounds are known human carcinogens.

In workers, inhalation of chromium(VI) has been shown to cause lung cancer. Chromium(VI) also causes lung cancer in animals. An increase in stomach tumors was observed in humans and animals exposed to chromium(VI) in drinking water.

How can chromium affect children?

It is likely that health effects seen in children exposed to high amounts of chromium will be similar to the effects seen in adults.

We do not know if exposure to chromium will result in birth defects or other developmental effects in people. Some developmental effects have been observed in animals exposed to chromium(VI).

How can families reduce the risk of exposure to chromium?

- Children should avoid playing in soils near uncontrolled hazardous waste sites where chromium may have been discarded.
- Chromium is a component of tobacco smoke. Avoid smoking in enclosed spaces like inside the home or car in order to limit exposure to children and other family members.
- Although chromium(III) is an essential nutrient, you should avoid excessive use of dietary supplements containing chromium.

Is there a medical test to determine whether I've been exposed to chromium?

Since chromium(III) is an essential element and naturally occurs in food, there will always be some level of chromium in your body. Chromium can be measured in hair, urine, and blood.

Higher than normal levels of chromium in blood or urine may indicate that a person has been exposed to chromium. However, increases in blood and urine chromium levels cannot be used to predict the kind of health effects that might develop from that exposure.

Has the federal government made recommendations to protect human health?

The EPA has established a maximum contaminant level of 0.1 mg/L for total chromium in drinking water.

The FDA has determined that the chromium concentration in bottled drinking water should not exceed 0.1 mg/L.

The Occupational Health and Safety Administration (OSHA) has limited workers' exposure to an average of 0.005 mg/m^3 chromium(VI), 0.5 mg/m^3 chromium(III), and 1.0 mg/m^3 chromium(0) for an 8-hour workday, 40-hour workweek.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2012. Toxicological Profile for Chromium. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

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AND DISEASE REGISTRY

COPPER

CAS # 7440-50-8

Division of Toxicology ToxFAQs™ **September 2004**

This fact sheet answers the most frequently asked health questions (FAQs) about copper. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Copper is a metal that occurs naturally in the environment, and also in plants and animals. Low levels of copper are essential for maintaining good health. High levels can cause harmful effects such as irritation of the nose, mouth and eyes, vomiting, diarrhea, stomach cramps, nausea, and even death. Copper has been found in at least 906 of the 1,647 National Priority Sites identified by the Environmental Protection Agency (EPA).

What is copper?

Copper is a metal that occurs naturally throughout the environment, in rocks, soil, water, and air. Copper is an essential element in plants and animals (including humans), which means it is necessary for us to live. Therefore, plants and animals must absorb some copper from eating, drinking, and breathing.

Copper is used to make many different kinds of products like wire, plumbing pipes, and sheet metal. U.S. pennies made before 1982 are made of copper, while those made after 1982 are only coated with copper. Copper is also combined with other metals to make brass and bronze pipes and faucets.

Copper compounds are commonly used in agriculture to treat plant diseases like mildew, for water treatment and, as preservatives for wood, leather, and fabrics.

What happens to copper when it enters the environment?

❑ Copper is released into the environment by mining, farming, and manufacturing operations and through waste water releases into rivers and lakes. Copper is also released from natural sources, like volcanoes, windblown dusts, decaying vegetation, and forest fires.
❑ Copper released into the environment usually attaches to particles made of organic matter, clay, soil, or sand.
❑ Copper does not break down in the environment. Copper compounds can break down and release free copper into the air, water, and foods.

How might I be exposed to copper?

❑ You may be exposed to copper from breathing air, drinking water, eating foods, or having skin contact with copper, particulates attached to copper, or copper-containing compounds.
❑ Drinking water may have high levels of copper if your house has copper pipes and acidic water.
❑ Lakes and rivers that have been treated with copper compounds to control algae, or that receive cooling water from power plants, can have high levels of copper. Soils can also contain high levels of copper, especially if they are near copper smelting plants.
❑ You may be exposed to copper by ingesting copper-containing fungicides, or if you live near a copper mine or where copper is processed into bronze or brass.
❑ You may be exposed to copper if you work in copper mines or if you grind metals containing copper.

How can copper affect my health?

Everyone must absorb small amounts of copper every day because copper is essential for good health. High levels of copper can be harmful. Breathing high levels of copper can cause irritation of your nose and throat. Ingesting high levels of copper can cause nausea, vomiting, and diarrhea. Very-high doses of copper can cause damage to your liver and kidneys, and can even cause death.

How likely is copper to cause cancer?

We do not know whether copper can cause cancer in humans. The EPA has determined that copper is not classifiable as to human carcinogenicity.

How can copper affect children?

Exposure to high levels of copper will result in the same type of effects in children and adults. We do not know if these effects would occur at the same dose level in children and adults. Studies in animals suggest that the young children may have more severe effects than adults, but we don't know if this would also be true in humans. There is a very small percentage of infants and children who are unusually sensitive to copper.

We do not know if copper can cause birth defects or other developmental effects in humans. Studies in animals suggest that high levels of copper may cause a decrease in fetal growth.

How can families reduce the risk of exposure to copper?

The most likely place to be exposed to copper is through drinking water, especially if your water is corrosive and you have copper pipes in your house. The best way to lower the level of copper in your drinking water is to let the water run for at least 15 seconds first thing in the morning before drinking or using it. This reduces the levels of copper in tap water dramatically.

If you work with copper, wear the necessary protective clothing and equipment, and always follow safety procedures. Shower and change your clothes before going home each day.

Is there a medical test to show whether I've been exposed to copper?

Copper is found throughout the body; in hair, nails, blood, urine, and other tissues. High levels of copper in these samples can show that you have been exposed to higher-than normal levels of copper. These tests cannot tell whether you will experience harmful effects. Tests to measure copper levels in the body are not usually available at a doctor's office because they require special equipment, but the doctor can send samples to a specialty laboratory.

Has the federal government made recommendations to protect human health?

The EPA requires that levels of copper in drinking water be less than 1.3 mg of copper per one liter of drinking water (1.3 mg/L).

The U.S. Department of Agriculture has set the recommended daily allowance for copper at 900 micrograms of copper per day (µg/day) for people older than eight years old.

The Occupational Safety and Health Administration (OSHA) requires that levels of copper in the air in workplaces not exceed 0.1 mg of copper fumes per cubic meter of air (0.1 mg/m^3) and 1.0 mg/m^3 for copper dusts.

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2004. Toxicological Profile for Copper. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

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DIETHYL PHTHALATE
CAS # 84-66-2

Agency for Toxic Substances and Disease Registry ToxFAQs September 1996

This fact sheet answers the most frequently asked health questions (FAQs) about diethyl phthlate. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

SUMMARY: Exposure to diethyl phthalate occurs when you use plastics that contain it, and when you eat food from plastic containers made with it. Health effects have not been reported in people exposed to diethyl phthalate. This substance has been found in at least 248 of the 1,430 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is diethyl phthalate?
(Pronounced dī ĕth′əl thăl′āt)

Diethyl phthalate is a colorless liquid that has a bitter, disagreeable taste. This synthetic substance is commonly used to make plastics more flexible. Products in which it is found include toothbrushes, automobile parts, tools, toys, and food packaging.

Diethyl phthalate can be released fairly easily from these products, as it is not part of the chain of chemicals (polymers) that makes up the plastic. Diethyl phthalate is also used in cosmetics, insecticides, and aspirin.

What happens to diethyl phthalate when it enters the environment?

- Diethyl phthalate has been found in waste sites and landfills from discarded plastics.
- It may break down in the air.
- It can become attached to particles of dust in the air, and can settle out.
- It is broken down to harmless products by microorganisms in soil and water.
- Small amounts of it can build up in fish and shellfish living in water containing it.

How might I be exposed to diethyl phthalate?

- Eating food that was contained in plastic packaging.
- Eating contaminated fish and shellfish.
- Drinking contaminated water near waste sites and landfills that contain diethyl phthalate.
- Using consumer products that contain it.

How can diethyl phthalate affect my health?

No information is available regarding possible effects caused by diethyl phthalate if you breathe, eat, or drink it, or if it touches your skin. Very high oral doses of diethyl phthalate have caused death in animals, but brief oral exposures to lower doses caused no harmful effects.

Weight gain was decreased in animals that ate high doses of diethyl phthalate for a long time. The liver and kidneys of these animals were larger than normal, but not from any harmful effects of diethyl phthalate.

It is not known if diethyl phthalate causes birth defects in humans. Fewer live babies were born to female animals that were exposed to diethyl phthalate throughout their lives.

The presence of an extra rib has been noted in newborn rats whose mothers were given very high dietary doses of diethyl phthalate, but this effect is not considered harmful by all scientists.

Some birth defects occurred in rats whose mothers received high doses of diethyl phthalate by injection during pregnancy. Humans are not exposed to diethyl phthalate by this route.

Diethyl phthalate can be mildly irritating when applied to the skin of animals. It can also be slightly irritating when put directly into the eyes of animals.

How likely is diethyl phthalate to cause cancer?

The EPA has determined that diethyl phthalate is not classifiable as to its carcinogenicity in humans.

Diethyl phthalate placed directly on the skin of rats daily for 2 years was not carcinogenic. Liver tumors were seen in mice that had diethyl phthalate placed directly on their skin daily for 2 years. This type of tumor is common in mice, and the smallest dose resulted in a similar number of tumors as the largest dose.

It is not clear if diethyl phthalate will cause a similar effect in humans. Other studies of cancer in humans or animals exposed to diethyl phthalate were not located.

Is there a medical test to show whether I've been exposed to diethyl phthalate?

There is no routine medical test to show if you have been exposed to diethyl phthalate. However, it has been measured in semen, fat, and kidney tissue in laboratory studies. These tests aren't available at most doctors' offices, but can be done at special laboratories that have the right equipment.

Has the federal government made recommendations to protect human health?

The EPA requires that spills or accidental releases into the environment of 1,000 pounds or more of diethyl phthalate be reported to the EPA.

The National Institute for Occupational Safety and Health (NIOSH) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommend a maximum concentration of 5 milligrams of diethyl phthalate per cubic meter of air (5 mg/m^3) in workplace air for an 8- to 10-hour workday, 40-hour workweek.

Glossary

Carcinogenicity: Ability to cause cancer.

CAS: Chemical Abstracts Service.

Insecticide: Substance that kills insects.

Milligram (mg): One thousandth of a gram.

Oral: Taken by mouth.

Synthetic: Made by humans.

Tumor: An abnormal mass of tissue.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for diethyl phthalate (update). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Lead – ToxFAQs™

CAS # 7439-92-1

This fact sheet answers the most frequently asked health questions (FAQs) about lead. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to lead can happen from breathing workplace air or dust, eating contaminated foods, or drinking contaminated water. Children can be exposed from eating lead-based paint chips or playing in contaminated soil. Lead can damage the nervous system, kidneys, and reproductive system. Lead has been found in at least 1,272 of the 1,684 National Priority List (NPL) sites identified by the Environmental Protection Agency (EPA).

What is lead?

Lead is a naturally occurring bluish-gray metal found in small amounts in the earth's crust. Lead can be found in all parts of our environment. Much of it comes from human activities including burning fossil fuels, mining, and manufacturing.

Lead has many different uses. It is used in the production of batteries, ammunition, metal products (solder and pipes), and devices to shield X-rays. Because of health concerns, lead from paints and ceramic products, caulking, and pipe solder has been dramatically reduced in recent years. The use of lead as an additive to gasoline was banned in 1996 in the United States.

What happens to lead when it enters the environment?

- Lead itself does not break down, but lead compounds are changed by sunlight, air, and water.
- When lead is released to the air, it may travel long distances before settling to the ground.
- Once lead falls onto soil, it usually sticks to soil particles.
- Movement of lead from soil into groundwater will depend on the type of lead compound and the characteristics of the soil.

How might I be exposed to lead?

- Eating food or drinking water that contains lead. Water pipes in some older homes may contain lead solder. Lead can leach out into the water.
- Spending time in areas where lead-based paints have been used and are deteriorating. Deteriorating lead paint can contribute to lead dust.
- Working in a job where lead is used or engaging in certain hobbies in which lead is used, such as making stained glass.
- Using health-care products or folk remedies that contain lead.

How can lead affect my health?

The effects of lead are the same whether it enters the body through breathing or swallowing. Lead can affect almost every organ and system in your body. The main target for lead toxicity is the nervous system, both in adults and children. Long-term exposure of adults can result in decreased performance in some tests that measure functions of the nervous system. It may also cause weakness in fingers, wrists, or ankles. Lead exposure also causes small increases in blood pressure, particularly in middle-aged and older people and can cause anemia. Exposure to high lead levels can severely damage the brain and kidneys in adults or children and ultimately cause death. In pregnant women, high-levels of exposure to lead may cause miscarriage. High-level exposure in men can damage the organs responsible for sperm production.

How likely is lead to cause cancer?

We have no conclusive proof that lead causes cancer in humans. Kidney tumors have developed in rats and mice that had been given large doses of some kind of lead compounds. The Department of Health and Human Services (DHHS) has determined that lead and lead compounds are reasonably anticipated to be human carcinogens and the EPA has determined that lead is a probable human carcinogen. The International Agency for Research on Cancer (IARC) has determined that inorganic lead is probably carcinogenic to humans and that there is insufficient information to determine whether organic lead compounds will cause cancer in humans.

Lead

CAS # 7439-92-1

How can lead affect children?

Small children can be exposed by eating lead-based paint chips, chewing on objects painted with lead-based paint, or swallowing house dust or soil that contains lead.

Children are more vulnerable to lead poisoning than adults. A child who swallows large amounts of lead may develop blood anemia, severe stomachache, muscle weakness, and brain damage. If a child swallows smaller amounts of lead, much less severe effects on blood and brain function may occur. Even at much lower levels of exposure, lead can affect a child's mental and physical growth.

Exposure to lead is more dangerous for young and unborn children. Unborn children can be exposed to lead through their mothers. Harmful effects include premature births, smaller babies, decreased mental ability in the infant, learning difficulties, and reduced growth in young children. These effects are more common if the mother or baby was exposed to high levels of lead. Some of these effects may persist beyond childhood.

How can families reduce the risks of exposure to lead?

- Avoid exposure to sources of lead.
- Do not allow children to chew or mouth surfaces that may have been painted with lead-based paint.
- If you have a water lead problem, run or flush water that has been standing overnight before drinking or cooking with it.
- Some types of paints and pigments that are used as make-up or hair coloring contain lead. Keep these kinds of products away from children.
- If your home contains lead-based paint or you live in an area contaminated with lead, wash children's hands and faces often to remove lead dusts and soil, and regularly clean the house of dust and tracked in soil.

Is there a medical test to determine whether I've been exposed to lead?

A blood test is available to measure the amount of lead in your blood and to estimate the amount of your recent exposure to lead. Blood tests are commonly used to screen children for lead poisoning. Lead in teeth or bones can be measured by X-ray techniques, but these methods are not widely available. Exposure to lead also can be evaluated by measuring erythrocyte protoporphyrin (EP) in blood samples. EP is a part of red blood cells known to increase when the amount of lead in the blood is high. However, the EP level is not sensitive enough to identify children with elevated blood lead levels below about 25 micrograms per deciliter (µg/dL). These tests usually require special analytical equipment that is not available in a doctor's office. However, your doctor can draw blood samples and send them to appropriate laboratories for analysis.

Has the federal government made recommendations to protect human health?

The Centers for Disease Control and Prevention (CDC) recommends that states test children at ages 1 and 2 years. Children should be tested at ages 3–6 years if they have never been tested for lead, if they receive services from public assistance programs for the poor such as Medicaid or the Supplemental Food Program for Women, Infants, and Children, if they live in a building or frequently visit a house built before 1950; if they visit a home (house or apartment) built before 1978 that has been recently remodeled; and/or if they have a brother, sister, or playmate who has had lead poisoning. CDC has updated its recommendations on children's blood lead levels. Experts now use an upper reference level value of 97.5% of the population distribution for children's blood lead. In 2012-2015, the value to identify children with blood lead levels that are much higher than most children have, is 5 micrograms per deciliter (µg/dL). EPA limits lead in drinking water to 15 µg per liter.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for lead (Update). Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636.

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Manganese - ToxFAQs™

CAS # 7439-96-5

This fact sheet answers the most frequently asked health questions (FAQs) about manganese. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Manganese is a trace element and eating a small amount from food or water is needed to stay healthy. Exposure to excess levels of manganese may occur from breathing air, particularly where manganese is used in manufacturing, and from drinking water and eating food. At high levels, it can cause damage to the brain. Manganese has been found in at least 869 of the 1,669 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA).

What is manganese?

Manganese is a naturally occurring metal that is found in many types of rocks. Pure manganese is silver-colored, but does not occur naturally. It combines with other substances such as oxygen, sulfur, or chlorine. Manganese occurs naturally in most foods and may be added to some foods.

Manganese is used principally in steel production to improve hardness, stiffness, and strength. It may also be used as an additive in gasoline to improve the octane rating of the gas.

What happens to manganese when it enters the environment?

- Manganese can be released to the air, soil, and water from the manufacture, use, and disposal of manganese-based products.
- Manganese cannot break down in the environment. It can only change its form or become attached to or separated from particles.
- In water, manganese tends to attach to particles in the water or settle into the sediment.
- The chemical state of manganese and the type of soil determine how fast it moves through the soil and how much is retained in the soil.
- The manganese-containing gasoline additive may degrade in the environment quickly when exposed to sunlight, releasing manganese.

How might I be exposed to manganese?

- The primary way you can be exposed to manganese is by eating food or manganese-containing nutritional supplements. Vegetarians, who consume foods rich in manganese such as grains, beans and nuts, as well as heavy tea drinkers, may have a higher intake of manganese than the average person.
- Certain occupations like welding or working in a factory where steel is made may increase your chances of being exposed to high levels of manganese.
- Manganese is routinely contained in groundwater, drinking water, and soil at low levels. Drinking water containing manganese or swimming or bathing in water containing manganese may expose you to low levels of this chemical.

How can manganese affect my health?

Manganese is an essential nutrient, and eating a small amount of it each day is important to stay healthy.

The most common health problems in workers exposed to high levels of manganese involve the nervous system. These health effects include behavioral changes and other nervous system effects, which include movements that may become slow and clumsy. This combination of symptoms when sufficiently severe is referred to as "manganism". Other less severe nervous system effects such as slowed hand movements have been observed in some workers exposed to lower concentrations in the work place.

Manganese

CAS # 7439-96-5

Exposure to high levels of manganese in air can cause lung irritation and reproductive effects.

Nervous system and reproductive effects have been observed in animals after high oral doses of manganese.

How likely is manganese to cause cancer?

The EPA concluded that existing scientific information cannot determine whether or not excess manganese can cause cancer.

How can manganese affect children?

Studies in children have suggested that extremely high levels of manganese exposure may produce undesirable effects on brain development, including changes in behavior and decreases in the ability to learn and remember. We do not know for certain that these changes were caused by manganese alone. We do not know if these changes are temporary or permanent. We do not know whether children are more sensitive than adults to the effects of manganese, but there is some indication from experiments in laboratory animals that they may be.

Studies of manganese workers have not found increases in birth defects or low birth weight in their offspring. No birth defects were observed in animals exposed to manganese.

How can families reduce the risk of exposure to manganese?

- Children are not likely to be exposed to harmful amounts of manganese in the diet. However, higher-than-usual amounts of manganese may be absorbed if their diet is low in iron. It is important to provide your child with a well-balanced diet.
- Workers exposed to high levels of airborne manganese in certain occupational settings may accumulate manganese dust on their work clothes. Manganese-contaminated work clothing should be removed before getting into your car or entering your home to help reduce the exposure hazard for yourself and your family.

Is there a medical test to determine whether I've been exposed to manganese?

Several tests are available to measure manganese in blood, urine, hair, or feces. Because manganese is normally present in our body, some is always found in tissues or fluids.

Because excess manganese is usually removed from the body within a few days, past exposures are difficult to measure with common laboratory tests.

Has the federal government made recommendations to protect human health?

The EPA has determined that exposure to manganese in drinking water at concentrations of 1 mg/L for up to 10 days is not expected to cause any adverse effects in a child.

The EPA has established that lifetime exposure to 0.3 mg/L manganese is not expected to cause any adverse effects.

The Food and Drug Administration (FDA) has determined that the manganese concentration in bottled drinking water should not exceed 0.05 mg/L.

The Occupational Health and Safety Administration (OSHA) has established a ceiling limit (concentration that should not be exceeded at any time during exposure) of 5 mg/m^3 for manganese in workplace air.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2012. Toxicological Profile for Manganese. Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636.

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Mercury - ToxFAQs™

CAS # 7439-97-6

This fact sheet answers the most frequently asked health questions (FAQs) about mercury. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to mercury occurs from breathing contaminated air, ingesting contaminated water and food, and having dental and medical treatments. Mercury, at high levels, may damage the brain, kidneys, and developing fetus. This chemical has been found in at least 714 of 1,467 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA).

What is mercury?

Mercury is a naturally occurring metal which has several forms. The metallic mercury is a shiny, silver-white, odorless liquid. If heated, it is a colorless, odorless gas.

Mercury combines with other elements, such as chlorine, sulfur, or oxygen, to form inorganic mercury compounds or "salts," which are usually white powders or crystals. Mercury also combines with carbon to make organic mercury compounds. The most common one, methylmercury, is produced mainly by microscopic organisms in the water and soil. More mercury in the environment can increase the amounts of methylmercury that these small organisms make.

Metallic mercury is used to produce chlorine gas and caustic soda, and is also used in thermometers, some dental fillings, and batteries. Mercury salts are sometimes used in skin lightening creams and as antiseptic creams and ointments.

What happens to mercury when it enters the environment?

- Inorganic mercury (metallic mercury and inorganic mercury compounds) enters the air from mining ore deposits, burning coal and waste, and from manufacturing plants.
- It enters the water or soil from natural deposits, disposal of wastes, and volcanic activity.
- Methylmercury may be formed in water and soil by small organisms called bacteria.
- Methylmercury builds up in the tissues of fish. Larger and older fish tend to have the highest levels of mercury.

How might I be exposed to mercury?

- Eating fish or shellfish contaminated with methylmercury.
- Breathing vapors in air from spills, incinerators, and industries that burn mercury-containing fossil fuels.
- Release of mercury from dental work and medical treatments.
- Breathing contaminated workplace air or skin contact during use in the workplace.
- Practicing rituals that include mercury.

How can mercury affect my health?

The nervous system is very sensitive to all forms of mercury. Methylmercury and metallic mercury vapors are more harmful than other forms, because more mercury in these forms reaches the brain. Exposure to high levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus. Effects on brain functioning may result in irritability, shyness, tremors, changes in vision or hearing, and memory problems.

Short-term exposure to high levels of metallic mercury vapors may cause effects including lung damage, nausea, vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes, and eye irritation.

Mercury

CAS # 7439-97-6

How likely is mercury to cause cancer?

There are inadequate human cancer data available for all forms of mercury. Mercuric chloride has caused increases in several types of tumors in rats and mice, and methylmercury has caused kidney tumors in male mice. The EPA has determined that mercuric chloride and methylmercury are possible human carcinogens.

How can mercury affect children?

Very young children are more sensitive to mercury than adults. Mercury in the mother's body passes to the fetus and may accumulate there, possibly causing damage to the developing nervous system. It can also pass to a nursing infant through breast milk. However, the benefits of breast feeding may be greater than the possible adverse effects of mercury in breast milk.

Mercury's harmful effects that may affect the fetus include brain damage, mental retardation, incoordination, blindness, seizures, and inability to speak. Children poisoned by mercury may develop problems of their nervous and digestive systems, and kidney damage.

How can families reduce the risk of exposure to mercury?

Carefully handle and dispose of products that contain mercury, such as thermometers or fluorescent light bulbs. Do not vacuum up spilled mercury, because it will vaporize and increase exposure. If a large amount of mercury has been spilled, contact your health department. Teach children not to play with shiny, silver liquids.

Properly dispose of older medicines that contain mercury. Keep all mercury-containing medicines away from children.

Pregnant women and children should keep away from rooms where liquid mercury has been used.

Learn about wildlife and fish advisories in your area from your public health or natural resources department.

Is there a medical test to determine whether I've been exposed to mercury?

Tests are available to measure mercury levels in the body. Blood or urine samples are used to test for exposure to metallic mercury and to inorganic forms of mercury. Mercury in whole blood or in scalp hair is measured to determine exposure to methylmercury. Your doctor can take samples and send them to a testing laboratory.

Has the federal government made recommendations to protect human health?

The EPA has set a limit of 2 parts of mercury per billion parts of drinking water (2 ppb).

The Food and Drug Administration (FDA) has set a maximum permissible level of 1 part of methylmercury in a million parts of seafood (1 ppm).

The Occupational Safety and Health Administration (OSHA) has set limits of 0.1 milligram of organic mercury per cubic meter of workplace air (0.1 mg/m^3) and 0.05 mg/m^3 of metallic mercury vapor for 8-hour shifts and 40-hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1999. Toxicological profile for mercury. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636.

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

ATSDR
AGENCY FOR TOXIC SUBSTANCES
AND DISEASE REGISTRY

METHYL *TERT*-BUTYL ETHER (MTBE) CAS # 1634-04-4

Agency for Toxic Substances and Disease Registry ToxFAQs **September 1997**

This fact sheet answers the most frequently asked health questions (FAQs) about methyl *tert*-butyl ether (MTBE). For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Methyl *tert*-butyl ether (MTBE) is a flammable liquid which is used as an additive in unleaded gasoline. Drinking or breathing MTBE may cause nausea, nose and throat irritation, and nervous system effects. MTBE has been found in at least 11 of the 1,430 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is methyl *tert*-butyl ether?

(Pronounced mĕth′əl tũr′shē-ĕr′ē byo͞ot′l ē′thər)

Methyl *tert*-butyl ether (MTBE) is a flammable liquid with a distinctive, disagreeable odor. It is made from blending chemicals such as isobutylene and methanol, and has been used since the 1980s as an additive for unleaded gasolines to achieve more efficient burning.

MTBE is also used to dissolve gallstones. Patients treated in this way have MTBE delivered directly to their gall bladders through special tubes that are surgically inserted.

What happens to MTBE when it enters the environment?

- ☐ MTBE quickly evaporates from open containers and surface water, so it is commonly found as a vapor in the air.
- ☐ Small amounts of MTBE may dissolve in water and get into underground water.
- ☐ It remains in underground water for a long time.
- ☐ MTBE may stick to particles in water, which will cause it to eventually settle to the bottom sediment.
- ☐ MTBE may be broken down quickly in the air by sunlight.
- ☐ MTBE does not build up significantly in plants and animals.

How might I be exposed to MTBE?

- ☐ Touching the skin or breathing contaminated air while pumping gasoline.
- ☐ Breathing exhaust fumes while driving a car.
- ☐ Breathing air near highways or in cities.
- ☐ Drinking, swimming, or showering in water that has been contaminated with MTBE.
- ☐ Receiving MTBE treatment for gallstones.

How can MTBE affect my health?

Breathing small amounts of MTBE for short periods may cause nose and throat irritation. Some people exposed to MTBE while pumping gasoline, driving their cars, or working in gas stations have reported having headaches, nausea, dizziness, and mental confusion. However, the actual levels of exposure in these cases are unknown. In addition, these symptoms may have been caused by exposure to other chemicals.

There are no data on the effects in people of drinking MTBE. Studies with rats and mice suggest that drinking MTBE may cause gastrointestinal irritation, liver and kidney damage, and nervous system effects.

How likely is MTBE to cause cancer?

There is no evidence that MTBE causes cancer in humans. One study with rats found that breathing high levels of MTBE for long periods may cause kidney cancer. Another study with mice found that breathing high levels of MTBE for long periods may cause liver cancer.

The Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), and the EPA have not classified MTBE as to its carcinogenicity.

Is there a medical test to show whether I've been exposed to MTBE?

MTBE and its breakdown product, butyl alcohol, can be detected in your breath, blood, or urine for up to 1 or 2 days after exposure. These tests aren't available at most doctors' offices, but can be done at special laboratories that have the right equipment. There is no other test specific to determining MTBE exposure.

Has the federal government made recommendations to protect human health?

The EPA has issued guidelines recommending that, to protect children, drinking water levels of MTBE not exceed 4 milligrams per liter of water (4 mg/L) for an exposure of 1-10 days, and 3 mg/L for longer-term exposures.

The American Conference of Governmental Industrial Hygienists (ACGIH) has recommended an exposure limit of 40 parts of MTBE per million parts of air (40 ppm) for an 8-hour workday, 40-hour workweek.

Glossary

Carcinogenicity: Ability to cause cancer.

CAS: Chemical Abstracts Service.

Evaporate: To change into a vapor or gas.

Milligram (mg): One thousandth of a gram.

ppm: Parts per million.

Sediment: Mud and debris that have settled to the bottom of a body of water.

References

This ToxFAQs information is taken from the 1996 Toxicological Profile for Methyl *tert*-Butyl Ether produced by the Agency for Toxic Substances and Disease Registry, Public Health Service, U.S. Department of Health and Human Services, Public Health Service in Atlanta, GA.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Polycyclic Aromatic Hydrocarbons (PAHs) - ToxFAQs™

This fact sheet answers the most frequently asked health questions (FAQs) about polycyclic aromatic hydrocarbons (PAHs). For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to polycyclic aromatic hydrocarbons usually occurs by breathing air contaminated by wild fires or coal tar, or by eating foods that have been grilled. PAHs have been found in at least 600 of the 1,430 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA).

What are polycyclic aromatic hydrocarbons?

(Pronounced pŏl′ĭ-sī′klĭk ăr′ə-măt′ĭk hī′drə-kar′bənz)

Polycyclic aromatic hydrocarbons (PAHs) are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat. PAHs are usually found as a mixture containing two or more of these compounds, such as soot.

Some PAHs are manufactured. These pure PAHs usually exist as colorless, white, or pale yellow-green solids. PAHs are found in coal tar, crude oil, creosote, and roofing tar, but a few are used in medicines or to make dyes, plastics, and pesticides.

What happens to PAHs when they enter the environment?

- PAHs enter the air mostly as releases from volcanoes, forest fires, burning coal, and automobile exhaust.
- PAHs can occur in air attached to dust particles.
- Some PAH particles can readily evaporate into the air from soil or surface waters.
- PAHs can break down by reacting with sunlight and other chemicals in the air, over a period of days to weeks.
- PAHs enter water through discharges from industrial and wastewater treatment plants.
- Most PAHs do not dissolve easily in water. They stick to solid particles and settle to the bottoms of lakes or rivers.
- Microorganisms can break down PAHs in soil or water after a period of weeks to months.
- In soils, PAHs are most likely to stick tightly to particles; certain PAHs move through soil to contaminate underground water.
- PAH contents of plants and animals may be much higher than PAH contents of soil or water in which they live.

How might I be exposed to PAHs?

- Breathing air containing PAHs in the workplace of coking, coal-tar, and asphalt production plants; smokehouses; and municipal trash incineration facilities.
- Breathing air containing PAHs from cigarette smoke, wood smoke, vehicle exhausts, asphalt roads, or agricultural burn smoke.
- Coming in contact with air, water, or soil near hazardous waste sites.
- Eating grilled or charred meats; contaminated cereals, flour, bread, vegetables, fruits, meats; and processed or pickled foods.
- Drinking contaminated water or cow's milk.
- Nursing infants of mothers living near hazardous waste sites may be exposed to PAHs through their mother's milk.

Polycyclic Aromatic Hydrocarbons

How can PAHs affect my health?

Mice that were fed high levels of one PAH during pregnancy had difficulty reproducing and so did their offspring. These offspring also had higher rates of birth defects and lower body weights. It is not known whether these effects occur in people.

Animal studies have also shown that PAHs can cause harmful effects on the skin, body fluids, and ability to fight disease after both short- and long-term exposure. But these effects have not been seen in people.

How likely are PAHs to cause cancer?

The Department of Health and Human Services (DHHS) has determined that some PAHs may reasonably be expected to be carcinogens.

Some people who have breathed or touched mixtures of PAHs and other chemicals for long periods of time have developed cancer. Some PAHs have caused cancer in laboratory animals when they breathed air containing them (lung cancer), ingested them in food (stomach cancer), or had them applied to their skin (skin cancer).

Is there a medical test to show whether I've been exposed to PAHs?

In the body, PAHs are changed into chemicals that can attach to substances within the body. There are special tests that can detect PAHs attached to these substances in body tissues or blood. However, these tests cannot tell whether any health effects will occur or find out the extent or source of your exposure to the PAHs. The tests aren't usually available in your doctor's office because special equipment is needed to conduct them.

Has the federal government made recommendations to protect human health?

The Occupational Safety and Health Administration (OSHA) has set a limit of 0.2 milligrams of PAHs per cubic meter of air (0.2 mg/m^3). The OSHA Permissible Exposure Limit (PEL) for mineral oil mist that contains PAHs is 5 mg/m^3 averaged over an 8-hour exposure period.

The National Institute for Occupational Safety and Health (NIOSH) recommends that the average workplace air levels for coal tar products not exceed 0.1 mg/m^3 for a 10-hour workday, within a 40-hour workweek. There are other limits for workplace exposure for things that contain PAHs, such as coal, coal tar, and mineral oil.

Glossary

Carcinogen: A substance that can cause cancer.

Ingest: Take food or drink into your body.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for polycyclic aromatic hydrocarbons. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636.

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

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APPENDIX B

REPORT FORMS

WEEKLY SAFETY REPORT FORM

Week Ending: ____________ Project Name/Number: ____________

Report Date: ____________ Project Manager Name: ____________

Summary of any violations of procedures occurring that week:

Summary of any job related injuries, illnesses, or near misses that week:

Summary of air monitoring data that week (include and sample analyses, action levels exceeded, and actions taken):

Comments:

Name: ____________ Company: ____________

Signature: ____________ Title: ____________

INCIDENT REPORT FORM

Date of Report: ____________________

Injured: ____________________

Employer: ____________________

Site: ____________________ Site Location: ____________________

Report Prepared By: ____________________ ____________________
Signature Title

ACCIDENT/INCIDENT CATEGORY (check all that applies)

- ___Injury
- __ Property Damage
- __ On-site Equipment
- __ Mechanical
- ___ Illness
- ___ Fire
- ___ Motor Vehicle
- ___ Spill
- ___ Near Miss
- ___ Chemical Exposure
- ___ Electrical
- ___ Other

DATE AND TIME OF ACCIDENT/INCIDENT: Narrative report of Accident/Incident: Identify: 1) actions leading to or contributing to the accident/incident; 2) the accident/incident occurrence; and 3) actions following the accident/incident.

WITNESS TO ACCIDENT/INCIDENT:

Name:		Company:	
Address:		Address:	
Phone No.:		Phone No.:	
Name:		Company:	
Address:		Address:	
Phone No.:		Phone No.:	

INJURED - ILL:

Name: ____________________ SSN: ____

Address: ____________________ Age: ____

Length of Service: ____________________ Time on Present Job: ____________________________

Time/Classification: ____

SEVERITY OF INJURY OR ILLNESS:

____ Disabling ___ Non-disabling ___ Fatality

____ Medical Treatment ___ First Aid Only

ESTIMATED NUMBER OF DAYS AWAY FROM JOB: ______________________________

NATURE OF INJURY OR ILLNESS: ____

____

____

____

CLASSIFICATION OF INJURY:

__ Abrasions

__ Bites

__ Blisters

__ Bruises

__ Chemical Burns

__ Cold Exposure

__ Concussion

__ Lacerations

_____ Dislocations

_____ Faint/Dizziness

_____ Fractures

_____ Frostbite

_____ Heat Burns

_____ Heat Exhaustion

_____ Heat Stroke

____ Punctures

____ Radiation Burns

____ Respiratory Allergy

____ Sprains

____ Toxic Resp. Exposure

____ Toxic Ingestion

____ Dermal Allergy

Part of Body Affected: ____

Degree of Disability: ____

Date Medical Care was Received: ____

Where Medical Care was Received: ____

Address (if off-site): ____

(If two or more injuries, record on separate sheets)

PROPERTY DAMAGE:

Description of Damage: ______________________________

____

Cost of Damage: $ ______________________________

ACCIDENT/INCIDENT LOCATION: ______________________________

ACCIDENT/INCIDENT ANALYSIS: Causative agent most directly related to accident/incident (Object, substance, material, machinery, equipment, conditions)

____

____

____

____

Was weather a factor?:______________________________

____

Unsafe mechanical/physical/environmental condition at time of accident/incident (Be specific):

____

____

____

Personal factors (Attitude, knowledge or skill, reaction time, fatigue):

____

____

ON-SITE ACCIDENTS/INCIDENTS:

Level of personal protection equipment required in Site Safety Plan:

____

____

Modifications:

____

Was injured using required equipment?:

____

____

If not, how did actual equipment use differ from plan?:

____

____

ACTION TAKEN TO PREVENT RECURRENCE: (Be specific. What has or will be done? When will it be done? Who is the responsible party to insure that the correction is made?

ACCIDENT/INCIDENT REPORT REVIEWED BY:

SSO Name Printed SSO Signature

OTHERS PARTICIPATING IN INVESTIGATION:

Signature Title

Signature Title

Signature Title

ACCIDENT/INCIDENT FOLLOW-UP: Date:

Outcome of accident/incident:

Physician's recommendations:

Date injured returned to work:

Follow-up performed by:

Signature Title

ATTACH ANY ADDITIONAL INFORMATION TO THIS FORM

APPENDIX C

EMERGENCY HAND SIGNALS

EMERGENCY SIGNALS

In most cases, field personnel will carry portable radios for communication. If this is the case, a transmission that indicates an emergency will take priority over all other transmissions. All other site radios will yield the frequency to the emergency transmissions.

Where radio communications is not available, the following air-horn and/or hand signals will be used:

EMERGENCY HAND SIGNALS

OUT OF AIR, CAN'T BREATHE!

Hand gripping throat

LEAVE AREA IMMEDIATELY, NO DEBATE!

(No Picture) Grip partner's wrist or place both hands around waist

NEED ASSISTANCE!

Hands on top of head

OKAY! – I'M ALL RIGHT!

- I UNDERSTAND!

Thumbs up

NO! - NEGATIVE!

Thumbs down