FORMER JB SIMS GENERATING STATION-HARBOR ISLAND
PFAS DATA GAP INVESTIGATION WORK PLAN

GRAND HAVEN, MICHIGAN

Prepared for:

HDR Michigan, Inc.

5405 Data Court

Ann Arbor, Michigan 48108

On behalf of:

City of Grand Haven

Grand Haven, Michigan

Prepared by:

Wood Environment & Infrastructure Solutions, Inc.

46850 Magellan Drive, Ste 190

Novi, Michigan

June 2022

TABLE OF CONTENTS

FIGURES

ATTACHMENTS

ACRONYM LIST

bgs	below ground surface
BLP	Board of Light and Power
COC	Chain of Custody
DI	Deionized Water
DOT	Department of Transportation
EDC	Electronic Data Collection
ft	Feet
GPS	Global Positioning System
GRCC	Generic Residential Cleanup Criteria
GSI	Groundwater Surface Water Interface
HSA	Hollow Stem Auger
IDW	Investigation Derived Waste
LC-MS/MS	Liquid Chromatography and Tandem Mass Spectrometry
MS/MSDs	Matrix Spike/Matrix Spike Duplicate
NAD	North American Datum
ng/L	nanograms per liter
PFAS	Per- and polyfluoroalkyl substances
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
POC	Point of Contact
ppt	parts per trillion
PVC	Polyvinyl chloride
QC	quality control
SAP	Sampling Analysis Plan
SOP	Standard Operating Procedure
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
VAS	Vertical Aquifer Sampling

1 INTRODUCTION

Wood Environment & Infrastructure Solutions, Inc. (Wood), have prepared this per- and polyfluorinated alkyl substances (PFAS) Data Gap Investigation (DGI) Work Plan for the former JB Sims Generating Station located in Harbor Island, City of Grand Haven, Michigan (Site) for HDR Michigan, Inc. (HDR) on behalf of the City of Grand Haven.

1.1 Site Description

The Site is located on the southwestern portion of Harbor Island in Grand Haven, Michigan, and is operated by the Grand Haven Board of Light and Power (BLP). The Site is situated on Harbor Island with the Grand River and the South Channel of the Grand River surrounding the island, which flows in a westerly direction toward Lake Michigan located about one mile west of the Site. **Figure 1** depicts the location of the Site relative to the surrounding area.

According to the Grand Haven BLP's Environmental Restoration Plan overview, Harbor Island has been used for industrial purposes and waste disposal for over 100 years for city trash, dredge materials, and coal ash from JB Sims Plant Units 1 & 2 impoundments among other previous industrial uses. According to publicly available information, it appears that contamination is existing on site but limited to PFAS, volatile organic compounds, cyanide, ammonia and Coal Combustion Residuals (CCR) Constituents of Concern which is covered under the Federal CCR Rule 40 CFR §257 and Part 115, Solid Waste Management, of the NREPA, 1994 PA 451, as amended under the supervision of Michigan Department of Environment, Great Lakes, and Energy (EGLE).

PFAS contamination is initially suspected to be related to the trash dumped at the Site. Previous investigations' soil boring logs show trash ranging in depth between 5 and 16 feet (ft) below ground surface (bgs) and was identified as "wood, leather, concrete cuttings, metal shavings, glass, rubber and trace metals". The exact location of the trash/dump site is unknown. **Figure 2** shows the Man Altered locations within the Site as referenced in the 1993 Harbor Island Master Plan prepared to the City of Grand Haven by Ayres, Lewis, Norris & May, Inc. The Man Altered locations are the suspected historical dump locations.

1.2 Previous Investigations/Regulatory Involvement

Groundwater investigations began at the Site in 2017 to include activities associated with CCR. PFAS investigations began on May 21, 2021 and continued through January 2022 at selected locations as shown on Table 1. In general, PFAS concentrations only exceeded USEPA's Lifetime Health Advisory of 70 nanograms per liter (ng/L)/parts per trillion (ppt) for either perfluorooctane sulfonate (PFOS) or perfluorooctanoic acid (PFOA) at five monitoring wells (MW-02, MW-03, MW-06, MW-08 and MW-10) and at two piezometers (PZ-13 and PZ-32). The concentrations of PFOA ranged between 8.23 ng/L and 134.68 ng/L for the locations that exceeded. The concentrations of PFOS ranged between 17.26 ng/L and 289.88 ng/L for the locations that exceeded. PFAS analytical results exceeded the EGLE Maximum Contaminant Level (MCL) at 22 locations (MW-01R, MW-02, MW-03, MW-04, MW-06, MW-08, MW-09, MW-10, PZ-11, PZ-12, PZ-13, PZ-17, PZ-18, PZ-20, PZ-23, PZ-24, PZ-25, PZ-26, PZ-28, PZ-30, PZ-31, and PZ-32). **Figure 3** shows the PFAS concentration map from the January 2022 sampling event. **Figure 4** shows the highest PFAS concentration map from the surface water samples collected at the Site. The PFAS compounds analyzed were the Michigan 28-analyte PFAS List.

The PFAS analytical results indicate that municipal solid waste may be the source however, there are no concentrations with the magnitude indicative of a source area (i.e., exceeding 1,000 ng/L). In addition, some of the boring logs that showed trash, had either PFAS concentrations not detected above laboratory detection limits (MW-07) or detections not exceeding any criteria (MW-04, MW05 andPZ-15) suggesting that the trash may not be the PFAS source. The PFAS analytical results for PZ-13 located at the west side of the Site, closer to the Grand River, showed the highest PFAS concentrations including the precursors indicating a PFAS source or a source is closer to that location. The soil boring log for PZ-13 did not show any trash component within the soil column.

1.3 Geological Information

The Site is located in an area of glacial drift (consisting of fine to medium sand with occasional beds of gravel) which is underlain by Marshall Sandstone. The glacial drift is between 100 to 200 feet thick in the area.

The former 3A/B Impoundments were engineered clay lined above ground units built over a field of ash from Units 1 & 2. The inactive 1/2 Impoundment was a depression in the ground where sluiced ash was disposed. The Site was also previously used as the city dump. Materials documented from the former dump consist of a layer of mixed debris which includes glass, wood, plastic, ceramic, concrete, leather, brick and metal within a matrix of dark-grey to black, fine-grained sand. The extent of the historic trash dump is detailed in the ERM Report titled “Coal Ash Delineation Sampling Results, Grand Haven Board of Light & Power, Grand Haven, Michigan” dated February 8, 2016 (ERM, 2016).

1.4 Surface Water

Harbor Island, the location of the Site is located in the Grand River. The Grand River discharges into Lake Michigan, which is located approximately one mile to west of the Site.

1.5 Groundwater

Groundwater was encountered between 5 and 15 ft bgs within the unconsolidated fill material, which consists of fine sand, ash, and municipal solid waste, located above the silt and clay unit. As described in the Groundwater Monitoring System Certification, (ERM, 2017b), sand in the uppermost aquifer assumes an effective porosity of 30 percent (%) and consists of poorly-graded fine sand with an estimated hydraulic conductivity of 27 feet per day and well-graded fine sand with an estimated hydraulic conductivity of 53 feet per day. Golder conducted site aquifer performance testing in September of 2021. The results of the aquifer performance testing provide additional data for updating the hydraulic conductivity. The recently calculated hydraulic conductivity for the areas west of the wetland is an average range of 0.19 feet per day to 242 feet per day. Golder also assumed Kz/Kr of 0.01 which is 100 times greater than Kz. This wide range of variability is the result of the varying fill materials that form Harbor Island. In addition, a calculated hydraulic conductivity for the piezometers located on the eastern side of the wetland is an average 8.34 feet per day (Golder, 2022).

Localized groundwater flow is radially inward when river levels are high and radially outward when the river levels are low affecting the zone of groundwater flux along the water's edge. This determination of groundwater flow is based on three months of data (October, November and December of 2021). Localized flow direction and gradients across the Site are also influenced by precipitation and surface infiltration, particularly in wetland areas or where the water table is in direct contact with the surface water. (Golder, 2022). In general, the groundwater flow directions change seasonally.

2 SAMPLING RATIONALE

The PFAS investigation will be completed to meet the following objectives:

1) Evaluate PFAS concentrations across Harbor Island and to locate the potential sources;
2) Evaluate the historical conditions and to see if there is a link between the historical dumping operations and PFAS; and
3) Determine if there is a correlation between surface water concentrations at the Grand River and the PFAS concentrations observed onsite.

To achieve these goals, the PFAS investigation will consist of a Hydrogeologic Investigation; activities for this effort are discussed in the following subsections. Other non-CCR analytes will not be analyzed during this phase as this is an investigation is to understand the source of the PFAS contamination.

2.1 Data Gap Investigation

The DGI will consist of the following:

- The submittal of a Wetland Permit application to complete drilling within the wetland.
- The installation of up to 40 Vertical Aquifer Sampling (VAS) borings. Some of these will be completed in stages as step-outs depending on concentrations of PFAS observed in soil and groundwater samples;
    - VAS boring depths and sample collection intervals are subject to change based on site observations. Groundwater will be collected at each location, but drilling will cease once trash is no longer observed at a boring (**Figure 5)**.
- Up to two PFAS groundwater samples will be completed from each VAS location; The first sample location will be collected at groundwater table and then the location of where the most trash has been observed (**Figure 5**). If trash is not observed within the boring, only one sample will be collected from the first encountered groundwater depth;
- The installation of four direct push technology (DPT) borings.
    - DPT boring depths and sample collection intervals are subject to change based on site observations. Groundwater will be collected at each location, but drilling will cease once trash is no longer observed at a boring or 20 feet has been reached, whichever comes first;
- The collection of up to 44 subsurface soil samples;

- The installation of up to 10 permanent groundwater monitoring wells based on the 10 highest PFAS locations;
- The gauging and sampling of new and existing permanent groundwater monitoring wells;
- The collection of up to 6 surface water samples. This will be completed as a part of the initial DGI and will not be associated with the quarterly sampling. Wetland samples will not be included in this investigation and will only be included during quarterly monitoring; and
- All new monitoring wells and 10 existing monitoring wells will be sampled and gauged quarterly for a year. Quarterly sampling will also include collection of up to six surface water samples from stilling wells and additional surface water locations located at the Site.

3 REQUEST FOR ANALYSES

Analyses of samples will be analyzed for PFAS by MERIT Laboratories, Inc. located in East Lansing, Michigan using Liquid Chromatography and Tandem Mass Spectrometry (LC-MS/MS) for 31 PFAS analytes by United States Environmental Protection Agency (USEPA) Method 8327 Michigan 31 List, with a standard 15-day turnaround time.

The Michigan 31 PFAS compound analytical suite that will be used for the analysis of soil, groundwater and surface water collected as part of this scope of work include:

1. Perfluorotetradecanoic acid (PFTeDA)
2. Perfluorotridecanoic acid (PFTrDA)
3. Perfluorododecanoic acid (PFDoA)
4. Perfluoroundecanoic acid (PFUnA)
5. Perfluorodecanoic acid (PFDA)
6. Perfluorononanoic acid (PFNA)
7. PFOA
8. Perfluoroheptanoic acid (PFHpA)
9. Perfluorohexanoic acid (PFHxA)
10. Perfluoropentanoic Acid (PFPeA)
11. Perfluorobutanoic Acid (PFBA)
12. Perfluorodecanesulfonic acid (PFDS)
13. Perfluorononanesulfonic acid (PFNS)
14. PFOS
15. Perfluoroheptanesulfonic acid (PFHpS)
16. Perfluorohexanesulfonic acid (PFHxS)
17. Perfluoropentanesulfonic acid (PFPeS)
18. Perfluorobutanesulfonic acid (PFBS)
19. Perfluoroocatanesulfonamide (PFOSA)
20. 1H,1H,2H,2H-Perfluorodecanesulfonic acid (8:2FTS)
21. 1H,1H,2H,2H-Perfluorooctanesulfonic acid (6:2FTS)
22. 1H,1H,2H,2H-Perfluorohexanesulfonic acid (4:2FTS)
23. 2-(N-Ethylperfluorooctanesulfonamido) acetic acid (N-EtFOSAA)
24. 2-(N-Methylperfluorooctanesulfonamido) acetic acid (N-MeFOSAA)

25. Hexafluoropropylene oxide dimer acid (HFPO-DA)
26. 11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)
27. 9-chlorohexadecafluro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)
28. 4,8-dioxa-3H-perfluorooonanoic acid (ADONA)
29. Perfluoro-4-ethylcyclohexanesulfonic Acid (PFECHS)
30. Perfluorobutylsulfonamide (PFBSA)
31. Perfluorohexanesulfonamide (PFHxSA)

In addition to the 31 PFAS listed above, the samples will be analyzed for 5:3 Fluorotelomer Carboxylic Acid (5:3 FTCA), which is a common PFAS compound found landfill leachate. These lists may be revised as required as federal regulatory requirements and/or other promulgated state standards are determined. In addition, the analysis of Investigation Derived Waste (IDW) characterization samples will be analyzed by Trace Analytical. Analytes required for waste characterization are currently unknown and will be determined by the waste disposal facility at the time of IDW disposal.

3.1 Analyses Narrative

Field quality control (QC) samples will be collected to provide additional data that will be used to evaluate whether the sample collection and handling procedures have affected the quality of the samples. A summary of field QC samples are discussed in **Section 8**.

3.2 Analytical Laboratory

For this project, samples collected for PFAS analysis will be compared to the following:

<u>Soil samples</u> – EGLE GRCC Groundwater Surface Water Interface (GSI) for Groundwater Protection values (surface and subsurface):

- PFOS - 240 ppt
- PFOA – 10,000,000 ppt

<u>Surface water samples – EGLE PFAS Surface Water Criteria (not used as a drinking water source)</u>

- <u>PFOS – 12 ppt</u>
- <u>PFOA – 12,000 ppt</u>

<u>Surface Water samples – EGLE PFAS Surface Water Criteria (used as a drinking water source)</u>

- <u>PFOS – 11 ppt</u>
- <u>PFOA – 420 ppt</u>

<u>Groundwater samples</u> –EGLE PFAS Drinking Water MCLs:

- PFOS - 16 ppt
- PFOA – 8 ppt
- PFHxA – NA/400,000 ppt
- PFHxS – NA/51 ppt
- PFNA – NA/6 ppt
- PFBS – NA/420 ppt
- HFPO-DA – NA/370 ppt

4 FIELD METHODS AND PROCEDURES

Proper sampling procedures are a key component to an effective sampling program. All environmental sampling at the Site will continue to be performed by properly trained personnel in accordance with the methods presented in this Sampling and Analysis Plan (SAP). The approach to conducting the hydrogeological investigation is described in the following subsections.

4.1 Hydrogeologic Investigation Sampling

To evaluate concentrations of PFAS in soil and groundwater near source locations and to determine groundwater flow direction, the installation of soil borings, monitoring wells, temporary monitoring wells, and the collection of groundwater, soil, and surface water samples for PFAS analysis will be completed.

4.1.1 Preparation and Pre-mobilization

Prior to Site mobilization, it will be necessary to complete multiple pre-mobilization activities including coordinating with the BLP's point of contact (POC) and obtaining utility clearances and dig permits. Sufficient time must be allotted for coordination of permits and approvals, where required. Work will be conducted in accordance with relevant regulations and in coordination with the BLP's POC.

Utility Clearances and Dig Permits – Prior to the commencement of drilling activities, Wood will hire a private utility locator contractor and submit the necessary applications through the MISS Dig system to have utilities located prior to drilling. Drilling operations will not begin until all underground hazards have been located. To assist with utility location, utility maps may be requested from the POC showing the locations of utilities and other infrastructure features at each investigative area. In addition, the first 5 feet bgs will be completed with a hand auger to ensure underground utilities are not compromised during boring advancement. After preparation and pre-mobilization activities are complete, Wood will mobilize to the Site.

4.1.2 Temporary Monitoring Well Installation and Sampling

Up to four (4) temporary monitoring wells will be advanced in the investigative areas (**Figure 5**). Temporary monitoring wells will be advanced using a track-mounted Geoprobe®-type drill rig until the water table is encountered as described in standard operating procedures (SOP) AFW-19 (*Temporary Monitoring Well Installation – Direct Push Extractable Screen*) (**Attachment A**). The first five feet will be advanced using a hand auger.

Soil cores will be collected continuously, visually screened for evidence of chemical impacts (e.g., discoloring or staining), and logged in accordance with the Unified Soil Classification System (USCS) by a Wood geologist and documented on soil boring logs (**Attachment B**).

The borehole will be advanced until the water table is reached (expected to be between 10 and 15 ft bgs), and a temporary (5 ft) screen will be installed intercepting the water table. The well system will be purged to ensure drilling water used has been removed using a peristaltic pump. The temporary monitoring well will be developed by purging a minimum of three times the volume of drilling water introduced plus three times the well volume with methods described in SOP AFW-05 (*Monitoring Well Development*) (**Attachment A**). Temporary monitoring well development activities will be documented on electronic monitoring well development forms (**Attachment B**).

Upon completion of well development, groundwater samples will be collected using low-flow methods as described in SOP AFW-03 (*Groundwater Sampling*), EGLE *Groundwater PFAS Sampling Guidance* (**Attachment A)**. Temporary monitoring well groundwater samples will be analyzed for the Michigan 31 List for PFAS compounds described in **Section 3.0**. Development water and purged water will be poured back next to the groundwater sampling location and soil cuttings from soil borings will be returned to the borehole. Temporary monitoring well locations will be surveyed by Wood for horizontal control using a handheld 6000 series global positioning system (GPS) receiver. Temporary monitoring well locations will be abandoned using methods described in SOP AFW-06 *Borehole Abandonment* and drilling/sampling equipment will be decontaminated upon completion of well installation.

4.1.3 Vertical Aquifer Sampling

Up to forty (40) VAS borings will be advanced to a depth of 20 ft bgs. VAS borings will be advanced using a DPT drill rig. The first 5 ft will be advanced using a hand auger. Soil cores will be collected continuously, visually screened for evidence of chemical impact (e.g., discoloring or staining), and logged in accordance with the USCS by a Wood geologist and documented on soil boring logs (**Attachment B**).

The borehole will be advanced until the water table is reached (the upper most sample interval will be collected first); a stainless steel extractable well screen (2-3 ft long), with PFAS-free rubber O-ring packer attached to the upper portion of the screen, will be advanced to seal off the required sample interval. The packer will seal off the outer drill casing and the system will be purged (developed). The sample interval will be purged (developed) by removing a minimum of three well volumes with methods described in SOP AFW-05 (*Monitoring Well Development*) (**Attachment A**).

Upon completion of VAS interval purging, groundwater samples will be collected using low-flow methods as described in SOP AFW-03 (*Groundwater Sampling*) and EGLE *Groundwater PFAS Sampling Guidance* (**Attachment A**). During the purging process, water quality parameters [pH, specific conductance, temperature, oxidation reduction potential, turbidity and dissolved oxygen (DO)] will be measured using a water quality meter prior to sample collection. Purge records, water quality parameters, and sampling data will be recorded on electronic groundwater sample forms (**Attachment B**). VAS groundwater samples will be analyzed for 31 PFAS compounds described in **Section 3.0**.

Once the groundwater sampling is complete, the entire screen assembly and packer will be removed, decontaminated, and drilling will continue to the next deeper sample interval. At each VAS boring, groundwater samples will be collected at the top of the water table and the bottom of the boring, a maximum depth of 20 ft bgs. Total depth will be determined by visual observation of trash ending at the boring.

Development water and purged water will be poured back next to the groundwater sampling location and soil cuttings from soil borings will be returned to the borehole. Temporary monitoring well locations will be surveyed by Wood for horizontal control using a handheld 6000 series GPS receiver. VAS boreholes will be abandoned using methods described in SOP AFW-06 (*Borehole Abandonment*) (**Attachment A**). Boreholes will be backfilled using hydrated bentonite chips for the entire borehole. Drilling and sampling equipment will be decontaminated upon completion of well installation.

4.1.4 Permanent Monitoring Well Installation

Up to ten (10) permanent groundwater monitoring wells will be installed in the investigative areas. Permanent monitoring well locations will be installed contingent on PFAS results of the initial sampling event. Groundwater monitoring wells will be installed up to a maximum depth of 20 ft bgs and will screen the top of the water table. At locations where VAS borings are not completed, soil cores will be collected using a track-mounted Geoprobe®-type drill rig until the water table is encountered (estimated maximum depth of 15 feet bgs) to determine water table elevation. The first 5 ft will be advanced using a hand auger. Soil cores will be collected continuously, visually screened for evidence of chemical impact (e.g., discoloring or staining), logged in accordance with the USCS by a Wood geologist and documented on soil boring logs located in **Attachment B**.

Permanent monitoring wells will be installed by a state-licensed drilling contractor in accordance with state-specific requirements. Permanent monitoring wells will be installed by using a track-mounted

Geoprobe®-type drill rig with a hollow stem auger (HSA) as described in SOP AFW-04 (*Monitoring Well Installation*) (**Attachment A**).

Permanent Monitoring wells will be constructed with 2-inches, inside diameter schedule 40 polyvinyl chloride (PVC) casing that will be flush-threaded and will have a threaded bottom cap installed. Well screens will be constructed of 2-inch inside diameter factory-cut mill-slotted pipe that will contain appropriate slot size based upon site-specific conditions. Monitoring wells will be installed with a 5 ft screen; the screen will intersect the top of the water table. Filter pack sand will consist of commercially available, clean silica sand with uniform sorting, or similar size compatible with the well slot size, to a minimum of 2 ft above the top of the screen. The annular seal and well annulus will be filled with granular bentonite that is hydrated during placement. The augers will be used as a tremie for filter pack placement and bentonite seal. The top of each well casing will be fitted with a water-tight locking cap. Each monitoring well will be completed with a 2-ft by 2-ft concrete pad that is a minimum of 4-inches thick and a flush mount water-tight well cover. Boring logs and monitoring well installation logs will be generated for each permanent monitoring well on forms provided in **Attachment B**.

A minimum of 24-hours following permanent monitoring well installation, each well will be developed in accordance with SOP AFW-05 (*Monitoring Well Development*) (**Attachment A**). A minimum of 48-hours following monitoring well development, groundwater samples will be collected using low-flow methods as described in SOP AFW-03 (*Groundwater Sampling*), EGLE *Groundwater PFAS Sampling Guidance* (**Attachment A**). Permanent monitoring well groundwater samples will be analyzed for 31 PFAS compounds described in **Section 3.0**.

Drilling equipment will be decontaminated upon completion of well installation.

Demobilization will occur once investigations activities are completed, and the investigation areas have been restored to the original conditions.

4.1.5 Soil Sampling

Subsurface soil samples will be collected at up to (44) locations in the investigative areas (**Figure 5**) and in accordance with SOP AFW-02 (*Soil Sampling*) and EGLE *Soil PFAS Sampling Guidance* (**Attachment A**). Samples will be collected at each boring location at a depth that will be determined by Wood's geologist during drilling. Soil sample collection information will be documented on electronic soil sample collection logs (**Attachment B**). Soil samples will be analyzed for Michigan 31 PFAS compounds described in **Section 3.0**. Sampling equipment will be decontaminated upon completion of boring advancement.

4.1.6 Surface Water Sampling

Up to six (6) surface water samples will be collected from the Grand River which surrounds the Site (**Figure 6**). Surface water samples will be collected by immersing the laboratory-supplied sample container directly into the surface water body in accordance with SOP AFW-08 (*Surface Water Sampling*) and EGLE *Surface Water PFAS Sampling Guidance* (**Attachment A**). Surface water sample collection information will be documented on electronic surface water sample collection logs (**Attachment B**). Surface water samples will be analyzed for 31 PFAS compounds described in **Section 3.0**. Sampling equipment will be decontaminated upon completion of each surface water sample collected.

4.1.7 Equipment Decontamination

Drilling equipment will be decontaminated between VAS locations and the installation of monitoring wells following the SOP AFW-10 (*Drilling, Development, and Heavy Equipment Decontamination*) (**Attachment A**). A bermed, lined, central decontamination pad or portable decon station will be used for decontamination efforts. The decontamination pad or station will be sufficient to containerize the fluids produced during the decontamination process. The drill rigs will be decontaminated prior to arrival of execution of investigative activities. After each boring has been drilled and sampled, all down-hole equipment will be decontaminated prior to proceeding to the next drilling/sampling location. Steam cleaning will be used for all components that do not come in direct contact with samples. For components that come into direct contact with sample media (e.g., extractable screen and water sampling devices) will have the following two stage decontamination approach:

1. Wash equipment (steam cleaning or potable water rinses);
2. Final equipment rinse with PFAS-free water.

4.1.8 Surveying

Soil sample locations, surface water locations, and temporary monitoring wells will be surveyed by Wood personnel using a handheld Trimble GPS unit or equivalent. After the monitoring well installations and sampling activities are completed, newly installed monitoring wells will be surveyed by a licensed land surveyor. Horizontal coordinates will be surveyed to the nearest 0.1 foot and referenced to the relevant State Plane Coordinate System using the North American Datum (NAD) of 1983, as adjusted in 1991. Elevation measurements will be made both at ground surface and at a casing measurement point at each of the wells. Elevations will be surveyed to the nearest 0.01 foot and referenced to the North American Vertical Datum of 1988. The survey reference point on the monitoring well casing will be marked for future reference by the surveyor. Static water levels will be measured from the top of casing of each permanent monitoring well to help depict the groundwater flow within the Site.

5 SAMPLE CONTAINERS, PRESERVATION, PACKAGING AND SHIPPING

Sample container, volumes, and method specific preservation is documented in the Site-specific Quality Assurance Project Plan. Preservation will be supplied by Eurofins Lancaster or Trace Analytical and bottles will be "pre-doped", preserving the sample prior to shipment to the laboratory.

5.1 Packaging and Shipping

All sample containers will be placed into coolers and packed and shipped in accordance with SOP AFW-11 (*Sample Handling and Custody*) (**Attachment A**). Sample containers will be bagged to ensure sample containers are not in contact with wet ice, will be packed into coolers, and shipped to Eurofins Lancaster or Trace Analytical for overnight delivery.

6 DISPOSAL OF RESIDUAL MATERIALS

IDW will consist of decontamination water, disposable personal protection equipment (PPE), and general trash. Purged water and development water can be poured back next to the groundwater sampling location or returned to the borehole and soil cuttings from soil borings can be returned to the borehole and do not need to be containerized and disposed of as IDW. PPE and trash will be placed in plastic bags and placed into sanitary trash containers and disposed at a sanitary landfill.

7 SAMPLE DOCUMENTATION AND SHIPMENT

7.1 Field Documentation

A field logbook will be maintained for documentation of pertinent field activities from each activity conducted during the investigation (e.g., utility clearance, sampling, and surveying). Field logs and other forms (except for soil boring logs) will be completed on mobile devices for the purpose of electronic data collection (EDC) in accordance with SOP AFW-17 (*Electronic Field Forms*) (**Attachment A**). In addition, digital photographs will be taken to document significant observations during activities. Field documentation including field notes, photographs, and other forms (e.g., sampling forms, etc.) will be included in the Final Technical Memorandum.

7.1.1 Photographs

Digital photographs will be taken to document significant observations during activities. Photographs will be included in Technical Memorandum upon request.

7.2 Labeling/Sample Identification

Hydrogeological investigation samples will be designated a unique ID and include sample intervals for each sample collected at VAS borings/temporary monitoring well locations.

7.3 Sample Chain Of Custody (COC) Forms and Custody Seals

All sample containers will be placed into coolers and packed and shipped in accordance with SOP AFW-11 (*Sample Handling and Custody*) (**Attachment A**). COCs will accompany all samples during shipment(s) to respective laboratories in coolers with signed custody seals.

8 QUALITY CONTROL

Field QC samples will be collected for hydrogeological investigation samples to confirm sampling and analytical precision.

8.1 Field Quality Control Samples

Field quality control samples are intended to help evaluate conditions resulting from field activities and are intended to accomplish two primary goals: assessment of field contamination and assessment of sampling variability. Field QC samples that will be obtained are discussed in the following subsections.

8.1.1 Assessment of Field Contamination (Equipment Blanks)

Field equipment blanks are samples that have been collected to ensure proper decontamination efforts are made and to ensure there is not cross-contamination between samples from sampling equipment during the collection process. During the hydrogeological sampling efforts, equipment blanks will be obtained from extractable screens and soil sampling devices. Field blanks will be collected at a rate of five percent for each media for samples collected that come into direct contact with non-disposable sampling equipment. Equipment blanks will be obtained after decontamination efforts are completed. Equipment blanks will be prepared by pouring laboratory-supplied deionized water (DI) directly over the sampling equipment and letting if flow into sample containers.

8.1.2 Assessment of Field Variability (Field Duplicate or Co-located Samples)

Field duplicate samples are samples that have been collected at the same location, using the same methods, in the sample collection process. Duplicate samples will be obtained from the same sample location, immediately following collection of the parent sample. The field duplicate samples will be labeled as “blind” and will be shipped along with field samples and analyzed by the same laboratory. Field duplicates will be collected at a rate of 10 percent for each media of hydrogeological samples collected.

8.1.3 Laboratory Quality Control Samples

Matrix spikes are known amounts of specific chemical constituents added by the laboratory to selected samples to evaluate the effect of the sample matrix on the preparation and analytical procedures. Matrix spikes are performed in duplicate and are referred to as Matrix Spikes/Matrix Spike Duplicates (MS/MSDs). Spike samples have the exact same identification (ID) as the original sample and are identified on the COC. Additional volume will be collected to accommodate laboratory analysis. MS/MSDs will be collected at a rate of five percent for each media of hydrogeological samples collected.

8.1.4 Source Water Assessment Samples

To identify and limit trace PFAS detections introduced through low-level PFAS contamination in water supplied used for decontamination of drilling and sampling equipment, source water blanks will be submitted to the laboratory for PFAS analysis. The analytical laboratory will be responsible for providing PFAS-free water to use for equipment blanks. The laboratory will certify that each batch of DI water is PFAS-free. Water used for drilling and decontamination efforts will be sampled and submitted to the laboratory for PFAS analysis to ensure water sources used do not contribute to trace PFAS contamination during investigative activities.

8.1.5 Temperature Blanks

For each cooler that is shipped to the analytical laboratory, a laboratory provided container will be included that is marked “temperature blank.” This blank will be used by the sample custodian to check the temperature of samples upon receipt.

9 FIELD HEALTH AND SAFETY PROCEDURES

Field activities will be conducted in accordance with the Health and Safety Plan (HSP) that will be prepared for this Site. Field members will conduct daily tailgate meetings prior to work beginning each day; documentation of meetings will be recorded in the field tablet will be maintained in the project file (**Attachment B**). Activities and hazards associated with fieldwork completed during this investigation are located in the Site-specific HSP.

TABLES

Table 1
Groundwater PFAS Historical Analytical Results
Harbor Island
GRand Haven, MI

Analyte	Abbreviation	Regulatory Criteria		Sample ID	MW-01R				MW-02				MW-03				MW-04			
		EGLE DWC (EPA Lifetime Health Advisory)	EGLE PFAS Drinking Water MCLs	Date	5/21/21	6/24/21	10/26/21	1/11/22	5/21/21	6/24/21	10/26/21	1/11/22	5/21/21	6/24/21	10/26/21	1/11/22	5/21/21	6/24/21	10/26/21	1/11/22
4:2 Fluorotelomer Sulfonic Acid	4:2 FTS	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
6:2 Fluorotelomer Sulfonic Acid	6:2 FTS	NC	NC	ng/L	**1.79**	<20	<20	<20	**2.54**	<20	<20	<20	**4.41**	<20	<20	<20	**3.88**	<20	<20	<20
8:2 Fluorotelomer Sulfonic Acid	8:2 FTS	NC	NC	ng/L	<2	<2	<2	<2	**0.1**	<2	<2	<2	**0.14**	<2	<2	<2	<2	<2	<2	<2
4,8-dioxa-3H-perfluorononanoic acid	ADONA	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorooctane Sulfonamide	FOSA	NC	NC	ng/L	**0.88**	<10	<10	<10	**0.6**	<10	<10	<10	**0.31**	<10	<10	<10	**0.37**	<10	<10	<10
Hexafluoropropylene oxide dimer acid	HFPO-DA or	NC	**370**	ng/L	**0.66**	<2	<2	<2	**1.29**	<2	<2	<2	**0.06**	<2	<2	<2	**0.25**	<2	<2	<2
N-Ethyl Perfluorooctane Sulfonamidoacetic Acid	N-EtFOSAA	NC	NC	ng/L	**0.63**	<10	<10	<10	**0.1**	<10	<10	<10	**2.18**	<10	<10	<10	<10	<10	<10	<10
N-Methyl Perfluorooctane Sulfonamidoacetic Acid	N-MeFOSAA	NC	NC	ng/L	**0.19**	<10	<10	<10	**0.26**	<10	<10	<10	**0.19**	<10	<10	<10	**0.15**	<10	<10	<10
Perfluorobutanoic Acid	PFBA	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	**7.56**	**9.37**	<2	<2	**10.9**	<2	**18.95**
Perfluorobutane Sulfonic Acid	PFBS	NC	**420**	ng/L	**2.51**	<2	**2.24**	**2.48**	**1.43**	<2	<2	<2	**2.24**	<2	**2.03**	**2.58**	<2	**3.37**	**3.12**	**4.32**
Perfluorodecanoic Acid	PFDA	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorododecanoic Acid	PFDoA	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorodecane Sulfonic Acid	PFDS	NC	NC	ng/L	**0.69**	<2	<2	<2	**0.85**	<2	<2	<2	**0.75**	<2	<2	<2	**0.81**	<2	<2	<2
Perfluoroheptanoic Acid	PFHpA	NC	NC	ng/L	**0.55**	<2	<2	<2	**2.01**	<2	<2	<2	**1.75**	<2	<2	<2	<2	<2	**2.09**	**4.45**
Perfluoroheptane Sulfonic Acid	PFHpS	NC	NC	ng/L	**0.22**	<2	<2	<2	**0.99**	<2	<2	<2	**3.29**	**4.45**	**3.82**	**5.47**	<2	<2	<2	<2
Perfluorohexanoic Acid	PFHxA	NC	**400,000**	ng/L	<2	<2	**3.56**	<2	<2	<2	<2	<2	**4.21**	**2.96**	<2	**3.7**	**20.37**	<2	**13.54**	**16.75**
Perfluorohexane Sulfonic Acid	PFHxS	NC	**51**	ng/L	**1.08**	<2	<2	**2.36**	**3.19**	**2.66**	**3.1**	**3.57**	**8.71**	**10.38**	**6.48**	**9.37**	**1.77**	**3.32**	**3.44**	**4.21**
Perfluorononanoic Acid	PFNA	NC	**6**	ng/L	<2	<2	<2	<2	**0.25**	<2	<2	<2	**0.16**	<2	<2	<2	<2	<2	<2	<2
Perfluorooctanoic Acid	PFOA	**70**	**8**	ng/L	<2	**4.6**	**3.14**	**3.55**	**13.23**	**10.33**	**9.39**	**14.75**	**18.29**	**19**	**12.13**	**16.59**	**8.78**	**7.5**	**6.3**	**9.03**
Perfluorononane Sulfonic Acid	PFNS	NC	NC	ng/L	**0.24**	<2	<2	<2	**0.3**	<2	<2	<2	**0.27**	<2	<2	<2	**0.44**	<2	<2	<2
Perfluorooctane Sulfonic Acid	PFOS	**70**	**16**	ng/L	**23.87**	**34.39**	**30.73**	**44.44**	**41.85**	**48.09**	**38.27**	**73.45**	**84.66**	**125.56**	**54.81**	**104.32**	**11.7**	**20.35**	**14.15**	**16.87**
Perfluoropentanoic Acid	PFPeA	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	**26.7**
Perfluoropentane Sulfonic Acid	PFPeS	NC	NC	ng/L	**1.64**	<2	<2	<2	<2	<2	<2	**5.05**	<2	**2.72**	**5.34**	**4.34**	**2.05**	<2	**4.26**	**2.83**
Perfluorotetradecanoic acid	PFTeA	NC	NC	ng/L	**0.4**	<2	<2	<2	**0.54**	<2	<2	<2	**0.51**	<2	<2	<2	**0.48**	<2	<2	<2
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	NC	NC	ng/L	**0.18**	<2	<2	<2	**0.23**	<2	<2	<2	**0.24**	<2	<2	<2	**0.23**	<2	<2	<2
Perfluorotridecanoic Acid	PFTriA	NC	NC	ng/L	**0.7**	<2	<2	<2	**0.76**	<2	<2	<2	**0.74**	<2	<2	<2	**0.76**	<2	<2	<2
Perfluoroundecanoic Acid	PFUnA	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	**0.06**	<2	<2	<2
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid	9Cl-PF3ONS	NC	NC	ng/L	**0.11**	<2	<2	<2	**0.14**	<2	<2	<2	**0.17**	<2	<2	<2	**0.14**	<2	<2	<2

Notes:
< = less than
Bold = Analyte detected above laboratory detection limit
Eexceeds EGLE MCL
Exceeds EGLE DWC
DWC = Drinking Water Criteria
EGLE = Michigan Department of Environment, Great Lakes, and Energy
EPA = United States Environmental Protection Agency
MCL = Maximum Contaminant Level
ng/L = nanograms per liter (parts per trillion)
PFAS = per- and polyfluoroalkyl substances

Table 1
Groundwater PFAS Historical Analytical Results
Harbor Island
GRand Haven, MI

Analyte	Abbreviation	Regulatory Criteria		Sample ID	MW-05				MW-06				MW-07				MW-08			
		EGLE DWC (EPA Lifetime Health Advisory)	EGLE PFAS Drinking Water MCLs	Date	5/21/21	6/24/21	10/26/21	1/11/22	5/21/21	6/24/21	10/26/21	1/11/22	5/21/21	6/24/21	10/26/21	1/11/22	5/21/21	6/24/21	10/26/21	1/11/22
4:2 Fluorotelomer Sulfonic Acid	**4:2 FTS**	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
6:2 Fluorotelomer Sulfonic Acid	**6:2 FTS**	NC	NC	ng/L	**0.59**	<20	<20	<20	**1.5**	<20	<20	<20	**1.08**	<20	<20	<20	**3.52**	<20	<20	<20
8:2 Fluorotelomer Sulfonic Acid	**8:2 FTS**	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
4,8-dioxa-3H-perfluorononanoic acid	**ADONA**	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorooctane Sulfonamide	**FOSA**	NC	NC	ng/L	**0.34**	<10	<10	<10	**0.2**	<10	<10	<10	**0.04**	<10	<10	<10	**0.4**	<10	<10	<10
Hexafluoropropylene oxide dimer acid	**HFPO-DA or**	NC	**370**	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
N-Ethyl Perfluorooctane Sulfonamidoacetic Acid	**N-EtFOSAA**	NC	NC	ng/L	<10	<10	<10	<10	**0.06**	<10	<10	<10	<10	<10	<10	<10	**0.23**	<10	<10	<10
N-Methyl Perfluorooctane Sulfonamidoacetic Acid	**N-MeFOSAA**	NC	NC	ng/L	**0.16**	<10	<10	<10	**0.14**	<10	<10	<10	**0.18**	<10	<10	<10	**0.22**	<10	<10	<10
Perfluorobutanoic Acid	**PFBA**	NC	NC	ng/L	**15.58**	**17.15**	**17.02**	**21.67**	<2	<2	<2	<2	**1.9**	<2	**2.29**	<2	<2	**15.33**	<2	**7.95**
Perfluorobutane Sulfonic Acid	**PFBS**	NC	**420**	ng/L	**5.92**	**8.63**	**8.27**	**8.15**	**2.06**	<2	**2.2**	**2.11**	**0.64**	<2	<2	<2	**2.47**	**2.68**	**3.01**	**2.47**
Perfluorodecanoic Acid	**PFDA**	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorododecanoic Acid	**PFDoA**	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorodecane Sulfonic Acid	**PFDS**	NC	NC	ng/L	**1.08**	<2	<2	<2	**0.93**	<2	<2	<2	**1.01**	<2	<2	<2	**1.1**	<2	<2	<2
Perfluoroheptanoic Acid	**PFHpA**	NC	NC	ng/L	**6.91**	**4.56**	<2	**5.04**	**1.02**	<2	<2	<2	**0.05**	<2	<2	<2	<2	**8.26**	**5.48**	**5.74**
Perfluoroheptane Sulfonic Acid	**PFHpS**	NC	NC	ng/L	<2	<2	<2	<2	**0.09**	<2	<2	<2	<2	<2	<2	<2	**1.75**	**3.62**	**5.89**	**3.49**
Perfluorohexanoic Acid	**PFHxA**	NC	**400,000**	ng/L	**18.86**	**16.05**	**14.46**	**14.31**	**2.18**	<2	**3.03**	**3.16**	<2	<2	<2	<2	**12**	**12.01**	**7.81**	<2
Perfluorohexane Sulfonic Acid	**PFHxS**	NC	**51**	ng/L	**0.92**	<2	**2.34**	**2.19**	**0.41**	<2	<2	<2	<2	<2	<2	<2	**3.77**	**4.58**	**6.64**	**5.75**
Perfluorononanoic Acid	**PFNA**	NC	**6**	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	**2.36**	**2.82**	**2.55**	**3.23**
Perfluorooctanoic Acid	**PFOA**	**70**	**8**	ng/L	**5.3**	**4.91**	**5.42**	**4.23**	**9.42**	**8.23**	**6.94**	**7.28**	<2	<2	<2	<2	**19.84**	**18.73**	**17.97**	**18.5**
Perfluorononane Sulfonic Acid	**PFNS**	NC	NC	ng/L	**0.38**	<2	<2	<2	**0.33**	<2	<2	<2	**0.36**	<2	<2	<2	**0.4**	<2	<2	<2
Perfluorooctane Sulfonic Acid	**PFOS**	**70**	**16**	ng/L	**0.07**	**2.34**	**4.28**	<2	**17.26**	**19.27**	**19.22**	**18.23**	**0.03**	<2	<2	<2	**235.78**	**267.73**	**289.88**	**282.73**
Perfluoropentanoic Acid	**PFPeA**	NC	NC	ng/L	**31.5**	**26.94**	**23.96**	**28.69**	<2	<2	<2	<2	**1.08**	<2	<2	<2	<2	<2	<2	**7.47**
Perfluoropentane Sulfonic Acid	**PFPeS**	NC	NC	ng/L	**1.13**	<2	<2	<2	**1.31**	<2	<2	<2	**0.17**	<2	<2	<2	**1.88**	**4.14**	**5.21**	**2.72**
Perfluorotetradecanoic acid	**PFTeA**	NC	NC	ng/L	**0.65**	<2	<2	<2	**0.56**	<2	<2	<2	**0.63**	<2	<2	<2	**0.67**	<2	<2	<2
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	**11Cl-PF3OUdS**	NC	NC	ng/L	**0.29**	<2	<2	<2	**0.26**	<2	<2	<2	**0.28**	<2	<2	<2	**0.3**	<2	<2	<2
Perfluorotridecanoic Acid	**PFTriA**	NC	NC	ng/L	**1.04**	<2	<2	<2	**0.9**	<2	<2	<2	**0.94**	<2	<2	<2	**1.01**	<2	<2	<2
Perfluoroundecanoic Acid	**PFUnA**	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid	**9Cl-PF3ONS**	NC	NC	ng/L	**0.19**	<2	<2	<2	**0.16**	<2	<2	<2	**0.17**	<2	<2	<2	**0.18**	<2	<2	<2

Notes:
< = less than
Bold = Analyte detected above laboratory detection limit
Eexceeds EGLE MCL
Exceeds EGLE DWC
DWC = Drinking Water Criteria
EGLE = Michigan Department of Environment, Great Lakes, and Energy
EPA = United States Environmental Protection Agency
MCL = Maximum Contaminant Level
ng/L = nanograms per liter (parts per trillion)
PFAS = per- and polyfluoroalkyl substances

Table 1
Groundwater PFAS Historical Analytical Results
Harbor Island
GRand Haven, MI

Analyte	Abbreviation	Regulatory Criteria: EGLE DWC (EPA Lifetime Health Advisory)	Regulatory Criteria: EGLE PFAS Drinking Water MCLs	Sample ID / Date	MW-09				MW-10			PZ-11	PZ-12	PZ-13		PZ-14		PZ-15		PZ-16	
				Date	5/21/21	6/24/21	10/26/21	1/11/22	5/21/21	6/24/21	1/6/22	1/12/22	1/12/22	10/27/21	1/12/22	10/27/21	1/12/22	10/27/21	1/12/22	10/27/21	1/12/22
4:2 Fluorotelomer Sulfonic Acid	**4:2 FTS**	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	**7.71**	**30.63**	<2	<2	<2	<2	<2	<2
6:2 Fluorotelomer Sulfonic Acid	**6:2 FTS**	NC	NC	ng/L	**1.35**	<20	<20	<20	**1.55**	<20	<20	<20	<20	**600.1**	**2149.5**	<20	<20	<20	<20	<20	<20
8:2 Fluorotelomer Sulfonic Acid	**8:2 FTS**	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	**8.79**	**17.83**	<2	<2	<2	<2	<2	<2
4,8-dioxa-3H-perfluorononanoic acid	**ADONA**	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorooctane Sulfonamide	**FOSA**	NC	NC	ng/L	**0.18**	<10	<10	<10	**0.12**	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Hexafluoropropylene oxide dimer acid	**HFPO-DA or**	NC	**370**	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
N-Ethyl Perfluorooctane Sulfonamidoacetic Acid	**N-EtFOSAA**	NC	NC	ng/L	<10	<10	<10	<10	**2.91**	<10	**10.05**	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
N-Methyl Perfluorooctane Sulfonamidoacetic Acid	**N-MeFOSAA**	NC	NC	ng/L	**0.14**	<10	<10	<10	**0.2**	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Perfluorobutanoic Acid	**PFBA**	NC	NC	ng/L	<2	<2	**2.31**	<2	<2	**14.57**	**10.14**	<2	**16.08**	**100.29**	**254.93**	<2	<2	<2	<2	<2	**9.34**
Perfluorobutane Sulfonic Acid	**PFBS**	NC	**420**	ng/L	**0.39**	<2	<2	<2	**1.78**	<2	**2.09**	**2.38**	<2	**20.62**	**66.14**	<2	<2	**2.79**	**2.28**	**3.36**	**3.98**
Perfluorodecanoic Acid	**PFDA**	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorododecanoic Acid	**PFDoA**	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorodecane Sulfonic Acid	**PFDS**	NC	NC	ng/L	**1.04**	<2	<2	<2	**1.1**	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluoroheptanoic Acid	**PFHpA**	NC	NC	ng/L	**0.21**	<2	<2	<2	<2	**3.54**	**4.23**	<2	**17.72**	<2	**158.72**	<2	<2	<2	<2	<2	**4**
Perfluoroheptane Sulfonic Acid	**PFHpS**	NC	NC	ng/L	**0.16**	<2	<2	<2	**0.89**	<2	<2	<2	<2	**5.64**	**18.82**	<2	<2	<2	<2	<2	<2
Perfluorohexanoic Acid	**PFHxA**	NC	**400,000**	ng/L	<2	<2	<2	<2	<2	**6.54**	**6.66**	<2	**28.98**	**263.37**	**889.62**	<2	<2	<2	<2	<2	**5.4**
Perfluorohexane Sulfonic Acid	**PFHxS**	NC	**51**	ng/L	**0.43**	<2	<2	<2	**2.11**	**2.57**	**2.81**	<2	**7.17**	**80.47**	**311.33**	<2	<2	<2	<2	<2	<2
Perfluorononanoic Acid	**PFNA**	NC	**6**	ng/L	<2	<2	<2	<2	**0.48**	<2	<2	<2	<2	**2.69**	**5.38**	<2	<2	<2	<2	<2	<2
Perfluorooctanoic Acid	**PFOA**	**70**	**8**	ng/L	**1.66**	<2	<2	<2	**11.18**	**9.2**	**10.7**	**4.69**	**15.69**	**48.93**	**134.68**	<2	<2	<2	<2	**4.2**	**5.39**
Perfluorononane Sulfonic Acid	**PFNS**	NC	NC	ng/L	**0.38**	<2	<2	<2	**0.44**	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorooctane Sulfonic Acid	**PFOS**	**70**	**16**	ng/L	**42.7**	**46.68**	**38.13**	**37.2**	**77.34**	**82.64**	**83.56**	**23.92**	**18.99**	**92.67**	**272.92**	**7.97**	**8.35**	<2	<2	**4.73**	**4.34**
Perfluoropentanoic Acid	**PFPeA**	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	**55.83**	**393.52**	**1467.7**	<2	<2	<2	<2	<2	**7.21**
Perfluoropentane Sulfonic Acid	**PFPeS**	NC	NC	ng/L	**0.45**	<2	<2	<2	**1.35**	<2	<2	<2	<2	<2	**124.01**	<2	<2	<2	<2	<2	<2
Perfluorotetradecanoic acid	**PFTeA**	NC	NC	ng/L	**0.59**	<2	<2	<2	**0.68**	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	**11Cl-PF3OUdS**	NC	NC	ng/L	**0.27**	<2	<2	<2	**0.3**	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorotridecanoic Acid	**PFTriA**	NC	NC	ng/L	**0.91**	<2	<2	<2	**1.03**	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluoroundecanoic Acid	**PFUnA**	NC	NC	ng/L	**1.19**	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid	**9Cl-PF3ONS**	NC	NC	ng/L	**0.18**	<2	<2	<2	**0.19**	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2

Notes:
< = less than
Bold = Analyte detected above laboratory detection limit
Eexceeds EGLE MCL
Exceeds EGLE DWC
DWC = Drinking Water Criteria
EGLE = Michigan Department of Environment, Great Lakes, and Energy
EPA = United States Environmental Protection Agency
MCL = Maximum Contaminant Level
ng/L = nanograms per liter (parts per trillion)
PFAS = per- and polyfluoroalkyl substances

Table 1
Groundwater PFAS Historical Analytical Results
Harbor Island
GRand Haven, MI

Analyte	Abbreviation	Regulatory Criteria		Sample ID	PZ-17	PZ-18	PZ-19	PZ-20	PZ-23		PZ-24		PZ-25		PZ-26		PZ-27		PZ-28		PZ-30
		EGLE DWC (EPA Lifetime Health Advisory)	EGLE PFAS Drinking Water MCLs	Date	10/27/21	10/27/21	10/27/21	10/27/21	10/27/21	1/12/22	10/27/21	1/12/22	10/27/21	1/12/22	10/27/21	1/12/22	10/27/21	1/13/22	10/27/21	1/13/22	10/27/21
4:2 Fluorotelomer Sulfonic Acid	4:2 FTS	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
6:2 Fluorotelomer Sulfonic Acid	6:2 FTS	NC	NC	ng/L	**123.36**	<20	<20	<2	<2	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
8:2 Fluorotelomer Sulfonic Acid	8:2 FTS	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
4,8-dioxa-3H-perfluorononanoic acid	ADONA	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorooctane Sulfonamide	FOSA	NC	NC	ng/L	<10	<10	<10	<2	<2	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Hexafluoropropylene oxide dimer acid	HFPO-DA or	NC	**370**	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
N-Ethyl Perfluorooctane Sulfonamidoacetic Acid	N-EtFOSAA	NC	NC	ng/L	<10	<10	<10	<2	<2	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
N-Methyl Perfluorooctane Sulfonamidoacetic Acid	N-MeFOSAA	NC	NC	ng/L	<10	<10	<10	<2	<2	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Perfluorobutanoic Acid	PFBA	NC	NC	ng/L	**85.46**	**18.82**	**31.22**	**41**	**5.08**	**15.67**	**9.32**	<2	**13.05**	<2	**16.85**	**16.19**	**11.69**	**13.41**	**17.97**	**14.77**	**111.18**
Perfluorobutane Sulfonic Acid	PFBS	NC	**420**	ng/L	**17.12**	**3.97**	**4.9**	**11.23**	<2	**3.25**	<2	<2	**2.83**	**2.46**	**2.21**	**2.13**	**3.56**	**3.78**	**5.24**	**4.56**	**14.52**
Perfluorodecanoic Acid	PFDA	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorododecanoic Acid	PFDoA	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorodecane Sulfonic Acid	PFDS	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluoroheptanoic Acid	PFHpA	NC	NC	ng/L	<2	**11.66**	**10.29**	**22.86**	**2.53**	**3.91**	<2	<2	**2.18**	**4.6**	<2	<2	**3.96**	**6.72**	**6.64**	**9.72**	**44.89**
Perfluoroheptane Sulfonic Acid	PFHpS	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorohexanoic Acid	PFHxA	NC	**400,000**	ng/L	**204.6**	**21.1**	**39.21**	**67.09**	**4.22**	**8.66**	<2	**2.29**	**6.31**	**6.85**	**3.47**	**2.79**	**8.22**	**10.32**	**27.61**	**21.42**	**166.9**
Perfluorohexane Sulfonic Acid	PFHxS	NC	**51**	ng/L	**23.73**	**5.9**	**4.37**	**13.07**	<2	<2	<2	**2.13**	<2	<2	<2	<2	**3**	**2.32**	**5.23**	**4.3**	**16.34**
Perfluorononanoic Acid	PFNA	NC	**6**	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	**2.11**	<2	<2	**2.05**	<2	<2	<2
Perfluorooctanoic Acid	PFOA	**70**	**8**	ng/L	**24.44**	**17.69**	**5.4**	**11.01**	**22.24**	**12.85**	**6.6**	**18.57**	**6.99**	**10.83**	**8.53**	**5.38**	**6.58**	**7.07**	**12.66**	**12.66**	**16.14**
Perfluorononane Sulfonic Acid	PFNS	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorooctane Sulfonic Acid	PFOS	**70**	**16**	ng/L	**19.69**	**18.29**	**6.22**	**11.95**	**11.4**	**4.09**	**2.88**	**5.62**	**5.26**	**3.05**	**20.29**	**18.05**	**12.97**	**11.86**	**34.23**	**34.23**	**49.41**
Perfluoropentanoic Acid	PFPeA	NC	NC	ng/L	**365.98**	**28.95**	**78.26**	**148.93**	<2	**6.12**	<2	<2	<2	**4.8**	<2	<2	<2	**20.43**	**34.71**	**34.71**	**418.14**
Perfluoropentane Sulfonic Acid	PFPeS	NC	NC	ng/L	**33.99**	**2.95**	**3.08**	**9.35**	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	**24**
Perfluorotetradecanoic acid	PFTeA	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorotridecanoic Acid	PFTriA	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluoroundecanoic Acid	PFUnA	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid	9Cl-PF3ONS	NC	NC	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2

Notes:
< = less than
Bold = Analyte detected above laboratory detection limit
Eexceeds EGLE MCL
Exceeds EGLE DWC
DWC = Drinking Water Criteria
EGLE = Michigan Department of Environment, Great Lakes, and Energy
EPA = United States Environmental Protection Agency
MCL = Maximum Contaminant Level
ng/L = nanograms per liter (parts per trillion)
PFAS = per- and polyfluoroalkyl substances

Table 1
Groundwater PFAS Historical Analytical Results
Harbor Island
GRand Haven, MI

Analyte	Abbreviation	Regulatory Criteria		Sample ID	PZ-31		PZ-32	
		EGLE DWC (EPA Lifetime Health Advisory)	EGLE PFAS Drinking Water MCLs	Date	10/27/21	1/13/22	10/27/21	1/13/22
4:2 Fluorotelomer Sulfonic Acid	**4:2 FTS**	NC	NC	ng/L	<2	<2	<2	<2
6:2 Fluorotelomer Sulfonic Acid	**6:2 FTS**	NC	NC	ng/L	<20	<20	<20	<20
8:2 Fluorotelomer Sulfonic Acid	**8:2 FTS**	NC	NC	ng/L	<2	<2	<2	<2
4,8-dioxa-3H-perfluorononanoic acid	**ADONA**	NC	NC	ng/L	<2	<2	<2	<2
Perfluorooctane Sulfonamide	**FOSA**	NC	NC	ng/L	<10	<10	<10	<10
Hexafluoropropylene oxide dimer acid	**HFPO-DA or**	NC	**370**	ng/L	<2	<2	<2	<2
N-Ethyl Perfluorooctane Sulfonamidoacetic Acid	**N-EtFOSAA**	NC	NC	ng/L	**23.65**	**38.29**	<10	<10
N-Methyl Perfluorooctane Sulfonamidoacetic Acid	**N-MeFOSAA**	NC	NC	ng/L	<10	<10	<10	<10
Perfluorobutanoic Acid	**PFBA**	NC	NC	ng/L	<2	<2	**18.53**	**20.2**
Perfluorobutane Sulfonic Acid	**PFBS**	NC	**420**	ng/L	**2.81**	**2.95**	**3.73**	**3.81**
Perfluorodecanoic Acid	**PFDA**	NC	NC	ng/L	<2	<2	<2	<2
Perfluorododecanoic Acid	**PFDoA**	NC	NC	ng/L	<2	<2	<2	<2
Perfluorodecane Sulfonic Acid	**PFDS**	NC	NC	ng/L	<2	<2	<2	<2
Perfluoroheptanoic Acid	**PFHpA**	NC	NC	ng/L	**8.78**	**12.32**	**8.71**	**12.99**
Perfluoroheptane Sulfonic Acid	**PFHpS**	NC	NC	ng/L	<2	<2	**4.43**	**2.9**
Perfluorohexanoic Acid	**PFHxA**	NC	**400,000**	ng/L	**10.43**	**13.51**	**18.8**	**23.44**
Perfluorohexane Sulfonic Acid	**PFHxS**	NC	**51**	ng/L	**3.81**	**2.38**	**7.64**	**8.67**
Perfluorononanoic Acid	**PFNA**	NC	**6**	ng/L	<2	<2	**2.23**	**2.23**
Perfluorooctanoic Acid	**PFOA**	**70**	**8**	ng/L	**6.42**	**7**	**16.04**	**18.15**
Perfluorononane Sulfonic Acid	**PFNS**	NC	NC	ng/L	<2	<2	<2	<2
Perfluorooctane Sulfonic Acid	**PFOS**	**70**	**16**	ng/L	**28.58**	**25.7**	**214.74**	**220.6**
Perfluoropentanoic Acid	**PFPeA**	NC	NC	ng/L	**21.33**	**21.33**	**32.35**	**35.38**
Perfluoropentane Sulfonic Acid	**PFPeS**	NC	NC	ng/L	<2	<2	**6.77**	**3.52**
Perfluorotetradecanoic acid	**PFTeA**	NC	NC	ng/L	<2	<2	<2	<2
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	**11Cl-PF3OUdS**	NC	NC	ng/L	<2	<2	<2	<2
Perfluorotridecanoic Acid	**PFTriA**	NC	NC	ng/L	<2	<2	<2	<2
Perfluoroundecanoic Acid	**PFUnA**	NC	NC	ng/L	<2	<2	<2	<2
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid	**9Cl-PF3ONS**	NC	NC	ng/L	<2	<2	<2	<2

Notes:
< = less than
Bold = Analyte detected above laboratory detection limit
Eexceeds EGLE MCL
Exceeds EGLE DWC
DWC = Drinking Water Criteria
EGLE = Michigan Department of Environment, Great Lakes, and Energy
EPA = United States Environmental Protection Agency
MCL = Maximum Contaminant Level
ng/L = nanograms per liter (parts per trillion)
PFAS = per- and polyfluoroalkyl substances

Table 2
Surfacewater PFAS Historical Analytical Results
Harbor Island
GRand Haven, MI

Analyte	Abbreviation	Regulatory Criteria: EGLE Water Quality Standard = GSI Criteria		Regulatory Criteria: EGLE DWC (EPA Lifetime Health Advisory)	Regulatory Criteria: EGLE PFAS Drinking Water MCLs	Laboratory Reporting Limit	Sample ID	SW_SG-1		SW_N SG-2		SW_SE MW-7		SW_N MW-8		SW_SW MW-8		SW_NE MW-10		East Wetlands	East Wetlands SW_MW-5	Unit 1/2 Near MW-5	Unit 1/2 Near SG-2	Unit 3 North	Unit 3 South	CPR 01 East
		Non-Drinking Water Source	Drinking Water Source				Date	6/24/21	10/28/21	6/24/21	10/28/21	6/24/21	10/28/21	7/16/21	10/28/21	7/16/21	10/28/21	6/24/21	10/28/21	6/24/21	10/28/21	6/24/21	6/24/21	7/16/21	7/16/21	7/16/21
4:2 Fluorotelomer Sulfonic Acid	4:2 FTS	NC	NC	NC	NC	2	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<8.7	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
6:2 Fluorotelomer Sulfonic Acid	6:2 FTS	NC	NC	NC	NC	20	ng/L	<20	<20	<20	<20	<20	<20	<20	<20	<86.96	<20	<20	<20	<20	<20	<20	<20	**72.04**	**59.72**	**20.4**
8:2 Fluorotelomer Sulfonic Acid	8:2 FTS	NC	NC	NC	NC	2	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<8.7	<2	<2	<2	<2	<2	<2	<2	**12.21**	**9.22**	<2
4,8-dioxa-3H-perfluorononanoic acid	ADONA	NC	NC	NC	NC	2	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<8.7	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorooctane Sulfonamide	FOSA	NC	NC	NC	NC	10	ng/L	<10	<10	<10	<10	<10	<10	<10	<10	<43.48	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Hexafluoropropylene oxide dimer acid	HFPO-DA or GenX	NC	NC	NC	**370**	2	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<8.7	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
N-Ethyl Perfluorooctane Sulfonamidoacetic Acid	N-EtFOSAA	NC	NC	NC	NC	10	ng/L	<10	<10	<10	<10	<10	<10	<10	<10	<43.48	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
N-Methyl Perfluorooctane Sulfonamidoacetic Acid	N-MeFOSAA	NC	NC	NC	NC	10	ng/L	<10	<10	<10	<10	<10	<10	<10	<10	<43.48	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Perfluorobutanoic Acid	PFBA	NC	NC	NC	NC	2	ng/L	**5.53**	**3.44**	**5.3**	**4.51**	<2	<2	<2	<2	**6.36 J**	<2	<2	**3.97**	**13.2**	**24.25**	**20.34**	**15.05**	**10.15**	**9.39**	**10.6**
Perfluorobutane Sulfonic Acid	PFBS	NC	NC	NC	**420**	2	ng/L	**3.99**	<2	**2.63**	**2.34**	**2.55**	**2.04**	<2	**2.25**	<8.7	**2.29**	**2.17**	**2.29**	**3.7**	**5.14**	**4.48**	**3.4**	<2	<2	<2
Perfluorodecanoic Acid	PFDA	NC	NC	NC	NC	2	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<8.7	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorododecanoic Acid	PFDoA	NC	NC	NC	NC	2	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<8.7	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorodecane Sulfonic Acid	PFDS	NC	NC	NC	NC	2	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<8.7	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluoroheptanoic Acid	PFHpA	NC	NC	NC	NC	2	ng/L	**4.06**	<2	**3.55**	<2	**2.73**	<2	**3.67**	<2	**3.92 J**	<2	**3.81**	<2	**9.7**	**12**	**22.08**	**17.02**	**7.69**	**8.12**	**12.34**
Perfluoroheptane Sulfonic Acid	PFHpS	NC	NC	NC	NC	2	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<8.7	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorohexanoic Acid	PFHxA	NC	NC	NC	**400,000**	2	ng/L	**6.17**	<2	**5.13**	**2.84**	**3.99**	<2	**3.97**	**3.34**	**4.03**	**5.97**	**5.26**	**3.03**	**19.1**	**38.89**	**28.87**	**17.35**	**27.93**	**23.85**	**25.86**
Perfluorohexane Sulfonic Acid	PFHxS	NC	NC	NC	**51**	2	ng/L	<2	<2	**2.55**	<2	<2	<2	<2	<2	<8.7	<2	<2	<2	**3.49**	**10.69**	**6.6**	**5.38**	**4.91**	**4.89**	**7.22**
Perfluorononanoic Acid	PFNA	NC	NC	NC	NC	2	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<8.7	<2	<2	<2	<2	<2	<2	**4.93**	<2	<2	**7.51**
Perfluorooctanoic Acid	PFOA	**12,000**	**420**	**70**	**8**	2	ng/L	**3.24**	<2	**4.61**	**2.51**	**2.7**	<2	**3.12**	<2	**2.28**	**2.19**	**2.08**	**2.27**	**8.33**	**12.35**	**6.8**	**14.86**	**8.1**	**7.51**	**9.36**
Perfluorononane Sulfonic Acid	PFNS	NC	NC	NC	NC	2	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<8.7	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorooctane Sulfonic Acid	PFOS	**12**	**11**	**70**	**16**	2	ng/L	**10.17**	**2.65**	**18.37**	**8.57**	**5.88**	**3.07**	**11.83**	**14.21**	**9.58**	**5.55**	**13.48**	**12.68**	**9.21**	**24.25**	**2.93**	**39.15**	**23.96**	**20.66**	**73.2**
Perfluoropentanoic Acid	PFPeA	NC	NC	NC	NC	2	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	**3.33 J**	**8.01**	<2	<2	**24.12**	**77.63**	**45.4**	**26.03**	**35.36**	**34.92**	**44.68**
Perfluoropentane Sulfonic Acid	PFPeS	NC	NC	NC	NC	2	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<8.7	<2	<2	<2	<2	**7.13**	<2	<2	<2	<2	<2
Perfluorotetradecanoic acid	PFTeA	NC	NC	NC	NC	2	ng/L	<2	<2	**2.41**	<2	<2	<2	<2	<2	<8.7	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	NC	NC	NC	NC	2	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<8.7	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluorotridecanoic Acid	PFTriA	NC	NC	NC	NC	2	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<8.7	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Perfluoroundecanoic Acid	PFUnA	NC	NC	NC	NC	2	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<8.7	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid	9Cl-PF3ONS	NC	NC	NC	NC	2	ng/L	<2	<2	<2	<2	<2	<2	<2	<2	<8.7	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2

Notes:
< = less than
Bold = Analyte detected above laboratory detection limit
Eexceeds EGLE GSI
Exceeds EGLE MCL
Exceeds EGLE DWC
DWC = Drinking Water Criteria
EGLE = Michigan Department of Environment, Great Lakes, and Energy
EPA = United States Environmental Protection Agency
GSI = Groundwater Surfacewater Interface
MCL = Maximum Contaminant Level
ng/L = nanograms per liter (parts per trillion)
PFAS = per- and polyfluoroalkyl substances

Table 2
Surfacewater PFAS Historical Analytical Results
Harbor Island
GRand Haven, MI

Analyte	Abbreviation	Regulatory Criteria				Laboratory Reporting Limit	Sample ID	CPR 02 North	CPR 03 South (west of Coal Pile Runoff Point)
		EGLE Water Quality Standard = GSI Criteria		EGLE DWC (EPA Lifetime Health Advisory)	EGLE PFAS Drinking Water MCLs				
		Non-Drinking Water Source	Drinking Water Source				Date	7/16/21	7/16/21
4:2 Fluorotelomer Sulfonic Acid	4:2 FTS	NC	NC	NC	NC	2	ng/L	<2	<2
6:2 Fluorotelomer Sulfonic Acid	6:2 FTS	NC	NC	NC	NC	20	ng/L	<20	<20
8:2 Fluorotelomer Sulfonic Acid	8:2 FTS	NC	NC	NC	NC	2	ng/L	<2	<2
4,8-dioxa-3H-perfluorononanoic acid	ADONA	NC	NC	NC	NC	2	ng/L	<2	<2
Perfluorooctane Sulfonamide	FOSA	NC	NC	NC	NC	10	ng/L	<10	<10
Hexafluoropropylene oxide dimer acid	HFPO-DA or GenX	NC	NC	NC	**370**	2	ng/L	<2	<2
N-Ethyl Perfluorooctane Sulfonamidoacetic Acid	N-EtFOSAA	NC	NC	NC	NC	10	ng/L	<10	<10
N-Methyl Perfluorooctane Sulfonamidoacetic Acid	N-MeFOSAA	NC	NC	NC	NC	10	ng/L	<10	<10
Perfluorobutanoic Acid	PFBA	NC	NC	NC	NC	2	ng/L	**13.98**	**11.86**
Perfluorobutane Sulfonic Acid	PFBS	NC	NC	NC	**420**	2	ng/L	<2	<2
Perfluorodecanoic Acid	PFDA	NC	NC	NC	NC	2	ng/L	<2	<2
Perfluorododecanoic Acid	PFDoA	NC	NC	NC	NC	2	ng/L	<2	<2
Perfluorodecane Sulfonic Acid	PFDS	NC	NC	NC	NC	2	ng/L	<2	<2
Perfluoroheptanoic Acid	PFHpA	NC	NC	NC	NC	2	ng/L	**12.12**	**12.73**
Perfluoroheptane Sulfonic Acid	PFHpS	NC	NC	NC	NC	2	ng/L	<2	<2
Perfluorohexanoic Acid	PFHxA	NC	NC	NC	**400,000**	2	ng/L	**27.09**	**28.12**
Perfluorohexane Sulfonic Acid	PFHxS	NC	NC	NC	**51**	2	ng/L	**6.66**	**7.81**
Perfluorononanoic Acid	PFNA	NC	NC	NC	NC	2	ng/L	<2	**4.4**
Perfluorooctanoic Acid	PFOA	**12,000**	**420**	**70**	**8**	2	ng/L	**6.85**	**9.49**
Perfluorononane Sulfonic Acid	PFNS	NC	NC	NC	NC	2	ng/L	<2	<2
Perfluorooctane Sulfonic Acid	PFOS	**12**	**11**	**70**	**16**	2	ng/L	**11.04**	**39.24**
Perfluoropentanoic Acid	PFPeA	NC	NC	NC	NC	2	ng/L	**48.82**	**47.14**
Perfluoropentane Sulfonic Acid	PFPeS	NC	NC	NC	NC	2	ng/L	<2	<2
Perfluorotetradecanoic acid	PFTeA	NC	NC	NC	NC	2	ng/L	<2	<2
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	NC	NC	NC	NC	2	ng/L	<2	<2
Perfluorotridecanoic Acid	PFTriA	NC	NC	NC	NC	2	ng/L	<2	<2
Perfluoroundecanoic Acid	PFUnA	NC	NC	NC	NC	2	ng/L	<2	<2
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid	9Cl-PF3ONS	NC	NC	NC	NC	2	ng/L	<2	<2

Notes:
< = less than
Bold = Analyte detected above laboratory detection limit
Eexceeds EGLE GSI
Exceeds EGLE MCL
Exceeds EGLE DWC
DWC = Drinking Water Criteria
EGLE = Michigan Department of Environment, Great Lakes, and Energy
EPA = United States Environmental Protection Agency
GSI = Groundwater Surfacewater Interface
MCL = Maximum Contaminant Level
ng/L = nanograms per liter (parts per trillion)
PFAS = per- and polyfluoroalkyl substances

FIGURES

Document Path: G:\GrandHaven\a_MXD\SiteOverview.mxd

DRAFT

1231 N 3RD ST, GRAND HAVEN, MI 49417	wood.	SITE MAP FIGURE 1

Imagery provided by google

Document Path: G:\GrandHaven\a_MXD\SiteFeatures.mxd

DRAFT

Prepared/Date: DGJ 4/20/2022
Checked/Date: DH 4/20/2022

1231 N 3RD ST, GRAND HAVEN, MI 49417	wood.	SITE FEATURES FIGURE 2

Imagery provided by google

Document Path: G:\GrandHaven\a_MXD\Exceedances.mxd

DRAFT

1231 N 3RD ST, GRAND HAVEN, MI 49417	wood.	CONCENTRATION MAP FIGURE 3

Imagery provided by google

Document Path: G:\GrandHaven\a_MXD\PFASExceedances.mxd

DRAFT

1231 N 3RD ST,
GRAND HAVEN,
MI 49417

wood.

CONCENTRATION MAP

FIGURE 4

Imagery provided by google

DRAFT

Document Path: G:\GrandHaven\a_MXD\SampleLocations_NewBorings.mxd

1231 N 3RD ST,
GRAND HAVEN,
MI 49417

wood.

PROPOSED SAMPLE LOCATIONS

FIGURE 5

Document Path: G:\GrandHaven\a_MXD\SurfaceWaterSamples.mxd

DRAFT

1231 N 3RD ST,
GRAND HAVEN,
MI 49417

wood.

SURFACE WATER SAMPLE LOCATIONS

FIGURE 6

Imagery provided by google

ATTACHMENT A

Standard Operating Procedures

FIELD SAMPLING PROTOCOLS TO AVOID CROSS-CONTAMINATION OF PER- AND POLYFLUORINATED ALKYL SUBSTANCES (PFAS) SOP AMEC-01 (PFAS)

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to describe the procedures/considerations when collecting potable water samples at potential per-and polyfluorinated alkyl substances (PFAS) contaminated areas. This SOP also describes a tiered approach that should be used to assist with field decisions. Sampling specific SOPs should also be reviewed prior to conducting field sampling activities at PFAS areas. The information contained within this SOP is included within sampling specific SOPs as applicable.

2.0 SCOPE

This procedure applies to all AMEC Engineering and Consulting of Michigan (AMEC) personnel and subcontractors who collect or otherwise handle samples of potable water for analysis of PFAS. This SOP should be reviewed by all on-site personnel prior to implementation of field activities.

3.0 REFERENCES

Transport Canada, 2013. *Perfluorochemical (PFC) Field Sampling Protocol*. May.

Delta Consultants, 2010. *Report of Investigation Activities at Select Firefighting Foam Training Areas and Foam Discharge Sites in Minnesota*. February. MPCA, 2008. *Closed Landfill Program Sampling Protocol for Monitoring Wells.* October.

4.0 GENERAL

Given the low detection limits associated with laboratory PFAS analysis, and the many potential sources of trace levels of PFAS, field personnel are advised to act on the side of caution by strictly following the subject protocols, frequently replacing nitrile gloves, and rinsing field equipment to help mitigate the potential for false detections of PFAS. Specific items related to field sampling are discussed below.

5.0 PROCEDURES

This section contains both the responsibilities and procedures involved with field sampling for analysis of PFAS. Proper procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with site-specific work plans. The site-specific work plans will generally provide the following information:

- Sample collection objectives;
- Locations to be sampled;
- Number and volume of samples to be collected at each location;
- Types of chemical analyses to be conducted for the samples;

- Specific quality control (QC) procedures and sampling required;
- Any additional sampling requirements or procedures beyond those covered in this SOP, as necessary; and,
- At a minimum, the procedures outlined in this SOP for field sampling will be followed.

5.1 RESPONSIBILITIES

Project Manager

The Project Manager (PM) shall provide the site-specific work plan to the Field Lead, which shall include the sampling requirements for each investigation area. The PM will report deviations to the procedure provided in this SOP to the Michigan Department of Environmental Quality (MDEQ) PM.

Field Lead

The Field Lead shall ensure that samples are collected using procedures that are in accordance with the site-specific work plans, and applicable SOPs. The Field Lead shall also be required to make rational and justifiable decisions when deviations from these procedures are necessary because of field conditions or unforeseen issues and report the deviations to the PM.

Field Personnel

Field personnel assigned to sampling activities are responsible for completing their tasks according to specifications outlined in the site-specific work plans, applicable SOPs, and other appropriate procedures. Field personnel are responsible for reporting deviations from procedures to the Field Lead.

5.2 FIELD PROCEDURES/CONSIDERATIONS

The following are procedures/considerations to be made during field activities at potential PFAS release areas. A summary of the prohibited and acceptable items for PFAS investigation areas is included in Table 1. A checklist, provided as Attachment 1, shall be used by the Field Lead daily prior to the commencement of fieldwork to ensure the field team is in compliance with this protocol.

Field Equipment

- **Do not use Teflon®-containing materials** (e.g., Teflon® tubing, bailers, tape, plumbing paste, or other Teflon® materials) since Teflon® contains fluorinated compounds.
- High-density polyethylene (HDPE), low-density polyethylene (LDPE), and silicon materials are acceptable for sample collection, as they do not contain fluorinated compounds. However, samples may not be stored in containers made of LDPE materials because PFAS can stick to LDPE and bias sample results low.
- **Post-It Notes are not allowed** on project sites.
- **Do not use markers other than Sharpies®markers.** Pens will be used when documenting field activities in the field log and on field forms as well as labeling sample containers and preparing the Chain of Custody.

- **Do not use chemical (blue) ice packs** during the sampling program. This includes the use of ice packs for the storage of food and/or samples.

Field Clothing and Personal Protective Equipment

- **Do not wear water resistant, waterproof, or stain-treated clothing** during the field program. Field clothing made of synthetic and natural fibers (preferably cotton) are acceptable. Field clothing should be laundered without the use of fabric softener. Preferably, field gear should be cotton construction and well laundered (i.e., washed a minimum of 6 prior to use after purchase). New clothing may contain PFAS related treatments. **Do not use new clothing** while sampling or sample handling.
- **Do not wear clothing or boots containing Gore-Tex™** during the sampling program as it contains a PFAS membrane.
- Safety footwear will consist of steel-toed boots made with polyurethane and PVC, untreated leather boots, or well-worn leather boots. Newer leather boots may be worn if they are covered with polypropylene, polyethane, or PVC boot covers.
- Disposable nitrile gloves must be worn at all times. Further, a new pair of nitrile gloves shall be donned prior to the following activities at each sample location:
  - Prior to contact with sample bottles or water containers;
  - After contact with non-decontaminated surfaces, or when judged necessary by field personnel.

Sample Containers

- Different laboratories may supply sample collection containers of varying sizes dependent on the type of media to be sampled (e.g., soil, groundwater, etc.). All samples should be collected in polypropylene or HDPE bottles. The screw cap will be made of polypropylene or HDPE and may be lined or unlined. However, if lined, the liner may not be made of Teflon® or contain PFAS.
- Container labels will be completed using pen after the caps have been placed back on each bottle.
- Glass sample containers are not to be used due to potential loss of analyte through adsorption.

Wet Weather

- Field sampling occurring during wet weather (e.g., rainfall and snowfall) should be conducted while wearing appropriate clothing that will not pose a risk for cross-contamination. Teams will avoid synthetic gear that has been treated with water-repellant finishes containing PFAS. Use rain gear made from polyurethane, vinyl, and wax or rubber-coated materials.
- Teams should consider the use of a gazebo tent, which can be erected overtop of the sample location and provide shelter from the rain. It should be noted that the canopy material is likely a treated surface and should be handled as such; therefore, gloves should be worn when setting up and moving the tent, changed immediately afterwards and further contact with the tent should be avoided until all sampling activities have been finished and the team is ready to move on to the next sample location.

Personnel Hygiene

- Field personnel will not use cosmetics, moisturizers, hand cream, or other related products as part of their personal cleaning/showering routine on the morning of a sampling event, unless the products are applied to a part of the body that will be coved by clothing. These products may contain surfactants and represent a potential source of PFAS.
- Many manufactured sunblock and insect repellants contain PFAS and should not be brought or used on-site. Sunblock and insect repellants that are used on-site should consist of 100% natural ingredients, unless previously vetted by the project chemist. A list of acceptable sunscreens and insect repellents is provided in Table 1.
- For washroom breaks, field personnel will leave the exclusion zone and then remove gloves and overalls. Field personnel should wash as normal with extra time for rinsing with water after soap use. When finished washing, the use of a mechanical dryer is preferred and the use of paper towel for drying is to be avoided (if possible).

Food Considerations

- No food or drink shall be brought on-site, with the exception of bottled water and hydration drinks (i.e., Gatorade® and Powerade®), which will only be allowed to be brought and consumed within the staging area.

Visitors

- Visitors to the investigation area are asked to remain outside of the exclusion zone during sampling activities.

6.0 TIERED APPROACH TO ASSIST WITH FIELD DECISIONS

In evaluating whether products contain PFAS and are suitable for use in the field, the tiered approach presented in Table 2 will be used to assist with field decisions. Any member of the field team should contact the PM or Field lead with questions.

Table 1. Summary of Prohibited and Acceptable Items for PFAS Sampling

Prohibited Items	Acceptable Items
Field Equipment	
Teflon® containing materials	High-density polyethylene (HDPE) and Low density polyethylene (LDPE) materials
LDPE sample containers	HDPE sample containers and acetate liners
Waterproof field books not manufactured by Rite in the Rain	Rite in the Rain products or loose leaf paper (non-waterproof)
Plastic clipboards, binders, or spiral hard cover notebooks	Aluminum field clipboards or with Masonite
	Sharpies®, pens
Post-It Notes	

Chemical (blue) ice packs	Regular ice
Field Clothing and PPE	
New clothing or water resistant, waterproof, or stain-treated clothing, clothing containing Gore-Tex™	Well-laundered clothing, defined as clothing that has been washed 6 or more times after purchase, made of synthetic or natural fibers (preferable cotton)
Clothing laundered using fabric softener	No fabric softener
Boots containing Gore-Tex™	Boots made with polyurethane and PVC, well-worn or untreated leather boots, leather boots with boot covers
Tyvek®	Reflective safety vests, Cotton Clothing, synthetic under clothing, body braces
No cosmetics, moisturizers, hand cream, or other related products as part of personal cleaning/showering routine on the morning of sampling, unless the products are applied to body parts that will be covered by clothing.	**Sunscreens** - Alba Organics Natural Sunscreen, Yes To Cucumbers, Aubrey Organics, Jason Natural Sun Block, Kiss my face, Baby sunscreens that are "free" or "natural" **Insect Repellents** - Jason Natural Quit Bugging Me, Repel Lemon Eucalyptus Insect repellant, Herbal Armor, California Baby Natural Bug Spray, BabyGanics, Deep Woods Off **Sunscreen and insect repellant -** Avon Skin So Soft Bug Guard Plus – SPF 30 Lotion

Table 1. Summary of Prohibited and Acceptable Items for PFAS Sampling (continued)

Prohibited Items	Acceptable Items
Sample Containers	
LDPE or glass containers	HDPE or polypropylene
Teflon®-lined caps	Lined or unlined HDPE or polypropylene caps
Rain Events	
Waterproof or resistant rain gear	Polyurethane, vinyl, wax or rubber-coated rain gear. Gazebo tent that is only touched or moved prior to and following sampling activities
Equipment Decontamination	
Decon 90	Alconox® and/or Liquinox®
Water from an on-site well	Potable water from municipal drinking water supply
Food Considerations	
All food and drink, with exceptions noted on the right	Bottled water and hydration drinks (i.e. Gatorade® and Powerade®) to be brought and consumed only in the staging area

Table 2. Tiered Approach

Tier and Description	Action
Tier 1: Products that *will come into direct contact* with field samples include, but are not limited to, , sample containers, and well construction materials	These products will undergo the greatest scrutiny and requires chemist's input to help evaluate the materials as a possible source of contamination[A] and as possible sampling or storage materials or both

Tier 2: Products that *will not come into direct contact* with samples, but could be *reasonably expected to contain PFAS*, such as waterproof or nonstick products	Project team/affected person can review the Safety Data Sheet (SDS)[B] and if it shows PFAS, product should not be used. If product SDS does not indicate PFAS, confirm with chemist before use
Tier 3: Products that *will not come into direct contact* with samples and are *not expected to contain PFAS*, such as ballpoint pens, zipper bags, and body braces	Project team/affected person can review SDS and if no PFAS, then appropriate to use

[A] Tier 1 products will undergo the closest scrutiny. It may be necessary to have Tier 1 products analyzed for PFAS to confirm that a specific batch or lot number does not contain PFAS. Alternate products will need to be evaluated/used if PFAS are identified in the product.

[B] SDS Check: To evaluate product SDS and/or manufacturing specs, check if the product contains anything with “fluoro” in the name or the acronyms TPE, FEP, ETFE, and/or PFA. If fluorinated compounds are not listed in the manufacturing specs and/or on the SDSs, product can be used.

Attachment 1 to SOP AFW-01
Daily PFC Protocol Checklist

Date: ______________________ Installation Name: _______________________________________

Weather (*temp./precipitation*): _______________________ Site Name: _______________________________

Field Clothing and PPE:

☐ Field crew in compliance with Tables 1 and 2, SOP AFW-01

☐ No materials containing Tyvek®

☐ Field crew has not used fabric softener on clothing

☐ Field crew has not used cosmetics, moisturizers, hand cream, or other related products this morning

☐ Field crew has not applied unacceptable sunscreen or insect repellant

Field Equipment:

☐ No Teflon® containing materials on-site

☐ All sample materials made from stainless steel, HDPE, acetate, silicon, or polypropylene

☐ No waterproof field books on-site

☐ No plastic clipboards, binders, or spiral hard cover notebooks on-site

☐ No adhesives (Post-It Notes) on-site

☐ Coolers filled with regular ice only. No chemical (blue) ice packs in possession

Sample Containers:

☐ All sample containers made of HDPE or polypropylene. Samples are not stored in containers made of LDPE

☐ Caps are lined or unlined and made of HDPE or polypropylene

Wet Weather (as applicable):

☐ For personnel in direct contact with samples and/or sampling equipment, wet weather gear made of polyurethane and PVC only

Equipment Decontamination:

☐ "PFC-free" water on-site for decontamination of sample equipment

☐ Alconox and Liquinox to be used as decontamination materials

Food Considerations:

☐ No food or drink on-site with exception of bottled water and/or hydration drinks (i.e., Gatorade and Powerade) that is available for consumption only in the staging area

If any applicable boxes cannot be checked, the Field Manager shall describe the noncompliance issues below and work with field personnel to address noncompliance issues prior to commencement of that day's work. Corrective action shall include removal of noncompliance items from the site or removal of worker offsite until in compliance. Repeated failure to comply with PFC sample protocols will result in the permanent removal of worker(s) from the site.

Describe the noncompliance issues (include personnel not in compliance) and action/outcome of noncompliance:

____

____

____

Field Manager Name: _________________________________

Field Manager Signature: _________________________________ Time: ______________________

SOIL SAMPLING
SOP AMEC-02 (PFAS)

1.0 PURPOSE

The purpose of this technical procedure is to describe the methodology for collecting soil samples in order to document the areal and vertical extent of contaminated soil and to determine the geotechnical, physical, and chemical properties of the soil while conducting potential per-and polyfluorinated alkyl substances (PFAS) investigation sampling.

2.0 SCOPE

This procedure applies to all Amec Foster Wheeler personnel and subcontractors who collect or otherwise handle samples of surficial or subsurface soil during PFAS investigations.

3.0 REFERENCES

ASTM International (ASTM), *Standard Practice for Clarification of Soils for Engineering Purposes (Unified Soil Classification System), Method D-2487-11,*

(ASTM), 1999, *Standard Method for Penetration Test and Split-Barrel Sampling of Soils*, Method D-1586-99, Philadelphia, Pennsylvania.

ASTM International (ASTM), 1994, *Standard Practice for Thin-Walled Tube Sampling of Soils*, Method D-1587-94, Philadelphia, Pennsylvania. International (ASTM), 1995, *Standard Practice for Ring-Lined Barrel Sampling of Soils*, Method D-3550-84 (1995)e1, Philadelphia, Pennsylvania.

Barth, D.S. and B.J. Mason. 1984. *Soil Sampling Quality Assurance User's Guide.* EPA-600/4-84-043.

Environmental Protection Agency. 1984. *Characterization of Hazardous Waste Sites - A Methods Manual, Available Sampling Methods.* Volume II, 2nd Edition. EPA-600/4-84-076.

Mason, B.J. 1983. *Preparation of Soil Sampling Protocol: Techniques and Strategies.* EPA-600/4-83-020.

Hewitt, Alan D., et al. 2007. *Protocols for Collection of Surface Soil Samples at Military Training and Testing Ranges for the Characterization of Energetic Munitions Constituents*. U.S. Army Corps of Engineers. ERDC/CRREL TR-07-10.

4.0 DEFINITIONS

Borehole - Any hole drilled or hydraulically driven into the subsurface for the purpose of identifying lithology, collecting soil samples, and/or installing monitoring wells.

Composite soil sample – a combination of soil aliquots collected at various locations, or at various depths at a single location. Analysis of composite samples yields a value representing an average over the various sampled sites or depths from which individual samples were collected.

Core Sampler – A metal tube (probe rod), generally 4- to 5-feet long by 2.25- to 3.25-inch OD, typically utilized along with drive rods and a polyvinyl chloride (PVC) or acetate or equivalent liner that is used to collect soil cores utilizing a direct-push rig. Inside the probe rods are smaller diameter, center rods affixed with a solid drive tip that seals the lower end of the probe rods during pushing. After reaching the target depth, advancement is halted and the center rods and drive tip are removed, which opens the bottom end of the probe rods. A sample liner is attached to the rod string and is lowered to the bottom of the push rods, and the assembly is then advanced to collect the soil sample within the liner. The center rod string is withdrawn from the probe rods, and the liner is removed to access the recovered soil core. The process of direct-pushing and soil core recovery may be repeated within the same boring until reaching total boring depth.

Discrete soil sample – a discrete aliquot from a distinct sampling interval (of a specific sample size) that is representative of one specific location at a specific point in time.

Drilling Jars – A set pair of linked, heat-treated steel bars. The jars may be attached to a wireline sampling string incorporating a split spoon or other impact sampler. The jars are used to drive the sampler into the soil ahead of the bottom of the borehole

Shelby Tube Sampler – A thin-walled metal tube used to recover relatively undisturbed samples. These tubes are available in various sizes, ranging from 2 to 5 inches in outside diameter and 18 to 54 inches in length. A stationary piston device is included in the sampler to reduce sampling disturbance and increase sample recovery.

Split-Spoon Sampler – A steel tube, split in half lengthwise, with the halves held together by threaded collars at either end of the tube. This device can be driven into resistant (semiconsolidated) materials using a drive weight or drilling jars mounted in the drilling rig. A standard split-spoon sampler (used for performing standard penetration tests) is 2 inches in outside diameter and 1-3/8 inches in inside diameter. This standard spoon typically is available in two common lengths, providing either 20-inch or 26-inch internal longitudinal clearance for obtaining 18-inch or 24-inch long samples, respectively. Six-inch long sleeves (tubes) of brass, stainless steel, or plastic are commonly placed inside the sampler to collect and retain soil samples. A five-foot long split-spoon sampler is also available. A California modified split-spoon sampler is also commonly used. The design is similar to the standard split-spoon except the outside diameter is 2 1/2 inches and the inside diameter is 2 inches.

5.0 PROCEDURES

This section contains both the responsibilities and procedures involved with soil sampling for analysis of PFAS. Proper procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with site-specific work plans. The site-specific work plans will generally provide the following information:

- Sample collection objectives;
- Locations to be sampled;
- Number and volume of samples to be collected at each location;
- Types of chemical analyses to be conducted for the samples;
- Specific quality control procedures and sampling required;
- Any additional sampling requirements or procedures beyond those covered in this SOP, as necessary; and
- At a minimum, the procedures outlined in this SOP for field sampling will be followed.

5.1 RESPONSIBILITIES

Project Manager

The Project Manager shall provide site-specific work plan to the Field Lead, which shall include the sampling requirements, locations and depths for the project.

Field Lead

The Field Lead shall ensure that soil samples are collected according to this technical procedure. The Field Lead shall also be required to make rational and justifiable decisions when deviations from this procedure are necessary because of field conditions or unforeseen problems.

Field Personnel

Field personnel assigned to subsurface soil sampling activities during drilling or probing are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from procedures to the Project Manager or the Field Lead.

5.2 FIELD PROCEDURES/CONSIDERATIONS

Collecting soil samples is an important site characterization activity. Soil samples are used to determine the nature and extent of contamination, to identify hazardous substance source areas, and to determine the geotechnical, hydrogeologic, physical, and chemical properties of a site. Soil sampling strategies will be determined and documented before initiating sampling. Field conditions at the investigation area may preclude collection at one or more predetermined sampling locations. Additional soil sampling may be required if unexpected subsurface conditions are observed during the course of the sampling. Proper sampling techniques, proper selection of sampling equipment, and proper decontamination procedures will eliminate cross-contamination and the introduction of contaminants from external sources. Soil conditions can vary widely at a hazardous waste site. Such variations can affect the rate of contaminant migration through the soil. Therefore, it is important that detailed records be maintained during sampling, particularly with respect to the sample location, depth, color, odor, lithology, hydrogeology, and readings derived from field monitoring equipment. Surface and shallow subsurface soil samples shall be described utilizing the Unified Soil Classification System and / or ASTM guidance D2487 Standard Practices for Classification of Soils for Engineering Purposes (Unified Soil Classification System), unless otherwise specified by the work plan.

The following are procedures/considerations to be made during field activities at potential PFAS release areas.

5.2.1 FIELD EQUIPMENT

Equipment and supplies used to collect, document, and package surface or subsurface soil samples may include, but is not limited to, the following items:

- Nitrile gloves;
- Stainless steel spoons/trowels;
- Stainless steel hand auger;
- Stainless steel split spoon, split barrel, or continuous sampler;
- Stainless steel bowls/pans;
- Field logbook and boring log (**Not** “write in the rain” © or other water resistant paper);
- Pens;
- Paper towels;
- Aluminum foil;

- Appropriate decontamination equipment;
- Appropriate personnel protective equipment and safety equipment as specified in the Health and Safety Plan and in other SOPs;
- Sample cooler with ice (no blue ice);
- Sample jars (i.e., no glass) and labels;
- Bubble wrap;
- Chain-of-Custody forms;
- Munsell Soil Color charts;
- Grain size charts;
- Hand lens;
- Brass sleeves;
- Brass caps;
- Acetate liners;
- Ziplock freezer bags;
- Stainless steel deionized water spraying devices;
- Non PFAS plastic sheeting; and
- Non PFAS tape.

5.2.2 DECONTAMINATION

Before collecting any soil samples, all sampling devices shall be decontaminated. If dedicated or disposable equipment is used, it will be rinsed with deionized water where applicable. Mobile decontamination supplies will be provided so that equipment can be decontaminated in the field. Each piece of sampling equipment shall be decontaminated before initiation of sampling operations and between each sample location and interval. Decontamination solutions shall be replenished between sampling locations as needed. Spent decontamination fluids will be containerized, properly labeled and appropriately disposed of according to the investigation derived waste (IDW) plans addressed in the site-specific work plan.

5.2.3 SURFACE SOIL SAMPLING

Any surface vegetation will be removed before sampling with a decontaminated shovel or sampling spoon. Surface soil samples may be collected as either discrete or composite samples. Each surface soil sample will be collected using either a stainless steel spoon or trowel. The sampler, wearing clean disposable nitrile gloves, will remove pebbles, roots, etc. from the mixture as the sample is collected. Each sample will be collected by thoroughly homogenizing material from the zero (i.e., zero is considered ground surface where no vegetation is present, and/or the surface directly below where vegetation must be removed) to 6-inch below ground surface depth interval (unless other depth intervals are specified in the work plan). A decontaminated stainless steel scoop or trowel will be used to remove a thin layer of soil from the area that comes into contact with the shovel (if used to gain a specific sampling depth). A second decontaminated stainless steel spoon or trowel will then be used to collect the soil sample.

Each soil sample fraction collected will be thoroughly mixed (i.e., homogenized) using the sampling spoon or trowel. The homogenized material will then be divided among the appropriate sample containers. The sample containers will then be sealed tightly. Care should be taken to ensure the container (bowl, pan, etc.) used for homogenization and the sampling utensils do not interfere with the analytes of interest (e.g., an aluminum pan should not be used for soil samples submitted for inorganic analyses; only stainless steel bowls are allowed).

All personnel who collect or handle the soil samples will wear disposable nitrile gloves to prevent cross-contamination and provide personal protection. New gloves shall be donned for sample collection at each sampling location (i.e., at each new vertical or horizontal position), or whenever gloves are torn or otherwise compromised.

If collecting a composite sample, each aliquot will be collected by placing equal amounts of soil collected from multiple locations into a decontaminated collection container. The aliquots will then be combined (i.e. homogenized) using a spoon or trowel. The homogenized material will then be divided equally among the appropriate sample containers.

5.2.4 SUBSURFACE SOIL SAMPLING

Split-Spoon Sampling

Split-spoon samples for chemical analysis are usually obtained in brass, plastic, or stainless steel sleeves. The type of sleeve to be used if applicable, along with the length and type of sampler, will be stated in the project work plans. The split-spoon sampler is connected to the drill rod string or a wireline sampling string and is driven by a drive hammer (140 or 340 pound, depending on the size of the sampler) or drilling jars into the undisturbed soil ahead of the bottom of the borehole. The procedure for collecting samples from the split-spoon sampler will be outlined in the project work plans. The standard procedure is described below.

- Calibrate all field analytical and health and safety monitoring equipment according to the instrument manufacturer’s specifications. Calibration results will be recorded on the appropriate form(s) as specified by the project-specific work plans. Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.

- Wear the appropriate personal protective equipment as specified in the project work plans and the applicable drilling method SOP.
- Between each sampling location and prior to each sampling run, decontaminate the sampler, sleeves, and other nondisposable sampling equipment as described in SOP AFW-10.
- Advance the borehole to the desired depth or target horizon where the sampling run is to begin.
- When the desired sampling depth or target horizon is reached, remove the drill bit or plug from inside the drive casing or augers.
- Insert the sleeves into the split-spoon sampler (if determined necessary), connect the halves, and screw together the rear threaded collar and front drive shoe. Attach the split-spoon sampler to the bottom end of the drill rod string or wireline sampling string. Set up and attach the specified weight hammer, if used.
- Drive the sampler into the soil at the bottom of the borehole. Record the type of sampler assembly and hammer weight on the Boring Log and/or other appropriate form(s), as specified in the project work plans. To minimize off-gassing of the volatiles, the sampler should not be driven until the sampling team is ready to process the sample.
- Pull the drill rod or wireline sampling string up from the bottom of the borehole and remove the sampler.
- Remove the drive shoe and rear collar from the sampler and open the split barrel.
- If sleeves are used, remove the sleeves one at a time, starting with the sleeve adjoining the drive shoe. Observe and record the amount of sample recovery on the Boring Log. Any observed field problems associated with the sampling attempt (e.g., refusal) or lack of recovery should be noted on the Boring Log.
- If sleeves are used, select sleeve(s) to be submitted for laboratory analysis. Sample sleeve selection should be based on four factors: judgment that the sample represents relatively undisturbed intact material, not slough; proximity to the drive shoe; minimal exposure to air; lithology; and obvious evidence of contamination. The soil core should also be visually recorded on a Boring Log.
- Appropriately label and number each sleeve or soil sample container to be submitted for analysis. The label will contain, at a minimum, the following information:
    - Project number;

- Location ID;
- Boring number;
- Sample number;
- Bottom depth of sleeve, if applicable;
- Date and time of sample collection;
- Parameters for analysis; and,
- Sampler's initials.

- Document the sampling event on the Soil Sample Collection Field Sheet or an equivalent form as specified in the project work plans. At a minimum, this log will contain:
  - Project name and number;
  - Location ID
  - Date and time of the sampling event;
  - Drilling and sampling methods;
  - Sample number;
  - Sample location;
  - Boring number;
  - Sample depth;
  - Sample description;
  - Unusual events; and,
  - Signature or initials of the sampler.
- Appropriately preserve (no blue ice permitted to cool samples), package, handle, and ship the sample in accordance with the procedures outlined in SOP AFW-11 and the project work plans. The samples shall also be maintained under proper chain of custody. Samples stored on-site will be subject to the provisions of SOP AFW-11.
- Repeat this sampling procedure at the intervals specified in the project work plans until the bottom of the borehole is reached and/or last sample collected.

Core Sampling using Direct Push Technology (DPT)

A core sampler may be used to collect subsurface soil samples. The procedure for collecting soil samples using a core sampler should be outlined in the project work plans. The standard procedure is described below.

- Calibrate all field analytical and health and safety monitoring equipment.
- Wear the appropriate personal protective equipment.

- Between each sampling location and prior to each sampling run, decontaminate the sampler and other sampling equipment as described in SOP AFW-10.
- Advance the probe rods equipped with a solid drive tip to the desired depth or target horizon where the sampling run is to begin. After reaching the target depth, the center rods and drive tip are removed and a new acetate liner is attached to the center rod string.
- Once the liner and center rods are inserted into the probe rods, the assembly is advanced to collect the soil sample within the liner. The assembly is pushed about 4 to 5 feet into the soil with a continuous, rapid motion. At shallow depths and/or in soft soils, the assembly may be advanced without impact from the drive hammer. At greater depths and in harder substrates impact from the drive hammer is likely required to advance the sampling assembly. The liner and center rods are withdrawn from the probe rods, noting which end of the liner is up.
- The DPT contractor will cut the liner and present it to the geologist/engineer for inspection and sample collection. Upon receiving the liner, the field geologist/engineer will observe and record the amount of sample recovery and any associated problems.
- Sample selection should be based on five factors: judgment that the sample represents relatively undisturbed intact material, not slough; proximity to the drive shoe; minimal exposure to air; lithology; and obvious evidence of contamination. The soil core should also be visually recorded on a soil Boring Log.
- Appropriately label and number each soil sample container to be submitted for analysis. The label will contain, at a minimum, the following information:
  - Project number;
  - Location ID;
  - Boring number;
  - Sample number;
  - Date and time of sample collection;
  - Parameters for analysis; and,
  - Sampler's initials.
- Document the sampling event on the soil sample collection field sheet or an equivalent form as specified in the project work plans. At a minimum, this log will contain:
  - Project name and number;
  - Location ID;
  - Date and time of the sampling event;
  - Drilling and sampling methods;
  - Sample number;

- Sample location;
- Boring number;
- Sample depth;
- Sample description;
- Unusual events; and,
- Signature or initials of the sampler.

- Appropriately preserve (no blue ice permitted to cool samples), package, handle, and ship the sample in accordance with the procedures outlined in SOP AFW-11 and the project work plans. The samples shall also be maintained under proper chain of custody. Samples stored on-site will be subject to the provisions of SOP AFW-11.
- Repeat this sampling procedure at the intervals specified in the project work plans until the bottom of the borehole is reached and/or last sample collected.

GROUNDWATER SAMPLING
SOP AFW-03 (PFAS)

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use by field personnel in the collection and documentation of groundwater samples for chemical analysis. Proper collection procedures are necessary to assure the quality and integrity of all groundwater samples. Additional specific procedures and requirements will be provided in the site-specific work plans, as necessary.

2.0 SCOPE

This procedure applies to all Amec Foster Wheeler personnel and subcontractors who collect or otherwise handle groundwater samples during per- and polyfluorinated alkyl substances (PFAS) investigations. Sample collection will also be conducted in accordance with SOP AMEC-01 (PFAS), *Field Sampling Protocols to Avoid Cross Contamination of Per- and Polyfluorinated Alkyl Substances (PFAS)*.

3.0 REFERENCES

ASTM International, 2007, *Standard Guide for Sampling Ground-Water Monitoring Wells*, D 4448-01 (Reapproved 2007).

Barcelona et al, 1985, *Practical Guide for Groundwater Sampling*, Illinois State Water Survey, Champaign, Illinois, ISWS Contract Report 374, November.

U.S. Environmental Protection Agency (EPA), 1987, *Compendium of Superfund Field Operations Methods*, EPA 540/P-87/001a, OSWER 9355.0-14, September.

EPA, 1988, *EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA*, Interim Final OSWER Directive 9355.3-01, August.

EPA, 1992, *EPA RCRA Groundwater Monitoring: Draft Technical Guidance*, November.

4.0 DEFINITIONS

Bailer – A bailer is an enclosed cylindrical tube containing a floating ball check-valve at the bottom. Lowering the bailer into water causes the ball to float allowing water to enter the cylinder. Raising the bailer through the water column causes the ball to settle, creating a seal to trap the water so that it can be brought to the surface.

Bladder Pump – A bladder pump is an enclosed cylindrical tube containing a flexible membrane bladder. Well water enters the bladder through a one-way check-valve at the bottom. Gas is forced into the annular space (positive displacement) surrounding the bladder through a gas supply line. The gas displaces the well water through a one-way check-value at the top. The water is brought to the surface through a water discharge line. Gas (air or nitrogen) is provided by compressors or cylinders.

Dedicated Groundwater Monitoring Equipment – Dedicated groundwater monitoring equipment is used to purge and sample only one well. The equipment is commonly installed within, and remains in the well, for the duration of the monitoring program. Dedicated equipment does not need to be decontaminated between sampling events.

Electric Submersible Pump – An electric submersible pump is an enclosed cylindrical tube containing a motor with rotary attachments. Well water enters the cylinder through a one-way check valve. Electrical power to the motor causes rotors or impellers to turn and displace the groundwater.

Peristaltic Pump – A peristaltic pump is a self-priming, low volume pump consisting of a rotor and ball bearing rollers. Tubing placed around the rotors is squeezed by the rotors as they revolve. The squeezing produces a wavelike contractual movement that causes water to be drawn through the tubing. During purging and sampling, only the tubing is placed down the well. All of the mechanical systems of the pump remain above ground during purging and sampling activities. The peristaltic pump is typically limited to sampling at depths of less than 25 feet. Operating two or more peristaltic pumps in parallel can increase operational depths slightly.

5.0 PROCEDURES

This section contains both the responsibilities and procedures involved with groundwater sampling. Proper groundwater sampling procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with site-specific work plans. The work plans will generally provide the following information:

- Sample collection objectives;
- Locations of groundwater samples to be collected;

- Numbers and volumes of samples to be collected;
- Types of chemical analyses to be conducted for the samples;
- Specific quality control (QC) procedures and sampling required;
- Management procedures for groundwater investigation derived waste (IDW); and
- Any additional groundwater sampling requirements or procedures beyond those covered in this SOP, as necessary.
- At a minimum, the procedures outlined in this SOP for groundwater sampling will be followed.

5.1 RESPONSIBILITIES

Compliance with this procedure is the responsibility of project management and field personnel. This SOP and the site-specific work plans should be reviewed before performing groundwater sampling at the project investigation area.

Project Manager

The Project Manager (PM) is responsible for ensuring that sample collection activities are conducted in accordance with this SOP, SOP AMEC-01 (PFAS) *Field Sampling Protocols to Avoid Cross Contamination of Per- and Polyfluorinated Alkyl Substances (PFAS),* and with any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

Field Lead

The Field Lead is responsible for periodic observation of field activities and review of field generated documentation associated with this SOP. The Field Lead is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing non-conformances, etc.) if problems occur.

Field Personnel

Field personnel assigned to groundwater sampling activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from procedures to the PM or Field Lead.

5.2 FIELD PROCEDURES/CONSIDERATIONS

The following are procedures/considerations to be made during field activities at potential PFAS release areas.

5.2.1 FIELD EQUIPMENT

Purging and sampling equipment is constructed from a variety of materials. The most inert material (e.g., silicone and high-density polyethylene), with respect to known or anticipated contaminants in the well(s), will be used whenever possible. The various types of purging and sampling equipment available for groundwater sampling are described in *ASTM Standard Guide for Sampling Ground-Water Monitoring Wells, D 4448-01* (ASTM, 2007) or *Collection of Groundwater Samples at Known or Suspected Groundwater Contaminated Sites* or *Compendium of Superfund Field Operations Methods* (EPA, 1987).

If non-dedicated sampling equipment is to be used, and the contaminant histories of the wells are known, it is advisable to establish a sampling order starting with the least contaminated well and progressing to the most contaminated well last. All field equipment and supplies will be considered using the Tiered Approach provided in Table 2 of SOP AMEC-01 (PFAS), *Field Sampling Protocols to Avoid Cross Contamination of Per- and Polyfluorinated Alkyl Substances (PFAS)* prior to use onsite.

5.2.2 DECONTAMINATION

Sampling equipment will be thoroughly decontaminated before mobilization to each investigation area and between borings or wells at each investigation area or as required in the site-specific work plans. Decontamination procedures will be performed in accordance with SOP AMEC-10 (PFAS), *Equipment Decontamination*. Before collecting any groundwater samples, all sampling devices shall be decontaminated. If dedicated or disposable equipment is used, it will be rinsed with deionized water where applicable. Mobile decontamination supplies will be provided so that equipment can be decontaminated in the field. Each piece of sampling equipment shall be decontaminated daily before initiation of sampling operations and between each sample location and interval. Non-PFAS decontamination solutions shall be replenished between sampling locations as needed. Spent decontamination fluids will be containerized, properly labeled and appropriately disposed of according to the investigation derived waste (IDW) plans addressed in the site-specific work plan.

5.2.3 GROUNDWATER PURGING AND SAMPLING

Groundwater Purging and Sampling with a Bladder Pump

Pre-sample purging and sampling should be conducted in accordance with the site-specific work plans. The standard procedure for purging and sampling using a bladder pump is in agreement with procedures described in the *Compendium of Superfund Field Operations Methods* (EPA, 1987) and will be conducted as described below.

- Inspect the equipment to ensure that it is in good working order.
- Calibrate all field analytical test equipment (e.g., pH, specific conductance, dissolved oxygen, oxidation-reduction potential, turbidity and temperature) according to the instrument manufacturers' specifications or scope-specific work plan. Calibration results will be recorded on the appropriate form(s) as specified by the site-specific work plans. Instruments that cannot be calibrated according to the manufacturers' specifications will be removed from service and tagged.
- An exception to the daily calibration requirements will be made in the case of the water level meters. These instruments will be calibrated at the beginning of the project and then every six months using a steel surveyors tape.
- If non-dedicated equipment is being used, decontaminate the equipment as described in SOP AMEC-10. During decontamination, the equipment should again be inspected for damage and, if present, repaired or replaced with undamaged equipment.
- Visually inspect the well to ensure that it is undamaged, properly labeled, and secured. Damage or other conditions that may affect the integrity of the well will be recorded on the Field Log and brought to the attention of the Field Lead.
- Uncap the well and monitor the air space immediately above the open casing per the health and safety plan. Observe if any air is flowing into or out of the casing. In the event such conditions are observed, they should be noted on the Groundwater Sample Collection Form.
- Obtain a static depth to water level measurement. If the total well depth has not been verified within the past year, obtain a total well depth measurement. Calculate the volume of water in the well (cased well volume) as follows:

$$\pi \left(\frac{d}{2}\right)^2 (h_1 - h_2) \times 7.48 = \text{cased well volume (in gallons)}$$

Where:

d = inside diameter of well casing (in feet)

h_1 = depth of well from top of casing (in feet)

h_2 = depth to water from top of casing (in feet)

- Record static water level, total well depth, and volume calculations on the sample collection field sheet.
- If using non-dedicated equipment, lower the pump and associated tubing and/or lines into the well. The pump intake should be located near the middle of the saturated portion of the screened interval and the depth of the pump intake will be recorded on the Groundwater Sample Collection Form. For low yielding wells it may be necessary to gently lower the pump during purging to follow the declining water level in the well.
- Attach the compressor or cylinder to the controller and the controller to the gas supply line, making sure that the compressor is downwind of the monitoring well. Attach the sampling tube to the discharge supply line. Adjust the pressure/discharge cycle on the controller.
- Begin purging. Collect and dispose of purge water in accordance with the criteria specified by the site-specific work plans.
- Physical parameters (i.e., pH, specific conductance, dissolved oxygen, oxidation-reduction potential, turbidity and temperature) of the purge water will be measured when purging begins, after each well casing volume, and then periodically throughout the purging procedure. These measurements will be recorded on Groundwater Sample Collection Forms. Purging is considered complete when water quality indicator parameters have stabilized (i.e., three consecutive readings are within tolerances specified in Table 4-1) (ASTM, 2007; EPA, 1992 and Barcelona et al, 1985). If stability is not reached within the removal of three well casing volumes, then purging is continued until stability is attained, up to a maximum purging period of one hour. If parameters have not stabilized after the additional hour of purging, the sample may be collected.

Table 4-1

Parameter	Units	Requirement
pH	Standard Units	± 0.1
Specific Conductivity	Micromhos/centimeter (umho/cm, or µS/cm)	± 3 percent
Temperature	Degrees Celcius (ºC)	± 0.5 ^{o}C
Oxidation-Reduction Potential (ORP)	Millivolts (mV)	± 10 percent
Dissolved Oxygen	Milligrams/liter (mg/L)	± 10 percent
Turbidity	Nephelometric Turbidity Units (NTUs)	± 10 percent, but less than 10 NTUs

- For slowly recharging wells, the parameters may not stabilize before the well casing is emptied, even when using low flow purging rates. In this case, purging will be considered complete when one well volume (i.e., well casing plus filter pack volume) has been purged from the well and the well goes dry.
- The well will then be allowed to recharge, and sampling must be initiated within 24-hours of purging. The depth to the water level in the well will be measured and recorded immediately prior to sample collection. If the volume of water in the recharged well is not sufficient to completely fill all required sample containers, then sample collection may follow multiple well recharge events within 48 hours after completion of purging. All sample containers for a given analytical method (e.g., EPA 8330) must be concurrently and completely filled following a single recharge event. The date and time of each sample collection will be recorded.
- Inspect the sample bottles (obtained from the analytical laboratory prior to the sampling event) to be used to ensure that they are appropriate for the samples being collected, are undamaged, and have had the appropriate types and volumes of preservatives added. The types of sample containers to be used and sample preservation requirements will be provided in the site-specific work plans.
- Turn on the pump and adjust the pressure/discharge cycle on the pump controller so that the water will flow smoothly and without agitation into the sample containers.
- Collect the sample directly into the provided sample bottle (container), allowing the discharge to flow gently down the inside of the bottle, minimizing aeration of the sample. Completely fill

the bottle; however, samples collected for metals and general water chemistry analysis should be filled to the base of the bottleneck.

- The samples should be collected in the order of volatility, collecting the samples for the analysis of the most volatile parameters first, followed by the samples for the least volatile parameters. The samples for volatiles analysis should be collected during one full discharge cycle. Do not partially fill a container for volatile parameter analysis during one cycle and complete the filling during the next cycle.
- Document the sampling event on the Groundwater Sample Collection Form.
- As soon as possible after sample collection, place the sample in a separate, appropriately sized, airtight, seam sealing, polyethylene bag (i.e., Ziploc®). Seal the bag, removing any excess air. Place the bagged sample inside the shipping container.
- Handle and ship the sample according to the procedures outlined in SOP AMEC-11, following appropriate chain of custody procedures.

Groundwater Purging and Sampling with a Peristaltic Pump

Purging and sampling will be conducted per the site-specific work plans. The standard procedure for groundwater purging and sampling using a peristaltic pump is in agreement with procedures described in the *Compendium of Superfund Field Operations Methods* (EPA, 1987) and will be conducted as described below.

- Inspect the equipment to ensure that it is in good working order.
- Calibrate all field analytical test equipment (e.g., pH, specific conductance, dissolved oxygen, oxidation-reduction potential, turbidity, and temperature) according to the instrument manufacturers' specifications or scope-specific work plan. Calibration results will be recorded on the appropriate form(s) as specified by the site-specific work plans. Instruments that cannot be calibrated according to the manufacturers' specifications will be removed from service and tagged.
- An exception to the daily calibration requirements will be made in the case of the water level meters. These instruments will be calibrated at the beginning of the project and then every six months using a steel surveyors tape.
- Conduct equipment decontamination; however, the old silicone tubing used in the pump head should not be decontaminated. New tubing should be used for each well.
- Visually inspect the well to ensure that it is undamaged, properly labeled, and secured. Damage or other conditions that may affect the integrity of the well will be recorded on the Field Log and brought to the attention of the Field Manager.

- Uncap the well and monitor the air space immediately above the open casing per the health and safety plan. Observe if any air is flowing into or out of the casing. In the event such conditions are observed, they should be noted on the Groundwater Sample Collection Form.
- Obtain a static water level measurement and calculate the cased well volume as described in Section 4.2.2 of this SOP.
- Connect new silicone tubing to the rotor head of the pump motor and tighten until snug.
- Run a short section of the tubing from the discharge side of the pump head to a collection vessel.
- Insert the free end of the influent tubing into the well and lower it to the middle of the saturated portion of the well screen. The depth of the tubing intake will be recorded on the Groundwater Sample Collection Form. For low yielding wells, it may be necessary to gently lower the tubing intake during purging to follow the declining water level in the well.
- Begin purging. Collect and dispose of purge water in accordance with the criteria specified by the site-specific work plan.
- Physical parameters (i.e., pH, specific conductance, dissolved oxygen, oxidation-reduction potential, turbidity and temperature) of the purge water will be measured when purging begins, after each well casing volume, and then periodically throughout the purging procedure. These measurements will be recorded on Groundwater Sample Collection Forms. Purging is considered complete when water quality indicator parameters have stabilized (i.e., three consecutive readings are within tolerances specified in Table 4-1) (ASTM, 2007; EPA, 1992 and Barcelona et al, 1985). If stability is not reached within the removal of three well casing volumes, then purging is continued until stability is attained, up to a maximum purging period of one hour. If parameters have not stabilized after the additional hour of purging, the sample may be collected.
- For slowly recharging wells, the parameters may not stabilize before the well casing is emptied, even when using low flow purging rates. In this case, purging will be considered complete when one well volume (i.e., well casing plus filter pack volume) has been purged from the well and the well goes dry.
- The well will then be allowed to recharge, and sampling must be initiated within 24-hours of purging. The depth to the water level in the well will be measured and recorded immediately prior to sample collection. If the volume of water in the recharged well is not sufficient to completely fill all required sample containers, then sample collection may follow multiple well recharge events within 48 hours after completion of purging. All sample containers for a given analytical method (e.g., EPA 8330) must be concurrently and completed filled following a single recharge event. The date and time of each sample collection will be recorded.

- Inspect the sample bottles (obtained from the analytical laboratory prior to the sampling event) to be used to ensure that they are appropriate for the samples being collected, are undamaged, and have had the appropriate types and volumes of preservatives added. The types of sample containers to be used and sample preservation requirements will be provided by the analytical laboratory.
- Turn on and adjust the rotor speed of the pump so that the water will flow smoothly and without agitation into the sample containers.
- Collect the sample directly into the provided sample bottle (container), allowing the discharge to flow gently down the inside of the bottle, minimizing aeration of the sample. Completely fill the bottle; however, samples collected for metals and general water chemistry analyses should be filled to the base of the bottleneck.
- The samples should be collected in the order of volatility, collecting the samples for the analysis of the most volatile parameters first, followed by the samples for the least volatile parameters. The samples for volatiles analysis should be collected during one full discharge cycle. Do not partially fill a container for volatile parameter analysis during one cycle and complete the filling during the next cycle.
- Document the sampling event on the Groundwater Sample Collection Form.
- As soon as possible after sample collection, place the sample in a separate, appropriately sized, airtight, seam sealing, polyethylene bag (i.e., Ziploc®). Seal the bag, removing any excess air. Place the bagged sample inside the shipping container.
- Handle and ship the sample according to the procedures outlined in SOP AMEC-11 following appropriate chain of custody procedures.

Groundwater Purging and Sampling with an Electric Submersible Pump

Purging and sampling will be conducted in accordance with the site-specific work plans. The standard procedure for purging and sampling using a submersible pump is in agreement with procedures described in the *Compendium of Superfund Field Operations Methods* (EPA, 1987) and is described below.

- Inspect the equipment to ensure that it is in good working order.
- Calibrate all field analytical test equipment (e.g., pH, specific conductance, dissolved oxygen, oxidation-reduction potential, turbidity and temperature) according to the instrument manufacturers' specifications or scope-specific work plan. Calibration results will be recorded on the appropriate form(s) as specified by the site-specific work plans. Instruments that cannot be calibrated according to the manufacturers' specifications will be removed from service and tagged.

- An exception to the daily calibration requirements will be made in the case of the water level meters. These instruments will be calibrated at the beginning of the project and then every six months using a steel surveyors tape.
- If non-dedicated equipment is being used, decontaminate the equipment as described in SOP AMEC-10. During decontamination, the equipment should again be inspected for damage and, if present, repaired or replaced with undamaged equipment.
- Visually inspect the well to ensure that it is undamaged, properly labeled, and secured. Damage or other conditions that may affect the integrity of the well will be recorded on the Field Log and brought to the attention of the Field Manager.
- Uncap the well and monitor the air space immediately above the open casing per the health and safety plan. Observe if any air is flowing into or out of the casing. In the event such conditions are observed, they should be noted on the Groundwater Sample Collection Form.
- Obtain a static water level measurement and calculate the cased well volume as described in Section 4.2.2 of this SOP.
- If using non-dedicated equipment, lower the pump and associated lines into the well. The pump intake should be located near the middle of the saturated portion of the screened interval and the depth of the pump intake will be recorded on the field form. For low yielding wells it may be necessary to gently lower the pump during purging to follow the declining water level in the well.
- Place the generator downwind of the well. Start the generator, and then plug the pump into the generator.
- Begin purging. Collect and dispose of purge water in accordance with the criteria specified by the site-specific work plans.
- Physical parameters (i.e., pH, specific conductance, dissolved oxygen, oxidation-reduction potential, turbidity, and temperature) of the purge water will be measured when purging begins, after each well casing volume, and then periodically throughout the purging procedure. These measurements will be recorded on Groundwater Sample Collection Forms. Purging is considered complete when water quality indicator parameters have stabilized (i.e., three consecutive readings are within tolerances specified in Table 4-1) (ASTM, 2007; EPA, 1992 and Barcelona et al, 1985). If stability is not reached within the removal of three well casing volumes, then purging is continued until stability is attained, up to a maximum purging period of one hour. If parameters have not stabilized after the additional hour of purging, the sample may be collected.
- For slowly recharging wells, the parameters may not stabilize before the well casing is emptied, even when using low flow purging rates. In this case, purging will be considered complete when

one well volume (i.e., well casing plus filter pack volume) has been purged from the well and the well goes dry.

- The well will then be allowed to recharge, and sampling must be initiated within 24-hours of purging. The depth to the water level in the well will be measured and recorded immediately prior to sample collection. If the volume of water in the recharged well is not sufficient to completely fill all required sample containers, then sample collection may follow multiple well recharge events within 48 hours after completion of purging. All sample containers for a given analytical method (e.g., EPA 8330) must be concurrently and completely filled following a single recharge event. The date and time of each sample collection will be recorded.
- Inspect the sampling bottles (obtained from the analytical laboratory prior to the sampling event) to be used to ensure that they are appropriate for the samples being collected, are undamaged, and have had the appropriate types and volumes of preservatives added. The types of sample containers to be used and sample preservation requirements will be provided by the analytical laboratory.
- Turn on and adjust the flow rate of the pump by using the check-valve on the discharge line so that the water will flow smoothly and without agitation into the sample bottles.
- Collect the sample directly into the provided sample bottle (container), allowing the discharge to flow gently down the inside of the bottle, minimizing aeration of the sample. Completely fill the bottle; however, samples collected for metals and general water chemistry analyses should be filled to the base of the bottleneck.
- The samples should be collected in the order of volatility, collecting the samples for the analysis of the most volatile parameters first, followed by the samples for the least volatile parameters. The samples for volatiles analysis should be collected during one full discharge cycle. Do not partially fill a container for volatile parameter analysis during one cycle and complete the filling during the next cycle.
- Document the sampling event on the Groundwater Sample Collection Form.
- As soon as possible after sample collection, place the sample in a separate, appropriately sized, airtight, seam sealing, polyethylene bag (i.e., Ziploc®). Seal the bag, removing any excess air. Place the bagged sample inside the shipping container.
- Handle and ship the sample according to the procedures outlined in SOP AMEC-11, following appropriate chain of custody procedures.

Groundwater Purging and Sampling with a Bailer

Purging and sampling will be conducted in accordance with the site-specific work plans. The standard procedure for purging and sampling with a bailer is in agreement with procedures described in the *Compendium of Superfund Field Operations Methods* (EPA, 1987) and is described below.

- Inspect the equipment to ensure that it is in good working order.
- Calibrate all field analytical test equipment (e.g., pH, specific conductance, dissolved oxygen, oxidation-reduction potential, turbidity and temperature) according to the instrument manufacturers' specifications or scope-specific work plan. Calibration results will be recorded on the appropriate form(s) as specified by the site-specific work plans. Instruments that cannot be calibrated according to the manufacturers' specifications will be removed from service and tagged.
- An exception to the daily calibration requirements will be made in the case of the water level meters. These instruments will be calibrated at the beginning of the project and then every six months using a steel surveyors tape.
- If non-dedicated equipment is being used, decontaminate the equipment as described in SOP AMEC-10. During decontamination, the equipment should again be inspected for damage and, if present, repaired or replaced with undamaged equipment.
- Visually inspect the well to ensure that it is undamaged, properly labeled, and secured. Damage or other conditions that may affect the integrity of the well will be recorded on the Field Activity Daily Log and brought to the attention of the Field Manager.
- Uncap the well and monitor the air space immediately above the open casing per the health and safety plan. Observe if any air is flowing into or out of the casing. In the event such conditions are observed, they should be noted on the Groundwater Sample Collection Form.
- Obtain a static water level measurement and calculate the cased well volume as described in Section 4.2.2 of this SOP.
- Secure the bailer to a five foot length of stainless bailer wire with a bowline knot or clip. Attach the bailer wire to bailing line or chain.
- Begin purging by slowly lowering the bailer into the groundwater. Allow the floating ball valve to seat, and slowly retrieve the bailer. Repeat this procedure to purge the well. Collect, transport, and dispose of purge water in accordance with the criteria specified in the site-specific work plans.
- During purging, the descent of the bailer should be controlled to prevent freefall inside the well. In the event the bailer encounters an obstruction inside the well, no attempts should be made to push the bailer beyond the obstruction. If the bailer becomes lodged in the well, the line should not be pulled with such force that it would part from the bailer. Such conditions should also be noted on the Groundwater Sampling Form and brought to the immediate attention of the Field Manager.
- The well will then be allowed to recharge, and sampling must be initiated within 24-hours of purging. The depth to the water level in the well will be measured and recorded immediately prior to sample collection. If the volume of water in the recharged well is not sufficient to

completely fill all required sample containers, then sample collection may follow multiple well recharge events within 48 hours after completion of purging. All sample containers for a given analytical method (e.g., EPA 8330) must be concurrently and completed filled following a single recharge event. The date and time of each sample collection will be recorded.

- Inspect the sampling bottles (obtained from the analytical laboratory prior to the sampling event) to be used to ensure that they are appropriate for the samples being collected, are undamaged, and have had the appropriate types and volumes of preservatives added. The types of sample containers to be used and sample preservation requirements will be provided in the site-specific work plans.
- Lower the sample collection bailer and submerge into the water column as above. Retrieve the bailer and insert a bottom-emptying device into the bailer so that the water will flow smoothly and without agitation into the sample bottles.
- Collect the sample water directly into the provided sample bottles (containers), allowing the discharge to flow gently down the inside of the bottles, minimizing aeration of the sample. Completely fill the bottles; however, samples collected for metals and general water chemistry analyses should be filled to the base of the bottleneck.
- Document the sampling event on the Groundwater Sample Collection Form.
- As soon as possible after sample collection, place the sample in a separate, appropriately sized, airtight, seam sealing, polyethylene bag (i.e., Ziploc®). Seal the bag, removing any excess air. Place the bagged sample inside the shipping container.
- Handle and ship the sample according to the procedures outlined in SOP AMEC-11, following appropriate chain of custody procedures.

Groundwater Sampling using Inflatable Packers

Inflatable Packers are used to isolate portions of an open-hole bedrock well for sampling or other hydrogeological assessment purposes. Expandable rubber bladders are positioned one above the other on a metal pipe. Their configuration permits discharge and power supply lines to pass through the packers with a pump sandwiched in between. The packers are inflated with compressed air to hydraulically isolate water-bearing fractures identified through borehole geophysical logging or core samples.

Pumping of water from within a packed interval can be used to estimate yield of the selected zone, and for the analysis of samples collected from a targeted zone, facilitating the assessment of the vertical extent of groundwater contamination. If samples are to be collected for field screening or laboratory analysis, low-flow sampling techniques would be employed before sample collection. The resolution of the groundwater quantity and quality within the borehole is based on the length of the bedrock borehole interval tested and usually does not exceed 20 feet in length. The steps for collecting groundwater samples using inflatable packers are outlined below:

- If packers are not seated properly, water will leak around the system during the sampling event. To determine if leakage around the packer is occurring, the water level above the top packer is monitored to see if the level drops while the target interval is being pumped. If the water level drops, the packers will be re-seated by deflating and re-inflating the packers. A dropping water level does not necessarily mean the packers have a poor seal. Another possibility is that there are vertical fractures that connect fractures within the sampling zone to fractures above the top packer.
- Packers are assembled at the surface with the selected pump sandwiched between individual bladders.
- Assembled unit is lowered to a predetermined depth.
- Bladders are inflated from air-lines originating at the surface. Bladder pressures are determined accordingly:

  G = Inflation pressure at gauge (PSI)

  DP = Depth to top of packer (feet)

  DW = Depth to static water level in well (feet)

  Sp = Unconfined packer pressure rating for the well size (PSI)

  PP = Injection pump pressure (PSI)

  To calculate Packer Inflation Pressure for sampling (i.e., pump out):

  $$G = [(DP - DW) \times .43] + Sp + [(DP - DW) \times .43 \times .2]$$

- Inspect the sampling bottles (obtained from the analytical laboratory prior to the sampling event) to be used to ensure that they are appropriate for the samples being collected, are undamaged, and have had the appropriate types and volumes of preservatives added. The types of sample containers to be used and sample preservation requirements will be provided in the site-specific work plans.

- Turn on and adjust the flow rate of the pump so that the water will flow smoothly and without agitation into the sample bottles.
- Collect the sample directly into the provided sample bottle (container), allowing the discharge to flow gently down the inside of the bottle, minimizing aeration of the sample. Completely fill the bottle; however, samples collected for metals and general water chemistry analyses should be filled to the base of the bottleneck.
- The samples should be collected in the order of volatility, collecting the samples for the analysis of the most volatile parameters first, followed by the samples for the least volatile parameters. The samples for volatiles analysis should be collected during one full discharge cycle. Do not partially fill a container for volatile parameter analysis during one cycle and complete the filling during the next cycle.
- Document the sampling event on the Groundwater Sample Collection Form.
- As soon as possible after sample collection, place the sample in a separate, appropriately sized, airtight, seam sealing, polyethylene bag (i.e., Ziploc®). Seal the bag, removing any excess air. Place the bagged sample inside the shipping container.
- Handle and ship the sample according to the procedures outlined in SOP AMEC-11, following appropriate chain of custody procedures.

MONITORING WELL INSTALLATION
SOP AFW-04 (PFAS)

1.0 PURPOSE

This Standard Operating Procedure (SOP) provides procedures and requirements for the installation of monitoring wells using various drilling techniques, including but not limited to, direct push technology (DPT), hollow-stem auger, rotary, sonic, or dual-tube percussion. The details within this SOP should be used in conjunction with project-specific work plans.

2.0 SCOPE

These procedures apply to all Amec Foster Wheeler personnel and subcontractors who perform monitoring well installation activities during per- and polyfluorinated alkyl substances (PFAS) investigations.

3.0 REFERENCES

U.S. Environmental Protection Agency (EPA), 1986, *Resource Conservation and Recovery Act (RCRA) Ground Water Monitoring Technical Enforcement Guidance Document*, OSWER-9950.1, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, U.S. Government Printing Office, Washington D.C.

EPA, 1987, *A Compendium of Superfund Field Operations Methods*, EPA-500/P-87/001, U.S. Government Printing Office, Washington D.C.

4.0 DEFINITIONS

Air Rotary Casing Hammer Drilling – A drilling method using a non-rotating drive casing that is advanced simultaneously with a slightly smaller diameter rotary bit attached to a string of drill pipe. The drive casing is a heavy-walled, threaded pipe that allows for pass-through of the rotary drill bit inside the center of the casing. Air is forced down through the center drill pipe to the bit, and then upward through the space between the drive casing and the drill pipe. The upward return stream of air removes cuttings from the bottom of the borehole.

Annular Space – The space between:

- Concentric drill pipes;
- An inner drill pipe and outer drive casing;

- Drill pipe or drive casing and the borehole wall; or,
- Well screen or casing and the borehole wall.

Borehole – Any hole drilled into the subsurface for the purpose of identifying lithology, collecting soil or rock samples, and/or installing groundwater wells.

Cuttings – Pieces of soil, sediment, or rock cut by a bit in the process of drilling borings.

Direct Push Drilling – For the purposes of this monitoring well installation SOP, the term "direct push drilling" refers to using DPT to push or drive hollow rods into the ground for the purpose of installing monitoring wells with a maximum inside diameter of 1 inch when using 2.625 inch inside diameter DPT rods. Direct push drilling uses an expendable drive point that is fitted to the lower end of a string of drive rods that are advanced into the ground using percussive hammering. No cuttings are brought to the surface during drilling, although soil cores may be retrieved using various sampling tools.

Dual-Tube Percussion Drilling – A drilling method using non-rotating drive casing with a bit on the bottom of the casing string. A smaller diameter tube or drill pipe is positioned inside the drive casing. The drive casing is advanced by the use of a percussion hammer, thereby causing the bit to cut or break up the sediment or soil at the bottom of the boring. Air is forced down the annular space between the drive casing and inner drill pipe and cuttings are forced upward with the return stream of air within the center of the inner drill pipe.

Filter Pack – Granular filter material (sand, gravel, etc.) placed in the annular space between the well screen and the borehole wall to increase the effective diameter of the well and to minimize the movement of fine-grained material into the well.

Grout – For the purposes of this SOP, the term "grout" consists of a neat cement grout mixture generally containing five to six gallons of clean water mixed with each 94 pound bag of Portland cement. The grout is emplaced within a borehole as a slurry, and once properly set and cured, is capable of restricting movement of water.

Hollow-Stem Auger Drilling – A drilling method using augers with open centers. The augers are advanced with a screwing or rotating motion into the ground. Cuttings are brought to the surface by the rotating action of the augers, thereby clearing the borehole.

Monitoring Well – A well that provides for the collection of representative groundwater samples, the detection and collection of representative light and dense non-aqueous phase organic liquids, the measurement of fluid levels, and the assessment of hydrogeologic characteristics of saturated materials in the vicinity of the well.

Mud Rotary Drilling – For the purposes of this monitoring well installation SOP, the term "mud rotary drilling" refers to direct circulation (as opposed to reverse circulation) mud rotary drilling. Mud rotary drilling uses a rotating drill bit which is attached to the lower end of a string of drill pipe. Drilling mud is pumped down through the inside of the drill pipe and out through the bit. The mud then flows upward in the annular space between the borehole and the drill pipe, carrying the cuttings in suspension, within the drilling mud, to the surface.

Sonic Drilling – Sonic drilling uses a combination of rotary motion, oscillation/vibration, and hydraulic downward force to advance a drill bit and drive casing. Soil or rock cores are retrieved using a core barrel as the drive casing is advanced.

Tremie – A tubular device or pipe used to place grout, bentonite, or filter pack in the annular space of a borehole.

Well Screen – A commercially available, factory-perforated, wire wound, continuous wrap, or slotted casing segment used in a well to maximize the entry of groundwater from the producing zone and to minimize the entrance of sand.

5.0 PROCEDURES

This section contains both the main project team responsibilities and the procedures for monitoring well installation activities. The procedures described herein are applicable as requirements for monitoring well installations using DPT, hollow-stem auger, mud rotary, air rotary, air rotary casing hammer, sonic, or dual tube percussion drilling techniques. Site-specific factors need to be considered in the selection of well construction and completion materials, specification of well designs, and choosing borehole drilling methods. These factors will be incorporated in project planning activities and the compilation of project-specific work plans. The work plans will contain the following information related to monitoring well installation:

- Objectives of the monitoring well;
- Specific location of the well to be installed;
- Zone or depth well is to be installed;
- Drilling method(s) to be used;
- Well construction materials to be used;
- Specification of well design(s) including Well Construction Diagrams; and,

- Additional procedures or requirements beyond the scope of this SOP.

5.1 RESPONSIBILITIES

Project Manager

The Project Manager (PM) is responsible for ensuring that all monitoring well installation activities are conducted and documented in accordance with this SOP, SOP AFW-01 (PFAS) *Field Sampling Protocols to Avoid Cross Contamination of Per- and Polyfluorinated Alkyl Substances (PFAS),* and any other appropriate procedures. This will be accomplished through staff training and by quality assurance/quality control (QA/QC) monitoring activities.

Field Lead

The Field Lead is responsible for periodic observation of well installation activities to assure implementation of this SOP. The Field Lead is also responsible for the review and approval of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to monitoring well installation requirements, issuing non-conformances, etc.) identified during the performance of these activities.

Field Personnel

Field personnel assigned to monitoring well installation activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. Field staff are responsible for reporting deviations from the procedures to the PM or the Field Lead.

All personnel are responsible for carefully reviewing

5.2 FIELD PROCEDURES/CONSIDERATIONS

The following are procedures/considerations to be made during field activities at potential PFAS release areas.

5.2.1 FIELD PREPARATION

Before mobilization of a rig to the well site, ensure that the monitoring well location has been appropriately cleared of all underground utilities, buried objects, and overhead utilities, and that drill permits (e.g., FAA permits) have been issued per the project work plans. Review all forms and diagrams documenting the location of the cleared monitoring well site and the location of any identified underground utility lines, other buried objects, and overheard utilities.

Downhole drilling, sampling, well construction, and development equipment (including but not limited to drill pipe, drive casing, drill rods, bits, tools, tremie pipe, non-disposable bailers, etc.) will be thoroughly decontaminated before mobilization to each investigation area and between borings or wells at each investigation area or as required in the project-specific work plans. Decontamination procedures will be performed in accordance with SOP AFW-10 (PFAS), *Equipment Decontamination*.

Clear the work area of brush and minor obstructions and then mobilize the rig to the planned monitoring well location. The responsible field personnel (e.g., rig geologist or engineer) should then review with the driller the proposed borehole and well design and the details of the monitoring well installation plan, including any potential drilling or completion problems.

Calibrate field equipment according to the instrument manufacturer's specifications. Document the calibration results on the appropriate form(s). Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.

Workers will be provided with, and don, the appropriate personal protective equipment as specified by the project-specific work plans. Typically, the minimum personal protection will include a hard hat, safety glasses, gloves and steel-toed boots.

All field equipment and supplies will be considered using the Tiered Approach provided in Table 2 of SOP AFW-01 (PFAS), *Field Sampling Protocols to Avoid Cross Contamination of Per- and Polyfluorinated Alkyl Substances (PFAS)* prior to use onsite.

5.2.2 BOREHOLE DRILLING

Commence drilling and advance the borehole while conducting health and safety air monitoring according to the work plans. Perform air monitoring as often as necessary to ensure the safety of workers. Record all measurements in the field log and/or other appropriate form(s) as specified in the project-specific work plans. Record other pertinent information (date, investigation area, well or boring number, and location) in the field log and/or on other appropriate form(s) as specified by the work plans. In addition, note and record observed field conditions, any unusual circumstances, and weather conditions.

During drilling, collect representative cutting and/or soil samples as required by the project-specific work plans. Compile a Boring Log or lithologic log from the cuttings and samples.

At total depth, remove soil cuttings through circulation or by rapidly spinning the augers as applicable, prior to constructing the well. Review logs and notes with the driller for any zones or depths exhibiting drilling problems that may affect the planned well installation. Condition the hole or take other actions mutually agreed upon by the rig geologist (or engineer), lead technical personnel, and the driller to ensure or aid in the well development.

Remove the drill pipe and bit if using sonic or rotary techniques, remove the center bit plug if using the hollow-stem auger technique, or disengage the expendable drive point if using DPT. The well construction materials will then be installed inside the open borehole or through the center of the drive casing or augers.

Measure the total depth of the completed boring using a weighted sounding line. The borehole depth is checked to assure that formation material has not collapsed or heaved to fill the borehole. If heaving has taken place or the borehole has collapsed, options for cleaning, re-drilling, or installation in the open section of the boring should be discussed with lead technical personnel.

In the event that the borehole was over-drilled, bentonite pellets, or bentonite chips (as specified in the project-specific work plans) may be added to the boring to raise the bottom of the borehole to the desired depth. The bentonite should be installed through a tremie pipe to fill the borehole from the bottom of the boring upward. During installation, the tremie pipe should be submerged below the top of the bentonite column in the borehole to prevent free-fall and bridging. Bentonite should be added gradually to the borehole to prevent bridging. Bentonite addition will stop when its level has reached approximately one foot below the desired base of the well string (i.e., casing, screen, end plug or sump, etc.). The bentonite plug will be hydrated for at least one hour before installation of a well string and filter pack.

5.2.3 WELL INSTALLATION

Calculate volumes of filter pack, bentonite pellets/slurry, and grout required, based on borehole and well casing dimensions. If required by the project-specific work plans, determine the filter pack and well screen slot size for the monitoring well. For most monitoring well installations, the filter pack and well screen slot size will be determined prior to the start of the installation activities.

Inspect the casing, screen, and any other well construction materials prior to installation to assure that no damage has occurred during shipment and decontamination activities. Measure and record the length of each section of well screen, blank casing, and the end cap in order to determine the actual total length of well string and screen interval, and to calculate desired stickup.

Connect and carefully lower the well string through the open borehole, drive rods or casing, or inside of the augers until the well string is at the desired depth. The well string should be suspended by the installation rig and should not rest on the bottom of the boring. In the event the well string was dropped, lowered abruptly, or for any other reason suspected of being damaged during placement, the string should be removed from the boring and inspected. In certain instances, the well string may rise after being placed in the borehole due to heaving sands. If this occurs, the driller must not place any drilling equipment on the well string (drill pipe, hammers, etc.) to prevent the casing from rising. The amount of rise should be noted by the rig geologist or engineer who should then consult lead technical personnel for an appropriate course of action.

Record, at a minimum, the following information on the appropriate forms per the project-specific work plans:

- Total length of well string;
- Actual calculated length between top of blank casing and top of screen interval;
- Total measured length of screen interval;
- Total measured length between bottom of screen interval and end cap or sump;
- Total depth of boring;
- Depth from ground surface to top of grout or bentonite backfill in bottom of borehole (if present);
- Installed depth to base of well string (i.e. bottom of end cap or sump); and,
- Installed depth to top and bottom of well screen.

When using the mud rotary drilling technique, tremie the filter pack into the annular space around the screen. Clean, potable water may be used to assist with the filter pack tremie operation. For all other drilling techniques, the filter pack may be allowed to free fall or be tremied per the project-specific work plans. If using DPT rods, drive casing, or augers, the drive rods, casing, or augers should be pulled slowly during filter pack installation in increments no greater than 5 feet. For temporary or DPT-installed wells, a pre-pack filter may be attached to or fitted around the screen and placed concurrently with the well string.

Filter pack settlement should be monitored by initially measuring the sand level before beginning to withdraw the drive casing/augers. In addition, depth soundings using a weighted tape shall be taken repeatedly to continually monitor the level of the sand. The top of the well casing shall also be monitored to detect any movement due to settlement or from drive casing/auger removal. If the top of the well casing moves upwards at any time during the well installation process, the driller should not be allowed to set drilling equipment (e.g., downhole hammers, drill pipe, etc.) on the top of the casing to prevent further movement.

Filter pack should be added until its height is approximately 2 feet above the top of the screen (unless otherwise specified in the project-specific work plans), and verification of its placement (by sounding) should be conducted. The filter pack should then be gently surged using a surge block or swab in order to settle the pack material and reduce the possibility of bridging. Surging is completed by lowering a surge block or swab into the well casing and alternately lowering and raising it within the saturated portion of the screen.

The height of the filter pack will then be re-sounded and additional filter pack placed as necessary. Once the placement of the filter pack is completed, the depth to the top of the pack is measured and recorded on the appropriate forms per the work plans.

A 3-foot thick (unless otherwise specified in the project-specific work plans) bentonite seal is then installed on top of the filter pack. If pellets or chips are used, they should be added gradually to avoid bridging. Repeated depth readings will be taken using a weighted tape to ascertain the top of the bentonite seal. Bentonite chips and pellets will not hydrate properly if they are not continually submerged in water and must be allowed to hydrate for a minimum of 12 hours prior to grout installation. Granular bentonite must be used if the seal is to be placed above the water table.

After hydration of the bentonite seal, grout (or cement bentonite grout, as specified in the project-specific work plans) is then pumped through a side-discharging tremie pipe and filled from the top of the bentonite seal upward for permanent well installations. The bottom of the tremie pipe should be maintained below the top of the grout column to prevent free fall and bridging. When using drive casing or hollow-stem auger techniques, the drive casing/augers should be raised in incremental intervals, keeping the bottom of the drive casing/augers below the top of the grout. Grouting will cease when the grout level has risen to within approximately 1 to 2 feet of the ground surface, depending on the surface completion type (flush mount or aboveground). Grout levels should be monitored to assure that grout taken into the formation is replaced by additional grout. If settling of the grout occurs, additional topping off of the grout may be necessary.

Grout will not be installed above the bentonite seal for temporary well applications. After completion of development, sampling, and surveying, temporary well casing will be completely removed from the borehole. The borehole will then be abandoned in accordance with SOP AFW-06 (PFAS) *Borehole Abandonment*.

Record, at a minimum, the following information on the appropriate forms per the project-specific work plans:

- Type and total volume of filter pack material installed;
- Total surging time and amount of settlement;
- Final measured depth to top of filter pack;
- Type and total volume of bentonite seal material installed;
- Amount of water added to hydrate bentonite seal;
- Amount of time bentonite seal hydrated;
- Final measured depth to top of bentonite seal;
- Type and mixture of grout material(s) used;
- Total volume of grout installed;
- Total number of lifts used to install grout;
- Final measured depth to top of grout seal;
- Final top of casing measurement after installation completion (feet below ground surface or feet above ground surface); and
- Type of well cap (lockable hinged or expansion plug) used to secure well.

5.2.4 PERMANENT WELL SURFACE COMPLETION

For aboveground completions, the protective steel casing will be centered on the well casing and inserted into the grouted annulus. Prior to installation, a 2-inch deep temporary spacer shall be placed between the PVC well cap and the bottom of the protective casing cover to keep the protective casing from settling onto the well cap. After the protective casing has set, a drainage hole may be drilled into the protective casing if required by the project-specific work plans. The drainage hole is positioned approximately 2 inches above ground surface. The protective casing will be painted with a rust-preventive colored paint. The well head will be labeled to identify, at a minimum, the well identification, total depth, and date of installation. A minimum of 24 hours after grouting should elapse before installation of the concrete pad and steel guard posts for aboveground completions, or street boxes or vaults for flush mount completions.

For aboveground completions, a concrete pad, a minimum of 2-foot by 2-foot by 4-inch thick, is constructed at ground surface around the protective steel casing. The concrete pad is sloped away from the protective casing to promote surface drainage from the well. If traffic conditions warrant extra protection, three steel bucking posts will be embedded to a depth approximately 2 feet below the top of the concrete pad. The posts will be installed in concrete filled post holes spaced equally around the well at a distance of approximately 2 feet from the protective steel casing. Where removal of bucking posts is required for well access, mounting sleeves should be imbedded into the concrete.

For flush mount (or subgrade) completions, a street box or vault is set and cemented in position. The top of the street box or vault will be raised slightly above grade and the cement sloped to grade to promote surface drainage away from the well.

Record, at a minimum, the following information on the appropriate forms per the project-specific work plans:

- Type and dimensions of surface completion installed;
- Dimensions of concrete pad installed (for above ground completions);
- Number and position of steel bucking posts (if applicable); and
- Number, type and size of bolts (for flush mount completions).

5.2.5 DEMOBILIZATION

Following well completion and demobilization of the rig, the well site should be cleared of all debris and trash and restored to a neat and clean appearance per the project-specific work plans. All investigation-derived waste generated at the well site should be appropriately contained and managed per the work plans.

MONITORING WELL DEVELOPMENT
SOP AFW-05 (PFAS)

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes general guidelines for developing new or temporary groundwater monitoring wells and redeveloping existing monitoring wells. Additional site-specific well development procedures and requirements may be provided in the project-specific work plans.

2.0 SCOPE

These procedures apply to all Amec Foster Wheeler personnel and subcontractors who perform monitoring well development activities during per- and polyfluorinated alkyl substances (PFAS) investigations. Field procedures will also be conducted in accordance with SOP AFW-01 (PFAS), *Field Sampling Protocols to Avoid Cross Contamination of Per- and Polyfluorinated Alkyl Substances (PFAS)*.

3.0 REFERENCES

U.S. Environmental Protection Agency (EPA), 1992, *Monitoring Well Development Guidelines For Superfund Project Managers*, OSWER-9950.1, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Ground Water Forum, April.

4.0 DEFINITIONS

Surge Block – A plunger-like tool, consisting of leather or rubber discs sandwiched between steel or wooden disks that may be solid or valved, that is used in well development.

Surging – A well development technique where the surge block is alternately lifted and dropped within the well casing above or adjacent to the screen to create a strong inward and outward movement of water through the well intake.

Well Development – The act of stressing the formation around the well screen so that mobile, artifact particulates are removed from the well, filter pack, and formation in the immediate vicinity of the monitoring well. The purpose of development is to try to ensure proper hydraulic connection between the well and the geologic materials in the vicinity of the well, produce a well capable to yielding groundwater samples of acceptably low turbidity, and to obtain groundwater samples as similar as possible to in situ conditions.

5.0 PROCEDURES

This section contains both the main project team responsibilities and the procedures for monitoring well development activities. The procedures described herein are applicable as requirements for monitoring well development methods including surging and bailing, surging and pumping, or combinations of these processes. Site-specific factors need to be considered in the selection of well development methods. These factors will be incorporated in project planning activities and the compilation of project-specific work plans. The standard procedure for field personnel to use in assessing and documenting well development is described below and is intended only for development methods listed above.

5.1 RESPONSIBILITIES

Project Manager

The Project Manager (PM) is responsible for ensuring that monitoring wells are properly developed and that the development process is properly documented. This will be accomplished by staff training and by maintaining quality assurance/quality control (QA/QC).

Field Lead

The Field Lead is responsible for periodic inspections and review of field generated documentation associated with well development. If deviations from project requirements occur, the Field Lead is also responsible for issuing non-conformance reports and requests for corrective action.

Field Personnel

Field personnel are responsible for conducting monitoring well development and documentation in accordance with the specifications outlined in this SOP, SOP AFW-01 (PFAS) *Field Sampling Protocols to Avoid Cross Contamination of Per- and Polyfluorinated Alkyl Substances (PFAS)*, and with the project work plans. All field staff are responsible for reporting deviations from procedures to the PM or Field Lead.

5.2 FIELD PROCEDURES/CONSIDERATIONS

The following are procedures/considerations to be made during field activities at potential PFAS release areas.

5.2.1 FIELD PREPARATION

Downhole equipment (including but not limited to drill pipe, drive casing, drill rods, bits, tools, non-disposable bailers, etc.) will be thoroughly decontaminated before mobilization to each investigation area and between wells at each investigation area or as required in the project-specific work plans. Decontamination procedures will be performed in accordance with SOP AFW-10 (PFAS), *Equipment Decontamination*. For a newly installed monitoring well, allow the grout to cure for a minimum of 24 hours prior to development.

Calibrate all field analytical test equipment (e.g., pH, temperature, conductivity, oxidation and reduction potential, and turbidity) according to the instrument manufacturer's specifications and the project-specific work plan or sampling and analysis plan. Specific test equipment to be used should be identified in the project-specific work plans. Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.

An exception to the daily calibration requirements will be made in the case of the water level meters. The tape of these instruments will be checked prior to the beginning of the project, and each succeeding six months, using a steel surveyor's tape.

Workers will be provided with, and don, the appropriate personal protective equipment as specified by the project-specific work plans. Typically, the minimum personal protection will include a hard hat, safety glasses, gloves and steel-toed boots.

All field equipment and supplies will be considered using the Tiered Approach provided in Table 2 of SOP AFW-01 (PFAS), *Field Sampling Protocols to Avoid Cross Contamination of Per- and Polyfluorinated Alkyl Substances (PFAS)* prior to use onsite.

5.2.2 WELL DEVELOPMENT/REDEVELOPMENT

Visually inspect the well to ensure that it is undamaged, properly labeled and secured. Any observed problems with the well head should be noted in the field log and reported to the Field Manager.

Unlock the well and obtain a depth to water level measurement. Calculate the volume of water in the well (cased well volume) as follows:

$$\pi\left(\frac{d}{2}\right)^2 (h_1 - h_2) \times 7.48 = \text{gallons per cased well volume}$$

Where:
d = inside diameter of well casing, ft
h_1 = depth of well from top of casing, ft
h_2 = depth to water from top of casing, ft.
The depth to the bottom of the well should be measured and then compared to the well completion form or diagram for the well. If sand or sediment is present inside the well, it should first be removed by bailing. Do not insert bailers, pumps, or surge blocks into the well if obstructions, parting of the casing, or other damage to the well is suspected. Report such conditions to the Field Manager and obtain approval to continue or cease well development activities.

Begin development by first gently surging the well with a surge block, followed by bailing or pumping. This is then continued with alternate surging and bailing or pumping. At no time should the surge block be forced down the well if excessive resistance is encountered. During development, the surge block or bailer should not be allowed to free-fall or descend rapidly such that it becomes lodged in the casing or damages the end cap or sediment trap at the bottom of the well.

Use of a surge block may not be required in the development of certain wells, particularly small diameter wells (i.e., 2-inches or less). Equipment typically used to develop small diameter wells (e.g., bladder pumps, electric submersible pumps, bailers, and tubing with check valve, may be raised and lowered in the water column to effectively surge the well during the development process.

While developing, take periodic water level measurements (at least one every five minutes) to determine if drawdown is occurring and record the measurements on the well development record. If a well is pumped or bailed to dryness, then development will cease and not resume until the water level in the well recovers to approximately 80 percent of static, pre-development water level conditions.

While developing, calculate the rate at which water is being removed from the well. Record the volume on the Well Development Form.

While developing, water is also periodically collected and readings taken of the indicator parameters: pH, specific conductance, oxidation/reduction potential, dissolved oxygen, turbidity, and temperature. Development is considered complete when the indicator parameters have stabilized (i.e., three consecutive pH, specific conductance, and temperature readings are within tolerances specified in the project work plans or within 10% if not otherwise specified) and the maximum turbidity is 50 NTUs or less, or the well develops dry. Additionally, three times the amount of water used during drilling and well installation activities will be removed during development of newly installed wells. In certain instances, for slow recharging wells or small-diameter wells, the parameters may not stabilize. In this case, well development is considered complete upon the removal of three times the amount of water used during drilling and well installation activities (if used) or when the best achievable water quality has been attained (i.e. no further improvement observed) using a combination of surging and pumping as described above.

Obtain a water level and turbidity measurement at the completion of development.

Complete documentation of the well development event on the Well Development Form. At a minimum this record must contain:

- Project name and number;
- Well identification number;
- Well depth, casing size, and completion date;
- Method of development;
- Volume of water removed;
- Water levels (including the time of measurement);
- Physical description of the water (e.g., discoloration, turbidity, odor, etc.) and solids removed from the well;
- Test equipment readings for pH, conductivity, temperature and turbidity (including the time of collection); and,
- Signature of the well development observer.

Collect and appropriately dispose of water removed from the well in accordance with criteria listed in the project-specific work plans and regulatory requirements.

Allow the well to recover for at least 24 hours prior to sampling (new monitoring wells only).

BOREHOLE ABANDONMENT
SOP AFW-06 (PFAS)

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for field personnel to use in the supervision of borehole or soil boring abandonment and groundwater monitoring well abandonment activities. Additional specific borehole and well abandonment procedures and requirements will be provided in the project-specific work plans.

2.0 SCOPE

These procedures apply to all Amec Foster Wheeler personnel and subcontractors who perform soil boring or monitoring well abandonment activities during per- and polyfluorinated alkyl substances (PFAS) investigations. Procedures will also be conducted in accordance with SOP AFW-01 (PFAS), *Field Sampling Protocols to Avoid Cross Contamination of Per- and Polyfluorinated Alkyl Substances (PFAS)*.

3.0 REFERENCES

U.S. Environmental Protection Agency (EPA), 1991, *Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells,* EPA/600/4-89/034, U.S. Environmental Protection Agency, Office of Research and Development, March.

4.0 DEFINITIONS

Borehole Abandonment – The process whereby boreholes or soil borings are grouted or sealed following completion of drilling, sampling and/or logging.

5.0 PROCEDURES

This section contains responsibilities, procedures and requirements for borehole abandonment. Abandonment procedures to be used at a particular investigation area must incorporate project-specific regulatory requirements. Consequently, the project-specific work plans will identify the following:

- Abandonment objectives,
- Boreholes to be abandoned,
- Specific procedures for borehole abandonment beyond those covered in this SOP (e.g., state-specific procedures); and,
- Applicable site-specific regulatory requirements for borehole abandonment.

5.1 RESPONSIBILITIES

Project Manager

The Project Manager (PM) is responsible for ensuring that sample collection activities are conducted in accordance with this SOP, SOP AFW-01 (PFAS) *Field Sampling Protocols to Avoid Cross Contamination of Per -and Polyfluorinated Alkyl Substances (PFAS),* and with any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

Field Lead

The Field Lead is responsible for periodically observing field activities and review of field generated documentation associated with this SOP. The Field Lead is also responsible for the implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to the abandonment requirements, issuing non-conformances, etc.) if problems occur.

Field Personnel

Field personnel assigned to borehole and well abandonment activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from the procedures to the PM or Field Lead.

5.2 FIELD PROCEDURES/CONSIDERATIONS

After drilling, logging and/or sampling, boreholes should be backfilled by the method required by the applicable regulatory agency and described in the project-specific work plans. This typically consists of backfilling to the surface with bentonite chips, pellets or bentonite-cement grout. If bentonite chips or pellets are used, they should be added to the borehole in 2-foot lifts and hydrated with water from a potable water supply. This process should be repeated until the entire borehole is plugged using no less than 5 gallons of water per ten feet of borehole. If bentonite grout is used the following guidelines should be followed:

- Bentonite should be thoroughly mixed into the grout and within the percentage range specified in the work plans. If not otherwise specified in the work plans, the cement-bentonite grout mixture should be of the following proportions: 94 pounds of Portland cement, 5 pounds of powdered bentonite and a maximum of 8 gallons of water. The grout is usually tremied into the hole; however, for selected boreholes (e.g., shallow borings well above the water table) at certain sites, the grout may be allowed to free fall. In either case, care must be taken to ensure the grout does not bridge, forming gaps or voids in the grout column.

- The volume of the borehole prior to sealing should be calculated and compared to the grout volume used during abandonment to aid in verifying that bridging did not occur.
- When using a tremie pipe to place grout in the borehole, the bottom of the tremie should be submerged into the grout column and withdrawn slowly as the hole fills with grout. If allowing the grout to free fall (and not using a tremie), the grout should be poured slowly into the boring. The rise of the grout column should also be visually monitored or sounded with a weighted tape.
- If the method used to drill the boring utilized a drive casing, the casing should be slowly extracted during grouting such that the bottom of the casing does not come above the top of the grout column.
- During the grouting process, the drilling hands performing the task should be supervised to assure that potentially contaminating material (oil, grease, or fuels from gloves, pumps, hoses, et. al) does not enter the grout mix and that personnel are properly wearing personal protective equipment as specified in the project Health and Safety Plan.
- Following grouting, barriers should be placed over grouted boreholes as the grout is likely to settle in time, creating a physical hazard. Grouted boreholes will typically require at least a second visit to “top off” the hole.
- The surface hole condition should match the pre-drilling condition (asphalt, concrete, or smoothed flush with native surface), unless otherwise specified in the project-specific work plans.

SURFACE WATER SAMPLING

SOP AMEC-08 (PFAS)

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use by field personnel in the collection and documentation of surface water samples for laboratory analyses and water quality measurements. Proper collection procedures are necessary to assure the quality and integrity of all surface water samples. Additional specific procedures and requirements will be provided in the site-specific work plan, as necessary.

2.0 SCOPE

This procedure applies to all Amec Foster Wheeler personnel and subcontractors with the responsibility for determining water quality in the field and for the collection, preparation, preservation, and submittal of surface water samples for laboratory analyses. Sample collection will also be conducted in accordance with SOP AMEC-01 (PFAS), *Field Sampling Protocols to Avoid Cross Contamination of Per- and Polyfluorinated Alkyl Substances (PFAS)*.

3.0 REFERENCES

U.S. Environmental Protection Agency (EPA), 1987, *Compendium of Superfund Field Operations Methods*, EPA 540/P-87/001a, OSWER 9355.0-14, September.

EPA, 1988, *EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA*, Interim Final OSWER Directive 9355.3-01, August.

De Vera, E.R., B.P. Simians, R.D. Stephens, and D.L. Storm. 1990. *Samplers and Sampling Procedures for Hazardous Waste Streams*. EPA-600/2-80-018.

Korte, N. and P. Kearl. 1984. *Procedures for the Collection and Preservation of Groundwater and Surface Water Samples and for the Site of Monitoring Wells*. U.S. Department of Energy, Grand Junction, Colorado.

4.0 DEFINITIONS

Surface water – Includes all water on the surface of the ground directly exposed to the atmosphere, including, but not limited to, lakes, ponds, reservoirs, artificial impoundments, streams, rivers, springs, seeps, and wetlands.

Vernal pool – Temporary small, shallow bodies of freshwater that support communities of amphibians and invertebrates.

5.0 PROCEDURES

This section contains both the team member responsibilities and procedures involved with surface water sampling. Proper surface water sampling procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with site-specific work plans. The site-specific work plans will generally provide the following information:

- Sample collection objectives;
- Approximate locations and depths of surface water samples to be collected;
- Numbers and volumes of surface water samples to be collected;
- Types of analyses to be conducted for the samples;
- Specific quality control procedures required; and,
- Any additional surface water sampling requirements or procedures beyond those covered in this SOP, as necessary.

5.1 RESPONSIBILITIES

Project Manager

The Project Manager (PM) is responsible for ensuring that sample collection activities are conducted in accordance with this SOP, SOP AMEC-01 (PFAS) *Field Sampling Protocols to Avoid Cross Contamination of Per- and Polyfluorinated Alkyl Substances (PFAS)*, and with any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

Field Lead

The Field Lead is responsible for periodic observation of field activities and review of field generated documentation associated with this SOP. The Field Lead is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing non-conformances, etc.) if problems occur.

Field Personnel

Field personnel assigned to surface water sampling activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from procedures to the PM or the Field Lead.

5.2 FIELD PROCEDURES/CONSIDERATIONS

The following are procedures/considerations to be made during field activities at potential PFAS release areas.

5.2.1 EQUIPMENT SELECTION

For most investigation areas, a decontaminated bottle sampler attached to a pole (e.g., PVC pipe) can be used as the sampling device, or the sample container itself can serve as the sampling device.

There are several more sophisticated sampling devices that can be used to collect water at discrete depths in deep bodies of water (e.g., Van Dorn and Kemmerer samplers). However, for most routine area investigations of shallow lakes, ponds, and streams, this equipment is not necessary.

The following equipment will typically be used during surface water sampling events:

- Water Quality Meter;
- Laboratory-provided sample containers;
- Self-adhesive sample bottle labels;
- High-density polyethylene (HDPE), stainless-steel, or glass beakers, dippers, bailers or other sampling device;
- Appropriate health and safety equipment specified in the Health and Safety Plan;
- Field notes and data sheets (e.g., sample collection form and Chain of Custody);
- Pen;
- Plastic bags;
- Cooler with ice; and,
- GPS receiver.

Laboratory-provided sample containers will be used to directly collect water samples if sample containers do not contain preservatives. Where required by site conditions, remote sampling into sample containers will be allowed by clamping the container onto the end of a clean extension rod. The extension rod must be made of material that does not include contaminants of interest.

Beakers or dippers (i.e., transfer containers), which may be attached to extension rods, may be used if sample containers have preservatives or remote sampling site conditions prevent sampling by direct sample container immersion. The beakers or dippers will be obtained from a scientific instrument supplier so that the material composition of such a sampling container may be documented. The selected type of transfer device, the composition of this device, and the volume of the device will be recorded on the sample log. Bailers may be used if direct access to the sampling point can be reached. Sample transfer containers must be disposable or decontaminated prior to each use. Discrete depth sampling devices may be used when the site-specific work plan directs that specific depth intervals be sampled.

All field equipment and supplies will be considered using the Tiered Approach provided in Table 2 of SOP AMEC-01 (PFAS), *Field Sampling Protocols to Avoid Cross Contamination of Per- and Polyfluorinated Alkyl Substances* (PFAS) prior to use onsite. Sampling equipment will be thoroughly decontaminated before mobilization to each investigation area and between sample locations at each investigation area or as required in the site-specific work plans. Decontamination procedures will be performed in accordance with SOP AMEC-10 (PFAS), *Equipment Decontamination*.

5.2.2 FIELD PREPARATION

Pre-Sample Planning

In general, surface water sample locations may include shallow or deep lakes, ponds and other types of impoundments, creeks and streams, ditches, low-lying areas, and intermittently wet drainage areas. These bodies of water may receive contaminant input from surface runoff; groundwater; or from direct discharge through a sluice, ditch, or pipe.

If up-to-date information is not available, conduct a reconnaissance of all planned surface water sample locations to determine accessibility to the water body, depth of water, dangerous conditions (e.g., strong currents, boggy bottoms, log jams or beaver dams, waterfalls, steep banks, thick vegetation, etc.), and sampling and personal protection equipment selection criteria. Access to water bodies such as streams may be hampered by thick vegetation, and lakes and ponds that will require the use of a boat may not be accessible by road. Therefore, the logistics of getting sampling equipment and containers to and from the investigation areas must be considered before attempting to sample.

As a general rule, samples should not be collected after heavy rains or during storm events because they will not be representative samples reflecting normal (i.e., baseline) conditions.

When surface water samples are collected at sediment sample locations, the surface water sample should be collected prior to the sediment sample (i.e., the sediment sample will suspend the fines), and the surface water sample should be collected no more than 1 foot above the sediment, unless samples are to be collected in a stratified water column. If samples are to be collected in a stratified water column, the sample depths will be specified in the site-specific work plans.

The number of sample points, and the specific analytes to be measured, are provided in the site-specific work plans. Sample locations and the number of samples collected will vary with the size of the water body and the nature of the source input.

Streams, Tributaries, and Creeks

In moving water bodies such as streams, tributaries, and creeks, sample points should be located where the water is homogeneous both horizontally and vertically. Samples should be taken far enough downstream from the source input for the discharge to be completely mixed. Locations immediately below riffle areas will be vertically mixed and narrow channel areas promote horizontal or cross-channel mixing. Sampling should take place downstream of riffle areas and narrow channel areas where low flow and minimal turbulence conditions are present. The selection of strategically located sample sites may depend on several factors, such as homogeneity, accessibility, intake points for water supplies, stream velocity, and geomorphology.

In general, a single grab sample collected at mid-depth in the center of the channel is adequate to represent the entire mixed cross-section of small streams less than 20 feet wide. The site-specific work plan will designate whether a single mid-point sample, vertical profile samples, or discrete depth samples are required. If vertical profile samples are specified in the site-specific work plan for larger and deeper streams or creeks, these samples should be taken from mid-stream just below the surface, at mid-depth, and just above the bottom and composited. If discrete depth samples are specified by the site-specific work plan, these samples should be taken at the desired depths, if possible. The pH, temperature, specific conductivity, and dissolved oxygen should be measured for each sample point when vertical composite samples are collected. The number of vertical composites and the depths sampled are determined in the site-specific work plan. Water depth can either be measured with a graduated staff (e.g., yardstick) at shallow depths or with one of various manual or electronic devices available for deeper depths.

Stagnated areas or pools in a stream or creek could contain different contaminant concentrations than those from the flowing areas, depending on the physical and chemical properties of the contaminant and the proximity of these areas to the source. A sample may be taken at mid-depth to determine if these areas represent contaminant sinks.

Lakes, Lagoons, Ponds, and Impoundments

The selection of representative sample points in standing bodies of water depends on the size, shape, and depth of the basin, and will be specified in the site-specific work plan. Samples can be collected along a vertical transect and/or horizontal grid. The site-specific work plan will designate whether a single mid-point sample, vertical profile samples, or discrete depth samples are required. In larger basins, stratification may inhibit uniform vertical mixing. In these instances, discrete depth samples may be collected at each stratification layer. In smaller basins, such as ponds, lagoons, and impoundments, the entire water column is generally uniformly mixed and one sample at the deepest point may be adequate. The deepest point is usually in the center of small ponds and other containment catch basins. For impoundments with a dam, the deepest point is generally near the base of the dam. Water depth can either be measured with a graduated staff (e.g., yardstick) at shallow depths or with one of various manual or electronic devices for deeper depths.

Wading into the water body to collect samples is not recommended in shallow lakes and ponds. Wading will disturb bottom sediments, which may contaminate the water column resulting in a false positive parameter result. Therefore, a boat is typically used to collect representative water samples in lakes, lagoons, ponds, and impoundments.

Equipment Decontamination

Before sampling begins, sampling devices (e.g., bailers, beakers, dippers, etc.) shall be decontaminated. Mobile decontamination supplies may be utilized so that equipment can be decontaminated on-site. Each piece of sampling equipment shall be decontaminated before sampling operations and between sampling locations. Decontamination of field equipment will be performed in accordance with SOP AMEC-10 *Equipment Decontamination*.

5.2.3 GENERAL SAMPLING PROCEDURES

- Samples will be collected first from areas that are suspected of being the least contaminated to minimize the risk of sample cross-contamination. In flowing water bodies, sampling shall progress from downstream to upstream to avoid sediment disturbance affecting subsequent samples.
- Prior to sampling, the water body characteristics (e.g., size and depth) should be observed and described in the field logbook.
- Collect X-Y coordinates of the sample location using a portable GPS instrument. If a GPS is ineffective due to the terrain or tree canopy, mark the location in the field with a stake or flag after sampling is complete.
- Don a clean pair of nitrile gloves.
- Surface debris (i.e., sticks, leaves, vegetation) will be cleared from the sample location prior to sample collection, taking care not to disturb bottom or attached sediments.
- Measure water quality parameters (pH, dissolved oxygen, specific conductivity, and temperature) at each sample location prior to collecting a water sample. Samples for water quality parameters will be collected in a separate container at a like location and depth as the samples for laboratory analysis.
- Collect the sample in accordance with the appropriate method-specific procedures in Section 5.2.4.
- Document the sampling event on the sample collection form. As soon as possible after sample collection, place the sample in a separate, appropriately sized, airtight, seam sealing, polyethylene

bag (i.e., Ziploc®). Seal the bag, removing any excess air. Place the bagged sample inside the shipping container.
- Handle and ship the sample according to the procedures outlined in SOP AMEC-11, following appropriate chain of custody procedures.

Note: Collection of surface water samples in deep-water areas may require the use of a boat. The BPM and Health and Safety Manager shall be consulted for additional health and safety requirements.

5.2.4 METHOD SPECIFIC SAMPLE COLLECTION PROCEDURES

Samples Collected by Container Immersion

Surface water sample collection by container immersion will be done in accordance with the following procedures:

- The outside of all capped sample containers shall be triple rinsed with the surface water being sampled before filling the containers with the sample to be analyzed.
- Submerge the sample container or transfer container below the water surface with minimal surface disturbance and with the open end pointed upstream.
- If possible, the sample container or transfer container will be lowered no closer than 3 to 6 inches above the bottom sediments.

Samples Collected by Bailer

Surface water sample collection with a bailer will be done in accordance with the following procedures:

- A disposable HDPE bailer or equivalent will be used;
- Depth of water at each sampling site will be measured and the bailer will be lowered to the appropriate sampling location in accordance with the sampling plan;
- If possible, the bailer will be lowered no closer than 3 to 6 inches above the bottom sediments;
- The bailer will be inserted facing downstream and withdrawn very slowly and carefully to avoid agitation of the bottom sediments; and,
- Transfer the sample from the bailer directly into the sample container. Minimize aeration of the sample as much as possible.

Samples Collected by Discrete Depth Sampling Devices

Surface water sample collection with a discrete depth sampling device will be done in accordance with the following procedure:

- A Van Dorn sampler, Kemmerer sampler, or equivalent will be used.
- Depth of water at each sampling site will be measured and the sampling device will be lowered to the appropriate sampling depth in accordance with the site-specific work plan.
- If possible, the sampling device will be lowered no closer than 3 to 6 inches above the bottom sediments.
- The sampling device will be lowered facing upstream and opened once at the desired sampling depth. The device will be withdrawn very slowly and carefully to avoid agitation of the bottom sediments.
- Transfer the sample from the device directly into the sample container. Minimize aeration of the sample as much as possible.

6.0 RECORDS

Field notes shall be recorded on the Daily Field Record and Surface Water Sampling Form. The following information is required according to the sampling method performed:

- GPS coordinates, or distance to two fixed objects, or distance and compass bearing from at least one fixed object;
- Distance of sample collection point from right or left edge of water;
- Water depth;
- Estimate of surface area of water body;
- Sample depth interval;
- Sample collection method (grab, discrete);
- Surface water and investigation area conditions (e.g., floating oil or debris, gassing, etc.);
- Location of any discharge pipes, sewers, or tributaries;
- Instrument calibration;
- Required investigation area maps (If a staff gauge is measured and not co-located with surface water location it must be included in the investigation area map).; and,
- Weather observations (e.g., wind speed, is it sunny or cloudy, and approximate wave height).

EQUIPMENT DECONTAMINATION
SOP AMEC-10 (PFAS)

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines for use by field personnel in the decontamination of drilling, sampling, development, and heavy equipment. The details within this SOP are applicable as general requirements for drilling and heavy equipment decontamination, and should also be used in conjunction with site-specific work plans.

2.0 SCOPE

These procedures apply to all Amec Foster Wheeler personnel and subcontractors who prepare equipment for use during investigation at potential per- and polyfluorinated alkyl substances (PFAS) release areas. This SOP should be reviewed by all on-site personnel prior to implementation of field activities.

3.0 REFERENCES

U.S. Environmental Protection Agency (EPA), 1987, *Compendium of Superfund Field Operations Methods*, EPA 540/P-87/001a, OSWER 9355.0-14, September.

EPA, 1988, *EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA*, Interim Final OSWER Directive 9355.3-01, August.

EPA, 1991, *Management of Investigation Derived Wastes During Site Inspections*, EPA 540/G-191/009, May.

4.0 DEFINITIONS

Heavy Equipment – Drill rigs, excavators, dozers, back-hoes, trucks, or other similar type machinery used to drill soil borings, break concrete, excavate soil or other similar type activity.

Laboratory Grade Detergent – A standard brand of laboratory-grade detergent, such as “Alconox” or “Liquinox.”

Potable Water – Water dispensed from a municipal water system or a water supply well used and approved for drinking.

5.0 PROCEDURES

This section contains both the responsibilities and procedures involved with equipment decontamination. Proper decontamination procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with site-specific work plans. The work plans will generally provide the following information:

- Sample collection objectives;
- Specific quality control (QC) procedures and sampling required; and
- Management procedures for investigation derived waste (IDW).

At a minimum, the procedures outlined in this SOP for equipment decontamination will be followed.

5.1 RESPONSIBILITIES

Compliance with this procedure is the responsibility of project management and field personnel. This SOP and the site-specific work plans should be reviewed before implementing drilling, sampling, development, and heavy equipment decontamination at the project investigation area.

Project Manager

The Project Manager (PM) is responsible for ensuring that decontamination of drilling, sampling, development and heavy equipment is conducted in accordance with this SOP and with any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

Field Lead

The Field Lead has the responsibility for periodic review of procedures and documentation associated with the decontamination of equipment. The Field Lead is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing non-conformances, etc.) if problems occur.

Field Personnel

Field personnel assigned to monitor the subject decontamination activities are responsible for ensuring these tasks are completed according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from procedures to the PM or the Field Lead.

5.2 GENERAL

This section provides requirements for the construction of a temporary decontamination facility for drilling, development, and heavy equipment and the decontamination procedures to be followed. The site-specific work plans will provide detailed information regarding:

- Types of equipment requiring decontamination under this SOP;
- Location of the decontamination station;
- Types and/or specifications on materials to be used in the fabrication of the decontamination station; and,
- Types of materials and additional details on the procedures to be used in the decontamination process.

Field personnel associated with construction of the decontamination station or decontamination of drilling or heavy equipment must read both this SOP and the site-specific work plans prior to implementation of related decontamination activities.

5.3 DECONTAMINATION FACILITY

A decontamination facility will be set up in an area exclusively for decontamination of drilling, sampling, well development, and/or heavy equipment. Decontamination of equipment will be conducted within the station.

At a minimum, the station will be constructed such that all rinsates, liquid spray, soil, debris, and other decontamination wastes are fully contained and may be collected for appropriate waste management and disposal. The facility may be as simple as a bermed pad lined with polyethylene sheeting with an impermeable sump for collecting rinse water. More sophisticated designs involving self-contained metal decontamination pads in combination with bermed polyethylene sheeting may also be used, depending on project-specific requirements. These requirements along with specific equipment and construction specifications for the decontamination facility will be provided in the site-specific work plans.

5.4 DECONTAMINATION PROCEDURES

Each piece of drilling and sampling equipment shall be decontaminated daily before initiation of sampling operations and between each sample location and interval. Decontamination solutions shall be replenished between sampling locations as needed. Spent decontamination fluids will be containerized, properly labeled and appropriately disposed of according to the investigation derived waste (IDW) plans addressed in the site-specific work plan.

5.4.1 DOWNHOLE EQUIPMENT

Downhole drilling, sampling, and development equipment (including but not limited to drill pipe, drive casing, drill rods, bits, tools, non-disposable bailers, etc.) will be thoroughly decontaminated before mobilization to each investigation area and between borings or wells at each investigation area or as required in the site-specific work plans. The standard procedure will be performed as described below.

- Appropriate personal protective equipment (as specified in the site-specific work plans) must be worn by all personnel involved with the subject task to limit personal exposure.
- Equipment caked with drill cuttings, soil, or other material will initially be scraped or brushed. The scrapings will be containerized and appropriately disposed.
- Equipment will then be sprayed with potable water using a high-pressure washer.
- Washed equipment will then be rinsed with “PFAS-free” water.
- Decontaminated downhole equipment (e.g., drill pipe, drive casing, bits, tools, bailers, etc.) will be placed on clean plastic sheeting to prevent contact with contaminated soil and allowed to air dry. If equipment is not used immediately, it will be covered or wrapped in plastic sheeting to minimize airborne contamination (i.e., dust).
- Field sampling equipment and other downhole equipment used multiple times at each sample location will require cleaning between uses utilizing a four stage decontamination process. The equipment will first be rinsed in a bucket containing a mixture of potable water and soap. Alconox® and Liquinox® soap is acceptable for use since the Material Safety Data Sheets do not list fluoro-surfactants as an ingredient. The equipment will then be rinsed in each of two buckets of clean potable water. Water used for the final rinse during decontamination of sampling equipment will be laboratory certified “PFAS-free” water.
- Decontamination activities will be documented by the Field Lead, lead geologist, or lead engineer in the field log and/or appropriate form(s), as specified in the site-specific work plans.

5.4.2 HEAVY EQUIPMENT

Heavy equipment (e.g., drill rigs, development rigs, backhoes, trucks, and other earthmoving equipment) will be decontaminated between drilling locations and at the decontamination facility upon entering and prior to leaving the site. Decontamination will be performed in accordance with the site-specific work plans. The standard procedure will be performed as described below.

- Appropriate personal protective equipment will be worn by all personnel involved in the task, in order to limit personal exposure.
- Heavy equipment caked with drill cuttings, soil, or other material will be initially scraped or brushed to remove bulk soil and containerized in accordance with the site-specific work plan.

- Heavy equipment will then be moved to the decontamination pad and sprayed with potable water using a high pressure washer.
- Heavy equipment will then be rinsed with “PFAS-free” water.
- During the decontamination effort, fluid collection and containment systems should be inspected for any leaks or problems, which might potentially result in an inadvertent release at the investigation area, thereby contributing to the volume of waste or contamination. Any identified problems should be immediately repaired and documented.
- Decontamination activities will be documented in the field log and/or appropriate form(s), as specified in the site-specific work plans.
- Between boreholes at the same location the back-end of the drilling rigs will be washed with potable water until surfaces are visibly free of soil buildup.

SAMPLE HANDLING AND CUSTODY
SOP AMEC-11 (PFAS)

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use by field personnel in the handling and custody procedures for environmental samples. Proper sample handling and collection procedures are necessary to assure the quality and integrity of media samples. Additional specific procedures and requirements will be provided in the site-specific work plan, as necessary.

2.0 SCOPE

This procedure applies to all Amec Foster Wheeler personnel and subcontractors collecting environmental per- and polyfluorinated alkyl substances (PFAS) samples.

3.0 REFERENCES

U.S. Environmental Protection Agency (EPA), Office of Emergency and Remedial Response, EPA/540/R-96/0, Dec 96 -*Sampler's Guide to the Contract Laboratory Program.*

EPA, Office of Emergency and Remedial Response, EPA/540/R-941/013, Feb 94 - *User's Guide to the Contract Laboratory Program.*

American Society for Testing and Materials. 1996. *Standard Guide for Sampling Chain-of-Custody Procedures*. D 4840-95.

4.0 DEFINITIONS

Chain-of-Custody Record – legal documentation of custody of sample materials and instructions for analytical laboratory.

Custody – physical possession or control. A sample is under custody if it is in possession or under control so as to prevent tampering or alteration of its characteristics.

Sample Label – a record attached to samples to ensure legal documentation of traceability.

5.0 PROCEDURES

This section contains both the responsibilities and procedures involved with sample handling and chain of custody. An essential part of the sampling activities of any environmental project is assuring the integrity of the sample from collection to data reporting. Sample labels and chain-of-custody forms are used to document identification and handling of samples from the time of collection through the completion of chemical analysis. In some projects, analytical data may be used in litigation. Accountability of the history of a sample must be available to demonstrate that the data are a true representation of the media sampled. The chain-of-custody record is used as evidence in legal proceedings to demonstrate that a sample was not tampered with or altered in any way that may bias the analytical accuracy of the laboratory results. It is extremely important that chain-of-custody records be complete, accurate and consistent. At a minimum, the procedures outlined in this SOP for sample handling and chain of custody will be followed.

5.1 RESPONSIBILITIES

Compliance with this procedure is the responsibility of project management and field personnel. This SOP and the site-specific work plans should be reviewed before sample handling at the project investigation area.

Project Manager

The Project Manager is responsible for ensuring that sample handling and custody activities are conducted in accordance with this SOP and with any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

Field Lead

The Field Lead shall ensure that the samples are correctly collected, labeled, tracked by chain-of-custody, and stored until they are delivered directly to the shipper or laboratory (i.e., on-site or off-site).

Field Personnel

Sample Collector

The Sample Collector shall ensure the samples are correctly collected, labeled, tracked by chain-of-custody, and stored until they are delivered directly to the Sample Shipper or laboratory (i.e. on-site or off-site). The Sample Collector shall maintain custody of the samples until they are relinquished to the Sample Shipper or laboratory. The Sample Collector shall be responsible for informing the Sample Shipper of sampling conditions and if any of the samples are potentially hazardous. (NOTE: The Sample Collector and Sample Shipper can be the same person.)

Sample Shipper

The Sample Shipper shall pack the sample shipping coolers, ensure that the chain-of-custody forms are correct, and ship and/or deliver the samples to the laboratory. The Sample Shipper shall determine which samples are potentially hazardous and ship them accordingly.

5.2 SAMPLE CUSTODY

Sample custody procedures are designed to ensure that sample integrity is maintained from collection to final disposition. A critical aspect of sound sample collection and analysis protocols is the maintenance of strict chain-of-custody procedures as described in this technical procedure. Chain-of-custody procedures include tracking and documentation during sample collection, shipment, and laboratory processing. A sample is considered to be in an individual's custody if it is: (1) in the physical possession of the responsible party; (2) in view of the responsible party after being in their possession (3) secured to prevent tampering; or (4) placed in a designated, secure area that is controlled and restricted by the responsible party.

Custody will be documented throughout all sampling activities on the chain-of-custody record for each day of sampling. This record will accompany the samples from the investigation area to the laboratory. All personnel with sample custody are required to sign, date, and note on the record the time when receiving and relinquishing samples from their immediate custody. Any discrepancies will be noted at this time. Samples will be shipped to subcontract laboratories via overnight air courier. Bills of lading will be used as custody documentation during this time and will be retained as part of the permanent sample custody documentation. In some cases, samples may be hand delivered to the laboratory; hand delivery will be noted on the chain-of-custody form. The subcontractor laboratory is responsible for sample custody once samples are received.

5.3 SAMPLE LABELS

A label will be attached to all sample containers at the time of sample collection. The label will contain the following information:

- Unique chain-of-custody control number;
- Sample identification;
- Analyses requested; and,
- Preservative used.

When sample collection is complete; the Sample Collector fills in the following information in ink:

- Date and time of sample collection; and,
- Sampler's initials.

5.4 CHAIN-OF-CUSTODY RECORDS

Chain-of-custody forms will be used to document the integrity of all samples to maintain a record of sample collection, transfer of samples between personnel, shipment of samples, and receipt of samples at the laboratory. Each sample/analysis at each sampling location will be logged onto a chain-of-custody form. The chain-of-custody forms shall include the following information:

- Project name and project number if applicable;

- Name and address of laboratory to receive the samples;
- Chain-of-custody control number;
- Sample type, sample method;
- Location ID, sample ID;
- Matrix code;
- Analyses requested;
- Field QC for matrix spike (MS)/matrix spike duplicate (MSD), if applicable;
- Container type, size and number;
- Preservatives used;
- Turn-around-time for laboratory analysis; and,
- Comments to Laboratory or Sample Collector, if applicable.

The Sample Collector will enter the following information using black or blue ink:

- Sampler's initials;
- Date of collection;
- Time of collection (24-hour format);
- Depths, if applicable;
- Pump/equipment number, if applicable; and,
- Void reason, if applicable.

The Sample Collector shall verify the chain-of-custody record is complete, accurate in all aspects, and consistent with all other sample documentation (e.g. number of samples, sample labels, field logs). The Sample Collector will sign the "Sampled By" and "Relinquished By" fields on the chain- of-custody record, marking the date and time custody is transferred to the Sample Shipper or other authorized person.

The Sample Shipper will perform the following duties:

- Obtain the signature of the Sample Collector, on the chain-of-custody form, to transfer sample custody;
- Record the carrier service and airbill number on the chain-of-custody;
- Sign and enter the date and time relinquished to the shipper; and,
- Prepare the samples for shipment from the field to the laboratory.

The Sample Shipper will sign the "Received By" box, marking the date and time of receipt of the samples from the Sample Collector or other sample custodian. Every transfer of physical custody shall be documented on the chain-of-custody record.

Any corrections to the chain-of-custody form entries will be made by a single-line strike mark through the incorrect item, and then entering the correct entry adjacent to the strikeout item. Corrections will be initialed and dated by the person making the change. After the form has been inspected and determined to be complete, the sample shipper will sign, date, and note the time of transfer and will reference a shipper tracking number on the form. The chain-of-custody form will be placed inside the cooler after the sample packer has detached or made an appropriate copy of the form. Field copies of the completed chain of custody forms maintained in project files.

5.5 SAMPLE STORAGE

In some cases, samples that cannot be shipped immediately to a laboratory must be temporarily stored in an Amec Foster Wheeler controlled sample refrigerator until arrangements can be made for delivery. The Sample Collector or Shipper shall place samples in the refrigerator [samples and signed chain of custody record(s)] and secure the refrigerator with a unique, keyed lock, restricting access to one field personnel at a time. A temperature blank must accompany samples overnight.

Samples temporarily stored in the refrigerator must be received by the field personnel that placed them in storage, and in turn, may be "relinquished to" the appropriate laboratory, the Sample Shipper or another sample custodian. Each transfer of custody shall be recorded on the appropriate chain-of-custody form(s).

6.0 RECORDS

Distribution of the chain-of-custody record:

- Original form sealed in a plastic bag and taped inside the top of the shipping container; and,
- Copies to the Project Manager.

PRIVATE AND PUBLIC WATER SUPPLY WELL SAMPLING

SOP AFW-13 (PFAS)

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures by which Amec Foster Wheeler personnel should conduct groundwater sampling at private and public water supply wells that may contain per-and polyfluorinated alkyl substances (PFAS). Proper procedures are necessary to assure the quality and integrity of groundwater analytical results. Additional specific procedures and requirements will be provided in installation-specific work plans and/or field work notifications, as applicable.

2.0 SCOPE

This procedure applies to all AMEC personnel involved in the sampling of private and/or public water supply wells. Construction and operation of water supply wells will vary; therefore, this SOP may not be applicable to all situations.

This procedure has been developed to serve as management-approved professional guidance for the AMEC Program. As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment to accommodate unforeseen circumstances. Deviation from this procedure in planning or in the execution of planned activities must be approved by the Project Manager.

3.0 REFERENCES

U.S. Environmental Protection Agency (EPA), 2013. Science and Ecosystem Support Division (SESD) Operating Procedure: Potable Water Supply Sampling. SESDPROC-305-R3. Effective date May 30, 2013.

EPA, 1998. Safe Drinking Water Act: Definition of a Public Water System. Section 1401(4). Amended by the 1996 Safe Drinking Water Act Amendments. Effective date August 6, 1998.

4.0 DEFINITIONS

Potable Water – Water that meets the standards for drinking purposes of the State or local authority having jurisdiction, or water that meets the standards prescribed by the EPA's National Primary Drinking Water Regulations (40 CFR 141).

Private Water Supply Well – A well that can serve as a private drinking water system, has fewer than 15 individual connections, or regularly serves an average of less than 25 individuals for less than 60 days out of the year.

Public Water Supply Well – A well and distribution system that has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year. The term includes (1) any collection, treatment, storage, and distribution facilities under control of the supplier of water and used primarily in connection with the system; and (2) any collection (including wells) or pretreatment storage facilities not under the control of the supplier which are used primarily in connection with the system.

Note: The definitions provided for private and public water supply wells are generally accepted industry-wide. However, the definitions should be confirmed with the local and state regulatory authorities where the work is being conducted. Site-specific definitions should be included in the installation-specific work plans.

5.0 PROCEDURE

This section contains both the responsibilities and procedures involved with sampling private and public supply wells. Proper procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with installation-specific work plans. The installation-specific work plans will generally provide the following information:

- Sample collection objectives;
- Water well locations to be sampled;
- Number and volume of samples to be collected at each well;
- Types of chemical analyses to be conducted for the samples;
- Specific quality control procedures and sampling required;
- Any additional sampling requirements or procedures beyond those covered in this SOP, as necessary; and
- At a minimum, the procedures outlined in this SOP for water supply well sampling will be followed.

5.1 RESPONSIBILITIES

Project Manager

The Project Manager (PM) is responsible for ensuring that sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The PM will select the appropriate sampling methodology and analytical program based on the objectives of the sampling. The PM is also responsible for ensuring that the site-specific sampling plan is clear in defining sampling methods.

Field Manager

The Field Manager is responsible for periodic observation of field activities and review of field generated documentation associated with this SOP. The Field Manager is also responsible for implementation of corrective action (i.e. retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing non-conformances, etc.) if problems occur.

Field Personnel

Field personnel assigned to water supply well sampling activities are responsible for completing tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from procedures to the Project Manager or Field Manager.

5.2 METHOD SUMMARY

The basic procedures for sampling private and public water supply wells are similar to those for sampling of groundwater monitoring wells, as specified in Groundwater Sampling SOP AFW-03 (PFCs), and sampling of water at a treatment system, as specified in Groundwater Treatment System Influent and Effluent Sampling SOP AFW-09 (PFCs). The main difference is how or where the well water is accessed. Wells with in-place plumbing are commonly found at residences, and water supply wells may or may not have sampling ports at the well head. The procedure can be summarized as follows.

- Decontaminate any equipment that will come into contact with water inside the well and/or sampled water as specified in SOP AFW-10 (PFCs);
- Purge water until specific parameters have stabilized, toward ensuring formation water (as opposed to stagnant well water) will be sampled;
- Collect samples in laboratory-supplied containers; and
- Follow standard sample handling and custody procedures to contain and transport samples to the off-site laboratory.

5.3 FIELD PROCEDURES

Field procedures will incorporate other applicable project-specific SOPs, particularly SOP AFW-01 (PFAS), *Field Sampling Protocols to Avoid Cross-Contamination of Per- and Polyfluorinated Alkyl Substances (PFAS)*.

5.3.1 PREPARATION

Office Procedures

- Contact the well owner with the proposed schedule for sampling, and coordinate with the well owner on timing; obtain information on the pumping rate and frequency during the last several weeks, if available.
- Review the installation-specific work plan and the procedure including sampling information on the wells to be tested, if available.
- Check out and ensure the proper operation of all field equipment.
- Assemble a sufficient number of field forms to complete the field assignment (do not use waterproof paper). Plan to use a tablet to generate electronic documents.
- Assemble appropriate testing equipment.

Equipment Selection and Sampling Considerations

This SOP assumes that private or public water supply wells are equipped with operational mechanical systems to collect samples. If the mechanical systems for supply wells are not operational, then the sampling should be conducted as described in SOP AFW-03 (PFAS) for Groundwater Sampling and the details provided in the installation-specific work plans.

The following should be considered when choosing the location to collect a potable water sample from a private and/or public water supply well (EPA, 2013):

- Taps selected for sample collection should be supplied with water from a service pipe connected directly to a water main in the segment of interest.
- Whenever possible, choose the tap closest to the water source, and prior to the water lines entering the residence, office, building, etc., and also prior to any holding or pressurization tanks.
- The sampling tap must be protected from exterior contamination associated with being too close to a sink bottom or to the ground. Contaminated water or soil from the faucet exterior may enter the bottle during the collection procedure because it is difficult to place a bottle under a low tap without grazing the neck interior against the outside faucet surface. If the tap is too close to the ground for direct collection into the appropriate sample container, it is acceptable to use a smaller container to transfer sample to a larger container. The smaller container should be made of high-density polyethylene (HDPE) or polypropylene, and should be decontaminated as specified in SOP AFW-10 (PFAS).
- When filling any sample container, care should be taken that splashing drops of water from the ground or sink do not enter into either the bottle or cap.
- Leaking taps that allow water to discharge from around the valve stem handle and down the outside of the faucet, or taps in which water tends to run up on the outside of the lip, are to be avoided as sampling locations.
- Disconnect any hoses, filters, or aerators attached to the tap before sampling. These devices can harbor a bacterial population if they are not routinely cleaned or replaced when worn or cracked.
- Taps where the water flow is not constant should be avoided because temporary fluctuation in line pressure may cause clumps of microbial growth that are lodged in a pipe section or faucet connection to break loose. A smooth flowing water stream at

moderate pressure without splashing should be used. The sample should be collected without changing the water flow.

Data Form

The Groundwater Sample Collection Log form will be completed electronically using a tablet.

5.3.2 PERFORMING THE SAMPLING

Private and public water supply well samples will be collected by filling sample containers from sample ports at each designated location. Ideally, the sample should be collected from a tap or spigot located at or near the well head or pump house and before the water supply is introduced into any storage tanks or treatment units. If the sample must be collected at a point in the water line beyond a tank, a sufficient volume of water should be purged to provide a complete exchange of fresh water into the tank and the tap or spigot. If the sample is collected from a tap or spigot located just before a storage tank, spigots located downstream of the tank should be turned on to prevent any backflow from the tank to the tap or spigot. Several spigots may be opened to provide for a rapid exchange of water.

The following general procedures will be used. These procedures may be modified to reflect site-specific conditions.

- Don personal protective equipment (PPE) appropriate for the task, in accordance with the site-specific Health and Safety Plan and Activity Hazard Analysis, as applicable.
- Sample wells from least contaminated to most contaminated, if possible.
- The sample port for a private water supply well will be opened and allowed to flush for at least 15 minutes, when possible. The sample port for a public water supply well will be allowed to flush for at least three minutes.
- The samples will then be collected directly from the sample port into the laboratory-supplied container. Samples should be collected with as little agitation or disturbance as possible.

VERTICAL AQUIFER PROFILING
SOP AFW-16 (PFAS)

1.0 PURPOSE

This Standard Operating Procedure (SOP) provides procedures and requirements for the collection of groundwater grab samples for the purpose of vertical aquifer profiling (VAP). Proper collection procedures are necessary to assure the quality and integrity of all groundwater samples. Additional specific procedures and requirements will be provided in project-specific work plans, as applicable.

2.0 SCOPE

These procedures apply to all Amec Foster Wheeler personnel and subcontractors who perform VAP activities during per- and polyfluorinated alkyl substances (PFAS) investigations.

3.0 REFERENCES

U.S. Environmental Protection Agency (EPA), 1986, *Resource Conservation and Recovery Act (RCRA) Ground Water Monitoring Technical Enforcement Guidance Document*, OSWER-9950.1, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, U.S. Government Printing Office, Washington D.C.

EPA, 1987, *A Compendium of Superfund Field Operations Methods*, EPA-500/P-87/001, U.S. Government Printing Office, Washington D.C.

EPA, 1991, *Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells,* EPA/600/4-89/034, U.S. Environmental Protection Agency, Office of Research and Development, March.

4.0 DEFINITIONS

Air Rotary Casing Hammer Drilling – A drilling method using a non-rotating drive casing that is advanced simultaneously with a slightly smaller diameter rotary bit attached to a string of drill pipe. The drive casing is a heavy-walled, threaded pipe that allows for pass-through of the rotary drill bit inside the center of the casing. Air is forced down through the center drill pipe to the bit, and then upward through the space between the drive casing and the drill pipe. The upward return stream of air removes cuttings from the bottom of the borehole.

Annular Space – The space between:

- Concentric drill pipes;
- An inner drill pipe and outer drive casing;
- Drill pipe or drive casing and the borehole wall; or,
- Well screen or casing and the borehole wall.

Bladder Pump – A bladder pump is an enclosed cylindrical tube containing a flexible membrane bladder. Well water enters the bladder through a one-way check-valve at the bottom. Gas is forced into the annular space (positive displacement) surrounding the bladder through a gas supply line. The gas displaces the well water through a one-way check-value at the top. The water is brought to the surface through a water discharge line. Gas (air or nitrogen) is provided by compressors or cylinders.

Borehole – Any hole drilled into the subsurface for the purpose of identifying lithology, collecting soil or rock samples, and/or installing groundwater wells.

Cuttings – Pieces of soil, sediment, or rock cut by a bit in the process of drilling borings.

Direct Push Drilling – For the purposes of this monitoring well installation SOP, the term "direct push drilling" refers to using DPT to push or drive hollow rods into the ground for the purpose of installing monitoring wells with a maximum inside diameter of 1 inch when using 2.625 inch inside diameter DPT rods. Direct push drilling uses an expendable drive point that is fitted to the lower end of a string of drive rods that are advanced into the ground using percussive hammering. No cuttings are brought to the surface during drilling, although soil cores may be retrieved using various sampling tools.

Dual-Tube Percussion Drilling – A drilling method using non-rotating drive casing with a bit on the bottom of the casing string. A smaller diameter tube or drill pipe is positioned inside the drive casing. The drive casing is advanced by the use of a percussion hammer, thereby causing the bit to cut or break up the sediment or soil at the bottom of the boring. Air is forced down the annular space between the drive casing and inner drill pipe and cuttings are forced upward with the return stream of air within the center of the inner drill pipe.

Electric Submersible Pump – An electric submersible pump is an enclosed cylindrical tube containing a motor with rotary attachments. Well water enters the cylinder through a one-way check valve. Electrical power to the motor causes rotors or impellers to turn and displace the groundwater.

Hollow-Stem Auger Drilling – A drilling method using augers with open centers. The augers are advanced with a screwing or rotating motion into the ground. Cuttings are brought to the surface by the rotating action of the augers, thereby clearing the borehole.

Mud Rotary Drilling – For the purposes of this monitoring well installation SOP, the term "mud rotary drilling" refers to direct circulation (as opposed to reverse circulation) mud rotary drilling. Mud rotary drilling uses a rotating drill bit which is attached to the lower end of a string of drill pipe. Drilling mud is pumped down through the inside of the drill pipe and out through the bit. The mud then flows upward in the annular space between the borehole and the drill pipe, carrying the cuttings in suspension, within the drilling mud, to the surface.

Peristaltic Pump – A peristaltic pump is a self-priming, low volume pump consisting of a rotor and ball bearing rollers. Tubing placed around the rotors is squeezed by the rotors as they revolve. The squeezing produces a wavelike contractual movement that causes water to be drawn through the tubing. During purging and sampling, only the tubing is placed down the well. All of the mechanical systems of the pump remain above ground during purging and sampling activities. The peristaltic pump is typically limited to sampling at depths of less than 25 feet. Operating two or more peristaltic pumps in parallel can increase operational depths slightly.

Sonic Drilling – Sonic drilling uses a combination of rotary motion, oscillation/vibration, and hydraulic downward force to advance a drill bit and drive casing. Soil or rock cores are retrieved using a core barrel as the drive casing is advanced.

Tremie – A tubular device or pipe used to place grout, bentonite, or filter pack in the annular space of a borehole.

Well Screen – A commercially available, factory-perforated, wire wound, continuous wrap, or slotted casing segment used in a well to maximize the entry of groundwater from the producing zone and to minimize the entrance of sand.

5.0 PROCEDURES

This section contains both the main project team responsibilities and the procedures for VAP activities. The procedures described herein are applicable as requirements for VAP investigations using DPT, hollow-stem auger, mud rotary, air rotary, air rotary casing hammer, sonic, or dual tube percussion drilling techniques. Site-specific factors need to be considered in the selection of well construction materials and choosing borehole drilling methods. These factors will be incorporated in project planning activities and the compilation of project-specific work plans. The work plans will contain the following information related to monitoring well installation:

- Objectives of the VAP well;
- Specific location of the VAP well to be advanced;
- Zone or depth VAP well is to be installed;

- Drilling method(s) to be used;
- Well construction materials to be used;
- Additional procedures or requirements beyond the scope of this SOP.

5.1 RESPONSIBILITIES

Project Manager

The Project Manager is responsible for ensuring that all VAP activities are conducted and documented in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by quality assurance/quality control (QA/QC) monitoring activities.

Field Lead

The Field Lead is responsible for periodic observation of VAP activities to assure implementation of this SOP. The Field Lead is also responsible for the review and approval of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to monitoring well installation requirements, issuing non-conformances, etc.) identified during the performance of these activities.

Field Personnel

Field personnel assigned to VAP activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. Field staff are responsible for reporting deviations from the procedures to the Project Manager or the Field Lead.

5.2 FIELD PROCEDURES/CONSIDERATIONS

The following are procedures/considerations to be made during field activities at potential PFAS release areas.

5.2.1 FIELD PREPARATION

Before mobilization of a rig to the well site, ensure that the VAP location has been appropriately cleared of all underground utilities, buried objects, and overhead utilities, and that drill permits (e.g., FAA permits) have been issued per the project work plans. Review all forms and diagrams documenting the location of the cleared monitoring well site and the location of any identified underground utility lines, other buried objects, and overheard utilities.

Decontaminate drill rig and drilling equipment, including down-hole equipment and well construction materials, before borehole drilling.

Clear the work area of brush and minor obstructions and then mobilize the rig to the planned monitoring well location. The responsible field personnel (e.g., rig geologist or engineer) should then review with the driller the proposed borehole and well design and the details of the monitoring well installation plan, including any potential drilling or completion problems.

Calibrate field equipment according to the instrument manufacturer's specifications. Document the calibration results on the appropriate form(s). Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.

Workers will be provided with, and don, the appropriate personal protective equipment as specified by the project-specific work plans. Typically, the minimum personal protection will include a hard hat, safety glasses, gloves and steel-toed boots.

5.2.2 VERTICAL AQUIFER PROFILING

Commence drilling and advance the borehole while conducting health and safety air monitoring according to the work plans. Perform air monitoring as often as necessary to ensure the safety of workers. Record all measurements in the field log and/or other appropriate form(s) as specified in the project-specific work plans. Record other pertinent information (date, investigation area, well or boring number, and location) in the field log and/or on other appropriate form(s) as specified by the work plans. In addition, note and record observed field conditions, any unusual circumstances, and weather conditions.

During drilling, collect representative cutting and/or soil samples as required by the project-specific work plans. Compile a Boring Log or lithologic log from the cuttings and samples.

When direct push drilling, groundwater grab samples will be collected at intervals specified in the project-specific work plans. The borehole will be advanced using a screened sampler (Geoprobe Systems ® SP-22 or equivalent) with a sheath covering the screened portion during drilling to prevent water from entering the borehole. Once the borehole is advanced to the first sampling interval the sheath will be withdrawn, exposing the sampler screen and allowing groundwater to enter the device from adjacent formation soil.

When sonic drilling, groundwater grab samples will be collected at intervals specified in the project-specific work plans. A temporary screen will be used to collect groundwater from the required sample depth. The borehole will be advanced to the required depth (the upper most sample interval will be sampled first); the well screen with a stainless steel and rubber O-ring packer attached to the upper portion of the screen will be advanced into native soil to seal off the required sample interval. The packer will seal off the outer drill casing and the system will be purged to ensure drilling water used has been removed using a stainless-steel pump. A minimal of three times the volume of water introduced (for each respective interval) will be removed prior to sampling.

Groundwater samples will be collected using a peristaltic, electric submersible, or mechanical bladder pump depending on depth of borehole. Groundwater grab samples will be collected in accordance with SOP AFW-03 *Groundwater Sampling*.

5.2.3 BOREHOLE ABANDONMENT

After drilling, logging and/or sampling, boreholes should be backfilled by the method required by the applicable regulatory agency and described in the project-specific work plans. This typically consists of backfilling to the surface with bentonite chips, pellets or bentonite-cement grout. If bentonite chips or pellets are used, they should be added to the borehole in 2-foot lifts and hydrated with water from a potable water supply. This process should be repeated until the entire borehole is plugged using no less than 5 gallons of water per ten feet of borehole. If bentonite grout is used the following guidelines should be followed:

- Bentonite should be thoroughly mixed into the grout and within the percentage range specified in the work plans. If not otherwise specified in the work plans, the cement-bentonite grout mixture should be of the following proportions: 94 pounds of Portland cement, 5 pounds of powdered bentonite and a maximum of 8 gallons of water. The grout is usually tremied into the hole; however, for selected boreholes (e.g., shallow borings well above the water table) at certain sites, the grout may be allowed to free fall. In either case, care must be taken to ensure the grout does not bridge, forming gaps or voids in the grout column.
- The volume of the borehole prior to sealing should be calculated and compared to the grout volume used during abandonment to aid in verifying that bridging did not occur.
- When using a tremie pipe to place grout in the borehole, the bottom of the tremie should be submerged into the grout column and withdrawn slowly as the hole fills with grout. If allowing the grout to free fall (and not using a tremie), the grout should be poured slowly into the boring. The rise of the grout column should also be visually monitored or sounded with a weighted tape.
- If the method used to drill the boring utilized a drive casing, the casing should be slowly extracted during grouting such that the bottom of the casing does not come above the top of the grout column.

- During the grouting process, the drilling hands performing the task should be supervised to assure that potentially contaminating material (oil, grease, or fuels from gloves, pumps, hoses, et. al) does not enter the grout mix and that personnel are properly wearing personal protective equipment as specified in the project Health and Safety Plan.
- Following grouting, barriers should be placed over grouted boreholes as the grout is likely to settle in time, creating a physical hazard. Grouted boreholes will typically require at least a second visit to "top off" the hole.
- The surface hole condition should match the pre-drilling condition (asphalt, concrete, or smoothed flush with native surface), unless otherwise specified in the project-specific work plans.

5.2.4 DEMOBILIZATION

Following well completion and demobilization of the rig, the well site should be cleared of all debris and trash and restored to a neat and clean appearance per the project-specific work plans. All investigation-derived waste generated at the well site should be appropriately contained and managed per the project-specific work plans.

ELECTRONIC FIELD FORMS
SOP AFW-17 (PFAS)

1.0 PURPOSE

This Standard Operating Procedure (SOP) provides procedures and requirements for the use of mobile devices for the purposes of electronic data collection (EDC) during per- and polyfluorinated alkyl substances (PFAS) investigations. Mobile devices utilized for EDC during field sampling programs are primarily used for data capture and documentation purposes. As the use of field devices for EDC is expected to increase, additional specific procedures and requirements may be provided in project-specific work plans, as applicable.

Note: This document is not intended to serve as a "user's manual" for Mobile Devices/forms. Appropriate training shall be done by the Mobile Device Programming/Field Form Development Team or someone with adequate experience using the devices.

2.0 SCOPE

These procedures apply to all Amec Foster Wheeler personnel using Mobile Devices during PFAS investigations.

3.0 DEFINITIONS

Mobile Device – An electronic device such as a tablet or smartphone running either Android or iOS operating systems. Manufacturers include, but are not limited to Apple, Samsung, HTC and LG. For the purposes of this document, unless otherwise specified Mobile Devices refers to tablets.

Field Forms – Hard-copy or electronic field data records used to capture and document information and observations during field sampling events. For the purposes of this document, unless otherwise specified, Field Forms refers to the electronic format used to collect data using Mobile Devices.

doForms® – a third-party form-building software package used to create electronic versions of field forms for use on Mobile Devices.

Field Lead Review – This electronic field form review is conducted by the Field Lead within the first two days after receipt of field forms from Field Personnel. The Field Lead Review identifies deviations from the work plan and other site-specific details that would otherwise not be caught by the QA/QC Lead

QA/QC Review – This electronic field form review is conducted by the QA/QC Lead. The QA/QC Review checks format, reasonableness of data, and overall completeness of field forms. The QA/QC Review is completed within one week of receipt of field forms from Field Lead.

4.0 PROCEDURES

This section provides both the responsibilities of Amec Foster Wheeler personnel and SOPs as they relate to using electronic field forms on Mobile Devices on PFAS projects. Each PFAS project team member plays a role with respect to Mobile Device use; in order to maximize the benefit gained from the use of mobile devices for EDC, it is important that the following procedures are followed as closely as possible.

Handling and care procedures for Mobile Devices, creation of new electronic field forms, revision to existing electronic forms, and transmittal and archiving of captured data prior to, during and subsequent to field sampling events are also detailed in the sections below.

4.1 RESPONSIBILITIES

Mobile Device Programming/Field Form Development Team

The responsibilities of this Team are as follows:

- Ensuring that electronic field forms/applications required for each PFAS project are loaded on designated Mobile Devices prior to each field event;
- Ensuring newly developed and existing electronic field forms/applications developed for field sampling, documentation and observations meet current PFAS program quality assurance/quality control (QA/QC) guidelines;
- Ensuring data captured using developed electronic field forms meet current PFAS program QA/QC guidelines;
- Downloading collected original submitted (unaltered) data routinely in both .csv and excel formats, and coordinating with Data Manager where to store raw data files for archival purposes;
- Notifying Field Leads when payment/renewal of licensing fees associated with electronic forms used on the Mobile Devices is required;

- Testing (alpha/beta) all newly developed field forms to the maximum extent practical prior to distributing for field use, reducing the likelihood that field team members will have to troubleshoot a faulty field form;
- Notifying field sampling teams in advance when new forms/form revisions are available for use; and,
- Providing technical support to field team members during field events should assistance be needed over the phone or via email (e.g. recovering a lost document in the event of a Mobile Device crash).

Field Personnel

Field Personnel are responsible for the following:

- Understanding the basic operation of Mobile Devices and how to navigate the various field forms/application;
- Adhering to security/care requirements associated with the use of Mobile Devices;
- Alerting the Field Lead and, if needed, the Mobile Device Programming/Field Form Development Team of issues/problems with Mobile Devices as soon as a they occur; and,
- Ensuring field forms are completely filled out and signed prior to daily submittal to Field Lead and QA/QC Lead.

Field Lead

The Field Lead is responsible for the following:

- Ensuring the required number of Mobile Devices are prepared for the upcoming field event(s);
- Ensuring all Field Personnel understand and follow security/care requirements associated with the use of mobile devices;
- Coordinating with the Mobile Device Programming/Field Form Development Team for troubleshooting purposes in the event it is needed in the field; and,
- Ensuring that field forms are completely filled out and signed by Field Personnel prior to daily submittal to Field Lead and QA/QC Lead.

Field Lead

The Field Lead is responsible for the following:

- Acquiring the required number of mobile devices prior to field events;
- Ensuring that the Mobile Device Programming/Field Form Development Team has loaded the required forms/applications onto each device required for the field event and the previous project's data and files have been cleared from the Mobile Device;
- Ensuring that Field Personnel have been adequately trained to use the mobile devices and field forms/applications;
- Potentially delegating any of these responsibilities to the Field Lead;
- Receiving field forms on a daily basis from Field Personnel to track progress and perform the Field Lead Review for content; and,
- Submitting field forms to the QA/QC Lead following the Field Lead Review (within two working days).

QA/QC Lead

The QA/QC Lead is responsible for the following:

- Receiving electronic field forms via email from Field Lead and performing a formal QA/QC on each form;
- Filing a copy of all original submitted (unaltered) forms;
- Providing immediate feedback to Field Personnel and Project Manager should field forms require attention to clarify an entry or correct an error;
- Communicating with the Mobile Device Programming/Field Form Development Team should field forms require attention;
- Documenting all significant changes made to field form entries by emailing proposed changes to Field Lead and receiving authorization to make proposed change; and,
- Inserting signature and date on field forms once the content and format meet the expectations of the project.

Data Manager

The Data Manager is responsible for the following:

- Assisting the Mobile Device Programming/Field Form Development Team Lead with developing the field forms;

4.2 FIELD PROCEDURES/CONSIDERATIONS

The following are procedures for Mobile Devices usage at different stages of the project. Timeframes for each of the submittals are summarized in **Table 1** and included in the sections below.

4.2.1 FIELD PREPARATION

Any Mobile Device training needed for Field Personnel shall be conducted in the office prior to field mobilization. The Field Lead should consider all potential forms/applications that are anticipated to be used during an upcoming field event. The Field Lead confirms with the Mobile Device Programming/Field Form Development Team that the anticipated forms/applications are available for use, and are loaded on the mobile devices prior to field mobilization. Once the Field Lead/Field Lead has all Mobile Devices in hand for the field effort, the devices shall be fully charged. Hard copies of field forms from the QPP shall be taken to the field as backup to the digital field forms.

4.2.2 SECURITY/CARE

Mobile Device Security Guidelines:

- Never share security passcode with someone other than Amec Foster Wheeler employees;
- Do not leave devices unattended. Devices must be secured at all times when not in use; and,
- If the device cannot be secured, keep it with you.

Mobile Device Care Guidelines

- Keep protective cases on the devices at all times while in the field;
- When traveling, keep devices in carry-on baggage, if possible. If device must be kept in checked baggage, ensure that adequate cushion (clothing, towels, etc.) is surrounding devices in bags;
- Operate the Mobile Devices within the operating range temperatures recommended by the manufacturer (32°F to 95°F). Do not store the Mobile Devices in temperatures less than -4°F or greater than 113°F.
- Report damage and discontinue use if protective case is compromised; and,

- Avoid long-term direct exposure to sunlight for the screen.

4.2.3 FIELD USE STEPS

1. **Prepare** - The Field Team Lead (or designee) will discuss with the Field Personnel the use of Mobile Devices for EDC, photographic documentation, or other relevant applications at the pre-job meeting on the first day of each field event.
2. **Complete** - Field Personnel completes the electronic field form entries and verifies no blank entries remain. Each question/field/cell is to be completed with relevant information, or a predetermined acceptable value before submitting forms. Field Personnel may use terms such as “NA”, “TBD”, etc. if a particular field is not applicable or cannot be determined. Field Personnel are to complete the Field Form entries during the field event and must be fully completed prior to submittal.
    a. Save as Incomplete - If additional time is needed to completely fill out forms in the evening before submitting.
    b. Save as Complete - This allows completed forms to remain on the device for later upload if internet access is unavailable.
3. **Submit** – Field Personnel submits the field forms daily to the Field Lead for review.
4. **Delete** - Electronic Field Forms shall not be deleted from electronic devices before confirming with the Field Lead that completed forms were received. Once Field Lead confirms receipt of Field Forms, those forms can be deleted from the Mobile Device. In the event a Field Form is inadvertently deleted or the Mobile Device crashes, the Mobile Device Programming/Field Form Development Team may be able to recover the lost form, and should be contacted ASAP.

4.2.4 QA/QC PROCESS

Field Lead Review

Field Forms shall be submitted daily to the Field Lead. The Field Lead Review identifies content errors that the QA/QC Lead may not catch, as the Field Lead is expected to have a better working knowledge of the site investigation. The Field Lead shall perform the review, make corrections and forward field forms to the QA/QC Lead within two working days of receipt. The QA/QC Lead has the primary role of reviewing each field form generated in the field.

QA/QC Review

The QA/QC Lead will conduct a formalized review (QA/QC Review) and sign-off on each form if no edits/changes are necessary. If minor changes are required on field forms, the QA/QC Lead will confirm those changes are needed with the Field Lead/Field Lead and finalize forms him/herself. Field forms requiring more significant changes may be sent back to the project team for edits and then resubmitted back to the QA/QC Lead. Field forms will be sent back to the Field Lead once finalized and within one week of receipt, to be incorporated into site investigation reports.

4.2.5 POST-JOB

Mobile Devices

Mobile Devices shall be returned to the owning office immediately after downloading photos and other items/files removed. This shall be done in the first couple of days back in the office. Shipping shall be done via FedEx.

Electronic Field Forms

Finalized field forms should be submitted to the Data Manager by the Field Lead within one week following the field effort. This provides adequate time for the most recent field forms to go through both Field Lead Review and QA/QC Review. Final QA/QC reviewed field forms will be compiled and presented as an appendix in the Project-specific Site Inspection Report.

4.2.6 MOBILE DEVICE/FIELD FORM UPDATES AND MODIFICATIONS

Field forms may be modified by the Mobile Device Programming/Field Form Development Team remotely. If a Field Form modification is required, the Field Personnel and/or Field Lead will be notified by the Mobile Device Programming/Field Form Development Team. Once field form revision/modification is compete, each mobile device must be updated manually in the field or in the office using the “Update” button/icon within the doForms® application. If a problem is noted with a field form while Field Personnel are using it during a sampling event, the Mobile Device Programming/Field Form Development Team can make quick corrections or changes and push it out to Field Personnel, pending internet access needed to update the device(s). Field Personnel will use the “Update” feature to receive the changes.

If changes are required or requested, the user submits a Mobile Form Support Request (located on each Mobile Device) to the Mobile Device Programming/Field Form Development Team. The formalized request allows new ideas to be tracked. This support request form is one of the options in doForms®. Once these changes are made to field forms by the Mobile Device Programming/Field Form Development Team, each device will need to go through the "Update" process.

Table 1. Summary of Timeframes for Submittals

Submittal Schedule	
Task	**Timeframe**
Field Forms from Field Personnel to Field Lead	Daily
Field Forms from Field Lead to QA/QC Lead	Two working days following receipt
QA/QC Lead completes review, finalizes Field Forms and returns to Field Lead	One week following receipt of Field Forms from Field Lead
Return Mobile Devices to owning office	Two days following field effort completion

TEMPORARY MONITORING WELL INSTALLATION – DIRECT PUSH EXTRACTABLE SCREEN
SOP AFW-19 (PFAS)

1.0 PURPOSE

This Standard Operating Procedure (SOP) provides procedures and requirements for the collection of groundwater grab samples from temporary monitoring wells via direct push boreholes with an extractable screen. Proper collection procedures are necessary to assure the quality and integrity of all groundwater samples. Additional specific procedures and requirements will be provided in project-specific work plan, as applicable.

2.0 SCOPE

These procedures apply to all Amec Foster Wheeler personnel and subcontractors who perform temporary monitoring well installation activities during per- and polyfluorinated alkyl substances (PFAS) investigations.

3.0 REFERENCES

U.S. Environmental Protection Agency (EPA), 1986, *Resource Conservation and Recovery Act (RCRA) Ground Water Monitoring Technical Enforcement Guidance Document*, OSWER-9950.1, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, U.S. Government Printing Office, Washington D.C.

EPA, 1987, *A Compendium of Superfund Field Operations Methods*, EPA-500/P-87/001, U.S. Government Printing Office, Washington D.C.

EPA, 1991, *Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells,* EPA/600/4-89/034, U.S. Environmental Protection Agency, Office of Research and Development, March.

4.0 DEFINITIONS

Annular Space – The space between:

- Concentric drill pipes;
- An inner drill pipe and outer drive casing;
- Drill pipe or drive casing and the borehole wall; or,
- Well screen or casing and the borehole wall.

Borehole – Any hole drilled into the subsurface for the purpose of identifying lithology, collecting soil or rock samples, and/or installing groundwater wells.

Cuttings – Pieces of soil, sediment, or rock cut by a bit in the process of drilling borings.

Direct Push Drilling – For the purposes of this monitoring well installation SOP, the term "direct push drilling" refers to using DPT to push or drive hollow rods into the ground for the purpose of installing monitoring wells with a maximum inside diameter of 1 inch when using 2.625 inch inside diameter DPT rods. Direct push drilling uses an expendable drive point that is fitted to the lower end of a string of drive rods that are advanced into the ground using percussive hammering. No cuttings are brought to the surface during drilling, although soil cores may be retrieved using various sampling tools.

Electric Submersible Pump – An electric submersible pump is an enclosed cylindrical tube containing a motor with rotary attachments. Well water enters the cylinder through a one-way check valve. Electrical power to the motor causes rotors or impellers to turn and displace the groundwater.

Peristaltic Pump – A peristaltic pump is a self-priming, low volume pump consisting of a rotor and ball bearing rollers. Tubing placed around the rotors is squeezed by the rotors as they revolve. The squeezing produces a wavelike contractual movement that causes water to be drawn through the tubing. During purging and sampling, only the tubing is placed down the well. All of the mechanical systems of the pump remain above ground during purging and sampling activities. The peristaltic pump is typically limited to sampling at depths of less than 25 feet. Operating two or more peristaltic pumps in parallel can increase operational depths slightly.

Tremie – A tubular device or pipe used to place grout, bentonite, or filter pack in the annular space of a borehole.

Well Screen – A commercially available, factory-perforated, wire wound, continuous wrap, or slotted casing segment used in a well to maximize the entry of groundwater from the producing zone and to minimize the entrance of sand.

5.0 PROCEDURES

This section contains both the main project team responsibilities and the procedures for temporary monitoring well installation activities. The procedures described herein are applicable as requirements for temporary monitoring well installation investigations using DPT drilling techniques. The project-specific work plan will contain the following information related to temporary monitoring well installation:

- Objectives of the temporary monitoring well;
- Specific location of the temporary monitoring well to be advanced;
- Zone or depth temporary monitoring well is to be installed;
- Drilling method to be used;
- Well construction materials to be used;
- Additional procedures or requirements beyond the scope of this SOP.

5.1 RESPONSIBILITIES

Project Manager

The Project Manager is responsible for ensuring that all temporary monitoring well activities are conducted and documented in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by quality assurance/quality control (QA/QC) monitoring activities.

Field Lead

The Field Lead is responsible for periodic observation of temporary monitoring well activities to assure implementation of this SOP. The Field Lead is also responsible for the review and approval of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to temporary monitoring well installation requirements, issuing non-conformances, etc.) identified during the performance of these activities.

Field Personnel

Field personnel assigned to temporary monitoring well activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. Field staff are responsible for reporting deviations from the procedures to the Project Manager or the Field Lead.

5.2 FIELD PROCEDURES/CONSIDERATIONS

The following are procedures/considerations to be made during field activities at potential PFAS release areas.

5.2.1 FIELD PREPARATION

Before mobilization of a rig to the well site, ensure that the temporary monitoring well location has been appropriately cleared of all underground utilities, buried objects, and overhead utilities, and that drill permits (e.g., FAA permits) have been issued per the project-specific work plan. Review all forms and diagrams documenting the location of the cleared monitoring well site and the location of any identified underground utility lines, other buried objects, and overheard utilities.

Decontaminate drill rig and drilling equipment, including down-hole equipment and well construction materials, before borehole drilling.

Clear the work area of brush and minor obstructions and then mobilize the rig to the planned monitoring well location. The responsible field personnel (e.g., rig geologist or engineer) should then review with the driller the proposed borehole and well design and the details of the monitoring well installation plan, including any potential drilling or completion problems.

Calibrate field equipment according to the instrument manufacturer's specifications. Document the calibration results on the appropriate form(s). Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.

Workers will be provided with, and don, the appropriate personal protective equipment as specified by the project-specific work plan. Typically, the minimum personal protection will include a hard hat, safety glasses, gloves and steel-toed boots.

5.2.2 TEMPORARY MONITORING WELL INSTALLATION AND SAMPLING

Commence drilling and advance the borehole while conducting health and safety air monitoring according to the project-specific work plan (if applicable). Perform air monitoring as often as necessary to ensure the safety of workers. Record all measurements in the field log and/or other appropriate form(s) as specified in the project-specific work plan. Record other pertinent information (date, investigation area, well or boring number, and location) in the field log and/or on other appropriate form(s) as specified by the project-specific work plan. In addition, note and record observed field conditions, any unusual circumstances, and weather conditions.

Complete a Soil Boring Log or lithologic log for the entire boring if soil cores are obtained for visual observations. During drilling, collect representative soil samples as required by the project-specific work plan (if applicable).

Groundwater grab samples will be collected from temporary monitoring wells as specified in the project-specific work plan. The borehole will be advanced using a screened sampler (Geoprobe Systems ® SP-22 or equivalent) with a sheath covering the screened portion during drilling to prevent water from entering the borehole. Once the borehole is advanced to the sampling interval the sheath will be withdrawn, exposing the sampler screen and allowing groundwater to enter the device from adjacent formation soil.

Temporary monitoring wells will be developed by purging three times the water used during drilling and an additional three times the temporary well volume prior to sample collection. Groundwater samples will be collected using a peristaltic or electric submersible. Groundwater grab samples will be collected in accordance with SOP AFW-03 *Groundwater Sampling*.

5.2.3 BOREHOLE ABANDONMENT

After drilling, logging and/or sampling, boreholes should be backfilled by the method required by the applicable regulatory agency and described in the project-specific work plan. This typically consists of backfilling to the surface with bentonite chips, pellets or bentonite-cement grout. If bentonite chips or pellets are used, they should be added to the borehole in 2-foot lifts and hydrated with water from a potable water supply. This process should be repeated until the entire borehole is plugged using no less than 5 gallons of water per ten feet of borehole. If bentonite grout is used the following guidelines should be followed:

- Bentonite should be thoroughly mixed into the grout and within the percentage range specified in the project-specific work plan. If not otherwise specified in the project-specific work plan, the cement-bentonite grout mixture should be of the following proportions: 94 pounds of Portland cement, 5 pounds of powdered bentonite and a maximum of 8 gallons of water. The grout is usually tremied into the hole; however, for selected boreholes (e.g., shallow borings well above the water table) at certain sites, the grout may be allowed to free fall. In either case, care must be taken to ensure the grout does not bridge, forming gaps or voids in the grout column.
- The volume of the borehole prior to sealing should be calculated and compared to the grout volume used during abandonment to aid in verifying that bridging did not occur.
- When using a tremie pipe to place grout in the borehole, the bottom of the tremie should be submerged into the grout column and withdrawn slowly as the hole fills with grout. If allowing the grout to free fall (and not using a tremie), the grout should be poured slowly into the boring. The rise of the grout column should also be visually monitored or sounded with a weighted tape.
- If the method used to drill the boring utilized a drive casing, the casing should be slowly extracted during grouting such that the bottom of the casing does not come above the top of the grout column.
- During the grouting process, the drilling hands performing the task should be supervised to assure that potentially contaminating material (oil, grease, or fuels from gloves, pumps, hoses,

et. al) does not enter the grout mix and that personnel are properly wearing personal protective equipment as specified in the project Health and Safety Plan.

- Following grouting, barriers should be placed over grouted boreholes as the grout is likely to settle in time, creating a physical hazard. Grouted boreholes will typically require at least a second visit to "top off" the hole.
- The surface hole condition should match the pre-drilling condition (asphalt, concrete, or smoothed flush with native surface), unless otherwise specified in the project-specific work plan.

5.2.4 DEMOBILIZATION

Following well completion and demobilization of the rig, the well site should be cleared of all debris and trash and restored to a neat and clean appearance per the project specific work plan. All investigation-derived waste generated at the well site should be appropriately contained and managed per the project-specific work plan.

GROUNDWATER PFAS SAMPLING

Guidance

Introduction

This sampling guidance discusses the processes and acceptable items and materials that should be used when sampling groundwater monitoring wells for per- and polyfluoroalkyl substances (PFAS). The guidance primarily addresses the collection of representative water samples from the subsurface saturated zone. In addition, this guidance will be used to support the sampling objectives and procedures based on the Quality Assurance Project Plan (QAPP) developed prior to sampling activities. This guidance assumes staff has basic familiarity with and/or understanding of basic groundwater sampling procedures.

NOTE: Review the **General PFAS Sampling Guidance** document prior to reviewing this guidance document.

This sampling guidance may be varied or changed as required, depending on site conditions, equipment limitations, or limitations imposed by the procedure. The ultimate procedures used should be documented in the final report.

The MDEQ intends to update the information contained within this Groundwater PFAS Sampling Guidance document as new information becomes available. The user of this Groundwater PFAS Sampling Guidance is encouraged to visit the Michigan PFAS Action Response Team (MPART) webpage (www.michigan.gov/PFASresponse) to access the most current version of this document.

PFAS has been detected in groundwater in Michigan at concentrations over 810,000 parts per trillion (ppt). Many commercial laboratories have extremely low PFAS detection limits of about 1 ppt. Therefore, there is a high potential of false positives if proper procedures are not followed during sample collection.

This Groundwater PFAS Sampling Guidance discusses the collection of groundwater samples and methods to prevent cross-contamination that can occur from:

- Field clothing and personal protective equipment (PPE)
- Personal care products (PCPs)
- Food Ppckaging
- Sampling equipment
- Equipment decontamination
- Filtering of surface water
- Sample collection and handling
- Sample shipment

Contents

1. Potential Sources for PFAS Cross-Contamination

Potential sources for PFAS cross-contamination include items and materials used within the sampling environment, such as sampling equipment, field clothing, personal protective equipment (PPE), sun and biological protection products, personal hygiene, personal care products (PCPs), and food packaging. A detailed discussion about potential sources for PFAS cross-contamination is included in the **General PFAS Sampling Guidance**, which should be reviewed before reading this document. However, a high-level summary is presented in this guidance.

All of the items and materials discussed in each of the MDEQ's PFAS Sampling Guidance Documents are divided into three major groups:

- Prohibited (●) identifies items and materials that should not be used when sampling. It is well documented that they contain PFAS or that PFAS are used in their manufacture.

- Allowable (■) identifies items and materials that have been proven not to be sources of PFAS cross contamination and are considered acceptable for sampling.

- Needs Screening (▲) identifies items and materials that have the potential for PFAS cross-contamination due to a lack of scientific data or statements from manufacturers to prove otherwise. These items and materials are further sub-divided into two categories:

    - **Category 1:** Items and materials that <u>will come in direct contact</u> with the sample. These should not be used when sampling unless they are known to be PFAS-free, by collecting an equipment blank sample prior to use.

    - **Category 2:** Items and materials that <u>will not come in direct contact</u> with the sample. These should be avoided, if possible, unless they are known to be PFAS-free by collecting an equipment blank sample prior to use.

Please note that at this time no published research is available that documents the use of various materials and effect on sample results. Therefore, a conservative approach is recommended, and the guidance is based on the collection of multiple environmental samples at various PFAS sites. Sampling staff should take practical and appropriate precautions to avoid items that are likely to contain PFAS at the sampling site as well as avoid specific items during the sampling event.

A general overview of PFAS contamination sources during sampling can be found in **Section 4.2** of the **General PFAS Sampling Guidance**. Any items or materials utilized that are not identified in this guidance or not discussed in **Section 4.2** should be evaluated as described in **Section 4.2.1 of the General PFAS Sampling Guidance**.

Sampling staff should take practical and appropriate precautions to avoid items that are likely to contain PFAS at the sampling site as well as avoid specific items during the sampling event (see below).

1.1 Field Clothing and PPE

Materials, field clothing, and equipment screening should be performed during the QAPP development or the planning phase of sampling programs. The screening should be performed on all items and materials that are expected to come into contact with the samples and are defined as **Category 1.** Due to the extensive use of PFAS in many industries and products, PPE may contain PFAS. During a PFAS investigation, PPE containing PFAS should be avoided to prevent cross-contamination.

As with any field mobilization, it is the responsibility of all personnel to be aware of the physical, chemical, and biological hazards associated with a particular site. Personal safety is paramount. The safety of staff should not be compromised by fear of PFAS-containing items or materials without any scientific basis. Any deviation from this guidance, including those necessary to ensure the health and safety of sampling personnel, should be recorded in field notes and discussed in the final report.

Any additional field clothing and/or PPE items that might be required for groundwater sampling and not discussed in this sampling guidance should be evaluated as described in **Sections 4.2.1** and **4.2.2** of the **General PFAS Sampling Guidance**.

NOTE: Special attention should be given to clothing that has been advertised as having waterproof, water-repellant, or dirt and/or stain characteristics. They are likely to have PFAS in their manufacturing.

Field sampling during wet weather (e.g., rainfall and snow) should be conducted while wearing the proper field clothing.

- ● Dust and fibers must not be allowed to collect on field clothing or PPE.
- ● Do not use clothing that has been advertised as waterproof, dirt and/or stain repellant that has not been verified to be made of PFAS-free materials.
- ■ Use powderless nitrile gloves
- ■ Only use clothing/PPE that has been verified to be made of PFAS-free materials.
- ▲ Latex gloves should be screened before use.

Powderless nitrile gloves should be changed frequently any time there is an opportunity for cross-contamination. See **Section 5** of this guidance for additional glove instructions.

1.2 Personal Care Products (PCPs)

A number of sampling guidance documents recommend that personal hygiene and PCPs (e.g., cosmetics, shampoo, sunscreens, dental floss, etc.) not be used prior to and on the day(s) of sampling because the presence of PFAS in these products has been documented (OECD, 2002, Fujii, 2013, Borg and Ivarsson, 2017). However, if the MDEQ's sampling SOPs are followed, these items should not come into contact with the sampling equipment or the sample being collected. As of the date of this sampling guidance, cross-contamination of samples due to the use of PCPs has not been documented during the collection of thousands of samples. However, field personnel should be aware of the potential of cross-contamination of the sampling equipment or actual samples would come into contact with these products. The following precautions should be taken when dealing with personal hygiene or PCPs before sampling:

- ● Do not handle or apply PCPs in the sampling area.
- ● Do not handle or apply PCPs while wearing PPE that will be present during sampling.
- ■ Move to the staging area and remove PPE if applying personal care products becomes necessary.
- ■ Wash hands thoroughly after the handling or application of PCPs and, when finished, put on a fresh pair of powderless nitrile gloves.

●- Prohibited ■- Allowable ▲- Needs Screening

1.3 Food Packaging

PFAS has been used by the paper industry as a special protective coating against grease, oil, and water for paper and paperboards, including food packaging since the late 1950s (Trier et al., 2018). PFAS application for food packaging includes paper products that come into contact with food such as paper plates, food containers, bags, and wraps (OECD, 2002). Pre-wrapped food or snacks (such as candy bars, microwave popcorn, etc.) must not be in the sampling and staging areas during sampling due to PFAS contamination of the packaging. When staff requires a break to eat or drink, they should remove their gloves, coveralls, and any other PPE, if worn, in the staging area and move to the designated area for food and beverage consumption. When finished, staff should wash their hands and put on a fresh pair of powderless nitrile gloves at the staging area, before returning to the sampling area.

- ● Do not handle, consume, or otherwise interact with pre-wrapped food or snacks, carry-out food, fast food, or other food items while on-site during sampling.
- ■ Move to the staging area and remove PPE prior to leaving the sampling and staging areas if consuming food on site becomes necessary.

2. Groundwater Sampling Equipment

Do not use any equipment that contains any known fluoropolymers including, but not limited to:

NOTE: Manufacturers can change the chemical composition of any product. As a result, all materials that will come into direct contact with the sample media (defined as Category 1) should be tested to confirm they are "PFAS-free," i.e. will not contaminate samples at detectable levels. **There is no guarantee that materials in the "Allowable" category will always be PFAS- free.**

- ● Do not use polytetrafluoroethylene (PTFE), that includes the trademark Teflon® and Hostaflon®, which can be found in many items, including but not limited to ball check-valves on certain bailers, the lining of some hoses and tubing, some wiring, certain kinds of gears, lubricant, and some objects that require the sliding action of parts.
- ● Do not use Polyvinylidene fluoride (PVDF), that includes the trademark Kynar®, which can be found in many items, including but not limited to tubing, films/coatings on aluminum, galvanized or aluminized steel, wire insulators, and lithium-ion batteries.
- ● Do not use Polychlorotrifluoroethylene (PCTFE), that includes the trademark Neoflon®, which can be found in many items, including but not limited to valves, seals, gaskets, and food packaging.
- ● Do not use Ethylene-tetrafluoro-ethylene (ETFE), that includes the trademark Tefzel®, which can be found in many items, including but not limited to wire and cable insulation and covers, films for roofing and siding, liners in pipes, and some cable tie wraps.
- ● Do not use Fluorinated ethylene propylene (FEP), that includes the trademarks Teflon® FEP and Hostaflon® FEP, and may also include Neoflon®, which can be found in many items, including but not limited to wire and cable insulation and covers, pipe linings, and some labware.
- ● Do not use low density polyethylene (LDPE) for any items that will come into **direct contact** with the sample media. LDPE can be found in many items, including but not limited to containers and bottles, plastic bags, and tubing.
    - ▲ **However**, LDPE may be used if an equipment blank has confirmed it to be PFAS-free. LDPE does not contain PFAS in the raw material but may contain PFAS cross-contamination from the manufacturing process.
- ■ LDPE bags (e.g., Ziploc®) that **do not** come into direct contact with the sample media and do not introduce cross-contamination with samples may be used.

●- Prohibited ■- Allowable ▲- Needs Screening

- ■ Use items and materials that are either made of high-density polyethylene (HDPE), polypropylene, silicone, polyvinyl chloride(PVC), or acetate.
- ■ Keep tubing in the original cardboard or bag in which it was shipped.
- ■ Store tubing in a clean location free of dust and fibers.
- ■ Use nylon line, cotton string, or other PFAS-free material when raising and lowering bailers.
- ■ When using bladder pumps, use pumps made of stainless steel with polyethylene bladders.
- ■ Glass bottles or containers may be used if they are known to be PFAS-free, however, PFAS have been found to adsorb to glass, especially when the sample is in contact with the glass for a long period of time (e.g. being stored in a glass container). If the sample comes into direct contact with the glass for a short period of time (e.g. using a glass container to collect the sample, then transferring the sample to a non-glass sample bottle), the adsorption is minimal.
- ▲ In many submersible pumps, the O-Rings do not come into contact with the groundwater sample, and in this case, the O-Rings should be treated as internal pump components. The O-Rings present a low possibility of cross-contamination. Equipment blanks should be collected simulating actual field sampling procedures and not for individual pump components.

Field rental equipment companies offer “PFAS-free” bladder pumps; however, caution is advised, and an equipment rinsate blank is required. Rental equipment should be treated as being contaminated and only used after proper decontamination has been done.

Staff should follow the **MDEQ PFAS Sampling Quick Reference Field Guide** at the end of this document for approved and prohibited items for documenting and sampling groundwater for PFAS.

3. Equipment Decontamination

It is customary with groundwater sampling that the equipment is decontaminated before the sampling event. If the previous user of the equipment is not known, and it is unclear how the equipment was handled—especially rental equipment—decontaminate the equipment before sampling. Any **Category 1** non-dedicated sampling equipment (equipment used for more than one location) must be verified as PFAS free before use.

For non-dedicated **Category 1** sampling equipment, the following materials and procedures must be used for decontamination:

- ● Do not use Decon 90®.
- ■ Laboratory supplied PFAS-free deionized water is preferred for decontamination.
- ■ Alconox®, Liquinox®, and Citranox® can be used for equipment decontamination.
- ■ Sampling equipment can be scrubbed using a polyethylene or Polyvinyl chloride (PVC) brush to remove particulates.
- ■ Decontamination procedures should include triple rinsing with PFAS-free water.
- ■ Commercially available deionized water in an HDPE container may be used for decontamination if the water is verified to be PFAS-free.
- ▲ Municipal drinking water may be used for decontamination purposes if it is known to be PFAS-free.

NOTE: All samples must be collected using PFAS-free High-Density Polyethylene (HDPE), glass, or polypropylene bottles provided by the laboratory, with Teflon®-free caps.

● - Prohibited ■ - Allowable ▲ - Needs Screening

4. Groundwater Sample Collection Methods

4.1 Method summary

Before a well is sampled, stagnant water in the well casing must be removed or purged in order to obtain a representative groundwater sample. The instruments most commonly used for purging by the MDEQ are bailers, submersible pumps, and inertia pumps. MDEQ staff may oversee purging and sampling conducted by noncontact gas bladder pumps, suction-lift pumps, and other pumps, but the MDEQ does not typically use these pumps. The MDEQ typically samples groundwater using bailers, or by low-flow methods utilizing a peristaltic pump.

Prior to purging, the water level in the well and the total depth of the well should be measured, using the procedures described in the QAPP to determine the volume of water in the well. When using a bailer, a minimum of three well volumes should be purged, unless the well runs dry. When using low-flow methods, purging should continue until the selected indicator parameters have stabilized (see **Section 4.7 Low-Flow Methods**).

Once purging is completed or the groundwater in the well recovers, the groundwater pH, temperature, specific conductance, and turbidity should be measured using the procedures described in the QAPP. After the correct sample containers have been prepared, sampling may proceed. Care should be taken when choosing the sampling device, since some devices may affect the integrity of the sample.

NOTE: Purging is mandatory in all cases where there is the potential for the data to be used for enforcement purposes.

Purging and sampling should occur in a progression from the least contaminated well to the most contaminated well, if this information is known; disposable equipment should be used for each well or equipment must be decontaminated prior to use and between each well.

4.2 Calculations

If it is necessary to calculate the volume of water in the well, use the following equation:

Well volume (gallons) = $\pi r^2 h (cf)$
where:

r = radius of monitoring well (feet)
h = height of the water column (feet) (This may be determined by subtracting the depth to the water from the total depth of the well as measured from the same reference point.)
cf = conversion factor (gallons/linear foot) = 7.48 gal/ft^3

If the diameter of the monitoring well is known, standard conversion factors can be applied to simplify the equation above. Monitoring well diameters are typically two, three, four, or six inches.

Well volumes, in gallons per linear foot, for these common monitoring well diameters are as follows:

Well diameter	2-inches	3-inches	4-inches	6-inches
Volume (gal/ft.)	0.1632	0.3672	0.6528	1.4688

The volume of water in the well can then be calculated by multiplying the appropriate value of gallons per linear foot by the height of the water column in feet (h).

This well volume is typically tripled to determine the volume to be purged.

4.3 Preparation Procedures

The success of any sampling effort depends on thorough preparation. The following steps should be followed in preparing for groundwater well sampling:

1. Determine the extent of the sampling effort, the sampling methods to be used, and the types and quantities of equipment and supplies needed.
2. Develop and implement a site-specific sampling plan.
3. Prepare the schedule and coordinate with the laboratory, staff, contractors, and the regulated facility, as appropriate.
4. Obtain necessary sampling and monitoring equipment and supplies.
5. Decontaminate or preclean equipment, and ensure that it is in working order.
6. Perform a general site survey prior to site entry in accordance with the site-specific Health and Safety Plan (HASP), if appropriate.
7. Identify all monitoring wells to be sampled.
8. Start at the least contaminated well, if known.
9. Powderless nitrile gloves should be changed between each discrete task in the well purging and sampling process.
10. Remove the locking well cap; note the location, time of day, date and general weather conditions in the field logbook or Monitor Well and Groundwater Data Sheets.
11. Remove the well casing cap.
12. Lower the water level measuring device into the well until the water surface is encountered. Refer to the QAPP for specific water level measurement procedures.
13. Measure the distance from the water surface to a known reference measuring point on the well casing or protective barrier post and record the distance in the field logbook or Monitor Well and Groundwater Data Sheets. Alternatively, if no known reference point is available, note that the water level measurement is from the top of the steel casing, top of the riser pipe from ground surface, or some specific position on the well head.
14. Measure total depth of the well and record the depth in the field logbook or Monitor Well and Groundwater Data Sheets.
15. Calculate the volume of water in the well and the volume to be purged using the equations in **Section 4.2 Calculations**.

4.4 Purging Procedures

Wells should be purged to ensure that a representative sample is obtained. Generally, at a minimum, purging of three well volumes is effective. Bailers, submersible pumps, and inertia pumps are the purging devices most commonly used.

NOTE: Reference and utilize the *MDEQ Purge Water Disposal Policy* for detailed purge water disposal procedures.

- ■ Purge water should be containerized, characterized, and properly disposed of. Sample results for the well can be used to assist in waste characterization.

  If no other option is available and only a small volume of purge water has been generated, purge water may be disposed of on the ground near the well.

- ● Do not dispose of purge water in a way that the disposal will exacerbate existing contamination.

4.4.1 Bailers

Bailers are the simplest purging device used and have many advantages. They generally consist of a rigid length of tube, with a ball check-valve at the bottom. A line is used to lower the bailer into the well and retrieve a volume of water.

Manual purging with bailers is best suited to shallow and/or narrow-diameter wells. For deep, larger-diameter wells that require purging large volumes of water, other devices may be more appropriate.

Procedures for purging with a bailer are as follows:

1. Determine the volume of water to be purged as described in **Section 4.2 Calculations.**
2. Attach the line to the bailer and slowly lower the bailer until it is completely submerged. Be careful not to drop the bailer to the water, as it causes turbulence and the possible loss of volatile organic contaminants. On the bailer's first trip down the well, it is good sampling practice to gently lower it to the bottom of the well casing so that the sampler has an adequate length of line in hand to bail the well dry, should it be needed.
3. Pull the bailer out in a manner that the line never touches the ground.
4. Empty the bailer into a graduated pail.
5. Collect and dispose of purge water in accordance with the *MDEQ Purge Water Disposal Policy* and any additional requirements in the site-specific sampling plan. If purge water is disposed of on the ground, this should be done away from the base of the well.

4.4.2 Submersible Pumps

The use of submersible pumps for purging is permissible, provided they are constructed of suitably noncontaminating materials. The chief drawback, however, is possible cross-contamination between wells. Although some units can be disassembled easily to allow surfaces contacted by contaminants to be cleaned, field decontamination may be difficult and require solvents that can affect sample analysis.

> **NOTE:** Submersible pumps may be the only practical sampling device for extremely deep wells (greater than 300 feet of water). Under those conditions, it is recommended that dedicated pump systems be installed to eliminate the potential for cross-contamination of well samples.

The use of submersible pumps in multiple well-sampling programs should be carefully compared to other sampling mechanisms (e.g., bailers, peristaltic pumps). In many cases, a sample can be collected by a bailer after purging with a submersible pump.

Submersible pumps generally use one of two types of power supplies: electric or compressed gas. Electrically powered pumps can run off a 12-volt DC rechargeable battery, or a 110 or 220-volt AC power supply. Pumps powered by compressed air normally use a small electric or gas-powered air compressor. They may also utilize compressed gas (i.e., nitrogen) from bottles. Differently sized pumps are available for different depth or diameter monitoring wells.

Procedures for purging with a submersible pump are as follows:

1. Determine the volume of water to be purged as described in **Section 4.2 Calculations**.
2. Assemble the pump, hoses, and safety cable, then lower the pump into the well. Make sure the pump is deep enough so that all the water is not evacuated (running the pump dry may cause damage).
3. Determine the volume of water purged by discharging purged water into a graduated pail or by attaching a flow meter to the outlet hose.
4. Use a ground fault circuit interrupter or ground the generator to avoid possible electric shock.
5. Connect the power supply and purge the well until the specified volume of water has been evacuated. If the pumping rate exceeds the well recharge rate, lower the pumping rate, lower the pump further into the well, and continue pumping.
6. Collect and dispose purge waters in accordance with the *MDEQ Purge Water Disposal Policy* and any additional requirements in the site-specific sampling plan. If purge water is disposed on the ground, this should be done away from the base of the well.

4.4.3 Inertia Pumps

Inertia pumps, such as the WaTerra® pump and piston pump, are manually operated. They are the most appropriate to use when wells are too deep to bail by hand, or too shallow, narrow, or inaccessible for a submersible pump. Inertia pumps are made of plastic or stainless steel and may be either decontaminated or discarded.

Procedures for purging with an inertia pump are as follows:

1. Determine the volume of water to be purged as described in **Section 4.2 Calculations.**
2. Assemble the pump and lower it to the appropriate depth in the well.
3. Begin pumping manually, discharging the water into a graduated pail. Purge until the specified volume of water has been evacuated.
4. Collect and dispose purge waters in accordance with the *MDEQ Purge Water Disposal Policy* and any additional requirements in the site-specific sampling plan. If purge water is disposed on the ground, this should be done away from the base of the well.

4.5 Representative Sample Collection

The primary goal in performing groundwater sampling is to obtain a representative sample of the aquifer or water-bearing zone. Groundwater sampling results can be compromised in two primary ways: collecting a non-representative sample or handling the sample incorrectly.

A monitoring well will have little or no vertical mixing of the water, and stratification will occur. The well water in the screened section will mix with the groundwater due to normal flow patterns, but the well water above the screened section will remain isolated, become stagnant, and may no longer be representative of the groundwater quality. Also, stagnant water may contain foreign material inadvertently or deliberately introduced from the surface, resulting in a non-representative sample. To safeguard against collecting non-representative stagnant water, the following guidelines and techniques should be adhered to during sampling:

1. As a general rule, all monitoring wells should be purged prior to sampling; see **Section 4.3 Purging Procedures.** To obtain a representative sample, a minimum of three volumes of water in the well casing should be purged. When using low-flow methods, purging should continue until the selected indicator parameters have stabilized. Indicator parameters typically used in low-flow purging include groundwater pH, specific conductivity, turbidity, temperature, dissolved oxygen and oxidation-reduction potential. The appropriate set of indicator parameters for the specific sampling event should be chosen by the project manager in advance of the sampling event. Alternatively, for low-yielding groundwater formations, the well can be pumped dry. For deeper wells, packers can be used to isolate a portion of the screened interval, minimizing the volume of groundwater that must be purged. In a high-yielding groundwater formation and where there is no stagnant water in the well above the screened section, purging is not as critical.
2. When purging with a pump, the pump should be set within the screened interval. When sampling a screened well, the sample should also be collected from the same depth within the screened interval at which the pump was set.
3. The well should be sampled as soon as possible after purging.
4. For wells that are pumped or bailed to dryness prior to the purging procedure being completed, the well should be allowed to recover (for up to, but no longer than, 24 hours) prior to collecting a sample.
5. A non-representative sample can also result from excessive pre-pumping of the monitoring well. Stratification of the constituent concentration in the groundwater formation may occur, or heavier-than-water compounds may sink to the lower portions of the aquifer. Excessive pumping can dilute or increase the constituent concentrations relative to those at the sampling point of interest.
6. A sampling methodology must be used that accounts for the effects of aquifer heterogeneities, while minimizing alterations in water chemistry that could result from sampling disturbances. The MDEQ will accept properly conducted purging methods designed to minimize drawdown, by controlling the flow from the well while monitoring stabilization indicator parameters, commonly referred to as low-flow methods. Available low-flow procedures include:

    - United States Environmental Protection Agency (USEPA), Office of Research and Development, Office of Solid Waste and Emergency Responses, EPA/540/S-95/504, April 1996, USEPA Ground Water Issue, *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*, Robert Puls and Michael Barcelona
    - USEPA, Region 1, July 30, 1996, Revision 3, *Low Stress (Low-Flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells*

4.6 Low-Flow Methods

Low-flow sampling involves the slow removal of a minimal amount of water from a well to ensure that stagnant water is removed and that water in the well is representative of water in the formation. The advantage of low-flow sampling is that, when conducted properly, it avoids disrupting the formation and minimizes turbidity that can be introduced by other purging and sampling devices, such as bailers. Instead of removing a set volume of water from the well, low-flow sampling uses a pump (typically a peristaltic pump), set at a low rate of flow, to continuously remove water until a set of indicator parameters are stabilized.

Flow rates are typically on the order of 100 to 200 milliliters per minute (ml/min) and should never exceed 500 ml/min. Indicator parameters are measured using probes inside a flow through cell and may include pH, specific conductance, dissolved oxygen, oxidation-reduction (redox) potential, temperature, and turbidity. Not all indicators may be used for a specific sampling; staff is most likely to use pH, specific conductivity, temperature, and turbidity.

NOTE: For a detailed discussion of low-flow methods, see USEPA, Office of Research and Development, Office of Solid Waste and Emergency Responses, EPA/540/S-95/504, April 1996, USEPA Ground Water Issue, *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*, Robert Puls and Michael Barcelona

5. Groundwater Sample Collection Procedures

Groundwater samples can be collected using bailers, submersible pumps, inertia pumps, and peristaltic pumps used for purging. Several factors must be considered when choosing a sampling device, and care should be taken when reviewing the advantages or disadvantages of any one device (see **Section 2 Groundwater Sampling Equipment**). It may be appropriate to use a sampling device different than that used to purge. The most common example of this is the use of a submersible pump to purge and a bailer to sample.

The following considerations should be taken during sample collection to prevent contamination:

- ● Dust and fibers must be kept out of sample bottles.
- ● The sample cap should never be placed directly on the ground during sampling.
    - ▲ If sampling staff must set the sample bottle cap down during sample collection and a second member of the sampling crew (wearing a fresh pair of powderless nitrile gloves) is not available, set the cap on a clean surface (cotton sheeting, HDPE sheeting, triple rinsed cooler lid, etc.).
- ● Do not sample without powderless nitrile gloves.
- ● Regular/thick size markers (Sharpie® or otherwise) are to be avoided; as they may contain PFAS.
- ■ Fine and Ultra-Fine point Sharpie® markers are acceptable to label the empty sample bottle while in the staging area provided the lid is on the sample bottle and gloves are changed following sample bottle labeling.
- ■ Ballpoint pens may be used when labeling sample containers. If ballpoint pens do not write on the sample container labels, preprinted labels from the laboratory may be used.
- ■ Hands should be well washed and gloved.
- ■ Use HDPE or polypropylene sample bottles with Teflon®-free caps, provided by the laboratory.
- ■ Commercialy bought sample bottles used with automatic sampling equipment should be decontaminated prior to sampling and equipment blank samples should be collected using laboratory supplied PFAS-free water.
- ■ Glass bottles or containers may be used if they are known to be PFAS-free, however, PFAS have been found to adsorb to glass, especially when the sample is in contact with the glass for a long period of time (e.g. being stored in a glass container). If the sample comes into direct contact with the glass for a short period of time (e.g. using a glass container to collect

the sample, then transferring the sample to a non-glass sample bottle), the adsorption is minimal.

- ■ Bottles should only be opened immediately prior to sampling.
- ■ Bottles should be capped immediately after collecting the sample.
- ■ Samples should be double bagged using resealable low density polyethelene (LDPE) bags (e.g., Ziploc®).
- ■ Follow any guidance or requirements in the PFAS analytical reference method that will be used for testing samples, for sample collection, storage, preservation, and holding times.
- ■ In the absence of formal USEPA guidance for PFAS groundwater sample storage, the documentation in USEPA Method 537 Rev. 1.1 should be used as a guide for thermal preservation (holding temperature) and holding times for groundwater or other samples. Samples must be chilled during storage and shipment and must not exceed 50°F (10º C) during the first 48 hours after collection. Samples stored in the laboratory must be held at or below 50°F (10°C) until extraction but should not be frozen.

NOTE: USEPA Method 537 Rev. 1.1 was developed for the analysis of finished drinking water samples **only**.

- ■ Groundwater samples should be extracted as soon as possible but must be extracted within 14 days. Extracts must be stored at room temperature and analyzed within 28 days after extraction.
- ▲ Off-brand markers should be known to be PFAS free prior to use.
- ▲ Latex gloves should be screened before use.

5.1 Bailers

1. Complete purging. Measure the groundwater pH, temperature, and specific conductance using the procedures described in the QAPP.
2. Assemble the appropriate sample containers, and label with appropriate sample labels.
3. Attach a nylon or cotton line to the bailer.
4. Lower the bailer slowly and gently into the well, attempt to minimize contact with the casing, and avoid splashing the bailer into the water. Stop lowering at a point adjacent to the screen.
5. Allow the bailer to fill and then slowly and gently retrieve the bailer from the well. Attempt to minimize contact with the casing, to ensure that flakes of rust or other foreign materials are not knocked into the bailer.
6. Remove the cap from the sample container and keep it in a gloved hand (two sample collection personnel may be needed).
7. Begin slowly pouring groundwater from the bailer into the sample container.
8. Replace the well cap once all sample containers are filled.
9. Cap the sample container tightly, label the container, and place the container in a temperature-controlled carrier.
10. Log all samples in the field logbook and on Monitor Well and Groundwater Data Sheets.
11. Package the samples for transport to the analytical laboratory. Complete chain-of-custody records.
12. Properly dispose of the bailer and line.

NOTE: For bailers especially, two sample collection personnel may be needed.

5.2 Submersible Pumps (Low-Flow Sampling)

1. Complete purging, keeping the pump approximately in the middle of the screened interval. Measure the groundwater pH, temperature, and specific conductance using the procedures described in the QAPP.
2. Assemble the appropriate sample containers, and label with the appropriate sample labels.
3. Reduce the purge water flow rate to a manageable sampling rate by adjusting the control box or by attaching a gate valve to the tubing (if not already fitted).
4. If the flow rate cannot be adjusted, run the water down the side of a clean jar and fill the sample containers from the jar.
5. Remove the pump and assembly. Dedicate the tubing to the monitoring well.
6. Replace the well cap once all sample containers are filled.
7. Cap the sample container tightly, label the container, and place it in a temperature-controlled carrier.
8. Log all of the samples in the field logbook and/or the Monitor Well and Groundwater Data Sheets.
9. Package the samples for transport to the analytical laboratory. Complete chain-of-custody records.
10. Decontaminate equipment in accordance with **Section 3 Equipment Decontamination**.

5.3 Inertia Pumps

1. Complete purging, keeping the pump approximately in the middle of the screened interval. Measure the groundwater pH, temperature, and specific conductance using the procedures described in the QAPP.
2. Assemble the appropriate sample containers, and label with appropriate sample labels.
3. Manually regulate the flow rate and discharge the sample from the pump outlet directly into the appropriate sample container.
4. Remove the pump from the well.
5. Replace the well cap once all sample containers are filled.
6. Cap the sample container tightly, label the container, and place it in a temperature-controlled carrier.
7. Log all samples in the field logbook and/or the Monitor Well and Groundwater Data Sheets.
8. Transport the samples to the decontamination zone, and package them for transport to the analytical laboratory. Complete chain-of-custody records.
9. Decontaminate equipment in accordance with **Section 3 Equipment Decontamination**.

5.4 Peristaltic Pumps (Low-Flow Sampling)

1. Determine that the indicator parameters (see **Section 4.4**) have stabilized. Complete purging, keeping the pump approximately in the middle of the screened interval. Record indicator parameters at 3-minute intervals.
2. Assemble the appropriate sample containers, and label with appropriate sample labels.
3. Collect samples.
4. Remove the pump and assembly. Dedicate the tubing to the monitoring well or properly dispose.
5. Replace the well cap once all sample containers are filled.
6. Cap the sample container tightly, label the container, and place it in a temperature-controlled carrier.
7. Log all samples in the field logbook and/or the Monitor Well and Groundwater Data Sheets.
8. Package the samples for transport to the analytical laboratory. Complete chain-of-custody records.
9. Decontaminate equipment in accordance with **Section 3 Equipment Decontamination**.

When the depth to the water table exceeds 25 feet below grade, suction-lift mechanisms, such as peristaltic pumps, cannot be used to sample groundwater. A bladder or submersible pump can be used in the case when groundwater is located deeper than 25 feet below grade. Both of these pumps are submerged beneath the water table and will come into contact with the groundwater being sampled.

6. Field Quality Assurance/Quality Control

Sample blanks and duplicates are the primary means of assuring and assessing quality control during sample collection or transport.

Field blanks consist of:

- **Equipment blanks**
  - Equipment blanks consist of laboratory verified PFAS-free water poured over (for equipment such as static water level indicators) or through (for equipment such as pumps, bailers and flow through cells) the sampling equipment, collected in laboratory-supplied sample containers, and analyzed.
  - Equipment blanks should be collected prior to the first use of sampling equipment in the field (particularly if there is any uncertainty as to whether the equipment is constructed from PFAS containing materials) and occasionally after decontamination.
  - Equipment blanks should be collected from a representative sample of disposable sampling equipment (one bailer from a box, a length of tubing from a roll) to document that these items are not contributing PFAS to groundwater samples.
  - In the field, equipment blanks should be collected at a minimum frequency of one per day (or at a different frequency as specified in the sampling plan).

> **NOTE:** Refer to the specific sampling plan to determine the appropriate number and frequency regarding field quality assurance and quality control.

- **Trip blanks**
  - Trip blanks consist of laboratory-verified PFAS-free water in a laboratory-supplied sample container. Trip blanks travel with the field samples and are analyzed in the same batch.
  - Typically trip blanks are collected to assess the potential cross contamination from VOCs. The current MDEQ minimum analyte PFAS list does not contain PFAS that are volatile.
  - Trip blanks could be used to evaluate the potential cross-contamination present the lab in the containers or deionized water provided from the lab.

- **Field blanks**
  - o Field blanks consist of laboratory verified PFAS-free water in a laboratory supplied sample container.
  - o A field blank is opened at the sampling site and exposed to ambient conditions for approximately the same amount of time as an actual sampling container (generally 1 to 3 minutes). Alternately, the PFAS—free water can be poured from one sample container into another to mimic sample collection activities. The field blank then travels with the field samples and is analyzed in the same batch.
  - o A field blank must be collected once every twenty samples (or at a different frequency as specified in sampling plan) or once during any sampling event, when an ambient source of PFAS (particularly atmospheric) is suspected.
  - o If an atmospheric source of PFAS is suspected, collect the equipment blank downwind of the suspected source

- **Field duplicates**
  - o Groundwater sample duplicates are two samples collected immediately sequentially from the same well. Duplicate samples should be labeled to prevent anyone, other than the sample collector, from knowing which specific well(s) are being duplicated.
  - o Duplicates are analyzed in the same batch and serve as a quality check on the accuracy and precision of sampling procedures.
  - o Duplicates are recommended once every ten samples or once per day (whichever is less; or at a different frequency as specified in the sampling plan.

7. Filtration

Filtering of the groundwater samples is sometimes necessary. PFAS can adsorb to particulate matter, and unfiltered samples may result in high biased results. However, the filter material should be carefully evaluated. A study between four different filter materials (PTFE, glass, polyethersulfone [PES], and nylon) found that glass filters adsorbed the least amount of PFAS and nylon adsorbed the most and is therefore not recommended for PFAS sampling.

NOTE: It is recommended that filtering of the samples should **only be performed in the laboratory** in order to reduce the possibility of cross contamination.

The following recommendations should be used when considering filtering of the samples:

- ● **Field filtration of the sample is generally not advised.**
  - ▲ If filtering is absolutely necessary, if specifically requested by a client or for other reasons:
    - ● Do not use any filters that contain any PFAS, such as PTFE filters
    - ● Do not use nylon filters.
    - ■ Glass filters are recommended to be used.
    - ■ Consider use of a centrifuge in the laboratory to reduce the need for sample filtering.

8. Sample Shipment

Once the sample is collected in laboratory-supplied containers, the following recommendations should be used for sample shipment:

- ■ Check the cooler periodically to ensure samples are well iced and at the proper temperature.

- ■ Refresh with regular ice, if needed, double bagged in LDPE resealable storage bags if needed.
- ■ Regular ice should be used to cool and maintain the sample at or below the proper temperature.
  - ▲ Chemical or blue ice may be used if it is known to be PFAS-free and it is absolutely certain that the sample is cooled and maintained at or below the proper temperature during collection and through transit to the laboratory.
- ■ Complete the appropriate Monitor Well and Groundwater Data Sheets.
- ■ Shipping containers should be packed with enough PFAS-free noncombustible, absorbent, cushioning material, such as bubble wrap, to minimize the possibility of breakage.
- ■ Complete a Chain of Custody (COC) form for each separate shipping container. The forms should be hand-carried to the laboratory by the sampler.
- ■ If unable to hand-carry the COC and other forms to the laboratory, forms should be single bagged in LDPE (e.g. Ziploc®) storage bags and taped to the inside of the cooler lid.

NOTE: Chain-of-custody procedures must be followed and documented.

- ■ The cooler should be taped closed with a custody seal and, if shipping, shipped by overnight courier.
- ■ Samples should be shipped as soon as possible (e.g. overnight) to ensure the samples arrive within the analytical holding time specified by the lab.

[THIS PAGE IS INTENTIONALLY LEFT BLANK]

Michigan Department of Environmental Quality

MDEQ PFAS Sampling Quick Reference Field Guide[1]

All Items Used During Sampling Event

● Prohibited
• Items or materials that contain fluoropolymers such as o Polytetrafluoroethylene (PTFE), that includes the trademarks Teflon® and Hostaflon® o Polyvinylidene fluoride (PVDF), that includes the trademark Kynar® o Polycholotrifluoroethylene (PCTFE), that includes the trademark Neoflon ® o Ethylene-tetrafluoro-ethylene (ETFE), that includes the trademark Tefzel® o Fluorinated ethylene propylene (FEP), that includes the trademarks Teflon® FEP and Hostaflon® FEP • Items or materials that contain any other fluoropolymer

Pumps, Tubing, and Sampling Equipment

● Prohibited	■ Allowable	▲ Needs Screening[2]
• Items or materials containing any fluoropolymer (potential items include tubing, valves, or pipe thread seal tape)	• High-density polyethylene (HDPE) • Low-density polyethylene (LDPE) tubing • Polypropylene • Silicone • Stainless-steel • Any items used to secure sampling bottles made from: o Natural rubber o Nylon (cable ties) o Uncoated metal springs o Polyethylene	• Any items or materials that will come into direct contact with the sample that have **not** been verified to be PFAS-free o Do not assume that any sampling items or materials are PFAS-free based on composition alone

Sample Storage and Preservation

● Prohibited	■ Allowable	▲ Needs Screening[2]
• Polytetrafluoroethylene (PTFE): Teflon® lined bottles or caps	• Glass jars[4] • Laboratory-provided PFAS-Free bottles: o HDPE or polypropylene • Regular wet ice • Thin HDPE sheeting • LDPE resealable storage bags (i.e. Ziploc®) that will not contact the sample media[6]	• Aluminium foil[4] • Chemical or blue ice[5] • Plastic storage bags other than those listed as ■ Allowable • Low-density polyethylene (LDPE) bottles

Field Documentation

● Prohibited	■ Allowable	▲ Needs Screening[2]
• Clipboards coated with PFAS • Notebooks made with PFAS treated paper • PFAS treated loose paper • PFAS treated adhesive paper products	• Loose paper (non-waterproof, non-recycled) • Rite in the Rain® notebooks • Aluminium, polypropylene, or Masonite field clipboards • Ballpoint pens, pencils, and Fine or Ultra-Fine Point Sharpie® markers	• Plastic clipboards, binders, or spiral hard cover notebooks • All markers not listed as ■ Allowable • Post-It® Notes or other adhesive paper products • Waterproof field books

Decontamination

● Prohibited	■ Allowable	▲ Needs Screening[2]
• Decon 90® • PFAS treated paper towel	• Alconox®, Liquinox®, or Citranox® • Triple rinse with PFAS-free deionized water • Cotton cloth or untreated paper towel	• Municipal water • Recycled paper towels or chemically treated paper towels

Clothing, Boots, Rain Gear, and PPE

● Prohibited	■ Allowable	▲ Needs Screening[2]
● New or unwashed clothing ● Anything made of or with: o Gore-Tex™ or other water-resistant synthetics ● Anything applied with or recently washed with: o Fabric softeners o Fabric protectors, including UV protection o Insect resistant chemicals o Water, dirt, and/or stain resistant chemicals	● Powderless nitrile gloves ● Well-laundered synthetic or 100% cotton clothing, with most recent launderings not using fabric softeners ● Made of or with: o Polyurethane o Polyvinyl chloride (PVC) o Wax coated fabrics o Rubber / Neoprene o Uncoated Tyvek®	● Latex gloves ● Water and/or dirt resistant leather gloves ● Any special gloves required by a HASP ● Tyvek® suits, clothing that contains Tyvek®, or coated Tyvek®

Food and Beverages

● Prohibited	■ Allowable
● No food should be consumed in the staging or sampling areas, including pre-packaged food or snacks. ■ If consuming food on-site becomes necessary, move to the staging area and remove PPE. After eating, wash hands thoroughly and put on new PPE.	● Brought and consumed only outside the vicinity of the sampling area: o Bottled water o Hydration drinks (i.e. Gatorade®, Powerade®)

Personal Care Products (PCPs) - for day of sample collection[6]

● Prohibited	■ Allowable	▲ Needs Screening[2]
● Any PCPs[6], sunscreen, and insect repellent applied in the sampling area.	PCPs[6], sunscreens, and insect repellents applied in the staging area, away from sampling bottles and equipment followed by thoroughly washing hands: **PCPs[6]:** ● Cosmetics, deodorants/antiperspirants, moisturizers, hand creams, and other PCPs[6] **Sunscreens:** ● Banana Boat® for Men Triple Defense Continuous Spray Sunscreen SPF 30 ● Banana Boat® Sport Performance Coolzone Broad Spectrum SPF 30 ● Banana Boat® Sport Performance Sunscreen Lotion Broad Spectrum SPF 30 ● Banana Boat® Sport Performance Sunscreen Stick SPF 50 ● Coppertone® Sunscreen Lotion Ultra Guard Broad Spectrum SPF 50 ● Coppertone® Sport High Performance AccuSpray Sunscreen SPF 30 ● Coppertone® Sunscreen Stick Kids SPF 55 ● L'Oréal® Silky Sheer Face Lotion 50 ● Meijer® Clear Zinc Sunscreen Lotion Broad Spectrum SPF 50 ● Meijer® Sunscreen Continuous Spray Broad Spectrum SPF 30 ● Meijer® Clear Zinc Sunscreen Lotion Broad Spectrum SPF 15, 30 and 50 ● Meijer® Wet Skin Kids Sunscreen Continuous Spray Broad Spectrum SPF 70 ● Neutrogena® Beach Defense Water+Sun Barrier Lotion SPF 70 ● Neutrogena® Beach Defense Water+Sun Barrier Spray Broad Spectrum SPF 30 ● Neutrogena® Pure & Free Baby Sunscreen Broad Spectrum SPF 60+ ● Neutrogena® UltraSheer Dry-Touch Sunscreen Broad Spectrum SPF 30 **Insect Repellents:** ● OFF® Deep Woods ● Sawyer® Permethrin	● Products other than those listed as ■Allowable

[1] This table is not considered to be a complete listing of prohibited or allowable materials. All materials should be evaluated prior to use during sampling. The manufacturers of various products should be contacted in order to determine if PFAS was used in the production of any particular product.

[2] Equipment blank samples should be taken to verify these products are PFAS-free prior to use during sampling.

[3] **For surface water foam samples:** LDPE storage bags may be used in the sampling of foam on surface waters. In this instance, it is allowable for the LDPE bag to come into direct contact with the sample media.

[4] **For fish and other wildlife samples:** Depending on the project objectives, glass jars and aluminum foil might be used for PFAS sampling. PFAS has been found to bind to glass and if the sample is stored in a glass jar, a rinse of the jar is required during the sample analysis. PFAS are sometimes used as a protective layer for some aluminum foils. An equipment blank sample should be collected prior to any aluminum foil use.

[5] Regular ice is recommended as there are concerns that chemical and blue ice may not cool and maintain the sample at or below 42.8˚F (6°C) (as determined by EPA 40 CFR 136 – NPDES) during collection and through transit to the laboratory.

[6] Based on evidence, avoidance of PCPs is considered to be precautionary because none have been documented as having cross-contaminated samples due to their use. However, if used, application of PCPs must be done at the staging area and away from sampling bottles and equipment, and hands must be thoroughly washed after the use of any PCPs prior to sampling.

●- Prohibited ■- Allowable ▲- Needs Screening

GENERAL PFAS SAMPLING GUIDANCE

This document contains an introduction to PFAS, biosecurity recommendations, and general recommendations to decrease the possibility of cross-contamination.

Michigan Department of Environmental Quality

Revised 10/16/2018

Michigan Department of Environmental Quality

GENERAL PFAS SAMPLING

Guidance

CONTENTS

Acronyms

Acronyms used throughout the **General PFAS Sampling Guidance** document and/or each sampling guidance are as follows:

AFFF – Aqueous film forming foam

CAS Number – Chemical abstracts service number

COC – Chain of Custody

DEPA – Danish Environmental Protection Agency (Denmark)

EINECS – European List of Notified Chemical Substances (European Union)

ENCS – Existing and New Chemical Substances Inventory (Japan)

ETFE – Ethylene-tetrafluoroethylene

FCMP – Fish Contaminant monitoring program

FCSV – Fish consumption screening values

FDA – Food and Drug Administration (United States of America)

FEP – Fluorinated ethylene propylene

HASP – Health and Safety Plan

HDPE – High-density polyethylene

IECSC – Inventory of Existing Chemical Substances Produced or Imported in China

ITRC – Interstate Technology & Regulatory Council

KECI – Korea Existing Chemicals Inventory (South Korea)

KEMI – Swedish Chemical Agency (Sweden)

LDPE – Low-density polyethylene

LHA – Lifetime Health Advisory (United States Environmental Protection Agency)

MDEQ – Michigan Department of Environmental Quality

MDHHS – Michigan Department of Health and Human Services

MPART – Michigan PFAS Action Response Team

MSDS – Material Safety Data Sheet (former reference)

ng/L – Nanograms per liter

NZIoC – New Zealand Inventory of Chemicals (New Zealand)

PCPs – Personal care products

PID – Photoionization detector

PFAA – Perfluoroalkyl acids

PFAS – Per- and Polyfluoroalkyl Substances

PFC – Polyfluorocarbons

PFCA – Perfluoroalkyl carboxylic acids

PFOA – Perfluorooctanoic acid

PFOS – Perfluorooctanesulfonic acid

PFPE – Perfluoropolyethers

PFSA – Perfluoroalkyl sulfonic acids

PICCS – Philippine Inventory of Chemicals and Chemical Substances (Philippines)

ppb – Parts per billion

PPE – Personal protection equipment

ppt – Parts per trillion

PTFE – Polytetrafluoroethylene

PVC – Polyvinyl chloride

PVDF – Polyvinylidene fluoride

PVF – Polyvinyl fluoride

QA/QC – Quality assurance/quality control

QAPP – Quality Assurance Project Plan

OECD – Organization for Economic Cooperation and Development

SDS – Safety Data Sheet

SWAS – Surface Water Assessment Section (MDEQ)

TSCA – Toxic Substances Control Act (United States of America)

USEPA – United States Environmental Protection Agency

UV – Ultraviolet

VOC – Volatile organic compounds

WRD – Water resources division (MDEQ)

Disclaimer

The Michigan Department of Environmental Quality (MDEQ) intends to update the information contained within this PFAS Sampling Guidance document as new information becomes available. The user of this PFAS Sampling Guidance is encouraged to visit the Michigan PFAS Action Response Team webpage (www.michigan.gov/PFASresponse) to access the current version of this document.

1. Introduction

Per- and polyfluoroalkyl Substances (PFAS) are a class of **emerging contaminants** composed of more than 3,000 human-made, fluorinated, organic chemicals (Buck et al., 2011, Wang et al., 2017). The actual number of compounds is continuously changing, as some PFAS are no longer produced due to regulatory and voluntary actions, while new ones are created as alternatives. The carbon-fluorine bond that exists in PFAS is one of the strongest bonds in nature, they are tough to break and are resistant to thermal, chemical, and biological degradation.

NOTE: Emerging Contaminants are chemicals and materials in the environment and present real or potential human health or environmental risks, and either…

- Do not have peer-reviewed human health standards
  or:
- Standards/regulations are evolving due to new science, new laboratory analytical capabilities, and new knowledge about the chemicals.

Due to their unique chemical properties, various PFAS can lower surface tension (act as surfactants), are oil-repelling (oleophobic), and are water-repelling (hydrophobic), yet are also relatively water soluble. They have been used extensively in many industries worldwide for a wide variety of applications. PFAS were first invented in the late 1930's and commercially used from the 1940's as non-stick coatings. PFAS continued to be used in many industries and various products as more PFAS were developed with unique chemical properties. Some of the documented PFAS uses are in hydraulic fluids, biocides, construction products, fire-fighting foams, household products, wetting and mist suppressing agents, surfactants for oil and natural gas recovery enhancement, polymerization agents, low-friction bearings and seals, insulators, cables, wires, protective coatings for a wide variety of materials, nonstick coatings, surgical patches, cardiovascular grafts, implants, oil and water repellent coatings for a wide range of materials such as paper and cardboard packaging products, carpets, leather products, and textiles (OECD, 2013). The presence of PFAS in these materials is a potential source of environmental concern and cross-contamination.

The probability of false positives is relatively high during PFAS sample collection due to the potential for many sources of cross-contamination, combined with low laboratory detection limits (nanograms per liter (ng/L) or parts per trillion (ppt)). There are many products that could be found in the sampling environment, that have not been documented to either contain or not contain PFAS, and may come into contact with the samples, introducing causing cross-contamination.

The United States Environmental Protection Agency (USEPA) has established a Lifetime Health Advisory (LHA) for Perfluorooctanoic acid (PFOA) and Perfluorooctanesulfonic acid (PFOS), separately or combined, of 70 ppt. The MDEQ cleanup criteria protective of groundwater used for drinking water purposes is also 70 ppt for PFOS and PFOA, individually or combined. The MDEQ has also promulgated a standard under Rule 57 for PFOS of 11 ppt for surface water that is used as a drinking water source and 12 ppt for surface water that is not used as a drinking water source.

2. Purpose and Objectives

The purpose of this document is to provide guidance and information to staff who will:

- Collect or handle PFAS environmental samples.
- Perform subsurface activities such as soil borings and/or well installation or well abandonment at PFAS sites.

This document is intended to supplement the MDEQ media-specific PFAS sampling guidance documents and is a resource for PFAS sampling.

The objectives of this document are as follows:

- Provide guidance on avoiding PFAS cross-contamination during sampling.
- Improve sampling consistency and data quality.
- Provide guidance to MDEQ staff and contractors.

Because PFAS are emerging contaminants and information about their use in various materials is still not available; the MDEQ will update this document as new information becomes available.

NOTE: This guidance does not include specific information for sampling environmental media and should not be used to replace specific sampling guidance documents required for use by MDEQ staff.

3. Farm Biosecurity

In the event PFAS sampling occurs on or near a farm, staff need to follow the requirements in this document when conducting sample collection, to reduce the likelihood of transporting animal diseases.

3.1 Scheduling

To avoid cross-contamination from previous sampling locations, it is preferable that staff visit only one farm in a day.

3.2 Before Sampling

Staff should review **Section 4.2.4. Field Clothing and Personal Protective Equipment (PPE)** before going into the field.

Staff must have a clean vehicle, clean clothing, and clean boots to visit the sampling location. Before arriving at the farm, staff should call the owner of the farm to indicate they will be arriving shortly and ask if there are any additional biosecurity requirements for their farm. Once at the farm, staff should park away from any animals and barns; preferably in a designated visitor area or on concrete.

Immediately before exiting the vehicle, place disposable PFAS-free boot covers over boots. (*NOTE: Disposable boot covers can be slippery, especially in icy/snowy conditions.*)

3.3 While Sampling

Staff should not approach animal areas unless necessary for testing. If access to an animal area is needed, staff should always be accompanied by farm personnel.

3.4 After Sampling

Dispose of used disposable boot covers at the facility if possible; otherwise, place in a plastic bag, seal and place in the vehicle trunk to dispose of properly later.

4. General PFAS Sampling

The following sections discuss technical issues such as the need to use PFAS-free water; information about PFAS-free clothing and PPE; and laboratory issues that should be considered when sampling for PFAS.

4.1 Sampling Objectives

Before conducting any PFAS sampling, it is recommended that a project-specific Quality Assurance Project Plan (QAPP) should be developed. The QAPP must meet MDEQ policy and should include the analyte list, method of analysis, environmental matrices, and reporting limits, which are based on the project objectives. All of these considerations will be discussed in more detail in this guidance document.

4.2 PFAS Cross-Contamination Potential Sources

Potential sources of PFAS cross-contamination in the typical sampling environment include water used during drilling or decontamination, materials used within the sampling environment, sampling equipment, field clothing and personal protective equipment (PPE), sun and biological protection products, personal hygiene and personal care products (PCPs), food packaging, and the environment itself.

The materials associated with sampling that have the potential for PFAS cross-contamination have been divided into three major groups:

- Prohibited (●) identifies items and materials that should not be used when sampling. It is well documented that they contain PFAS or that PFAS are used in their manufacture.

- Allowable (■) identifies items and materials that have been proven not to be sources of PFAS cross contamination and are considered allowable for sampling.

- Needs Screening (▲) identifies items and materials that have the potential for PFAS cross-contamination due to a lack of scientific data or statements from manufacturers to prove otherwise. These items and materials are further sub-divided into two categories:

    - **Category 1:** Items and materials that <u>will come in direct contact</u> with the sample. These should not be used when sampling unless they are known to be PFAS-free, by collecting an equipment blank sample prior to use.

    - **Category 2:** Items and materials that <u>will not come in direct contact</u> with the sample. These should be avoided, if possible, unless they are known to be PFAS-free by collecting an equipment blank sample prior to use.

All of the materials or items discussed in each of the MDEQ's PFAS Sampling Guidance Documents will be divided into ● Prohibited ■ Allowable, or ▲ Needs Screening. Several examples of prohibited and allowable materials and materials that need screening are listed in the **MDEQ PFAS Sampling Quick Reference Field Guide** at the end of this document. Also, materials and items that are specific to a particular environmental media or sampling method will be thoroughly explained in that media's sampling guidance document (such as peristaltic pumps for groundwater sampling).

> **NOTE:** If recommended PPE will be used during sampling, **Category 2** materials are not expected to be a source of cross-contamination as long as they do not come into contact with the samples.

Please note that at this time no published research is available that documents the use of various materials and their effect on sample results. Therefore, a conservative approach is recommended in this guidance based on the evaluation of multiple environmental samples at various PFAS sites. Field sampling occurring during extreme weather (e.g., rainfall, snowfall, or extreme heat) should be conducted while wearing the appropriate clothing that will not pose a risk for cross-contamination but will also ensure the safety of the field personnel.

4.2.1 PFAS-Free Water

The term PFAS-free water is defined here as water that does not contain significant concentrations of any compound in a specific PFAS analyte list that is being analyzed at a project-defined level. The significant concentrations depend on project data quality objectives and could, for instance, be less than the laboratory reporting limit, <1/2 the limit of quantitation, or other defined criteria for the specific PFAS compound of interest (ITRC, 2017).

NOTE: The confirmation of PFAS-free water should always be performed prior to the commencement of work. Site or public water supplies have been identified in many instances to contain detectable levels of PFAS.

One important consideration for each project is to identify a PFAS-free water source to use for decontamination of sampling and drilling equipment when applicable. The decontamination of sampling tools or small equipment parts can be performed using laboratory-supplied verified PFAS-free water. Other water can only be used for decontamination purposes if it has been analyzed and shown to be PFAS-free as defined for the project.

4.2.2 Materials Screening

Materials screening should be performed during the Health and Safety Plan (HASP) and QAPP development or the planning phase of sampling programs. The screening should be performed on all of the items and materials that are expected to come into contact with the samples and defined as **Category 1**.

Material screening should include a review of Safety Data Sheets (SDSs; formerly Material SDS [MSDSs]). Make sure the review uses current SDSs, because the actual composition of a particular item or material may have changed over time without changing the actual item or material name. All products from the United States or abroad should be screened. Text fragments such as “perfluoro,” “fluoro,” or “fluorosurfactant” may identify the use of PFAS in specific items or materials.

NOTE: Manufacturers can change the chemical composition of any product. As a result, equipment blank samples should be collected for all materials that will come into direct contact with the sample media, regardless of what category they might be in, to confirm they are “PFAS-free”, i.e. will not contaminate samples at detectable levels. **There is no guarantee that materials in the ‘Allowable category will always be PFAS-free.**

Some countries have official national lists of industrial chemicals defined by regulations, such as:

- Toxic Substances Control Act (TSCA) in the United States.
- European List of Notified Chemical Substances (EINECS), as well as substances pre-registered under the Registration, Evaluation, Authorization, and restriction of Chemicals (REACH) in the European Union.
- Swedish Chemical Agency (KEMI) in Sweden.

- Domestic Substances List (DSL) in Canada.
- Inventory of Existing New Chemical Substances Produced or Imported in China (IECSC)
- Existing and New Chemical Substances Inventory (ENCS) in Japan.
- Korea Existing Chemicals Inventory (KECI) in South Korea.
- New Zealand Inventory of Chemicals (NZIoC) in New Zealand.
- Philippine Inventory of Chemicals and Chemical Substances (PICCS) in the Philippines.

The information available on these lists includes the chemical names and various identity numbers, which is usually the Chemical Abstracts Service number (CAS Number) (KEMI, 2015). The lists may not contain a substantial amount of information because of laws in regards to proprietary information, which gives the suppliers the right to not name newly developed chemicals. The information is not always sufficient to identify if the items or materials contain PFAS, as many of the PFAS do not have an assigned CAS Number at this time (KEMI, 2015). The most recent summary conducted by the Organization for Economic Co-operation and Development (OECD) identified 4,730 PFAS-related CAS numbers (OECD, 2018).

Sometimes manufacturers provide information about their products online or upon request, which may indicate if PFAS were used in the manufacturing of a particular item or material.

4.2.3 Sampling Equipment

The actual list of PFAS-containing materials potentially encountered onsite will change based on the specific sampled media and site-specific sampling conditions. Do not use any equipment that contains any known fluoropolymers. Consider all of the following:

- ● Do not use polytetrafluoroethylene (PTFE) that includes the trademark Teflon® and Hostaflon®, which can be found in many items, including but not limited to the lining of some hoses and tubing, some wiring, certain kinds of gears, and some objects that require the sliding action of parts.
- ● Do not use Polyvinylidene fluoride (PVDF) that includes the trademark Kynar®, which can be found in many items, including but not limited to tubing, films/coatings on aluminum, galvanized or aluminized steel, wire insulators, and lithium-ion batteries.
- ● Do not use Polychlorotrifluoroethylene (PCTFE) that includes the trademark Neoflon®, which can be found in many items, including but not limited to valves, seals, gaskets, and food packaging.
- ● Do not use Ethylene-tetrafluoroethylene (ETFE) that includes the trademark Tefzel®, which can be found in many items, including but not limited to the wire and cable insulation and covers, films for roofing and siding, liners in pipes, and some cable tie wraps.
- ● Do not use Fluorinated ethylene propylene (FEP) that includes the trademarks Teflon® FEP and Hostaflon® FEP, and may also include Neoflon®, which can be found in many items, including but not limited to the wire and cable insulation and covers, pipe linings, and some labware.
- ● Do not use low-density polyethylene (LDPE) for any items that will come into direct contact with the sample media. LDPE can be found in many items, including but not limited to containers and bottles, plastic bags, and tubing.
    - ▲ **However**, LDPE may be used if an equipment blank has confirmed it to be PFAS-free. LDPE does not contain PFAS in the raw material but may contain PFAS cross-contamination from the manufacturing process.

●- Prohibited ■- Allowable ▲- Needs Screening

- ■ LDPE bags (e.g., Ziploc®) that do not come into direct contact with the sample media and do not introduce cross-contamination with samples may be used.
- ■ Use materials that are either made of high-density polyethylene (HDPE), polypropylene, silicone, or acetate.
- ■ Glass bottles or containers may be used if they are known to be PFAS-free, however, PFAS have been found to adsorb to glass, especially when the sample is in contact with the glass for a long period of time (e.g. being stored in a glass container). If the sample comes into direct contact with the glass for a short period of time (e.g. using a glass container to collect the sample, then transferring the sample to a non-glass sample bottle), the adsorption is minimal.
- ■ Powderless nitrile gloves (which can be found at some hardware and major retail outlets).
- ▲ Latex gloves should be screened before use.
- ▲ Some sampling guidance documents allow the use of aluminum foil provided the shiny side is placed away from the sample (e.g., fish tissue sampling guidance). As a precaution, MDEQ recommends that aluminum foil not is used unless equipment blank samples confirm it is PFAS-free.

4.2.4 Field Clothing and Personal Protective Equipment (PPE)

Any field planning and mobilization effort should address the physical, chemical, and biological hazards associated with each PFAS site. The mitigation of potential risks may be documented in a site-specific HASP or a QAPP. Due to the extensive use of PFAS in many industries and products, PPE may contain PFAS. During PFAS investigation, PPE containing PFAS should be avoided to prevent cross-contamination. The development of the HASP or QAPP should consider these factors before mobilization in the field. All HASPs or QAPPs need to address the concern of potential exposure of staff to PFAS through PPE.

Personal safety is paramount. The safety of staff should not be compromised by fear of PFAS containing materials without any scientific basis. Any deviation from this guidance, including those necessary to ensure the health and safety of sampling personnel, must be recorded in field notes and discussed in the final report.

Globally, protective coatings for textiles are estimated to be about 50 percent of the total use of PFAS (DEPA, 2015). Due to its unique properties of water and oil repellency, PFAS has been used to coat various clothing (i.e., pants, jackets, and t-shirts) and leather products (i.e., boots, shoes, and jackets). Many of these types of clothing and PPE have the potential to be used in the sampling environment.

NOTE: The Danish Ministry of the Environment identified alternative polymer technology as being PFAS-free. Products treated with this technology are water- resistant, but not oil and dirt repellent to the same extent as products treated with PFAS- based agents (DEPA, 2015).

While preparing for sampling, particular focus should be made on clothing that has been advertised as having waterproof, water-repellant, or dirt and/or stain resistant characteristics. These types of clothing are most likely to have had PFAS used in their manufacturing.

Field Clothing and PPE that should be avoided (●) in the immediate sampling environment include the following:

- ● Do not use clothing that has been washed with fabric softener which may contain PFAS.
- ● Do not use clothing that has been made with or washed with water, dirt, and/or stain resistant chemicals.
- ● Do not use clothing chemically treated for insect resistance and ultraviolet protection (See **Section 4.2.5** on biological hazards).
- ● Do not use clothing or PPE items that have any of the brand or product names that have been found to contain PFAS by the Danish Ministry of the Environment and presented in **Table 1** below (DEPA, 2015).

Field Clothing and PPE that are allowable (■) to wear within the immediate sampling environment include the following:

> **NOTE**: There could be many PPE materials used during various sampling events, including hard hats and safety glasses. All clothing and PPE should be evaluated prior to sampling.

- ■ Powderless nitrile gloves.
- ■ Polyvinyl chloride (PVC) or wax-coated fabrics.
- ■ Neoprene.
- ■ Any boots made of polyurethane and/or PVC. If the HASP requires a specific type of boot such as (steel-toed), and PFAS-free cannot be purchased, PFAS- free over-boots may be worn. The overboots must be put on, and hands washed after putting the overboots on before the beginning of sampling activities. Overboots may only be removed in the staging area and after the sampling activities have been completed.
- ■ Synthetic and natural fibers (preferably cotton) that are well laundered (more than six times with no fabric softener) clothes and cotton overalls.

Field Clothing and PPE that must be evaluated (▲) before wearing within the immediate sampling environment include the following:

- ▲ Latex gloves.
- ▲ Water resistant or stain-treated clothing and PPE.
- ▲ Tyvek suits and clothing that contain Tyvek® (USEPA PFAS sampling guidance from USEPA Region 2 prohibits the use of Tyvek; available product information suggests Tyvek® may be used if required. Coated Tyvek® requires further evaluation; therefore, MDEQ recommends the collection of an Equipment Blank before Tyvek® use).

●- Prohibited ■- Allowable ▲- Needs Screening

Table 1 below provides a list of prohibited field clothing (DEPA, 2015). However, the manufacturer and/or vendor for the field clothing and/or PPE should be contacted to confirm that these brand or product names still contain PFAS. There have been instances where manufacturers have kept the same brand and/or product name but have changed the chemicals used during the manufacturing of a particular item.

Table 1. Prohibited Field Clothing and PPE Brand and Product Names

● Prohibited Materials[1] (DEPA, 2015)	
Advanced Dual Action Teflon® fabric protector.	Release Teflon®
Repel Teflon® fabric protector	High-Performance Release Teflon®
High performance Repel Teflon® fabric protector	Ultra Release Teflon®
NK Guard S series	GreenShield®
Tri-Effects Teflon® fabric protector	Lurotex Protector RL ECO®
Oleophobol CP®	Repellan KFC®
Rucostar® EEE6	UnidyneTM
Bionic Finish®	RUCO-GUARD®
RUCOSTAR®	RUCO-COAT®
RUCO-PROTECT®	RUCOTEC®
RUCO®	Resist Spills™
Resists Spills and Releases Stains™	Scotchgard™ Fabric Protector

[1]This list is not considered to be a complete listing of prohibited materials. All materials should be evaluated before use during sampling.

4.2.5 Sun and Biological Protection

Because biological hazards (sunburn, mosquitos, ticks, etc.) may be encountered during sampling, the elimination of specific clothing materials or PPE (sunscreens and insect repellants) could pose a health and safety hazard to staff.

The safety of staff should not be compromised by fear of PFAS containing materials without any scientific basis. Personal safety is paramount. Any deviation from this guidance, including those necessary to ensure the health and safety of MDEQ staff, should be recorded in field notes and discussed in the final report.

Prolonged sun exposure will require sunscreens, which may have included PFAS in their manufacture. Protection against insects may require the use of insect repellant. **Table 2** contains a detailed list of sunscreens and insect repellants that have been analyzed and found to be PFAS-free as of the date of this document. Note that this is not a comprehensive list of allowable insect repellants or sunscreens; other products may meet the requirements for use. Listing or omission of any product does not imply endorsement or disapproval. Also, there is no guarantee that these products will always remain PFAS free.

> **NOTE:** Sunscreens and insect repellants must be evaluated on a case-by-case basis. Refer to **Section 4.6 Quality Control Samples** for details on collecting equipment blanks.

The MDEQ recommends that additional sunscreens and insect repellents be treated as (▲) Needs Screening and should be evaluated before use.

- ● Sunscreens and insect repellants should not be applied near the sample collection area.
- ■ Hands should be well washed after application or handling of these products, and afterwards, powderless nitrile gloves should be worn.

●- Prohibited ■- Allowable ▲- Needs Screening

Table 2. Sunscreen and Insect Repellents[1]

	■ Allowable Insect Repellants
Photos	**Insect Repellent Spray**
 	• OFF Deep Woods • Sawyer Permethrin
	■ Allowable Sunscreens
Photos	**Sunscreens**
  	• Banana Boat Sport Performance Sunscreen Lotion Broad Spectrum SPF 30. • Meijer Sunscreen Lotion Broad Spectrum SPF 30. • Neutrogena Ultra-Sheer Dry-Touch Sunscreen Broad Spectrum SPF 30.

■ Allowable Sunscreens
• Banana Boat for Men Triple Defense Continuous Spray Sunscreen SPF 30 • Banana Boat Sport Performance Coolzone Broad Spectrum SPF 30 • Banana Boat Sport Performance Sunscreen Lotion Broad Spectrum SPF 30 • Banana Boat Sport Performance Sunscreen Stick SPF 50 • Coppertone Sunscreen Lotion Ultra Guard Broad Spectrum SPF 50 • Coppertone Sport High-Performance AccuSpray Sunscreen SPF 30 • Coppertone Sunscreen Stick Kids SPF 55 • L'Oréal Silky Sheer Face Lotion 50+ • Meijer Clear Zinc Sunscreen Lotion Broad Spectrum SPF 15, 30 and 50 • Meijer Wet Skin Kids Sunscreen Continuous Spray Broad Spectrum SPF 70 • Neutrogena Beach Defense Water + Sun Barrier Lotion SPF 70 • Neutrogena Beach Defense Water + Sun Barrier Spray Broad Spectrum SPF 30 • Neutrogena Pure & Free Baby Sunscreen Broad Spectrum SPF 60+
▲ Materials That Require Screening
Sunscreens: Alba Organics Natural Sunscreen, Yes To Cucumbers, Aubrey Organics, Jason Natural Sun Block, Kiss My Face, and baby sunscreens that are "free" or "natural."
Insect Repellents: Jason Natural Quit Bugging Me, Repel Lemon Eucalyptus Insect repellant, Herbal Armor, California Baby Natural Bug Spray, Baby Ganics.
Sunscreen and Insect Repellent: Avon Skin So Soft Bug Guard Plus – SPF 30 Lotion.

[1]This table is not considered to be a complete listing of allowable materials and materials that require screening. All materials should be evaluated before use during sampling. Some of the sunscreen and insect repellent testing has been performed using a PFAS screening Method known as Particle Induce Gamma-Ray Emission (PIGE). The use of approved gloves should always be used, and the sample should never come into contact with any of the sunscreen or insect repellent products. An Equipment Blank sample could also be collected to verify the product as PFAS-free.

● - Prohibited ■ - Allowable ▲ - Needs Screening

If an insect repellant has not been approved and staff needs protection against biting insects:

NOTE: The words "Natural" and/or "Organic" in the product name or to describe it does not mean that it is PFAS-free.

- Tuck pant legs into socks and/or boots to seal the gap between the boots and the pants to reduce the risk of being bitten by ticks.
- Wear well-washed, light-colored clothing to easily see ticks during field activities.
- Light-colored clothing, long sleeves, and large-brimmed hats also prevent sunburn.
- Equipment Blank samples should be collected to verify that the preferred insect repellant or sunscreen is PFAS-free by using the testing procedures identified in **Section 4.6 Quality Control Samples**.

4.2.6 Personnel Hygiene and Personal Care Products (PCPs)

A number of sampling guidance documents recommend that personal hygiene and personal care products (PCPs) (e.g., cosmetics, shampoo, sunscreens, dental floss, etc.) not be used prior to and on the day(s) of sampling because the presence of PFAS in these products has been documented (OECD, 2002, Fujii, 2013, Borg and Ivarsson, 2017). However, if the MDEQ's sampling SOPs are followed, these items should not come into contact with the sampling equipment or the sample being collected. As of the date of this sampling guidance, cross-contamination of samples due to the use of PCPs has not been documented during the collection of thousands of samples. However, field personnel should be aware of the potential of cross-contamination if the sampling equipment or actual samples would come into contact with these products. The following precautions should be taken when dealing with personal hygiene or PCPs before sampling:

- ● Do not handle or apply PCPs in the sampling area.
- ● Do not handle or apply PCPs while wearing PPE that will be present during sampling.
- ■ Move to the staging area and remove PPE if applying personal care products becomes necessary.
- ■ Wash hands thoroughly after the handling or application of PCPs and, when finished, put on a fresh pair of powderless nitrile gloves.

4.2.7 Food Packaging

PFAS has been used by the paper industry as a special protective coating against grease, oil, and water for paper and paperboards, including food packaging since the late 1950s (Trier et al., 2018). PFAS application for food packaging includes paper products that come into contact with food such as paper plates, food containers, bags, and wraps (OECD, 2002). In January 2016, the Food and Drug Administration (FDA) banned the use of PFAS which has eight carbon atoms (such as PFOA and PFOS) or more, in food packaging materials. However, PFOA and PFOS or other eight or more carbon chain PFAS may still be detected in food packaging because of the use of recycled paper which may contain PFAS. Various studies have found up to 57percent detection frequency in food contact materials such as paper (Trier et al., 2011; Rosenmai et al., 2013; Schaider et al., 2017).

NOTE: Short-chain PFAS have not been banned for use in the manufacturing of contact food materials in the United States.

PFAS has been used by the paper industry as a special protective coating against grease, oil, and water for paper and paperboards, including food packaging since the late 1950s (Trier et al., 2018). PFAS application for food packaging includes paper products that come into contact with food such as paper plates, food containers, bags, and wraps (OECD, 2002). Pre-wrapped food or snacks (such as candy bars, microwave popcorn, etc.) must not be in the sampling and staging areas during sampling due to PFAS contamination of the packaging. When staff requires a break to eat or drink, they should remove their gloves, coveralls, and any other PPE, if worn, in the staging area and move to the designated area for food and beverage consumption. When finished, staff should wash their hands and put on a fresh pair of powderless nitrile gloves at the staging area, before returning to the sampling area.

- ● Do not handle, consume, or otherwise interact with pre-wrapped food or snacks, carry-out food, fast food, or other food items while on-site during sampling.
- ■ Move to the staging area and remove PPE prior to leaving the sampling and staging areas if consuming food on site becomes necessary.

4.3 PFAS Sampling Procedures

4.3.1 Sample Containers, Handling, and Collection

All bottles used for PFAS sampling should come from the laboratory that will also be performing the PFAS analysis. Commercial laboratories that have demonstrated awareness and elimination of possible PFAS cross-contamination from sample containers and laboratory supplies should be used. Recommended sampling containers will be discussed for each environmental media. Any sampling containers provided by the laboratory should be verified as PFAS-free.

Before sampling, staff may come into contact with textiles and fabrics treated with PFAS, such as carpets and car interiors. Staff should be aware that these materials, and any other surfaces that repel water and are stain resistant, have the potential of being treated with PFAS. However, these are considered **Category 2** materials and the field personnel should be aware of the possible PFAS use. Sample containers and equipment that will be used for sampling should not be stored on or come into contact with materials suspected to contain PFAS.

For all environmental media, hands should be well washed before sampling. Clean powderless nitrile gloves must be put on before sample collection, handling of sample containers, and handling sampling equipment. The sample container must be kept sealed at all times and only open during the sample collection. The sampling container cap or lid should never be placed on any surface unless it is PFAS-free. The sampling container cap or lid must never be placed directly on the ground. A list of various materials used in sampling and handling can be found in the **MDEQ Quick Reference Field Guide** located at the end of this document.

In the absence of formal USEPA guidance for PFAS sample storage, the documentation in EPA Method 537 Rev. 1.1 should be used as a guide for thermal preservation (holding temperature), and holding times for other environmental media samples (with the exception of biota – in order to limit microbial growth, biota samples such as fish and vegetation are recommended to be kept frozen until the sample is prepared).

If published analytical reference methods, other than EPA Method 537 Rev. 1.1 are used, follow the guidelines or requirements in those methods for sample storage, preservation, and hold times. Otherwise EPA Method 537 Rev. 1.1 requries that samples must be chilled during storage and shipment, and must not exceed 50°F (10°C) during the first 48 hours after collection.

4.3.2 Sample Shipment

In general, for all environmental media sampled for PFAS, samples must be kept on ice from the time of sample collection to the arrival at the laboratory. The following procedures should be used for sample shipment:

- ■ Regular ice should be used to cool and maintain the sample at or below the proper temperature.
  - ▲ Chemical or blue ice may be used if it is known to be PFAS-free and it is absolutely certain that the sample is cooled and maintained at or below the proper temperature during collection and through transit to the laboratory.
- ■ Refresh with regular ice, if needed, double bagged in LDPE resealable storage bags if needed.
- ■ Fish and other wildlife samples should be placed on dry ice and frozen before the shipment to the lab. If fish is frozen, shipping the samples overnight on ice should be acceptable.
- ■ The samples, ice, and chain of custody (COC) should always be bagged in polyethylene (i.e., Ziploc®) bags.
- ■ Chain of Custody and other forms should be single bagged in LDPE resealable storage bags and taped to the inside of the cooler lid.
- ■ The cooler should be taped closed with a custody seal and shipped by overnight courier.
- ■ Samples should be shipped as soon as possible (e.g. overnight) to ensure the samples arrive within the analytical holding time specified by the lab.

4.3.3 Preferential Sampling Sequence

A preferred sampling sequence should be established before any sampling event to reduce the risk of cross-contamination. In general, the sampling sequence should be such that sampling starts in areas where it is expected or known to be least contaminated, to areas anticipated or identified to be most contaminated. If analytical results from past sampling events are available, the sampling sequence can be readily determined.

For many PFAS investigation sites, no PFAS sampling has been conducted. In these cases, all site information on possible PFAS uses and potential PFAS migration patterns (e.g., upgradient, downgradient) from PFAS sources at the site should be reviewed before the sampling event to help establish the sampling sequence.

If multiple samples (i.e., monitoring wells) will be collected for an area where a particular or potential PFAS release in the environment might have been documented, samples that are known to be upgradient from the impacted area should be sampled first, followed by those that are furthest downgradient from the suspected source. The remaining wells should be progressively sampled from the most distant downgradient to those closer to the known PFAS source.

If no information is available about the site, samples are to be collected in the following order:

1) drinking water (e.g., residential wells).
2) surface water.
3) groundwater.

4.4 Decontamination Procedures

It is customary with sampling that equipment is decontaminated at the conclusion of the sampling event. <u>If the previous user of the equipment is not known, and it is unclear how the equipment was handled, especially rental equipment, the equipment should be decontaminated.</u>

Disposable **Category 1** sampling equipment should be used, especially for sample bottles and other materials that are used where the sample may be in contact with the sampling equipment for an extended time period.

Non-disposable sampling equipment used at multiple sites or sampling locations can become highly contaminated with PFAS. Decontamination procedures must be implemented to prevent cross-contamination, especially between individual sample locations. It is customary to decontaminate sampling equipment at the end of the sampling event, whether the event is a single sampling location or several sites that conclude at the end of the workday.

Throughout the sampling guidance documents, information will be provided about any media-specific decontamination procedures. For non-dedicated **Category 1** sampling equipment, there are many decontamination methods, two of which are listed below.

Decontamination Method 1:

- ● Do not use Decon 90®.
- ● Do not put equipment away without decontaminating it.
- ■ Laboratory supplied PFAS-free deionized water is preferred for decontamination.
- ■ Alconox®, Liquinox®, and Citranox® can be used for equipment decontamination.
- ■ Sampling equipment can be scrubbed using polyethylene or polyvinylchloride (PVC) brush to remove particulates.
- ■ Decontamination procedures should include triple rinsing with PFAS-free water.
- ■ Do decontaminate sampling equipment after sampling at each location, or at the end of the workday.
- ■ Commercially available deionized water in an HDPE container may be used for decontamination if the water is verified to be PFAS-free as defined in **Section 4.2.1** of this document.
- ▲ Municipal drinking water may be used for decontamination purposes if it is known to be PFAS-free.

Decontamination Method 2:

1. In a PFAS-free bucket, wash the equipment with a mixture of PFAS-free water and PFAS-free soap (bucket #1)
2. In a second PFAS-free bucket (bucket #2), rinse the equipment with PFAS-free water
3. A second rinse should be done with PFAS-free water using either a third bucket (bucket #3) or, if washed and rinsed, the second bucket (bucket #2).
4. For decontamination of additional equipment, change the decontamination water between cleanings.

4.5 Laboratory Considerations

The PFAS analytical list is available on the MPART website (www.michigan.gov/PFASresponse) under Testing and Treatment. This list includes the 14 analytes required to be analyzed for drinking water samples when using USEPA Method 537 Rev. 1.1, and the 24 analytes the MDEQ recommends be analyzed for all other environmental media. The MPART website should be visited to download the most recent document. Laboratories should be able to analyze and report PFAS results that will meet the project-specific data quality objectives identified in the QAPP.

Drinking Water Samples

> **NOTE:** USEPA Method 537 Rev. 1.1 was developed to be used only for finished drinking water samples, and contains specific requirements for sample preservation, shipping storage, and holding times.

USEPA Method 537 Revision 1.1 must be used for testing finished drinking water samples. Other methods are available for non-drinking water samples. Many laboratories refer to the isotope dilution method as 'modified Method 537,' however, the USEPA does not recognize isotope dilution as an acceptable modification of USEPA Method 537 Rev. 1.1 for drinking water analysis. USEPA drinking water methods are generally prescriptive, and only limited modifications are allowed because the finished treated drinking water is assumed to be free of significant interferences.

USEPA Method 537 Rev. 1.1 was designed for finished drinking water and chemical preservation using Trizma® to buffer the sample and remove free chlorine. Non-chlorinated finished drinking water may also be analyzed using USEPA Method 537 Rev. 1.1.

Other Environmental Media Samples

There are currently no published USEPA methods using isotope dilution for determining PFAS in non-drinking water matrices or other sample media. There are USEPA methods for analyzing PFAS in additional matrices going through the development and validation process and may be available as early as fall of 2018. Some commercial laboratories have developed isotope dilution methods based on existing published methods, however, there may be significant differences between SOPs from different commercial laboratories regarding the details of the preparation and analysis of PFAS samples. A review of the laboratory's procedure and certifications should be done to ensure that the laboratory is capable of providing data that meet the data quality objectives of the project. MDEQ is implementing a laboratory SOP review process. Staff should refer to the MDEQ internal shared drive to see whether SOPs have been reviewed for the lab they are considering.

The following non-USEPA analytical methods have been published for use in determining PFAS in various media:

- ISO (International Organization for Standardization) Method 25101 (ISO, 2009) - Water quality Determination of PFOA and PFOS - Method for unfiltered samples of drinking water, groundwater, and surface water, using solid phase extraction and liquid chromatography/mass spectrometry (HPLC/MS/MS.)

- ASTM D7979 (ASTM, 2017) - Standard Test Method for Determination of Per- and Polyfluoroalkyl Substances in Water, Sludge, Influent, Effluent and Wastewater by Liquid Chromatography-Tandem Mass Spectrometry (LC/MS/MS). This method has been investigated for use with surface water, sludge, and wastewater for selected PFAS. This method has not been evaluated on drinking water matrices. Some commercial laboratories have modified this method and are using isotope dilution.

- ASTM D7968 (ASTM, 2017) - Standard Test Method for Determination of Polyfluorinated Compounds in Soil by Liquid Chromatography-Tandem Mass Spectrometry (LC/MS/MS). This procedure utilizes a quick extraction and is not intended to generate an exhaustive accounting of the content of PFAS in difficult soil matrices.

4.6 Quality Control Samples

4.6.1 Laboratory Quality Control Samples

The QAPP should describe what batch quality control (QC) samples – such as method blank (MB), laboratory control sample (LCS), laboratory control sample duplicate (LCSD), field duplicate (FD), matrix spike (MS), and matrix spike duplicate (MSD) – are prepared for each media type. In some cases, depending on the project, additional QC samples may be required. For samples with high concentrations of PFAS, an FD may be warranted. The QAPP should also reference the laboratory SOP.

4.6.2 Field Quality Control Samples

Field QC samples can be used to evaluate the field equipment and supplies as well as assess the possibility of cross-contamination during sampling, transport, and storage of samples. For samples such as equipment rinse blanks (EB), field blanks (FB), and trip blanks (TB) the following is required:

- EB should be collected by passing laboratory verified PFAS-free water over or through decontaminated field sampling equipment before the collection of samples to assess the adequacy of the decontamination process and/or to evaluate potential contamination from the equipment used during sampling. The recommended frequency should be in the QAPP.

- FB are prepared in the laboratory by placing an aliquot of PFAS-free water reagent water in a sample container and treating it as a sample in all respects, including shipment to the sampling site, exposure to sampling site conditions, storage, preservation, and all analytical procedures. The purpose of the FB is to determine if method analytes or other interferences are present in the field environment. The recommended frequency should be in the QAPP.

- TB are a bottle of PFAS-free water that should be prepared in the laboratory, should then travel from the laboratory to the site, and then get transported back to the laboratory without having been exposed to any sampling procedures. Typically, a TB is used for volatile compounds, but it may be recommended for PFAS sampling to assess cross-contamination introduced from the laboratory and during shipping procedures. The recommended frequency should be in the QAPP

5. References

Agency for Toxic Substances and Disease Registry (ATSDR). "Draft Toxicological Profile for Perfluoroalkyls." *United States Department of Health and Human Services. (*2015). *ATSDR.* Web. 19 June 2018. https://www.atsdr.cdc.gov/toxprofiles/tp200.pdf

ASTM International. "ASTM D7979 - Standard Test Method for Determination of Per- and Polyfluoroalkyl Substances in Water, Sludge, Influent, Effluent and Wastewater by Liquid Chromatography Tandem Mass Spectrometry (LC/MS/MS)." ASTM International. Web. 19 June 2018. https://www.astm.org/Standards/D7979.htm

ASTM International. "ASTM D7968 - Standard Test Method for Determination of Polyfluorinated Compounds in Soil by Liquid Chromatography Tandem Mass Spectrometry (LC/MS/MS)." ASTM International. Web. 19 June 2018. https://www.astm.org/Standards/D7968.htm

Borg, Daniel and Ivarsson, Jenny. "Analysis of PFASs and TOF in Products." *Nordic Co-Operation* 543 (2017): 1-47. *Nordic Council of Ministers*. Web. 19 June 2018. https://norden.diva-portal.org/smash/get/diva2:1118439/FULLTEXT01.pdf

Buck, Robert C et al. "Perfluoroalkyl and Polyfluoroalkyl Substances in the Environment: Terminology, Classification, and Origins." *Integrated Environmental Assessment and Management* 7(4) (2011): 513–541. *PMC*. Web. 11 June 2018. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3214619/

Danish Environmental Protection Agency (DEPA). "Polyfluoroalkyl substances (PFASs) in textiles for children." DEPA 137 (2015). *ResearchGate*. Web. 19 June 2018. https://www.researchgate.net/publication/299228813_Alternatives_to_perfluoroalkyl_and_polyfluoroalkyl_substances_PFAS_in_textiles_LOUS_Survey_of_chemical_substances_in_consumer_products

Fujii, Y. et al. "Occurrence of perfluorinated carboxylic acids (PFCAs) in personal care products and compounding agents." *Chemosphere* 93(3) (2013):538-544. *NCBI.* Web. 19 June 2018. https://www.ncbi.nlm.nih.gov/pubmed/23932147

Interstate Regulatory Technology Council (ITRC). "Regulations, Guidance, and Advisories for Per- and Polyfluoroalkyl Substances (PFAS)." (2017). *ITRC Web.* Web. 19 June 2018. https://pfas-1.itrcweb.org/wp-content/uploads/2018/01/pfas_fact_sheet_regulations__1_4_18.pdf

International Organization of Standardization (ISO). "ISO 25101:2009 Water quality -- Determination of perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA) -- Method for unfiltered samples using solid phase extraction and liquid chromatography/mass spectrometry." (2009). *Iso*. Web. 19 June 2018. https://www.iso.org/standard/42742.html

KEMI. "Occurrence and use of highly fluorinated substances and alternatives" *Swedish Chemicals Agency.* (2015). *KEMI*. Web. 19 June 2018. https://www.kemi.se/en/global/rapporter/2015/report-7-15-occurrence-and-use-of-highly-fluorinated-substances-and-alternatives.pdf

Organization for Economic Cooperation and Development (OECD)/UNEP Global PFC Group, "Technical Guidance Document on the Use of Socio-Economic Analysis in Chemical Risk Management Decision Making." *Risk Management Series* (14) (2002). OECD. Web. 19 June 2018. http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=ENV/JM/MONO(2002)10&docLanguage=En

Organization for Economic Cooperation and Development (OECD) (2013), OECD/UNEP Global PFC Group, Synthesis paper on per- and polyfluorinated chemicals (PFCs), Environment, Health and Safety, Environment Directorate, OECD. Web. 19 June 2018. https://www.oecd.org/env/ehs/risk-management/PFC_FINAL-Web.pdf

Rosenmai, A.K. et al. “Fluorochemicals used in food packaging inhibit male sex hormone synthesis.” *Toxicology and Applied Pharmacology* 266(1) (2013): 132-142. *Elsevier*. Web. 19 June 2018. https://www.sciencedirect.com/science/article/pii/S0041008X12004644

Schaider, Laurel A. et al. “Fluorinated Compounds in U.S. Fast Food Packaging.” *Environmental Science and Technology Letters* 4(3) (2017): 105-111. *ACS*. Web. 19 June 2018. https://pubs.acs.org/doi/abs/10.1021/acs.estlett.6b00435

Trier, Xenia et al. “Polyfluorinated surfactants (PFS) in paper and board coatings for food packaging.” *Environmental Science and Pollution Research.* 18(7) (2011): 1108-1120. *SpringerLink*. Web. 19 June 2018. https://link.springer.com/article/10.1007/s11356-010-0439-3

United States Environmental Protection Agency (USEPA). SHOEMAKER, J. A., P. GRIMMETT, AND B. BOUTIN. Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS). (USEPA Method 537 Revision 1.1) USEPA, Washington, DC, 2008. https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=525468

Wang, Zhanyun et al. “A Never-Ending Story of Per- and Polyfluoroalkyl Substances (PFASs)?” *Environmental Science & Technology* 51(5) (2017): 2508-2518. *ACES Publications*. Web. 11 June 2018. https://pubs.acs.org/doi/pdf/10.1021/acs.est.6b04806

6. Trademarks

Trademarks used in this document are as follows, and do not constitute an endorsement by the MDEQ:
Alconox® is a registered trademark of Alconox, Inc.
Bionic Finish® is a registered trademark of the Rudolf Group.
Citronex® is a registered trademark of Citronex.
Decon 90® is a trademark of Decon Laboratories Limited.
Gatorade® is a registered trademark of Stokely-Van Camp, Inc.
Gore-Tex® is a registered trademark of W. L. Gore & Associates, Inc.
GreenShield® is a registered trademark of BigSky Technologies LLC.
Hostaflon® FEP is a registered trademark of Hoechst AG.
Hostaflon® is a registered trademark of the Chemours Company (formerly E. I. DuPont de Nemours and Company).
Kynar® is a registered trademark of Arkema, Inc.
Liquinox® is a registered trademark of Alconox, Inc.
Lurotex Protector RL ECO® is a registered trademark of BASF Group.
Neoflon® FEP is a registered trademark of Daikin Industries, Ltd.
Neoflon® is a registered trademark of Daikin Industries, Ltd.
NK Guard S series™ is a registered trademark of Nicca.
Post-It® notes are a registered trademark of 3M.
Powerade® is a registered trademark of The Coca-Cola Company.
Repellan KFC® is a registered trademark of Pulcra Chemicals.
Resist Spills and Releases Stains™ is a registered trademark of Nano-Tex.
Resist Spills™ is a registered trademark of Nano-Tex.
Rite in the Rain® is a registered trademark of JL Darling LLC.
RUCO® is a registered trademark of the Rudolf Group.
RUCO-COAT® is a registered trademark of the Rudolf Group.
RUCO-GUARD® is a registered trademark of the Rudolf Group.
RUCO-PROTECT® is a registered trademark of the Rudolf Group.
Rucostar® EEE6 is a registered trademark of the Rudolf Group.
RUCOSTAR® is a registered trademark of the Rudolf Group.
RUCOTEC® is a registered trademark of the Rudolf Group.
Scotchgard™ Fabric Protector is a registered trademark of 3M.
Sharpie® is registered trademark of Newell Brands.
Teflon® is a trademark of the Chemours Company (formerly E.I. DuPont de Nemours and Company).
Tefzel® is a registered trademark of the Chemours Company (formerly E. I. DuPont de Nemours and Company).
Trizma® is a registered trademark of the Sigma-Aldrich Company.
Tyvek® is a registered trademark of the Chemours Company (formerly E. I. DuPont de Nemours and Company).
Unidyne™ is a registered trademark of Daikin Industries, Ltd.
Ziploc® is a registered trademark of S. C. Johnson & Son.

[THIS PAGE IS INTENTIONALLY LEFT BLANK]

Michigan Department of Environmental Quality

MDEQ PFAS Sampling Quick Reference Field Guide[1]

All Items Used During Sampling Event

Prohibited

- Items or materials that contain fluoropolymers such as
  - o Polytetrafluoroethylene (PTFE), that includes the trademarks Teflon® and Hostaflon®
  - o Polyvinylidene fluoride (PVDF), that includes the trademark Kynar®
  - o Polycholotrifluoroethylene (PCTFE), that includes the trademark Neoflon ®
  - o Ethylene-tetrafluoro-ethylene (ETFE), that includes the trademark Tefzel®
  - o Fluorinated ethylene propylene (FEP), that includes the trademarks Teflon® FEP and Hostaflon® FEP
- Items or materials that contain any other fluoropolymer

Pumps, Tubing, and Sampling Equipment

Prohibited	Allowable	Needs Screening[2]
• Items or materials containing any fluoropolymer (potential items include tubing, valves, or pipe thread seal tape)	• High-density polyethylene (HDPE) • Low-density polyethylene (LDPE) tubing • Polypropylene • Silicone • Stainless-steel • Any items used to secure sampling bottles made from: o Natural rubber o Nylon (cable ties) o Uncoated metal springs o Polyethylene	• Any items or materials that will come into direct contact with the sample that have **not** been verified to be PFAS-free o Do not assume that any sampling items or materials are PFAS-free based on composition alone

Sample Storage and Preservation

Prohibited	Allowable	Needs Screening[2]
• Polytetrafluoroethylene (PTFE): Teflon® lined bottles or caps	• Glass jars[4] • Laboratory-provided PFAS-Free bottles: o HDPE or polypropylene • Regular wet ice • Thin HDPE sheeting • LDPE resealable storage bags (i.e. Ziploc®) that will not contact the sample media[6]	• Aluminium foil[4] • Chemical or blue ice[5] • Plastic storage bags other than those listed as Allowable • Low-density polyethylene (LDPE) bottles

Field Documentation

Prohibited	Allowable	Needs Screening[2]
• Clipboards coated with PFAS • Notebooks made with PFAS treated paper • PFAS treated loose paper • PFAS treated adhesive paper products	• Loose paper (non-waterproof, non-recycled) • Rite in the Rain® notebooks • Aluminium, polypropylene, or Masonite field clipboards • Ballpoint pens, pencils, and Fine or Ultra-Fine Point Sharpie® markers	• Plastic clipboards, binders, or spiral hard cover notebooks • All markers not listed as Allowable • Post-It® Notes or other adhesive paper products • Waterproof field books

Decontamination

Prohibited	Allowable	Needs Screening[2]
• Decon 90® • PFAS treated paper towel	• Alconox®, Liquinox®, or Citranox® • Triple rinse with PFAS-free deionized water • Cotton cloth or untreated paper towel	• Municipal water • Recycled paper towels or chemically treated paper towels

Clothing, Boots, Rain Gear, and PPE

● Prohibited	■ Allowable	▲ Needs Screening[2]
• New or unwashed clothing • Anything made of or with: o Gore-Tex™ or other water-resistant synthetics • Anything applied with or recently washed with: o Fabric softeners o Fabric protectors, including UV protection o Insect resistant chemicals o Water, dirt, and/or stain resistant chemicals	• Powderless nitrile gloves • Well-laundered synthetic or 100% cotton clothing, with most recent launderings not using fabric softeners • Made of or with: o Polyurethane o Polyvinyl chloride (PVC) o Wax coated fabrics o Rubber / Neoprene o Uncoated Tyvek®	• Latex gloves • Water and/or dirt resistant leather gloves • Any special gloves required by a HASP • Tyvek® suits, clothing that contains Tyvek®, or coated Tyvek®

Food and Beverages

● Prohibited	■ Allowable
• No food should be consumed in the staging or sampling areas, including pre-packaged food or snacks. ■ If consuming food on-site becomes necessary, move to the staging area and remove PPE. After eating, wash hands thoroughly and put on new PPE.	• Brought and consumed only outside the vicinity of the sampling area: o Bottled water o Hydration drinks (i.e. Gatorade®, Powerade®)

Personal Care Products (PCPs) - for day of sample collection[6]

● Prohibited	■ Allowable	▲ Needs Screening[2]
• Any PCPs[6], sunscreen, and insect repellent applied in the sampling area.	PCPs[6], sunscreens, and insect repellents applied in the staging area, away from sampling bottles and equipment followed by thoroughly washing hands: **PCPs[6]:** • Cosmetics, deodorants/antiperspirants, moisturizers, hand creams, and other PCPs[6] **Sunscreens:** • Banana Boat® for Men Triple Defense Continuous Spray Sunscreen SPF 30 • Banana Boat® Sport Performance Coolzone Broad Spectrum SPF 30 • Banana Boat® Sport Performance Sunscreen Lotion Broad Spectrum SPF 30 • Banana Boat® Sport Performance Sunscreen Stick SPF 50 • Coppertone® Sunscreen Lotion Ultra Guard Broad Spectrum SPF 50 • Coppertone® Sport High Performance AccuSpray Sunscreen SPF 30 • Coppertone® Sunscreen Stick Kids SPF 55 • L'Oréal® Silky Sheer Face Lotion 50 • Meijer® Clear Zinc Sunscreen Lotion Broad Spectrum SPF 50 • Meijer® Sunscreen Continuous Spray Broad Spectrum SPF 30 • Meijer® Clear Zinc Sunscreen Lotion Broad Spectrum SPF 15, 30 and 50 • Meijer® Wet Skin Kids Sunscreen Continuous Spray Broad Spectrum SPF 70 • Neutrogena® Beach Defense Water+Sun Barrier Lotion SPF 70 • Neutrogena® Beach Defense Water+Sun Barrier Spray Broad Spectrum SPF 30 • Neutrogena® Pure & Free Baby Sunscreen Broad Spectrum SPF 60+ • Neutrogena® UltraSheer Dry-Touch Sunscreen Broad Spectrum SPF 30 **Insect Repellents:** • OFF® Deep Woods • Sawyer® Permethrin	• Products other than those listed as ■Allowable

[1] This table is not considered to be a complete listing of prohibited or allowable materials. All materials should be evaluated prior to use during sampling. The manufacturers of various products should be contacted in order to determine if PFAS was used in the production of any particular product.

[2] Equipment blank samples should be taken to verify these products are PFAS-free prior to use during sampling.

[3] **For surface water foam samples:** LDPE storage bags may be used in the sampling of foam on surface waters. In this instance, it is allowable for the LDPE bag to come into direct contact with the sample media.

[4] **For fish and other wildlife samples:** Depending on the project objectives, glass jars and aluminum foil might be used for PFAS sampling. PFAS has been found to bind to glass and if the sample is stored in a glass jar, a rinse of the jar is required during the sample analysis. PFAS are sometimes used as a protective layer for some aluminum foils. An equipment blank sample should be collected prior to any aluminum foil use.

[5] Regular ice is recommended as there are concerns that chemical and blue ice may not cool and maintain the sample at or below 42.8˚F (6°C) (as determined by EPA 40 CFR 136 – NPDES) during collection and through transit to the laboratory.

[6] Based on evidence, avoidance of PCPs is considered to be precautionary because none have been documented as having cross-contaminated samples due to their use. However, if used, application of PCPs must be done at the staging area and away from sampling bottles and equipment, and hands must be thoroughly washed after the use of any PCPs prior to sampling.

● - Prohibited ■ - Allowable ▲ - Needs Screening

RESIDENTIAL WELL PFAS SAMPLING

Guidance

Introduction

This sampling guidance discusses the processes and acceptable items and materials that should be used by the Michigan Department of Environmental Quality (MDEQ) and local health department staff conducting residential well sampling for per- and polyfluoroalkyl substances (PFAS). This guidance will be used to support the sampling objectives and procedures based on any and Quality Assurance Project Plan (QAPP) developed before starting field activities.

NOTE: Review the **General PFAS Sampling Guidance** document prior to reviewing this guidance document.

This guidance assumes staff has basic familiarity with and/or understanding of basic residential well sampling procedures. If you are a homeowner or resident interested in sampling your own well, please see the separate **For Homeowners – Residential Well PFAS Sampling Guidance.**

The MDEQ intends to update the information contained within this Residential Well PFAS Sampling Guidance document as new information becomes available. The user of this Residential Well PFAS Sampling Guidance is encouraged to visit the Michigan PFAS Action Response Team (MPART) webpage (www.michigan.gov/PFASresponse) to access the most current version of this document.

PFAS has been detected in groundwater in Michigan from residential wells at concentrations over 60,000 parts per trillion (ppt). Many commercial laboratories have low PFAS detection limits of about 1 ppt. Therefore, there is a high potential of false positives if proper procedures are not followed during sample collection.

This Residential Well PFAS Sampling Guidance discusses the potential for cross-contamination that can occur from:

- Field clothing and personal protective equipment (PPE)
- Sampling equipment
- Sample collection and handling
- Sample shipment

CONTENTS

NOTE: Additional information about PFAS testing can be found on the Michigan PFAS Action Response Team (MPART) website: www.michigan.gov/PFASresponse

1. Typical Well Construction

There are several different types of drinking water well construction methods found in Michigan—rotary drilling, cable tool, auger drilling, cable tool, auger drilling, hand driving, jetting, hollow-rod and dug wells. Well construction does not affect sampling methods but may provide additional insight into the meaning of the results.

Before sampling, staff should obtain the well construction record through the MDEQ's statewide groundwater database, Wellogic (https://secure1.state.mi.us/wellogic), or by contacting the local health department. Records for wells constructed since the year 2000 are typically located in Wellogic. Older well records may be found in the Scanned Water Well Record Retrieval System (see link in Wellogic). The well record will indicate the drilling method, well depth, type of formations encountered, grout (present or absent), type of pumping equipment, and more.

2. Potential Sources for PFAS Cross-Contamination

Potential sources for PFAS cross-contamination include items and materials used within the sampling environment, such as sampling equipment, field clothing, personal protective equipment (PPE), sun and biological protection products, personal hygiene, personal care products (PCPs), and food packaging, A detailed discussion about potential sources for PFAS cross-contamination is included in the **General PFAS Sampling Guidance**, which should be reviewed before reading this document. However, a high-level summary is presented in this guidance.

All of the items and materials discussed in each of the MDEQ's PFAS Sampling Guidance Documents are divided into three major groups:

- Prohibited (●) identifies items and materials that should not be used when sampling. It is well documented that they contain PFAS or that PFAS are used in their manufacture.

- Allowable (■) identifies items and materials that have been proven not to be sources of PFAS cross contamination and are considered acceptable for sampling.

- Needs Screening (▲) identifies items and materials that have the potential for PFAS cross-contamination due to a lack of scientific data or statements from manufacturers to prove otherwise. These items and materials are further sub-divided into two categories:

    - **Category 1:** Items and materials that <u>will come in direct contact</u> with the sample. These should not be used when sampling unless they are known to be PFAS-free, by collecting an equipment blank sample prior to use.

    - **Category 2:** Items and materials that <u>will not come in direct contact</u> with the sample. These should be avoided, if possible, unless they are known to be PFAS-free by collecting an equipment blank sample prior to use.

Please note that at this time no published research is available that documents the use of various materials and effect on sample results. Therefore, a conservative approach is recommended, and the guidance is based on the collection of multiple environmental samples at various PFAS Sites. Sampling staff should take practical and appropriate precautions to avoid items that are likely to contain PFAS at the sampling site as well as avoid specific items during the sampling event.

2.1 Field Clothing, Personal Protection Equipment (PPE), and Residential Well Sampling Materials and Equipment

Materials, field clothing, and equipment screening should be performed during the QAPP development or the planning phase of sampling programs. The screening should be performed on all the items and materials that are expected to come into contact with the samples and are defined as **Category 1.** Due to the extensive use of PFAS in many industries and products, PPE may contain PFAS. During a PFAS investigation, PPE-containing PFAS should be avoided to prevent cross-contamination. Personal safety is paramount. The safety of staff should not be compromised by fear of PFAS-containing materials without any scientific basis. Any deviation from this guidance, including those necessary to ensure the health and safety of sampling personnel, should be recorded in field notes and discussed in the final report. Do not use any materials or equipment that contains any known fluoropolymers or that potentially has been cross-contaminated with PFAS such as, but not limited to the following:

- ● Do not use polytetrafluoroethylene (PTFE), that includes the trademark Teflon® and Hostaflon®, which can be found in many items, including but not limited to the lining of some hoses and tubing, some wiring, certain kinds of gears, lubricant, and some objects that require the sliding action of parts.
- ● Do not use Polyvinylidene fluoride (PVDF), that includes the trademark Kynar®, which can be found in many items, including but not limited to tubing, films/coatings on aluminum, galvanized or aluminized steel, wire insulators, and lithium-ion batteries.
- ● Do not use Polychlorotrifluoroethylene (PCTFE), that includes the trademark Neoflon®, which can be found in many items, including but not limited to valves, seals, gaskets, and food packaging.
- ● Do not use Ethylene-tetrafluoro-ethylene (ETFE), that includes the trademark Tefzel®, which can be found in many items, including but not limited to wire and cable insulation and covers, films for roofing and siding, liners in pipes, and some cable tie wraps.
- ● Do not use Fluorinated ethylene propylene (FEP), that includes the trademarks Teflon® FEP and Hostaflon® FEP, and may also include Neoflon®, which can be found in many items, including but not limited to wire and cable insulation and covers, pipe linings, and some labware.
- ● Do not use low density polyethylene (LDPE) for any items that will come into **direct contact** with the sample media. LDPE can be found in many items, including but not limited to containers and bottles, plastic bags, and tubing.
  - ▲ **However**, LDPE may be used if an equipment blank has confirmed it to be PFAS-free. LDPE does not contain PFAS in the raw material but may contain PFAS cross-contamination from the manufacturing process.

Staff should follow the **MDEQ PFAS Sampling Quick Reference Field Guide** table for approved and prohibited items for documenting and sampling residential wells for PFAS. The following materials or items are allowable:

- ■ LDPE bags (e.g. Ziploc®) that **do not** come into direct contact with the sample media and do not introduce cross contamination with samples may be used.
- ■ Materials that are either made of high density polyethylene (HDPE), polypropylene, silicone, or acetate.
- ■ PFAS-free bottles containing Trizma® preservative provided by the laboratory.
- ■ Powderless nitrile gloves (which can be found at some hardware and major retail outlets).
- ▲ Latex gloves should be screened before use.

●- Prohibited ■- Allowable ▲- Needs Screening

2.2 Personal Care Products (PCPs)

A number of sampling guidance documents recommend that personal hygiene and personal care products (PCPs) (e.g., cosmetics, shampoo, sunscreens, dental floss, etc.) not be used prior to and on the day(s) of sampling because the presence of PFAS in these products has been documented (OECD, 2002, Fujii, 2013, Borg and Ivarsson, 2017). However, if the MDEQ's sampling SOPs are followed, these items should not come into contact with the sampling equipment or the sample being collected. As of the date of this sampling guidance, cross-contamination of samples due to the use of PCPs has not been documented during the collection of thousands of samples. However, field personnel should be aware of the potential of cross-contamination if the sampling equipment or actual samples would come into contact with these products. The following precautions should be taken when dealing with personal hygiene or PCPs before sampling:

- ● Do not handle or apply PCPs in the sampling area.
- ● Do not handle or apply PCPs while wearing PPE that will be present during sampling.
- ■ Move to the staging area and remove PPE if applying personal care products becomes necessary.
- ■ Wash hands thoroughly after the handling or application of PCPs and, when finished, put on a fresh pair of powderless nitrile gloves.

2.3 Food Packaging

PFAS has been used by the paper industry as a special protective coating against grease, oil, and water for paper and paperboards, including food packaging since the late 1950s (Trier et al., 2018). PFAS application for food packaging includes paper products that come into contact with food such as paper plates, food containers, bags, and wraps (OECD, 2002). Pre-wrapped food or snacks (such as candy bars, microwave popcorn, etc.) must not be in the sampling and staging areas during sampling due to PFAS contamination of the packaging. When staff requires a break to eat or drink, they should remove their gloves, coveralls, and any other PPE, if worn, in the staging area and move to the designated area for food and beverage consumption. When finished, staff should wash their hands and put on a fresh pair of powderless nitrile gloves at the staging area, before returning to the sampling area.

- ● Do not handle, consume, or otherwise interact with pre-wrapped food or snacks, carry-out food, fast food, or other food items while on-site during sampling.
- ■ Move to the staging area and remove PPE prior to leaving the sampling and staging areas if consuming food on site becomes necessary.

3. Residential Well Sample Collection and Handling Procedures

Obtain sample bottles – All bottles used for PFAS sampling must come from certified or accredited laboratories that will be performing the PFAS analysis. Bottles should contain Trizma®.

Schedule the sampling visit – Before scheduling a sampling visit:

- Obtain a copy of the well record, if available. Well records may be obtained through the on-line tool Wellogic, or by contacting the local health department.

- Contact the well owner by telephone or send a postcard or letter to the owner of record's mailing address proposing a sample collection date and request that any loose pets be secured on the day of sample collection to protect staff. Provide staff with contact information if a different sampling day or special instructions are needed. If possible, inquire ahead of time about any treatment systems installed on the residential water system, or ask the resident to bypass the

● - Prohibited ■ - Allowable ▲ - Needs Screening

treatment system on the day of sample collection. This is so staff can get a representative sample of what is being produced by the well.

Identify water treatment devices and an appropriate sample tap – The typical residential well sample will either be collected from inside the residents' home or an outside tap. The sample should not be taken from a hose. Gain access to the interior of the home, if possible, to identify any treatment systems such as in-line filtration, softening, iron removal, or other treatment systems before selecting the sample tap location. Primary consideration for sample location should be the kitchen faucet, however, acceptable sample locations include a laundry sink, outside tap, or other commonly used distribution points-of-use within the home.

- ▲ Avoid using leaky or spraying faucets, if possible.
- ▲ When swivel or single lever faucets are used for sampling, please ensure that only cold water is used for flushing and sample collection.
- ■ The sampling of residential wells in a known PFAS-impacted area should be selected in order from least to most contaminated well, if known.

If there is no untreated tap available at the residence and the treatment system cannot be bypassed, consider utilizing the kitchen sink tap, bathroom faucet, or outside tap. Note on the sample request form if the sample was collected from a treated tap.

The sampling of irrigation wells might be required if the resident is using the water for gardening, occasionally use it for drinking water, or to better understand a PFAS plume.

- ● Do not collect the sample from any garden hose or other devices used for irrigation.
- ■ The sample should be located as close to the well as possible.

Flush using Untied States Environmental Protection Agency (USEPA) Method 537 – USEPA Method 537 v1.1, section 8.2.2 states that the sampler open the tap and allow the system to flush until the water temperature has stabilized (approximately 3 to 5 minutes). Samples are collected from the flowing system.

- Options for flushing include running water at a nearby laundry sink, another household sink, or bathtub; flushing a toilet; opening the outside tap; or a combination of any of these taps.
- If an outside tap is used, collect flushed water in a bucket and dispose of the water in the yard.

Sample Collection – Careful planning must be done in advance of the sample collection to minimize the potential for cross-contamination. Use powderless nitrile gloves during sample collection. Powderless nitrile gloves should be changed frequently, at any time there is an opportunity for cross-contamination of the sampling, including, but not limited to, the following activities:

- Before sample collection.
- While handling any sample, including quality assurance/quality control (QA/QC) samples, such as field reagent blanks.
- Handling of any non-dedicated sampling equipment (equipment used for more than one specific location), contact with non-decontaminated surfaces, or when judged necessary by staff.

The following considerations should be taken during sample collection to prevent contamination:

- ● Attention should be given such that no dust or fibers fall into the sample bottle.
- ● Never set the cap down, touch any part of the cap that contacts the bottle, or let anything touch the rim of the bottle or inside the cap.
- ● Care should be given such that no splashed drops of water from the sink or ground enter the sample bottle.

●- Prohibited ■- Allowable ▲- Needs Screening

- ● Do not let the sample bottle overflow; if the bottle overflows, the Trizma presevative will be flushed out.
- ● Do not use markers other than Fine or Ultra-Fine point Sharpies®, which have been proven to be PFAS-free.
- ■ Use PFAS-free markers to label the empty sample bottle prior to or immediately after the sample collection. Make sure the cap is on the sample bottle and gloves are changed after sample bottle labeling. Allow the ink to dry completely before proceeding. Preprinted labels from the laboratory can also be used. A recommended practice is to place the labeled container on the polyethylene bag as used below, after labeling.
- ■ Ensure that the sample tap is protected from dust, dirt, and debris, and ensure the sample tap is not too close to the sink bottom or the ground so that splashing is avoided.
- ■ Notes should be taken, and the presence of Teflon® tape on the piping should be noted.
- ■ A residential well sample should be collected from the cold water tap only.
- ■ Whenever possible, note and remove any attachments from the taps, including aerators, screens, washers, hoses, and water filters.
- ■ Use HDPE or polypropylene sample bottles provided by the laboratory, with Teflon®-free caps.
- ■ Glass bottles or containers may be used if they are known to be PFAS-free, however, PFAS have been found to adsorb to glass, especially when the sample is in contact with the glass for a long period of time (e.g. being stored in a glass container). If the sample comes into direct contact with the glass for a short period of time (e.g. using a glass container to collect the sample, then transferring the sample to a non-glass sample bottle), the adsorption is minimal.
- ■ Fill the bottle to the neck only, taking care to not flush out the Trizma preservative
- ■ Cap the bottle, then gently agitate by hand until preservative is dissolved. Do not reopen the bottle.
- ■ Samples should be double bagged using resealable low density polyethelene (LDPE) bags (e.g., Ziploc®).
- ■ Prior to shipment samples need to be chilled, and must not exceed 50° F (10°C) during the first 48 hours after collection. (EPA Method 537 Rev. 1.1).

4. Sample Shipment

The following recommendations should be used for the sample shipment:

- ■ Wet ice should be used to cool and maintain the sample at or below 50°F (10°C) during the first 48 hours after collection. (EPA Method 537 Rev. 1.1).
    - ▲ Chemical or blue ice may be used if it is known to be PFAS-free and it is absolutely certain that the sample is cooled and maintained at or below 42.8°F (6°C) during collection and through transit to the laboratory.
- ■ Use wet ice that is double bagged using resealable low density polyethelene (LDPE) bags (e.g., Ziploc®).
- ■ Check the cooler periodically to ensure samples are well iced and at the proper temperature.
- ■ Refresh with regular ice, if needed, double bagged in LDPE resealable storage bags if needed.
- ■ Samples must be chilled **during shipment** and must not exceed 50°F (10°C) during the first 48 hours after collection. (EPA Method 537 Rev. 1.1).
- ■ Chain of Custody (COC) should be single-bagged in resealable low density polyethelene (LDPE) bags (e.g., Ziploc®) and taped to the inside of the cooler lid.
- ■ The cooler should be taped closed with a custody seal and shipped by overnight courier.
- ■ Residential well samples should be shipped to the laboratory as soon as possible (e.g. overnight), so the lab may perform the necessary steps within the 14 day holding time beginning the date of sample collection (EPA Method 537 Rev. 1.1).

●- Prohibited ■- Allowable ▲- Needs Screening

Michigan Department of Environmental Quality

MDEQ PFAS Sampling Quick Reference Field Guide[1]

All Items Used During Sampling Event

Prohibited
• Items or materials that contain fluoropolymers such as o Polytetrafluoroethylene (PTFE), that includes the trademarks Teflon® and Hostaflon® o Polyvinylidene fluoride (PVDF), that includes the trademark Kynar® o Polycholotrifluoroethylene (PCTFE), that includes the trademark Neoflon ® o Ethylene-tetrafluoro-ethylene (ETFE), that includes the trademark Tefzel® o Fluorinated ethylene propylene (FEP), that includes the trademarks Teflon® FEP and Hostaflon® FEP • Items or materials that contain any other fluoropolymer

Pumps, Tubing, and Sampling Equipment

Prohibited	Allowable	Needs Screening[2]
• Items or materials containing any fluoropolymer (potential items include tubing, valves, or pipe thread seal tape)	• High-density polyethylene (HDPE) • Low-density polyethylene (LDPE) tubing • Polypropylene • Silicone • Stainless-steel • Any items used to secure sampling bottles made from: o Natural rubber o Nylon (cable ties) o Uncoated metal springs o Polyethylene	• Any items or materials that will come into direct contact with the sample that have **not** been verified to be PFAS-free o Do not assume that any sampling items or materials are PFAS-free based on composition alone

Sample Storage and Preservation

Prohibited	Allowable	Needs Screening[2]
• Polytetrafluoroethylene (PTFE): Teflon® lined bottles or caps	• Glass jars[4] • Laboratory-provided PFAS-Free bottles: o HDPE or polypropylene • Regular wet ice • Thin HDPE sheeting • LDPE resealable storage bags (i.e. Ziploc®) that will not contact the sample media[6]	• Aluminium foil[4] • Chemical or blue ice[5] • Plastic storage bags other than those listed as Allowable • Low-density polyethylene (LDPE) bottles

Field Documentation

Prohibited	Allowable	Needs Screening[2]
• Clipboards coated with PFAS • Notebooks made with PFAS treated paper • PFAS treated loose paper • PFAS treated adhesive paper products	• Loose paper (non-waterproof, non-recycled) • Rite in the Rain® notebooks • Aluminium, polypropylene, or Masonite field clipboards • Ballpoint pens, pencils, and Fine or Ultra-Fine Point Sharpie® markers	• Plastic clipboards, binders, or spiral hard cover notebooks • All markers not listed as Allowable • Post-It® Notes or other adhesive paper products • Waterproof field books

Decontamination

Prohibited	Allowable	Needs Screening[2]
• Decon 90® • PFAS treated paper towel	• Alconox®, Liquinox®, or Citranox® • Triple rinse with PFAS-free deionized water • Cotton cloth or untreated paper towel	• Municipal water • Recycled paper towels or chemically treated paper towels

Clothing, Boots, Rain Gear, and PPE

● Prohibited	■ Allowable	▲ Needs Screening[2]
• New or unwashed clothing • Anything made of or with: o Gore-Tex™ or other water-resistant synthetics • Anything applied with or recently washed with: o Fabric softeners o Fabric protectors, including UV protection o Insect resistant chemicals o Water, dirt, and/or stain resistant chemicals	• Powderless nitrile gloves • Well-laundered synthetic or 100% cotton clothing, with most recent launderings not using fabric softeners • Made of or with: o Polyurethane o Polyvinyl chloride (PVC) o Wax coated fabrics o Rubber / Neoprene o Uncoated Tyvek®	• Latex gloves • Water and/or dirt resistant leather gloves • Any special gloves required by a HASP • Tyvek® suits, clothing that contains Tyvek®, or coated Tyvek®

Food and Beverages

● Prohibited	■ Allowable
• No food should be consumed in the staging or sampling areas, including pre-packaged food or snacks. ■ If consuming food on-site becomes necessary, move to the staging area and remove PPE. After eating, wash hands thoroughly and put on new PPE.	• Brought and consumed only outside the vicinity of the sampling area: o Bottled water o Hydration drinks (i.e. Gatorade®, Powerade®)

Personal Care Products (PCPs) - for day of sample collection[6]

● Prohibited	■ Allowable	▲ Needs Screening[2]
• Any PCPs[6], sunscreen, and insect repellent applied in the sampling area.	PCPs[6], sunscreens, and insect repellents applied in the staging area, away from sampling bottles and equipment followed by thoroughly washing hands: **PCPs[6]:** • Cosmetics, deodorants/antiperspirants, moisturizers, hand creams, and other PCPs[6] **Sunscreens:** • Banana Boat® for Men Triple Defense Continuous Spray Sunscreen SPF 30 • Banana Boat® Sport Performance Coolzone Broad Spectrum SPF 30 • Banana Boat® Sport Performance Sunscreen Lotion Broad Spectrum SPF 30 • Banana Boat® Sport Performance Sunscreen Stick SPF 50 • Coppertone® Sunscreen Lotion Ultra Guard Broad Spectrum SPF 50 • Coppertone® Sport High Performance AccuSpray Sunscreen SPF 30 • Coppertone® Sunscreen Stick Kids SPF 55 • L'Oréal® Silky Sheer Face Lotion 50 • Meijer® Clear Zinc Sunscreen Lotion Broad Spectrum SPF 50 • Meijer® Sunscreen Continuous Spray Broad Spectrum SPF 30 • Meijer® Clear Zinc Sunscreen Lotion Broad Spectrum SPF 15, 30 and 50 • Meijer® Wet Skin Kids Sunscreen Continuous Spray Broad Spectrum SPF 70 • Neutrogena® Beach Defense Water+Sun Barrier Lotion SPF 70 • Neutrogena® Beach Defense Water+Sun Barrier Spray Broad Spectrum SPF 30 • Neutrogena® Pure & Free Baby Sunscreen Broad Spectrum SPF 60+ • Neutrogena® UltraSheer Dry-Touch Sunscreen Broad Spectrum SPF 30 **Insect Repellents:** • OFF® Deep Woods • Sawyer® Permethrin	• Products other than those listed as ■Allowable

[1] This table is not considered to be a complete listing of prohibited or allowable materials. All materials should be evaluated prior to use during sampling. The manufacturers of various products should be contacted in order to determine if PFAS was used in the production of any particular product.

[2] Equipment blank samples should be taken to verify these products are PFAS-free prior to use during sampling.

[3] **For surface water foam samples:** LDPE storage bags may be used in the sampling of foam on surface waters. In this instance, it is allowable for the LDPE bag to come into direct contact with the sample media.

[4] **For fish and other wildlife samples:** Depending on the project objectives, glass jars and aluminum foil might be used for PFAS sampling. PFAS has been found to bind to glass and if the sample is stored in a glass jar, a rinse of the jar is required during the sample analysis. PFAS are sometimes used as a protective layer for some aluminum foils. An equipment blank sample should be collected prior to any aluminum foil use.

[5] Regular ice is recommended as there are concerns that chemical and blue ice may not cool and maintain the sample at or below 42.8˚F (6°C) (as determined by EPA 40 CFR 136 – NPDES) during collection and through transit to the laboratory.

[6] Based on evidence, avoidance of PCPs is considered to be precautionary because none have been documented as having cross-contaminated samples due to their use. However, if used, application of PCPs must be done at the staging area and away from sampling bottles and equipment, and hands must be thoroughly washed after the use of any PCPs prior to sampling.

● - Prohibited ■ - Allowable ▲ - Needs Screening

SOIL PFAS SAMPLING

Guidance

Introduction

This guidance document discusses the processes, decontamination procedures, and acceptable items and materials for sampling soil for per- and polyfluoroalkyl substances (PFAS). In addition, this guidance will be used to support the sampling objectives and procedures based on any Quality Assurance Project Plan (QAPP) developed prior to sampling activities. This guidance assumes staff has basic familiarity with and/or understanding of basic soil sampling procedures.

NOTE: Review the General PFAS Sampling Guidance prior to reviewing this guidance document.

The Michigan Department of Environmental Quality (DEQ) intends to update the information contained within this PFAS Sampling Guidance document as new information becomes available. The user of this PFAS Sampling Guidance is encouraged to visit the Michigan PFAS Action Response Team webpage (www.michigan.gov/PFASresponse) to access the current version of this document.

Because PFAS compounds can be analyzed at concentrations in the parts per trillion (ppt) range, precautions must be taken to prevent cross-contamination. Field sampling equipment, either rented or not, that is used at multiple sites or sampling locations (also described as non-dedicated equipment), could become highly contaminated with PFAS. If site-specific information is available, sampling should be conducted from the least to the most contaminated locations. Additional guidance on the sampling sequence can be found in **Section 4.3.3** of the **General PFAS Sampling Guidance**.

Soil sampling involves the use of non-dedicated equipment, such as scoops, trowels, shovels, augers and other drilling-related equipment, which could be a source of cross-contamination. Decontamination procedures outlined in this guidance document should be followed to avoid cross contamination and equipment should be verified as PFAS-free.

The site-specific quality assurance document will generally provide the following information:

- Sample collection objectives.
- Locations, number, and volume of samples.
- Types of chemical analyses.
- Specific quality control procedures.
- Additional sampling requirements, as necessary.

This soil sampling guidance document discusses the collection of surface and sub-surface soil samples for PFAS and methods to prevent cross-contamination that can occur from:

- Field clothing and personal protection equipment (PPE)
- Sampling equipment
- Equipment decontamination
- Sample collection and handling
- Sample shipment

Contents

NOTE: Additional information about PFAS testing can be found on the Michigan PFAS Action Response Team (MPART) website: www.michigan.gov/PFASresponse

1. Potential Sources for PFAS Cross-Contamination

Potential sources for PFAS cross-contamination include items and materials used within the sampling environment, such as sampling equipment, field clothing, personal protective equipment (PPE), sun and biological protection products, personal hygiene, personal care products (PCPs), and food packaging. A detailed discussion about potential sources for PFAS cross-contamination is included in the **General PFAS Sampling Guidance**, which should be reviewed before reading this document. However, a high-level summary is presented in this guidance.

All of the items and materials discussed in each of the MDEQ's PFAS Sampling Guidance Documents are divided into three major groups:

- Prohibited (●) identifies items and materials that should not be used when sampling. It is well documented that they contain PFAS or that PFAS are used in their manufacture.

- Allowable (■) identifies items and materials that have been proven not to be sources of PFAS cross contamination and are considered acceptable for sampling.

- Needs Screening (▲) identifies items and materials that have the potential for PFAS cross-contamination due to a lack of scientific data or statements from manufacturers to prove otherwise. These items and materials are further sub-divided into two categories:

    - **Category 1:** Items and materials that <u>will come in direct contact</u> with the sample. These should not be used when sampling unless they are known to be PFAS-free, by collecting an equipment blank sample prior to use.

    - **Category 2:** Items and materials that <u>will not come in direct contact</u> with the sample. These should be avoided, if possible, unless they are known to be PFAS-free by collecting an equipment blank sample prior to use.

Please note that at this time no published research is available that documents the use of various materials and effect on sample results. Therefore, a conservative approach is recommended, and the guidance is based on the collection of multiple environmental samples at various PFAS Sites. Sampling staff should take practical and appropriate precautions to avoid items that are likely to contain PFAS at the sampling site as well as avoid specific items during the sampling event.

A general overview of PFAS contamination sources during sampling can be found in **Section 4.2** of the **General PFAS Sampling Guidance**. Any items or materials utilized that are not identified in this guidance or not discussed in **Section 4.2** should be evaluated as described in **Section 4.2.1**.

Sampling staff should take practical and appropriate precautions to avoid items that are likely to contain PFAS at the sampling site as well as avoid specific items during the sampling event (see below).

1.1 Field Clothing and Personal Protection Equipment (PPE)

> **NOTE**: Both field clothing and PPE should be kept dust and fiber free.

A general overview of field clothing and PPE can be found in **Section 4.2.2** from the **General PFAS Sampling Guidance**. Materials, field clothing, and equipment screening should be performed during the QAPP development or the planning phase of sampling programs. The screening should be performed on all items and materials that are expected to come into contact with the samples and are defined as **Category 1**. This Soil Sampling Guidance assumes that the soil samples will be collected in an environment where only Level D protection (such as steel toe boots, eye protection, hardhat, etc.) is required by the Health and Safety Plan (HASP). During a PFAS investigation, PPE that contains PFAS should be avoided to prevent cross-contamination.

As with any field mobilization, it is the responsibility of all personnel to be aware of the physical, chemical, and biological hazards associated with a particular site. Personal safety is paramount. Any deviation from this guidance, including those necessary to ensure the health and safety of sampling personnel, should be recorded in field notes and discussed in the final report. Any additional field clothing and/or PPE items that might be required for the soil sampling and not discussed in the Sampling Guidance should be evaluated as described in **Sections 4.2.1** and **4.2.2** of the **General PFAS Sampling Guidance**.

Field sampling during wet weather (e.g., rainfall and snow) should be conducted while wearing the proper field clothing.

- ● Dust and fibers must not be allowed to collect on field clothing or PPE.
- ■ Do not use clothing that has been advertised as waterproof, dirt and/or stain repellant that has not been verified to be made of PFAS-free materials.
- ■ Only use clothing/PPE that has been verified to be made of PFAS-free materials.

Powderless nitrile gloves should be changed frequently any time there is an opportunity for cross-contamination. See **Section 6** of this guidance for additional glove instructions.

1.2 Personal Care Products (PCPs)

A number of sampling guidance documents recommend that personal hygiene and personal care products (PCPs) (e.g., cosmetics, shampoo, sunscreens, dental floss, etc.) not be used prior to and on the day(s) of sampling because the presence of PFAS in these products has been documented (OECD, 2002, Fujii, 2013, Borg and Ivarsson, 2017). However, if the MDEQ's sampling SOPs are followed, these items should not come into contact with the sampling equipment or the sample being collected. As of the date of this sampling guidance, cross-contamination of samples due to the use of PCPs has not been documented during the collection of thousands of samples. However, field personnel should be aware of the potential of cross-contamination if the sampling equipment or actual samples would come into contact with these products.

The following precautions should be taken when dealing with personal hygiene or PCPs before sampling:

- ● Do not handle or apply PCPs in the sampling area.
- ● Do not handle or apply PCPs while wearing PPE that will be present during sampling.
- ■ Move to the staging area and remove PPE if applying personal care products becomes necessary.
- ■ Wash hands thoroughly after the handling or application of PCPs and, when finished, put on a fresh pair of powderless nitrile gloves.

1.3 Food Packaging

PFAS has been used by the paper industry as a special protective coating against grease, oil, and water for paper and paperboards, including food packaging since the late 1950s (Trier et al., 2018). PFAS application for food packaging includes paper products that come into contact with food such as paper plates, food containers, bags, and wraps (OECD, 2002). Pre-wrapped food or snacks (such as candy bars, microwave popcorn, etc.) must not be in the sampling and staging areas during sampling due to PFAS contamination of the packaging. When staff requires a break to eat or drink, they should remove their gloves, coveralls, and any other PPE, if worn, in the staging area and move to the designated area for food and beverage consumption. When finished, staff should wash their hands and put on a fresh pair of powderless nitrile gloves at the staging area, before returning to the sampling area.

- ● Do not handle, consume, or otherwise interact with pre-wrapped food or snacks, carry-out food, fast food, or other food items while on-site during sampling.
- ■ Move to the staging area and remove PPE prior to leaving the sampling and staging areas if consuming food on site becomes necessary.

2. Soil Sampling Equipment

Soil sampling equipment is categorized into **Category 1** and **Category 2:**

Category 1: Any item that will directly contact with the soil, including shovels, trowels, spoons, bowls, hand augers buckets and extensions, and augers and direct push equipment, including any split spoon or sampling barrels. This equipment has a high likelihood of cross-contamination occurring if the proper decontamination procedures are not followed. These items should be known to be PFAS free.

NOTE: As a precautionary action, an equipment rinsate blank should be collected even if the sampling materials are made of materials that are not expected to contain PFAS.

Category 2: Any item that will not directly contact the soil, including field books, Munsell® color charts, Post-It® Notes, aluminum foil, and recycled paper towels.

Although these items will not directly contact soil samples, cross-contamination may still occur. Every effort should be made to ensure these items are PFAS-free. Be aware that surfaces of this field equipment or the containers in which they are kept may contain PFAS.

Do not use any equipment that contains any known fluoropolymers or that potentially has been cross-contamination with PFAS such as, but not limited to:

- ● Do not use Polytetrafluoroethylene (PTFE) that includes the trademark Teflon® and Hostaflon®, which can be found in many items, including but not limited to the lining of some hoses and tubing, some wiring, certain kinds of gears, and some objects that require the sliding action of parts.
- ● Do not use Polyvinylidene fluoride (PVDF) that includes the trademark Kynar®, which can be found in many items, including but not limited to tubing, films/coatings on aluminum, galvanized or aluminized steel, wire insulators, and lithium-ion batteries.
- ● Do not use Polychlorotrifluoroethylene (PCTFE), that includes the trademark Neoflon®, which can be found in many items, including but not limited to valves, seals, gaskets, and food packaging.
- ● Do not use Ethylene-tetrafluoro-ethylene (ETFE) that includes the trademark Tefzel®, which can be found in many items, including but not limited to wire and cable insulation and covers, films for roofing and siding, liners in pipes, and some cable tie wraps.
- ● Do not use Fluorinated ethylene propylene (FEP), that includes the trademarks Teflon® FEP and Hostaflon® FEP,

NOTE: Manufacturers can change the chemical composition of any product. As a result, all materials that will come into contact with the sample matrices (defined as Category 1) should be tested to confirm they are "PFAS-free", i.e. will not contaminate samples at detectable levels. **There is no guarantee that materials in the 'Allowable' category will always be PFAS-free.**

●- Prohibited ■ – Allowable ▲- Needs Screening

and may also include Neoflon®, which can be found in many items, including but not limited to wire and cable insulation and covers, pipe linings, and some labware.

- ● Do not use low density polyethylene (LDPE) for any items that will come into **direct contact** with the sample media. LDPE can be found in many items, including but not limited to containers and bottles, plastic bags, and tubing.
  - ▲ **However**, LDPE may be used if an equipment blank has confirmed it to be PFAS-free. LDPE does not contain PFAS in the raw material but may contain PFAS cross-contamination from the manufacturing process.
- ■ LDPE bags (e.g. Ziploc®) that **do not** come into direct contact with the sample media and do not introduce cross-contamination with samples may be used.
- ■ Use items and materials that are either made of high density polyethylene (HDPE), polypropylene, silicone, or acetate.
- ▲ Post-It® Notes should be screened before use.

Staff should follow the **MDEQ PFAS Sampling Quick Reference Field Guide** table for approved and prohibited items for documenting and sampling residential wells for PFAS.

NOTE: Special care and consideration should be given to the field sampling equipment when stored and handled outside the site boundaries or between different sample locations.

Many times, the release of PFAS in the environment occurs concurrently with other chemicals. For example, the release of PFAS present in the aqueous film forming foam (AFFF) is generally associated with the release of flammable liquids, such as jet fuels. As a result, sampling soil for PFAS may occur within plumes of volatile organic compounds (VOCs). For staff protection, the use of a photoionization detector (PID) is recommended to measure VOCs that might be present in the soil. The PID used during PFAS sampling to screen for VOCs may be made of materials that contain PFAS. However, the PID is a **Category 2** field equipment item and will have a very low possibility of cross contamination.

3. Soil Sampling Methods

Soils are usually sampled to define the subsurface geology and presence of aquifers or aquitards (lithology), or to determine the presence or absence of contaminants—in this case, PFAS (chemical analysis).

3.1 Soil Sampling for Lithologic Description

Soil samples are collected to determine the lithologic and physical makeup of the sample (i.e.: clay, sand, gravel, brown, mottled, etc.). This is done to determine the subsurface geologic stratigraphy of the site and help identify possible aquifers and aquitards in the subsurface. Soil can be collected loose or cored.

3.1.1 Loose Soil Samples

A loose soil sample is usually obtained by auger or rotary drilling processes, where the process delivers loose drilled soil to the surface for collection and interpretation. In the auger drilling process, the auger flights deliver soil cuttings to the surface around the auger string. These soils can be collected by a shovel and bagged in LDPE bags (e.g. Ziploc) or piled for later lithologic analysis and entry into a geologic log.

3.1.2 Cored Soil Samples

A cored soil sample is collected with a coring type of mechanism in a way that preserves the soil structure. Most coring mechanisms consist of a steel core barrel with a clear plastic liner (use an acetate or other PFAS-free liner) into which the soil core enters. Once the core barrel is retrieved at the surface, this liner is removed and cut open. The soil core is then sliced open to reveal a clean face. This clean face is examined for lithology and structure.

3.2 Soil Sampling for Chemical Analysis

Soils collected for chemical analysis are usually collected by using the core soil sample method. The soil samples need to be as undisturbed as possible. The requirement of an undisturbed soil sample **excludes** the use of loose auger cuttings or rotary methods of soil collection.
During the soil sampling process, the soil sampling device is removed from the ground. The liner is removed and placed on the cutting board and opened using a liner cutting device. The soil sample is visually inspected, and observations recorded in the site field book. The core is cut open to reveal a "clean" face for sampling. This process avoids the possibility of picking up any contaminants that may have gotten smeared onto the soil surface as the soil core entered the liner.

4. Equipment Decontamination Before Sampling

It is customary with soil sampling that the equipment is decontaminated at the conclusion of the sampling event. If the previous user of the equipment is not known, and it is unclear how the equipment was handled—especially rental equipment—decontaminate the equipment prior to sampling.

Disposable **Category 1** sampling equipment should be used, especially for sample bottles and other materials that are used where the soil sample may be in contact with the sampling equipment for an extended period of time. Field sampling equipment used at multiple sites or sampling locations can become highly contaminated with PFAS. Decontamination procedures should be implemented to prevent cross-contamination, including between individual sample locations.

For non-dedicated **Category 1** sampling equipment, the following items, materials, and procedures should be used for decontamination:

- ● Do not use Decon 90®.
- ■ Laboratory supplied PFAS-free deionized water is preferred for decontamination.
- ■ Alconox®, Liquinox®, and Citranox® can be used for equipment decontamination.
- ■ Sampling equipment can be scrubbed using a polyethylene or Polyvinyl chloride (PVC) brush to remove particulates.
- ■ Decontamination procedures should include triple rinsing with PFAS-free water.
- ■ Commercially available deionized water in an HDPE container may be used for decontamination if the water is verified to be PFAS-free.
- ▲ Municipal drinking water may be used for decontamination purposes if it is known to be PFAS-free.

NOTE: All samples should be collected using PFAS-free High-Density Polyethylene (HDPE), glass, or polypropylene bottles provided by the laboratory, with Teflon®-

●- Prohibited ■ – Allowable ▲- Needs Screening

5. Sample Collection and Handling

The following considerations should be observed for sample collection:

- ● Dust and fibers must be kept out of sample bottles.
- ● The sample cap should never be placed directly on the ground during sampling.
    - ▲ If sampling staff must set the sample bottle cap down during sample collection and a second member of the sampling crew (wearing a fresh pair of powderless nitrile gloves) is not available, set the cap on a clean surface (cotton sheeting, HDPE sheeting, triple rinsed cooler lid, etc.).
- ● Do not sample without powderless nitrile gloves.
- ● Regular size Sharpie® are to be avoided. Thicker markers may contain PFAS.
- ■ Fine and Ultra-Fine point Sharpie® markers are acceptable.
- ■ Ballpoint pens may be used when labeling sample containers. If ballpoint pens do not write on the sample container labels, preprinted labels from the laboratory may be used.
- ■ Bottles should only be opened immediately prior to sampling.
- ■ Hands should be well washed and gloved.
- ■ Use HDPE, glass, or polypropylene sample bottles with Teflon®-free caps, provided by the laboratory.
- ■ Glass bottles or containers may be used if they are known to be PFAS-free, however, PFAS have been found to adsorb to glass, especially when the sample is in contact with the glass for a long period of time (e.g. being stored in a glass container). If the sample comes into direct contact with the glass for a short period of time (e.g. using a glass container to collect the sample, then transferring the sample to a non-glass sample bottle), the adsorption is minimal.
- ■ Commercially bought sample bottles used with automatic sampling equipment should be decontaminated prior to sampling and equipment blank samples should be collected using laboratory supplied PFAS-free water.
- ■ Samples should be double bagged using resealable low density polyethelene (LDPE) bags (e.g., Ziploc®).
- ■ Follow any guidance or requirements in the PFAS analytical reference method that will be used for testing samples, for sample collection, storage, preservation, and holding times.
- ■ If a published testing method is not used, and in the absence of formal United States Environmental Protection Agency (USEPA) guidance for PFAS sample storage, the documentation in USEPA Method 537 Rev. 1.1 should be used as a guide for thermal preservation (holding temperature) and holding times for soil or other samples. Samples must be chilled during storage and shipment and must not exceed 50°F (10º C) during the first 48 hours after collection.
- ▲ Latex gloves should be screened before use.

NOTE: USEPA Method 537 Rev. 1.1 was developed for the analysis of finished drinking water samples only. It was not designed for soils or other matrices that could cause significant interferences to the method. Other analytical methods such as ASTM D7968-14 or D7968-17a may be better at resolving interferences in soil samples. These methods were developed specifically for other matrices such as soil and sediments.

If site-specific information is available, sampling should be conducted from the least to the most contaminated location. Additional guidance on the sampling sequence can be found in **Section 4.3.3** of the **General PFAS Sampling Guidance**.

If possible, collect PFAS samples prior to collecting non-PFAS samples or field parameters (pH, temperature, etc.).

●- Prohibited ■ – Allowable ▲- Needs Screening

Powderless nitrile gloves should be changed any time there is an opportunity for cross-contamination during sampling, including, but not limited to:

- Immediately prior to sample collection
- Each time sampling equipment is placed in and then removed from soil at a new location
- Handling of any sample, including quality assurance/quality control (QA/QC) samples
- After the handling of any non-dedicated sampling equipment
- After contact with non-decontaminated surfaces
- After decontamination of sampling equipment
- When judged necessary by field personnel

6. Sample Shipment

The following procedures should be used for sample shipment:

■ Regular ice should be used to cool and maintain the sample at or below 42.8°F (6°C).

  ▲ Chemical or blue ice may be used if it is known to be PFAS-free and it is absolutely certain that the sample is cooled and maintained at or below 42.8°F (6°C) during collection and through transit to the laboratory.

■ Check the cooler periodically to ensure samples are well iced and at the proper temperature.

■ Refresh with regular ice, if needed, double bagged in LDPE resealable storage bags if needed.

■ Chain of Custody and other forms should be single bagged in LDPE (e.g. Ziploc®) storage bags and taped to the inside of the cooler lid.

■ The cooler should be taped closed with a custody seal and shipped by overnight courier.

■ Samples should be shipped as soon as possible (e.g. overnight) to ensure the samples arrive within the analytical holding time specified by the lab.

7. Equipment Decontamination After Sampling

It is customary to decontaminate soil sampling equipment at the end of the sampling event, whether it is a single sampling location or the conclusion of the workday. This is to ensure sampling equipment is decontaminated ahead of time for the next sampling event.

● Do not put equipment away without decontaminating it.

■ Do decontaminate sampling equipment after sampling at each location, or at the end of the workday. Follow the decontamination guidelines in **Section 4 (Equipment Decontamination Before Sampling)** of this document.

[THIS PAGE IS INTENTIONALLY LEFT BLANK]

Michigan Department of Environmental Quality

MDEQ PFAS SAMPLING QUICK REFERENCE FIELD GUIDE[1]

All Items Used During Sampling Event

● Prohibited
• Items or materials that contain fluoropolymers such as o Polytetrafluoroethylene (PTFE), that includes the trademarks Teflon® and Hostaflon® o Polyvinylidene fluoride (PVDF), that includes the trademark Kynar® o Polycholotrifluoroethylene (PCTFE), that includes the trademark Neoflon ® o Ethylene-tetrafluoro-ethylene (ETFE), that includes the trademark Tefzel® o Fluorinated ethylene propylene (FEP), that includes the trademarks Teflon® FEP and Hostaflon® FEP • Items or materials that contain any other fluoropolymer

Pumps, Tubing, and Sampling Equipment

● Prohibited	■ Allowable	▲ Needs Screening[2]
• Items or materials containing any fluoropolymer (potential items include tubing, valves, or pipe thread seal tape)	• High-density polyethylene (HDPE) • Low-density polyethylene (LDPE) tubing • Polypropylene • Silicone • Stainless-steel • Any items used to secure sampling bottles made from: o Natural rubber o Nylon (cable ties) o Uncoated metal springs o Polyethylene	• Any items or materials that will come into direct contact with the sample that have **not** been verified to be PFAS-free o Do not assume that any sampling items or materials are PFAS-free based on composition alone

Sample Storage and Preservation

● Prohibited	■ Allowable	▲ Needs Screening[2]
• Polytetrafluoroethylene (PTFE): Teflon® lined bottles or caps	• Glass jars[4] • Laboratory-provided PFAS-Free bottles: o HDPE or polypropylene • Regular wet ice • Thin HDPE sheeting • LDPE resealable storage bags (i.e. Ziploc®) that will not contact the sample media[6]	• Aluminium foil[4] • Chemical or blue ice[5] • Plastic storage bags other than those listed as ■ Allowable • Low-density polyethylene (LDPE) bottles

Field Documentation

● Prohibited	■ Allowable	▲ Needs Screening[2]
• Clipboards coated with PFAS • Notebooks made with PFAS treated paper • PFAS treated loose paper • PFAS treated adhesive paper products	• Loose paper (non-waterproof, non-recycled) • Rite in the Rain® notebooks • Aluminium, polypropylene, or Masonite field clipboards • Ballpoint pens, pencils, and Fine or Ultra-Fine Point Sharpie® markers	• Plastic clipboards, binders, or spiral hard cover notebooks • All markers not listed as ■ Allowable • Post-It® Notes or other adhesive paper products • Waterproof field books

Decontamination

● Prohibited	■ Allowable	▲ Needs Screening[2]
• Decon 90® • PFAS treated paper towel	• Alconox®, Liquinox®, or Citranox® • Triple rinse with PFAS-free deionized water • Cotton cloth or untreated paper towel	• Municipal water • Recycled paper towels or chemically treated paper towels

Clothing, Boots, Rain Gear, and PPE

● Prohibited	■ Allowable	▲ Needs Screening[2]
• New or unwashed clothing • Anything made of or with: o Gore-Tex™ or other water-resistant synthetics • Anything applied with or recently washed with: o Fabric softeners o Fabric protectors, including UV protection o Insect resistant chemicals o Water, dirt, and/or stain resistant chemicals	• Powderless nitrile gloves • Well-laundered synthetic or 100% cotton clothing, with most recent launderings not using fabric softeners • Made of or with: o Polyurethane o Polyvinyl chloride (PVC) o Wax coated fabrics o Rubber / Neoprene o Uncoated Tyvek®	• Latex gloves • Water and/or dirt resistant leather gloves • Any special gloves required by a HASP • Tyvek® suits, clothing that contains Tyvek®, or coated Tyvek®

Food and Beverages

● Prohibited	■ Allowable
• No food should be consumed in the staging or sampling areas, including pre-packaged food or snacks. ■ If consuming food on-site becomes necessary, move to the staging area and remove PPE. After eating, wash hands thoroughly and put on new PPE.	• Brought and consumed only outside the vicinity of the sampling area: o Bottled water o Hydration drinks (i.e. Gatorade®, Powerade®)

Personal Care Products (PCPs) - for day of sample collection[6]

● Prohibited	■ Allowable	▲ Needs Screening[2]
• Any PCPs[6], sunscreen, and insect repellent applied in the sampling area.	PCPs[6], sunscreens, and insect repellents applied in the staging area, away from sampling bottles and equipment followed by thoroughly washing hands: **PCPs[6]:** • Cosmetics, deodorants/antiperspirants, moisturizers, hand creams, and other PCPs[6] **Sunscreens:** • Banana Boat® for Men Triple Defense Continuous Spray Sunscreen SPF 30 • Banana Boat® Sport Performance Coolzone Broad Spectrum SPF 30 • Banana Boat® Sport Performance Sunscreen Lotion Broad Spectrum SPF 30 • Banana Boat® Sport Performance Sunscreen Stick SPF 50 • Coppertone® Sunscreen Lotion Ultra Guard Broad Spectrum SPF 50 • Coppertone® Sport High Performance AccuSpray Sunscreen SPF 30 • Coppertone® Sunscreen Stick Kids SPF 55 • L'Oréal® Silky Sheer Face Lotion 50 • Meijer® Clear Zinc Sunscreen Lotion Broad Spectrum SPF 50 • Meijer® Sunscreen Continuous Spray Broad Spectrum SPF 30 • Meijer® Clear Zinc Sunscreen Lotion Broad Spectrum SPF 15, 30 and 50 • Meijer® Wet Skin Kids Sunscreen Continuous Spray Broad Spectrum SPF 70 • Neutrogena® Beach Defense Water+Sun Barrier Lotion SPF 70 • Neutrogena® Beach Defense Water+Sun Barrier Spray Broad Spectrum SPF 30 • Neutrogena® Pure & Free Baby Sunscreen Broad Spectrum SPF 60+ • Neutrogena® UltraSheer Dry-Touch Sunscreen Broad Spectrum SPF 30 **Insect Repellents:** • OFF® Deep Woods • Sawyer® Permethrin	• Products other than those listed as ■Allowable

[1] This table is not considered to be a complete listing of prohibited or allowable materials. All materials should be evaluated prior to use during sampling. The manufacturers of various products should be contacted in order to determine if PFAS was used in the production of any particular product.

[2] Equipment blank samples should be taken to verify these products are PFAS-free prior to use during sampling.

[3] **For surface water foam samples:** LDPE storage bags may be used in the sampling of foam on surface waters. In this instance, it is allowable for the LDPE bag to come into direct contact with the sample media.

[4] **For fish and other wildlife samples:** Depending on the project objectives, glass jars and aluminum foil might be used for PFAS sampling. PFAS has been found to bind to glass and if the sample is stored in a glass jar, a rinse of the jar is required during the sample analysis. PFAS are sometimes used as a protective layer for some aluminum foils. An equipment blank sample should be collected prior to any aluminum foil use.

[5] Regular ice is recommended as there are concerns that chemical and blue ice may not cool and maintain the sample at or below 42.8˚F (6°C) (as determined by EPA 40 CFR 136 – NPDES) during collection and through transit to the laboratory.

[6] Based on evidence, avoidance of PCPs is considered to be precautionary because none have been documented as having cross-contaminated samples due to their use. However, if used, application of PCPs must be done at the staging area and away from sampling bottles and equipment, and hands must be thoroughly washed after the use of any PCPs prior to sampling.

●- Prohibited ■- Allowable ▲- Needs Screening

SURFACE WATER PFAS SAMPLING

Guidance

Introduction

This sampling guidance contains the processes, decontamination procedures, and acceptable items and materials for sampling surface water for Per- and Polyfluoroalkyl Substances (PFAS). This guidance will be used to support the sampling objectives and procedures based on the Quality Assurance Project Plan (QAPP) developed prior to any field activities. This guidance assumes staff has basic familiarity with and/or understanding of basic surface water sampling procedures.

NOTE: Review the **General PFAS Sampling Guidance** prior to reviewing this guidance document.

The Michigan Department of Environmental Quality (MDEQ) intends to update the information contained within this Surface Water PFAS Sampling Guidance document as new information becomes available. The user of this Surface Water PFAS Sampling Guidance is encouraged to visit the Michigan PFAS Action Response Team webpage (www.michigan.gov/PFASresponse) to access the current version of this document.

PFAS has been detected in surface water in Michigan at concentrations of over 19,000 parts per trillion (ppt). Because PFAS compounds can be analyzed at concentrations in the parts per trillion (ppt) range, precautions must be taken to prevent cross-contamination. Therefore, there is a high possibility of false positives if decontamination procedures are not followed diligently. This sampling guidance covers both the collection of samples from shallow and deep surface water bodies.

This Surface Water PFAS Sampling Guidance discusses the collection of surface water samples and methods to prevent cross-contamination that can occur from:

- Field clothing and personal protective equipment (PPE)
- Personal care products (PCPs)
- Food packaging
- Sampling equipment
- Equipment decontamination
- Filtering of surface water
- Sample collection and handling
- Sample shipment

Contents

NOTE: Additional information about PFAS testing can be found on the Michigan PFAS Action Response Team (MPART) website: www.michigan.gov/PFASresponse

1. Potential Sources for PFAS Cross-Contamination

Potential sources for PFAS cross-contamination include items and materials used within the sampling environment, such as sampling equipment, field clothing, personal protective equipment (PPE), sun and biological protection products, personal hygiene, personal care products (PCPs), and food packaging. A detailed discussion about potential sources for PFAS cross-contamination is included in the **General PFAS Sampling Guidance**, which should be reviewed before reading this document. However, a high-level summary is presented in this guidance.

All of the items and materials discussed in each of the MDEQ's PFAS Sampling Guidance Documents are divided into three major groups:

- Prohibited (●) identifies items and materials that should not be used when sampling. It is well documented that they contain PFAS or that PFAS are used in their manufacture.

- Allowable (■) identifies items and materials that have been proven not to be sources of PFAS cross contamination and are considered acceptable for sampling.

- Needs Screening (▲) identifies items and materials that have the potential for PFAS cross-contamination due to a lack of scientific data or statements from manufacturers to prove otherwise. These items and materials are further sub-divided into two categories:

    - **Category 1:** Items and materials that <u>will come in direct contact</u> with the sample. These should not be used when sampling unless they are known to be PFAS-free, by collecting an equipment blank sample prior to use.

    - **Category 2:** Items and materials that <u>will not come in direct contact</u> with the sample. These should be avoided, if possible, unless they are known to be PFAS-free by collecting an equipment blank sample prior to use.

Please note that at this time no published research is available that documents the use of various materials and effect on sample results. Therefore, a conservative approach is recommended, and the guidance is based on the collection of multiple environmental samples at various PFAS Sites. Sampling staff should take practical and appropriate precautions to avoid items that are likely to contain PFAS at the sampling site as well as avoid specific items during the sampling event.

A general overview of PFAS contamination sources during sampling can be found in **Section 4.2** of the **General PFAS Sampling Guidance**. Any items or materials utilized that are not identified in this guidance or not discussed in **Section 4.2** should be evaluated as described in **Section 4.2.1**.

Sampling staff should take practical and appropriate precautions to avoid items that are likely to contain PFAS at the sampling site as well as avoid specific items during the sampling event (see below).

1.1 Field Clothing and Personal Protection Equipment (PPE)

A general overview of field clothing and PPE can be found in **Section 4** of the **General PFAS Sampling Guidance**.

As with any field mobilization, it is the responsibility of all personnel to be aware of the physical, chemical and biological hazards associated with a particular site. Personal safety is paramount. The safety of staff should not be compromised by fear of PFAS-containing materials without any scientific basis. Any deviation from this guidance, including those necessary to ensure the health and safety of sampling personnel, should be recorded in field notes and discussed in the final report.

Depending on the project objectives and sampling plan, the collection of surface water samples could be as simple as a grab sample or as complex as a sample collected using a Van Dorn® sampler from a boat. Generally, for surface water sampling, approved field clothing (discussed in **Section 4** of the **General PFAS Sampling Guidance**) is required. Life jackets made of PFAS-free materials should be used. The coatings used on waders are of particular concern during surface water sampling. Ensure the waders are made from PFAS-free materials before use.

> **NOTE**: Special attention should be given to clothing that has been advertised as having waterproof, water-repellant, or dirt and/or stain characteristics. They are likely to have PFAS in their manufacturing.
>
> **NOTE**: Life jackets may have protective coatings that contain PFAS.

- ● Do not use waders made of Gore-Tex or other known PFAS containing materials.
- ■ Life jackets made of polyethylene foam and nylon shell fabric may be used.
- ■ Waders made of Neoprene or other PFAS-free materials may be used.

Any field clothing and/or PPE items that might be required for surface water sampling and not discussed in this guidance should be evaluated as described in **Section 4.2.2** of the **General PFAS Sampling Guidance**.

> **NOTE**: Both field clothing and PPE should be kept dust and fiber free. During the sample collection, extra care should be taken so that no dust or fibers can fall into the sample bottle.

Powderless nitrile gloves should frequently be changed any time there is an opportunity for cross-contamination of the sampling including, but not limited to, the following activities:

- Each time sampling equipment is handled.
- Prior to sample collection.

●- Prohibited ■ – Allowable ▲- Needs Screening

- After handling any sample, including QA/QC samples such as field reagent blanks or equipment rinsate blanks.
- After the handling of any non-dedicated sampling equipment, contact with non-decontaminated surfaces, or when judged necessary by field personnel.
- During and after decontamination of non-dedicated sampling equipment.

1.2 Personal Care Products (PCPs)

A number of sampling guidance documents recommend that personal hygiene and personal care products (PCPs) (e.g., cosmetics, shampoo, sunscreens, dental floss, etc.) not be used prior to and on the day(s) of sampling because the presence of PFAS in these products has been documented (OECD, 2002, Fujii, 2013, Borg and Ivarsson, 2017). However, if the MDEQ's sampling SOPs are followed, these items should not come into contact with the sampling equipment or the sample being collected. As of the date of this sampling guidance, cross-contamination of samples due to the use of PCPs has not been documented during the collection of thousands of samples. However, field personnel should be aware of the potential of cross-contamination if the sampling equipment or actual samples would come into contact with these products. The following precautions should be taken when dealing with personal hygiene or PCPs before sampling:

- ● Do not handle or apply PCPs in the sampling area.
- ● Do not handle or apply PCPs while wearing PPE that will be present during sampling.
- ■ Move to the staging area and remove PPE if applying personal care products becomes necessary.
- ■ Wash hands thoroughly after the handling or application of PCPs and, when finished, put on a fresh pair of powderless nitrile gloves.

1.3 Food Packaging

PFAS has been used by the paper industry as a special protective coating against grease, oil, and water for paper and paperboards, including food packaging since the late 1950s (Trier et al., 2018). PFAS application for food packaging includes paper products that come into contact with food such as paper plates, food containers, bags, and wraps (OECD, 2002). Pre-wrapped food or snacks (such as candy bars, microwave popcorn, etc.) must not be in the sampling and staging areas during sampling due to PFAS contamination of the packaging. When staff requires a break to eat or drink, they should remove their gloves, coveralls, and any other PPE, if worn, in the staging area and move to the designated area for food and beverage consumption. When finished, staff should wash their hands and put on a fresh pair of powderless nitrile gloves at the staging area, before returning to the sampling area.

- ● Do not handle, consume, or otherwise interact with pre-wrapped food or snacks, carry-out food, fast food, or other food items while on-site during sampling.
- ■ Move to the staging area and remove PPE prior to leaving the sampling and staging areas if consuming food on site becomes necessary.

2. Surface Water Sampling Equipment

Surface water sampling equipment that is also used for non-PFAS sampling such as dippers, Kemmerer®, or Van Dorn® samplers, should be decontaminated prior to collecting PFAS samples to avoid cross contamination. This non-dedicated equipment (equipment used for more than one water body or location) should be verified that it is PFAS free at least once prior to use. Surface water sampling equipment can fall into **Category 1** or **Category 2**:

●- Prohibited ■ – Allowable ▲- Needs Screening

Category 1: Surface water sampling equipment that will come into contact with the surface water sample include sample bottles and various surface water samplers or tubing. Sample bottles should be provided by the laboratory and known to be PFAS free. Any surface water samplers, tubing, or materials that will come into contact with the surface water samples should be screened and known to be PFAS-free. The tubing should always be kept in the original cardboard or bag in which it was shipped. The tubing should always be stored in a clean location free of dust and fibers.

NOTE: As a precautionary action, an equipment rinsate blank should be collected even if the sampling materials are made of materials that are not expected to contain PFAS.

Category 2: Examples of field equipment that do **not** come into contact with the surface water samples include water quality meters, GPS receivers, notebooks, clipboards, and turbidity meters. The surface of some of these pieces of field equipment, or the storage boxes in which they are kept, might contain PFAS.

Do not use any equipment that contains any known fluoropolymers including, but not limited to:

- ● Do not use polytetrafluoroethylene (PTFE), that includes the trademark Teflon® and Hostaflon®, which can be found in many items, including but not limited to the lining of some hoses and tubing, some wiring, certain kinds of gears, and some objects that require the sliding action of parts.
- ● Do not use Polyvinylidene fluoride (PVDF), that includes the trademark Kynar®, which can be found in many items, including but not limited to tubing, films/coatings on aluminum, galvanized or aluminized steel, wire insulators, and lithium-ion batteries.
- ● Do not use Polychlorotrifluoroethylene (PCTFE), that includes the trademark Neoflon®, which can be found in many items, including but not limited to valves, seals, gaskets, and food packaging.
- ● Do not use Ethylene-tetrafluoro-ethylene (ETFE), that includes the trademark Tefzel®, which can be found in many items, including but not limited to wire and cable insulation and covers, films for roofing and siding, liners in pipes, and some cable tie wraps.
- ● Do not use Fluorinated ethylene propylene (FEP), that includes the trademarks Teflon® FEP and Hostaflon® FEP, and may also include Neoflon®, which can be found in many items, including but not limited to wire and cable insulation and covers, pipe linings, and some labware.
- ● Do not use low density polyethylene (LDPE) for any items that will come into **direct contact** with the sample media. LDPE can be found in many items, including but not limited to containers and bottles, plastic bags, and tubing.
  - ▲ **However**, LDPE may be used if an equipment blank has confirmed it to be PFAS-free. LDPE does not contain PFAS in the raw material but may contain PFAS cross-contamination from the manufacturing process.
- ■ LDPE bags (e.g. Ziploc®) that **do not** come into direct contact with the sample media and do not introduce cross contamination with samples may be used.
- ■ Use materials that are either made of high density polyethylene (HDPE), polypropylene, silicone, or acetate.
- ■ Use only powderless nitrile gloves (which can be found at some hardware and major retail outlets).
- ■ Keep tubing in the original cardboard or bag in which it was shipped.

Note: Manufacturers can change the chemical composition of any product. As a result, all materials that will come into direct contact with the sample media should be tested to confirm they are "PFAS-free", i.e. will not contaminate samples at detectable levels. **There is no guarantee that materials in the 'Allowable' category will always be PFAS- free.**

●- Prohibited ■ – Allowable ▲- Needs Screening

- ■ Store tubing in a clean location free of dust and fibers.
- ▲ Latex gloves should be screened before use.
- ▲ Post-It® Notes should be screened before use.

NOTE: Depending on the project objectives, boats might be required to be used during surface water sampling. Boats might have various parts that may contain PFAS, including protective water repellent coatings. When boats are used on rivers, samples should always be collected on the upgradient side of the boat.

Depending on the project data quality objectives, water samples can be collected as: a simple grab directly into the sample bottle; a grab sample at a selected depth using any of several collection bottles with subsequent transfer to the sample bottle(s); or as a depth integrated sample. A depth integrated sample can be collected using a simple weighted bottle constructed to allow gradual water inflow (e.g., chlorophyll sampler), or by using a Van Dorn® or Kemmerer® sampler and compositing grab samples from several depths. Composited samples are then transferred to the sample bottle.

Surface water sampling collection can be divided into two method categories as presented in the following Table 1.

Table 1. Surface Water Sampling Methods[1]

Depth to Surface Water Sample	Locations	Sampling Method
0-5 feet	Streams, rivers, creeks, tributaries, lakes, lagoons, ponds, and impoundments.	Direct method, swing, telescoping, and Van Dorn, depth integrating samplers.
Over 5 feet	Large streams, rivers, tributaries, lakes, lagoons, ponds, and impoundments.	Peristaltic pump, swing, telescoping, Van Dorn, Kemmerer, and depth integrating samplers.

[1]This table includes the most frequently used methods for surface water samples.

2.1 Container Immersion

Two types of immersion sampling equipment are available for surface water sampling: extension rods and submersible devices. Extension rods can be used to immerse the actual sample bottle, different types of beakers, or peristaltic pump tubing into the surface water. Submersible devices (i.e., Kemmerer Bottle, Van Dorn Sampler) are fully immersed into the surface water using a rope.

2.1.1 Extension Rods

The most common extension rods are telescoping or swing samplers. Both types of sampling equipment are very similar in design and concept, and both facilitate the immersion of either the sampling bottle or various beakers or scoops. Lists of various extension rod designs are provided below:

- Pendulum or angular beaker.
- Fixed scoop.
- Fix or rotatable head bottle holder.

A peristaltic pump can also be used with extension rods by attaching the tubing to the extension rods and immersing both the rods and the connected tubing to the desired depth in the surface water.

- ■ Use only sample collection equipment, tubing, beakers, and/or scoop materials that are known to be PFAS-free such as stainless steel, glass, HDPE, polyvinyl chloride (PVC), or silicone.
- ■ Extension rods made of materials such as aluminum that has been identified as being PFAS-free can be used.

A specialized extension rod that features a telescoping design for the handle could also be used as a subsurface grab sampler. The sample is collected using a cable from the handle, which has a ring that can be opened for the sample collection after the desired depth has been reached.

2.1.2 Submersible Devices

The most common submersible devices being used are Kemmerer Bottles or Van Dorn Samplers. These devices are primarily used when the samples are collected at depths greater than 5 feet from a boat and/or structure such as a bridge or pier. All submersible devices are submerged in the surface water using a rope.

NOTE: Careful evaluation of all submersible samplers' parts should be done. Any parts that might contain PFAS should be replaced with PFAS-free materials. Equipment rinsate blank samples should be collected to make certain the sampler is PFAS-free.

The Kemmerer Bottle sampler is typically constructed of a stainless-steel tube with polyurethane end seals that can collect a total sample volume of 1.2 liters. The Kemmerer Bottle is not ideal for the collection of samples close to the surface, as the tube is immersed vertically in the water.

The Van Dorn® bottle sampler is typically constructed of 1-liter transparent acrylic tube with two end stoppers. The sampler is suspended horizontally, which is ideal for the sample collection in shallow water bodies as well as sampling at depth.

When submersible samplers are used, the following recommendations should be followed:

- ● Do not use any sampling bottle with Teflon end seals.
- ■ Use a Kemmerer® Bottle made of stainless steel with polyurethane end seals.
- ■ Use a Van Dorn® bottle sampler that uses stoppers made of PFAS-free materials.
- ■ Use nylon line, stainless steel cable, or line or wires made of PFAS-free materials for sample collection.
- ■ Use tubing for the sampling ports made of HDPE, polypropylene, silicone, PVC, or other PFC-free materials.

2.2 Direct Sampling

For surface water samples collected near the shore (e.g., from streams, rivers, lakes, and other surface waters), the direct method can be used to collect the water samples directly into the sample container.

- ● Do not sample without powderless nitrile gloves.

- ● Never place the sample cap directly on the ground or boat deck during sampling.
- ■ Use powderless nitrile gloves
- ■ Hands should be well washed
- ■ Use HDPE sample bottles with Teflon®-free caps, provided by the laboratory.
- ■ If sample bottles that are known to be PFAS-free are not available, the sample container and lid should be rinsed with water that is known to be PFAS-free at least 3 times prior to collecting the sample.
- ■ If samples are collected while wading in the water body, the bottle should be immersed inverted and upstream of the collector.
- ■ If samples are collected from a boat, the bottles should be submerged upstream of the boat.

NOTE: Unless specifically required by the project objectives, surface water samples should ***not*** be taken at the top layer of the water body or of surface scums. PFAS are expected to accumulate at the surface water air interface or be present in the surface runoff, so samples taken at the surface are likely to result in high biased results that are not representative of the bulk surface water.

3. Equipment Decontamination

Field sampling equipment that is used at multiple sites or sampling locations (non-dedicated equipment) could become contaminated with PFAS.

The following should be considered when decontaminating any equipment that contacts the sampling media:

- ● Do not use Decon 90®.
- ■ Laboratory supplied PFAS-free deionized water is preferred for decontamination.
- ■ Alconox®, Liquinox®, and Citranox® can be used for equipment decontamination.
- ■ Sampling equipment can be scrubbed using a polyethylene or Polyvinyl chloride (PVC) brush to remove particulates.
- ■ Decontamination procedures should include triple rinsing with PFAS-free water.
- ■ Commercially available deionized water in an HDPE container may be used for decontamination if the water is verified to be PFAS-free.
- ▲ Municipal drinking water may be used for decontamination purposes if it is known to be PFAS-free.

4. Sample Collection and Handling

A preferred sampling sequence should be established prior to any sampling event to reduce the risk of cross contamination. In general, the sampling sequence should begin in areas expected or known to be least contaminated, proceeding to anticipated areas or identified to be most contaminated. If analytical results from past sampling events are available, the sampling sequence can be readily determined.

However, for many PFAS investigation sites, no PFAS sampling has been conducted. In these cases, all site information on possible PFAS uses and potential PFAS migration patterns (e.g., upgradient, downgradient) from PFAS sources at the site should be reviewed prior to the sampling event to help establish the sampling sequence.

If multiple samples (i.e., monitoring wells, surface water, residential) will be collected in an area where a PFAS release in the environment has been documented, samples that are known to be upgradient from the impacted area should be sampled first, followed by those that are furthest downgradient from the

●- Prohibited ■ – Allowable ▲- Needs Screening

suspected source. The remaining samples should be progressively sampled from the one most distant downgradient to those closer to the known PFAS source.

If no information is available about the site, samples are to be collected in the following order:

1. Drinking Water (e.g., residential wells)
2. Surface Water
3. Groundwater

When collecting and handling surface water samples:

- ● Do not insert or let tubing or any materials inside the sample bottle.
- ● Dust and fibers must be kept out of sample bottles.
- ● The sample cap should never be placed directly on the ground during sampling. If sampling staff must set the sample bottle cap down during sample collection and a second member of the sampling crew (wearing a fresh pair of powderless nitrile gloves) is not available, set the cap on a clean surface (cotton sheeting, HDPE sheeting, triple rinsed cooler lid, etc.).
- ● Regular/thick size markers (Sharpie® or otherwise) are to be avoided; as they may contain PFAS.
- ■ Fine or Ultra-Fine point Sharpies® may be used to label the empty sample bottle while in the staging area provided the lid is on the sample bottle and powderless nitrile gloves are changed following sample bottle labeling.
- ■ Ballpoint pens may be used when labeling sample containers. If ballpoint pens do not write on the sample container labels, preprinted labels from the laboratory may be used.
- ■ Hands should be well washed and gloved.
- ■ Use HDPE, or polypropylene sample bottles with Teflon®-free caps, provided by the laboratory.
- ■ Bottles should only be opened immediately prior to sampling.
- ■ Bottles should be capped immediately after collecting the sample.
- ■ Samples should be double bagged using resealable low density polyethylene (LDPE) bags (e.g., Ziploc®).
- ■ Follow any guidance or requirements in the PFAS analytical reference method that will be used for testing samples, for sample collection, storage, preservation, and holding times.

If a published testing method is not used, and in the absence of formal United States Environmental Protection Agency guidance for PFAS sample storage, the documentation in USEPA Method 537 Rev. 1.1 should be used as a guide for thermal preservation (holding temperature), and holding times for surface water or other samples. Samples must be chilled during storage and shipment, and must not exceed 50°F (10º C) during the first 48 hours after collection.

NOTE: USEPA Method 537 Rev. 1.1 was developed for the analysis of finished drinking water samples only. It was not designed for testing surface water or other matrices that could cause significant interferences to the method.

Surface water samples should be extracted as soon as possible but must be extracted within 14 days. Extracts must be stored at room temperature and analyzed within 28 days after extraction (EPA Method 537 Rev. 1.1).

● - Prohibited ■ – Allowable ▲ - Needs Screening

5. Filtering of Surface Water

Since PFAS can adsorb to particulate matter, unfiltered samples may result in high-biased results. PFAS are known to absorb to various filters. As a result, filtering of surface water samples prior to delivery to the lab should be avoided unless called for in the project data quality objectives. To reduce the need for filtering, samples should be collected with as minimal disturbance to sediments as possible.

NOTE: It is recommended that filtering of the samples should **only be performed in the laboratory** in order to reduce the possibility of cross contamination.

If it is known beforehand that samples will need to be filtered the procedure should be discussed with the laboratory and sample handling methods and responsibilities should be described in the sampling workplan and QAPP.

The following recommendations should be used when considering filtering of the samples:

- ● **Field filtration of the sample is generally not advised.**
    - ▲ If filtering is absolutely necessary, if specifically requested by a client or for other reasons:
- ● Do not use any filters that contain any PFAS, such as PTFE filters
- ● Do not use nylon filters.
- ■ Glass filters are recommended to be used.
- ■ Consider use of a centrifuge in the laboratory to reduce the need for sample filtering.

6. Sample Shipment

When prepping samples for shipping:

- ■ Check the cooler periodically to ensure samples are well iced and at the proper temperature.
- ■ Refresh with regular ice, if needed, double bagged in LDPE resealable storage bags if needed.
- ■ Regular ice should be used to cool and maintain the sample at or below the proper temperature.
    - ▲ Chemical or blue ice may be used if it is known to be PFAS-free and it is absolutely certain that the sample is cooled and maintained at or below the proper temperature during collection and through transit to the laboratory.
- ■ Chain of Custody and other forms should be double bagged in LDPE (Ziploc®) storage bags and taped to the inside of the cooler lid.
- ■ The cooler should be taped closed with a custody seal and, if shipping, shipped by overnight courier.
- ■ Samples should be shipped as soon as possible (e.g. overnight) to ensure the samples arrive within the analytical holding time specified by the lab.

DEQ Michigan Department of Environmental Quality

MDEQ PFAS Sampling Quick Reference Field Guide[1]

All Items Used During Sampling Event

● Prohibited
• Items or materials that contain fluoropolymers such as o Polytetrafluoroethylene (PTFE), that includes the trademarks Teflon® and Hostaflon® o Polyvinylidene fluoride (PVDF), that includes the trademark Kynar® o Polycholotrifluoroethylene (PCTFE), that includes the trademark Neoflon ® o Ethylene-tetrafluoro-ethylene (ETFE), that includes the trademark Tefzel® o Fluorinated ethylene propylene (FEP), that includes the trademarks Teflon® FEP and Hostaflon® FEP • Items or materials that contain any other fluoropolymer

Pumps, Tubing, and Sampling Equipment

● Prohibited	■ Allowable	▲ Needs Screening[2]
• Items or materials containing any fluoropolymer (potential items include tubing, valves, or pipe thread seal tape)	• High-density polyethylene (HDPE) • Low-density polyethylene (LDPE) tubing • Polypropylene • Silicone • Stainless-steel • Any items used to secure sampling bottles made from: o Natural rubber o Nylon (cable ties) o Uncoated metal springs o Polyethylene	• Any items or materials that will come into direct contact with the sample that have **not** been verified to be PFAS-free o Do not assume that any sampling items or materials are PFAS-free based on composition alone

Sample Storage and Preservation

● Prohibited	■ Allowable	▲ Needs Screening[2]
• Polytetrafluoroethylene (PTFE): Teflon® lined bottles or caps	• Glass jars[4] • Laboratory-provided PFAS-Free bottles: o HDPE or polypropylene • Regular wet ice • Thin HDPE sheeting • LDPE resealable storage bags (i.e. Ziploc®) that will not contact the sample media[6]	• Aluminium foil[4] • Chemical or blue ice[5] • Plastic storage bags other than those listed as ■ Allowable • Low-density polyethylene (LDPE) bottles

Field Documentation

● Prohibited	■ Allowable	▲ Needs Screening[2]
• Clipboards coated with PFAS • Notebooks made with PFAS treated paper • PFAS treated loose paper • PFAS treated adhesive paper products	• Loose paper (non-waterproof, non-recycled) • Rite in the Rain® notebooks • Aluminium, polypropylene, or Masonite field clipboards • Ballpoint pens, pencils, and Fine or Ultra-Fine Point Sharpie® markers	• Plastic clipboards, binders, or spiral hard cover notebooks • All markers not listed as ■ Allowable • Post-It® Notes or other adhesive paper products • Waterproof field books

Decontamination

● Prohibited	■ Allowable	▲ Needs Screening[2]
• Decon 90® • PFAS treated paper towel	• Alconox®, Liquinox®, or Citranox® • Triple rinse with PFAS-free deionized water • Cotton cloth or untreated paper towel	• Municipal water • Recycled paper towels or chemically treated paper towels

Clothing, Boots, Rain Gear, and PPE

● Prohibited	■ Allowable	▲ Needs Screening[2]
• New or unwashed clothing • Anything made of or with: o Gore-Tex™ or other water-resistant synthetics • Anything applied with or recently washed with: o Fabric softeners o Fabric protectors, including UV protection o Insect resistant chemicals o Water, dirt, and/or stain resistant chemicals	• Powderless nitrile gloves • Well-laundered synthetic or 100% cotton clothing, with most recent launderings not using fabric softeners • Made of or with: o Polyurethane o Polyvinyl chloride (PVC) o Wax coated fabrics o Rubber / Neoprene o Uncoated Tyvek®	• Latex gloves • Water and/or dirt resistant leather gloves • Any special gloves required by a HASP • Tyvek® suits, clothing that contains Tyvek®, or coated Tyvek®

Food and Beverages

● Prohibited	■ Allowable
• No food should be consumed in the staging or sampling areas, including pre-packaged food or snacks. ■ If consuming food on-site becomes necessary, move to the staging area and remove PPE. After eating, wash hands thoroughly and put on new PPE.	• Brought and consumed only outside the vicinity of the sampling area: o Bottled water o Hydration drinks (i.e. Gatorade®, Powerade®)

Personal Care Products (PCPs) - for day of sample collection[6]

● Prohibited	■ Allowable	▲ Needs Screening[2]
• Any PCPs[6], sunscreen, and insect repellent applied in the sampling area.	PCPs[6], sunscreens, and insect repellents applied in the staging area, away from sampling bottles and equipment followed by thoroughly washing hands: **PCPs[6]:** • Cosmetics, deodorants/antiperspirants, moisturizers, hand creams, and other PCPs[6] **Sunscreens:** • Banana Boat® for Men Triple Defense Continuous Spray Sunscreen SPF 30 • Banana Boat® Sport Performance Coolzone Broad Spectrum SPF 30 • Banana Boat® Sport Performance Sunscreen Lotion Broad Spectrum SPF 30 • Banana Boat® Sport Performance Sunscreen Stick SPF 50 • Coppertone® Sunscreen Lotion Ultra Guard Broad Spectrum SPF 50 • Coppertone® Sport High Performance AccuSpray Sunscreen SPF 30 • Coppertone® Sunscreen Stick Kids SPF 55 • L'Oréal® Silky Sheer Face Lotion 50 • Meijer® Clear Zinc Sunscreen Lotion Broad Spectrum SPF 50 • Meijer® Sunscreen Continuous Spray Broad Spectrum SPF 30 • Meijer® Clear Zinc Sunscreen Lotion Broad Spectrum SPF 15, 30 and 50 • Meijer® Wet Skin Kids Sunscreen Continuous Spray Broad Spectrum SPF 70 • Neutrogena® Beach Defense Water+Sun Barrier Lotion SPF 70 • Neutrogena® Beach Defense Water+Sun Barrier Spray Broad Spectrum SPF 30 • Neutrogena® Pure & Free Baby Sunscreen Broad Spectrum SPF 60+ • Neutrogena® UltraSheer Dry-Touch Sunscreen Broad Spectrum SPF 30 **Insect Repellents:** • OFF® Deep Woods • Sawyer® Permethrin	• Products other than those listed as ■Allowable

[1] This table is not considered to be a complete listing of prohibited or allowable materials. All materials should be evaluated prior to use during sampling. The manufacturers of various products should be contacted in order to determine if PFAS was used in the production of any particular product.

[2] Equipment blank samples should be taken to verify these products are PFAS-free prior to use during sampling.

[3] **For surface water foam samples:** LDPE storage bags may be used in the sampling of foam on surface waters. In this instance, it is allowable for the LDPE bag to come into direct contact with the sample media.

[4] **For fish and other wildlife samples:** Depending on the project objectives, glass jars and aluminum foil might be used for PFAS sampling. PFAS has been found to bind to glass and if the sample is stored in a glass jar, a rinse of the jar is required during the sample analysis. PFAS are sometimes used as a protective layer for some aluminum foils. An equipment blank sample should be collected prior to any aluminum foil use.

[5] Regular ice is recommended as there are concerns that chemical and blue ice may not cool and maintain the sample at or below 42.8°F (6°C) (as determined by EPA 40 CFR 136 – NPDES) during collection and through transit to the laboratory.

[6] Based on evidence, avoidance of PCPs is considered to be precautionary because none have been documented as having cross-contaminated samples due to their use. However, if used, application of PCPs must be done at the staging area and away from sampling bottles and equipment, and hands must be thoroughly washed after the use of any PCPs prior to sampling.

● - Prohibited ■ - Allowable ▲ - Needs Screening

ATTACHMENT B

Field Forms

Site Name:

Project Number:

Well ID:

Location ID:

Drilling Subcontractor:

Installation Date:

Drilling Personnel:

Decon Performed:

Technician Name:

Drilling Method:

Other Amec Foster Wheeler Representatives:

Measurement Point (riser)
Elevation (ft msl):

Land Surface Elevation (ft):

Approximate Diameter
of Borehole (in):

Depth to Water (ft):

During Drilling:

Date:

Post Development:

Date:

Hydrologic Unit:

Water added during
drilling (gal):

Water removed during
development (gal):

Top of Bentonite Seal (ft):

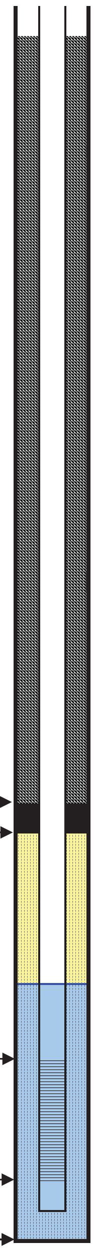
Top of Filter Pack (ft):

Top of Screen Interval (ft):

Bottom of Screened Interval (ft):

Bottom of Filter Pack (ft):

Bottom of Borehole (ft):



Protective Casing:

Type:

Dimensions (in):

Stickup (ft):

Length (ft):

Guard Post:

Surface Pad:

Dimensions:

Type:

Annular Seal (grout above well seal):

Material:

Installation Method:

Bentonite Seal:

Manufacturer:

Material:

Type:

Installation Method:

Hydration time (hrs):

Filter Pack Material:

Manufacturer:

Material:

Size:

Installation Method:

Surging time:

Well Casing (Riser):

Manufacturer:

Type/Material:

Length:

Diameter (in):

Well Screen:

Manufacturer:

Type/Material:

Diameter (in):

Slot Size (in):

Slot Type:

Sump/End Cap:

Notes:

Technician Signature:

Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).

Technician Name (print):

QA/QC'd by:

QA/QC Date:

ATTACHMENT 1 TO SOP AFW-01
DAILY PFC PROTOCOL CHECKLIST

Project Name:	**Project Number:**
Contract:	**Task Order:**
Installation:	**Weather (temp./precipitation):**
Site Name:	
Field Manager:	**Date and Time:**

Field Clothing and PPE (as applicable):

- ☐ Field crew in compliance with Tables 1 and 2, SOP AFW-01
- ☐ Field crew has not used fabric softener on clothing
- ☐ Field crew has not used cosmetics, moisturizers, hand cream, or other related products or exposed body parts this morning
- ☐ Field crew has not applied unacceptable sunscreen or insect repellant

Field Equipment:

- ☐ No Teflon® containing materials on-site
- ☐ All sample materials made from stainless steel, HDPE, acetate, silicon, or polypropylene
- ☐ No waterproof field books on-site other than Rite-in-the-Rain® Products
- ☐ No plastic clipboards, binders, or spiral hard cover notebooks on-site
- ☐ No adhesives (Post-it® Notes) on-site
- ☐ Coolers filled with regular ice only. No chemical (blue) ice packs in possession

Sample Containers:

- ☐ All sample containers made of HDPE or polypropylene. Samples are not stored in containers made of LDPE
- ☐ Caps are lined or unlined and made of HDPE or polypropylene

Wet Weather (as applicable):

- ☐ For personnel in direct contact with samples and/or sampling equipment, wet weather gear made of Vinyl, polyurethane, PVC, latex or rubber-coated materials only

Equipment Decontamination:

- ☐ "PFC-free" water on-site for decontamination of sample equipment
- ☐ Alconox and Liquinox to be used as decontamination materials

Food Considerations:

- ☐ No food or drink on-site with exception of bottled water and/or hydration drinks (i.e., Gatorade and Powerade) that is available for consumption only in the staging area

If any applicable boxes cannot be checked, the Field Manager shall describe the noncompliance issues below and work with field personnel to address noncompliance issues prior to commencement of that day's work. Corrective action shall include removal of noncompliance items from the investigation area or removal of worker offsite until in compliance. Repeated failure to comply with PFC sample protocols will result in the permanent removal of worker(s) from the investigation area.

Describe the noncompliance issues (include personnel not in compliance) and action/outcome of noncompliance:	**Field Manager Signature:**
	Field Manager Name (print)**:**

WELL DEVELOPMENT LOG

Site Name: **Project Number:**

Well ID: ______ **Start Date:** ______
Sample Technician: ______ **End Date:** ______
Initial Depth to Water: ______ **Total Depth of Well:** ______
Development Method: ______ **Depth to Water After Purging:** ______
Pump Start Time: ______ **1 Casing Volume (gal):** ______
Total Volume Purged (gal): **3 Casing Volumes (gal):**

Time	Intake Depth (feet)	Rate (gpm)	Water Level (feet)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Cum. Volume (gal.)	Comments/Observations During Purging (color, sediment, etc.)

Instruments (Manufacturer, Model, and Serial No.):

Calculations:

Saturated well casing volume: $V = \Pi(R^2)H*7.48$ gal/ft^3

V = Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

Technician Signature:

Notes:

Technician Name (print)**:**

QA/QC'd by: **QA/QC Date:**

FIELD ACTIVITY DAILY LOG

Site Name: **Project Number:**

Technician Name: **Date and Time:**

Personnel Onsite:

Weather Conditions:

Description of Daily Activities and Events:

List Samples Collected:

Deviation from Plans:

Visitors on Site:	**Important Telephone Calls / Photos Taken:**	**Technician Signature:**
		Technician Name (print)**:**

QA/QC'd by: **QA/QC Date:**

WATER QUALITY SAMPLING INSTRUMENT CALIBRATION FORM

Site Name: **Calibration Start Time:** **Calibration End Time:**

Project Number: **Sample Technician:** **Date:**

Morning (AM) Calibration

Time (24hr)	Temperature (°C)	pH (SU)	Turbidity (NTUs)	Specific Electrical Conductance (mS/cm)	D.O. (mg/L)	ORP/Eh (mV)	Barometric Pressure (mm Hg)	Comments

Afternoon (PM) Calibration

Time (24hr)	Temperature (°C)	pH (SU)	Turbidity (NTUs)	Specific Electrical Conductance (mS/cm)	D.O. (mg/L)	ORP/Eh (mV)	Barometric Pressure (mm Hg)	Comments

Calibration Materials Record:

pH Calibration Standards			Specific Electrical Conductance, Salinity, Dissolved Oxygen (DO) and Oxidation Reduction Potential (ORP) Calibration Standards			Turbidity Standards		
Standard	Cal. Standard Lot #	Expiration Date	Standard	Cal. Standard Lot #	Expiration Date	Standard	Cal. Standard Lot #	Expiration Date
pH (4)			Spec. Conductance			10		
pH (7)			D.O.			100		
pH (10)			ORP					

Instruments (Manufacturer, Model, and Serial No.):

	Manufacturer/Model	Serial No
Water Quality Meter:		
Turbidity Meter:		

Calibrated Within Acceptance Criteria (Y/N):

If No, Provide Explanation:

Notes:

Technician Signature:

Technician Name (print): re8d

QA/QC'd by: **QA/QC Date:**

SAMPLE COLLECTION LOG
SEDIMENT / SURFACE SOIL / SURFACE WATER

Site Name:	**Project Number:**
Location ID:	**Date:**
Latitude/Longitude:	**Sample Technician:**

SEDIMENT SAMPLE

Description

NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength,consistency

Sample ID:	**Sample Date:**
Sample Depth	**Sample Collection Time:**
Duplicate Collected:	**Other QA/QC:**
Duplicate Sample ID:	**Blank ID(s):**
Sample Container Type(s):	**Sample Collection Methods:**
Preservative(s):	**Analysis/Method(s):**

SURFACE SOIL SAMPLE

Description

NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength,consistency

Sample ID:	**Sample Date:**
Sample Depth:	**Sample Collection Time:**
Duplicate Collected:	**Other QA/QC:**
Duplicate Sample ID:	**Blank ID(s):**
Sample Container Type(s):	**Sample Collection Methods:**
Preservative(s):	**Analysis/Method(s):**

SURFACE WATER SAMPLE

Time	Intake Depth (feet)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, etc.)

Sample ID:	**Sample Date:**
Sample Depth:	**Sample Collection Time:**
Duplicate Collected:	**Sample Collection Methods:**
Duplicate ID:	**Sample Container Type(s):**
Other QA/QC:	**Surface Water Depth (in):**
Blank ID(s):	**Water Body and Water Quality Characteristics:**
Preservative(s):	
Analysis/Method(s):	

Location Sketch:

Instruments (Manufacturer, Model, and Serial No.):

Notes:

Technician Signature:

Technician Name (print):

QA/QC'd by: **QA/QC Date:**

GROUNDWATER SAMPLING RECORD

amec

Project Name: **Project Number:**

Contract:	**Task Order:**
Installation:	**Technician(s):**
Well ID:	**Date:**
Initial Depth to Water (ft):	**Well Diameter (in):**
Total Depth of Well (ft):	**1 Casing Volume (gal):**
Method of Purging:	**3 Casing Volumes (gal):**
Measuring Point (toc, tor, etc.):	**Pump Intake Depth (feet):**

Time	Water Level (feet)	Flow Rate (mL/min)	Cum. Volume (gal.)	Temp. (°C)	pH (SU)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
Stabilization Criteria				±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
Stability Reached (Y/N):						If No, Provide Explanation				
Final Values:										

Sample ID:	**Method of Sampling:**
QA/QC Samples (Yes/No):	**Sample Date:**
Duplicate ID:	**Sample Collection Time:**
Sample Container Type(s):	**Total Volume Purged (gal):**
Preservative(s):	**Sample Depth (ft):**
Analysis/Method(s):	**Depth to Water After Sampling (ft):**

Instruments (Manufacturer, Model, and Serial No.):

Equipment Calibrated (Y/N): Calibrated Within Criteria (Y/N):

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

Signature:

Notes:

Name (print):

QA/QC'd by: **QA/QC Date:**

Groundwater Gauging Form

Site Name:
Date:
Project Number:
Field Staff:

Well ID	Time	Depth to Groundwater (btoc,ft)	Depth to Bottom (btoc, ft)	Depth to Product (btoc, ft)	Notes/Remarks

Notes: