Site Characterization Sampling & Analysis Plan

Wisconsin Air National Guard
Air Fighter Wing Facility
F-35 Beddown: Combined Three Projects W9133L-16-D-005/W50S9F-21-F-0001
XGFG182019
XGFG182053
XGFG202053

Prepared for:

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Truax Field
Madison, Wisconsin

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1.0 Introduction

This document presents the Sampling and Analysis Plan (SAP) for subsurface assessment to be performed at the Sunshade for CT Mission (new)/Sunshade for Deployable Mission (new) and the asbestos and lead bearing paint inspection at the existing Gun Shop – Building B420 at the Wisconsin Air National Guard (WIANG) base located at Truax Field in Madison for the F-35 beddown project. Ayres Associates will conduct this assessment in accordance with NR 700 Wisconsin Administrative Code. Asbestos inspection will follow the Wisconsin Administrative Code NR 441 and National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulations.

The SAP outlines the policy and organizational structure for completing the assessment, describes the rationale and approach to the project, summarizes the tasks to be performed, and outlines the schedule for implementing the assessment. The SAP outlines the objectives of the sampling program and describes in detail the activities and sampling procedures to be used during the project. Changes required in the procedures described in this SAP due to site conditions, or other constraints, will be properly documented in the site logbook. Significant changes to the SAP, such as the addition or deletion of tasks, will be detailed in a technical memorandum to the client and the Wisconsin Department of Natural Resources (WDNR).

Site Address and Location

Address of Site: F35: Bed Down (Two site locations)
Truax Field
3200 Pierstorff Street
Madison, Wisconsin

The site is located in the Northeast ¼ of the Northwest ¼ of Section 29, Township 8 North, Range 10 East, Dane County, Wisconsin. WTM Coordinates x: 573861.85115, y: 295690.15869 (See Figure 1.)

Responsible Party and Project Consultant

The project contacts for this site are as follows:

Client: FSB Architects & Engineers
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Site Owner: Wisconsin Air National Guard (WIANG)
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2.0 Project Background

The WIANG installation at Truax Field has been home to the 115th Fighter Wing since 1995. The installation has been home to primarily fighter/attack aircraft, most recently F-16 and RC-26B aircraft. In April 2020, the United States Air Force announced that the 115th Fighter Wing would receive a fleet of F-35A aircraft. The base will transition from operations involving F-16 aircraft to F-35A aircraft, including upgrading facilities to house the new aircraft.

FSB Architects & Engineers (FSB) has been retained by the WIANG to upgrade their installation to accommodate the F-35A aircraft including the construction of a Sunshade for CT Mission/Deployable Mission and renovation of the Gun Shop-Building B420. Ayres Associates will be partnering with FSB on the project to provide environmental services including assessment of soil and groundwater for volatile organic compound (VOC) and Per- and Polyfluorinated Alkyl Substances (PFAS) which have been previously documented at sites near the proposed location of the Sunshade site. The presence of VOC compounds in soil and groundwater are associated with the use and storage of petroleum and other hazardous substances at the installation. The PFAS contamination detected at the site is attributed to the storage and use of firefighting foams at Hangar 414 and other nearby buildings or firefighting equipment testing areas at the base.

The Wisconsin Department of Natural Resources (WDNR) is requiring assessment of VOC and PFAS concentrations in soil and groundwater at the proposed Sunshade site and submittal of a Materials Management Plan based upon the results of this assessment. In addition to the subsurface investigation and preparation of a Materials Management Plan for the Sunshade site, an asbestos inspection and lead-bearing paint assessment will be conducted on the Gun Shop-Building B420 so that these materials, if present, are properly managed prior to building renovation.

3.0 Initial Evaluation

Site Location and Description

The project site is located in the Northeast ¼ of the Northwest ¼ of Section 29, Township 8 North, Range 10 East, Dane County, Wisconsin. The site (herein referred to as site or property) is located at Truax Field, 3200 Pierstorff Street, Madison, Wisconsin (Figure 1).

With the recent announcement that the base will be transitioning to F-35A aircraft, several buildings and engineering appurtenances will require replacement or retrofitting to accommodate the new mission.

Site History and Background

Background information for the Sunshade site and the Gun Shop-Building B420 was gathered from environmental reports for nearby sites at Truax Field obtained from the WDNR Bureau of Remediation and Redevelopment Tracking System (BRRTS). The “Draft Report, FY 16 Phase 1 Regional Site Inspections for Perfluorinated Compounds (March 2018), prepared by Amec Foster Wheeler under contract to the WIANG was also used as a source of information.

The WIANG installation at Truax Field was originally constructed in 1942 as an Army base. The base was deactivated as an active military base in 1968 when it became occupied by the WIANG. Since 1942 fighter/attack aircraft have been housed at Truax Field. Over the years, the installation has used and stored petroleum and other hazardous materials.

The Department of Defense has conducted environmental investigations at military bases across the country as part of the Installation Restoration Program. The WIANG base at Truax Field was one of the facilities included in the program. According to the WDDNR BRRTS, environmental activities have been conducted on the site since 1990 when a preliminary facility investigation indicated soil and groundwater in the proximity of Hangar 414 was impacted by petroleum. A subsequent investigation conducted by Dames and Moore defined an area of soil and groundwater contamination that resulted in excavation and disposal of petroleum-contaminated soil and operation of a soil vapor extraction system (SVE). The site was closed by the WDNR in 2012 with residual soil and groundwater contamination.

A Perfluorinated Compound Preliminary Assessment Site Visit was conducted on the base by BB&E, Inc. in 2015. The purpose of the visit was to identify sites with potential perfluorinated compound releases associated with Aqueous Film Forming Foam (AFFF) use and storage. Results of the assessment are documented in the “Final Perfluorinated Compounds Preliminary Assessment Site Visit Report (December 2015) prepared by BB&E, Inc. Findings of the report concluded that Hangar 414 was equipped with a fire suppression system supplied with AFFF and that a site characterization of soil and groundwater was recommended.

A Phase 1 Regional Site Inspection for Perfluorinated Compounds was conducted at the base by Amec Foster Wheeler in 2017. This work included subsurface investigation of soil and groundwater for perfluorinated compounds based upon the recommendations of the 2015 BB&E Site Visit Report. Soil boring were advanced at Hangar 414, Hangar 406, Hangar 400 as well as several other buildings site for collection of soil and groundwater samples. Results of soil sample analysis indicated detectable perfluorinated compound concentrations. Groundwater analysis detected perfluorinated compounds at concentrations exceeding the EPA Drinking Water Health Advisory.

Environmental Concerns

Environmental concerns regarding the Sunshade site are related to the known volatile organic compound (VOC) perfluorinated compound contamination documented at nearby sites at Truax Field. Based upon the age of buildings at Truax field, including the Gun Shop-Building 420, asbestos and lead bearing paint may be present and would require proper handling prior to building renovation.

Regional Geology and Hydrogeology

Geology

Evaluation of the site geology is based on existing published regional information[1], and site-specific data collected from borings advanced in the project area. Subsurface information collected during previous assessment activities conducted on the site indicates that the unconsolidated sediments consist primarily of between 3 and 7 feet of clay and silty clay underlain by fine to medium-grained sand to a depth of at least 18 feet below ground surface.

Regional information indicates that surficial unconsolidated deposits consist of off-shore lake sediment consisting of plane-bedded and cross-bedded sand and plane bedded silt and clay. The unconsolidated deposits in the site area are estimated to be nearly 300 feet thick. The uppermost bedrock unit in the area of the site is the Cambrian age Mt. Simon Sandstone.

Hydrogeology

Groundwater aquifers are found within the unconsolidated glacial deposits and underlying sandstone bedrock. These aquifers are the source for domestic, municipal, and industrial water supplies in the Madison area and Dane County. The bedrock aquifer is the principal source for municipal water in Dane County. The City of Madison uses wells completed in the Mount Simon sandstone for its municipal water supply. Truax Field is supplied water from the City of Madison distribution system.

Depth to groundwater is generally less than five feet below ground surface. Previous investigations at the site indicate that shallow groundwater has been interpreted to flow south-southeast or northwest depending on the location at the base.

Site Conceptual Model

A site conceptual model is a preliminary evaluation and description of the natural environment that exists at the site, including hydrogeologic conditions, potential contamination sources, contaminant release mechanisms and migration routes, potential human and ecological receptors that may come in contact with contaminants, and potential exposure pathways. The conceptual model is based on existing published information or knowledge of a site and provides a preliminary framework for planning and implementing site characterization activities.

Based on existing information, the anticipated site stratigraphy in the Sunshade project area will consist of clay and silty clay overlying fine to medium-grained sand to the depth of exploration.

Depth to groundwater is anticipated to be within five feet of ground surface. Recharge to the upper aquifer system is likely through direct infiltration of precipitation and snowmelt. Discharge from the shallow aquifer system likely occurs by evapotranspiration and seepage into Starkweather Creek. Groundwater flow in

[1] Clayton, Lee and Attig, J.W. 1997. “Pleistocene Geologic Map of Dane County, Wisconsin, WGNHS Bulletin 95, Plate 1.

the shallow water table is interpreted to be south southeasterly (or northwest depending on location), based on previous investigations performed nearby.

Environmental impacts to be investigated at the Sunshade site, based on information from the Wisconsin Department of Natural Resources (WDNR) and the Wisconsin Air National Guard (WIANG) include volatile organic compounds (VOC) and Per- and Polyfluorinated Alkyl Substances (PFAS) in soil and groundwater. These compounds have been detected during previous investigations conducted at the site.

In addition, site buildings are scheduled for demolition or retrofitting. Therefore, building materials will be assessed for the presence of asbestos and lead-bearing paint.

Likely contaminant release mechanisms and exposure routes include direct contact and ingestion threats from impacted soil by on-site workers and off-site migration of contaminated groundwater. Infiltration of precipitation may also transport contaminants from soil into the groundwater; impacted groundwater could potentially be discharging to Starkweather Creek.

4.0 Sampling Objectives and Rationale

Data Quality Objectives (DQOs) are qualitative and quantitative statements that clearly state the objective of a proposed project, define the most appropriate type of data to collect, determine the appropriate conditions for data collection, and specify acceptable decision error limits that establish the quantity and quality of data needed for decision making. The DQOs are based on the use of the data that will be generated. Different data uses may require different quantities of data and levels of quality.

The need to implement remedial action at the sites identified in this SAP and the type of remedial action that may be required is contingent on the hydrogeologic conditions and other physical and environmental characteristics at the site. Therefore, a complete and accurate assessment of conditions at these sites is essential. The overall goal of this assessment is to provide information for redevelopment.

The following site characterization issues will be addressed to evaluate the potential threat to human health and welfare or the environment:

- Define topography and major geomorphic features
- Define the local geology including the origin, texture, thickness, and distribution of the unconsolidated deposits
- Determine local hydrogeologic conditions including depth to groundwater, groundwater flow directions, and gradients
- Determine the type and distribution of contaminants of concern in soil and groundwater for subsequent preparation of a Materials Management Plan
- Evaluate potential contaminant pathways and the potential for migration in soil and groundwater

The primary objectives of the assessment are to:

- Characterize the hydrogeologic and other environmental conditions
- Determine the presence of potential environmental impacts at the site
- Evaluate the threat, if any, to human health and the environment
- Evaluate the need to implement remedial action at the site regarding site redevelopment
- Assess the concentrations and possible environmental impacts from VOC and PFAS within the area of Sunshade construction
- Evaluate the groundwater flow system to determine the potential for off-site migration
- Characterize the Gun Shop-Building 420 for asbestos and lead paint prior to demolition or alterations.

Assessment Tasks

Tasks to be performed to meet the objectives of the assessment include advancing soil probes, installation of temporary groundwater monitoring wells, collection and laboratory analysis of soil, groundwater, asbestos, and lead paint samples, and evaluation of the data collected.

The number of probes and wells included in the sampling and analysis plan is summarized in Table 1. The locations of the proposed borings and wells are shown in Figure 2 and are within the zone of construction for the Sunshade. The exact location of these soil probes and borings are contingent on the location of underground utilities, site accessibility, and safety of field personnel.

Permitting

Permit and land access agreements may be required to install and sample monitoring wells on private property or Federal/State Military installations. Ayres Associates will work with FSB and the WIANG to obtain the required permits and resolve site access issues, as necessary.

Soil Samples

The number and types of samples collected for each site are summarized in Table 1, as well as in Table 3: Site Characterization Analytical Program. Shallow probes advanced to evaluate soil type and quality, and for subsequent installation of 1-inch diameter temporary monitoring wells, will be performed using Geoprobe™ System hydraulic push techniques. Continuous samples will be collected from the ground surface to the depth of exploration when advancing the probes. Geologic information obtained from the probes will be documented on Soil Boring Log Information Forms.

Samples of the unconsolidated material will be collected for detailed lithologic description, field screening, and laboratory analysis. Soil (and groundwater) sampling equipment will be decontaminated before use in accordance with Ayres SOP #510 (Appendix A).

Soil samples obtained from the probes will be screened for the presence of total ionizable VOCs. Field screening will be performed using a PID in accordance with standard operating procedure SOP #210. Samples will be selected for possible laboratory analysis based on visual and olfactory observations and PID screening results. If PID field screening results exceed five instrument units (above background), a co-located sample will be collected immediately from a fresh surface of the soil sample for possible laboratory analysis. Soil samples collected for VOC analysis will be screened and preserved using the procedures outlined for soil vapor screening and methanol preservation of soil samples (VOC analysis) SOP #210 and SOP #240, respectively. Soil sampling and soil vapor screening methodologies are discussed in Section 8.0.

Soil samples at each of the probe locations will be selected for laboratory analysis from the 1-2’ interval and from the interval 1’ above the water table. This methodology is in accordance with previous site characterization projects conducted in proximity of the Sunshade site and as described in WDNR’s Site Characterization Sampling For Contaminated Material Management Purposes memoranda, dated April 13, 2020 (Appendix B),

Within those prescribed intervals, the soil sample with the highest PID readings at each sampling location will be selected for laboratory analysis. If no volatile organic contamination is identified above background using the field screening, a sample from each sampling location will be selected based on obvious discoloration or other visible signs of contamination. Soil samples will be submitted to the laboratory and analyzed for PFAS and VOC using EPA Method 537 Mod and EPA Method 8260C, respectively.

Groundwater Samples

Groundwater samples will be collected from each of the temporary monitoring wells installed at the site. The samples will be collected in accordance with the procedures detailed in Section 8.0 of this document. The samples will be submitted to a laboratory and analyzed for VOC and PFAS using EPA Method 537 Mod and EPA Method 8260. Information obtained from the wells will be used to evaluate the groundwater flow system and determine the concentration of contaminants in groundwater for subsequent material management purposes during construction.

Asbestos Survey

The asbestos survey will include a physical inspection of the interior and exterior, collecting bulk samples of each homogenous suspect ACM, documenting the locations where samples are collected, determining the friability of suspect materials, and estimating quantities of suspect materials. Sample locations will be determined in the field.

Ayres will collect representative samples of potential ACM from homogenous material types following the Wisconsin Administrative Code NR 441 and National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulations, using wet-sampling methods and clean tools. It is assumed one (1) sample will be collected for 115 square feet of interior space, with a minimum of 8 samples.

Asbestos samples will be submitted under chain-of-custody to a national Voluntary Laboratory Accreditation Program (NVLAP) approved laboratory for analysis of asbestos content by polarized light microscopy (PLM) using EPA Method 600/R-93/116.

Lead Bearing Paint Survey

The lead-bearing paint survey will include collection of representative paint samples from interior and exterior masonry and metal surfaces using clean tools. The number of lead paint samples needed assumes a minimum of two (2) samples and up to 10 samples. The paint samples will be submitted under the chain of custody to a state-certified laboratory for lead analysis using Method 6010C. Paint containing more than 0.5 percent lead by weight or more than 1 milligram of lead per square centimeter is considered lead-bearing.

5.0 Schedule

A project schedule (Figure 3) was developed based upon the estimated duration of the various tasks described in this work plan. Actual start and completion dates and milestones are contingent on regulatory review schedules, work plan negotiations, well installation and access permitting, and the actual scope of work performed. Significant changes in review times or the scope of work outlined in this work plan will necessarily affect the project schedule.

Ayres Associates will manage (shorten or lengthen) the project schedule based upon the clients or project needs. The schedule can be shortened if circumstances prevent critical project milestones from being achieved. If necessary, Ayres Associates will shorten the schedule, where possible, by overlapping project tasks, decreasing lag time between tasks, decreasing task duration, or allocating additional resources.

6.0 Project Team and Management

Organization

Ayres Associates has assembled a project team experienced in the various requirements of this project. Project management and fieldwork will be directed and performed out of Ayres Associates' Madison, Wisconsin, office.

Project leadership and primary staff will be comprised of individuals experienced in the activities outlined in the scope of work. Our project team will provide experience in hydrogeologic analysis, geochemistry, risk assessment, environmental engineering, and remedial design.

7.0 Objectives of Sampling Program

The purpose of the sampling program is to characterize the nature and extent of contamination at the site. This requires obtaining the necessary information regarding the type, distribution, and concentration of chemical contaminants present, as well as site-specific hydrogeologic and other environmental conditions that may affect potential contaminant migration. This information will be used to evaluate the potential health and environmental risks posed by the contaminants identified as they relate to site redevelopment. The information will also be used to evaluate remedial technologies and alternatives that are appropriate for site conditions, if required, and to complete a Materials Management Plan (MMP) for use during site construction. The following overall site characterization issues will be addressed:

- Define the local geology including the origin, texture, thickness, and distribution of the unconsolidated deposits
- Determine the local hydrogeologic conditions including depth to groundwater, and groundwater flow directions and gradients
- Determine the type and distribution of contaminants of concern in the soil, sediment, and groundwater
- Evaluate potential contaminant pathways and the potential for migration in soil and groundwater
- Determine type and distribution of unconsolidated deposits
- Evaluate groundwater quality

Rationale for Selection of Analytical Parameters

The emphasis of this sampling program is on evaluation of the overall site hydrogeologic characteristics and the concentration and distribution of contaminants of concern in the soil, sediment, and groundwater. The proposed analytical program includes the collection and analysis of soil, groundwater, and building material samples.

Selection of the probe locations and sampling parameters to be analyzed for at the Sunshade site is based upon recommendations for previous investigations in the area as described by the WDNR in the Site Characterization Sampling for Contaminated Material Management Purposes memorandum dated April 2020. Therefore, the sampling program for this site assessment will include analysis of soil and groundwater for volatile organic compounds (VOC) and per- and polyfluoroalkyl substances (PFAS). Also, buildings materials at the Gun Shop-Building 420 will be inspected and select samples analyzed for asbestos and lead-bearing paint.

The laboratory program for the assessment is discussed in detail in Section 12.0.

Analytical Data Quality Levels

Two analytical levels address the data uses and the QA/QC effort required to achieve the desired level of quality appropriate for this project. These levels are:

Screening (Level 1) – Analytical level 1 provides the lowest data quality but the most rapid results. This level involves the use of field instruments and is used for data collection activities that involve non-rigorous analysis and quality assurance. Portable instruments will be used for health and safety monitoring and preliminary site characterization. A photo-ionization detector (PID) will be used to qualitatively assess environmental media for the presence of potential VOCs. This information will be used to evaluate the need for confirmatory analysis and will provide information on the degree of potential

impacts at the site. A PID will also be used to monitor ambient air conditions for health and safety. Additional field instrumentation will include a flow-through cell and multi-parameter water quality probe to measure pH, temperature, dissolved oxygen, conductivity, and oxidation-reduction potential in the aquifer.

Confirmation (Level 2) – Analytical level 2 involves analysis of sampling media in an off-site certified analytical laboratory. This level of analysis is used to meet data quality objectives that require a high degree of qualitative and quantitative accuracy using rigorous methods of analysis and quality assurance. Analytical level 2 uses standard, documented USEPA approved procedures for analysis but does not use data validation or documentation procedures required for higher level DQO objectives.

Analytical level 2 analysis will be used to provide confirmed identification and quantification of organic and inorganic compounds in soil and groundwater samples collected at the site. These methods provide detection limits that are sufficiently low to provide data that can be used to support decisions regarding site characterization, risk assessment, and evaluation of remedial alternatives. Detection limits for parameters to be analyzed during this assessment are further discussed in Section 12 (Laboratory Program).

Results obtained from the analytical program will be compared to the State of Wisconsin residual contaminant levels (RCLs) to support decisions regarding site characterization, risk assessment, remedial alternatives, and materials management. Soil concentrations will be compared to the applicable soil standards presented in WDNR NR 720 Wis. Adm. Code look-up tables including Residential Contact and Migration to Groundwater values that were calculated using U.S. EPA's regional screening level (RSL) web calculator. The non-industrial direct contact RCL for both PFOA and PFOS is 1.26 mg/kg. The industrial direct contact RCL for both PFOA and PFOS is 16.4 mg/kg. There is no pre-determined groundwater protective soil RCL for these compounds. These residual contaminant levels (RCLs) will be used to evaluate material management options for soil and groundwater during planned construction activities. These soil standards are presented in Table 5 of this work plan.

The applicable cleanup standards for VOC in groundwater in Wisconsin are presented in NR 140 Wis. Adm. Code. Groundwater VOC results will be compared with NR 140 standards. State groundwater quality standards have not been established for PFAS compounds. The DNR requested that Wisconsin Department of Health Services (DHS) recommend a PFOA and PFOS groundwater health standard in Wisconsin. The DHS has recommended that an enforcement standard of 20 ng/L and a preventative action limit of 2 ng/L be used for PFOA and PFOS individually and combined. Note that state and federal soil and groundwater standards are periodically updated; results obtained from the assessment will be compared to the most recent standards available. Groundwater results will be compared with the standards presented in Table 6.

8.0 Scope of Work

Field Assessment Objectives

The scope of work detailed in this work plan is designed to meet the objectives of the assessment outlined in Section 7.0. The emphasis of this phase of assessment will be on the evaluation of site hydrogeologic characteristics, soil, and groundwater quality, and to better define the threat to human health and the environment. Information collected during this assessment will be used to prepare a Materials Management Plan for managing environmental media, building materials, and other debris at the site during construction activities.

This phase of assessment will include advancing soil probes, installation of 1-inch diameter temporary wells, collection of building material samples, and laboratory analysis of soil, groundwater, asbestos, and lead-based paint. Data obtained from this phase of assessment will be used to further evaluate geologic characteristics of the site, horizontal groundwater flow directions, gradients, and velocity; and evaluate soil and groundwater quality, and building materials at the site. These data will be used to evaluate remedial options and engineering controls that may be required during construction. The scope of work for subsequent phases of assessment, if any, is contingent on this phase of assessment, and therefore, cannot be determined at this time.

Field Assessment Activities

Assessment Strategy

The purpose of the sampling program is to characterize the presence of VOC and PFAS contamination in soil and groundwater at the Sunshade site and determine the presence of asbestos and lead paint in the Gun Shop-Building 420 which is being proposed for renovation. This requires obtaining the necessary information regarding the type, distribution, and concentration of chemicals of concern identified by others at nearby sites, as well as site-specific hydrogeologic and other environmental conditions that may affect potential contaminant migration. This information will be used to help evaluate the potential health and environmental risks posed by the contaminants identified as they relate to site redevelopment. The information will also be used to prepare a Materials Management Plan for use during Sunshade construction. Sample locations and rationale are summarized in Table 1. Site-specific conditions, as well as overall project objectives, were considered in formulating our project approach. The overall goal of this assessment is to provide information for developing a materials management plan for the site. This will be done by supplementing the information previously gathered for this site to determine if and how this property has been affected by prior site activities. Field assessment tasks are detailed below.

Permitting

Permit and land access agreements may be required to install and sample monitoring wells on private property or Federal/State Military installations. Ayres Associates will work with FSB and the Wisconsin Air National Guard to obtain the required permits and resolve site access issues, as necessary.

Soil Assessment

Drilling and Soil Sampling Methods

The number and types of samples collected for the Sunshade site are summarized in Table 1 below, as well as in Table 3: Site Characterization Analytical Program. Shallow borings advanced to evaluate soil type and quality, and for subsequent installation of 1-inch diameter temporary monitoring wells, will be performed using Geoprobe™ System hydraulic push techniques. Continuous samples will be collected

from the ground surface to the depth of exploration when advancing the borings. Geologic information obtained from the boreholes will be documented on WDNR Soil Boring Log Information Form 4400-122.

Samples of the unconsolidated material will be collected for detailed lithologic description, field screening, and laboratory analysis. Soil (and groundwater) sampling equipment will be decontaminated before use to prevent cross-contamination in accordance with SOP #510.

Soil samples obtained from the borings will be screened for the presence of total ionizable VOCs. Field screening will be performed using a PID in accordance with standard operating procedure SOP #210. Samples will be selected for possible laboratory analysis based on visual and olfactory observations and PID screening results from WDNR prescribed sample intervals. If PID field screening results exceed five instrument units (above background), a co-located sample will be collected immediately from a fresh surface of the soil sample for possible laboratory analysis. Soil samples will be collected and preserved using the procedures outlined for soil vapor screening and methanol preservation of soil samples (VOC analysis) SOP #210 and SOP #240, respectively.

Borehole Abandonment

Each borehole advanced during this assessment, and not converted into a monitoring well, will be properly abandoned. All boreholes requiring abandonment will be abandoned in accordance with Chapter NR 141 Wisconsin Administrative Code. Because the probes are located in a tarmac used by aircraft, each boring will be abandoned with grout and resurfaced with concrete according to specifications provided by FSB. Borehole abandonment will be properly documented using a Well/Borehole Abandonment Form.

Groundwater Assessment

Temporary Well Installation

Temporary monitoring wells will be installed in borings advanced at the Sunshade site. The shallow monitoring wells will be installed at a depth of approximately 15 feet below ground surface, depending on the depth to groundwater. The purpose of the shallow monitoring wells is to evaluate groundwater flow and potential contaminant transport at the water table. Temporary monitoring wells will be constructed of 1-inch inside diameter (ID) schedule 40 PVC riser and screen. Each well will be constructed with a 5-foot length of 0.006-inch to 0.010-inch slot PVC screen, depending on the grain size of the sediments encountered. A summary of proposed temporary wells is presented in Table 2.

Monitoring wells will be installed in accordance with Ayres Associates' standard operating procedure SOP #110 and NR 141 Wisconsin Administrative Code. Monitoring well casing and screen will be inserted in the boreholes after the target depth is reached. A sand filter pack (#40-#70) will be installed around the well screen and will extend approximately 2 feet above the top of the screen. A filter pack seal will be placed above the sand filter pack. The seal will consist of 2 feet of fine-grained sand placed above the filter pack. Granular or chipped bentonite will be placed above the seal to a depth of approximately 4 inches below the ground surface. The remaining annular space will be filled with native soil. Temporary wells will be removed, and the boreholes abandoned after groundwater samples are collected and water level data are obtained.

Well Development

Monitoring wells will be developed after construction to remove fine-grained materials from within the well screen and filter pack. The well will be developed in accordance with Wisconsin Administrative Code NR 141. The wells will be developed by over pumping with a peristaltic pump until purge water remains clear. Logs of all well development procedures will be maintained. Purge water will be drummed, or permission will be obtained to discharge the water directly to the sanitary sewer. Well development procedures will be documented on WDNR Monitoring Well Development Form 4400-113B.

Monitoring Well Survey

Monitoring wells will be surveyed to determine their elevations and horizontal locations. At each monitoring well, the elevations of the top of the well casing will be surveyed to the nearest 0.01-foot. Ground surface elevation will be surveyed to the nearest 0.1-foot. Horizontal locations will be surveyed with respect to site features such as building corners, other site wells, and borings. GPS coordinates for the monitoring wells and soil borings will be obtained with a hand-held device.

Collection and Analysis of Soil and Groundwater Samples

Soil Samples

Soil samples will be collected for laboratory analysis from each of the soil probes advanced during this assessment. Sample locations are within the zone of construction for the Sunshade and the sampling depths will be at intervals consistent with other investigations conducted in the area and as described in the WDNR memorandum dated April 13, 2020 (Appendix B). Sampling depths are summarized in Table 1.

Two discrete soil samples will be collected from each probe for laboratory analysis; one sample from a depth of 1-2 feet below ground surface and a second sample at a depth of approximately 1-foot above the water table. The soil analytical program for this site will include volatile organic compounds (VOCs) and Per- and Polyfluorinated Alkyl Substances (PFAS). Soil sample analysis is further discussed in the Laboratory Program (Section 12).

Samples from the pre-determined depths will be selected for analysis based on visual and olfactory observation, PID field screening results, conditions of the subsurface geology, and results of previous assessments performed at this site. The physical/chemical properties of the analytes will also be considered in selecting soil samples for analysis. Decisions on the exact samples to be analyzed will be made by the field scientist and the project hydrogeologist. Soil samples collected for analysis of non-volatile parameters will be collected from the Geoprobe™ acetate liner and placed directly in the appropriate glassware. Soil samples collected for volatile analysis will be collected and preserved with methanol in accordance with SOP 220.

Groundwater Samples

To effectively evaluate the need for, and or type of, remediation required at the site, a complete and accurate assessment of groundwater quality is required. Data on contaminant types, concentrations, and distribution will be evaluated in conjunction with the physical/chemical properties of the constituents to determine their persistence and mobility within the subsurface.

Temporary wells, consisting of a 1-inch diameter length of sand-packed PVC screen and riser, will be installed in the five soil borings advanced below the water table. A 0.25-inch diameter high-density polyethylene (HDPE) tube will be inserted into the well and attached to a peristaltic pump. One round of groundwater samples will be collected from each of the monitoring wells installed at the site. Groundwater samples will be collected using the procedures detailed in Ayres SOP #310 and SOP #320. Samples obtained for VOC analysis will be collected according to procedures detailed in SOP #350. Samples obtained for PFAS will follow Ayres' PFAS/PFOA SOP #710 which contains key elements contained within WDNR-referenced PFAS Sampling Procedures on their website.

Prior to sample collection, water levels will be obtained from each of the monitoring wells. Groundwater samples will be collected from the monitoring wells using a peristaltic pump and low flow sampling techniques. Each monitoring well will be equipped with high-density polyethylene (HDPE) dedicated tubing. The tubing will be inserted into the well, so the intake is coincident with the middle of the well screen. Care will be taken to minimize disturbance of the water column and sediments that may be

present at the bottom of the well. The pump discharge line will be connected to the flow-through cell for monitoring water quality indicator parameters. The controller will be adjusted to an initial pumping rate of 1-liter/minute (L/min) until the line and pump are purged. The pumping rate will then be decreased to approximately 0.1 L/min. to 0.5 L/min., depending on the permeability of the geologic formation. The well will be purged until water quality parameters (pH, temperature, specific conductance, turbidity) stabilize for three consecutive measurements taken 3 minutes apart. (Note: measurement interval may be decreased based on hydraulic conditions of well [i.e., recharge] to prevent excessive drawdown.) Stabilization is defined when readings are within 10 percent of the previous reading and turbidity is less than or equal to 20 NTUs. Water levels will also be checked to document drawdown from pumping. Water quality indicator parameters will be recorded on the standard sampling log. Samples will be collected in pre-cleaned containers provided by the laboratory. Groundwater sampling information will be documented on the standard Ayres sampling forms.

The groundwater analytical program is detailed in Section 12 of this field sampling plan. Laboratory analysis for groundwater samples collected during this phase of assessment will include VOC and PFAS.

Real-time data on temperature, pH, specific conductance, dissolved oxygen, and oxidation-reduction (Redox) potential will be collected to complement the analytical data collected from the monitoring wells. These data will be used to construct a “geochemical model” of conditions at the site to assist in the interpretation and understanding of attenuation and or transformation processes that may be occurring in the aquifer, and the potential fate of the constituents of interest.

Temperature, pH, specific conductance, turbidity, dissolved oxygen, and redox potential will be obtained using an In-Situ®, Inc. Aqua Troll 600 multi-parameter water quality monitoring system, or equivalent. Simultaneous temperature, pH, specific conductance, turbidity, dissolved oxygen, and redox readings will be taken continuously during pumping until readings have stabilized. Stabilized readings will be recorded on the field sampling form. Water quality field parameters will be collected in accordance with SOP #330.

Data Analysis and Evaluation

Data obtained through the background data review and environmental assessment will be analyzed and interpreted by Ayres Associates. The objectives of the analysis will be to determine the presence and significance of regulated chemical impacts to soil and groundwater-related to historical activities at the site. The analytical data will be evaluated for temporal and spatial trends and compatibility with observations made in the field.

Results obtained from the analytical program will be compared to the State of Wisconsin residual contaminant levels (RCLs) to support decisions regarding site characterization, risk assessment, remedial alternatives, and materials management. Soil concentrations will be compared to the applicable soil standards presented in WDNR NR 720 Wis. Adm. Code look-up tables including Residential Contact and Migration to Groundwater values that were calculated using U.S. EPA's regional screening level (RSL) web calculator. The non-industrial direct contact RCL for both PFOA and PFOS is 1.26 mg/kg. The industrial direct contact RCL for both PFOA and PFOS is 16.4 mg/kg. There is no pre-determined groundwater protective soil RCL for these compounds. These residual contaminant levels (RCLs) will be used to evaluate material management options for soil and groundwater during planned construction activities.

The applicable cleanup standards for VOC in groundwater in Wisconsin are presented in NR 140 Wis. Adm. Code. Groundwater VOC results will be compared with NR 140 standards. State groundwater quality standards have not been established for PFAS compounds. The DNR has requested that Wisconsin Department of Health Services (DHS) DHS recommend a PFOA and PFOS groundwater health standard in Wisconsin. The Wisconsin Department of Health Services (DHS) has recommended that an enforcement standard of 20 ng/L and a preventative action limit of 2 ng/L be used for PFOA and PFOS individually and combined. Note that state and federal soil and groundwater standards are

periodically updated; results obtained from the assessment will be compared to the most recent standards available.

Site Assessment Report

A draft report summarizing findings of the site will be submitted to the WIANG for review and comment. The report will include a description of site conditions, subsurface geology, results and interpretation of the laboratory analytical data, and an accurate map showing the results and sample locations. A final report will be prepared following WIANG's review of the draft report. Reporting activities will include the completion and submission of required reports and forms. Project memoranda will also be prepared to keep the WIANG's project team and regulatory agencies apprised of project activities.

Asbestos, Lead Paint, and Hazardous Materials Survey

The Gun Shop-Building B420 is slated for renovation. The WIANG is requesting that this building be assessed for the presence of asbestos-containing materials (ACM) and lead-bearing paint. Ayres will provide a state-accredited asbestos inspector to conduct the assessment. The inspector will sample and assess the condition of suspect ACM and lead-based paint in conformance with applicable state and federal regulations. If access to any building presents a safety concern, the inspector will evaluate the possibility of any ACM based on professional judgment and experience but will not enter the structure or areas within the structure that he or she deems unsafe.

While on site, Ayres will inventory potentially hazardous materials that will require removal or special disposal before anticipated demolition, additionally, we will collect samples of dried paint from masonry surfaces and submit samples to a state-certified laboratory for lead analysis.

ACM Assessment

The ACM assessment includes the following:

- Review of previous asbestos inspection reports and building plans.
- Collect representative bulk samples of potential ACM from homogenous material types following the Wisconsin Administrative Code NR 441 and National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulations, using wet-sampling methods and clean tools. CONSULTANT proposes to collect an estimated 55 samples to evaluate homogeneous areas that are suspected of containing asbestos that would be necessary to supplement previous assessment activities.
- Assess the physical condition, location, and approximate quantity of ACM.
- Submit asbestos bulk samples under chain-of-custody to a national Voluntary Laboratory Accreditation Program (NVLAP) approved laboratory for analysis of asbestos content by polarized light microscopy (PLM) using EPA Method 600/R-93/116.
- Provide one letter report in portable document format (PDF) that summarizes the scope of services and results of the ACM analysis. The report will indicate the sample ID number, location on a diagram or layout map, and condition of the sample collection area, presence or absence of asbestos, and the estimated square footage of confirmed ACM, and copy of the inspector's certification.

Lead-Based Paint Assessment

Lead-paint assessment includes the following:

- Collect representative paint samples from interior and exterior masonry and metal surfaces using clean tools. Ayres estimates 10 paint samples will be collected from these surfaces.
- Ayres will submit samples to a state-certified laboratory for lead analysis (ICP).
- The location and area of masonry surfaces covered in paint containing more than 0.5 percent lead by weight or more than 1 milligram of lead per square centimeter will be documented in a table and on a diagram or layout map identifying the location of the lead-bearing paint sample.

The hazardous materials survey includes the following:

- Ayres will inventory potentially hazardous materials that could require removal or special disposal. The list will consist of those items identified in WDNR guidance WA-651 (Planning Your Demolition or Renovation Project: A guide to Hazard Evaluation, Recycling, and Waste Disposal).
- A list of potentially hazardous materials will be formatted into a table that includes estimated quantities of materials and their locations.

9.0 Quality Assurance/Quality Control (QA/QC) Samples

QA/QC samples will be collected to assure PFAS contamination is not introduced to the investigation samples from the drilling equipment or water used for equipment decontamination. Table 3 includes the QA/QC samples that will be collected, and the sample collection methodology is provided below.

Drilling Activities

- After the drilling tooling is decontaminated, an equipment blank will be collected. The equipment blank will be collected by pouring PFAS-free water used in decontamination over deconned drilling tooling and into laboratory-supplied containers.

- One sample of the PFAS-free decontamination rinse water will be analyzed for PFAS

Sample Collection Events

- Equipment blank samples will be collected at a rate of one equipment blank sample per environmental sampling event in accordance with Wisconsin PFAS Aqueous (Non-Potable Water) and Non-Aqueous Matrices Method Expectations Guidance (12/16/19).

- The sampling equipment that will be used at the equipment blank sample location will be decontaminated. Following decontamination, laboratory-provided PFAS-free deionized water will be run over non-dedicated equipment (i.e., water level meters). The rinsate will be collected in laboratory-supplied containers.

- Field duplicate samples will be collected at a rate of one duplicate sample per sampling event in accordance with Wisconsin PFAS Aqueous (Non-Potable Water) and Non-Aqueous Matrices Method Expectations Guidance (12/16/19).

- Matrix spike and matrix spike duplicate (MS/MSD) samples will be collected at a rate of one MS/MSD sample per sampling event.

- One trip blank will be submitted for each cooler that contains samples for VOC analysis.

- One methanol blank per day will be submitted for analysis when soil samples are collected for VOC analysis.

The QA/QC samples collected will be analyzed for the PFAS Laboratory Analyte List of 36 compounds via modified EPA Method 537. VOCs will be analyzed using EPA Method 8260.

10.0 Decontamination Procedures

All drilling equipment will be decontaminated before being brought to the worksite and between each of the boring locations. A temporary decontamination pad will be constructed at a location that is agreeable to/and approved by, the WIANG. All decontamination water will be containerized for offsite disposal as described in Section 11.0. Alconox detergent and a steam pressure washer will be used with a PFAS-free water rinse to decontaminate drilling equipment.

All non-disposable sampling equipment will be decontaminated prior to use and after each use (except for dedicated tubing left in monitoring wells). Non-disposable sampling equipment will be decontaminated using Alconox detergent and PFAS-free water. All decontamination water will be containerized for offsite disposal.

Ayres' SOP #710 details decontamination procedures during sampling. The following decontamination methods are allowable to use during sampling:

- Laboratory supplied PFAS-free deionized water
- Alconox®, Liquinox®, and Citranox®
- Sampling equipment scrubbed using polyethylene and PVC brush to remove particles.
- Triple-rinsing with PFAS-free water
- Decontaminating sampling equipment after sampling at each location, or between uses.
- Commercially available deionized water in an HDPE container if the water is verified to be PFAS-free
- Washing the equipment as follows: In a PFAS-free bucket, wash the equipment with a mixture of PFAS-free water and PFAS-free soap. In a second PFAS-free bucket, rinse the equipment with PFAS-free water. In a third bucket, (or if the second bucket can be washed and rinsed) rinse the equipment again with PFAS-free water. Change the decontamination water and soap between cleanings.

11.0 Storage and Disposal of Assessment Wastes

The drilling and sampling activities performed during this assessment are expected to generate solid and liquid "waste." The anticipated waste types and management procedures for each activity are summarized below:

- Drilling/ Monitoring Well Installation – Solid wastes consisting of wastepaper, plastic, well casing, protective clothing, and drill cuttings may be generated during drilling and well installation activities. All solid wastes exclusive of the drill cuttings will be bagged and disposed of as solid wastes in a Subtitle D municipal landfill.

  Soil cuttings generated during drilling and sampling procedures will be contained in 55-gallon DOT drums and left on-site for subsequent disposal.

- Well Development/Groundwater Sampling – Solid wastes generated during well development and groundwater sampling activities may include tubing and filters, bailer rope, plastic and paper, and disposable protective clothing. All solid wastes generated during these field activities will be bagged and disposed of as solid wastes in a Subtitle D municipal landfill.

Liquid waste generated during these activities will include well development water and purge water. Water obtained from each well installed during this assessment will be collected in 55-gallon DOT drums. Permission will be obtained from WIANG to discharge this water to the sanitary sewer at the point of generation if acceptable to the publicly owned treatment works. The decision to discharge the water to the sanitary sewer will be based on the type and concentration of contaminants. If permission cannot be obtained to discharge the water to the sanitary sewer, the water will be retained for subsequent off-site disposal that would be included in the Materials Management Plan task.

All 55-gallon drums containing solid or liquid wastes will be stored in a single secured location on WIANG-owned property within the project boundaries. Solids and liquids will be contained in separate drums. Each drum will be secured and properly labeled as to location, waste type, date, and other pertinent information.

12.0 Laboratory Program

The proposed analytical program for the assessment includes the collection of soil, groundwater, asbestos, and lead-paint samples. Table 3 summarizes the proposed analytical program for each site. This table provides the field and laboratory parameters, the number of sampling points and sampling rounds, and the total number of investigative samples, field duplicates, field blanks, equipment blanks, and trip blanks to be collected for each sample matrix.

Table 4 summarizes the appropriate laboratory glassware, preservatives, and holding times for each sample matrix. Analytical parameters, laboratory methods, and detection limits for soil and groundwater samples are summarized in Table 5 and Table 6, while those for lead and asbestos are presented in Table 7. Note that state and federal soil and groundwater standards are periodically updated; results obtained from the assessment will be compared to the most recent standards available.

13.0 NR 712.09 Submittal Certification

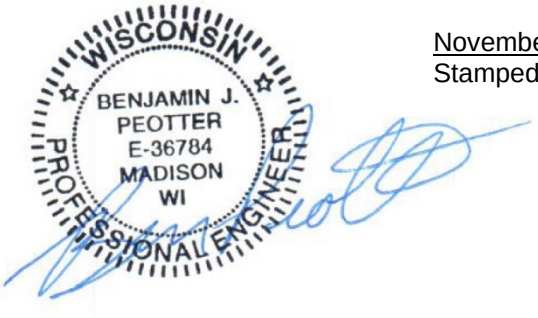
I, Thomas P. Gaieck, hereby certify that I am a hydrogeologist as that term is defined in s. NR 712.03 (1), Wis. Adm. Code, am registered in accordance with the requirements of ch. GHSS 2, Wis. Adm. Code, or licensed in accordance with the requirements of ch. GHSS 3, Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code.

Thomas P. Gaieck, PG — October 28, 2021
Date

I, Benjamin Peotter, hereby certify that I am a registered professional engineer in the State of Wisconsin, registered in accordance with the requirements of ch. A-E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A- E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726Wis. Adm. Code.

Benjamin Peotter, PE — October 29, 2021
Date
Manager-Development Services Midwest

36784-006
P.E. Number



November 2, 2021
Stamped Date

14.0 References

Amec Foster Wheeler, “Draft Report, FY 16 Phase 1 Regional Site Inspections for Perfluorinated Compounds” (March 2018)

American Society for Testing and Materials (ASTM). November 2013. Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process, E 1527-13. Philadelphia: ASTM.

BB&E, Inc., “Final Perfluorinated Compounds Preliminary Assessment Site Visit Report” (December 2015)

Clayton, Lee and Attig, J.W. 1997. “Pleistocene Geologic Map of Dane County, Wisconsin, WGNHS Bulletin 95, Plate 1.

Mickelson, David, M. 1983. “A Guide to the Glacial Landscapes of Dane County.” Wisconsin Geological and Natural History Survey, Field Trip Guidebook Volume 6.

Tables

Tables

Table 1 Summary of Proposed Sample Locations and Analyses

Project Site Location[1]	**No. Probes/Borings & Wells /Depth**	**No. Samples / Analysis Performed**	**Soil Sample Depths (ft)**
XGFG182053 F-35 Sunshade for CT Mission and XGFG202053 F-35 Sunshade for Deployable Mission	3 Soil Borings @ 15 feet 3 Temp. Wells @15 feet	6 Soil – VOC, PFAS[2] 3 GW – VOC, PFAS[2]	3 samples @ 1'-2' below ground surface 3 samples @ 1' above water table

[1]No soil or groundwater samples will be collected at project site XGFG182019 F-35 Gun Shop-Building 420 , asbestos and lead sampling only (see Table 3).
[2]PFAS (36 compounds), EPA Method 537 Mod

Table 2 Summary of Proposed Monitoring Wells

Project Site Location	Well Name[1]	Type of Well	Estimated Depth[2]
XGFG182053 F-35 Sunshade for CT Mission and XGFG202053 F-35 Sunshade for Deployable Mission	SS-AA-MW-1	Temp. Water Table Well	15 Feet
	SS-AA-MW-2	Temp. Water Table Well	15 Feet
	SS-AA-MW-3	Temp. Water Table Well	15 Feet

[1] Designations for wells installed during this assessment are prefaced with assigned project site number (01, 02, etc.) and "SS-AA" (Sunshade-Ayres Associates) to distinguish them from wells that may have been installed in the area during previous assessments.

[2] Estimated well depth is depth below ground surface.

Table 3 – Site Characterization Analytical Program
CT/Vistas/EMSL Laboratories

				Investigative Samples			Quality Control Samples					
Project Site Location	**Sample Matrix**	**Field Parameters**	**Laboratory Parameters**	**Sample Points**	**Sampling Rounds**	**Total Samples[1]**	**Equipment Blank[2]**	**Field Duplicates[3]**	**Field Blanks[4]**	**Trip Blanks[5]**	**MS/ MSD**	**Matrix Total**
XGFG182053 F-35 Sunshade for CT Mission and XGFG202053 F-35 Sunshade for Deployable Mission	Soil		VOC[2]	3	1	6	0	0	0	1	0	7
			PFAS	3	1	6	1	1	0	0	0	8
	Ground water	pH, Temp, Diss. Oxygen Turbidity Redox - Potential Conductivity	VOC	3	1	3	0	0	0	1	1	4
			PFAS	3	1	3	0	0	1	0	0	4
XGFG182019 F-35 Gun Shop-Repair B420	Bulk		Asbestos	55	1	55	0	0	0	0	0	55
							0	0	0	0	0	
	Bulk		Lead Paint	10	1	10	0	0	0	0	0	10
							0	0	0	0	0	

Notes:

[1]Total number of investigative samples includes only one round of soil and groundwater sampling at one site. Two soil samples and one groundwater sample will be collected at each probe/well location. Assumes 1 asbestos sample for 115 square feet of interior space, with a minimum of 8 samples. For larger buildings, assume 1 sample per 250 square feet of interior space. The number of lead paint samples needed assumes a minimum of 2 samples per structure and up to 10 samples for larger structures.

[2]One equipment blank per sampling event in accordance with Wisconsin PFAS Aqueous (Non-Potable Water) and Non-Aqueous Matrices Method Expectations Guidance (12/16/19).

[3]One field duplicate per sampling event for each site in accordance with Wisconsin PFAS Aqueous (Non-Potable Water) and Non-Aqueous Matrices Method Expectations Guidance (12/16/19).

[4]One field blank per sampling event for each site in accordance with Wisconsin PFAS Aqueous (Non-Potable Water) and Non-Aqueous Matrices Method Expectations Guidance (12/16/19).

[5]One trip blank will be submitted for each cooler that contains samples for VOC analysis.

One methanol blank per day will be submitted for analysis when soil samples are collected for VOC analysis.

VOC – Volatile Organic Compounds

PFAS - Per- and Polyfluorinated Alkyl Substances (PFAS)

Table 4
Sample Bottles, Preservatives, and Holding Times
CT Laboratories/Vista Analytical

Matrix	Analytes	Bottles	Preservatives	Holding Time
Soil	VOC PFAS Percent solids	1 x 60 mL tared glass jar 1 x 8 oz. HDPE or PP 1 x 4 oz. plastic cup	MeOH, Cool to 4° C Unpreserved Unpreserved	14 days 14 days 7 days
Groundwater	VOC PFAS	3 x 40 mL glass vials 2 x 125 mL HDPE or PP	1:1 HCL to pH<2, cool Unpreserved	14 days 14 days
Bulk	Asbestos	Re-sealable plastic baggie	None	None
Paint Chips	Lead	Re-sealable plastic baggie	None	None

Table 5
Compound List, Quantitation Limits and Standards
CT Laboratories
VOC 8260C (mg/Kg)
Soil

Analytes	CAS #	Current MDL	Current LOQ	WDNR (mg/Kg)		MS/MSD %R	MS/MSD %RPD
				Resident Soil	Migration to GW		
1,1,1,2-Tetrachloroethane	630-20-6	0.028	0.092	2.78	0.0534	74-114	13
1,1,1-Trichloroethane	71-55-6	0.024	0.081	640	0.1402	81-118	13
1,1,2,2-Tetrachloroethane	79-34-5	0.022	0.072	0.81	0.0002	6-149	18
1,1,2-Trichloroethane	79-00-5	0.016	0.052	1.59	0.0032	89-116	20
1,1-Dichloroethane	75-34-3	0.025	0.084	5.06	0.4834	83-116	21
1,1-Dichloroethene	75-35-4	0.026	0.086	320	0.005	83-117	19
1,1-Dichloropropene	563-58-6	0.011	0.037	ns	ns	84-119	16
1,2,3-Trichlorobenzene	87-61-6	0.022	0.072	62.6	ns	74-127	47
1,2,3-Trichloropropane	96-18-4	0.022	0.073	0.005	0.0519	75-116	20
1,2,4-Trichlorobenzene	120-82-1	0.03	0.11	24	0.408	74-128	35
1,2,4-Trimethylbenzene	95-63-6	0.026	0.087	219	1.3787	60-146	13
1,2-Dibromo-3-chloropropane	96-12-8	0.04	0.13	0.008	0.0002	61-118	29
1,2-Dibromoethane	106-93-4	0.023	0.077	0.05	0.000028	86-113	14
1,2-Dichlorobenzene	95-50-1	0.029	0.095	376	1.168	83-116	11
1,2-Dichloroethane	107-06-2	0.023	0.078	0.652	0.0028	83-118	16
1,2-Dichloropropane	78-87-5	0.012	0.040	3.4	0.0033	87-114	15
1,3,5-Trimethylbenzene	108-67-8	0.022	0.074	182	1.3787	84-122	13
1,3-Dichlorobenzene	541-73-1	0.027	0.091	297	1.1528	81-118	13

mg/Kg Standards reported as milligrams per kilogram, equivalent to parts per million (ppm)
Reporting Limit Lowest level that can be reliably achieved within specified limits of precision and accuracy (not statistically derived).
MDL Method Detection Limit (MDL). Smallest measured content from which it is possible to deduce the presence of an analyte with reasonable statistical certainty.
LOQ Limit of Quantitation (LOQ). The smallest measured content from which it is possible to quantify an analyte with an acceptable level of accuracy and precision.

WDNR Wisconsin Department of Natural Resources NR 720 Soil Residual Contaminant Level (Non-Industrial Soil Direct Contact Pathway and Migration to Groundwater Pathway).
MS/MSD %R Matrix Spike/Matrix Spike Duplicate Percent Recovery. MS/MSD shows the effect of the sample matrix on the accuracy of the analytical results. Measured as a percent of matrix spike analyte recovered.
MS/MSD %RPD Matrix Spike/Matrix Spike Duplicate Relative Percent Difference. Used to evaluate precision or how two different analyses match.

Table 5 (continued)
Compound List, Quantitation Limits and Standards
CT Laboratories
VOC 8260C (mg/Kg)
Soil

Analytes	CAS #	Current MDL	Current LOQ	WDNR (mg/Kg)		MS/MSD %R	MS/MSD %RPD
				Resident Soil	Migration to GW		
1,3-Dichloropropane	142-28-9	0.030	0.100	1490	ns	88-115	15
1,4-Dichlorobenzene	106-46-7	0.027	0.091	3.74	0.144	81-116	12
2,2-Dichloropropane	594-20-7	0.018	0.061	191	ns	65-134	17
2-Butanone (Methyl ethyl ketone)	78-93-3	0.09	0.30	28400	1.6661	72-131	24
2-Chlorotoluene	95-94-8	0.026	0.087	907	ns	79-122	15
2-Hexanone	591-78-6	0.11	0.37	237	ns	72-142	25
4-Chlorotoluene	106-43-4	0.026	0.086	253	ns	83-118	14
4-Methyl-2-pentanone	108-10-1	0.07	0.22	3360	0.2252	80-135	21
Acetone	67-64-1	0.28	0.95	63400	3.6766	57-143	28
Benzene	71-43-2	0.005	0.017	1.6	0.0051	88-115	24
Bromobenzene	108-86-1	0.03	0.11	342	ns	67-139	14
Bromodichloromethane	75-27-4	0.016	0.053	0.418	0.0003	80-115	15
Bromoform	75-25-2	0.018	0.060	25.4	0.0023	64-121	19
Bromomethane	74-83-9	0.04	0.14	9.6	0.0051	61-157	30
Carbon Disulfide	75-15-0	0.08	0.26	738	0.5919	82-118	22
Carbon tetrachloride	56-23-5	0.022	0.074	0.916	0.0039	71-118	13
Chlorobenzene	108-90-7	0.023	0.078	370	ns	87-113	11
Chlorodibromomethane	124-48-1	0.018	0.061	8.28	0.032	74-112	14
Chloroethane	75-00-3	0.06	0.21	ns	0.2266	0-304	34
Chloroform	67-66-3	0.021	0.069	0.454	0.0033	85-115	13
Chloromethane	74-87-3	0.05	0.17	159	0.0155	74-115	19

cis-1,2-Dichloroethene	156-59-2	0.027	0.090	156	0.0412	86-115	13

mg/Kg Standards reported as milligrams per kilogram, equivalent to parts per million (ppm)
Reporting Limit Lowest level that can be reliably achieved within specified limits of precision and accuracy (not statistically derived).
MDL Method Detection Limit (MDL). Smallest measured content from which it is possible to deduce the presence of an analyte with reasonable statistical certainty.
LOQ Limit of Quantitation (LOQ). The smallest measured content from which it is possible to quantify an analyte with an acceptable level of accuracy and precision.
WDNR Wisconsin Department of Natural Resources NR 720 Soil Residual Contaminant Level (Non-Industrial Soil Direct Contact Pathway and Migration to Groundwater Pathway).
MS/MSD %R Matrix Spike/Matrix Spike Duplicate Percent Recovery. MS/MSD shows the effect of the sample matrix on the accuracy of the analytical results. Measured as a percent of matrix spike analyte recovered.
MS/MSD %RPD Matrix Spike/Matrix Spike Duplicate Relative Percent Difference. Used to evaluate precision or how two different analyses match.

Table 5 (continued)
Compound List, Quantitation Limits and Standards
CT Laboratories
VOC 8260C (mg/Kg)
Soil

Analytes	CAS #	Current MDL	Current LOQ	WDNR (mg/Kg)		MS/MSD %R	MS/MSD %RPD
				Resident Soil	Migration to GW		
cis-1,3-Dichloropropene	10061-01-5	0.019	0.062	1210	0.0003	84-116	15
Dichlorodifluoromethane	75-71-8	0.04	0.14	126	3.0863	62-141	16
Diisopropyl ether	108-20-3	0.03	0.10	2260	ns	76-124	16
Ethylbenzene	100-41-4	0.021	0.070	8.02	1.57	86-118	24
Hexachlorobutadiene	87-68-3	0.028	0.094	1.63	ns	66-133	23
Isopropylbenzene	98-82-8	0.025	0.083	ns	ns	80-125	12
m & p-Xylene	108-38-3, 106-42-3	0.027	0.089	260	3.96	83-122	9
Methyl tert-butyl ether	1634-04-4	0.024	0.081	63.8	0.027	89-123	26
Methylene chloride	75-09-2	0.03	0.10	61.8	0.0026	76-125	24
Naphthalene	91-20-3	0.029	0.097	5.52	0.6582	22-196	20
n-Butylbenzene	104-51-8	0.026	0.086	108	ns	52-147	14
n-Propylbenzene	103-65-1	0.026	0.085	ns	ns	58-141	14
o-Xylene	95-47-6	0.024	0.080	434	3.96	78-127	24
p-Isopropyltoluene	99-87-6	0.022	0.073	162	ns	82-122	14
sec-Butylbenzene	135-98-8	0.028	0.092	145	ns	79-124	15
Styrene	100-42-5	0.029	0.096	867	0.22	89-116	14
Tert-Butylbenzene	98-06-6	0.025	0.082	183	ns	87-116	14
Tetrachloroethene	127-18-4	0.013	0.043	33	0.0045	84-121	13
Tetrahydrofuran	109-99-9	0.14	0.46	23300	0.0222	65-125	24
Toluene	108-88-3	0.013	0.044	818	1.1072	82-122	24
trans-1,2-Dichloroethene	156-60-5	0.010	0.033	1560	0.0626	83-118	22

trans-1,3-Dichloropropene	10061-02-6	0.023	0.075	1510	ns	79-115	16
Trichloroethene	79-01-6	0.015	0.049	1.3	0.0036	1-249	14
Trichlorofluoromethane	75-69-4	0.04	0.13	1230	ns	32-185	24
Vinyl chloride	75-01-4	0.010	0.032	0.067	0.0001	81-119	17

mg/Kg Standards reported as milligrams per kilogram, equivalent to parts per million (ppm)
Reporting Limit Lowest level that can be reliably achieved within specified limits of precision and accuracy (not statistically derived).
MDL Method Detection Limit (MDL). Smallest measured content from which it is possible to deduce the presence of an analyte with reasonable statistical certainty.
LOQ Limit of Quantitation (LOQ). The smallest measured content from which it is possible to quantify an analyte with an acceptable level of accuracy and precision.
WDNR Wisconsin Department of Natural Resources NR 720 Soil Residual Contaminant Level (Non-Industrial Soil Direct Contact Pathway and Migration to Groundwater Pathway).
MS/MSD %R Matrix Spike/Matrix Spike Duplicate Percent Recovery. MS/MSD shows the effect of the sample matrix on the accuracy of the analytical results. Measured as a percent of matrix spike analyte recovered.
MS/MSD %RPD Matrix Spike/Matrix Spike Duplicate Relative Percent Difference. Used to evaluate precision or how two different analyses match.

Table 5 (continued)
Compound List, Quantitation Limits and Standards
CT Laboratories
PFAS* EPA 537 Mod (mg/Kg)
Soil

Acronym	Analytes	CAS #	Current MDL	Current LOQ	WDNR (mg/kg)		MS/MSD %R	MS/MSD %RPD
					Resident Soil	Industrial Soil		
PFBA	Perfluorobutanoic acid	375-22-4	.000185	.000250	ns	ns	70-130	50
PFPeA	Perfluoropentanoic acid	2706-90-3	.000168	.000250	ns	ns	70-130	50
PFHxA	Perfluorohexanoic acid	307-24-4	.000120	.000250	ns	ns	70-130	50
PFHpA	Perfluoroheptanoic acid	375-85-9	.000305	.000500	ns	ns	70-130	50
PFOA	Perfluorooctanoic acid	335-67-1	.000276	.000500	ns	ns	70-130	50
PFNA	Perfluorononanoic acid	375-95-1	.000199	.000250	ns	ns	70-130	50
PFDA	Perfluorodecanoic acid	335-76-2	.000152	.000250	ns	ns	70-130	50
PFUnA	Perfluoroundecanoic acid	2058-94-8	.000174	.000250	ns	ns	70-130	50
PFDoA	Perfluorododecanoic acid	307-55-1	.000136	.000250	ns	ns	70-130	50
PFTriA	Perfluorotridecanoic acid	72629-94-8	.000109	.000250	ns	ns	60-130	50
PFTeA	Perfluorotetradecanoic acid	376-06-7	.000172	.000250	ns	ns	60-130	50
PFHxDA	Perfluorohexadecanoic acid	67905-19-5	.0000772	.000250	ns	ns	70-130	50
PFODA	Perfluorooctadecanoic acid	16517-11-6	.000233	.000250	ns	ns	40-130	50
PFBS	Perfluorobutanesulfonic acid	375-73-5	.000117	.000250	1.26	16.4	70-130	50
PFPeS	Perfluoropentanesulfonic acid	2706-91-4	.000257	.000500	1.26	16.4	70-130	50
PFHxS	Perfluorohexanesulfonic acid	355-46-4	.000225	.000250	1.26	16.4	70-130	50
PFHpS	Perfluoroheptanesulfonic acid	375-92-8	.000346	.000500	1.26	16.4	60-130	50

PFOS	Perfluorooctanesulfonic acid	1763-23-1	.000276	.000250	1.26	16.4	70-130	50
PFNS	Perfluorononanesulfonic acid	68259-12-1	.000467	.000500	1.26	16.4	70-130	50
PFDS	Perfluorodecanesulfonic acid	335-77-3	.000438	.000500	1.26	16.4	60-130	50

*	PFAS sampling was subcontracted to Vista Analytical
mg/Kg (ppm)	Standards reported as milligrams per kilogram, equivalent to parts per million
Reporting Limit	Lowest level that can be reliably achieved within specified limits of precision and accuracy (not statistically derived).
MDL	Method Detection Limit (MDL). Smallest measured content from which it is possible to deduce the presence of an analyte with reasonable statistical certainty.
LOQ	Limit of Quantitation (LOQ). The smallest measured content from which it is possible to quantify an analyte with an acceptable level of accuracy and precision.
WDNR	Wisconsin Department of Natural Resources NR 720 Soil Residual Contaminant Level (RCL) for Non-Industrial Soil Direct Contact Pathway and Industrial Soil Direct Contact Pathway. There is no protection of groundwater RCL for PFAS.
MS/MSD %R	Matrix Spike/Matrix Spike Duplicate Percent Recovery. MS/MSD shows the effect of the sample matrix on the accuracy of the analytical results. Measured as a percent of matrix spike analyte recovered.
MS/MSD %RPD	Matrix Spike/Matrix Spike Duplicate Relative Percent Difference. Used to evaluate precision or how two different analyses match.

Table 5 (continued)
Compound List, Quantitation Limits and Standards
CT Laboratories
PFAS* EPA 537 Mod (mg/Kg)
Soil

Acronym	Analytes	CAS #	Current MDL	Current LOQ	WDNR (mg/kg)		MS/MSD %R	MS/MSD %RPD
					Resident Soil	Industrial Soil		
PFDoS	Perfluorododecanesulfonic acid	79780-39-5	.000196	.000250	1.26	16.4	60-130	50
4:2 FTSA	4:2 Fluorotelomer sulfonic acid	757124-72-4	.000192	.000250	1.26	16.4	60-130	50
6:2 FTSA	6:2 Fluorotelomer sulfonic acid	27619-97-2	.000349	.000500	1.26	16.4	60-130	50
8:2 FTSA	8:2 Fluorotelomer sulfonic acid	39108-34-4	.000292	.000500	1.26	16.4	60-130	50
10:2 FTSA	10:2 Fluorotelomer sulfonic acid	120226-60-0	.000540	.000750	1.26	16.4	60-130	50
FOSA	Perfluorooctane sulfonamide	754-91-6	.000456	.000500	1.26	16.4	70-130	50
NMeFOSA	N-Methyl perfluorooctane sulfonamide	31506-32-8	.00297	.00300	1.26	16.4	70-130	50
NEtFOSA	N-Ethyl perfluorooctane sulfonamide	4151-50-2	.00214	.00300	1.26	16.4	70-130	50
NMeFOSAA	N-Methyl perfluorooctane sulfonamidoacetic acid	2355-31-9	.000483	.000500	1.26	16.4	70-130	50
NEtFOSAA	N-Ethyl perfluorooctane sulfonamidoacetic acid	2991-50-6	.000436	.000500	1.26	16.4	70-130	50
NMeFOSE	N-Methyl perfluorooctane sulfonamidoethanol	24448-09-7	.00223	.00300	1.26	16.4	70-130	50
NEtFOSE	N-Ethyl perfluorooctane sulfonamidoethanol	1691-99-2	.00273	.00300	1.26	16.4	70-130	50
HFPO-DA	Hexafluoropropylene oxide dimer acid	13252-13-6	.000531	.000750	ns	ns	70-130	50
DONA	4,8-Dioxa-3H-perfluorononanoic acid	919005-14-4	.000174	.000250	ns	ns	70-130	50

9Cl-PF3ONS	9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	756426-58-1	.000205	.000250	ns	ns	70-130	50
11Cl-PF3OUdS	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	763051-92-9	.000466	.000500	ns	ns	70-130	50

*	PFAS sampling was subcontracted to Vista Analytical
mg/Kg (ppm)	Standards reported as milligrams per kilogram, equivalent to parts per million
Reporting Limit	Lowest level that can be reliably achieved within specified limits of precision and accuracy (not statistically derived).
MDL	Method Detection Limit (MDL). Smallest measured content from which it is possible to deduce the presence of an analyte with reasonable statistical certainty.
LOQ	Limit of Quantitation (LOQ). The smallest measured content from which it is possible to quantify an analyte with an acceptable level of accuracy and precision.
WDNR	Wisconsin Department of Natural Resources NR 720 Soil Residual Contaminant Level (RCL) for Non-Industrial Soil Direct Contact Pathway and Industrial Soil Direct Contact Pathway. There is no protection of groundwater RCL for PFAS.
MS/MSD %R	Matrix Spike/Matrix Spike Duplicate Percent Recovery. MS/MSD shows the effect of the sample matrix on the accuracy of the analytical results. Measured as a percent of matrix spike analyte recovered.
MS/MSD %RPD	Matrix Spike/Matrix Spike Duplicate Relative Percent Difference. Used to evaluate precision or how two different analyses match.

Table 6
Compound List, Quantitation Limits, and Standards
CT Laboratories
VOC 8260 (µg/L)
Groundwater

Analytes	CAS #	Current MDL	Current LOQ	WDNR Enforcement Standard (µg/L)	MS/MSD %R	MS/MSD %RPD
1,1,1,2-Tetrachloroethane	630-20-6	0.6	1.9	70	80-117	11
1,1,1-Trichloroethane	71-55-6	0.5	1.8	200	84-130	10
1,1,2,2-Tetrachloroethane	79-34-5	0.7	2.4	0.2	73-124	15
1,1,2-Trichloroethane	79-00-5	0.4	1.5	5	80-121	12
1,1-Dichloroethane	75-34-3	0.3	1.1	850	82-123	11
1,1-Dichloroethene	75-35-4	0.4	1.5	7	83-129	11
1,1-Dichloropropene	563-58-6	0.7	2.2	ns	84-127	12
1,2,3-Trichlorobenzene	87-61-6	0.8	2.6	ns	70-125	23
1,2,3-Trichloropropane	96-18-4	0.6	1.9	60	64-119	17
1,2,4-Trichlorobenzene	120-82-1	0.5	1.7	70	73-121	20
1,2,4 and 1,3,5-Trimethylbenzene	95-63-6, 108-67-8	0.4	1.2	480	85-124	17
1,2-Dibromo-3-chloropropane	96-12-8	0.7	2.4	0.2	58-122	24
1,2-Dibromoethane	106-93-4	0.6	1.8	0.05	78-117	12
1,2-Dichlorobenzene	95-50-1	0.6	1.9	600	81-119	8
1,2-Dichloroethane	107-06-2	0.26	0.87	5	78-126	12
1,2-Dichloropropane	78-87-5	0.4	1.4	5	81-121	11
1,3-Dichlorobenzene	541-73-1	0.5	1.8	600	83-119	11
1,3-Dichloropropane	142-28-9	0.5	1.6	ns	83-119	11
1,4-Dichlorobenzene	106-46-7	0.6	2.0	75	82-118	11

ns — No standard established
µg/L — Standards reported as micrograms per liter, equivalent to parts per billion (ppb), except as noted

Reporting Limit	Lowest level that can be reliably achieved within specified limits of precision and accuracy (not statistically derived).
MDL	Method Detection Limit (MDL). Smallest measured content from which it is possible to deduce the presence of an analyte with reasonable statistical certainty.
LOQ	Limit of Quantitation (LOQ). The smallest measured content from which it is possible to quantify an analyte with an acceptable level of accuracy and precision.
MS/MSD %R	Matrix Spike/Matrix Spike Duplicate Percent Recovery. MS/MSD shows the effect of the sample matrix on the accuracy of the analytical results. Measured as a percent of matrix spike analyte recovered.
MS/MSD %RPD	Matrix Spike/Matrix Spike Duplicate Relative Percent Difference. Used to evaluate precision or how two different analyses match.
WDNR	Wisconsin Department of Natural Resources (WDNR) WAC Chapter NR 140 Groundwater Quality.

Table 6 (continued)
Compound List, Quantitation Limits, and Standards
CT Laboratories
VOC 8260 (µg/L)
Groundwater

Analytes	CAS #	Current MDL	Current LOQ	WDNR Enforcement Standard (µg/L)	MS/MSD %R	MS/MSD %RPD
2,2-Dichloropropane	594-20-7	0.5	1.6	ns	56-134	21
2-Butanone	78-93-3	4	14	4000	68-134	21
2-Chlorotoluene	95-94-8	0.4	1.4	ns	81-125	11
2-Hexanone	591-78-6	7	24	ns	64-140	26
4-Chlorotoluene	106-43-4	0.4	1.5	ns	82-125	11
4-Methyl-2-pentanone	108-10-1	6	19	500	66-140	19
Acetone	67-64-1	9	30	9000	47-139	27
Benzene	71-43-2	0.24	0.81	5	87-125	10
Bromobenzene	108-86-1	0.6	1.9	ns	78-120	10
Bromodichloromethane	75-27-4	0.4	1.4	0.6	81-120	10
Bromoform	75-25-2	0.7	2.3	4.4	61-121	17
Bromomethane	74-83-9	0.7	2.4	10	21-177	35
Carbon Disulfide	75-15-0	0.5	1.6	1000	86-133	18
Carbon tetrachloride	56-23-5	0.5	1.6	5	82-135	12
Chlorobenzene	108-90-7	0.5	1.5	ns	86-120	8
Chlorodibromomethane	124-48-1	0.4	1.4	60	73-118	15
Chloroethane	75-00-3	0.5	1.6	400	59-153	26
Chloroform	67-66-3	0.3	0.9	6	84-122	10
Chloromethane	74-87-3	0.7	2.5	30	56-145	18
cis-1,2-Dichloroethene	156-59-2	0.3	1.0	70	42-166	10

ns No standard established
µg/L Standards reported as micrograms per liter, equivalent to parts per billion (ppb), except as noted

Reporting Limit	Lowest level that can be reliably achieved within specified limits of precision and accuracy (not statistically derived).
MDL	Method Detection Limit (MDL). Smallest measured content from which it is possible to deduce the presence of an analyte with reasonable statistical certainty.
LOQ	Limit of Quantitation (LOQ). The smallest measured content from which it is possible to quantify an analyte with an acceptable level of accuracy and precision.
MS/MSD %R	Matrix Spike/Matrix Spike Duplicate Percent Recovery. MS/MSD shows the effect of the sample matrix on the accuracy of the analytical results. Measured as a percent of matrix spike analyte recovered.
MS/MSD %RPD	Matrix Spike/Matrix Spike Duplicate Relative Percent Difference. Used to evaluate precision or how two different analyses match.
WDNR	Wisconsin Department of Natural Resources (WDNR) WAC Chapter NR 140 Groundwater Quality.

Table 6 (continued)
Compound List, Quantitation Limits, and Standards
CT Laboratories
VOC 8260 (µg/L)
Groundwater

Analytes	CAS#	Current MDL	Current LOQ	WDNR Enforcement Standard (µg/L)	MS/MSD %R	MS/MSD %RPD
cis-1,3-Dichloropropene	10061-01-5	0.4	1.2	0.4	75-115	13
Dichlorodifluoromethane	75-71-8	0.4	1.5	1000	64-155	14
Diisopropyl ether	108-20-3	0.29	0.97	ns	74-131	11
Ethylbenzene	100-41-4	0.3	1.1	700	87-126	8
Hexachlorobutadiene	87-68-3	0.9	2.9	ns	63-138	20
Isopropylbenzene	98-82-8	0.4	1.4	ns	77-141	11
m, p and o-Xylene	108-38-3, 106-42-3, 95-47-6	0.5	1.8	2000	87-124	11
Methyl tert-butyl ether	1634-04-4	0.3	1.1	60	80-122	19
Methylene chloride	75-0902	0.5	1.7	5	64-124	13
Naphthalene	91-20-3	0.7	2.2	100	45-152	30
n-Butylbenzene	104-51-8	0.4	1.2	ns	79-132	12
n-Propylbenzene	103-65-1	0.5	1.8	ns	77-138	12
p-Isopropyltoluene	99-87-6	0.5	1.5	ns	85-126	11
sec-Butylbenzene	135-98-8	0.4	1.3	ns	87-130	11
Styrene	100-42-5	0.5	1.7	100	82-123	24
Tert-Butylbenzene	98-06-6	0.4	1.4	ns	84-125	10
Tetrachloroethene	127-18-4	0.5	1.8	5	82-131	11
Tetrahydrofuran	109-99-9	3.0	10.0	50	49-147	22
Toluene	108-88-3	0.3	1.1	800	86-124	10
trans-1,2-Dichloroethene	156-60-5	0.6	1.9	100	82-125	16

trans-1,3-Dichloropropene	10061-02-6	0.4	1.4	0.4	73-114	16
Trichloroethene	79-01-6	0.3	1.0	5	82-125	14
Trichlorofluoromethane	75-69-4	0.3	1.1	ns	74-153	15
Vinyl chloride	75-01-4	0.19	0.64	0.2	72-144	11

ns	No standard established
µg/L	Standards reported as micrograms per liter, equivalent to parts per billion (ppb), except as noted
Reporting Limit	Lowest level that can be reliably achieved within specified limits of precision and accuracy (not statistically derived).
MDL	Method Detection Limit (MDL). Smallest measured content from which it is possible to deduce the presence of an analyte with reasonable statistical certainty.
LOQ	Limit of Quantitation (LOQ). The smallest measured content from which it is possible to quantify an analyte with an acceptable level of accuracy and precision.
MS/MSD %R	Matrix Spike/Matrix Spike Duplicate Percent Recovery. MS/MSD shows the effect of the sample matrix on the accuracy of the analytical results. Measured as a percent of matrix spike analyte recovered.
MS/MSD %RPD	Matrix Spike/Matrix Spike Duplicate Relative Percent Difference. Used to evaluate precision or how two different analyses match.
WDNR	Wisconsin Department of Natural Resources (WDNR) WAC Chapter NR 140 Groundwater Quality.

Table 6 (continued)
Compound List, Quantitation Limits, and Standards
CT Laboratories
PFAS* EPA 537 Mod (µg/L)
Groundwater

Acronym	Analytes	CAS #	Current MDL	Current LOQ	WDNR Standards (ppt)		MS/MSD %R	MS/MSD %RPD
					Enforcement Standard	Preventative Action Limit		
PFBA	Perfluorobutanoic acid	375-22-4	.000729	.004	ns	ns	70-130	50
PFPeA	Perfluoropentanoic acid	2706-90-3	.00128	.004	ns	ns	70-130	50
PFHxA	Perfluorohexanoic acid	307-24-4	.00218	.004	ns	ns	70-130	50
PFHpA	Perfluoroheptanoic acid	375-85-9	.000591	.004	ns	ns	70-130	50
PFOA	Perfluorooctanoic acid	335-67-1	.000651	.004	ns	ns	70-130	50
PFNA	Perfluorononanoic acid	375-95-1	.000810	.004	ns	ns	70-130	50
PFDA	Perfluorodecanoic acid	335-76-2	.00149	.004	ns	ns	70-130	50
PFUnA	Perfluoroundecanoic acid	2058-94-8	.00105	.004	ns	ns	70-130	50
PFDoA	Perfluorododecanoic acid	307-55-1	.000792	.004	ns	ns	70-130	50
PFTriA	Perfluorotridecanoic acid	72629-94-8	.000494	.004	ns	ns	60-130	50
PFTeA	Perfluorotetradecanoic acid	376-06-7	.000755	.004	ns	ns	60-130	50
PFHxDA	Perfluorohexadecanoic acid	67905-19-5	.000294	.004	ns	ns	70-130	50
PFODA	Perfluorooctadecanoic acid	16517-11-6	.00614	.007	ns	ns	40-130	50

PFBS	Perfluorobutanesulfonic acid	375-73-5	.00179	.004	20	2	70-130	50
PFPeS	Perfluoropentanesulfonic acid	2706-91-4	.00242	.004	20	2	70-130	50
PFHxS	Perfluorohexanesulfonic acid	355-46-4	.000947	.004	20	2	70-130	50
PFHpS	Perfluoroheptanesulfonic acid	375-92-8	.000937	.004	20	2	60-130	50
PFOS	Perfluorooctanesulfonic acid	1763-23-1	.000807	.004	20	2	70-130	50
PFNS	Perfluorononanesulfonic acid	68259-12-1	.00387	.004	20	2	70-130	50
PFDS	Perfluorodecanesulfonic acid	335-77-3	.00123	.004	20	2	60-130	50

*	PFAS analysis subcontracted to Vista Analytical
ns	No standard established
ng/L	Standards reported as nanograms per liter, equivalent to parts per trillion (ppt), except as noted
Reporting Limit	Lowest level that can be reliably achieved within specified limits of precision and accuracy (not statistically derived).
MDL	Method Detection Limit (MDL). Smallest measured content from which it is possible to deduce the presence of an analyte with reasonable statistical certainty.
LOQ	Limit of Quantitation (LOQ). The smallest measured content from which it is possible to quantify an analyte with an acceptable level of accuracy and precision.
MS/MSD %R	Matrix Spike/Matrix Spike Duplicate Percent Recovery. MS/MSD shows the effect of the sample matrix on the accuracy of the analytical results. Measured as a percent of matrix spike analyte recovered.
MS/MSD %RPD	Matrix Spike/Matrix Spike Duplicate Relative Percent Difference. Used to evaluate precision or how two different analyses match.
WDNR	Wisconsin Department of Natural Resources (WDNR) recommended groundwater standard for PFOA and PFOS individually and combined.

Table 6 (continued)
Compound List, Quantitation Limits, and Standards
CT Laboratories
PFAS* EPA 537 Mod (µg/L)
Groundwater

Acronym	Analytes	CAS #	Current MDL	Current LOQ	WDNR Standards (ng/L)		MS/MSD %R	MS/MSD %RPD
					Enforcement Standard	Preventative Action Limit		
PFDoS	Perfluorododecanesulfonic acid	79780-39-5	.00417	.005	20	2	60-130	50
4:2 FTSA	4:2 Fluorotelomer sulfonic acid	757124-72-4	.00139	.004	20	2	60-130	50
6:2 FTSA	6:2 Fluorotelomer sulfonic acid	27619-97-2	.00200	.004	20	2	60-130	50
8:2 FTSA	8:2 Fluorotelomer sulfonic acid	39108-34-4	.00206	.004	20	2	60-130	50
10:2 FTSA	10:2 Fluorotelomer sulfonic acid	120226-60-0	.00313	.004	20	2	60-130	50
FOSA	Perfluorooctane sulfonamide	754-91-6	.00177	.004	20	2	70-130	50
NMeFOSA	N-Methyl perfluorooctane sulfonamide	31506-32-8	.00383	.020	20	2	70-130	50
NEtFOSA	N-Ethyl perfluorooctane sulfonamide	4151-50-2	.00511	.020	20	2	70-130	50
NMeFOSAA	N-Methyl perfluorooctane sulfonamidoacetic acid	2355-31-9	.00165	.004	20	2	70-130	50
NEtFOSAA	N-Ethyl perfluorooctane sulfonamidoacetic acid	2991-50-6	.00137	.004	20	2	70-130	50
NMeFOSE	N-Methyl perfluorooctane sulfonamidoethanol	24448-09-7	.00607	.020	20	2	70-130	50
NEtFOSE	N-Ethyl perfluorooctane sulfonamidoethanol	1691-99-2	.00944	.020	20	2	70-130	50
HFPO-DA	Hexafluoropropylene oxide dimer acid	13252-13-6	.00482	.005	ns	ns	70-130	50

DONA	4,8-Dioxa-3H-perfluorononanoic acid	919005-14-4	.000722	.004	ns	ns	70-130	50
9Cl-PF3ONS	9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	756426-58-1	.00145	.004	ns	ns	70-130	50
11Cl-PF3OUdS	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	763051-92-9	.00241	.004	ns	ns	70-130	50

*	PFAS sampling was subcontracted to Vista Analytical
ns	No standard established
ng/L	Standards reported as nanograms per liter, equivalent to parts per trillion (ppt), except as noted
Reporting Limit	Lowest level that can be reliably achieved within specified limits of precision and accuracy (not statistically derived).
MDL	Method Detection Limit (MDL). Smallest measured content from which it is possible to deduce the presence of an analyte with reasonable statistical certainty.
LOQ	Limit of Quantitation (LOQ). The smallest measured content from which it is possible to quantify an analyte with an acceptable level of accuracy and precision.
MS/MSD %R	Matrix Spike/Matrix Spike Duplicate Percent Recovery. MS/MSD shows the effect of the sample matrix on the accuracy of the analytical results. Measured as a percent of matrix spike analyte recovered.
MS/MSD %RPD	Matrix Spike/Matrix Spike Duplicate Relative Percent Difference. Used to evaluate precision or how two different analyses match.
WDNR	Wisconsin Department of Natural Resources (WDNR) recommended groundwater standard for PFOA and PFOS individually and combined.

Table 7
Compound List, Quantitation Limits, and Standards
CT Laboratories
Paint Chips Method 6010C (mg/kg)
Building Materials

Analyte	CAS#	Current MDL (mg/Kg)	Current LOQ (mg/Kg)	LCS/LCSD			MS/MSD			DUP
				Lower	Upper	RPD	Lower	Upper	RPD	RPD
Lead	7439-92-1	0.30	1.01	80	120	na	75	125	25	20

Table 7 (continued)
Compound List, Quantitation Limits, and Standards
CT Laboratories
Asbestos* EPA 600/R-93/116 (<1%)
Building Materials

Analyte	CAS#	Current MDL (mg/Kg)	Current LOQ (mg/Kg)	LCS/LCSD			MS/MSD			DUP
				Lower	Upper	RPD	Lower	Upper	RPD	RPD
Asbestos	1332-21-4	na	na	na	na	na	na	na	na	na

*Asbestos analysis subcontracted to EMSL

Table 7 (continued)
Compound List, Quantitation Limits, and Standards
CT Laboratories
Hexavalent Chromium Wipe Samples EPA 7199
Building Materials

Analyte	CAS#	Current MDL (mg/Kg)	Current LOQ (mg/Kg)	LCS/LCSD			MS/MSD			DUP
				Lower	Upper	RPD	Lower	Upper	RPD	RPD
Hexavalent Chromium	18540-29-9	0.000175	0.0006	80	120	na	na	na	na	na

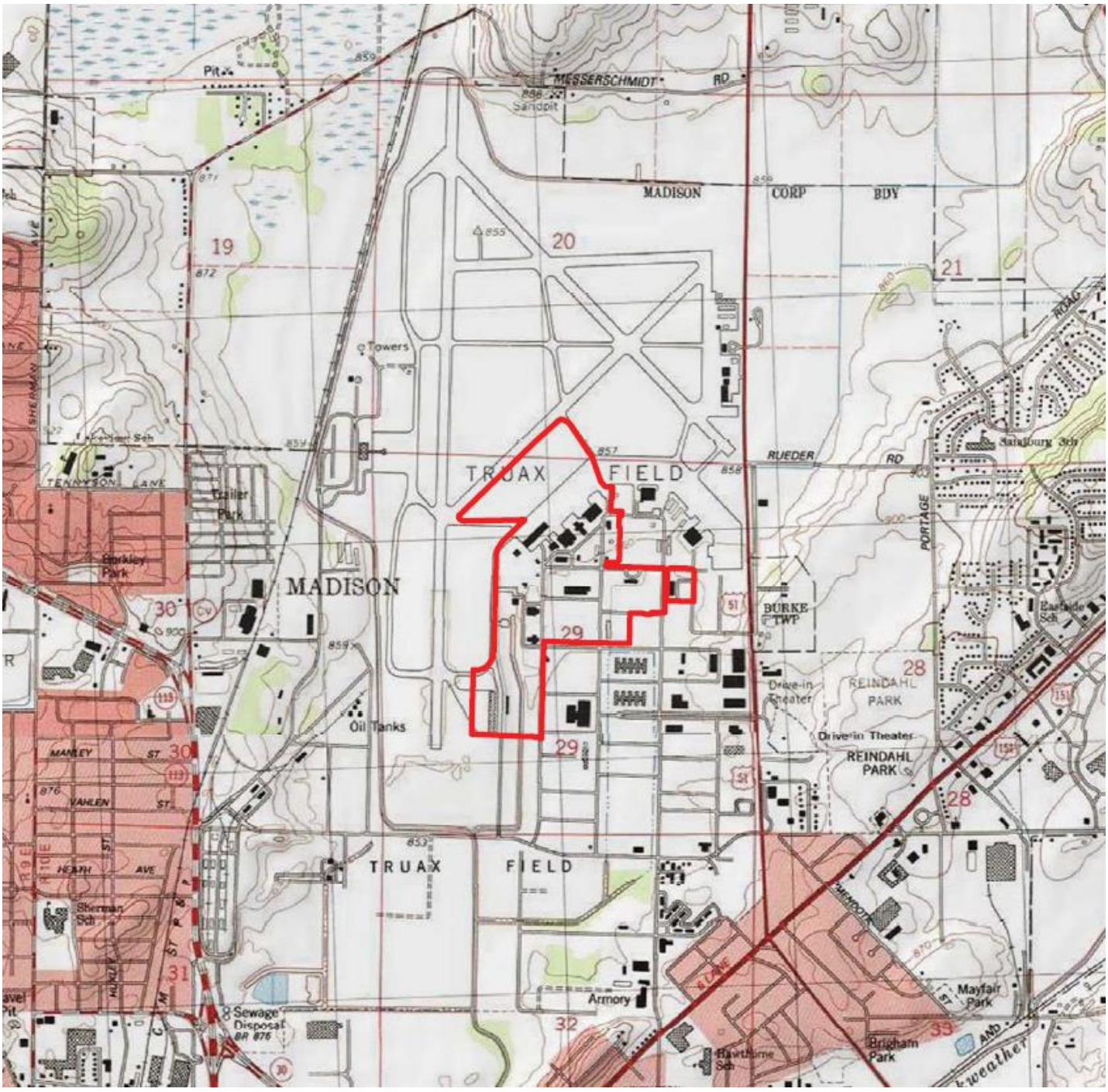
MDL — Method Detection Limit (MDL). Smallest measured content from which it is possible to deduce the presence of an analyte with reasonable statistical certainty.

LOQ — Limit of Quantitation (LOQ). The smallest measured content from which it is possible to quantify an analyte with an acceptable level of accuracy and precision.

MS/MSD %R — Matrix Spike/Matrix Spike Duplicate Percent Recovery. MS/MSD shows the effect of the sample matrix on the accuracy of the analytical results. Measured as a percent of matrix spike analyte recovered.

MS/MSD %RPD — Matrix Spike/Matrix Spike Duplicate Relative Percent Difference. Used to evaluate precision or how two different analyses match.

Figures

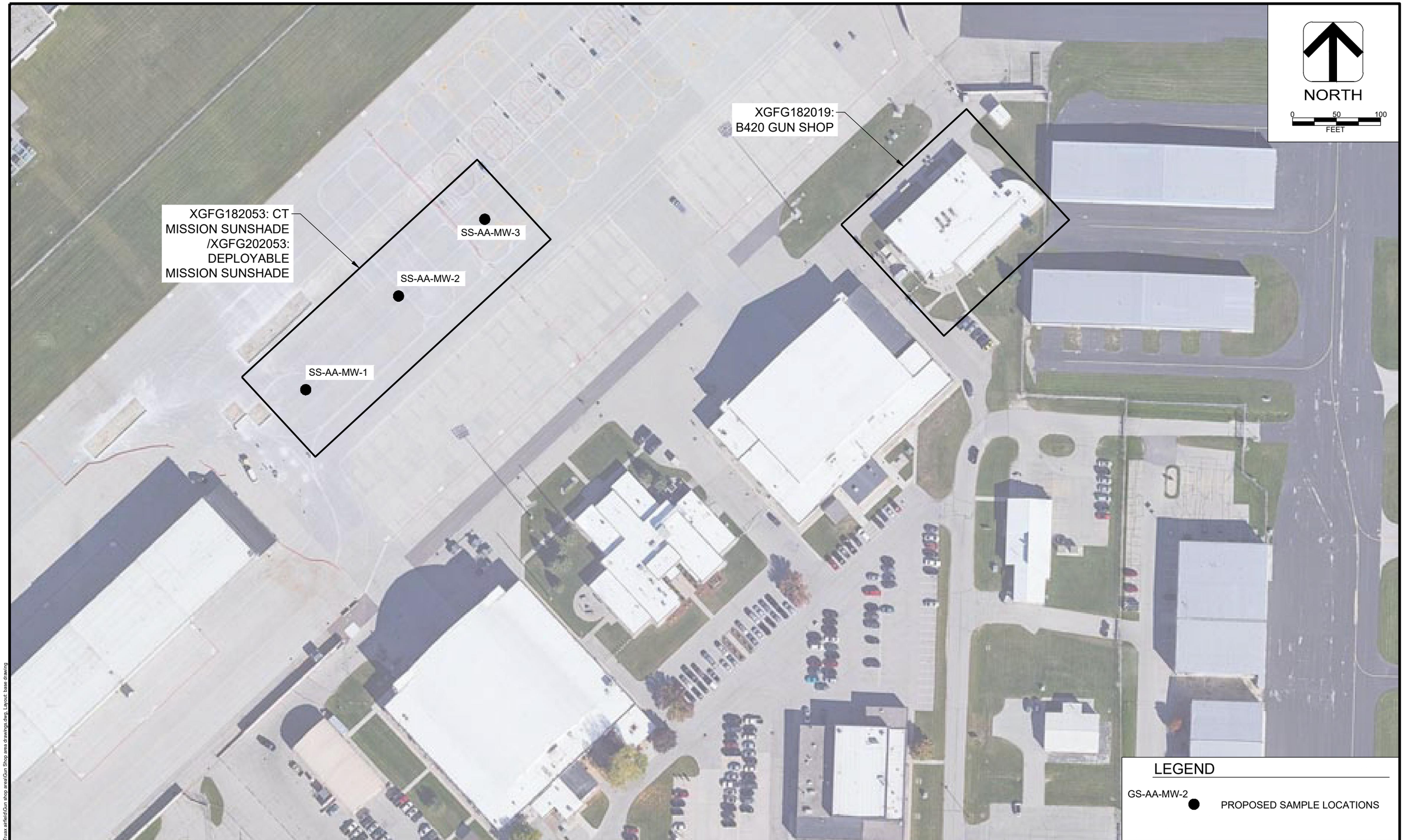


Source: Amec Foster Wheeler, March 2019

N

Figure 1 – Location Map
Sampling and Analysis Plan
F-35 Beddown Project Area
Truax Field, Madison, Wisconsin
October 2021 52-0716.00

AYRES ENVIRONMENTAL



DES BY T. GAIECK	BOOK NO							TRUAX FIELD B420 GUN SHOP AND CT MISSION/DEPLOYABLE MISSION SUNSHADES MADISON, WISCONSIN	AYRES Eau Claire, WI 54701 715.834.3161	SITE CHARACTERIZATION - SAMPLING LOCATIONS	SHEET NO 2
DR BY T. SHUPERT	PROJ NO 51-0467.20										
CHK BY T. GAIECK	DATE 6-02-21	NO	DATE	REVISION	NO	DATE	REVISION				

AA-Standard.stb
6/30/2021
I:\51\CAD\Env_sites\Truax airfield\Gun shop area\Gun Shop area drawings.dwg, Layout: base drawing

Figure 3

Project Schedule

Project Task	Estimated Time of Completion
Field Investigation/Asbestos and Lead Paint Inspection	November 2021
Laboratory Analysis of Soil, Groundwater and Building Samples	Mid December 2021
Reporting	January 1, 2022

Appendix A

Ayres Associates Standard Operating Procedures

AYRES ASSOCIATES
STANDARD OPERATING PROCEDURE

TITLE: Monitoring Well Drilling and Construction Procedures
SOP NUMBER: 110
EFFECTIVE DATE: May 2009

1.0 PURPOSE

The activities covered by this procedure are to insure that ground water monitoring wells are installed according to rigid, uniform guidelines (NR 141 Wisconsin Administrative Code) so that hydrogeologic data and ground water samples obtained from the wells are representative of actual conditions.

2.0 SCOPE

This operation procedure describes methods for the drilling and installation of groundwater monitoring wells in unconsolidated deposits in accordance with the requirements of Wisconsin Administrative NR 141, Groundwater Monitoring Well Requirements. Typical monitoring well installation and construction details for water table wells and piezometers are shown in Figures 110-1 and 110-2, respectively.

3.0 CHANGES FROM LAST REVISION

None applicable. This is an original SOP.

4.0 RESPONSIBILITIES

It is the responsibility of the project manager to ensure that all field staff assigned to the project are familiar with the work plan. It is the responsibility of the field scientist to review the work plan and obtain all necessary field equipment, and for establishing appropriate safety and health practices during the procedure.

5.0 EQUIPMENT NEEDED

Geologic logging forms and reference materials
Soils knife
Tape measure or rule
A water level measuring tape
Sample bags or containers
Field screening instrument and supplies
Health and safety supplies

6.0 OPERATING PROCEDURE

1. All boreholes will be horizontally located by measurements to fixed structures or reference points on the site. Utility clearance will be performed by the drilling contractor. Upon completion of the borings, well installations and other sampling, the horizontal coordinates of each boring will be located on a site grid and well elevations will be surveyed with respect to mean sea level.

2. Hollow stem augers will be used for well drilling and installation. Mud or

water rotary techniques may be employed if conditions require.

3. Potable water supply will be obtained from the local water utility.

4. If hollow-stem augers are used, then no drilling fluid is required. Potable water may be used to flush out the augers as needed to collect representative samples with the split-spoon sampler or Shelby tube.

If casing is installed in the borehole, potable water will be used as the drilling fluid. The water is circulated down the inside of the drill rods to lubricate the bit as it is advanced and to carry the cuttings up the outside of the rods. The casing is advanced by driving slightly behind the bit, in order to maintain the integrity of the borehole.

If conditions require the use of mud rotary techniques, then potable water and bentonite mud will be used. The bentonite will be sodium-rich montmorillonite-type material such as Volclay or Aqua Gel "Gold Seal," both Wyoming bentonites. A low density, high viscosity mud will be utilized to minimize mud loss to the formation, while maintaining the ability to remove cuttings from the borehole. If drilling fluid is being lost to the formation during drilling, the viscosity of the fluid will be increased by adding more bentonite. If the fluid loss persists, then the borehole will be cased with NW or HW flush joint casing through the zone of fluid loss. The actual mixture of bentonite and water will be determined in the field based on the performance of the mud in each individual borehole.

5. Cuttings will be screened for VOCs with a Photoionization Detector (PID) or a Flame Ionization Detector (FID); these results will be recorded and the cuttings will be placed in 55-gallon drums or other suitable containers and stored at the site for reclamation or disposal. If space and project layout permits cuttings will be thin-spread on-site with approval from the regulatory agency.

6. Samplings will be collected at the intervals provided in the site-specific work plan. Sampling will be performed using a standard split-spoon sampler (SOP 120). Samples for grain size analysis will be selected based on visual observations so as to be representative of the various stratigraphic units. Samples, best covering the spectrum of soils encountered, will be sent to a geotechnical laboratory for grain size analysis (ASTM Method D-421, D-422, and D-4318) and soil classification. The remaining samples will be archived on-site or returned to the office for further evaluation.
The soils will be classified using the Unified Soil Classification System (ASTM Method D-2487-87). A description of the soil and other pertinent information regarding drilling and sampling methods, and geohydrologic data will be recorded on a boring log.

7. For two-inch inside diameter monitoring wells, a minimum borehole diameter will be eight inches, using a 4¼-inch I.D. hollow stem auger

8. The depth to the water level in each boring will be measured just prior to construction of the well in the boring. In addition, the depth of the boring will be measured with a weighted tape to determine final depth.

9. The rotary system of the rig, including downhole equipment (drill rods, casing, samplers, bits, and hand tools), the mud tub, and the tremie pipes will be steam cleaned at a decontamination area before initiating drilling, and inspected to ensure the rig is free of leaking oil and grease. This procedure will be repeated between each borehole, and at the conclusion of the drilling program. All downhole tools will be kept from coming in contact with the ground by being placed on polyethylene sheeting. Prior to being used, the drilling fluid circulation system of the rig will be flushed by circulating potable water through the system. This will be repeated between each well.

10. Abandoned borings, if any, will be backfilled to the surface by pressure grouting using a tremie pipe lowered to the bottom to the boring. A cement-bentonite grout mixture, as specified below, will be used for the backfill material. If conditions warrant, backfilling of the boring to the surface will be completed by gravity pouring chipped bentonite to the bottom and filling to the surface.

11. Lubrication of drilling equipment (rods, sampling tools, casing) may be performed using a minimal amount of vegetable oil only. No synthetic or petroleum based lubricants will be allowed.

12. A 10-foot long screen will be placed to intercept the water table. Approximately three feet will extend above the water table and seven feet will extend below the water table. The top of the screen will be a minimum of five feet below the ground surface, unless the groundwater table is within five feet of the ground surface. In such cases, the top of the screen will be approximately two feet below the ground surface. An appropriate length of riser pipe (casing) will be attached to the screen and will extend about two feet above ground.

The well will be completed as described below, under “General Specifications and Procedures” and as shown on Figure 110-1.

13. Wells screened below the water table, also known as piezometers, will be installed with a five-foot screen. The well will be completed as described below, under “General Specifications and Procedures” and as shown on Figure 110-2.

8.0 General Specifications and Procedures

1. Minimum two-inch I.D. Schedule 40 or Schedule 80 threaded flush joint, PVC casing and PVC screen will be used. No glue or screws will be used in assembling the well screen and riser casing. Specific information regarding well construction materials and procedure will be obtained from the site-specific work plan.

2. The filter pack will be a well sorted, silica based sand or gravel. The sand or gravel used for filter packs will be hard and durable and will have an average specific gravity of not less than 2.50. The sand and gravel will be visibly free of clay, dust and micaceous and organic matter. Not more than 5% of the sand or gravel will be soluble in a 10% hydrochloric acid solution. Thin, flat or elongated pieces of the gravel, the maximum dimension of which exceeds 3 times the minimum dimension, may not constitute more than 2% of the material by weight. The filter pack for wells installed in unconsolidated material will be sized to retain at least 50% of the surrounding formation based on a sieve analysis. In formations which are predominantly silt and clay, the filter pack will be a fine sand. In bedrock, the filter pack shall be a medium or coarse sand or gravel. Crushed limestone, dolomite or any material containing clay or any other material that will adversely impact on the performance of the monitoring well may not be used as filter pack.

3. The screen slot size will be selected to retain 90% of the filter pack.

4. The casing and screen should not be stored directly on the ground. The well casing and screens shall be assembled on racks or on clean polyethylene spread out over level ground.

5. Casing and screen shall be steam cleaned according to the decontamination procedure presented in SOP 510 before installation in the borehole.

6. A bottom cap shall be installed below the well screen on all well installations.

7. The sand pack will be placed to extend from six inches beneath the bottom of the well to a minimum of two feet above the top of the well screen. This will be confirmed by measuring down the borehole annular space with weighted tape or with a measured small diameter pipe or rod. The sand pack will be poured directly down the annular space. If the top of the well screen is less than 10 feet below ground surface, the sand pack may extend less than two feet above the top of the screen, but will extend a minimum of six inches above the screen.

8. A minimum of two feet of fine sand will be placed above the top of the filter pack and below the bentonite seal, to prevent the movement of bentonite into the filter pack and well. If the top of the well screen is less than 10 feet below the ground surface, the thickness of the fine sand layer may be reduced to not less than one foot.

All permanent groundwater monitoring wells installed with filter packs shall be constructed with a filter pack seal. For all water table observation wells and piezometers, the filter pack seal shall extend two feet upward form the top of the

filter pack and shall consist of two feet of clean, fine sand. When high solids grout, granular bentonite slurry, bentonite-cement grout or neat cement grout is used as the annular space seal and, five feet of bentonite shall be placed on top of the clean fine sand seal. Bentonite chips no greater than 3/8-inch in diameter or bentonite pellets shall be used for seals placed below the water table. Bentonite granules may be used for seals when there is no standing water above the filter pack and the borehole is less than 25 feet or in areas where the depth to water tables is less than seven feet. For water tables less than 16 feet, the filter pack seal shall be reduced to two feet of bentonite to allow for the required amount of annular space sealant to be placed. For water table observation wells constructed in areas where the depth to water table is less than seven feet, the required filter pack seal may be reduced to allow for the required amount of annular space sealant to be placed.

A tape measure, measuring rod or similar device shall be used to ensure that the filter pack seal is installed over the proper depth interval. The tape measure, measuring rod or similar device shall be used to ensure that the filter pack seal is installed over the proper depth interval. The tape measure, measuring rod or similar device shall be carefully raised and lowered while the filter pack seal material is being placed to identify bridging. If bridging occurs the filter pack seal material shall be tamped into place, surrounding the well casing, using a measuring rod or similar device. When a tremie pipe is used to place the filter pack seal the procedures of s. NR 141.10(2) shall be followed. Bentonite pellets, bentonite chips or bentonite granules shall be hydrated in 2-foot lifts as placed in the borehole when placed above the water table.

9. All permanent groundwater monitoring wells will be installed with an annular space seal designed to achieve a permeability of 1×10^{-7} centimeters per second or less. For permanent groundwater monitoring wells constructed with filter packs, the annular space seal shall extend form the filter pack seal to the ground surface seal and shall be at least two feet in length. For water table observation wells constructed in areas where the depth to water table is less than seven feet, the annular space seal will be bentonite granules. For monitoring wells constructed into bedrock formations and without well screens, the annular space seal will extend from the bottom of the outer borehole to the ground surface seal and shall be at least two feet in length. Sealant materials may not contain additives. These requirements will be met by:

1) Bentonite granules slurry many be used as an annular space sealant in any type of monitoring well except where the depth to the water table is less than seven feet.
2) Bentonite sand slurry may be used as an annular space sealant in any type of monitoring well except where the depth to the water table is less than seven feet.
3) Bentonite pellets, bentonite chips or bentonite granules may be used to seal the annular space under the following conditions:

a) Bentonite granules may be used when there is no standing water in

the well above the filter pack and the total well depth is less than 25 feet or the depth to water table is less than seven feet.

b) Bentonite chips with diameter no larger than 3/8 inch or bentonite pellets may be used when the depth of standing water in the well is less than 30 feet and the total depth of the annular space seal is less than 50 feet except where the depth to the water table is less than seven feet.

4) High-solids grout approved by the department, bentonite-cement grout or neat-cement grout may be used to seal the annular space in which a bentonite filter pack seal has been placed except where the depth to the water table is less than seven feet.

When bentonite chips with diameter no larger than 3/8 inch, bentonite pellets or granules are used to seal the annular space, thy may either be poured freely down the borehole or added through a tremie pipe, provided the specifications of the filter pack seal are met. When a tremie pipe is used to place the annular space sealant, the procedures of s. NR 141.10(2) (a) and (b) shall be followed.

When grouts or slurries are used to seal the annular space, the material may be poured freely down a tremie pipe or pumped down a borehole with the use of a tremie pipe, provided the specifications of the filter pack seal are met. For wells 100 feet in depth or greater, the sealant material shall be pumped down the borehole with the use of a tremie pipe. When a tremie pipe is used to place the annular space sealant, the procedures of s. NR 141.10(2) shall be followed.

When any slurry or grout is used, there shall be a 12-hour period between the time the annular space seal is installed and the time the protective cover pipe is installed. Any settling in the annular space seal will be topped off before the protective cover pipe is installed. The top of the well casing will be covered with a protective cap.

10. A ground surface seal will be constructed above the annular space seal and will extend to a minimum of 60 inches below the land surface. The ground surface seal will consist of bentonite or concrete. If bentonite is used, the top of the surface seal will terminate two-inches below the land surface and native soil or topsoil will be placed above the bentonite to prevent drying out. The ground surface seal will be placed around the protective cover, and will not be placed between the protective cover and the well casing. The top of a concrete surface seal, or the soil above a bentonite seal, will be sloped away from the well casing.

11. A seven-foot long section of four-inch I.D. steel casing will be placed over the two-inch or four-inch well casing. The casing will be set approximately five feet into the bentonite-cement grout in the annular space, and should stick up above the ground at least two feet. If necessary, the finished well will be surrounded by protective posts. The protective casing will have a lock.

12. In some areas, such as parking lots or roadways, wells may have to be installed flush with the ground surface so that they will not present an obstacle to other activities. In such cases, a flush-mounted protective cap will cover the completed well. A lockable water-proof seal will be affixed to each well to prevent rain or other surface water from entering the well. Flush-mounted wells will not be vented. If flush mounted wells become necessary, they will be constructed according to the details in NR 141.13(3)(b).

9.0 Well Construction Documentation

A detailed diagram of the as-built well construction specifications will be maintained during installation and development, on WDNR forms 4400-113A and 4400–113B, respectively.

10.0 Well Labeling

The complete identification number and elevation of each monitoring well should be painted on or affixed to the protective casing or manhole cover. All permanent monitoring wells installed after February 1, 1990 will be labeled with WDNR supplied labels.

11.0 Surveying

The elevation of the top of the PVC well casing of each well will be determined by a surveyor to 0.01 foot, and the reference point permanently marked on the casing. The ground surface at each well location will be surveyed to the 0.1 foot. Elevations will be referenced to mean sea level datum. Well locations will be measured by surveying, by measuring tape, or by pace and compass, as specified in the project specific work plan.

AYRES ASSOCIATES
STANDARD OPERATING PROCEDURE

TITLE: Total VOC Soil Vapor Field Analysis
SOP NUMBER: 210
EFFECTIVE DATE: May 2003

1.0 PURPOSE

The purpose of this standard operating procedure is to ensure quality control and consistency in field-screening soil samples for the presence of volatile organic hydrocarbons using an organic vapor meter (OVM).

2.0 SCOPE

This procedure describes the steps for proper sample preparation and field screening of soil samples for the presence of volatile organic hydrocarbons using an organic vapor meter (OVM). This procedure couples a rapid field method for estimating total VOC concentrations in soil with sampling procedures that limit substrate disaggregation and exposure, to achieve representative estimates of vadose zone contamination. Note: The OVM calibration procedures detailed in this SOP are unique to the Thermal Environmental Instruments Model 580B OVM. Calibration procedures detailed in this SOP should not be referred to when using other VOC analyzers.

3.0 CHANGES FROM LAST REVISION

Revision #1- 1/15/04. Note was added in Section 7 – Operating Procedure regarding the type of organic vapor meter to use during this procedure. Calibration instructions for TEI Model 580B OVM inserted.

4.0 RESPONSIBILITIES

It is the responsibility of the field personnel to follow these procedures as closely as possible. Deviation from the procedures, or inconsistency in the repetitive use of the procedures may yield field data of low integrity. Field screening data may be used in defining the degree and extent of soil contamination, and is therefore subject to scrutiny by regulatory officials and clients. It is extremely important that field personnel follow the procedures consistently to achieve representative estimates of VOC concentrations in soil.

5.0 EQUIPMENT NEEDED

- Field portable total VOC analyzer (Photovac Model 2020 PID, or equivalent)
- Calibration gas cylinders and equipment
- Clear glass 40-mL VOA vials with hole-punched septums
- Aluminum foil liners (3” x 3 “ squares)
- 10-mL plastic syringes (tips and rubber plunger cap removed)
- Field screening logs

6.0 SAFETY

Safety concerns related to work at the site will be addressed in the site specific Health and Safety Plan.

7.0 OPERATING PROCEDURE

Preliminary to Operation

Note: The organic vapor meter (OVM) used for this procedure should be equipped with an internal pump for drawing organic vapors through the instrument. Meters equipped with a fan will not draw the sample through the instrument due to the vacuum created in the vials during the procedure.

- Review project work plan for site-specific sampling requirements and procedures. Review OVM users manual to ensure thorough understanding and proper use.
- Field instrumentation should be cleaned and checked for defects and any possible need for repair.
- Battery charging, calibration, and maintenance should be conducted in a controlled environment.
- Plastic sheeting should be placed on the working surface to maintain clean environment for equipment to be placed upon.
- The portable OVM should be calibrated daily or more often if required and as outlined below:

CALIBRATION

Calibration should be performed each day prior to instrument use.

1. Power-up instrument using power plug.

2. Depress ON / OFF key to ignite lamp and initiate sample pump.

3. Depress MODE / STORE Key.

4. Depress - / CRSR Key in response to LOG THIS VALUE? Prompt.

5. Depress - / CRSR Key to select Parameters Mode from the Main Menu.

6. Depress +/INC Key to advance thru the Run Mode selection parameter prompt.

7. Depress +/INC Key to advance thru the Auto Logging Mode selection parameter prompt.

8. Depress +/INC Key to advance thru the Average Time selection parameter prompt.

9. Depress +/INC Key to advance thru the Alarm Setting parameter prompt.

10. Depress +/INC Key to advance thru Lamp Selection parameter prompt.

11. Depress +/INC Key to advance thru Response Factor Setting parameter prompt.

12. Depress RESET Key to initiate calibration sequence.

13. Depress - / CRSR Key to decline restoration of the backup calibration.

14. Connect outlet of calibration tubing assembly to the Model 580B Detector Inlet.

15. Introduce Zero Air to Model 580B by opening flow regulator.

16. Depress RESET Key to “Zero” Model 580B.

17. Close Flow Regulator.

Note: Span Calibration procedure below assumes span gas has a concentration of 250 ppm isobutylene.

18. Simultaneously Depress RESET and - / CRSR Keys to activate the movable cursor.

19. Repeat step 18 until the cursor is at the ones place.

20. Simultaneously Depress RESET and +/INC Keys to increment the ones place value.

21. Repeat step 20 until the ones place value reads 0.

22. Repeat step 18 to move cursor to the tens place.

23. Repeat step 20 until the tens place value reads 5.

24. Repeat step 18 to move the cursor to the hundreds place.

25. Repeat step 20 until the hundreds place value reads 2.

26. Repeat step 18 to move the cursor to the thousands place.

27. Repeat step 20 until the thousands place value reads 0.

28. The LCD should now read: SPAN PPM = 0250 "+" TO CONTINUE

29. Depress =/INC to accept the span conc. value.

30. Connect isobutylene cylinder (250 ppm) to calibration tubing assembly.

31. Connect outlet of calibration tubing assembly to the Model 580B Detector Inlet.

32. Introduce isobutylene standard to Model 580B by opening flow regulator.

33. Reset key to "CALIBRATE" Model 580B.

34. Close Flow Regulator.

35. Depress +/INC. Key in response to "RESET" TO CALIBRATE message.

36. Depress MODE/STORE to return to the Run Mode.

The instrument has been calibrated and is ready to make measurements.

Operating Procedure

1. Open the split-spoon or disposable sample sleeve to obtain access to sample (note: sample may be obtained by other means other than slit-spoon sampling)

2. Expose a fresh soil surface using a sampling knife.

3. Immediately after exposing the sampling surface, obtain 25 grams of soil using a 10-mL plastic syringe. Obtain the soil in 5 to 10-gram plugs for ease of removing the soil from the syringe (depending on soil type), and place soil in VOA vials. Samples should be obtained from areas where visual (i.e., staining) or olfactory observations indicate contamination. In the absence of obvious indicators of contamination, obtain five separate 5-gram plugs of soil throughout the

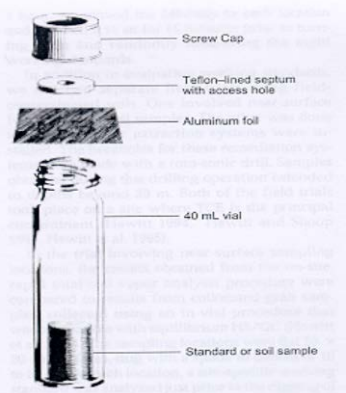


Figure 1. Modified VOA vials for rapid total VOC soil vapor analysis.

sample length. The sample lithology and experience of the sampler will also dictate where the sample will be collected.

4. Immediately cap the VOA vile using aluminum foil liner and hole-punched Teflon septum as shown in the Figure 1.

5. Disperse the soil by hand shaking for ten to fifteen seconds.

6. Total VOC vapor concentration in the headspace is then immediately analyzed by carefully puncturing the aluminum foil liner above the soil. Record the maximum response obtained within seconds of piercing the foil liner.

Note: DO NOT push the PID probe into the soil, it will clog the PID's pump and possibly give false readings on screening of subsequent samples. If you accidentally get soil into the probe, depress the PID's ON/OFF key, remove the probe from the detector inlet, thoroughly clean the probe with an Alconox™/water solution, and rinse the probe several times with distilled water. After the probe has dried, connect it to the detector inlet and depress the ON/OFF key to restart the PID.

Note: DO NOT heat the sample in direct sunlight. DO NOT heat the sample by placing it directly in front of a vehicle's heater duct. In winter, it may be necessary to warm the sample before screening. The sample should be left in a warm area of your vehicle for approximately five minutes to equilibrate. The key element to collecting good data from screening samples is letting all samples equilibrate for approximately the same time. Be consistent.

7. A co-located sample should be collected immediately from a fresh surface if the VOC screening response is greater than the analytical criteria established in the site-specific work plan (e.g., five instrument units). The soil samples should be collected and preserved using the procedures outlined for methanol preservation of soil samples (VOC analysis) SOP 220.

8. The remainder of the soil sample in the split-spoon should be thoroughly logged in the field by the field hydrogeologist. The soil should be contained in a sealable plastic bag for subsequent observation and description in the office.

8.0 RECORDS

Data collected during field activities will be recorded in field logs or daily report forms. Entries will include the following details:

- Date
- Project title
- Purpose and description of field activities
- Field personnel
- Equipment
- Unique field sample number
- Sample date and time

- Specific sample location description
- Field screening readings
- Name and signature of field personnel

Upon completion of field activities, copies of forms and field activity logs will be submitted to the project manager. Original forms will be filed in the project file.

9.0 CORRECTIVE ACTION

Significant problems or deviations from the SOP or work plan will be reported to the project manager as soon as possible. Deviation in procedures or actions that are required to correct a problem will be documented.

10.0 REFERENCES

US Army Corps of Engineers, "Estimating the Total Concentration of Volatile Organic Compounds In Soil", Special Report 97-12 (April 1997)

Thermal Environmental Instruments Model 580B OVM Instruction Manual

AYRES ASSOCIATES
STANDARD OPERATING PROCEDURE

TITLE: Methanol Preservation of Soil Samples
SOP NUMBER: 220
EFFECTIVE DATE: May 2009

1.0 PURPOSE

This operating procedure was prepared to maintain quality control in preservation of soil samples for volatile organic compound and gasoline range organics analysis in Wisconsin.

2.0 SCOPE

This procedure describes methods for performing soil sample preservation using methanol as the sample preservation material in accordance with current Wisconsin Department of Natural Resources (WDNR) analytical guidance and procedures.

3.0 CHANGES FROM LAST REVISION

Not applicable. This is an original SOP.

4.0 RESPONSIBILITIES

Project manager is responsible for discussing project scope and desired field activities with field personnel. Ayres project manager is responsible for obtaining the methanol impinger and methanol sample from the contracted laboratory prior to field activity. Ayres field personnel are responsible for acquiring and checking all necessary field equipment.

5.0 EQUIPMENT NEEDED

Sample Container - Tared 60 mL wide mouth vial (may be laboratory specific)

Digital Scale – It is important that no less than 25 grams of sample be collected.

Methanol - 25 mls of methanol are required for each soil sample.

Cooler – A cooler is required to keep the methanol sample on ice.

Chain of Custody – A chain-of-custody form should accompany the impinger and methanol field kit at all times.

6.0 SAFETY

Methanol is a flammable liquid and vapor. Causes respiratory tract irritation. Harmful if inhaled. May cause central nervous system depression. May be absorbed through intact skin. **Poison!** Causes eye and skin irritation. May be fatal or cause blindness if swallowed. May cause liver, kidney and heart damage

All methanol containers should have a WisDOT approved hazardous materials label visibly located on the outside of the shipment container.

7.0 OPERATING PROCEDURE

1. Place digital scale on level surface, shielded from wind and turn on. Place opened sample container provided by analytical laboratory on scale and tare. Place minimum of 25 grams of soil (maximum of 30 grams) into sample container. Note: Subsurface geology, contaminants of interest, field observations, and screening results will dictate what portion of the sample should be analyzed. See site-specific workplan for details

2. Pour one vial of the methanol into the sample. Replace the sample container top. Be careful to turn gently when replacing the top.

3. Be sure the sample container is properly labeled. Place the sample container on ice. Fill out the chain-of-custody.

4. The soil sample must be received by the analytical laboratory within 4 days and analyzed within 14 days.

8.0 RECORDS

Data collected during field activities will be recorded in field logs or daily report forms, as the project manager directs.

9.0 CORRECTIVE ACTION

Significant problems or deviations from the SOP or work plan shall be reported to the project manager as soon as possible. Deviation in procedures or actions required to correct a problem will be documented.

10.0 REFERENCES

Modified GRO Method for Determining Gasoline Range Organics [includes DRO Method, PUBL-SW-141] PUBL-SW-140. 09/01/1995

AYRES ASSOCIATES
STANDARD OPERATING PROCEDURE

TITLE: Ground Water Sampling Using Low-Flow Sampling Techniques
SOP NUMBER: 310
EFFECTIVE DATE: May 2009

1.0 PURPOSE

The activities covered by this procedure are to insure that the ground water samples taken will be representative of actual ground water quality, insure quality control and consistency in taking samples, and serve as a means to trace error(s) in sampling and data recording.

2.0 SCOPE

This procedure describes methods for obtaining representative samples from monitoring wells with the use of low-flow sampling techniques. In low-flow sampling, wells are purged at a very low flow rate to minimize drawdown and avoid disturbance in the well. This procedure will be used by Ayres Associates field personnel to collect ground water samples unless alternative methods are described in a project specific work plan. **Note: Low-flow sampling techniques will be limited to monitoring wells that, with sustained low-flow pumping, exhibit no continuous or significant drawdown.**

3.0 CHANGES FROM LAST REVISION

Added reference to SOP 330, revised April 7, 2006

4.0 RESPONSIBILITIES

Ayres Associates project manager is responsible for advising field personnel of the purpose of the ground water sampling event and the general site conditions expected. Field personnel are responsible for reviewing the site-specific work plan and familiarizing themselves with site conditions. Field personnel are responsible for obtaining the appropriate glassware from the laboratory, and all field-sampling supplies prior to the scheduled sampling event. It is the responsibility of the field scientist to be familiar with the sampling material being collected, analysis (chemical and physical) to be conducted on each sample, compatibility of the sampling equipment, analyses of concern, and for establishing appropriate safety and health practices on the procedure. Field personnel are responsible for communicating to the project manager potential constraints with the field methods outlined in the work plan or SOP.

5.0 EQUIPMENT NEEDED

- Project-specific sampling plan
- Site map and well keys
- Interface probe for measuring free product
- Sample collection equipment including pump, controller, tubing, and safety line for pump.
- Generator or other electrical supply, extension cord

- Tarp or plastic sheeting to place sampling equipment on
- Five-gallon bucket to measure purge water volume
- Sample bottles, labels, and Chain-of-Custody documents
- Shipping containers with labels
- Ground water sampling data sheets and/or a field log and calculator
- Field instruments including water meter, flow through cell, pH meter, dissolved oxygen meter, conductivity meter, and thermometer (or multiparameter meter)
- Spare batteries for field instruments

6.0 SAFETY

Safety concerns related to ground water sampling will be addressed in a site-specific Health and Safety Plan prepared for the project. In general, care should be taken to prevent ingestion or skin contact with potentially impacted ground water and inhalation of vapors from well. Care should also be taken in handling preservatives in sample bottles.

7.0 OPERATING PROCEDURE

Preliminary to Operation

1. Review project work plan for site-specific sampling requirements and procedures.

2. Field instrumentation should be cleaned and checked for defects and any possible need for repair.

3. Batteries should be checked in the field instruments and calculator.

4. Plastic sheeting should be placed on the ground for the bailer, line, water level meter, and other equipment to be placed upon.

5. ***Important Note*** - If water level data are required for calculating ground water flow direction or gradients, remove well caps from all wells and let water levels equilibrate prior to measuring water levels.

Operating Procedure

1. Place plastic sheeting on ground surface around well to keep sampling area clean and prevent sampling equipment from contacting ground surface.

2. Record the well number, time and date, and all pertinent information and data on ground water sampling record (Attached) or field logbook.

3. Identify measuring point marked on well casing. Measure the depth to ground water in the well to the nearest 0.01-foot with the water level measuring device. Measure depth to the bottom of the well to the nearest 0.01-foot with a weighted tape. Enter these data on the ground water sampling record.

4. Connect pump to tubing and lower pump intake to middle or slightly above middle of well screen. Care should be taken to avoid mixing stagnant water within the well or disturbing sediments at bottom of well.

5. Connect pump discharge line to flow-through cell inlet and pump to electrical source (for submersible pump) or air supply (for bladder pump).

6. Set pump controller to desired flow rate. Purge rates for low-flow sampling are typically 0.1 – 0.5 L/min (100 – 500 ML/min). A higher purge rate may be used for very permeable formations and for purging the initial volume of water in the tubing and pump. Collect purge water in a bucket for observation. Record the color, odor, and turbidity of the water. Purge water should be disposed in accordance with the project work plan.

7. An in-line flow-through cell will be used for field parameter measurements of temperature, pH, conductivity, dissolved oxygen, and oxidation-reduction potential (ORP) [See SOP #330]. The field parameters temperature, pH, and conductivity will be used as stabilization parameters. Water levels in the well should also be monitored to ensure no significant drop in water level occurs during pumping (< 1 foot). Flow rate should be adjusted accordingly.

8. Allow water to flow through the flow-through cell until the water quality parameters (temperature, pH, and conductivity) have stabilized for three consecutive measurements taken at three to five minute intervals. Stabilization is defined as +/- 3% for temperature and conductivity, and 0.2 units for pH.

9. Reduce the flow rate to less than 0.25 L/min for collection of samples for VOC analysis. Allow time for water to discharge from tubing at lower flow rate before sampling. The discharge from the pump should produce a thin, continuous stream of water when filling the vials. If cyclic discharge pumps are used (e.g., bladder pumps), vials should be completely filled from a single discharge cycle. Slightly higher flow rates may be acceptable for non-volatile parameters.

10. When samples are collected for analysis of dissolved constituents, the ground water samples should be filtered (SOP 340) in the field using disposable filters as specified in the work plan. Check laboratory analyte, container, and preservative requirements in the project work plan.

11. When obtaining duplicate samples, or filling multiple bottles for the same analysis, partially fill each of the bottles by alternating between bottles until all bottles are filled.

12. In areas of highly contaminated ground water, or in natural hydrologic regimes where ground water is either basic or acidic, it may be necessary to check the pH and add additional preservative to ensure samples meet preservation

requirements.

13. Affix labels to each sample bottle recording project name and or number, sample number, well number, date and time, preservative, and analyses required.

14. Record sample information on sampling record or in field log, along with a description of the physical appearance of the sample, including color, odor, and turbidity. Document all purge data including volumes removed, elapsed times, flow rates, water levels, stabilization readings, and final water quality indicator parameter values.

15. Place samples immediately in a shipping container maintained at 4 C.

16. Decontaminate reusable sampling equipment as described in SOP 510.

8.0 RECORDS

Data collected during field activities will be recorded in field logs or daily report forms. Entries will include the following details:

- Date
- Project title
- Purpose and description of field activities
- Field personnel
- Equipment
- Unique field sample number
- Sample date and time
- Depth to water
- Specific sample location description
- Preservation techniques
- Analytes and analytical methods
- Purge data including volumes removed, elapsed times, flow rates, water levels, stabilization readings, and final water quality indicator parameter values.
- Name and signature of field personnel

Upon completion of field activities, copies of forms and field activity logs will be submitted to the project manager. Original forms will be filed in the project file.

9.0 CORRECTIVE ACTION

Significant problems or deviations from the SOP or work plan will be reported to the project manager as soon as possible. Deviation in procedures or actions that are required to correct a problem will be documented.

10.0 REFERENCES

EPA/540/S-95/504, Low Flow (Minimal Drawdown) Ground-Water Sampling Procedures (April 1996)

AYRES ASSOCIATES
STANDARD OPERATING PROCEDURE

TITLE: Ground Water Sampling With Bailer
SOP NUMBER: 320
EFFECTIVE DATE: May 2009

1.0 PURPOSE

The activities covered by this procedure are to insure that the ground water samples taken will be representative of actual ground water quality, insure quality control and consistency in taking samples, and serve as a means to allow traceability of error(s) in sampling and data recording.

2.0 SCOPE

This procedure describes methods for obtaining representative samples from monitoring wells with the use of a bailer. This procedure will be used by Ayres Associates field personnel to collect ground water samples unless alternative methods are described in a project specific work plan.

3.0 CHANGES FROM LAST REVISION

Revised April 2003.

4.0 RESPONSIBILITIES

Ayres Associates project manager is responsible for advising field personnel of the purpose of the ground water sampling event and the general site conditions expected. Field personnel are responsible for obtaining the appropriate glassware from the laboratory prior to the scheduled sampling event. Ayres field personnel are responsible for reviewing the site-specific work plan and familiarizing themselves with site conditions. It is the responsibility of the field scientist to be familiar with the sampling material being collected, analysis (chemical and physical) to be conducted on each sample, compatibility of the sampling equipment, analyses of concern, and for establishing appropriate safety and health practices on the procedure. Field personnel are responsible for communicating to the project manager potential constraints with the field methods outlined in the work plan or SOP.

5.0 EQUIPMENT NEEDED

- Project-specific sampling plan
- Site map and well keys
- Interface probe for measuring free product
- Sample collection equipment including bailers
- A line to lower bailer, made of nylon, Teflon®, polypropylene, or stainless steel wire
- Tarp or plastic sheeting to place sampling equipment on
- Five-gallon bucket to measure purge water volume
- Sample bottles, labels, and Chain-of-Custody documents
- Shipping containers with labels

- Ground water sampling data sheets and/or a field log and calculator
- Field instruments including water meter, pH meter, dissolved oxygen meter, conductivity meter, and thermometer
- Spare batteries for field instruments

6.0 SAFETY

Safety concerns related to ground water sampling will be addressed in a site-specific Health and Safety Plan prepared for the project. In general, care should be taken to prevent ingestion or skin contact with potentially impacted ground water and inhalation of vapors from well. Care should also be taken in handling preservatives in sample bottles.

7.0 OPERATING PROCEDURE

Preliminary to Operation

1. Review project work plan for site-specific sampling requirements and procedures.

2. The bailer, water level measuring tape, and field meters should be cleaned and checked for defects and any possible need for repair.

3. Batteries should be checked in the field instruments and calculator.

4. Plastic sheeting should be placed on the ground for the bailer, line, water level meter, and other equipment to be placed upon.

5. ***Important Note*** - If water level data are required for calculating ground water flow direction or gradients, remove well caps from all wells and let water levels equilibrate prior to measuring water levels.

Operating Procedure

1. Place plastic sheeting on ground surface around well to keep sampling area clean and prevent sampling equipment from contacting ground surface.

2. Record the well number, time and date, and all pertinent information and data on ground water sampling record (Attached) or field logbook.

3. Identify measuring point marked on well casing. Measure the depth to ground water in the well to the nearest 0.01-foot with the water level measuring device. Measure depth to the bottom of the well to the nearest 0.01-foot with a weighted tape. Enter these data on the ground water sampling record.

4. Calculate the volume of water in the well using the equation:

$$\text{Volume (gallons)} = H \ (D/24)^2 \ 7.48 \text{ gal/ft}^3$$

Where: H = Depth of well minus depth to water (feet); and

D = Inside Diameter of well (inches).

5. Tie line securely to bailer.

6. Slowly lower the bailer in the well until top of bailer is just below the water level. Retrieve the bailer when filled. Do not let bailer free-fall down the well into the water.

7. Empty bailer into the measuring pail. Purge water should be disposed of in accordance with the project work plan.

8. Continue purging the well until at least four times the volume calculated in Step No. 4 has been removed. For low permeability formations, continue purging until the well is dry. If time permits, allow the well to recover completely and bail dry a second time. Record the actual volume of water purged and note whether the well was bailed dry on the sampling record or in the field logbook.

9. Allow water level in well to recover sufficiently so that an adequate volume of water is available to sample for the intended analyses. It is not necessary for the water level to return to its original level.

10. Begin removing the sample from the well with the bailer. Fill the appropriate glassware for each suite of parameters in order of decreasing volatility (i.e., use the first bailer for VOC analysis).

11. When sampling for volatile compounds (i.e., VOCs) pour sample into vials taking care not to agitate the water. Tilt the vials on an angle and let the water run down the inside of the vial. Fill the vials until a positive meniscus is formed at the top of the vial. Cap the vials immediately after filling to prevent undue contact with air (See SOP 350).

12. When samples are collected for analysis of dissolved constituents, the ground water samples should be filtered (SOP 340) in the field using disposable filters as specified in the work plan. Check laboratory analyte, container, and preservative requirements in the project work plan.

11. When obtaining duplicate samples, or filling multiple bottles for the same analysis, partially fill each of the bottles by alternating between bottles until all bottles are filled.

12. In areas of highly contaminated ground water, or in natural hydrologic regimes where ground water is either basic or acidic, it may be necessary to check the pH and add additional preservative to ensure samples meet preservation requirements.

13. Remove one bailer of water from the well and record its temperature, pH, and conductivity. Alternatively, field measurements can be obtained with the use of down well instrumentation. Follow recommended procedures for the specific instrument used. Note the color, odor, and turbidity of the water. Record the measurements, time, and any observations.

14. Affix labels to each sample bottle recording project name and or number, sample number, well number, date and time, preservative, and analyses required.

15 Record sample information on sampling record or in field log, along with a description of the physical appearance of the sample, including color, odor, and turbidity.

16. Place samples immediately in a shipping container maintained at 4 C.

17. Decontaminate reusable sampling equipment as described in SOP 510.

8.0 RECORDS

Data collected during field activities will be recorded in field logs or daily report forms. Entries will include the following details:

- Date
- Project title
- Purpose and description of field activities
- Field personnel
- Equipment
- Unique field sample number
- Sample date and time
- Depth to water
- Specific sample location description
- Preservation techniques
- Analytes and analytical methods
- Results of field measurements
- Name and signature of field personnel

Upon completion of field activities, copies of forms and field activity logs will be submitted to the project manager. Original forms will be filed in the project file.

9.0 CORRECTIVE ACTION

Significant problems or deviations from the SOP or work plan will be reported to the project manager as soon as possible. Deviation in procedures or actions that are required to correct a problem will be documented.

10.0 REFERENCES

AYRES ASSOCIATES
STANDARD OPERATING PROCEDURE

TITLE: Water Quality Parameters Using a Multi-Parameter Probe
SOP NUMBER: 330
EFFECTIVE DATE: April 2003

1.0 PURPOSE

This operating procedure was prepared to maintain quality control in performing measurements of water quality parameters using a multi-parameter down hole probe.

2.0 SCOPE

This procedure describes methods for collecting groundwater quality indicator parameter data using a multi-parameter down hole probe. This procedure will be used by Ayres Associates field personnel to insure quality control and consistency in performing water quality measurements. This procedure is written specifically for collecting groundwater quality measurements using an automated down hole data logging system.

3.0 CHANGES FROM LAST REVISION

Added table 1 Calibration standards, revised April 7, 2006

4.0 RESPONSIBILITIES

Project manager is responsible for supplying field personnel with appropriate boring logs and well construction information. Project manager should advise field personnel of site conditions and anticipated aquifer characteristics. Field personnel are responsible for reviewing project work plan and acquiring and checking all necessary field equipment.

5.0 EQUIPMENT NEEDED

Water Quality Probe – The water quality probe is a down hole device equipped with sensors for measuring various water quality parameters such as temperature, conductivity, pH, dissolved oxygen (DO) and oxidation-reduction potential (ORP). A programmable menu driven multi-channel data logger is used to store and transmit data.

Microcomputer - A compact personal computer is used to store the data obtained by the water quality probe. Requires appropriate program control software.

Flow Through Cell – Optional flow through cell allows readings to be collected continuously at the ground surface. Requires down hole pump to provide a continuous flow of water through the flow-through cell.

- Power cables
- Water level measuring tape
- Field log

- Decontamination equipment
- Calculator
- User's manual for water quality probe
- Well keys

6.0 SAFETY

Safety concerns related to work at the site will be addressed in the site-specific Health and Safety Plan.

7.0 OPERATING PROCEDURE

1. At the start of each field trip, the water quality probe, water level meter, and all other equipment should be examined for cleanliness and checked for defects. The water quality probe should be calibrated in accordance with the equipment manual.

2. Prior to performing the measurements, the following information is recorded:

- Well identification number
- Location of reference point from which water depths are measured
- Depth to groundwater from the reference point
- Date and time measurements are taken
- Type of equipment used

3. The microcomputer is programmed with the appropriate parameters necessary to record data in accordance with the equipment manual. After the microcomputer is programmed and the water quality probe is deployed, the sensors will relay data to the microcomputer where it is recorded and stored.

4. In the field, connect the multi-parameter probe to a portable computer (Pocket PC or laptop). Establish communication between the probe and the controlling software and program device as indicated (see manufacturer's instructions).

5. Calibrate the probe according to the following instructions (Specific to In-Situ Troll 9000 Multi-parameter probe):

- Fill the calibration cup to the marked line (lower line if thee or more sensors are installed) with Quick Cal Solution
- Remove the probe restrictor (installed to protect the sensors). Thread the cal cup onto the instrument until seated against the o-ring. Do not over tighten.
- Connect the Troll 9000 to a PC and establish a connection with Win-Situ or Pocket-Situ operating software. Select the Troll 9000 in the navigation tree. The software will automatically detect and display the installed sensors. If one or more sensors are installed in the wrong port, an error message will be displayed. Reinstall sensors in correct positions and refresh the device.

- Click on “Parameters” in the navigation tree.
- Select **Quick Cal** in the “information window’. The calibration will start and pH, conductivity, and ORP stabilization will begin immediately. The following “Status Indicators” may appear:
  Not Tested – May be displayed before the calibration begins.
  Unstable – Indicates the sensor response does not meet the criteria for a valid calibration. All parameters start out at “unstable” status.
  Nominal – Indicates the change in the sensor response over time meets a loosened or relaxed accuracy specification, compared to complete stabilization. Nominal stability will occur first.
  Stable – Indicates the change in the sensor response over time meets the stability criteria for a Quick Cal.

Reading – Current sensor response for each parameter.
Deviation – Change in response between the last two readings.

- All 3 parameters must indicate nominal or stable before the calibration can continue. When pH, ORP, and conductivity are stable, the next screen will be displayed automatically. Alternatively, you may click “accept” to store the early values.
- **Dissolved Oxygen Calibration:**
- Indicate “use vented cable” on barometric usage mode.
- To complete calibration, expose the DO sensor to air: Without disconnecting the cable, invert **the probe** so the membrane at the tip of the sensor is in **air**. Do this gently so water droplets do not splash membrane. For proper venting, loosen the end cap of the cal cup until a small hole in the threads near the o-ring is at least partially visible
- Click **Run** to start the DO stabilization
- When the DO response is stable, the calibration is complete and ready to take measurements.
- Calibration readings should correspond with the values listed in Table 1.

Table 1 - pH, ORP, & Conductivity Values at Various Temperatures

Temp ^{0}C	**pH** (+/- 0.02)	**mV** (+/- 5)	**µS/cm** (+/-40)
5	7.10	255	4990
10	7.04	247	5690
15	7.03	239	6450
20	7.02	231	7160
25	7.00	224	8000
30	6.98	217	8830
35	6.97	209	9690

6. The static water in the well is determined and recorded.

7. Set up individual “tests” for each well using the navigation tree. New test are set-up by Clicking **Add**

8. The water quality probe is suspended below the static water level. Click **Start** to begin recording readings. The probe cable can be secured to the protective casing with duct tape to prevent movement during data collection. **Note: See site-specific work plan to determine specific depth in well that measurements will be recorded (e.g., water table, screened interval, etc.).**

9. Alternatively, the multi-parameter probe can be inserted into a flow-through cell when a pump is used for ground water sampling. (See low-flow ground water sampling SOP 310 for details.)

8.0 RECORDS

Data collected during field activities will be recorded in field logs or daily report forms. Entries will include information regarding field activities including the following:

- Date
- Project title
- Purpose and description of field activities
- Name and signature of field personnel
- Equipment
- Unique well number
- Reference point and elevation
- Date and time of measurement
- Depth to water from reference point
- Unusual observations or circumstances which could affect measurements
- Results of field measurements (including computer disks containing data downloaded in the field)

Upon completion of field activities, copies of forms and field activity logs will be submitted to the project manager. Original forms will be filed in the project file.

9.0 CORRECTIVE ACTION

Significant problems or deviations from the SOP or work plan will be reported to the project manager as soon as possible. Deviation in procedures or actions required to correct a problem will be documented.

10.0 REFERENCES

In-Situ, Inc. Multi-Parameter Troll 9000, WQP-100, Operators Manual, December 2002.

AYRES ASSOCIATES
STANDARD OPERATING PROCEDURE

TITLE: VOA Sample Collection
SOP NUMBER: 350
EFFECTIVE DATE: May 2003

1.0 PURPOSE

This operating procedure was prepared to maintain quality control in collection and preservation of ground water samples for volatile organic compound (VOC) analysis. Procedure insures uniformity in sampling techniques and use of the equipment by different field technicians.

2.0 SCOPE

This procedure describes methods for performing ground water and surface water sample collection into 40mL vials for volatile organic compound (VOC) analysis. This procedure will be used by Ayres Associates field personnel to ensure quality control and consistency in performing ground water sampling. This procedure is written specifically for performing ground water sampling using three 40mL vials.

3.0 CHANGES FROM LAST REVISION

Not applicable. This is an original SOP.

4.0 RESPONSIBILITIES

Project manager is responsible for discussing project scope and desired field activities with field personnel. Ayres Associates project manager is responsible for obtaining the sample containers (40mL vials) from the contracted laboratory prior to field activity. Ayres field personnel are responsible for acquiring and checking all necessary field equipment.

5.0 EQUIPMENT NEEDED

- Three 40mL vials per sample
- Labels
- Distilled or deionized water
- Waterproof marking pen or pencil

6.0 SAFETY

A pH of less than “2” is required for preservation of VOC samples in Wisconsin. The analytical laboratory will pre-preserve the 40mL vials with Hydrochloric acid (HCL). HCL is a corrosive poison that causes severe burns. Read the Material Safety Data Sheet (MSDS) that will accompany the pre-preserved 40mL vials. Always were protective eyewear and skin protection when handling preservatives.

7.0 OPERATING PROCEDURE

Water and surface water sample collection for VOC into 40 mL vials consists of the following steps:

1. Remove cap of vial just prior to sampling.

2. Hold cap in same hand as the bottle.

3. Tilt vial slightly into water and fill slowly to minimize the turbulence and aeration. Bailer bottom emptying device is recommended.

4. Fill vial to overflow insuring that a positive meniscus is formed.

5. Place cap on top of septum and quickly screw it on snug. Do not over tighten, as vials are easily broken. Note: In freezing temperatures, do not allow vials to freeze as the vials break easily.

6. Turn vial upside down and tap it several times to insure that there are no air bubbles trapped in liquid or inside of container.

7. If bubbles are noticed, discard the sample and begin over with a new set of vials.

8. Wash outside of vial with distilled or organic free water and wipe clean with a paper towel.

9. Label and mark it with project number, description, sample number, sampler's initials, date, and time of sampling, etc., with a waterproof marker.

10. Store in ice-packed sample container and ship with a chain-of-custody record.

8.0 RECORDS

Data collected during field activities will be recorded in field logs or daily report forms, as the project manager directs.

9.0 CORRECTIVE ACTION

Significant problems or deviations from the SOP or work plan shall be reported to the project manager as soon as possible. Deviation in procedures or actions required to correct a problem will be documented.

10.0 REFERENCES

AYRES ASSOCIATES
STANDARD OPERATING PROCEDURE

TITLE: Field Blank and Equipment Blank Sample Collection
SOP NUMBER: 360
EFFECTIVE DATE: February 2014

1.0 PURPOSE

This operating procedure was prepared to maintain quality control in collecting field blanks or equipment blanks during field sampling procedures.

2.0 SCOPE

An equipment blank is a sample of reagent-grade water that is processed through the sampling equipment in the same manner as the actual sample. This process serves as a means to detect contamination that may result from contaminated equipment or inadequate decontamination procedures. A field blank, also known as an ambient blank, is a sample of reagent-grade water that is exposed to ambient field conditions when filling sample containers. This process is used to determine effect of exposure on the sampling media to ambient on-site conditions. It can also be used to determine the effectiveness of laboratory glassware decontamination, the effect of preservatives, reagents, etc. used in the preparation of environmental samples.

3.0 CHANGES FROM LAST REVISION

Name and procedure changed to include and distinguish Field Blank sample collection from Equipment Blank sample collection revised February 20, 2014.

4.0 EQUIPMENT NEEDED

- Sample containers with labels.
- Field tracking form (sampling logs or chain-of-custody log).
- Organic-free High Performance Liquid Chromatography (HPLC) or deionized water.

5.0 SAFETY

Primary safety concern associated with field blank sampling is handling of acids, bases, or solvents potentially used for sample preservation. Eye and skin protection should always be used when handling these preservatives.

6.0 PROCEDURE

Equipment Blank

1. Obtain appropriate sample containers. The project-specific work plan and/or quality assurance plan should designate the sampling intervals and parameters for equipment blank sampling.

2. Clean equipment in accordance with the project decontamination procedures (SOP 510) after use.

3. Rinse the equipment with organic-free distilled water and collect rinsate in sample containers. For water sampling blanks, the distilled water or deionized water should be processed in the same manner as the water samples collected. In the case of metals, the water must also pass through the filtering mechanism. For soil and/or sediment sampling, distilled or deionized water should be run over or through non-dedicated sampling equipment.

4. Fill each sample container with water washed over the equipment. Containers should be filled in a specified order beginning with most volatile constituents. Metals should be collected last.

5. Place all samples in a cooler with ice to lower the temperature to 4 deg. C.

6. Record sample information on the labels and sample tracking form.

7. Proceed with chain of custody.

<u>Field Blank</u>

1. Obtain appropriate sample containers. The project-specific work plan and/or quality assurance plan should designate the sampling intervals and parameters for field blank sampling.

2. Using organic-free distilled water, slowly fill the pre-preserved VOA vials until the water meniscus is slightly above the top of the vial. Tighten lid, and invert the vial to make sure air bubbles are not present.

3. Using organic-free distilled water, fill any other bottles designated for the Field Blank. Containers should be filled in a specified order beginning with most volatile constituents. Metals should be collected last. Field blanks should be collected under the same “ambient” conditions as all other investigative samples.

4. Place all samples in a cooler with ice to lower the temperature to 4 deg. C.

5. Record sample information on the labels and sample tracking form.

6. Proceed with chain of custody.

7.0 RECORDS

Data collected during field activities will be recorded in field logs or daily report forms. Entries will include information regarding field activities including the following:

- Date
- Project title
- Purpose and description of field activities
- Name and signature of field personnel
- Equipment
- Unique well and test number
- Unusual observations or circumstances which could affect test results or interpretation

Upon completion of field activities, copies of forms and field activity logs will be submitted to the project manager. Original forms will be filed in the project file.

8.0 CORRECTIVE ACTION

Significant problems or deviations from the SOP or work plan will be reported to the project manager as soon as possible. Deviation in procedures or actions required to correct a problem will be documented.

9.0 REFERENCES

AYRES ASSOCIATES
STANDARD OPERATING PROCEDURE

TITLE: Hydraulic Conductivity (Slug) Testing
SOP NUMBER: 410
EFFECTIVE DATE: May 2009

1.0 PURPOSE

This operating procedure was prepared to maintain quality control in performing single well aquifer or slug tests to measure aquifer hydraulic conductivity.

2.0 SCOPE

This procedure describes methods for performing single well aquifer tests to obtain quantitative data on aquifer characteristics and properties. This procedure will be used by field personnel to insure quality control and consistency in performing slug tests. This procedure is written specifically for performing slug tests using an automated data logger/pressure transducer, however; the same general principles and procedures apply when obtaining manual water level readings.

3.0 CHANGES FROM LAST REVISION

Not applicable. This is an original SOP.

4.0 RESPONSIBILITIES

Ayres project manager is responsible for supplying field personnel with appropriate boring logs and well construction information. Project manager should advise field personnel of site conditions and anticipated aquifer characteristics. Ayres field personnel are responsible for reviewing project work plan and acquiring and checking all necessary field equipment.

5.0 EQUIPMENT NEEDED

Data Logger - A programmable menu driven multi-channel data logger is used to store and transmit data. The data logger is used for recording water level data at specified intervals and for transferring data to a field plotter or computer.

Pressure Transducers - Pressure transducers are suspended down the well casing to record pressure changes due to changing water levels and transmit the data to a data logger.

Microcomputer - A compact personal computer is used to store the data obtained by the data logging system. The computer/software is useful for analyzing the data in the field to determine if the slug tests were performed successfully.

Field Printer - A portable battery-operated printer prints the data recorded by the data logging system. The printer is useful for analyzing the data in the field to determine if the slug tests were performed successfully.

Slug - A slug is a solid cylinder that is placed below the water table to displace water during a slug test. The cylinder is commonly three to five feet long with a diameter ranging from 0.75 inch to 1.0 inch. The cylinder is generally constructed of stainless steel. The slug is lowered and retrieved from the well with braided nylon or plastic coated line.

- Water level measuring tape
- Field log
- Decontamination equipment
- Calculator
- User's manual for data logger and transducers
- Duct tape
- Well keys

6.0 SAFETY

Safety concerns related to work at the site will be addressed in the site-specific Health and Safety Plan.

7.0 OPERATING PROCEDURE

1. At the start of each field trip, the data logger and pressure transducer, water level meter, and all other equipment should be examined for cleanliness and checked for defects.

2. Prior to performing the slug test, the following information is recorded:

    - Well identification number and test number
    - Location of reference point from which water depths are measured
    - Depth to groundwater from the reference point
    - Date and time test is started
    - Well depth, screen length, riser pipe radius, well screen radius, and thickness of the gravel pack plus the well screen
    - Type of test being performed (slug in - slug out)
    - Type of equipment used

3. The static water in the well is determined and recorded.

4. The pressure transducer is suspended below the static water level and connected to the data logger. The transducer cable is secured to the protective casing with duct tape to prevent movement during the test. The water level is then allowed to reach equilibrium and the head above the transducer as measured by the transducer is recorded.

5. The data logger is programmed with the appropriate parameters necessary to record and transmit data in accordance with the equipment manual. (Note: The data logger can be pre-programmed in the office with the majority of information. However, the **test number** and **reference elevation** must be programmed in the field **after** the transducer is set at the proper depth.)

6. A solid cylinder (slug) is introduced into the well and the data logger is simultaneously started. Water level readings are obtained until the water level approached equilibrium. A rising head test is conducted by monitoring water level recovery upon removal of the slug. (Note: A different test number and reference elevation must be entered each time a test is performed.)

7. Water level and time readings are obtained from the pressure transducer/data logger system as the water level returns to its static level (water depths are measured to the nearest 0.01 foot if measured manually). Water level measurements are taken according to a pre-programmed logarithmic interval.

SLUG TEST ANALYSIS:
The slug test data will be analyzed using Waterloo Hydrogeologic Inc., Aquifer Test graphical analysis and reporting software (or equivalent) using the methods appropriate for the site-specific hydrogeologic conditions (i.e., Bouwer & Rice, Hvorslev).

8.0 RECORDS

Data collected during field activities will be recorded in field logs or daily report forms. Entries will include information regarding field activities including the following:

- Date
- Project title
- Purpose and description of field activities
- Name and signature of field personnel
- Equipment
- Unique well and test number
- Reference point and elevation
- Date and time of test
- Depth to water from reference point
- Unusual observations or circumstances which could affect test results or interpretation
- Results of field measurements (including printout from field printer and computer disks containing data downloaded in the field)

Upon completion of field activities, copies of forms and field activity logs will be submitted to the project manager. Original forms will be filed in the project file.

9.0 CORRECTIVE ACTION

Significant problems or deviations from the SOP or work plan will be reported to the project manager as soon as possible. Deviation in procedures or actions required to correct a problem will be documented.

10.0 REFERENCES

AYRES ASSOCIATES
STANDARD OPERATING PROCEDURE

TITLE: Sampling Equipment Decontamination Procedures
SOP NUMBER: 510
EFFECTIVE DATE: May 2009

1.0 PURPOSE

When performing environmental investigations, all sampling equipment should be treated as if it is contaminated, and therefore should be thoroughly decontaminated between sampling points. Decontamination is defined as the process of neutralizing, washing, rinsing, and removing exposed outer surfaces of equipment and personal protective clothing to minimize the potential for contaminant migration and assures the collection of representative environmental samples. The only way to eliminate decontamination is by using disposable or dedicated sampling equipment. The effectiveness and thoroughness of any decontamination procedure will weigh heavily on the credibility of the environmental samples collected.

2.0 SCOPE

This procedure describes methods for decontamination of field sampling equipment used in the sampling of soils, soil gas, sludge, surface water, and ground water at waste sites which are to undergo physical and/or chemical analyses. This procedure is applicable at sites where chemical (organic and inorganic) wastes are a concern and most conventional sampling equipment constructed of metallic and synthetic materials. The manufacturer of a specific sampling apparatus should be contacted if there is concern regarding the reactivity of a decontamination rinsing agent with the equipment.

3.0 CHANGES FROM LAST REVISION

Modifications to safety and field decontamination procedures, April 2003.

4.0 RESPONSIBILITIES

It is the responsibility of the project manager to ensure that all field staff assigned to the project are using appropriate decontamination practices of all sampling equipment. It is the responsibility of the field scientist to be familiar with the sampling material being collected, analysis (chemical and physical) to be conducted on each sample, compatibility of the rinsates to the sampling equipment and analyses of concern, and for establishing appropriate safety and health practices on the procedure.

5.0 EQUIPMENT NEEDED

Inorganic Decontamination Procedure

- Kim wipes, steel wire brush, or other suitable equipment to remove excess soil
- Strong non-phosphate detergent/soap (Alconox)

- Large volume of tap quality wash water
- Rinse of ASTM Type II (distilled or deionized) water
- Rinse of dilute hydrochloric or nitric acid solution
- Heavy duty aluminum foil
- Clean room for air drying

Organic Decontamination Procedure

- Kim wipes, steel wire brush, or other suitable equipment to remove excess soil
- Strong nonphosphate detergent/soap (Alconox)
- Large volume of tap quality wash water
- Rinse of ASTM Type II (distilled or deionized) water
- Clean room for air drying
- Heavy duty aluminum foil

6.0 SAFETY

Safety concerns related to ground water sampling will be addressed in a site-specific Health and Safety Plan prepared for the project. In general, care should be taken to prevent ingestion or skin contact when handling chemicals during cleaning.

7.0 OPERATING PROCEDURE

Decontamination of field sampling and measurement equipment shall be carried out under controlled conditions prior to a sampling event whenever possible. Field equipment is transported to the field pre-cleaned. Cleaning procedures for field equipment should be documented and maintained for reference. All equipment is thoroughly rinsed with tap water immediately after use and is used only once if possible, after which it is labeled with the sampling location and cleaned under controlled conditions. When necessary, or under emergency sampling conditions such as accidental contamination of equipment, a field decontamination procedure (described below) must be performed. If this emergency cleaning procedure is required, a separate equipment and field blank will be collected and analyzed for evaluation of the field cleaning procedure. Equipment used in sampling will be identified with the sampling location and all field cleaning procedures employed by Ayres Associates will be documented in the project field log and maintained with the permanent project files. A written QA/QC report describing the procedural variation will be submitted to the designated QA officer for review and recorded in the permanent project file.

Sample specimen containers should be received pre-cleaned from a subcontract laboratory. The project manager is responsible for verifying the subcontract laboratory maintains an approved QA/QC plan which includes approved cleaning procedures. Decontamination procedures listed below are described in Appendix B of the E.P.A. Engineering and Support Branch Standard Operating Procedures and Quality Assurance Manual (1986). The standard cleaning solvent referenced shall be pesticide-grade isopropanol. The laboratory detergent

referenced shall be a standard brand of phosphate-free laboratory detergent such as Liquinox, Alconox, or an equivalent.

IN-HOUSE CLEANING PROCEDURE

- Equipment will be washed thoroughly with laboratory detergent and hot water using a brush to remove any particulate matter or surface film.
- Equipment will be rinsed thoroughly with hot tap water.
- Acid rinse non-metallic equipment with 10% HNO_3 (if nutrients are of interest, use 10% HCl instead of nitric acid).
- Rinse equipment thoroughly with deionized water.
- Rinse equipment twice with solvent and allow to air dry for at least 24 hours.
- Wrap equipment completely with aluminum foil to prevent contamination during storage and/or transport to the field.
- Rinse equipment thoroughly with tap water in the field as soon as possible after use.

FIELD CLEANING PROCEDURE

- Clean equipment with tap water and laboratory detergent using a brush, if necessary, to remove particulate matter and surface films.
- Rinse thoroughly with tap water.
- Rinse thoroughly with deionized water and allow to dry as long as possible.
- Wrap equipment with aluminum foil, if appropriate, to prevent contamination of equipment during transportation or storage.

Analyte-free water in the form of distilled water (with analytes of interest and interference's below detection limits) should be obtained from the contract laboratory or retail distributor and should be contained in glass, stainless steel, or shock-resistant inert (e.g. Nalgene) containers when stored or transported. The collection of equipment blanks provides a method of maintaining confidence in the rinse water quality. Documentation of reliability and purity of analyte free water is maintained through records of these equipment blanks.

MISCELLANEOUS EQUIPMENT CLEANING PROCEDURE

Any equipment that is in contact with sample waters must be rinsed thoroughly with tap water, soap, deionized water, and an analyte free water rinse before it may be used again. Heavily contaminated equipment must be scrubbed with a

brush to remove particulate material and will be rinsed with acetone or a combination of alternating acetone and hexane with a final acetone rinse before using the in-house decontamination procedure outlined earlier. In the event that a piece of equipment cannot be adequately field decontaminated, it is contained and removed from the sampling area for subsequent decontamination procedures including disassembly, if necessary. Equipment that cannot be thoroughly decontaminated will either be properly disposed of or will be dedicated to other uses such as free product recovery. Meters used in field parameter measurement should be rinsed with analyte free water between each sample measurement.

TUBING

Exterior of tubing must be decontaminated first using reagents described above. The tubing is soaked in a soapy water solution using a stainless steel sink, glass bowl, or other non-contaminant container. The inside ends of the tubing should be scrubbed using a bottle brush. The tubing exterior and ends should be flushed liberally with tap water followed by a rinsing of tubing surfaces with nitric acid, tap water, isopropanol, and finally analyte-free water. Wrap tubing in aluminum foil for storage and transport. Dedicated tubing left in the well will not require decontamination between sampling events.

PUMPS

Purging equipment is first scrubbed with a brush in order to remove any particulate material, if necessary, and rinsed with tap water. Tap water, soap solution, deionized water, and finally a thorough rinse with analyte free water should be sequentially passed through the pump using a stainless steel or glass container in supplying the final rinse. The equipment will be allowed to air dry before purging the next well.

Lanyards and measuring tapes should be field washed with laboratory detergent and rinsed with tap water and deionized or analyte-free water.

8.0 RECORDS

The activities completed for each equipment decontamination should be documented in writing. Included in this report should be the following:

- Site location, date, time, and weather
- Sample location where equipment was employed
- Location where decontamination was performed
- Individuals performing the decontamination
- Decontamination procedures
- Source of materials (solutions) used for decontamination
- Handling of rinse fluids and accumulated solids, if any
- QA/QC samples whether complete in the field or laboratory subsequent to sampling event

9.0 CORRECTIVE ACTION

Not Applicable

10.0 REFERENCES

Field Sampling Methods for Remedial Investigations, Mark E. Byrnes, 1994.

Standard Handbook for Solid and Hazardous Waste Facility Assessments, Martin N. Sara, 1993.

AYRES ASSOCIATES
STANDARD OPERATING PROCEDURE

TITLE: Ground Water Sampling for PFAS
SOP NUMBER: 710
EFFECTIVE DATE: October 2019

1.0 Introduction

Per- and polyfluoroalkyl substances (PFAS) are a group of synthetic chemicals which contain short, strong chains of carbon-fluorine bonds. These bonds are one of the strongest found in nature, making these chemicals very stable and persistent in the environment since they're resistant to thermal, chemical, and biological degradation. Due to their molecular chemistry, they exhibit unique characteristics such as being heat resistant, able to lower surface tension (act as surfactants), non-stick (oleophobic), stain resistant, and water-repellent (hydrophobic), while also being relatively water soluble. As such, they have been used since the 1940s in numerous industries and products such as clothing, cleaning products, fire-fighting foams, and non-stick products. These substances are a class of emerging contaminants, composed of more than 3,000 human-made, fluorinated, organic chemicals. 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.

PFAS have a half-life of two to nine years in humans and are likely to be carcinogenic. The main pathway of exposure for humans is via food (mainly fish and eating food that was packaged in material that contains PFAS) and air. In 2006, the Environmental Protection Agency (EPA) partnered with major chemical companies to eliminate the production and use of long-chain PFAS in their products by 2015, however the chemicals are still being produced and used in products by other countries. By 2016, the EPA established Lifetime Health Advisory Limits of 70 parts per trillion (ppt) as a guidance. Certain states such as New York and New Jersey subsequently established their own, stricter limits.

Since PFAS are found in common products used for environmental sampling, the risk of cross-contamination during sampling and the probability for false positives is relatively high. To help reduce this risk, certain precautions must be taken before, during, and after the sampling event.

2.0 Purpose and Objectives

The purpose of this standard operating procedure (SOP) is to ensure sample integrity and representation during PFAS sampling and provide guidance on avoiding PFAS cross-contamination during sampling. This document intends to improve sampling consistency and data quality, and to provide guidance to Ayres Associates staff.

This document is intended to supplement SOP 310 "Ground Water Sampling Using Low-Flow Sampling Techniques", SOP 320 "Groundwater Sampling with Bailer", SOP 370 "Surface Water Sampling", SOP 130 "Soil Sampling for Environmental Analysis" and other SOPs as needed. Please refer to these SOP's for specific sampling information such as responsibilities,

equipment needed (except if equipment contains PFAS products), general operating procedures for sampling, documentation, and records. SOP's regarding sampling, decontamination, chain-of custody (COC) form procedures, and others, should be followed but information in this SOP should enhance the information in other SOP's specifically when sampling for PFAS.

3.0 Changes from Last Revision

Not applicable. This is an original SOP.

4.0 General PFAS Sampling

4.1 PFAS Cross-Contamination Sources

Potential sources of cross contamination during sampling can be found in the following: water used during drilling or decontamination, sampling equipment, field clothing and personal protective equipment (PPE), sun and biological protection products, personal care and hygiene products (PCP), food packaging, and the environment itself. The following sections provide guidance on how to avoid such cross-contamination. It's important to realize not all products that are indicated as PFAS-free now will always be in the future. Sampling equipment and clothing should always be checked for PFAS. The following should be used as guidelines, not comprehensive lists. Ayres Associates intends to update the information contained within this SOP document as new information becomes available. Please refer to Attachment A for example considerations while PFAS sampling.

4.1.1 PFAS-Free Water

PFAS-free water should be used during decontamination and drilling. This is 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 the project data quality objectives. The confirmation of PFAS-free water should always be performed prior to the commencement of work. Since site or public water supplies have been identified in many instances to contain detectable levels of PFAS, laboratory supplied PFAS-free deionized water should be used.

4.1.2 Sampling Equipment

<u>Do not use</u> any equipment that contains any known fluoropolymers such as:

Polytetrafluoroethylene (PTFE) which includes that trademark Teflon® and Hostaflon® and can be found in items such as the lining of hoses and tubing, some wiring, bailers, and certain kinds of gears.

Polyvinylidene fluoride (PVDF) which includes trademark Kynar® and can be found in items such as films/coatings on aluminum, wire insulators, and lithium-ion batteries.

Polychlorotrifluoroethylene (PCTFE) which includes the trademark Neoflon® and can be found in items such as valves, seals, gaskets, and food packaging.

Ethylene-tetrafluoroethylene (ETFE) which includes trademark Tefzal® and can be found in items such as wire and cable insulation and covers, films for roofing and siding, liners in pipes, and some cable tie wraps.

Fluorinated ethylene propylene (FEP) which includes trademark Teflon® FEP and Hostaflon® FEP, and Neoflon® and can be found in items such as wire and cable insulation and coverage, pipe linings, and some labware.
Low-density Polyethylene (LDPE), which can be found in items such as containers, bottles, plastic bags, and tubing.
Glass containers
Waterproof field books, plastic clipboards, binders, or spiral hard cover notebooks, adhesives, permanent markers. (Specifically, do not use in the sampling area. If used in the staging area, change gloves after use and before sampling).

The following equipment <u>should be screened before use by sending equipment blanks to lab</u>:

Latex gloves
Aluminum foil
LDPE

The following equipment is <u>allowable to use.</u> 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 ‘allowable’ materials will always be PFAS-free:

LDPE bags such as trademark Ziploc®, only if it does not come into direct contact with the sample media
High-density polyethylene (HDPE), polypropylene, silicone, stainless steel, or acetate
Powderless nitrile gloves
Ball-point pens

4.1.3 Field Clothing and PPE

PPE or field clothing containing PFAS should not be worn when sampling for PFAS due to risk of cross-contamination. Focus should be on clothing claiming to be water-repellent, waterproof, and dirt/stain resistant since these clothing items are most likely to have PFAS used in their manufacturing. Many different types of PPE may be required for various sampling events. When in doubt, all PPE should be evaluated prior to sampling.

<u>Do not use</u> the following clothing and PPE when sampling for PFAS:

Clothing that has been washed with fabric softener which may contain PFAS.
Clothing that has been made with or washed with water, dirt, and/or stain resistant chemicals (including but not limited to Gore-Tex, Scotchgard, RUCO, etc).
Clothing that has been chemically treated for ultraviolet protection or insect resistance.
New unwashed clothing
Coated Tyvek
Latex gloves

Any clothing with the names included in the table below (Michigan Department of Environmental Quality (2018):

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

The following clothing and PPE <u>are allowable to use:</u>

Powderless nitrile gloves
Polyvinyl chloride (PVC) or wax-coated fabrics
Neoprene
Boots made of polyurethane and/or PVC. PFAS-free over-boots may be worn if specific boot needed for job contains PFAS. Over boots may only be removed in the staging area and after sampling activities are completed.
Synthetic and natural fibers (preferably cotton) that are well-laundered (more than six times with no fabric softener)

4.1.4 Sun and Biological Protection Products

The following sun and biological protection products <u>should be screened before use:</u>

Alba Organics Natural Sunscreen, Yes To Cucumbers, Aubrey Organics, Jason Natural Sun Block, Kiss My Face, Avon Skin So Soft Bug Guard Plus-SPF 30 Lotion
Baby sunscreens that are “free” or “natural”
Jason Natural Quit Bugging Me, Repel Lemon Eucalyptus Insect Repellent, Herbal Armor, California Baby Natural Bug Spray, Baby Ganics

The words “natural” and/or “organic” do not mean the product is PFAS-free.

The following sun and biological protection products <u>are allowable to use:</u>

<u>INSECT REPELLANTS</u>

OFF Deep Woods, Sawyer Permethrin
Jason Natural Quite Bugging Me
Repel Lemon Eucalyptus Insect repellant
Herbal Armor
California Baby Natural Bugspray

<u>SUNSCREENS</u>

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
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+

4.1.5 Personal Hygiene and Personal Care Products

Do not handle or apply personal care products (PCPs) such as cosmetics, shampoos, sunscreens, and dental floss in the sampling area or while wearing PPE that will be present during sampling. Move to a staging area and remove PPE if applying PCPs becomes necessary. Wash hands thoroughly after handling PCPs and wear a fresh pair of nitrile gloves when returning to sampling.

4.1.6 Food Packaging

Since the 1950s, PFAS have been used in food packaging as a special coating agent against grease, oil, and water for paper and paperboards. Although PFAS in these products has been banned in the United States since 2016 by the Food and Drug Administration (FDA), PFAS can remain in products today from recycling paper which still contain PFAS. Therefore, to prevent cross-contamination, do not handle, consume, or interact with pre-wrapped food, fast food, or food that is packaged in such products 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. 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.

4.2 PFAS Sampling Procedures

4.2.1 Sampling Collection

It is crucial to take detailed field notes regarding sampling procedures. All PFAS sample bottles should come from the laboratory that will also be performing the PFAS analysis and should be verified as PFAS-free. Sample containers and equipment that will be used for sampling should not be stored on or encounter materials suspected to contain PFAS. Hands should be washed before sampling activities commence and clean powderless nitrile gloves worn before sample collection. The sample container should always remain closed except when obtaining the sample and the cap should never be placed on a surface that is suspected to contain PFAS and should never be placed on the ground. Filtering the sample is ***not*** recommended for PFAS since they can adsorb onto the filter and the data would show a lower concentration of PFAS in the sample than what's real. Sampling should generally occur in a sequence from area of least contamination to area of most contamination to reduce cross-contamination. If other

sampling is performed on the same day as PFAS sampling, PFAS samples should be collected first. Aluminum foil is not allowable in the field sampling, storage, or shipping unless equipment blank samples confirm it is PFAS-free. Refer to SOP 310, 320, and 130 for detailed sampling requirements.

4.2.2 Sample Preservation, Shipping, Storage, and Hold Time

According to EPA Method 537 Rev. 1.1, PFAS drinking water samples only are to be preserved with 1.25 g Trizma, which is a buffering agent and removes free chlorine. Samples are stored in 250 mL polypropylene containers with polypropylene screw caps. The samples are filled to the neck of the bottle and agitated by hand until the preservative is dissolved. The samples require chilling during storage and shipment and must not exceed 50°F (10°C) during the first 48 hours after collection. This method has a holding time of 14 days. Currently, there aren't standards for other sample media, but the EPA plans to address this in the future. Until that information is available, follow the guidelines addressed in EPA Method 537 Rev. 1.1 for all other sample media except biota regarding thermal preservation (Trizma is specific to drinking water only), shipping, storage, and holding times.

4.2.3 Sample Shipment

Generally, all PFAS samples should be kept on ice from the time of collection to the arrival at the laboratory. The following list explains the procedure that should be used for sample shipment:

- Regular ice should be used to cool and maintain the sample at or below the proper temperature requirement. Chemical or blue ice may be used if it is known to be PFAS-free and it is certain that the samples are cooled to the requirements.
- Samples, COC, and ice should always be bagged in polyethylene bags.
- The COC and other forms should be single bagged in LDPE releasable storage bags and taped to the inside of the cooler
- It is recommended to ship PFAS samples separately from other samples since the quality of care collecting other samples is not as vigorous as PFAS samples.
- The cooler should be taped shut with a custody seal
- Sample should be shipped as soon as possible to ensure the samples arrive within the holding time requirements, generally 14 days for water.

4.2.4 Decontamination

Disposable sampling equipment should be used, especially for sample bottles and other equipment where the sample may be in direct contact with for an extended period. When using non-disposable sampling equipment, risk of PFAS contamination is high and decontamination methods should be used.

Do not use the following decontamination methods:

- Decon 90®
- Putting equipment away without decontaminating it

The following decontamination methods should be screened before use:

- Municipal drinking water

The following decontamination methods are allowable to use:

Laboratory supplied PFAS-free deionized water
Alconox®, Liquinox®, and Citranox®
Sampling equipment scrubbed using polyethylene and PVC brush to remove particles.
Triple-rinsing with PFAS-free water
Decontaminating sampling equipment after sampling at each location, or between uses.
Commercially available deionized water in an HDPE container if the water is verified to be PFAS-free
Washing the equipment as follows: In a PFAS-free bucket, wash the equipment with a mixture of PFAS-free water and PFAS-free soap. In a second PFAS-free bucket, rinse the equipment with PFAS-free water. In a third bucket, (or if second bucket can be washed and rinsed) rinse the equipment again with PFAS-free water. Change the decontamination water and soap between cleanings.

4.2.5 Quality Control Samples

Quality control samples should be collected according to EPA Method 537 Rev. 1.1

Equipment blanks should be collected by passing laboratory verified PFAS-free water over or through decontaminated field sampling equipment before the collection of samples. This will assess the adequacy of the decontamination process and the potential for contamination from the equipment used during sampling.

Field blanks are prepared in the laboratory by placing an aliquot of PFAS-free water reagent water in a sample container and treating is as a sample in all respects, including shipments to the sampling site, exposure to sampling conditions, preservation, and all analytical procedures. This will assess contamination resulting from the sampling process.

Trip blanks are a bottle of PFAS-free water that should be prepared in the laboratory, travel to the site, and be transported back to the laboratory without having been exposed to any sampling procedures. This can be useful when sampling for PFAS to assess cross-contamination introduced from the laboratory and during shipping procedures.

Field duplicates are replicate samples collected in the filed and submitted to the laboratory as two different samples.

4.3 Materials Screening

Materials screening should be performed during the Health and Safety Plan (HASP) and Quality Assurance Project Plan (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 sample.

Material screening should include a review of Safety Data Sheets (SDSs). 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**.** Manufacturers can change the chemical composition of any product.

As a result, before Ayres begins any PFAS sampling, screening will include the collection of equipment blanks of any sampling material that will come in direct contact with the sample. A sample should run through any equipment that is planned on being used during the actual sampling event and sent to a laboratory for analysis, regardless of what category they might be in, to confirm they are “PFAS-free.” Once the results verify that certain equipment items are PFAS-free, sampling for PFAS will only be done with those items.

5.0 Laboratory Protocols

EPA’s drinking water program does not have any requirements or method specification since PFOA, PFOS, and other Unregulated Contaminant Monitoring Rule 3 (UCMR 3) analytes are not regulated under the Safe Drinking Water Act (SDWA). However, Method 537 was developed to validate the analysis of drinking water and reliably demonstrated its proficiency for PFOS, PFOA, and 12 other PFAS analysis. EPA has also released a revised version of Method 537.1 for additional PFAS in drinking water in 2018. This method uses a solid phase extraction liquid chromatography/tandem mass spectrometry method for the determination of selected PFAS in drinking water. Certain laboratories offer an analysis for PFAS known as “Modified Method 537”, which is for drinking water and other environmental media. However, this method does not have a standardized description or studies to validate the performance of these modified methods, so EPA cannot validate the performance.

While assessing PFOA/PFOS results relative to the 2016 Health Advisories, EPA treated results below the minimum reporting levels (MRLs) as “zero”. Established MRLs for PFOA and PFOS are 20 and 40 parts per trillion (ppt), respectively. Since laboratories may reliably measure PFAS at lower levels, individual states can establish lower MRLs to meet project-specific data quality objectives.

An EPA isotope dilution method for non-potable aqueous and non-aqueous matrices is estimated to come out by the end of 2021. In the meantime, for non-potable water and non-aqueous matrices, the Department of Defense (DoD) Quality Systems Manual (QSM) 5.2 is recognized as the gold standard for PFAS analysis. However, this is not a method, but a set of performance-based requirements.

5.1 Wisconsin Protocols

While EPA issued a non-enforceable Lifetime Health Advisory level for PFOA and PFOS of 70 ppt in drinking water in 2016, Wisconsin Department of Health Services (DHS) has recommended a groundwater standard of 20 ppt, which is a combined standard for PFOS and PFOA. As of October 2016, the only lab in Wisconsin that met the UCMR 3 Laboratory Approval Program application and Proficiency Testing criteria for EPA Method 537 was Northern Lake Service, Inc., located in Crandon, WI.

Wisconsin uses EPA Method 537.1 for drinking water PFAS analysis and has come up with a Wisconsin document titled “Wisconsin PFAS Aqueous (non-potable water) and Non-Aqueous Matrices Method Criteria” (document ID EA-19-0001). This document would provide criteria specified by the Wisconsin Department of Natural Resources (WDNR) that is considered

suitable for PFAS analysis in non-drinking water matrices and would allow the WDNR to accredit Wisconsin labs for PFAS analysis. This Wisconsin document will be used until EPA publishes an isotope dilution method for non-drinking matrices. Once the EPA method for non-drinking matrices is established, this Wisconsin document will no longer be used.

6.0 Corrective Action

Significant problems or deviations from the SOP or work plan will be reported to the project manager as soon as possible. Deviation in procedures or actions that are required to correct a problem will be documented.

7.0 References

EPA/600/R-08/092, Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS, (September 2009).

Michigan Department of Environmental Quality, General PFAS Sampling Guidance, (October 2018).

California State Water Quality Control Board, Division of Water Quality, Per- and Polyfluoroalkyl Substances (PFAS) Sampling Guidelines, (March 20, 2019)

Appendix B

WDNR Site Characterization Technical Memoranda (April 2020)

SITE CHACTERIZATION SAMPLING
FOR CONTAMINATED MATERIAL MANAGEMENT PURPOSES
ALTER B400
TRUAX FIELD
APRIL 13, 2020

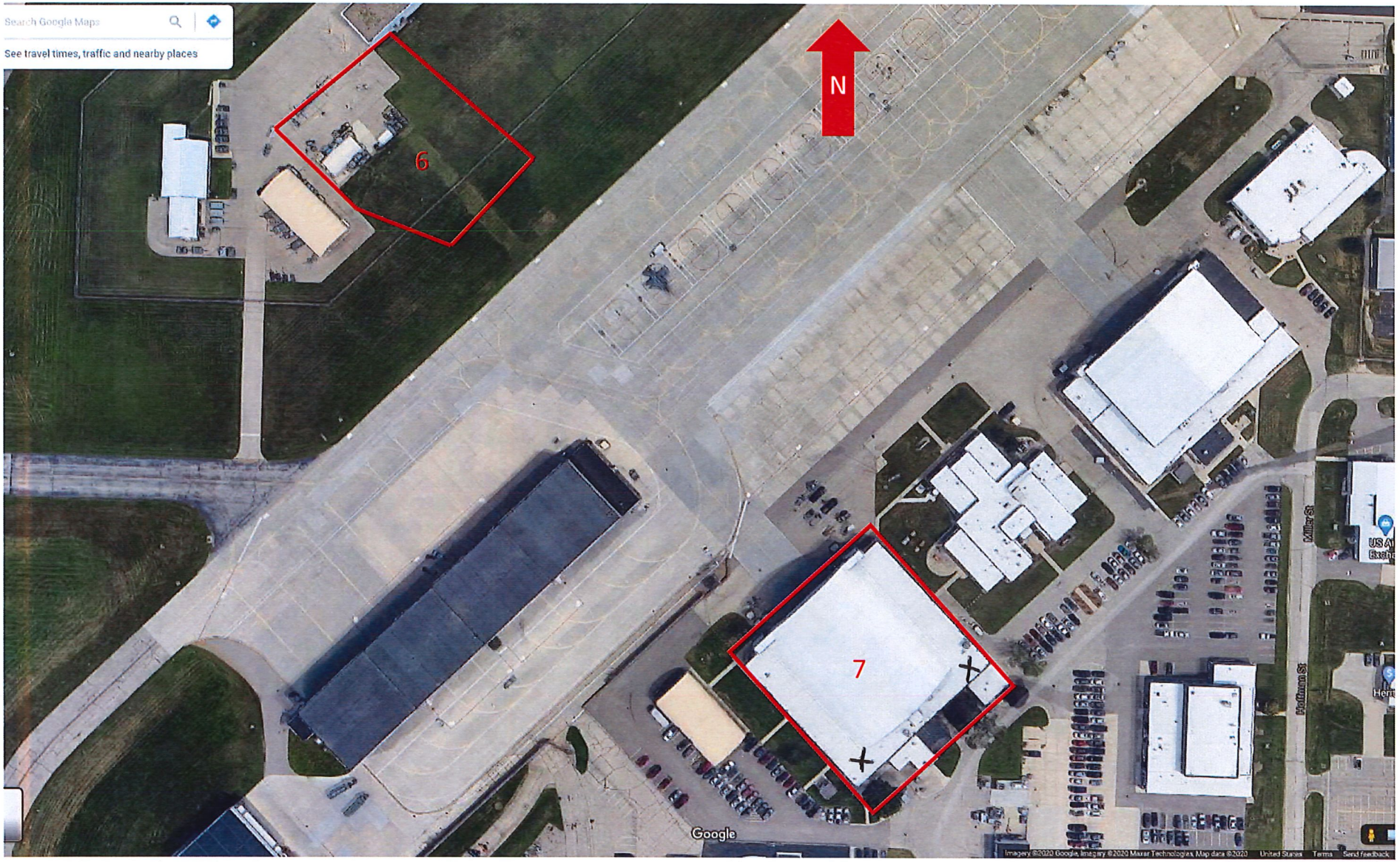
For project XGFG 182009 soil and groundwater samples will be collected at the locations shown on the attached map. All samples will be tested for the full range of volatile organic chemicals and the included list of PFAS compounds. This field information will be used to develop a contaminated materials management plan. The management plan will describe the reuse or disposal of contaminated soil and/or groundwater generated during site preparation and building construction.

Building 400 lies in an area of known PFAS soil and groundwater contamination. The planned interior work will not require soils to be excavated and moved off site. However, excavation for two planned elevator sumps will require soil movement. The planned soil and groundwater samples will be collected from the locations of the planned elevator sumps. At this time those locations are estimated. The marked samples locations are estimates. The samples shall be taken in the elevator sumps once those locations are known.

SAMPLING:
Two discrete soil samples will be collected from each boring at depths of: 1-2 feet below ground surface and 1 foot above the water table; two sample locations are shown on attached map for total of four soil samples

Groundwater samples will be collected from each boring: samples can be grab samples using a direct push method, permanent wells are not required; two sample locations for a total of two water samples.

ANALYSIS
All soil and groundwater samples will be analyzed at a lab, approved by the Department, to conduct volatile organic chemical and PFAS analysis. QA/QC requirements will be laboratory specific.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WISCONSIN DEPARTMENT OF NATURAL RESOURCES
NOTICE OF FINAL GUIDANCE & CERTIFICATION

Pursuant to ch. 227, Wis. Stats., the Wisconsin Department of Natural Resources has finalized and hereby certifies the following guidance document.

DOCUMENT ID

EA-19-0001

DOCUMENT TITLE

Wisconsin PFAS Aqueous (Non-Potable Water) and Non-Aqueous Matrices Method Expectations

PROGRAM/BUREAU

Certification Services / Environmental Analysis & Sustainability

STATUTORY AUTHORITY OR LEGAL CITATION

Wis. Stats. s. 299.11 and Wis. Admin. Code s. NR 149.41 (2)

DATE SENT TO LEGISLATIVE REFERENCE BUREAU (FOR PUBLIC COMMENTS)

9.16.19

DATE FINALIZED

12.16.19

DNR CERTIFICATION

I have reviewed this guidance document or proposed guidance document and I certify that it complies with sections 227.10 and 227.11 of the Wisconsin Statutes. I further certify that the guidance document or proposed guidance document contains no standard, requirement, or threshold that is not explicitly required or explicitly permitted by a statute or a rule that has been lawfully promulgated. I further certify that the guidance document or proposed guidance document contains no standard, requirement, or threshold that is more restrictive than a standard, requirement, or threshold contained in the Wisconsin Statutes.

Signature

Date 12/10/2019

Wisconsin PFAS Aqueous (Non-Potable Water) and Non-Aqueous Matrices Method Expectations

- Version 12.16.2019 -

Per- and Polyfluorinated Alkyl Substances (PFAS) Analysis Using Isotope Dilution by LC/MS/MS

The purpose of this document is to provide the expectations that will help the Program determine if a laboratory's method is considered suitable for analysis of PFAS in aqueous (non-potable water) and non-aqueous matrices for Wisconsin.

The Program has the legal authority under NR 149.41 (2) to determine whether the method selected by a laboratory is suitable for the matrix, type of analyte, expected level of analyte, regulatory limit, and anticipated interferences in the sample, when methods are not prescribed by covered programs under NR 149 or permits issued by the department.

Once the EPA publishes their 1600 series isotope dilution method, the Program will defer to that method for certification.

Potable water samples are analyzed utilizing EPA 537.1.

{F} = when "{F}" is listed after an expectation and the expectation is not met, then qualify the associated results on the test report. The qualifier can refer the data user to the narrative where detail is provided that indicates what the non-conformance was, and if known, the possible effects on the sample results.

Definitions are provided in Section **X, "Definitions,"** of this document.

I. Sample Handling

1. Instruct sample collectors to collect grab samples in high density polyethylene or polypropylene containers. {F} Avoid polytetrafluoroethylene (PTFE) containers and contact with PTFE surfaces.

2. Instruct sample collectors to collect an equipment blank when using equipment in the field to collect samples. {F}

3. Instruct sample collectors not to fill aqueous sample containers completely.

4. There is no chemical preservation necessary, just temperature preservation. Instruct sample collectors to ship aqueous and solid samples at above their freezing point to 6 °C. {F} Instruct sample collectors to ship tissue samples frozen. {F} Measure and document the temperature of aqueous and solid samples at sample receipt. Tissue samples received frozen can be documented as "frozen" at sample receipt.

5. Store aqueous and solid samples at above their freezing point to 6 °C at the laboratory. {F} Store tissue samples at less than or equal to -10 °C at the laboratory. {F} Store all extracts at 0 – 6 °C at the laboratory. {F}

6. Aqueous and solid sample holding times are within 28 days from collection to extraction and within 30 days from extraction to analysis. {F} Tissue sample holding times are within 1 year from collection to extraction and within 30 days from extraction to analysis. {F}

7. Rinse aqueous sample containers and all extract containers after transfers with one or more rinses of polar solvent to remove any PFAS that may have been adsorbed to container walls.

8. Thoroughly vortex or mix extracts and standards before transfer or aliquoting to remove any PFAS that may have been adsorbed to container walls.

9. Thoroughly vortex autosampler vials before loading the autosampler to remove any PFAS that may have adsorbed to container walls.

II. Initial Demonstration of Capability (IDC)

1. All analysts performing testing are expected to pass an IDC. If analysts perform only the extraction steps, then they are expected to pass the extraction portion of an IDC. If analysts perform only the analysis steps, then they are expected to pass the analysis portion of an IDC.

2. Analyze standards of all target (native) analytes and extracted internal standards (EIS) to determine retention times of the linear and branched isomers.

3. Analyze a method blank. The results are expected to be less than one-half the method reporting limit (MRL).

4. Assess precision and recovery by performing the entire procedure on four laboratory control samples (LCS) spiked at a midrange concentration of the initial calibration for each target (native) analyte. The average recovery is expected to be within 65-135%, and the RSD is expected to be less than or equal to 30%.

5. Assess recovery of the extracted internal standards (EIS) in each LCS. Except for FOSA, NMeFOSA, NEtFOSA, NMeFOSE, and NEtFOSE, EIS recoveries are expected to be within 50–150%. For FOSA, NMeFOSA, NEtFOSA, NMeFOSE, and NEtFOSE, EIS recoveries are expected to be within 20 – 150%.

III. Field Quality Control Samples

1. **Equipment blanks** (one per sampling event when equipment is used in the field to collect samples) – The results are expected to be less than the highest of the following {F}:

    a. 1/2 the MRL
    b. 1/10 the sample concentration

    It is not necessary to qualify equipment blank detections between the MDL and one-half the MRL.

2. **Field blanks** (one per sampling event for each sampling site) – The results are expected to be less than the highest of the following {F}:

    a. 1/2 the MRL
    b. 1/10 the sample concentration

    It is not necessary to qualify field blank detections between the MDL and one-half the MRL.

3. **Field duplicates** (one per sampling event for each sampling site) – The RPDs are expected to be less than or equal to 30% when analyte concentrations are greater than twice the MRL. {F} The RPDs are expected to be less than or equal to 50% when analyte concentrations are the MRL and twice the MRL. {F}

IV. Batch Quality Control Samples

1. **Method blank** (one per batch) – The results are expected to be less than the highest of the following {F}:

    a. 1/2 the MRL
    b. 1/10 the sample concentration

    It is not necessary to qualify method blank detections between the MDL and one-half the MRL.

    Method blanks are processed along with and under the same conditions, including all sample preparation steps (i.e. filtering, centrifuging), as the associated samples in the preparation batch.

2. **Laboratory control sample** (one per batch) – Spike with all target (native) analytes.

    Laboratory control samples are processed along with and under the same conditions, including all sample preparation steps (i.e. filtering, centrifuging), as the associated samples in the preparation batch.

    For aqueous and solids batches, spike the LCS at a low range (1 – 2x MRL) in each batch, or the laboratory may rotate spike concentrations between three consecutive batches alternating low range, midrange, and high range. Midrange and high range are relative to the initial calibration range. For aqueous and solid batches, the recoveries are expected to be within 60-135%, except for the low range (1 – 2x MRL) where the recoveries are expected to be within 50-150%. {F}

    For tissue batches, spike the LCS at midrange. For tissue batches the recoveries are expected to be within 60-135% with the following exceptions: for PFHxDA, PFODA, and NMeFOSA, the recoveries are expected to be within 50-135%; for PFDS, PFDoS, and 4:2 FTS, the recoveries are expected to be within 40-135%. {F}

3. **Extracted internal standards (EIS)** – Spike field samples and all quality control samples (preparation and instrument) with internal standards. The recoveries of these internal standards are used to adjust target (native) analyte concentrations. These isotopically labeled internal standards are added to the sample at the very beginning of the procedure, before extraction, centrifuging, filtering or phase separation takes place.

    In order to report quantitative results for the target (native) analytes using the EIS, a minimum signal to noise ratio of 10:1 is expected for each EIS. Do not report results with a qualifier if this minimum is not achieved.

    Except for FOSA, NMeFOSA, NEtFOSA, NMeFOSE, and NEtFOSE, the EIS recoveries are expected to be within 25-150% in samples. For FOSA, NMeFOSA, NEtFOSA, NMeFOSE, and NEtFOSE, these EIS recoveries are expected to be within 10-150% in samples. Once enough data points have been collected, the laboratory may develop their own statistical limits for these five EIS in samples. The statistical limits can be different than 10–150% as long as the expected minimum 10:1 signal to noise ratio is maintained for each EIS.

    If any EIS recoveries are outside of limits in a sample, reinject the sample. If the EIS recovery fails again, the data may be reported with a qualifier. {F}

    Use exact isotopically labeled analogs for the EIS where commercially available. As of December 2019, at least 25 of the 36 PFAS for which Wisconsin is offering certification are available as exact isotopically labeled analogs of the target (native) analytes. As of December 2019, the following 11 PFAS do not have exact isotopically labeled analogs commercially available and are therefore not currently necessary: PFTriA, PFODA, PFPeS, PFHpS, PFNS, PFDS, PFDoS, 10:2 FTSA, DONA, 9Cl-PF3ONS, and 11Cl-PF3OUdS.

For these 11 PFAS without an exact isotopically labeled analog commercially available, use an alternate EIS. The alternate EIS is expected to be isotopically labeled and is expected to be a chemically similar analyte that is close in retention time to the target (native) analyte. The alternate EIS may be from the same functional group as the target (native) analyte or have the same chain length as the target (native) analyte (whichever gives better performance). Typically, the alternate EIS comes from those EIS that are already in use. The same EIS can be used for more than one target (native) analyte.

V. Calibration (Initial and Continuing)

1. Perform initial calibration at setup and after an ICV or CCV standard failure. If an ICV or CCV standard fails, the laboratory may immediately analyze two additional consecutive ICV or CCV standards. If either of the two fails, or if immediate analysis is not possible, it is expected that a new initial calibration is performed. If both pass, then sample analysis can continue without a new initial calibration. If a CCV fails high and there are no detections in the associated samples, then analysis can proceed.

2. Initial calibration functions are expected to be as follows:

    a. Calibration factors have an RSD that is less than or equal to 20%.
    b. Linear regressions have a coefficient of determination that is greater than or equal to 0.99 and use a minimum of five non-zero concentration standards.
    c. Quadratic regressions have a coefficient of determination that is greater than or equal to 0.99 and use a minimum of six non-zero concentration standards.
    d. Do not force linear and quadratic regressions through zero.
    e. For each calibration standard, reprocess the target (native) analyte against the chosen calibration function. The reprocessed recoveries are expected to be within 70–130% of their actual concentrations, except for the lowest concentration standard, whose reprocessed recoveries are expected to be within 50–150% of their actual concentrations.

3. It is expected that sample analysis is not performed if the initial calibration fails.

4. Analyze standards of all target (native) analytes and EIS to determine retention times of the linear and branched isomers. Analyze branched isomers that have commercially available standards. As of December 2019, the following PFAS are commercially available as branched isomer analytical (quantitative) standards: PFHxS, PFOS, NMeFOSAA, and NEtFOSAA. As of December 2019, PFOA is commercially available as a branched isomer technical grade (qualitative) standard.

5. When an initial calibration is performed, it is expected that the midrange standard is used to establish absolute retention times. When an initial calibration is not performed, it is expected that the first CCV is used to establish absolute retention times.

6. Retention times of the target (native) analytes and the EIS are expected to fall within 0.4 minutes of the established absolute retention times. Comparison of the target (native) analyte and EIS retention times can help determine if analyte shifts occurred due to matrix effects.

7. **ICV (2nd source)** – It is expected that the ICV is performed with each new initial calibration before sample analysis. The ICV is analyzed after the ICB. As of December 2019, the following PFAS may be difficult to find as second sources and are therefore not currently necessary: PFHxDA, PFODA, PFDoS, NMeFOSA, NEtFOSA, NMeFOSE, and NEtFOSE. Recoveries in the ICV are expected to be within 70-130%. It is expected that sample analysis is not performed if the ICV fails.

8. **ICB** – It is expected that the ICB is analyzed immediately after the highest standard in the initial calibration and before the ICV to demonstrate the instrument is free from levels of contaminants that would bias results. The results of the ICB are expected to be less than one-half the MRL.

9. **CCV** – It is expected that CCVs are performed at the beginning and end of each analysis batch and after every 10 field samples.

    a. It is expected that the concentrations in the first CCV on non-initial calibration days are at the MRL.
    b. Target (native) analyte recoveries are expected to be within 50-150% for the CCV analyzed at the MRL.
    c. Target (native) analyte recoveries for all other CCVs are expected to be within 70-130%.
    d. It is expected that samples results are only reported when bracketed by passing CCVs unless the recovery failure is high and there are no detections of that analyte in the associated samples.

10. **CCB** – It is expected that the CCB is analyzed immediately after each CCV to demonstrate the instrument is free from levels of contaminants that would bias results. If method blanks or reagent blanks are analyzed after a CCV instead of a CCB, then it is expected that the CCB limits are used for assessment. The results of the CCBs are expected to be less than one-half the MRL.

11. It is expected that the same EIS as those used in samples are added to the initial calibration standards, ICV, CCVs, ICBs, and CCBs at the same concentration used in samples. The calibration standards (initial and continuing) are not extracted like samples. Since there is no matrix effect or extraction performed on these instrument quality control samples, the recoveries of the EIS are expected to be within 50 – 150%.

VI. Aqueous Sample Extraction

1. Extract the entire sample received in the sample container in which it was collected unless the exceptions listed below apply.

    a. Samples received at extremely high PFAS concentrations may be subsampled. {F}
    b. If more sample volume is received than what can be extracted through the solid phase extraction (SPE) cartridge, then subsampling is allowed. {F}

    Adsorption of target (native) analytes to sample collection container walls is known to occur in aqueous samples. Extract the entire aqueous sample volume. Subsampling of aqueous samples from the sample collection container is discouraged and can result in significant loss of longer-chain PFAS (e.g. carboxylic acids ≥ C9, sulfonic acids ≥ C7).

2. Spike the sample in the sample bottle it was received in by adding the EIS. Cap, invert and mix. It is expected that the EIS that are spiked into the sample are provided sufficient time to equilibrate in the sample before further processing. This allows the EIS time to disperse proportionally into the liquid phase and solid phase – same as the target (native) analytes and thereby providing a more accurate result. Add the EIS before any extraction, centrifuging, filtering or phase separation takes place.

    Biphasic and problematic sample matrices may have to use a different spiking procedure. It is best for the laboratory to contact the client prior to spiking and extraction to determine the best course of action to meet their data quality objectives. In these events, include detail in the narrative as to why spiking into the sample bottle was not possible, what was done instead, and if known, the possible effects on the sample results. {F}

3. If particulates in the sample have to be removed before using SPE, centrifuge the sample and take the liquid phase through the SPE. Samples should only be centrifuged when the suspended solids content visually appears to be high enough, by chemist inspection, that it would cause the SPE cartridge to clog.

   The laboratory could consider creating a "percent solids reference sample" that would include the minimum solids the laboratory has tested that would clog the SPE cartridge and use it to compare it to field samples. For reference, the Department of Defense has indicated that samples with percent solids greater than one percent may require centrifuging before performing the SPE procedure. Ideally, the entire sample is extracted, including the suspended solids.

4. If aqueous samples with a solid phase are centrifuged, the solid phase of the sample is expected to be a plug at the bottom of the container. It is expected that the solid phase remains in the container when rinsing the container walls with the polar elution solvent. Rinsing the container walls would therefore also include rinsing of the solids. If the polar elution solvent disrupts the solid phase significantly, the container can be centrifuged again before removing the solvent for use during the elution step of the SPE procedure.

5. If a total sample concentration is needed and there are significant solids in the sample, the initial spike of EIS into the sample container is sufficient for both phases. There is no need to re-spike the solid phase with EIS if it is being extracted separately.

6. Using filters to separate the solid phase from the liquid phase is discouraged unless there is data to demonstrate that the filters used do not result in contamination greater than one-half the MRL.

7. In the cases where a filter is used to separate the solid phase from the liquid phase, it is expected that the filter would also be rinsed to remove any potentially adsorbed PFAS. The filtrate is then added to the SPE cartridge during the elution step.

8. The data quality objectives from the data user should determine whether the solid phase of the sample has to be extracted or not. Not analyzing the solid phase may lead to a low bias in total sample concentration. Analyzing the liquid phase only would provide a liquid sample concentration result. It is expected that the laboratory would make it clear to the data user whether the reported concentrations are a total or liquid concentration sample result.

9. Determine sample volume by marking the sample level on the bottle or by weighing. It is expected that sample volumes would not be measured with a graduated cylinder. Sample volumes are expected to be measured and not assumed by container size.

   When the sample has significant solids, the laboratory should account for the weight or volume displaced by the solids in the initial sample volume determination and include this information in the test report.

10. Use an appropriate SPE cartridge for the target (native) analytes reported. A weak anion exchange cartridge has been shown to work with the PFAS for which Wisconsin is offering certification.

11. One or more rinses of polar solvent can be used for quantitative transfers. Rinse the sample bottle and cap with elution solvent, pour the solvent from each rinse through the SPE cartridge during the elution step, and collect the filtrate for analysis.

12. Bring to a quantitative final volume with the final injection solvent and vortex well.

VII. Non-Aqueous Sample Extraction

1. Homogenize the entire solid sample received in the sample container in which it was collected in by stirring the solids with a clean spatula or other suitable implement. This would help ensure that a representative subsample is taken.

2. For tissues (e.g. fish, wildlife), the target tissue (liver, fillet, whole fish) is isolated from the rest of the tissue sample. The target (isolated) tissue is ground and is typically provided to the analyst as a subsample. At the time of sample preparation, the analyst is to further homogenize the subsample by stirring with a clean spatula or other suitable implement. This would help ensure that a representative subsample is taken.

3. Spike a portion of the homogenized subsample by adding the EIS directly onto the sample. It is expected that the solvent used to carry the EIS spike onto the sample be allowed to evaporate prior to addition of the extraction solution.

4. Extract the PFAS from the non-aqueous samples with an appropriate solution prior to clean-up.

5. Use an appropriate clean-up cartridge (i.e. ENVI-Carb, W-AX, …) to remove the organic analytes extracted from the soil matrix. More than one type of clean-up cartridge can be used.

6. Use a clean-up cartridge on the fish tissue extract to eliminate known interferences with PFOS (e.g. bile acids such as taurodeoxycholic acid (TDCA)).

7. Ensure that all transfers are quantitative by solvent-rinsing with the elution solvent.

8. Bring to a quantitative final volume with the final injection solvent and vortex thoroughly.

VIII. Sample Analysis

1. Use an LC/MS/MS that is capable of negative ion ESI, produces unique product ions within retention time windows, and is able to provide a minimum of 10 scans across each peak.

2. Perform mass calibration such that the range of masses associated with all precursor and product ions are bracketed for both the primary and confirmation transitions. Documentation is expected to be available to demonstrate that the mass calibration covers this range. Calibrate the mass scale using the calibration analytes and procedure from the instrument manufacturer.

3. Analyte identification is performed using retention times, Signal/Noise ratio, Quantitation Parent Ion to Quantitation Daughter Ion (Quantitation Ion Transition), Confirmation Parent Ion to Confirmation Daughter Ion (Confirmation Ion Transition) and the Ion Transition Ratio.

4. Calculate sample results for the target (native) analytes that have exact isotopically labeled standards using isotope dilution (recovery correction using the EIS).

5. Calculate sample results for the target (native) analytes that do not have exact isotopically labeled standards using an alternate extracted isotopically labeled standard and internal standard quantitation recovery correction (recovery correction using the alternate EIS).

6. Use analytical (quantitative) standards containing both branched and linear isomers where commercially available. The analytical branched isomer standards are included in the initial calibration the same as the linear isomer

standards. Branched isomers in samples are quantitated against these analytical branched isomer standards. To calculate the target (native) analyte result, sum the resulting concentrations of all branched and linear isomers that have corresponding analytical standards.

7. Where analytical standards are not available for the branched isomers, use qualitative (technical grade) standards to identify the branched isomer using retention times, transitions, and ion transition ratios. Quantitate target (native) analytes that use qualitative branched isomer standards by integrating the branched and linear isomer peaks and sum the peak areas to get a total area. Calculate the target (native) analyte concentration using the linear isomer.

   Do not include branched isomer peaks in the initial calibration when qualitative standards are used, and do not use calibration functions from the qualitative branched isomer standards to quantitate branch isomer concentrations.

8. It is expected that the target (native) analytes that have exact labeled analogs would elute within 0.1 min of their analogs. {F}

9. Have a written policy on how retention time windows are established.

10. It is expected that the method reporting limit (MRL) concentration would not be below the lowest standard concentration in the initial calibration.

11. The MDL is expected to be less than the MRL.

12. Report sample results and all quality control blank results to the MDL and include the MRL with each result. Qualify results reported between the MDL and MRL as estimated concentrations.

    Example 1: MDL = 0.6, MRL = 2, sample result = 0.4. Report as:

Result	MDL	MRL
<0.6	0.6	2.0

    Example 2: MDL = 0.6, MRL = 2, sample result = 0.8. Report as:

Result	MDL	MRL
0.8 J	0.6	2.0

13. The MDL for PFOS and PFOA in non-potable waters are each expected to be no higher than 2 ng/L.

14. It is expected that high density polyethylene or polypropylene autosampler vials are single injection use only unless they are immediately recapped.

15. It is expected that all sample results are reported from a response that is no higher than the highest response in the initial calibration, except for samples that saturate the instrument. If supplemental EIS is needed to quantitate dilutions, qualify the results that used the supplemental EIS (in this case, true isotope dilution was not achieved).

16. It is expected that sample results that saturate the instrument are reported with “E” flags. {F}

17. For target (native) analytes, the Signal to Noise (S/N) ratio is expected to be greater than or equal to 3:1 for quantitation ions and confirmation ions. If the S/N is not achieved, it is expected that the peak would not be used in any way and the analyte would be reported as “not detected.”

18. All analytes that have two transitions are expected to include two transitions ions in the analysis (precursor ion to quantitation ion and precursor ion to confirmation ion). Use the confirmation ion for positive analyte identification. The department has provided a list of target (native) analytes and confirmation ions in section **XII**, "**Wisconsin Laboratory Accreditation Program PFAS Certification Offerings with Ions,"** of this document.

19. Assess primary and secondary ion transition ratios. It is expected that recoveries be within 50–150% of the value calculated from the midrange standard in the ICAL on ICAL days or from the beginning CCV on non-ICAL days. {F}

    The transition ratio = $\frac{\text{quantitation ion abundance}}{\text{confirmation ion abundance}}$ or $\frac{\text{confirmation ion abundance}}{\text{quantitation ion abundance}}$

    Either ratio protocol presented above can be used, but it is expected that the protocol is consistently used for all analytes.

    When the ion ratio fails, it is expected that the target (native) analytes would still be reported but qualify them as failing the ion ratio. {F} The ion transition ratio can help identify if bias is present. Ratios can be outside of limits due to interferences or the presence of branched isomers that are in the sample but not in the quantitation standards.

20. Document the primary and confirmation transitions and the ion transition ratio.

21. It is expected that the following transitions are used for quantitation of the following analytes [precursor – product] unless a technically justified reason is used and documented:

    a. PFOA 413-369
    b. PFOS 499-80
    c. PFHxS 399-80
    d. PFBS 299-80
    e. 4:2 FTS 327-307
    f. 6:2 FTS 427-407
    g. 8:2 FTS 527-507
    h. NEtFOSAA 584-419
    i. NMeFOSAA 570-419

22. The laboratory is expected to determine at what concentration the instrument has carryover at concentrations greater than one-half the MRL. The laboratory is expected to have a documented procedure to bring the instrument back in control after encountering a sample with carryover. PFAS have demonstrated a delayed release in the system.

23. Report results in acid form.

24. Verify standard purity and ensure that any standards with less than 98% purity are corrected for in the calculations.

25. Mass correct salt content in all calibration standards purchased as salts.

26. Perform a moisture analysis on solid samples (on a subsample different than that used for extraction) and adjust the final concentration of solid samples for the percent moisture.

27. If only the liquid phase of a biphasic sample was extracted, report the results as liquid concentration results instead of total sample concentration results. The lab should report the weight of the solid phase not prepared in this case. This can be detailed in the narrative.

28. If the data quality objective is to obtain a total sample concentration and the sample is biphasic, then extract and analyze both phases.

29. Do not subtract quality control blank values from sample result values.

30. Integrate linear and branched isomers in the samples in the same manner as the standards.

31. Include the following elements in the laboratory SOP:

    a. The extracted internal standards used to calculate the result of each target (native) analyte reported.
    b. The mass used for the precursor ion for each analyte.
    c. The mass used for the product quantitation ion for each analyte.
    d. The mass used for the product confirmation ion for each analyte.
    e. Instructions for conditioning and elution of the SPE cartridge.
    f. Indicate which branched isomers are calculated using the linear isomer standard.

32. PFOA and PFOS WP PT samples are necessary for aqueous (non-potable water) certification of PFOA and PFOS. To obtain the 36-analyte group for aqueous (non-potable water) or non-aqueous from Wisconsin, analyze a PT with a minimum of 6 PFAS that include PFOA and PFOS. It is expected that 80% of the spiked analytes pass.

33. Requirements in NR 149 still apply to this analysis unless otherwise specified in this document.

AS NEW INFORMATION IS PROVIDED BY THE EPA, THIS DOCUMENT WILL BE UPDATED.

IX. Other Considerations

1. Screen a separate aliquot of sample received prior to preparation of a quantitative analysis.
2. Prior to any quantitative analysis, at least one, if not multiple instrument blanks should be analyzed to assess the system for potential contamination. These instrument blanks should include EIS to enable quantitation of the contamination.
3. Evaluate all containers, water, reagents, solvents, materials, SPE cartridges, and equipment as sources of contamination. The lab should be able to demonstrate that these items are not introducing unacceptable positive or negative bias.
4. Supplies should be tested on a lot-by-lot basis.
5. Avoid contact with glassware.
6. Avoid any Teflon including Teflon lined caps.
7. Flush water purification system with 3 liters of reagent water before using.
8. Use LC PEEK tubing and stainless-steel frits.
9. Use polypropylene transfer lines.
10. Replace mobile phase after 48 hours of preparation.
11. Store standards in the containers they were received in and at the storage conditions recommended by the manufacturer.
12. Store solid PFSA standards in a desiccator as they can hydrate over time.
13. PFCA standards in methanol solution may undergo esterification to methyl esters. Ideally, purchase PFCA standard solutions in methanol that contain four mole equivalents of NaOH. Use basic methanol (0.3% NH_4OH v/v in methanol) rather than straight methanol for all standard dilutions to avoid this potential problem.
14. PFSA standards that are ^{18}O-labelled may exchange with water and therefore reducing purity.
15. To establish retention times, analyze individual standards of each analyte. Analyze a mixed standard of all analytes to confirm their separation and identification.
16. Validate each individual standard and labeled standard by analysis to confirm its identity and the absence of significant impurities.
17. Certified standards have been known to vary by as much as 20% between vendors. The laboratory should be able to demonstrate that the standards being used are of known and defensible quality.
18. Some certified standards are less than 90% pure and often contain impurities that are other PFAS being analyzed.
19. EIS should be 96% or greater purity. When the impurity consists of an unlabeled analyte, the EIS can result in a background artifact that is present in every sample, standard, and blank if the EIS is spiked at excessive concentrations.
20. Different certified standards can have different isomer content.
21. Calibration standards are solvent based only. Matrix matched calibration standards (such as those that include sand or fish tissue) should not be used for isotope dilution methods.
22. If the site where samples are being collected is considered a “newer” spill and source apportionment is one of the data quality objectives, ship the samples with dry ice. PFAS transformation can occur if the samples are not frozen.
23. Although matrix spikes and matrix spike duplicates (MS/MSDs) are not necessary, analyzing them would help with assessing measurement bias for those target (native) analytes that do not have exact labeled isotope analogs.
24. Solid samples should not be air dried unless required by a QAPP.
25. Perform solid and fish tissue PT samples.

X. Definitions

Confirmation Ion - one of the fragment ions (product ions) used to help qualitatively confirm presence of the analyte. The product ion chosen is typically one of the remaining ions with high sensitivity and minimum interferences, after the quantitation ion has been chosen. Not all precursor ions provide confirmation ions.

Extraction batch – a set of one to 20 environmental samples of the same certification matrix with a maximum time of 24 hours between the start of processing of the first and last samples in the batch.

Extracted Internal Standards (EIS) - isotopically labeled internal standards that undergo the same extraction and analysis as the other analytes in the sample. The EIS are added to the sample at the very beginning of the procedure before extraction, centrifugation, filtering, or phase separation. Ideally, these are exact isotopically labeled analogs of the target (native) analyte so that identical behavior can be assumed. The recoveries of these standards are used to adjust the target (native) analyte results.

Internal Standard Dilution Quantitation - measurement of native analytes using an alternate analog (surrogate) isotope (one that has the same chemical behavior and is close in retention time to the native analyte) thus providing a close approximation of matrix effects and losses that can occur during the preparatory and analytical procedures. The native analyte concentration is adjusted for the recovery of the alternate analog isotope. An alternate analog isotope is typically used when an exact analog isotope is not available.

Method Detection Limit (MDL) – the minimum measured concentration of a substance that is reported with 99% confidence that the measured concentration is distinguishable from method blank results. The MDL is generated according to the procedure specified in the latest revision of 40 CFR Part 136, Appendix B. The MDL is expected to meet S/N ratio, ion transition ratio, and both quantitation and confirmation ions.

Method Reporting Limit (MRL) – the minimum concentration reported as a quantitative value for a method analyte in a sample following analysis. This defined concentration is expected to be no lower than the concentration of the lowest calibration standard for that analyte and is only used if the recovery in the lowest standard is within 50 – 150%.

Native Analyte - the analyte being tested in the matrix of interest. It is also the analyte for which a result would be reported. It is defined as native to distinguish it from analyte standards added during the test procedure. Native analyte is also referred to as “target analyte” or “reported analyte.”

Precursor Ion – the deprotonated molecule of the analyte. The precursor ion is mass selected and fragmented to produce distinctive product ions of smaller m/z.

Product Ion – one of the fragment ions produced from the precursor ion.

Quantitation Ion – one of the fragment ions (product ions) used to quantitate analyte concentrations. The product ion chosen is typically one of high sensitivity and minimum interferences.

True Isotope Dilution Quantitation – measurement of native analytes using an exact analog (surrogate) isotope of the native analyte thus eliminating differences in chemical behavior. The native analyte concentration is adjusted for the recovery of the exact analog isotope that has been included in the preparatory and analytical procedures.

XI. Wisconsin Laboratory Accreditation Program PFAS Certification Offerings – 5.1.19

#	Acronym	Name	CAS #	# carbons	Acronyms (other)
Carboxylic Acids					
1	PFBA	Perfluorobutanoic acid	375-22-4	4	
2	PFPeA	Perfluoropentanoic acid	2706-90-3	5	
3	PFHxA	Perfluorohexanoic acid	307-24-4	6	
4	PFHpA	Perfluoroheptanoic acid	375-85-9	7	
5	PFOA	Perfluorooctanoic acid	335-67-1	8	
6	PFNA	Perfluorononanoic acid	375-95-1	9	
7	PFDA	Perfluorodecanoic acid	335-76-2	10	
8	PFUnA	Perfluoroundecanoic acid	2058-94-8	11	PFUdA, PFUnDA
9	PFDoA	Perfluorododecanoic acid	307-55-1	12	PFDoDA
10	PFTriA	Perfluorotridecanoic acid	72629-94-8	13	PFTrA, PFTrDA
11	PFTeA	Perfluorotetradecanoic acid	376-06-7	14	PFTeDA
12	PFHxDA	Perfluorohexadecanoic acid	67905-19-5	16	
13	PFODA	Perfluorooctadecanoic acid	16517-11-6	18	
Sulfonic Acids					
14	PFBS	Perfluorobutanesulfonic acid	375-73-5	4	
15	PFPeS	Perfluoropentanesulfonic acid	2706-91-4	5	
16	PFHxS	Perfluorohexanesulfonic acid	355-46-4	6	
17	PFHpS	Perfluoroheptanesulfonic acid	375-92-8	7	
18	PFOS	Perfluorooctanesulfonic acid	1763-23-1	8	
19	PFNS	Perfluorononanesulfonic acid	68259-12-1	9	
20	PFDS	Perfluorodecanesulfonic acid	335-77-3	10	
21	PFDoS	Perfluorododecanesulfonic acid	79780-39-5	12	PFDoDS
22	4:2 FTSA	4:2 Fluorotelomer sulfonic acid	757124-72-4	6	
23	6:2 FTSA	6:2 Fluorotelomer sulfonic acid	27619-97-2	8	
24	8:2 FTSA	8:2 Fluorotelomer sulfonic acid	39108-34-4	10	
25	10:2 FTSA	10:2 Fluorotelomer sulfonic acid	120226-60-0	12	
Sulfonamides, Sulfomidoacetic acids, Sulfonamidoethanols					
26	FOSA	Perfluorooctane sulfonamide	754-91-6	8	PFOSA
27	NMeFOSA	N-Methyl perfluorooctane sulfonamide	31506-32-8	9	MeFOSA
28	NEtFOSA	N-Ethyl perfluorooctane sulfonamide	4151-50-2	10	EtFOSA
29	NMeFOSAA	N-Methyl perfluorooctane sulfonamidoacetic acid	2355-31-9	11	MeFOSAA
30	NEtFOSAA	N-Ethyl perfluorooctane sulfonamidoacetic acid	2991-50-6	12	EtFOSAA

31	NMeFOSE	N-Methyl perfluorooctane sulfonamidoethanol	24448-09-7	11	MeFOSE
32	NEtFOSE	N-Ethyl perfluorooctane sulfonamidoethanol	1691-99-2	12	EtFOSE
Replacement Chemicals					
33	HFPO-DA	Hexafluoropropylene oxide dimer acid [1]	13252-13-6	6	PFPrOPrA
34	DONA	4,8-Dioxa-3H-perfluorononanoic acid [2]	919005-14-4	7	
35	9Cl-PF3ONS	9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid [3]	756426-58-1	8	F-53B Major
36	11Cl-PF3OUdS	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid [4]	763051-92-9	10	F-53B Minor

	1 - Also referred to as "GenX"
	2 - Also available as the ammonium salt = ADONA (Ammonium 4,8-dioxa-3H-perfluorononanoate) # 958445-44-8
	3 - Also available as the potassium salt = Potassium, 9-chlorohexadecafluoro-3-oxanone-1-sulfonate # 73606-19-6
	4 - Also available as the potassium salt = Potassium, 11-chloroeicosafluoro-3-oxaundecane-1-sulfonate # 83329-89-9

XII. Wisconsin Laboratory Accreditation Program PFAS Certification Offerings with Ions – 10.27.19

The masses presented are expected to be used, although if other masses are used for the precursor or product ions, the reason is expected to be documented (such as interferences). If the confirmation ion is weak (S/N < 3), it does not have to be used but instrument optimization can increase the S/N.

#	Acronym	Name	CAS #	Precursor Ion Mass	Primary Product Ion Mass	Suggested Confirmation Product Ion Mass
Carboxylic Acids						
1	PFBA	Perfluorobutanoic acid	375-22-4	**213**	**169**	**None**
2	PFPeA	Perfluoropentanoic acid	2706-90-3	**263**	**219**	**69, None**
3	PFHxA	Perfluorohexanoic acid	307-24-4	**313**	**269**	**119**
4	PFHpA	Perfluoroheptanoic acid	375-85-9	**363**	**319**	**169**
5	PFOA	Perfluorooctanoic acid	335-67-1	**413**	**369**	**169**
6	PFNA	Perfluorononanoic acid	375-95-1	**463**	**419**	**219**
7	PFDA	Perfluorodecanoic acid	335-76-2	**513**	**469**	**219**
8	PFUnA	Perfluoroundecanoic acid	2058-94-8	**563**	**519**	**269**
9	PFDoA	Perfluorododecanoic acid	307-55-1	**613**	**569, 319**	**569, 369, 319, 269, 169**
10	PFTriA	Perfluorotridecanoic acid	72629-94-8	**663**	**619**	**369, 319, 269, 169**
11	PFTeA	Perfluorotetradecanoic acid	376-06-7	**713**	**669**	**369, 319, 269, 169**
12	PFHxDA	Perfluorohexadecanoic acid	67905-19-5	**813**	**769**	**369, 319, 269, 219, 169**
13	PFODA	Perfluorooctadecanoic acid	16517-11-6	**913**	**869**	**369, 319, 269, 219, 169**
Sulfonic Acids						
14	PFBS	Perfluorobutanesulfonic acid	375-73-5	**299**	**80**	**99**
15	PFPeS	Perfluoropentanesulfonic acid	2706-91-4	**349**	**80**	**99**
16	PFHxS	Perfluorohexanesulfonic acid	355-46-4	**399**	**80**	**99**
17	PFHpS	Perfluoroheptanesulfonic acid	375-92-8	**449**	**99, 80**	**99, 80**
18	PFOS	Perfluorooctanesulfonic acid	1763-23-1	**499**	**80**	**99**
19	PFNS	Perfluorononanesulfonic acid	68259-12-1	**549**	**80**	**99**
20	PFDS	Perfluorodecanesulfonic acid	335-77-3	**599**	**99, 80**	**99, 80**
21	PFDoS	Perfluorododecanesulfonic acid	79780-39-5	**699**	**80**	**99, 62**
22	4:2 FTSA	4:2 Fluorotelomer sulfonic acid	757124-72-4	**327**	**307**	**81, 80**
23	6:2 FTSA	6:2 Fluorotelomer sulfonic acid	27619-97-2	**427**	**407**	**81, 80**
24	8:2 FTSA	8:2 Fluorotelomer sulfonic acid	39108-34-4	**527**	**507**	**81, 80**
25	10:2 FTSA	10:2 Fluorotelomer sulfonic acid	120226-60-0	**627**	**607**	**587, 81, 80**

Sulfonamides, Sulfomidoacetic acids, Sulfonamidoethanols						
26	FOSA	Perfluorooctane sulfonamide	754-91-6	**498**	**78**	**478, 169, None**
27	NMeFOSA	N-Methyl perfluorooctane sulfonamide	31506-32-8	**512**	**169**	**219**
28	NEtFOSA	N-Ethyl perfluorooctane sulfonamide	4151-50-2	**526**	**169**	**219**
29	NMeFOSAA	N-Methyl perfluorooctane sulfonamidoacetic acid	2355-31-9	**570**	**419**	**512, 483**
30	NEtFOSAA	N-Ethyl perfluorooctane sulfonamidoacetic acid	2991-50-6	**584**	**419**	**526, 483**
31	NMeFOSE	N-Methyl perfluorooctane sulfonamidoethanol	24448-09-7	**616**	**59**	**122, None**
32	NEtFOSE	N-Ethyl perfluorooctane sulfonamidoethanol	1691-99-2	**630**	**59**	**136, None**
Replacement Chemicals						
33	HFPO-DA	Hexafluoropropylene oxide dimer acid	13252-13-6	**329**	**285, 169**	**285, 169, None**
34	DONA	4,8-Dioxa-3H-perfluorononanoic acid	919005-14-4	**377**	**251**	**85, None**
35	9Cl-PF3ONS	9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	756426-58-1	**531**	**351**	**83, None**
36	11Cl-PF3OUdS	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	763051-92-9	**631**	**451**	**99, None**

NOTE: ISO 21675, SW 8327, and Wellington Laboratories provide precursor, product and confirmation ions for many of the extracted internal standards

Mass Source
EPA 537.1
DoD QSM 5.3
Janice Willey
EPA-821-R-11-007, PFAS in Sludge/Biosolids
ISO 21675
SW 8327
Wellington Laboratories
Confirmation mass have multiple sources