3M Environment, Health
Safety and Product Stewardship

3M Center 225-1N-22
St. Paul, MN 55144-1000

January 20, 2023

Mr. Jayson Schrank
Regional Spills Coordinator/Hydrogeologist
Remediation & Redevelopment Program
Wisconsin Department of Natural Resources
890 Spruce Street
Baldwin, Wisconsin 54002

RE: Submittal of Work Plan for Soil and Groundwater Investigation, 3M Company, Menomonie, Wisconsin, DNR BRRTS Activity # 02-17-590808 and DNR FID #617056660

Mr. Schrank:

Attached is the document entitled "Work Plan for Soil and Groundwater Investigation, 3M Company, Menomonie, Wisconsin" for the project located at 3M Menomonie, 1425 Stokke Parkway, Menomonie, Wisconsin. This Work Plan has been prepared in accordance with NR 716.07 and NR716.09, Wisc. Admin. Code in response to the Responsible Party letter received from the Wisconsin Department of Natural Resources (WDNR) on October 25, 2022 and our subsequent discussions, including our exchange of messages on December 19 and December 20, 2022 that extended the Work Plan submittal deadline to January 31, 2023.

3M respectfully requests the WDNR's formal review and written response to this Work Plan. The required review fee of $700 in accordance with NR 729, Wisc. Admin. Code is being sent to Ms. Hayley Schnae, the assigned Environmental Program Associate in Eau Claire, Wisconsin.

The Work Plan is also being uploaded to the WDNR Remediation and Redevelopment submittal portal by 3M's environmental consultant Tetra Tech, Inc. (Tetra Tech). Please contact me via email at bchambers2@mmm.com should you have any questions or concerns. 3M looks forward to receipt of your comments.

Sincerely,

Britta Chambers
Advanced Environmental Scientist
3M Corporate Environment

Enclosure

CC: Kristen Colberg, 3M Corporate Environment
LiJane Brunner, 3M Menomonie
Eric Carman, Tetra Tech

Work Plan for Soil and Groundwater Investigation
3M Company
Menomonie, Wisconsin

PREPARED FOR

3M Corporate EHS & Product Stewardship
3M Center, 225-1N-22
St. Paul, MN 55144

PRESENTED BY

Tetra Tech, Inc.
2001 Killebrew Drive, Suite 141
Bloomington, MN 55425

January 20, 2023

CERTIFICATION

Hydrogeologist:

I hereby certify that I am a hydrogeologist as that term is defined in s. NR712.03(1), 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. NR700 to 726, Wis. Adm. Code.

Mark A. Manthey, P.G.
Associate Hydrogeologist

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LIST OF ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
3M	3M Company
AFFF	Aqueous Film Forming Foam
bls	below land surface
BRTTS	Bureau for Remediation and Development Tracking System
ft	feet
IDW	Investigation Derived Wastes
NAVD88	North American Vertical Datum
Pace	PACE Analytical Services, LLC
PAHs	polynuclear aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PFAS	per- and polyfluoroalkyl substances
PID	photoionization detector
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
SIR	Site Investigation Report
Site	3M Menomonie, 1425 Stokke Parkway, Menomonie, Wisconsin
Tetra Tech	Tetra Tech, Inc.
µg/kg	micrograms per kilogram
VOCs	volatile organic compounds
WDNR	Wisconsin Department of Natural Resources
Wisc. Admin. Code	Wisconsin Administrative Code

1.0 INTRODUCTION

Tetra Tech, Inc. (Tetra Tech) has prepared this Work Plan on behalf of 3M Company (3M) to conduct a soil and groundwater investigation (Investigation) on the 3M Menomonie facility (Site) located at 1425 Stokke Parkway in Menomonie, Wisconsin. The location of the Site is presented in **Figure 1.**

This Work Plan has been prepared in accordance with Sections NR716.07 and NR716.09 Wisconsin Administrative Code (Wisc. Admin. Code, Modified February 1997)) and in response to a letter from the Wisconsin Department of Natural Resources (WDNR), dated October 25, 2022, for site activities associated with Bureau for Remediation and Development Tracking System (BRTTS) #02-17-590808. The Site is owned by 3M and Tetra Tech was retained by 3M as the environmental consultant to perform activities described in this Work Plan.

The objective of the activities described in this Work Plan are to determine if releases that have occurred at the Site may have impacted soil and groundwater, potential migration pathways, and to determine if impacts may have migrated off the Site in accordance with NR 716.07 and NR716.09, Wisc. Admin. Code.

This work plan includes the following sections:

- Introduction
- Site Background
- Site History and Releases
- Scope of Work
- Data Assessment and Reporting
- Anticipated Project Schedule
- Project References
- Standard Operating Procedures for Field Activities and Sample Collection

1.1 SITE LOCATION

The Site is located in Dunn County, in the southeast quarter (SE 1/4), Section 18 (S18) of Township 28 north (T28N) Range 12 west (12W). The Site is generally located south of I-94 and includes the primary facility and surrounding fields. The Wisconsin Transverse Mercator of 1991 coordinates are X coordinate 371,175.1 and Y coordinate 493827.0 corresponding to Latitude 44.9021 and Longitude -91.88505.

The Site is comprised of 11 individual Dunn County parcels. The identification numbers are listed below: 1725122812183100003, 1725122812184200007, 1725122812184200007, 1725122812184100004, 1725122812183400001, 1725122812184300002, 1725122812192100001, 1725122812191200001, 1725122812191200002, 1725122812192400001, and 1725122812191300001 (Dunn County, WI).

1.2 SITE LAYOUT

The Site is currently comprised of approximately 254 acres improved with three outbuildings, and 13 interconnected buildings that have an approximate footprint of 750,000 square feet. A small stormwater retention pond is located on the west side of the Site and a large stormwater retention pond is located on the northwest side of the Site. Stormwater is conveyed to these ponds through a series of underground piping and aboveground swales. Both retention ponds serve as infiltration basins and currently there are no stormwater discharges from the Site. The remainder of the Site consists of asphalt paved parking lots, gravel driving lanes, and landscaped areas. The Site details are presented in **Figure 2**.

2.0 SITE BACKGROUND

The Site has served as a research and product development facility for 3M since it was originally constructed in 1974. The Site houses 19 different 3M divisions related to film, tape, coatings, optical, and personal care related to product manufacturing. Prior to 1974, the Site and surrounding property were used for agricultural purposes.

2.1 TOPOGRAPHY AND DRAINAGE

The developed portion of the Site is generally flat at an elevation of approximately 890 feet (ft) above North American Vertical Datum of 1988 (NAVD88) according to the United States Geological Survey 2018 topographic map. However, topography on the west side of the Site slopes steeply to the west, toward an unnamed tributary to Lake Menomin that is at an elevation of approximately 820 ft NAVD88.

Surface water flow across the Site is west, toward the unnamed tributary to Lake Menomin. Lake Menomin is a reservoir on the Red Cedar River located on the southwest portion of Lake Menomin. The previous stormwater management system was replaced between 1992 and 2005 with the current man-made stormwater retention ponds in the west and northwest portion of the Site.

2.2 GEOLOGY

The underlying geologic materials at the Site consist of fine sand, sandy loam and sand. Shallow hand auger borings completed by Tetra Tech at the Site during April 2022 detected sand at approximately 6 inches below land surface (bls) to the termination of the hand auger borings at 2 ft bls. In May 2021, American Engineering Testing (AET) completed nine soil borings to depths ranging from approximately 23 ft bls to 30 ft bls (AET, 2021). Those borings were completed for geotechnical characterization prior to construction at several areas across the facility. The subsurface boring logs indicate clayey sand to fine sand and fill to depths of approximately seven ft bls and fine to medium grained sand to the base of the borings. Groundwater was not encountered in the upper 30 ft. The depth to bedrock in the vicinity of the Site is approximately 100 to 200 ft bls and is classified as a fine-grained sandstone of the Cambrian-age Eau Claire formation (Brown, 1988).

2.3 HYDROGEOLOGY

Groundwater flow is believed to be generally east to west, mirroring the site topography, although there have been no hydrogeologic investigations completed at the Site to date. Based on a review of water well logs in the vicinity of the Site, depth to groundwater ranges from 25 ft bls to 90 ft bls. The nearest well was constructed in 1975 to a depth of 98 ft bls and groundwater was reported at 50 ft bls (WDNR, 2022a).

Based on the site topography and surface water elevations, it is anticipated that groundwater near the eastern portion of the Site will be approximately 50 to 80 ft bls. It is expected that the groundwater table will be shallower near the western portion of the Site before the land surface slopes toward the unnamed tributary of Lake Menomin. The water table will be coincident with the water surface at the unnamed tributary.

2.4 POTENTIAL MIGRATION PATHWAYS

Primary migration pathways may include but are not limited to surface drainage, infiltration, sewer conveyance, shallow groundwater flow, and aerial deposition. Historical releases and wastewater could have migrated from the facility through shallow floor drains, sink drains, underground sumps, tanks, sewer lines, the stormwater detention pond, and accidental surface spills. The Site is connected to the City of Menomonie Water Department water supply and no other sources of water are used at the Site.

3.0 SITE HISTORY AND RELEASES

The Site was part of a larger tract of land developed for agricultural use from at least 1938 to 1974. The Site was acquired by 3M in 1974 and was redeveloped with the original portion of the manufacturing building, which consisted of office space, process areas, a maintenance area, and a utility room. Multiple additions were constructed between 1974 and 2017, bringing the total manufacturing building footprint into its current configuration, with additional process areas, warehouse space and cooler/chiller rooms.

From approximately 1974 to at least 1992, a wetland and the unnamed tributary on the west side of the Site was the discharge point of the former Site stormwater drainage system. Between 1992 and 2005, the two stormwater retention ponds were constructed on-site. Operations by 3M since 2005 have remained consistent with the current operations.

Based on review of property development and facility operations, areas that have been identified for further investigation include:

- Fill Material and Berms
- Stormwater Discharge Areas
- Historical Fire Extinguisher Training Area
- Aqueous Film Forming Foam (AFFF) Fire Suppression Systems
- November 2021 Sprinkler Water Release
- May 2022 Fire Line Release
- Hydraulically-upgradient (east) of the facility
- Upwind (northwest) of the facility

Descriptions of documented releases at the Site are included in the following sections.

3.1 NOVEMBER 2021 RELEASE

On November 3, 2021, during routine maintenance of the fire suppression system in Building 3, fire suppression water was released from an outdoor sprinkler system valve. Foam was observed in the water and the discharge was immediately ceased. It was determined that an estimated 100 gallons to 400 gallons of water containing AFFF was discharged onto a concrete pad and grass adjacent to the building. The WDNR was notified of the release and a response action was immediately initiated by 3M. On November 8, 2021, 3M's contractor, Bay West, removed the concrete pad and excavated a total of 7.5 cubic yards of grass and soil in a 17 ft semi-circle around the release point to a maximum depth of 14 inches. Four samples were collected at the base of the excavation which confirmed the presence of per- and polyfluoroalkyl substances (PFAS). Additional investigations will be completed in this area to include further defining the extent and depth of impacts from the release. The incident and response work performed by Bay West is summarized in an incident report dated May 2022 that is presented in **Appendix A** (Bay West, 2022). The release, response activities and results for the additional investigations will be further described in the Site Investigation Report (SIR).

3.2 MAY 2022 RELEASE

On May 16, 2022, 3M's contractor, McCabe, was in the process of capping and removing a fire suppression line in preparation for a building expansion project at Building 11. A release of fire water from the fire suppression line occurred after the cap on the pipe failed. An estimated 700-800 gallons of fire suppression water were released to the construction trench however most of the water was immediately recovered by another 3M contractor, Clean Harbors, using a vac-truck. The WDNR was notified of the release and additional response actions were initiated by 3M. Soil was excavated on May 17, 2022 and a total of approximately 125 cubic yards of soil were removed. Tetra Tech collected a total of 14 confirmatory samples, including 13 samples at or below the base of the excavation and one sidewall sample. The depth of the excavation ranged from 10 ft to 17 ft. Samples were submitted for laboratory analysis of PFAS; Concentrations of perfluorooctane sulfonic acid ranged from 1.8 micrograms per kilogram (µg/kg) to 98 µg/kg and Perfluorohexane sulfonic acid concentrations ranged from 1.1 to 5.9 µg/kg. Additional investigations will be completed in this area and a summary of the release and response activities will be described in the SIR.

3.3 HISTORCAL SOIL STOCKPILE

A soil stockpile is located on the northeast corner of the Site that contains soil and fill from various facility operations. According to historical aerial photographs the fill material has been present since at least 2005 and has changed dimensions and orientation as the facility has gone through modifications.

Composite soil samples were collected from the upper 3 ft of the surface of the stockpile during 2022 and were analyzed for PFAS. Concentrations of perfluorooctane sulfonic acid, perfluorobutanoic acid, perfluorooctanoic acid and perfluorohexanesulfonic acid were detected in composite samples collected from the stockpile.

The results from the sampling were communicated by 3M to WDNR on October 21, 2022. WDNR subsequently issued a Responsible Party letter to 3M on October 25, 2022 notifying 3M that WDNR had created a BRTTS Activity related to the communication. That letter requested that 3M initiate investigation activities included in this work plan (WDNR, 2022b). Additional sampling will be completed at the historical soil stockpile and will be described in the SIR.

4.0 SCOPE OF WORK

The objective of the activities described in this scope of work are to determine if releases that have occurred at the Site may have impacted soil and groundwater, potential migration pathways and to determine if impacts may have migrated off the Site in accordance with NR 716.07 and NR716.09, Wisc. Admin. Code.

This scope of work includes:

- Preparing a site-specific health and safety plan and job safety analyses for the field activities that will be implemented under this work plan.
- Clearing utilities prior to conducting field activities.
- Completing shallow hand auger borings to depths of approximately 2 ft bls.
- Completing deeper soil borings to depths of 10 ft bls or deeper.
- Collecting soil samples for field screening and laboratory analysis.
- Installing groundwater monitoring wells.
- Collecting groundwater samples for laboratory analysis.
- Collecting quality control samples.
- Handling of investigation derived waste (IDW).

Details regarding the field investigation, rationale, field, and laboratory methods are presented in the following sections.

4.1 SAMPLING METHODOLOGY AND RATIONALE

Sampling will be conducted within the areas identified as having the potential to have impacted media or areas of known releases. The areas recommended for sampling, a description of each area, recommended analytes for soil and groundwater sampling, estimated sample totals and depths, and rationale are presented in **Table 1**. The recommend sampling locations are presented in **Figure 3**.

The analytical methods, anticipated number of soil and groundwater samples per area is presented on **Table 2** and a list of analytes and method detection limits for soil and groundwater are included in **Appendix B**. The specific activities are described in the following sections and Tetra Tech standard operating procedures (SOPs) for sample collection (including PFAS) and other field methods are presented in **Appendix C**.

4.2 UTILITY CLEARANCE

Prior to mobilization of equipment to the Site, the Wisconsin one-call (Diggers Hotline) number will be called to locate subsurface utilities at the site. Tetra Tech personnel will coordinate with Diggers Hotline and 3M will locate privately held utilities in the areas of the proposed soil borings and monitoring wells.

Drilling and sampling locations may be adjusted in the field depending on the results of the utility clearance.

4.3 HAND AUGER BORINGS AND SOIL SAMPLING

Soil borings will be installed using hand augers, direct push and hollow stem auger techniques, depending on desired depths of sampling. Shallow hand auger borings will be completed to a maximum depth of 2 ft bls using a stainless-steel hand auger in accordance with ASTM International (ASTM) method D1452. Locations are shown on **Figure 3.**

Samples collected using a hand auger will be screened at the base of each boring with a photoionization detector (PID) and examined for visual or olfactory signs of impacts. Material recovered at the base of the hand auger boring will be recorded and described in the field notes.

The stainless-steel hand auger will be decontaminated between each of the sampling areas using a solution containing distilled water and Alconox detergent followed by a distilled water rinse. All wash and rinse water will be containerized, treated, and disposed of properly. Disposable gloves, paper towels and empty distilled water containers will be disposed of as a solid waste.

One grab sample will be collected from each hand auger boring for laboratory analysis. Soil samples will be transferred into clean, pre-labeled laboratory supplied containers.

Soil samples will be submitted for analysis of PFAS, volatile organic compounds (VOCs), polynuclear aromatic hydrocarbons (PAHs), and Resource Conservation and Recovery Act (RCRA) 8 metals. In addition, two soil samples collected from within a stormwater drainage area on the northwest side of the facility will be analyzed for polychlorinated biphenyls (PCBs).

Samples for PFAS analysis will be submitted to the PACE Analytical Services, LLC (Pace) laboratory in Minneapolis, Minnesota using EPA Method 537.1 by isotope dilution for the 33 PFAS analytes required by the State of Wisconsin. Remaining samples will be submitted to the Pace laboratory in Green Bay, Wisconsin. Method SW846 8260B will be used for analysis of samples for VOCs and PAHs will be analyzed using SW846 8270. RCRA 8 metals will be analyzed using SW846 6010 and 7470 for mercury. Soil samples will be analyzed for PCBs using Method SW846 8082A (**Table 2**). All samples will be shipped overnight or sent via courier to the project laboratories on wet ice. Each sample shipment will include chain-of-custody forms documenting the transfer and receipt of the samples and the analytical methods for which each sample is to be tested. The completed chain-of-custody forms will be included with the laboratory analytical reports.

4.4 SOIL BORINGS AND SOIL SAMPLING

The soil borings completed to depths of 10 ft bls or deeper will be installed using direct push techniques (ASTM D6282.D6282M-14) or hollow stem auger techniques (ASTM D6151). The locations of the soil borings are shown on **Figure 3**. Continuous soil samples will be collected from the soil borings. The soil samples collected from the soil borings installed using the direct push method will be collected at 5-foot intervals using a direct push soil sampler and PVC liners. The soil samples collected from the soil borings installed using the hollow stem auger drilling method will be collected at 2-foot intervals, in advance of the hollow stem auger drill bit, using standard split-barrel sampling techniques (ASTM Method D 1586). The soil samples will be screened for volatiles at approximately 2-ft intervals to the maximum depth of each boring with a PID. Electronic equipment, including a PID used for soil screening, will be maintained and calibrated following the manufacturers specifications. Calibration of the PID will be conducted daily at a minimum. Samples will be examined for visual or olfactory signs of contamination. Each sample will be visually classified by the Tetra Tech geologist/environmental technician directing the soil sampling activities in accordance with ASTM Method D2488 using the Unified Soil Classification System (USCS). Classification and screening information will be recorded on a soil boring log form. A copy of the soil boring log form (WDNR Form 4400-122) is included in **Appendix D**.

All non-disposable drilling and field equipment will be decontaminated between sampling locations using pressure washing, steam cleaning and /or scrubbing with Liquinox or equivalent and water. The fluid used in the decontamination will be containerized, treated, and disposed of properly.

Soil samples will be collected for laboratory analysis consistent with the methods described above. Each soil boring will be properly abandoned in accordance with the borehole abandonment procedures described in Chapter NR 141, Wisc. Admin. Code. Well and drill hole filling and sealing reports (WDNR Form 3300-005) will be completed for each soil boring and a copy of this form is presented in **Appendix D**.

4.5 INSTALLATION OF MONITORING WELLS AND GROUNDWATER SAMPLING

An anticipated seven monitoring wells will be installed following completion of the soil borings at the locations shown on **Figure 3**. Actual locations of monitoring wells may be adjusted based on the location of subsurface utilities or other access constraints.

The monitoring wells will be installed in accordance with the requirements specified in Chapter NR 141, Wisc. Admin. Code. Each monitoring well will be constructed of 2-inch diameter polyvinyl chloride well screen and casing. The length of the screened interval will be 10 ft. The monitoring well screens will be installed to intersect the top of the water table, with a targeted interval of 3 ft above the water table and 7 ft below the water table. The water table is anticipated to be encountered at a depth of between 50 and 80 ft bls. The monitoring wells will be developed in accordance with the monitoring well development procedures described in Chapter NR 141.21, Wisc. Admin. Code. The monitoring wells will be constructed with a lockable steel protective cover and provided with at least two bumper posts, if possible, based on field conditions. Forms documenting the monitoring well construction and development (WDNR Forms 4400-113A and 44000113B) will be completed for each well and copies of the forms are included in **Appendix D**.

A synoptic groundwater level measurement event will be conducted prior to pre-sample purging activities for monitoring wells.

The monitoring wells will be purged and sampled using low-flow techniques in accordance with the low-flow sampling procedures included in **Appendix C**. A portable pneumatic bladder pump and dedicated tubing will be used to purge and sample the monitoring wells. New bladders will be used to purge and sample each monitoring well. Throughout the purging process field parameters, including temperature, pH, specific conductivity, dissolved oxygen, oxidation-reduction (redox) potential, and turbidity will be measured. Readings will be recorded at set intervals (every 2 to 10 minutes). The groundwater samples submitted for laboratory analyses will be collected in laboratory-provided containers once the field parameters meet the appropriate stabilization criteria (three consecutive readings differing by less than 10 percent and +/-0.3 units for pH). Tetra Tech standard groundwater sampling logs will be completed for each monitoring well sampled, and a copy of the log is presented in **Appendix D**.

The portable pneumatic bladder pump will be decontaminated after the groundwater samples are collected from each monitoring well by rinsing the inside and outside of the pump with a solution of Liquinox (or equivalent) and distilled water followed by a double-rinse of distilled water. The pump will be dried with paper towels and allowed to air dry between samples. The fluid used in the decontamination will be containerized, treated, and disposed of properly. As noted above, dedicated tubing and new bladders will be used to purge and sample each monitoring well so these items will not require decontamination.

Groundwater samples and associated QA/QC samples will be shipped to the selected laboratories under chain-of-custody, as described above.

4.6 QUALITY CONTROL SAMPLES

QA/QC samples for the soil samples will include duplicates, field blanks, and equipment blanks at a frequency of one sample per 10 soil samples for PFAS, VOCs, PAHs, and RCRA 8 metals. Each cooler containing soil samples to be analyzed for VOCs and PFAS will include laboratory-provided trip blanks that will be submitted for analysis of VOCs and PFAS.

QA/QC samples for the groundwater samples will be collected at a frequency of one duplicate sample, one field blank, and one equipment blank per 10 samples for PFAS, VOCs, PAHs, and RCRA 8 metals. In addition, one trip blank will be analyzed for VOCs and one trip blank will be analyzed for PFAS per cooler of groundwater samples.

Field blanks will be collected by pouring laboratory-supplied PFAS-free water or distilled water directly into the laboratory supplied sample containers and equipment blanks will be collected by pouring laboratory-supplied PFAS-free water or distilled over the non-disposable field equipment (such as split-barrel sampler, auger bucket or lead auger, flow cell, or portable pneumatic bladder pump) directly into the laboratory supplied sample container. Trip blanks will use laboratory supplied containers and liquids.

4.7 INVESTIGATION DERIVED WASTES

IDW will be generated during the field investigation. These wastes will consist primarily of drilling/soil cuttings from monitoring well installation, groundwater (from monitoring well development and well purging), used bladders, used decontamination supplies (distilled water containers, paper towels, plastic sheeting), used personal protective equipment, and decontamination fluids. IDW will be segregated, containerized, and characterized by Tetra Tech. Fluids generated during the field activities will be containerized, treated, and disposed of properly. 3M will arrange for the proper disposal of soil and other non-liquid IDW.

5.0 DATA ASSESSMENT AND REPORTING

Following receipt of analytical results, Tetra Tech will review and conduct screening validation of field and laboratory data for acceptable accuracy and precision. In addition, Tetra Tech will prepare a SIR in accordance with NR 716.15, Wisc. Admin. Code following completion of the field investigation. The SIR will include, but will not be limited to the following:

- Description of project objectives;
- Narrative describing field activities and methods;
- Field documentation;
- WDNR Soil boring logs;
- WDNR Borehole abandonment forms for the soil borings;
- WDNR Monitoring well construction and development forms;
- Tetra Tech Groundwater sampling forms;
- Laboratory testing reports and tabular summary of lab data;
- Figures identifying sample locations, analytical data summary (as appropriate), and the potentiometric surface;
- Summary of investigation results including the November 2021 and April 2022 releases; and
- Conclusions and recommendations for a path forward.

6.0 SCHEDULE

Preliminary field activities have been completed per 3M's verbal communication to WDNR on November 16, 2022 and written notification on November 17, 2022 (3M, 2022). 3M undertook this approach at the Site to stay ahead of the onset of winter conditions. Preliminary activities performed on November 28 and 29, 2022 included completing hand auger borings and collecting shallow soil samples for laboratory analysis, as described in Section 4.3.

It is estimated that remaining field activities will take approximately 2 weeks to complete, and the laboratory analytical results will be received within approximately 10 weeks (depending on the laboratory turn-around time for results, notably for PFAS). Tetra Tech will prepare the summary report to WDNR on behalf of 3M within 10 weeks of receiving the analytical results.

The tentative schedule, based on review and approval of the Work Plan by WDNR is provided below:

- Submittal of Work Plan – January 2023
- Field Investigation – Initiated within 60 days of WDNR approval of Work Plan (expected March or April 2023
- Submittal of SIR – July 2023

7.0 REFERENCES

3M, November 17, 2022, Email from Britta Chambers of 3M to Jayson Schrank of WDNR, Notice of Upcoming Shallow Soil Sampling, 3M Menomonie, BRRTS #02-17-590808, 2 pages plus attachment.

Bay West, May 2022. *Spill Activation Form (ICS 201) Related to an AFFF Release on November 3, 2021*, 7 pages plus Figures, Tables and Appendices.

Brown, B.A. 1988, Bedrock Geology of Wisconsin, West-Central Sheet, Wisconsin Geological and Natural History Survey.

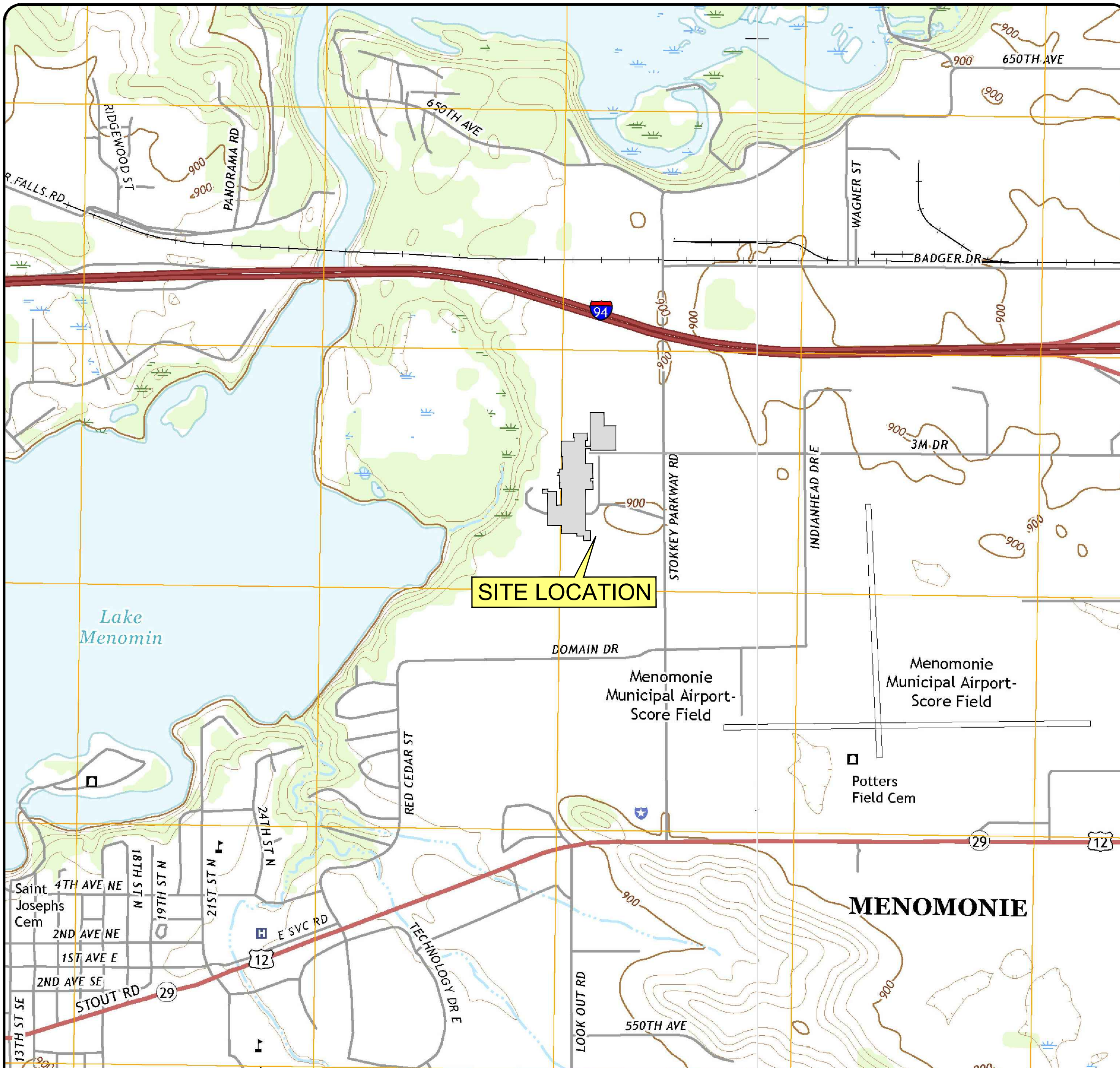
Dunn County, WI, General Map, Accessed December 2022, https://dunncowi.wgxtreme,com

Wisconsin Administrative Code, NR716.07 and NR716.09 , Modified February 1997, No. 494. Wisconsin codes established to provide uniform standards related to identification and investigation of sites and facilities that are subject to regulation under Wisconsin Statutes 289 and 292,

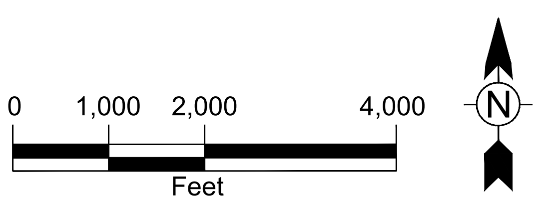
Wisconsin Department of Natural Resources (2022a), Accessed December 2022, https://dnr.wi.gov/WellConstruction Search.

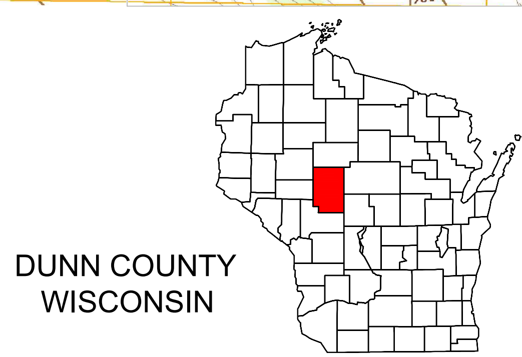
Wisconsin Department of Natural Resources (2022b), October 25, 2022, Letter from Jayson Schrank of WDNR to Britta Chambers of 3M, 6 pages.

Figures



SOURCE: U.S.G.S. TOPOGRAPHIC QUADRANGLES MENOMONIE NORTH AND RUSK, WI (2015)





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TETRA TECH

www.tetratech.com

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BLOOMINGTON, MN 55425
PHONE: 612.643.2200

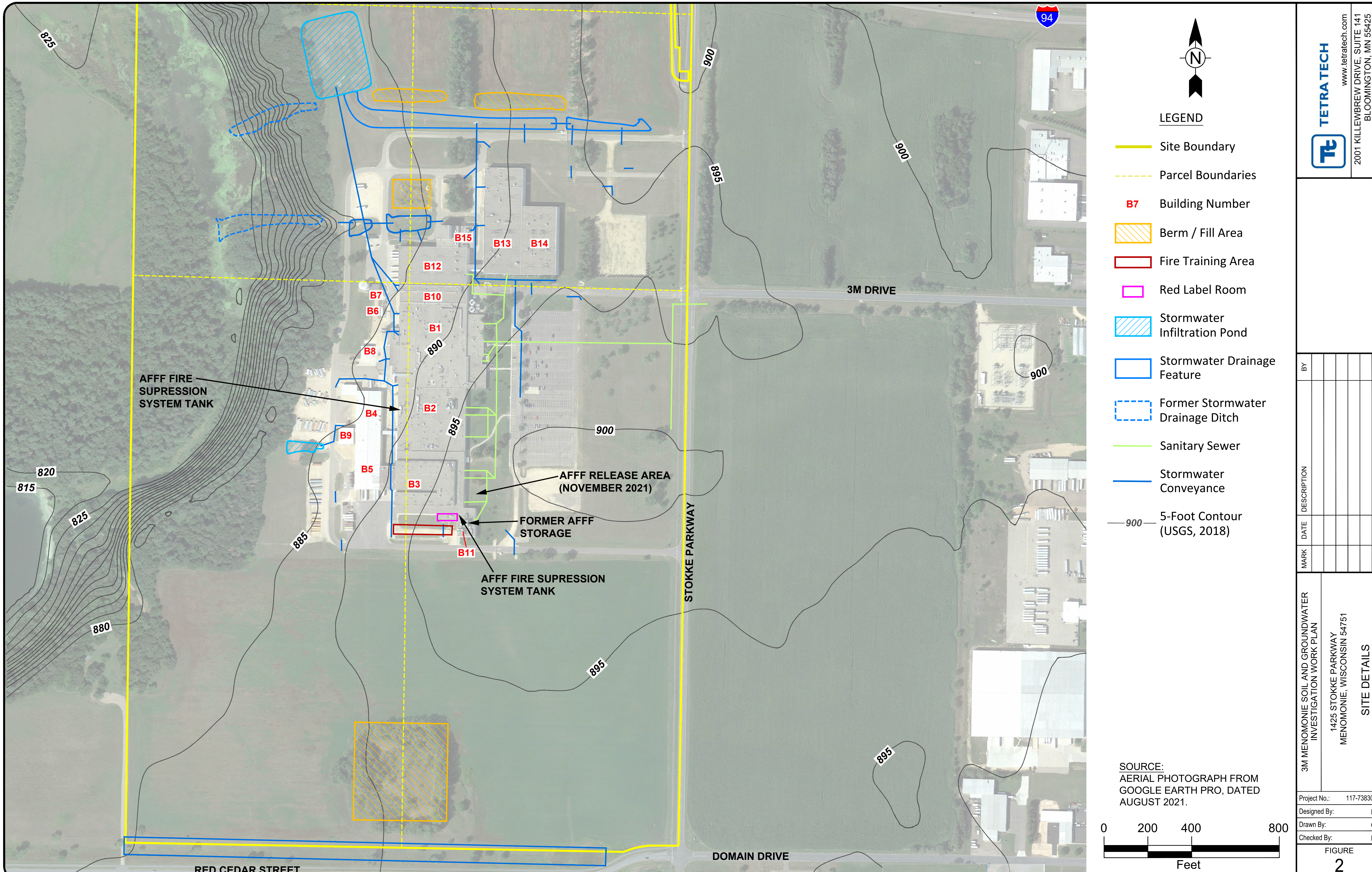
3M MENOMONIE SOIL AND GROUNDWATER INVESTIGATION WORK PLAN

1425 STOKKE PARKWAY
MENOMONIE, WISCONSIN 54751

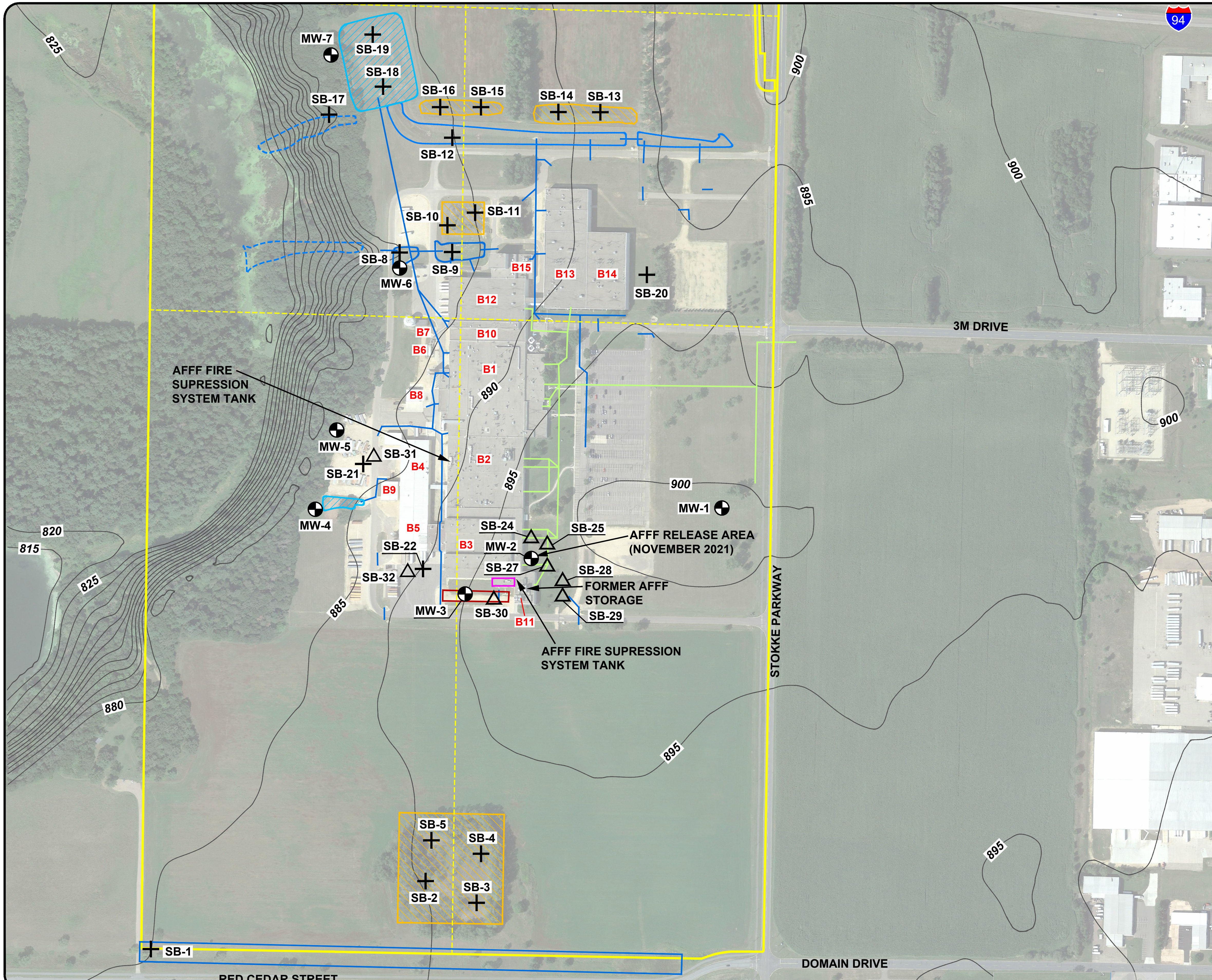
SITE LOCATION MAP

Project No:	117-7383011
Designed by:	CP
Checked by:	EC
FIGURE	1

Bar Measures 1 inch



12/9/2022 10:54:57 AM - P:\ACAD\7383-011-MENO\7383011001A.DWG - PAUGH, CHRISTINA



LEGEND

- Site Boundary
- Parcel Boundaries
- B7 Building Number
- Berm / Fill Area
- Fire Training Area
- Red Label Room
- Stormwater Infiltration Pond
- Stormwater Drainage Feature
- Former Stormwater Drainage Ditch
- Sanitary Sewer
- Stormwater Conveyance
- 900 5-Foot Contour (USGS, 2018)
- MW-1 Proposed Monitoring Well
- SB-1 Location of Proposed Hand Auger Boring (Depth Approximately 2 Feet)
- SB-25 Location of Proposed Soil Boring (Depth Approximately 10 Feet to 20 Feet)

N

NOTE:
SB-23 will be located approximately 1200 feet northwest of SB-19 and is intended as a background sample.

SOURCE:
AERIAL PHOTOGRAPH FROM GOOGLE EARTH PRO, DATED AUGUST 2021.

0 200 400 800
Feet

Bar Measures 1 inch

TETRA TECH
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PHONE: 612.643.2200

MARK	DATE	DESCRIPTION	BY

3M MENOMONIE SOIL AND GROUNDWATER INVESTIGATION WORK PLAN

1425 STOKKE PARKWAY
MENOMONIE, WISCONSIN 54751

PROPOSED SAMPLING LOCATIONS

Project No.:	117-7383011
Designed By:	EC
Drawn By:	CP
Checked By:	EC

FIGURE
3

1/16/2023 9:59:44 AM - P:\ACAD\7383-011-MENO\7383011002A.DWG - PAUGH, CHRISTINA

Tables

Table 1: 3M Menomonie Sampling Summary and Rationale

Area	Description	Proposed Sampling	Analytes Soil	Analytes Groundwater	Anticipated Sample Totals, Depths and Locations	Rationale for Sampling
Fill Material and Berms	Historical images show the construction of several fill stockpiles and berms on the north, south and east side of the property between the years of 1974 and 2010.	Collect two shallow soil samples per berm or fill material area that has not been previously investigated.	PFAS, VOCs, PAHs, , RCRA 8 Metals	N/A	Eight soil samples collected for analysis of PFAS, 10 soil samples for analysis of VOCs, PAHs, and RCRA 8 metals. Each sample collected from a depth of 1.5 to 2 feet bls. Soil Borings SB-2, SB-3, SB-4, SB-5, SB-10, SB-11, SB-13, SB-14, SB-15, SB-16	The source of the soil in the fill and berms is not known. Samples have previously been collected from the stockpiled fill northwest of the facility for analysis of PFAS and results will be augmented with this planned sampling.
Stormwater Discharge	A drainage ditch and large stormwater infiltration pond along with a former drainage ditch are located northwest of the facility.	Collect shallow soil samples from stormwater ponds and drainage ditch. Install and sample two water table monitoring wells.	PFAS, VOCs, PAHs. Two samples from the stormwater pond will also be analyzed for PCBs.	PFAS, VOCs, PAHs, RCRA 8 Metals and Cr^{+6}	7 soil samples for analysis of PFAS, VOCs, PAHs, and 2 samples for PCBs analysis. Each sample will be collected from a depth of 1.5 to 2 feet bls using a hand auger. Two soil samples will be collected for laboratory analysis from each boring associated with the monitoring wells. Depths for sampling will be based on highest indication of impacts, with preference given to the upper 3 feet of the boring and two feet above the water table. Two water table monitoring wells will be installed and sampled. Soil Borings SB-1, SB-8, SB-9, SB-12, SB-17, SB-18, SB-19; Monitoring Wells MW-6 and MW-7	Soil samples and groundwater samples will determine the potential impacts from discharges.
Fire Training	Fire training was conducted along the road to the south of the plant. The training included use of solvents as fuel and training in the use of fire extinguishers. Soils in this area may have received discharges of solvents and fire extinguisher chemicals (including possible AFFF).	Complete two soil borings, collect soil samples and install one water table monitoring well.	PFAS, VOCs	PFAS, VOCs	Three soil samples will be collected from each of the two borings for laboratory analysis. One boring will be advanced to a depth of 20 feet bls. The second boring will be advanced to the water table and a monitoring well will be installed in the boring on the western side of the fire training area. Soil Boring SB-30; Monitoring Well MW-3	Soil and groundwater may be impacted in this area.
AFFF Fire Suppression System	Releases of AFFF and fire suppression water potentially containing AFFF may have occurred at Building 2 and 11.	Complete shallow and deeper soil borings to collect soil samples near potential releases from sprinkler and hydrants and outside of Building 2 and Building 11 In addition, two monitoring wells will be located near the AFFF Suppression Tank and Fire Suppression System that have dual purpose of understanding groundwater quality in this area.	PFAS	PFAS	3 shallow soil samples will be collected at depths from 1.5 to 2 feet bls. Two soil samples per each of two deeper borings and one soil samples from each of the two borings associated with the monitoring wells. Soil Borings SB-20, SB-21, SB-22, SB-31, SB-32; Monitoring Wells MW-4 and MW-5	Sampling near in the AFFF Fire Suppression System tanks at Building 2 and Building 11 and potential releases from sprinklers and hydrants may have impacted soil and groundwater.
November 2021 AFFF Release	During routine maintenance of the fire suppression system on November 3, 2021, an exterior discharge was observed to contain foam from an adjacent AFFF suppression system. A response action was completed, and post-excavation sampling indicated residual impacts remain.	Install one water table monitoring well and three step out soil borings	PFAS	PFAS	A total of 12 soil samples will be collected from the soil borings associated with the monitoring well and the step-out borings. Three step-out borings will be completed at distances of 10 feet to 20 feet beyond the limits of the former excavation (depending on presence of utilities). Soil Borings SB-24, SB-25, SB-27; Monitoring Well MW-2.	This investigation within and around the excavation is designed to define the lateral and vertical extent of impacted soil from the release and a groundwater monitoring well installed to determine potential for impacts to groundwater from the release.

Area	Description	Proposed Sampling	Analytes Soil	Analytes Groundwater	Anticipated Sample Totals, Depths and Locations	Rationale for Sampling
May 2022, Fire Line Release	A release from the fire suppression water main line occurred on May 16, 2022 and approximately 700-800 gallons of fire suppression water, although most of the water was recovered.	Complete two soil borings	PFAS	N/A, as construction has occurred over the release area.	Four soil samples for analysis of PFAS, collect two samples from each boring for analysis, including one from 25 feet bls and one from 30 feet bls. Soil Borings SB-28 and SB-29.	These borings and samples will be used to determine the vertical extent of PFAS impacts resulting from the May 2022 release. Groundwater wells installed as part of this investigation will aid in determining if the release has impacted groundwater.
Upgradient Groundwater	This monitoring well is proposed for understanding groundwater quality in an area hydraulically upgradient from the 3M facility	Complete one soil boring and install a water table monitoring well.	PID Screening Only	PFAS, VOCs, PAHs, RCRA 8 Metals, and Cr^{+6}	One groundwater sample will be collected. Monitoring Well MW-1	Upgradient groundwater quality for comparison to groundwater quality at the facility and downgradient from the facility.
Background Soil	One soil sample will be collected upwind (northwest) of the facility to determine the potential for background constituents in soil.	Complete one shallow soil boring.	PFAS, RCRA 8 metals	N/A	One soil sample for analysis of PFAS and RCRA 8 metals. Soil Boring SB-23	This sample will aid in determining concentrations of PFAS and metals upwind of the facility in consideration of potential aerial deposition.

Notes:
Additional details regarding the sampling techniques, analytical methods and quality assurance/quality control (QA/QC) are included in the text and tables and appendices of this Work Plan.
Locations of proposed sampling locations are presented in Figure 3 of this work plan.
Actual sample numbers, depths and locations may change slightly based on field conditions. Estimated total samples by area are include in Table 2 of this Work Plan.
N/A = not applicable.
PFAS = per- and polyfluoroalkyl substances.
VOCs = volatile organic compounds
PAHs = polynuclear aromatic hydrocarbons.
PCBs = polychlorinated biphenyls.
Cr^{+6} = hexavalent chromium.
AFFF = aqueous film forming foam.
PID = photoionization detector.

Table 2. 3M Menomonie Soil and Groundwater Investigation Analytical Methods and Sample Totals Per Area

	Analysis	Analytical Method	Fill and Berms	Stormwater Discharge	Fire Training	AFFF Suppression	Nov 2021 Release	May 2022 Release	Upgradient Groundwater	Background Soil	Total*
Number of Soil Samples	VOCs	SW846 8260B	10	9	6	0	0	0	0	0	25
	PAHs	SW846 8270	10	9	6	0	0	0	0	0	25
	PFAS	EPA Method 537	8	9	6	9	12	4	0	1	51
	PCBs	SW846 8082A	0	2	0	0	0	0	0	0	2
	RCRA 8 Metals	SW846 6010 and 7470 (mercury)	10	9	0	0	0	0	0	1	20
Number of Ground Water Samples	VOCs	SW846 8260B	0	2	1	0	0	0	1	0	4
	PAHs	SW846 8270	0	2	1	0	0	0	1	0	4
	PFAS	EPA Method 537	0	2	1	2	1	0	1	0	7
	RCRA 8 Metals/Cr^{+6}	SW846 6010 and SM3500-CRB(Cr^{+6})	0	2	1	0	0	0	1	0	4

Notes:
Areas are described in **Table 1** of this Work Plan. Method detection limits are included in Appendix B of this Work Plan.
*Does not include QA/QC samples and actual sample quantities may change slightly based on field conditions.
VOCs = volatile organic compounds.
PAHs = polynuclear aromatic hydrocarbons.
PFAS = per- and polyfluoroalkyl substances.
PCBs = polychlorinated biphenyls.
Cr^{+6} = hexavalent chromium.

Appendix A
Incident Report for November 3, 2021, Release

Bay West

Spill Activation Form (ICS 201)

CLIENT AND PROPERTY OWNER INFORMATION			
Date:	11/3/21	**Project #:**	J 211100
Project Name:	3M - Menomonie		
Client:	3M	**Bay West PM:**	Mark Gretebeck
Client Contact:	Brad Luedtke	**Property Owner:**	3M
Client Phone:	715-578-2318	**Property Owner Phone:**	715-578-2318
Client Email:	bluedtke@mmm.com	**Property Owner Email:**	bluedtke@mmm.com

NOTIFICATIONS			
Incident Date:	11/3/21	**State Agency:**	WDNR
Duty Officer #:	WDNR SERTS ID # 20211103WC17-1	**Agency Contact:**	WDNR Regional Spills Coordinator Jayson Schrank

INCIDENT LOCATION AND RESPONSE					
Site Address:	1425 Stokke Pkwy			**Site Contact Name:**	Brad Luedtke
City:	Menomonie			**Site Contact Phone:**	715-578-2318
State	WI	**ZIP**	54751	**Site Contact Email:**	bluedtke@mmm.com
Location Description (mile marker, location on property, etc.):	Please see Figures 1 and 2.				

MATERIALS RELEASED			
Chemical Released:	Water with PFAS Containing Fire Suppressant	**Chemical Phase:**	☐ Solid ☑ Liquid ☐ Gas
Quantity Involved:	100-400 gallons	**Duration of Release:**	15-20 Minutes
Chemical Released:		**Chemical Phase:**	☐ Solid ☐ Liquid ☐ Gas
Quantity Involved:		**Duration of Release:**	
Chemical Released:		**Chemical Phase:**	☐ Solid ☐ Liquid ☐ Gas
Quantity Involved:		**Duration of Release:**	
☐ **Residential**	☑ **Commercial**	☐ **Inside**	☑ **Outside**
Released onto what surface:	☐ Air ☑ Pavement/ Impervious	☑ Soil / pervious	☐ Sewer ☐ On Water
Is it contained?	☑ Yes ☐ No	**Has 911 been called?**	☐ Yes ☑ No

SITUATION SUMMARY

11/3/21 - Assess and document, develop work plan, verify no immediate threats
11/8/21 - Remedial excavation, removal concrete pad, removal of impacted grass, place in lined, covered dumpster awaiting disposal by CleanHarbors

RESPONSE OBJECTIVES

- ☑ Investigation extent and magnitude of release
- ☑ Contain spilled material on land
- ☐ Contain spilled material on water
- ☑ Recover/excavate spilled material/ contaminated soil
- ☐ Package waste for disposal
- ☐ **Other:**
- ☑ Transport and dispose of waste material
- ☑ Collect samples and analyze for contamination / confirmation of cleanup
- ☑ Clean and restore of impacted area(s)
- ☐ Provide shelter / utilities / water for impacted public
- ☑ Document activities and generate closure report

ADDITIONAL CLIENT INFORMATION			
Billing Contact:	Brad Luedtke	**Account #**	J211100
Billing Phone:	715-578-2318	**MSA:**	◉ Yes ○ No
Billing Email:	bluedtke@mmm.com	**ER Retainer:**	◉ Yes ○ No

Bay West

Hazard Evaluation Form (ICS 215)

GENERAL INFORMATION

Date:	11/3/21	**Project #:**	J 211100
Project Name:	3M - Menomonie		
Client Contact:	Brad Luedtke	**Bay West PM:**	Mark Gretebeck
Safety Officer Completing HEF:			

CHEMICAL INFORMATION

Chemical Released:	Water with PFAS Containing Fire Suppressant		
Quantity Involved:	100-400 gallons		
Physical State:	☐ Solid ☑ Liquid ☐ Gas/Vapor	☐ Solid ☐ Liquid ☐ Gas/Vapor	☐ Solid ☐ Liquid ☐ Gas/Vapor
TLV or PEL	No Data (0.00037 mg/L EPA DWEL)		
IDLH	No Data		
Odor threshold	None		
Flash Point	Not Applicable °F	°F	°F
Lower Expl. Limit	Not Applicable %	%	%
Vapor Pressure	2.48x10-6 mmHg at 20°C mmHg	mmHg	mmHg
Ionization Potential	Unknown (varies) eV	eV	eV
Exposure Route(s)	▣ Inhalation ▣ Absorption ▣ Skin Contact	☐ Inhalation ☐ Absorption ☐ Skin Contact	☐ Inhalation ☐ Absorption ☐ Skin Contact
SDS / printed safety material available? MSDSonline; NIOSH	◉ Yes ○ No	Is the SDS attached?	○ Yes ◉ No

SYMPTOMS/EFFECTS OF EXPOSURE

▣ Carcinogen	▣ Headache	▣ Vertigo	▣ Nose/Throat Irritation
▣ Confusion	☐ Inebriation	▣ Vomiting	▣ Labored Breathing
☐ Dermatitis	☐ Skin Burns	▣ Skin Irritation	☐
▣ Dizziness	☐ Narcosis	▣ Eye Irritation	☐
▣ Fatigue	▣ Sensitization	▣ Lightheadedness	☐

PHYSICAL / BIOLOGICAL HAZARDS

☐ Fire/Explosion	☐ Confined Space	☐ Topography / Terrain	☐ Infectious Materials
☐ Corrosive	☐ Traffic	☐ Working at Heights	☐ Blood and Bodily Fluids
☐ Slips/Trips/Falls	☐ On/Near Water	☐ Lifting / Ergonomics	☐ Biological Warfare Agents
☐ Electrical	☐ Adverse Weather		
☐ Noise	☐ Plant/Animals/Insects		
☐ Utilities (Overhead / Buried)	☐ Sharps/Needles		

DECONTAMINATION

Decontamination Solution	Decontamination Materials	
▣ Water	▣ Plastic sheeting	▣ Garbage bags
▣ Detergent (Alconox)	▣ Tubs/basins	▣ Drums/containers
☐ Soda ash solution	▣ Sprayers	☐ Sorbent pads
☐	▣ Brushes	☐
Disposal Considerations:		

MONITORING PLAN

Monitoring required? ○ Yes ◉ No

Monitor Type	Action Level	Response	Action Level	Response
☐ 4-Gas Monitor	> 5% LEL	Monitor Continuously	> 10% LEL	Evacuate
	< 19.5 % or >%23.5	Ventilate and upgrade to Level B		Evacuate
	> 35 ppm CO	Upgrade to Level B	> 1200 ppm CO	Evacuate
	> 1 ppm H_2S	Upgrade to Level C	> 10 ppm H_2S	Upgrade to Level B
☐ Photoionization Detector (PID) [10.6 eV Lamp]				
☐ Dräger Tubes				
☐ pH Paper				
☐ Lumex				
☐				

PERSONAL PROTECTIVE EQUIPMENT

Initial PPE Level ☒ Level D ☒ Level C ☐ Level B ☐ Level A

Head, Eye, Face Protection	Hand Protection / Gloves	Skin Protection / Suits
☒ Hard hat	☐ Thermax liner gloves	☒ Coveralls
☐ Face-shield	☐ Cut-resistant chore gloves	☒ Insulated overall (cold wx gear)
☒ Safety glasses	☒ Insulated gloves (cold weather)	☐ Nomex suit
☒ Chemical goggles	☐ PVC (Monkey Grips)	☐ Firefighter turn-out gear
☒ Hearing protection	☒ Nitrile inner – sampling gloves	☒ Tyvek 400
☒ Insulated hat (cold weather)	☒ Nitrile outer	☒ TyChem SL (Stitched Saranex)
☐	☐ PVA glove	☐ TyChem 4000 (Sealed Saranex)
	☐ Neoprene	☐ Barricade – Level B
	☐ Natural rubber	☐ TyChem Proshield Fully Encapsulated
	☐ Butyl rubber	☐ TyChem TK Suit - Level A
	☐ Silvershield / 4H	☐
	☐	☐

Feet Protection	Respiratory Protection	Other Emergency Equipment
☒ Safety-toe boots	☐ SCBA	☐ First aid/BBP kit
☐ Insulated Safety-Toe boots	☐ SAR	☐ Fire extinguisher, 20 lb ABC
☐ Tingley boots	☐ SAR with escape bottle	☐ Personal flotation device
☒ Chemical boots	☐ Full Face APR	☐ Reflective Traffic Vest
☒ Tyvek boot covers	☐ Half Face APR	☒ Eye wash:
☒ Rubber boot covers	Cartridge:	☐ 1 L Bottles Qty:
☐ Latex boot covers	☐ Multi-gas 6006	☐ 15-minute station
☐ Waders	☐ Multi-gas / P100 - Combo	☐ Calcium gluconate (for HF)
☐	☐ Mercury 6009	☐ Grounding & Bonding Equipment
	☐ P100 7093	☐
	☐	

Bay West

GENERAL INFORMATION

Date:	11/3/21	**Project #:**	J 211100
Project Name:	3M - Menomonie		
Client Contact:	Brad Luedtke	**Bay West PM:**	Mark Gretebeck
Site Contact:	Brad Luedtke	**Site Contact Phone:**	715-578-2318
Time of day:		**Weather:**	

GENERAL SAFETY MESSAGE

Please see Site Safety and Health Plan for Excavation, Excavation Oversight and Soil Sampling at 3M Fire Suppression System Release Excavation 3M Menomonie, WI Bay West - November 2021

ITEMS DISCUSSED

Contact / Check in Procedures / Communications	Tools / Equipment Operation	Contingencies
▣ Client ▣ Security ☐ Emergency ☐ AHAs ☐ Work Zones ☐	▣ Hand Tools ☐ Vehicle Inspections ☐ Lift gate ☐ Ventilation ▣ Heavy Equipment ☐ Air Monitoring ☐ Bond/Grounding	▣ Hospital Map ☐ Fire ☐ Inclement Weather ▣ SDS ▣ Route Hazards ▣ Eye Wash ▣ Stop Work ▣ Spill Kit ▣ First Aid Kit ☐ Theft/threats of violence
Chemical Hazards	**Physical Hazards**	**Biological Hazards**
☐ Corrosive ☐ VOCs ▣ SVOCs ☐ Heavy Metals ▣ Acute Toxics ▣ Particulates ☐ PCBs ☐ Pesticides	▣ Noise (>85dBA) ☐ Heat Stress ▣ Cold Stress ☐ Lighting ▣ Pinch Points ▣ Slips/Trips/Falls ▣ Distractions ☐ Ergonomics ☐ Flammables	☐ Biological Warfare Agents ☐ Infectious Materials ☐ Sharps/Needles ☐ Blood and Bodily Fluids
Personnel Protection Requirements	**Decontamination Procedures**	**Waste**
▣ Competent Person ☐ Medical Clearance ▣ Eye Protection ▣ Foot Protection ☐ Decontamination ▣ Incident Reports	☐ Fire Extinguisher ▣ PPE ▣ Site Specific ☐ HazCom ☐ Respirators ☐ Safe Lifting ☐ Lab packing	▣ Safe handling/ packaging of wastes ▣ Labeling and Manifests containers ▣ Securing/ Transporting

SITE COMMUNICATION

Communication between the Project Manager, Client, Site Supervisor, and Field Techs shall be by:

▣ Voice ▣ Visual ☐ Telephone ☐ Radio ☐ Emergency warning device:

☐ Other:

Other Safety Information Discussed

**** IF ANY HAZARD OR CONDITIONS CHANGE, CONTACT THE PROJECT MANAGER AND RE-EVALUATE THE SAFETY OF THE JOB ****

Please see Site Safety and Health Plan for Excavation, Excavation Oversight and Soil Sampling at 3M Fire Suppression System Release Excavation 3M Menomonie, WI Bay West - November 2021

Emergency Response Guidebook

Safety Concerns	Corrective Action(s)

MEDICAL AND EMERGENCY INFORMATION					
Hospital Name Hospital Locator	Please see Site Safety and Health and Safety Plan			Phone Number	
Address	Please see Site Safety and Health Plan for Excavation, Excavation Oversight and Soil Sampling at 3M Fire Suppression System Release Excavation 3M Menomonie, WI Bay West - November 2021				
Police	911	Fire	911	Site Emergency Number	

HOSPITAL LOCATION / MAP

BAY WEST PERSONNEL

Your signature below indicates that you were present, coherent, and responsive during the meeting, that you're aware of site specific hazards, and agree to stop work when an uncontrolled hazard presents itself.

Role	Name	Signature	Time/Date signed
Project Manager	Mark Gretebeck	Mark Gretebeck	5/6/21
Safety and Health Officer	Griffin Kyger	Griffin Kyger	
Site Supervisor	Mark Gretebeck	Mark Gretebeck	
Field Technician	Mark Gretebeck	Mark Gretebeck	
Field Technician			
Field Technician			

Bay West

Daily Activity Log (ICS 214)

CLIENT AND PROPERTY OWNER INFORMATION

Date:	11/3/21	**Project #:**	J 211100
Project Name:	3M - Menomonie		
Client:	3M	**Bay West PM:**	Mark Gretebeck
Client Contact:	Brad Luedtke	**Property Owner:**	3M
Client Phone:	715-578-2318	**Property Owner Phone:**	715-578-2318
Client Email:	bluedtke@mmm.com	**Property Owner Email:**	bluedtke@mmm.com

NOTIFICATIONS

Duty Officer #:	WDNR SERTS ID # 20211103WC17-1	**State Agency:**	WDNR
Agency Case #:	Report #198536	**Agency Contact:**	WDNR Regional Spills Coordinator Jayson Schrank

INCIDENT LOCATION AND RESPONSE

Site Address:	1425 Stokke Pkwy					**Site Contact Name:**	Brad Luedtke
City:	Menomonie	**State:**	WI	**ZIP:**	54751	**Site Contact Phone:**	715-578-2318
Latitude/Longitude:	See Figures 1 and 2			**Bay West Time Notified/Arrived:**			

Location Description (mile marker, location on property, etc.):	Please see Figures 1 and 2.
Bay West Response Team (denote role PM, SS, Tech):	Mark Gretebeck - PM and SS
Weather:	Partly Sunny, 39 Degrees F, Winds from the West at 12 MPH

MATERIALS RELEASED

Chemical Released:	Water with PFAS Containing Fire Suppressant	**Chemical Phase:**	☐ Solid ☑ Liquid ☐ Gas
Quantity Involved:	100-400 gallons	**Duration of Release:**	15-20 Minutes
Chemical Released:		**Chemical Phase:**	☐ Solid ☐ Liquid ☐ Gas
Quantity Involved:		**Duration of Release:**	
Chemical Released:		**Chemical Phase:**	☐ Solid ☐ Liquid ☐ Gas
Quantity Involved:		**Duration of Release:**	

☐ **Residential** ☑ **Commercial** ☐ **Inside** ☑ **Outside**

Released onto what surface: ☐ Air ☑ Pavement/ Impervious ☑ Soil / pervious ☐ Sewer ☐ On Water

Is it contained? ☑ Yes ☐ No **Has 911 been called?** ☐ Yes ☑ No

INITIAL INCIDENT ASSESSMENT

(Describe incident as found upon arrival):

There was a 15-20 minute release of fire suppression water from a 2" outside valve for their sprinkler system. The water has PFOS foam in it. The fire suppression water discharged onto a concrete pad and the grass adjacent to the building. A remedial excavation is necessary to reomove the material. 3M indicated that they will have CleanHarbors handle the waste. We advised 3M to mark off the extent of the impacted area that will need to be excavated.

MONITORING RESULTS

Location	Parameter	Time	Result	Location	Parameter	Time	Result

ENVIRONMENTAL IMPACTS

(Discuss size and magnitude of impacts)

- ☐ Air
- ☐ Groundwater
- ☐ Indoor Commercial
- ☐ Indoor Residential
- ☑ Pavement/Impervious
- ☐ Sanitary Sewer
- ☐ Secondary Containment
- ☑ Soil/Porous Material
- ☐ Storm Sewer
- ☐ Surface Water
- ☐ Wetland

All impacted material was removed. No additional remedial action related to this release is recommended and/or warranted.

DETAILED DESCRIPTION OF REMEDIAL ACTIONS

Bay West completed the following activities:

- Removed small concrete pad in landscape area (see Figures 1 and 2 - attached)
- Lined roll-off container with plastic sheeting
- Excavated grass, topsoil and sand in a 17' half circle area to an average depth of 14"
- Placed soil in lined roll-off awaiting transport by CleanHarbors
- 3M collected 4 confirmation soil samples at base of excavation
- Samples 101-104 submitted by 3M to Pace Analytical Labs in SC. Analysis for PFAS. Results attached. No PFAS results exceed applicable standards (see Table 1 - attached)
- Waste transported at a later date by CleanHarbors to their Kimball Incineration Facility located at 2247 South Highway 71, Kimball, NE 69145, Phone Number 308-235-4012, EPA ID NED981723513
- 22,100 pounds (11.05 tons) was incinerated (waste documentation attached)
- Photos 1-10 attached

WASTE

Description of waste generated	Volume	Destination
PFAS impacted soil and grass	11.05 tons	CleanHarbors Kimball NE Incineration Facility

RECOMMENDATIONS

Recommended for site closure: (●) Yes ( ) No

All impacted areas were removed and incinerated, therefore, all aspects of this release have been properly addressed and no further remedial action associated with this release is recommended or warranted.

PROJECT COMPLETION CHECKLIST

☒	Photos Taken	☒	Site Restoration Complete	☒	Confirmation Samples	☒	Waste Profile Samples
☐	Field Sketch	☒	Manifests Complete	☒	Waste Secured	☒	Chain of Custody Maintained
☐		☐		☐		☐	Internal Disposal Request

Report Preparer:	Mark Gretebeck		
Signature:	Mark Gretebeck	**Date:**	5/24/22

Photo # 1 **:** View of plastic covering grass/landscape gravel in release area immediately adjacent to building between galvanized electrical conduits

Photo # 2**:** New, Unused, 40-Yard Roll-Off Container

Photo # 3 **:** Close up view of plastic covering grass/landscape gravel in release area immediately adjacent to building

Photo # 4**:** Start of excavation activities

Photo # 5 **:** Plastic lining applied to new, unused, 40-yard roll-off container

Photo # 6**:** Continuing with excavation of impacted grass and sand

Photo # : Continuing with excavation of impacted grass and sand

Photo # : Impacted grass, landscape gravel and sand in roll-off. Approx. 7.5 cubic yards final volume.

Figures

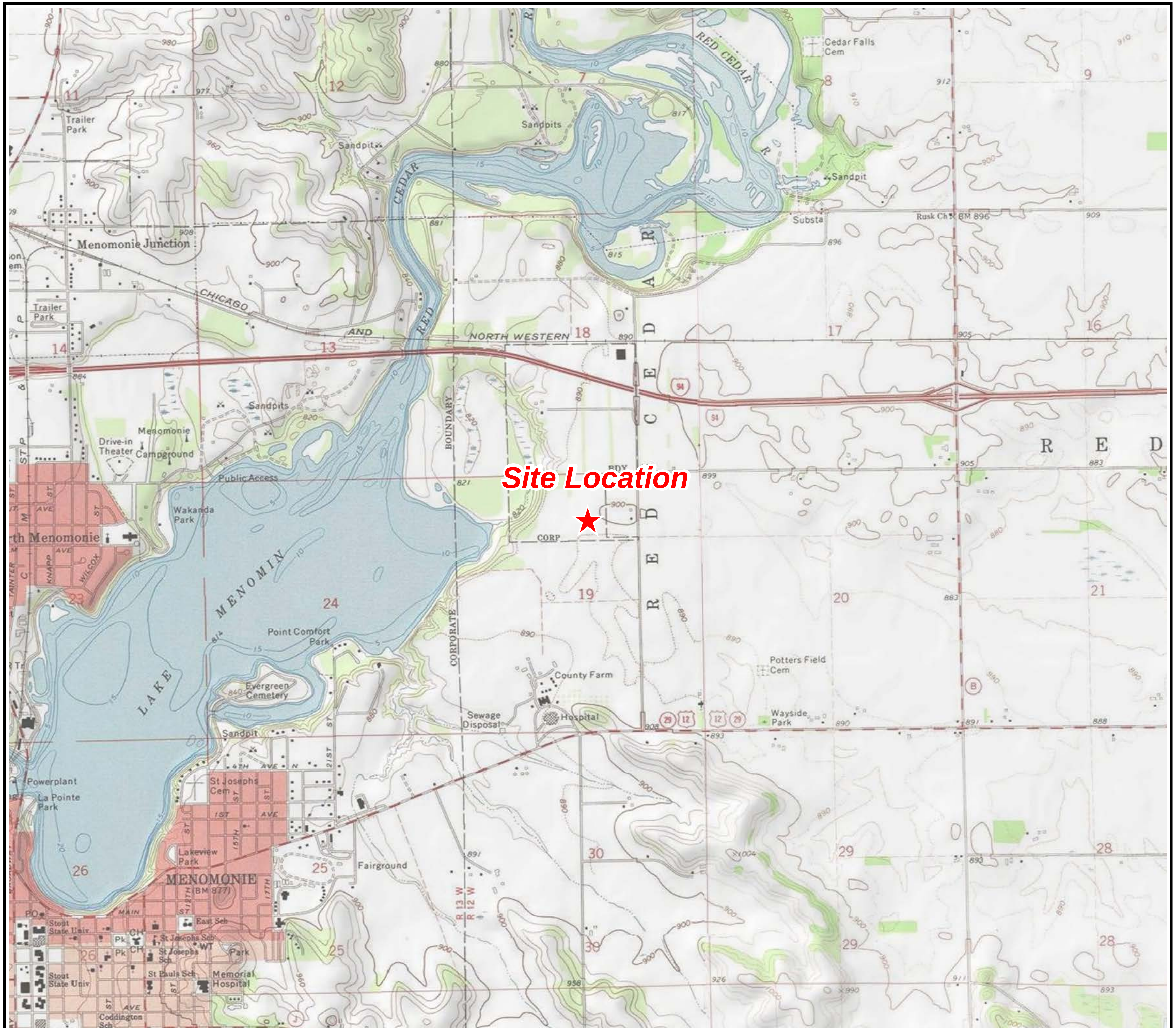
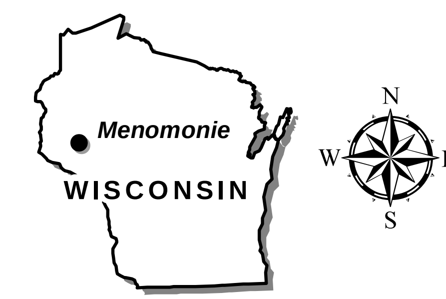


Figure 1

Site Location Map

ER Excavation

1425 Stokke Pkwy
Menomonie, WI 54751



Map Projection: NAD 1983 UTM Zone 15 N, Meters
Basemap: ESRI USA Topo Maps WMS

0 2,000 4,000 Feet
0 600 1,200 Meters

1 inch = 2,000 feet

★ Site Location

Bay West
Customer-Focused Environmental & Industrial Solutions

Drawn By: N.J. Date Drawn/Revised:2/21/2022 Project No.J211100

Y:\Clients\3M\3M_Menomonie\MapDocs\J211100\001_Excavation\J211100 FIG 1 Site Location Map.mxd

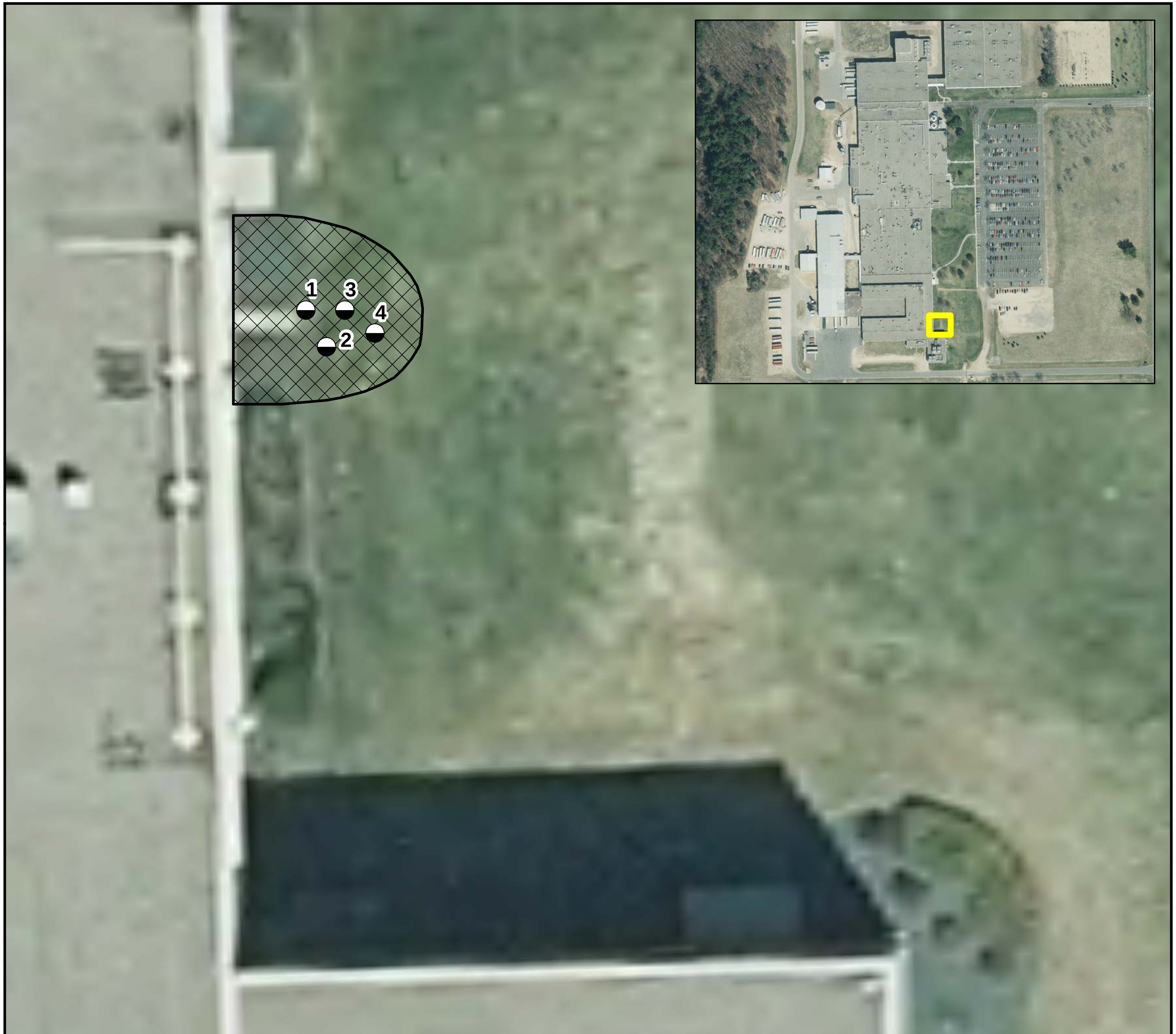
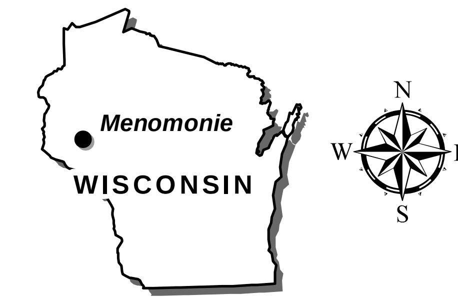


Figure 2

Excavation Extent & Sample Location Map

ER Excavation

1425 Stokke Pkwy
Menomonie, WI 54751



Map Projection: NAD 1983 UTM Zone 15 N, Meters
Basemap: Wisconsin DNR Aerial Imagery WMS, 2010

0 10 20 Feet
0 2 4 6 Meters

Soil Sample
Excavation Extent

Bay West
Customer-Focused Environmental & Industrial Solutions

Drawn By: N.J. Date Drawn/Revised: 2/24/2022 Project No.J211100

Y:\Clients\3M\3M_Menomonie\MapDocs\J211100\001_Excavation\J211100 FIG 2 Excavation Extent & Sample Location Map.mxd

Tables

Table 1
Soil Analytical Results

PFAS release at 3M Menomonie

	Sample ID	Industrial	101	102	103	104
	Date Sampled	RCL	11/8/2021	11/8/2021	11/8/2021	11/8/2021
11-Cl-PF3OUdS (11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid)	763051-92-9	NE	< 0.0019	< 0.0020	< 0.0019	< 0.0022
4:2 FTS (4:2 fluorotelomersulfonic acid)	757124-72-4	NE	< 0.0019	< 0.0020	< 0.0019	< 0.0022
6:2 FTS (6:2 fluorotelomersulfonic acid)	27619-97-2	NE	< 0.0019	< 0.0020	< 0.0019	< 0.0022
8:2 FTS (8:2 fluorotelomersulfonic acid)	39108-34-4	NE	< 0.0019	< 0.0020	< 0.0019	< 0.0022
9-Cl-PF3ON (9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid)	756426-58-1	NE	< 0.0019	< 0.0020	< 0.0019	< 0.0022
DONA (4,8-dioxa-3H-perfluorononanoic acid)	919005-14-4	NE	< 0.0019	< 0.0020	< 0.0019	< 0.0022
EtFOSAm (N-Ethylperfluorooctanesulfonamide)	4151-50-2	NE	< 0.0019	< 0.0020	< 0.0019	< 0.0022
EtFOSE (N-Ethylperfluorooctanesulfonamidoethanol)	1691-99-2	NE	< 0.0019	< 0.0020	< 0.0019	< 0.0022
HFPO-DA (2,3,3,3-tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)propanoic acid)	13252-13-6	NE	< 0.0039	< 0.0041	< 0.0038	< 0.0043
MeFOSA (N-Methylperfluorooctanesulfonamide)	31506-32-8	NE	< 0.0019	< 0.0020	< 0.0019	< 0.0022
MeFOSAA (N-Methyl perfluorooctanesulfonamidoacetic acid)	2355-31-9	NE	< 0.0019	< 0.0020	< 0.0019	< 0.0022
MeFOSE (N-Methylperfluorooctanesulfonamidoethanol)	24448-09-7	NE	< 0.0019	< 0.0020	< 0.0019	< 0.0022
N-EtFOSAA (N-Ethyl perfluorooctanesulfonamidoacetic acid)	2991-50-6	NE	< 0.0019	< 0.0020	< 0.0019	< 0.0022
PFBA (Perfluorobutyric acid)	375-22-4	NE	< 0.00097	< 0.0010	< 0.00096	< 0.0011
PFBS (Perfluorobutanesulfonic acid)	375-73-5	16400	< 0.00097	< 0.0010	< 0.00096	< 0.0011
PFDA (Perfluorodecanoic acid)	335-76-2	NE	< 0.00097	< 0.0010	< 0.00096	< 0.0011
PFDOA (Perfluorododecanoic acid)	307-55-1	NE	< 0.00097	< 0.0010	< 0.00096	**0.0011**
PFDoS (Perfluorododecanesulfonic acid)	79780-39-5	NE	**0.0028**	**0.0075**	**0.0041**	**0.0091**
PFDS (Perfluorodecanesulfonic acid)	335-77-3	NE	**0.0044**	**0.0081**	**0.0026**	**0.0055**
PFHpA (Perfluoroheptanoic acid)	375-85-9	NE	< 0.00097	< 0.0010	< 0.00096	< 0.0011
PFHpS (Perfluoroheptanesulfonic acid)	375-92-8	NE	< 0.00097	< 0.0010	**0.0039**	**0.0014**
PFHxA (Perfluorohexanoic acid)	307-24-4	NE	< 0.00097	< 0.0010	**0.0052**	**0.0024**
PFHxS (Perfluorohexanesulfonic acid)	355-46-4	NE	**0.0021**	**0.013**	**0.025**	**0.016**
PFNA (Perfluorononanoic acid)	375-95-1	NE	< 0.00097	< 0.0010	< 0.00096	< 0.0011
PFNS (Perfluorononanesulfonic acid)	68259-12-1	NE	**0.0069**	**0.0047**	**0.0031**	**0.0020**
PFOA (Perfluorooctanoic acid)	335-67-1	16.4	< 0.00097	**0.0014**	**0.0066**	**0.0023**
PFOS (Perfluorooctanesulfonate)	1763-23-1	16.4	**1.0**	**0.60**	**0.83**	**0.15**
PFOSAm (Perfluorooctanesulfonamide)	754-91-6	NE	**0.068**	**0.048**	**0.014**	**0.020**
PFPeA (Perfluoropentanoic acid)	2706-90-3	NE	< 0.00097	< 0.0010	**0.00096**	< 0.0011
PFPeS (Perfluoropentanesulfonic acid)	2706-91-4	NE	< 0.00097	< 0.0010	**0.0018**	< 0.0011
PFTeDA (Perfluorotetradecanoic acid)	376-06-7	NE	< 0.00097	< 0.0010	< 0.00096	< 0.0011
PFTrDA (Perfluorotridecanoic acid)	72629-94-8	NE	< 0.00097	< 0.0010	< 0.00096	< 0.0011
PFUnDA (Perfluoroundecanoic acid)	2058-94-8	NE	< 0.00097	< 0.0010	< 0.00096	< 0.0011

Notes:
All results in milligrams per kilogram
WIDNR – Wisconsin Department of Natural Resources
RCL – Residual Contaminant Lvels, as published December 2018
NE – Action level not established for this analyte
< – Less than the laboratory Limit of Quantitation
Bold – Analyte detected
Blue – Result exceeds the Industrial RCL

Analytical Data

Report of Analysis

3M
3M Center
260-05-N-17
St. Paul, MN 55144
Attention: Susan Wolf

Project Name: 3M Menomonie

Project Number: E21-2079

Lot Number:**WK15017**

Date Completed:12/13/2021
Revision Date: 12/15/2021

12/16/2021 2:46 PM
Approved and released by:
Project Manager II: **Cathy S. Dover**

The electronic signature above is the equivalent of a handwritten signature.

Pace Analytical Services, LLC (*formerly Shealy Environmental Services, Inc.*)
106 Vantage Point Drive West Columbia, SC 29172
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PACE ANALYTICAL SERVICES, LLC

SC DHEC No: 32010001 NELAC No: E87653 NC DENR No: 329 NC Field Parameters No: 5639

Case Narrative
3M
Lot Number: WK15017

Report Revision 12/15/2021:
This report has been revised to include the parent/original sample amount on the MS/MSD forms. These results were not reported in the original report due to LIMS issue. All other sample results are as reported in the original PDF report. This report supersedes and replaces any prior reports issued under this lot number.

This Report of Analysis contains the analytical result(s) for the sample(s) listed on the Sample Summary following this Case Narrative. The sample receiving date is documented in the header information associated with each sample. All results listed in this report relate only to the samples that are contained within this report.

Sample receipt, sample analysis, and data review have been performed in accordance with the Pace Quality Assurance Management Plan (QAMP), applicable Shealy standard operating procedures (SOPs), the 2003 NELAC standard, and Shealy policies. Additionally, the DoD QSM version 5.3 has been followed for these samples, and specifically Table B-15 was followed for all PFAS samples. Any exceptions to the QAMP, SOPs, NELAC standards, the DoD QSM, or policies are qualified on the results page or discussed below. Where applicable, all soil sample results (including LOQ and DL if requested) are corrected for dry weight unless flagged with a "W" qualifier.

PFAS by Isotope Dilution
Correction factors (CF) are used to calculate the original sample concentration. The CF is the inverse of the concentration factor (sample volume / extract final volume) times the dilution factor (DF). For undiluted analysis. The extract is prepared for injection by adding 182 uL of sample extract + 8 uL of reagent water + 10 uL of internal standard solution to a polypropylene auto sampler vial. An extra correction factor of 0.91 (182 uL / 200 uL = 0.91) applies. The CF is calculated as follows:

For solid samples:
CF = DF * FV / Ws/S/1000

FV is volume of extract (mL)
Ws is initial sample weight (gram)
S is %Solids
DF is dilution factor. For undiluted analysis, DF = 1/0.91.

Concentration (ug/kg) = Cs*CF,

$$C_s = \frac{\left(\frac{(A_s x C_{is})}{A_{is}}\right) - B}{M1}$$

Where

C_s is on column concentration of target analyte in the sample (ng/L)
C_{is} is concentration of internal standard in the sample (ng/L)
A_s is peak response of target analyte in the sample
A_{is} is peak response of internal standard in the sample
M1 is the average RF from ICAL or the slope from linear regression ICAL
B is the y-intercept from the ICAL

Samples WK15017-001 (101), WK15017-002 (102), WK15017-003 (103), and WK15017-004 (104) were collected in client-provided bottles which do not conform to method requirements.

The MS/MSD for batch 23612 and parent sample WK15017-004 (104), recovered outside control limits for PFOS. The associated LCS passed acceptance criteria.

In addition to the references above, samples associated with this report were performed in accordance with the 3M Technical Specifications Manual Revision 1, July 17, 2020.

The following SOP applies: ME003NI Determination of Per- and Polyfluoroalkyl Substances (PFAS) by LC/MS/MS (Isotope Dilution).

Cathy Dover

Cathy Dover, Project Manager

Sample Summary
3M
Lot Number: WK15017
Project Name: 3M Menomonie
Project Number: E21-2079

Sample Number	Sample ID	Matrix	Date Sampled	Date Received
001	101	Solid	11/08/2021 1045	11/12/2021
002	102	Solid	11/08/2021 1048	11/12/2021
003	103	Solid	11/08/2021 1100	11/12/2021
004	104	Solid	11/08/2021 1203	11/12/2021

(4 samples)

Detection Summary

3M

Lot Number: WK15017

Project Name: 3M Menomonie

Project Number: E21-2079

Sample	Sample ID	Matrix	Parameter	Method	Result	Q	Units	Page
001	101	Solid	PFDS	PFAS by ID	4.4		ug/kg	5
001	101	Solid	PFNS	PFAS by ID	6.9		ug/kg	5
001	101	Solid	PFOSA	PFAS by ID	68		ug/kg	5
001	101	Solid	PFDOS	PFAS by ID	2.8		ug/kg	5
001	101	Solid	PFHxS	PFAS by ID	2.1		ug/kg	5
001	101	Solid	PFOS	PFAS by ID	1000		ug/kg	5
002	102	Solid	PFDS	PFAS by ID	8.1		ug/kg	7
002	102	Solid	PFNS	PFAS by ID	4.7		ug/kg	7
002	102	Solid	PFOSA	PFAS by ID	48		ug/kg	7
002	102	Solid	PFDOS	PFAS by ID	7.5		ug/kg	7
002	102	Solid	PFHxS	PFAS by ID	13		ug/kg	7
002	102	Solid	PFOA	PFAS by ID	1.4		ug/kg	7
002	102	Solid	PFOS	PFAS by ID	600		ug/kg	7
003	103	Solid	PFDS	PFAS by ID	2.6		ug/kg	9
003	103	Solid	PFHpS	PFAS by ID	3.9		ug/kg	9
003	103	Solid	PFNS	PFAS by ID	3.1		ug/kg	9
003	103	Solid	PFOSA	PFAS by ID	14		ug/kg	9
003	103	Solid	PFPeS	PFAS by ID	1.8		ug/kg	9
003	103	Solid	PFDOS	PFAS by ID	4.1		ug/kg	9
003	103	Solid	PFHxS	PFAS by ID	25		ug/kg	9
003	103	Solid	PFHxA	PFAS by ID	5.2		ug/kg	9
003	103	Solid	PFOA	PFAS by ID	6.6		ug/kg	9
003	103	Solid	PFPeA	PFAS by ID	0.96		ug/kg	9
003	103	Solid	PFOS	PFAS by ID	830		ug/kg	9
004	104	Solid	PFDS	PFAS by ID	5.5		ug/kg	11
004	104	Solid	PFHpS	PFAS by ID	1.4		ug/kg	11
004	104	Solid	PFNS	PFAS by ID	2.0		ug/kg	11
004	104	Solid	PFOSA	PFAS by ID	20		ug/kg	11
004	104	Solid	PFDOS	PFAS by ID	9.1		ug/kg	11
004	104	Solid	PFHxS	PFAS by ID	16		ug/kg	11
004	104	Solid	PFDoA	PFAS by ID	1.1		ug/kg	11
004	104	Solid	PFHxA	PFAS by ID	2.4		ug/kg	11
004	104	Solid	PFOA	PFAS by ID	2.3		ug/kg	11
004	104	Solid	PFOS	PFAS by ID	150	S	ug/kg	11

(34 detections)

PFAS by LC/MS/MS

Client: **3M**		Laboratory ID: **WK15017-001**
Description: **101**		Matrix: **Solid**
Date Sampled: **11/08/2021 1045**	Project Name: **3M Menomonie**	% Solids: **89.2 11/29/2021 2339**
Date Received: **11/12/2021**	Project Number: **E21-2079**	

Run	Prep Method	Analytical Method	Dilution	Analysis Date	Analyst	Prep Date	Batch	Sample Wt.(g)	Final Vol. (mL)
1	SOP SPE	PFAS by ID SOP (3M)	1	11/30/2021 1611	MMM	11/24/2021 1322	23612	1.16	10.00
2	SOP SPE	PFAS by ID SOP (3M)	10	12/01/2021 1044	MMM	11/24/2021 1322	23612	1.16	10.00

Parameter	CAS Number	Analytical Method	Result	Q	LOQ	Units	Run
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)	756426-58-1	PFAS by ID SOP	ND		1.9	ug/kg	1
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3...)	763051-92-9	PFAS by ID SOP	ND		1.9	ug/kg	1
1H, 1H, 2H, 2H-perfluorodecane sulfonic acid (8:2 FTS)	39108-34-4	PFAS by ID SOP	ND		1.9	ug/kg	1
1H, 1H, 2H, 2H-perfluorooctane sulfonic acid (6:2 FTS)	27619-97-2	PFAS by ID SOP	ND		1.9	ug/kg	1
1H,1H,2H,2H-perfluorohexane sulfonic acid (4:2 FTS)	757124-72-4	PFAS by ID SOP	ND		1.9	ug/kg	1
Hexafluoropropylene oxide dimer acid (GenX)	13252-13-6	PFAS by ID SOP	ND		3.9	ug/kg	1
4,8-dioxa-3H-perfluorononanoic acid (ADONA)	919005-14-4	PFAS by ID SOP	ND		1.9	ug/kg	1
N-ethylperfluoro-1-octanesulfonamide (EtFOSA)	4151-50-2	PFAS by ID SOP	ND		1.9	ug/kg	1
N-ethylperfluoro-1-octanesulfonamidoacetic acid (EtFOSAA)	2991-50-6	PFAS by ID SOP	ND		1.9	ug/kg	1
2-N-ethylperfluoro-1-octanesulfonamido-ethanol (EtFOSE)	1691-99-2	PFAS by ID SOP	ND		1.9	ug/kg	1
N-methylperfluoro-1-octanesulfonamide (MeFOSA)	31506-32-8	PFAS by ID SOP	ND		1.9	ug/kg	1
N-methylperfluoro-1-octanesulfonamidoacetic acid (MeFOSAA)	2355-31-9	PFAS by ID SOP	ND		1.9	ug/kg	1
2-N-methylperfluoro-1-octanesulfonamido-ethanol (MeFOSE)	24448-09-7	PFAS by ID SOP	ND		1.9	ug/kg	1
Perfluoro-1-butanesulfonic acid (PFBS)	375-73-5	PFAS by ID SOP	ND		0.97	ug/kg	1
Perfluoro-1-decanesulfonic acid (PFDS)	**335-77-3**	**PFAS by ID SOP**	**4.4**		**0.97**	**ug/kg**	**1**
Perfluoro-1-heptanesulfonic acid (PFHpS)	375-92-8	PFAS by ID SOP	ND		0.97	ug/kg	1
Perfluoro-1-nonanesulfonic acid (PFNS)	**68259-12-1**	**PFAS by ID SOP**	**6.9**		**0.97**	**ug/kg**	**1**
Perfluoro-1-octanesulfonamide (PFOSA)	**754-91-6**	**PFAS by ID SOP**	**68**		**0.97**	**ug/kg**	**1**
Perfluoro-1-pentanesulfonic acid (PFPeS)	2706-91-4	PFAS by ID SOP	ND		0.97	ug/kg	1
Perfluorododecanesulfonic acid (PFDOS)	**79780-39-5**	**PFAS by ID SOP**	**2.8**		**0.97**	**ug/kg**	**1**
Perfluorohexanesulfonic acid (PFHxS)	**355-46-4**	**PFAS by ID SOP**	**2.1**		**0.97**	**ug/kg**	**1**
Perfluoro-n-butanoic acid (PFBA)	375-22-4	PFAS by ID SOP	ND		0.97	ug/kg	1
Perfluoro-n-decanoic acid (PFDA)	335-76-2	PFAS by ID SOP	ND		0.97	ug/kg	1
Perfluoro-n-dodecanoic acid (PFDoA)	307-55-1	PFAS by ID SOP	ND		0.97	ug/kg	1
Perfluoro-n-heptanoic acid (PFHpA)	375-85-9	PFAS by ID SOP	ND		0.97	ug/kg	1
Perfluoro-n-hexanoic acid (PFHxA)	307-24-4	PFAS by ID SOP	ND		0.97	ug/kg	1
Perfluoro-n-nonanoic acid (PFNA)	375-95-1	PFAS by ID SOP	ND		0.97	ug/kg	1
Perfluoro-n-octanoic acid (PFOA)	335-67-1	PFAS by ID SOP	ND		0.97	ug/kg	1
Perfluoro-n-pentanoic acid (PFPeA)	2706-90-3	PFAS by ID SOP	ND		0.97	ug/kg	1
Perfluoro-n-tetradecanoic acid (PFTeDA)	376-06-7	PFAS by ID SOP	ND		0.97	ug/kg	1
Perfluoro-n-tridecanoic acid (PFTrDA)	72629-94-8	PFAS by ID SOP	ND		0.97	ug/kg	1
Perfluoro-n-undecanoic acid (PFUdA)	2058-94-8	PFAS by ID SOP	ND		0.97	ug/kg	1
Perfluorooctanesulfonic acid (PFOS)	**1763-23-1**	**PFAS by ID SOP**	**1000**		**9.7**	**ug/kg**	**2**

Surrogate	Q	Run 1 % Recovery	Acceptance Limits	Q	Run 2 % Recovery	Acceptance Limits
13C2_4:2FTS		115	50-150		127	50-150
13C2_6:2FTS		123	50-150		129	50-150
13C2_8:2FTS		113	50-150		122	50-150
13C2_PFDoA		101	50-150		101	50-150
13C2_PFTeDA		106	50-150		101	50-150
13C3_PFBS		101	50-150		104	50-150
13C3_PFHxS		103	50-150		107	50-150
13C3-HFPO-DA		115	50-150		105	50-150

LOQ = Limit of Quantitation | B = Detected in the method blank | E = Quantitation of compound exceeded the calibration range | Q = Surrogate failure
ND = Not detected at or above the LOQ | N = Recovery is out of criteria | P = The RPD between two GC columns exceeds 40% | L = LCS/LCSD failure
H = Out of holding time | W = Reported on wet weight basis | S = MS/MSD failure

PFAS by LC/MS/MS

Client: **3M**		Laboratory ID: **WK15017-001**
Description: **101**		Matrix: **Solid**
Date Sampled: **11/08/2021 1045**	Project Name: **3M Menomonie**	% Solids: **89.2 11/29/2021 2339**
Date Received: **11/12/2021**	Project Number: **E21-2079**	

Surrogate	Q	Run 1 % Recovery	Acceptance Limits	Q	Run 2 % Recovery	Acceptance Limits
13C4_PFBA		99	50-150		101	50-150
13C4_PFHpA		97	50-150		102	50-150
13C5_PFHxA		100	50-150		105	50-150
13C5_PFPeA		102	50-150		104	50-150
13C6_PFDA		104	50-150		106	50-150
13C7_PFUdA		113	50-150		118	50-150
13C8_PFOA		100	50-150		109	50-150
13C8_PFOS		77	50-150		104	50-150
13C8_PFOSA		112	50-150		115	50-150
13C9_PFNA		75	50-150		96	50-150
d-EtFOSA		94	50-150		103	50-150
d5-EtFOSAA		117	50-150		117	50-150
d9-EtFOSE		99	50-150		102	50-150
d-MeFOSA		91	50-150		94	50-150
d3-MeFOSAA		112	50-150		120	50-150
d7-MeFOSE		95	50-150		100	50-150

LOQ = Limit of Quantitation
ND = Not detected at or above the LOQ
H = Out of holding time
B = Detected in the method blank
N = Recovery is out of criteria
W = Reported on wet weight basis
E = Quantitation of compound exceeded the calibration range
P = The RPD between two GC columns exceeds 40%
Q = Surrogate failure
L = LCS/LCSD failure
S = MS/MSD failure

PFAS by LC/MS/MS

Client: **3M**		Laboratory ID: **WK15017-002**	
Description: **102**		Matrix: **Solid**	
Date Sampled: **11/08/2021 1048**	Project Name: **3M Menomonie**	% Solids: **94.0**	**11/23/2021 0106**
Date Received: **11/12/2021**	Project Number: **E21-2079**		

Run	Prep Method	Analytical Method	Dilution	Analysis Date	Analyst	Prep Date	Batch	Sample Wt.(g)	Final Vol. (mL)
1	SOP SPE	PFAS by ID SOP (3M)	1	11/30/2021 1622	MMM	11/24/2021 1322	23612	1.04	10.00
2	SOP SPE	PFAS by ID SOP (3M)	5	12/01/2021 1054	MMM	11/24/2021 1322	23612	1.04	10.00

Parameter	CAS Number	Analytical Method	Result	Q	LOQ	Units	Run
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)	756426-58-1	PFAS by ID SOP	ND		2.0	ug/kg	1
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3...)	763051-92-9	PFAS by ID SOP	ND		2.0	ug/kg	1
1H, 1H, 2H, 2H-perfluorodecane sulfonic acid (8:2 FTS)	39108-34-4	PFAS by ID SOP	ND		2.0	ug/kg	1
1H, 1H, 2H, 2H-perfluorooctane sulfonic acid (6:2 FTS)	27619-97-2	PFAS by ID SOP	ND		2.0	ug/kg	1
1H,1H,2H,2H-perfluorohexane sulfonic acid (4:2 FTS)	757124-72-4	PFAS by ID SOP	ND		2.0	ug/kg	1
Hexafluoropropylene oxide dimer acid (GenX)	13252-13-6	PFAS by ID SOP	ND		4.1	ug/kg	1
4,8-dioxa-3H-perfluorononanoic acid (ADONA)	919005-14-4	PFAS by ID SOP	ND		2.0	ug/kg	1
N-ethylperfluoro-1-octanesulfonamide (EtFOSA)	4151-50-2	PFAS by ID SOP	ND		2.0	ug/kg	1
N-ethylperfluoro-1-octanesulfonamidoacetic acid (EtFOSAA)	2991-50-6	PFAS by ID SOP	ND		2.0	ug/kg	1
2-N-ethylperfluoro-1-octanesulfonamido-ethanol (EtFOSE)	1691-99-2	PFAS by ID SOP	ND		2.0	ug/kg	1
N-methylperfluoro-1-octanesulfonamide (MeFOSA)	31506-32-8	PFAS by ID SOP	ND		2.0	ug/kg	1
N-methylperfluoro-1-octanesulfonamidoacetic acid (MeFOSAA)	2355-31-9	PFAS by ID SOP	ND		2.0	ug/kg	1
2-N-methylperfluoro-1-octanesulfonamido-ethanol (MeFOSE)	24448-09-7	PFAS by ID SOP	ND		2.0	ug/kg	1
Perfluoro-1-butanesulfonic acid (PFBS)	375-73-5	PFAS by ID SOP	ND		1.0	ug/kg	1
Perfluoro-1-decanesulfonic acid (PFDS)	**335-77-3**	**PFAS by ID SOP**	**8.1**		**1.0**	**ug/kg**	**1**
Perfluoro-1-heptanesulfonic acid (PFHpS)	375-92-8	PFAS by ID SOP	ND		1.0	ug/kg	1
Perfluoro-1-nonanesulfonic acid (PFNS)	**68259-12-1**	**PFAS by ID SOP**	**4.7**		**1.0**	**ug/kg**	**1**
Perfluoro-1-octanesulfonamide (PFOSA)	**754-91-6**	**PFAS by ID SOP**	**48**		**1.0**	**ug/kg**	**1**
Perfluoro-1-pentanesulfonic acid (PFPeS)	2706-91-4	PFAS by ID SOP	ND		1.0	ug/kg	1
Perfluorododecanesulfonic acid (PFDOS)	**79780-39-5**	**PFAS by ID SOP**	**7.5**		**1.0**	**ug/kg**	**1**
Perfluorohexanesulfonic acid (PFHxS)	**355-46-4**	**PFAS by ID SOP**	**13**		**1.0**	**ug/kg**	**1**
Perfluoro-n-butanoic acid (PFBA)	375-22-4	PFAS by ID SOP	ND		1.0	ug/kg	1
Perfluoro-n-decanoic acid (PFDA)	335-76-2	PFAS by ID SOP	ND		1.0	ug/kg	1
Perfluoro-n-dodecanoic acid (PFDoA)	307-55-1	PFAS by ID SOP	ND		1.0	ug/kg	1
Perfluoro-n-heptanoic acid (PFHpA)	375-85-9	PFAS by ID SOP	ND		1.0	ug/kg	1
Perfluoro-n-hexanoic acid (PFHxA)	307-24-4	PFAS by ID SOP	ND		1.0	ug/kg	1
Perfluoro-n-nonanoic acid (PFNA)	375-95-1	PFAS by ID SOP	ND		1.0	ug/kg	1
Perfluoro-n-octanoic acid (PFOA)	**335-67-1**	**PFAS by ID SOP**	**1.4**		**1.0**	**ug/kg**	**1**
Perfluoro-n-pentanoic acid (PFPeA)	2706-90-3	PFAS by ID SOP	ND		1.0	ug/kg	1
Perfluoro-n-tetradecanoic acid (PFTeDA)	376-06-7	PFAS by ID SOP	ND		1.0	ug/kg	1
Perfluoro-n-tridecanoic acid (PFTrDA)	72629-94-8	PFAS by ID SOP	ND		1.0	ug/kg	1
Perfluoro-n-undecanoic acid (PFUdA)	2058-94-8	PFAS by ID SOP	ND		1.0	ug/kg	1
Perfluorooctanesulfonic acid (PFOS)	**1763-23-1**	**PFAS by ID SOP**	**600**		**5.1**	**ug/kg**	**2**

Surrogate	Q	Run 1 % Recovery	Acceptance Limits	Q	Run 2 % Recovery	Acceptance Limits
13C2_4:2FTS		115	50-150		130	50-150
13C2_6:2FTS		116	50-150		131	50-150
13C2_8:2FTS		124	50-150		129	50-150
13C2_PFDoA		103	50-150		108	50-150
13C2_PFTeDA		103	50-150		106	50-150
13C3_PFBS		98	50-150		110	50-150
13C3_PFHxS		96	50-150		114	50-150
13C3-HFPO-DA		102	50-150		108	50-150

LOQ = Limit of Quantitation | B = Detected in the method blank | E = Quantitation of compound exceeded the calibration range | Q = Surrogate failure
ND = Not detected at or above the LOQ | N = Recovery is out of criteria | P = The RPD between two GC columns exceeds 40% | L = LCS/LCSD failure
H = Out of holding time | W = Reported on wet weight basis | S = MS/MSD failure

PFAS by LC/MS/MS

Client: **3M**		Laboratory ID: **WK15017-002**
Description: **102**		Matrix: **Solid**
Date Sampled: **11/08/2021 1048**	Project Name: **3M Menomonie**	% Solids: **94.0 11/23/2021 0106**
Date Received: **11/12/2021**	Project Number: **E21-2079**	

Surrogate	Q	Run 1 % Recovery	Acceptance Limits	Q	Run 2 % Recovery	Acceptance Limits
13C4_PFBA		99	50-150		108	50-150
13C4_PFHpA		97	50-150		105	50-150
13C5_PFHxA		98	50-150		110	50-150
13C5_PFPeA		108	50-150		103	50-150
13C6_PFDA		114	50-150		110	50-150
13C7_PFUdA		109	50-150		117	50-150
13C8_PFOA		95	50-150		110	50-150
13C8_PFOS		87	50-150		104	50-150
13C8_PFOSA		112	50-150		122	50-150
13C9_PFNA		84	50-150		99	50-150
d-EtFOSA		107	50-150		101	50-150
d5-EtFOSAA		109	50-150		128	50-150
d9-EtFOSE		100	50-150		105	50-150
d-MeFOSA		95	50-150		98	50-150
d3-MeFOSAA		118	50-150		124	50-150
d7-MeFOSE		109	50-150		117	50-150

LOQ = Limit of Quantitation	B = Detected in the method blank	E = Quantitation of compound exceeded the calibration range	Q = Surrogate failure
ND = Not detected at or above the LOQ	N = Recovery is out of criteria	P = The RPD between two GC columns exceeds 40%	L = LCS/LCSD failure
H = Out of holding time	W = Reported on wet weight basis		S = MS/MSD failure

PFAS by LC/MS/MS

Client: **3M**		Laboratory ID: **WK15017-003**
Description: **103**		Matrix: **Solid**
Date Sampled: **11/08/2021 1100**	Project Name: **3M Menomonie**	% Solids: **93.1 11/29/2021 2339**
Date Received: **11/12/2021**	Project Number: **E21-2079**	

Run	Prep Method	Analytical Method	Dilution	Analysis Date	Analyst	Prep Date	Batch	Sample Wt.(g)	Final Vol. (mL)
1	SOP SPE	PFAS by ID SOP (3M)	1	11/30/2021 1632	MMM	11/24/2021 1322	23612	1.12	10.00
2	SOP SPE	PFAS by ID SOP (3M)	10	12/01/2021 1105	MMM	11/24/2021 1322	23612	1.12	10.00

Parameter	CAS Number	Analytical Method	Result	Q	LOQ	Units	Run
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)	756426-58-1	PFAS by ID SOP	ND		1.9	ug/kg	1
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3...)	763051-92-9	PFAS by ID SOP	ND		1.9	ug/kg	1
1H, 1H, 2H, 2H-perfluorodecane sulfonic acid (8:2 FTS)	39108-34-4	PFAS by ID SOP	ND		1.9	ug/kg	1
1H, 1H, 2H, 2H-perfluorooctane sulfonic acid (6:2 FTS)	27619-97-2	PFAS by ID SOP	ND		1.9	ug/kg	1
1H,1H,2H,2H-perfluorohexane sulfonic acid (4:2 FTS)	757124-72-4	PFAS by ID SOP	ND		1.9	ug/kg	1
Hexafluoropropylene oxide dimer acid (GenX)	13252-13-6	PFAS by ID SOP	ND		3.8	ug/kg	1
4,8-dioxa-3H-perfluorononanoic acid (ADONA)	919005-14-4	PFAS by ID SOP	ND		1.9	ug/kg	1
N-ethylperfluoro-1-octanesulfonamide (EtFOSA)	4151-50-2	PFAS by ID SOP	ND		1.9	ug/kg	1
N-ethylperfluoro-1-octanesulfonamidoacetic acid (EtFOSAA)	2991-50-6	PFAS by ID SOP	ND		1.9	ug/kg	1
2-N-ethylperfluoro-1-octanesulfonamido-ethanol (EtFOSE)	1691-99-2	PFAS by ID SOP	ND		1.9	ug/kg	1
N-methylperfluoro-1-octanesulfonamide (MeFOSA)	31506-32-8	PFAS by ID SOP	ND		1.9	ug/kg	1
N-methylperfluoro-1-octanesulfonamidoacetic acid (MeFOSAA)	2355-31-9	PFAS by ID SOP	ND		1.9	ug/kg	1
2-N-methylperfluoro-1-octanesulfonamido-ethanol (MeFOSE)	24448-09-7	PFAS by ID SOP	ND		1.9	ug/kg	1
Perfluoro-1-butanesulfonic acid (PFBS)	375-73-5	PFAS by ID SOP	ND		0.96	ug/kg	1
Perfluoro-1-decanesulfonic acid (PFDS)	**335-77-3**	**PFAS by ID SOP**	**2.6**		**0.96**	**ug/kg**	**1**
Perfluoro-1-heptanesulfonic acid (PFHpS)	**375-92-8**	**PFAS by ID SOP**	**3.9**		**0.96**	**ug/kg**	**1**
Perfluoro-1-nonanesulfonic acid (PFNS)	**68259-12-1**	**PFAS by ID SOP**	**3.1**		**0.96**	**ug/kg**	**1**
Perfluoro-1-octanesulfonamide (PFOSA)	**754-91-6**	**PFAS by ID SOP**	**14**		**0.96**	**ug/kg**	**1**
Perfluoro-1-pentanesulfonic acid (PFPeS)	**2706-91-4**	**PFAS by ID SOP**	**1.8**		**0.96**	**ug/kg**	**1**
Perfluorododecanesulfonic acid (PFDOS)	**79780-39-5**	**PFAS by ID SOP**	**4.1**		**0.96**	**ug/kg**	**1**
Perfluorohexanesulfonic acid (PFHxS)	**355-46-4**	**PFAS by ID SOP**	**25**		**0.96**	**ug/kg**	**1**
Perfluoro-n-butanoic acid (PFBA)	375-22-4	PFAS by ID SOP	ND		0.96	ug/kg	1
Perfluoro-n-decanoic acid (PFDA)	335-76-2	PFAS by ID SOP	ND		0.96	ug/kg	1
Perfluoro-n-dodecanoic acid (PFDoA)	307-55-1	PFAS by ID SOP	ND		0.96	ug/kg	1
Perfluoro-n-heptanoic acid (PFHpA)	375-85-9	PFAS by ID SOP	ND		0.96	ug/kg	1
Perfluoro-n-hexanoic acid (PFHxA)	**307-24-4**	**PFAS by ID SOP**	**5.2**		**0.96**	**ug/kg**	**1**
Perfluoro-n-nonanoic acid (PFNA)	375-95-1	PFAS by ID SOP	ND		0.96	ug/kg	1
Perfluoro-n-octanoic acid (PFOA)	**335-67-1**	**PFAS by ID SOP**	**6.6**		**0.96**	**ug/kg**	**1**
Perfluoro-n-pentanoic acid (PFPeA)	**2706-90-3**	**PFAS by ID SOP**	**0.96**		**0.96**	**ug/kg**	**1**
Perfluoro-n-tetradecanoic acid (PFTeDA)	376-06-7	PFAS by ID SOP	ND		0.96	ug/kg	1
Perfluoro-n-tridecanoic acid (PFTrDA)	72629-94-8	PFAS by ID SOP	ND		0.96	ug/kg	1
Perfluoro-n-undecanoic acid (PFUdA)	2058-94-8	PFAS by ID SOP	ND		0.96	ug/kg	1
Perfluorooctanesulfonic acid (PFOS)	**1763-23-1**	**PFAS by ID SOP**	**830**		**9.6**	**ug/kg**	**2**

Surrogate	Q	Run 1 % Recovery	Acceptance Limits	Q	Run 2 % Recovery	Acceptance Limits
13C2_4:2FTS		108	50-150		114	50-150
13C2_6:2FTS		113	50-150		132	50-150
13C2_8:2FTS		126	50-150		122	50-150
13C2_PFDoA		102	50-150		112	50-150
13C2_PFTeDA		106	50-150		100	50-150
13C3_PFBS		98	50-150		111	50-150
13C3_PFHxS		102	50-150		111	50-150
13C3-HFPO-DA		113	50-150		107	50-150

LOQ = Limit of Quantitation | B = Detected in the method blank | E = Quantitation of compound exceeded the calibration range | Q = Surrogate failure
ND = Not detected at or above the LOQ | N = Recovery is out of criteria | P = The RPD between two GC columns exceeds 40% | L = LCS/LCSD failure
H = Out of holding time | W = Reported on wet weight basis | S = MS/MSD failure

PFAS by LC/MS/MS

Client: **3M**		Laboratory ID: **WK15017-003**
Description: **103**		Matrix: **Solid**
Date Sampled: **11/08/2021 1100**	Project Name: **3M Menomonie**	% Solids: **93.1 11/29/2021 2339**
Date Received: **11/12/2021**	Project Number: **E21-2079**	

Surrogate	Q	Run 1 % Recovery	Acceptance Limits	Q	Run 2 % Recovery	Acceptance Limits
13C4_PFBA		99	50-150		106	50-150
13C4_PFHpA		100	50-150		103	50-150
13C5_PFHxA		103	50-150		113	50-150
13C5_PFPeA		99	50-150		105	50-150
13C6_PFDA		106	50-150		116	50-150
13C7_PFUdA		106	50-150		110	50-150
13C8_PFOA		98	50-150		114	50-150
13C8_PFOS		80	50-150		108	50-150
13C8_PFOSA		123	50-150		125	50-150
13C9_PFNA		80	50-150		101	50-150
d-EtFOSA		96	50-150		103	50-150
d5-EtFOSAA		115	50-150		125	50-150
d9-EtFOSE		100	50-150		108	50-150
d-MeFOSA		94	50-150		95	50-150
d3-MeFOSAA		110	50-150		127	50-150
d7-MeFOSE		110	50-150		109	50-150

LOQ = Limit of Quantitation | B = Detected in the method blank | E = Quantitation of compound exceeded the calibration range | Q = Surrogate failure
ND = Not detected at or above the LOQ | N = Recovery is out of criteria | P = The RPD between two GC columns exceeds 40% | L = LCS/LCSD failure
H = Out of holding time | W = Reported on wet weight basis | S = MS/MSD failure

PFAS by LC/MS/MS

Client: **3M**		Laboratory ID: **WK15017-004**
Description: **104**		Matrix: **Solid**
Date Sampled: **11/08/2021 1203**	Project Name: **3M Menomonie**	% Solids: **92.0 11/29/2021 2339**
Date Received: **11/12/2021**	Project Number: **E21-2079**	

Run	Prep Method	Analytical Method	Dilution	Analysis Date	Analyst	Prep Date	Batch	Sample Wt.(g)	Final Vol. (mL)
1	SOP SPE	PFAS by ID SOP (3M)	1	12/01/2021 1115	MMM	11/24/2021 1322	23612	1.01	10.00

Parameter	CAS Number	Analytical Method	Result	Q	LOQ	Units	Run
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)	756426-58-1	PFAS by ID SOP	ND		2.2	ug/kg	1
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3...)	763051-92-9	PFAS by ID SOP	ND		2.2	ug/kg	1
1H, 1H, 2H, 2H-perfluorodecane sulfonic acid (8:2 FTS)	39108-34-4	PFAS by ID SOP	ND		2.2	ug/kg	1
1H, 1H, 2H, 2H-perfluorooctane sulfonic acid (6:2 FTS)	27619-97-2	PFAS by ID SOP	ND		2.2	ug/kg	1
1H,1H,2H,2H-perfluorohexane sulfonic acid (4:2 FTS)	757124-72-4	PFAS by ID SOP	ND		2.2	ug/kg	1
Hexafluoropropylene oxide dimer acid (GenX)	13252-13-6	PFAS by ID SOP	ND		4.3	ug/kg	1
4,8-dioxa-3H-perfluorononanoic acid (ADONA)	919005-14-4	PFAS by ID SOP	ND		2.2	ug/kg	1
N-ethylperfluoro-1-octanesulfonamide (EtFOSA)	4151-50-2	PFAS by ID SOP	ND		2.2	ug/kg	1
N-ethylperfluoro-1-octanesulfonamidoacetic acid (EtFOSAA)	2991-50-6	PFAS by ID SOP	ND		2.2	ug/kg	1
2-N-ethylperfluoro-1-octanesulfonamido-ethanol (EtFOSE)	1691-99-2	PFAS by ID SOP	ND		2.2	ug/kg	1
N-methylperfluoro-1-octanesulfonamide (MeFOSA)	31506-32-8	PFAS by ID SOP	ND		2.2	ug/kg	1
N-methylperfluoro-1-octanesulfonamidoacetic acid (MeFOSAA)	2355-31-9	PFAS by ID SOP	ND		2.2	ug/kg	1
2-N-methylperfluoro-1-octanesulfonamido-ethanol (MeFOSE)	24448-09-7	PFAS by ID SOP	ND		2.2	ug/kg	1
Perfluoro-1-butanesulfonic acid (PFBS)	375-73-5	PFAS by ID SOP	ND		1.1	ug/kg	1
Perfluoro-1-decanesulfonic acid (PFDS)	**335-77-3**	**PFAS by ID SOP**	**5.5**		**1.1**	**ug/kg**	**1**
Perfluoro-1-heptanesulfonic acid (PFHpS)	**375-92-8**	**PFAS by ID SOP**	**1.4**		**1.1**	**ug/kg**	**1**
Perfluoro-1-nonanesulfonic acid (PFNS)	**68259-12-1**	**PFAS by ID SOP**	**2.0**		**1.1**	**ug/kg**	**1**
Perfluoro-1-octanesulfonamide (PFOSA)	**754-91-6**	**PFAS by ID SOP**	**20**		**1.1**	**ug/kg**	**1**
Perfluoro-1-pentanesulfonic acid (PFPeS)	2706-91-4	PFAS by ID SOP	ND		1.1	ug/kg	1
Perfluorododecanesulfonic acid (PFDOS)	**79780-39-5**	**PFAS by ID SOP**	**9.1**		**1.1**	**ug/kg**	**1**
Perfluorohexanesulfonic acid (PFHxS)	**355-46-4**	**PFAS by ID SOP**	**16**		**1.1**	**ug/kg**	**1**
Perfluoro-n-butanoic acid (PFBA)	375-22-4	PFAS by ID SOP	ND		1.1	ug/kg	1
Perfluoro-n-decanoic acid (PFDA)	335-76-2	PFAS by ID SOP	ND		1.1	ug/kg	1
Perfluoro-n-dodecanoic acid (PFDoA)	**307-55-1**	**PFAS by ID SOP**	**1.1**		**1.1**	**ug/kg**	**1**
Perfluoro-n-heptanoic acid (PFHpA)	375-85-9	PFAS by ID SOP	ND		1.1	ug/kg	1
Perfluoro-n-hexanoic acid (PFHxA)	**307-24-4**	**PFAS by ID SOP**	**2.4**		**1.1**	**ug/kg**	**1**
Perfluoro-n-nonanoic acid (PFNA)	375-95-1	PFAS by ID SOP	ND		1.1	ug/kg	1
Perfluoro-n-octanoic acid (PFOA)	**335-67-1**	**PFAS by ID SOP**	**2.3**		**1.1**	**ug/kg**	**1**
Perfluoro-n-pentanoic acid (PFPeA)	2706-90-3	PFAS by ID SOP	ND		1.1	ug/kg	1
Perfluoro-n-tetradecanoic acid (PFTeDA)	376-06-7	PFAS by ID SOP	ND		1.1	ug/kg	1
Perfluoro-n-tridecanoic acid (PFTrDA)	72629-94-8	PFAS by ID SOP	ND		1.1	ug/kg	1
Perfluoro-n-undecanoic acid (PFUdA)	2058-94-8	PFAS by ID SOP	ND		1.1	ug/kg	1
Perfluorooctanesulfonic acid (PFOS)	**1763-23-1**	**PFAS by ID SOP**	**150**	**S**	**1.1**	**ug/kg**	**1**

Surrogate	Q	Run 1 % Recovery	Acceptance Limits
13C2_4:2FTS		133	50-150
13C2_6:2FTS		135	50-150
13C2_8:2FTS		133	50-150
13C2_PFDoA		108	50-150
13C2_PFTeDA		106	50-150
13C3_PFBS		104	50-150
13C3_PFHxS		110	50-150
13C3-HFPO-DA		114	50-150
13C4_PFBA		104	50-150

LOQ = Limit of Quantitation | B = Detected in the method blank | E = Quantitation of compound exceeded the calibration range | Q = Surrogate failure
ND = Not detected at or above the LOQ | N = Recovery is out of criteria | P = The RPD between two GC columns exceeds 40% | L = LCS/LCSD failure
H = Out of holding time | W = Reported on wet weight basis | S = MS/MSD failure

PFAS by LC/MS/MS

Client: **3M**			Laboratory ID: **WK15017-004**
Description: **104**			Matrix: **Solid**
Date Sampled: **11/08/2021 1203**	Project Name: **3M Menomonie**		% Solids: **92.0** **11/29/2021 2339**
Date Received: **11/12/2021**	Project Number: **E21-2079**		

Surrogate	Q	Run 1 % Recovery	Acceptance Limits
13C4_PFHpA		105	50-150
13C5_PFHxA		106	50-150
13C5_PFPeA		102	50-150
13C6_PFDA		115	50-150
13C7_PFUdA		118	50-150
13C8_PFOA		104	50-150
13C8_PFOS		107	50-150
13C8_PFOSA		124	50-150
13C9_PFNA		101	50-150
d-EtFOSA		116	50-150
d5-EtFOSAA		133	50-150
d9-EtFOSE		102	50-150
d-MeFOSA		104	50-150
d3-MeFOSAA		127	50-150
d7-MeFOSE		107	50-150

LOQ = Limit of Quantitation | B = Detected in the method blank | E = Quantitation of compound exceeded the calibration range | Q = Surrogate failure
ND = Not detected at or above the LOQ | N = Recovery is out of criteria | P = The RPD between two GC columns exceeds 40% | L = LCS/LCSD failure
H = Out of holding time | W = Reported on wet weight basis | S = MS/MSD failure

QC Summary

PFAS by LC/MS/MS - MB

Sample ID:	WQ23612-001	**Matrix:**	Solid
Batch:	23612	**Prep Method:**	SOP SPE
Analytical Method:	PFAS by ID SOP (3M)	**Prep Date:**	11/24/2021 1322

Parameter	Result	Q	Dil	LOQ	Units	Analysis Date
9Cl-PF3ONS	ND		1	2.0	ug/kg	11/30/2021 1508
11Cl-PF3OUdS	ND		1	2.0	ug/kg	11/30/2021 1508
8:2 FTS	ND		1	2.0	ug/kg	11/30/2021 1508
6:2 FTS	ND		1	2.0	ug/kg	11/30/2021 1508
4:2 FTS	ND		1	2.0	ug/kg	11/30/2021 1508
GenX	ND		1	4.0	ug/kg	11/30/2021 1508
ADONA	ND		1	2.0	ug/kg	11/30/2021 1508
EtFOSA	ND		1	2.0	ug/kg	11/30/2021 1508
EtFOSAA	ND		1	2.0	ug/kg	11/30/2021 1508
EtFOSE	ND		1	2.0	ug/kg	11/30/2021 1508
MeFOSA	ND		1	2.0	ug/kg	11/30/2021 1508
MeFOSAA	ND		1	2.0	ug/kg	11/30/2021 1508
MeFOSE	ND		1	2.0	ug/kg	11/30/2021 1508
PFBS	ND		1	1.0	ug/kg	11/30/2021 1508
PFDS	ND		1	1.0	ug/kg	11/30/2021 1508
PFHpS	ND		1	1.0	ug/kg	11/30/2021 1508
PFNS	ND		1	1.0	ug/kg	11/30/2021 1508
PFOSA	ND		1	1.0	ug/kg	11/30/2021 1508
PFPeS	ND		1	1.0	ug/kg	11/30/2021 1508
PFDOS	ND		1	1.0	ug/kg	11/30/2021 1508
PFHxS	ND		1	1.0	ug/kg	11/30/2021 1508
PFBA	ND		1	1.0	ug/kg	11/30/2021 1508
PFDA	ND		1	1.0	ug/kg	11/30/2021 1508
PFDoA	ND		1	1.0	ug/kg	11/30/2021 1508
PFHpA	ND		1	1.0	ug/kg	11/30/2021 1508
PFHxA	ND		1	1.0	ug/kg	11/30/2021 1508
PFNA	ND		1	1.0	ug/kg	11/30/2021 1508
PFOA	ND		1	1.0	ug/kg	11/30/2021 1508
PFPeA	ND		1	1.0	ug/kg	11/30/2021 1508
PFTeDA	ND		1	1.0	ug/kg	11/30/2021 1508
PFTrDA	ND		1	1.0	ug/kg	11/30/2021 1508
PFUdA	ND		1	1.0	ug/kg	11/30/2021 1508
PFOS	ND		1	1.0	ug/kg	11/30/2021 1508

Surrogate	Q	% Rec	Acceptance Limit
13C2_4:2FTS		118	50-150
13C2_6:2FTS		116	50-150
13C2_8:2FTS		127	50-150
13C2_PFDoA		117	50-150
13C2_PFTeDA		107	50-150
13C3_PFBS		103	50-150
13C3_PFHxS		99	50-150
13C3-HFPO-DA		110	50-150

LOQ = Limit of Quantitation | ND = Not detected at or above the LOQ | N = Recovery is out of criteria
P = The RPD between two GC columns exceeds 40%
* = RSD is out of criteria | + = RPD is out of criteria

Note: Calculations are performed before rounding to avoid round-off errors in calculated results

PFAS by LC/MS/MS - MB

Sample ID: WQ23612-001
Batch: 23612
Analytical Method: PFAS by ID SOP (3M)

Matrix: Solid
Prep Method: SOP SPE
Prep Date: 11/24/2021 1322

Surrogate	Q	% Rec	Acceptance Limit
13C4_PFBA		104	50-150
13C4_PFHpA		103	50-150
13C5_PFHxA		104	50-150
13C5_PFPeA		109	50-150
13C6_PFDA		109	50-150
13C7_PFUdA		113	50-150
13C8_PFOA		107	50-150
13C8_PFOS		105	50-150
13C8_PFOSA		116	50-150
13C9_PFNA		103	50-150
d-EtFOSA		111	50-150
d5-EtFOSAA		122	50-150
d9-EtFOSE		117	50-150
d-MeFOSA		98	50-150
d3-MeFOSAA		116	50-150
d7-MeFOSE		116	50-150

LOQ = Limit of Quantitation
ND = Not detected at or above the LOQ
N = Recovery is out of criteria
P = The RPD between two GC columns exceeds 40%
* = RSD is out of criteria
+ = RPD is out of criteria

Note: Calculations are performed before rounding to avoid round-off errors in calculated results

PFAS by LC/MS/MS - MB

Sample ID: WQ23612-101
Batch: 23612
Analytical Method: PFAS by ID SOP (3M)

Matrix: Solid
Prep Method: SOP SPE
Prep Date: 11/24/2021 1322

Parameter	Result	Q	Dil	LOQ	Units	Analysis Date
9Cl-PF3ONS	ND		1	2.0	ug/kg	11/30/2021 1518
11Cl-PF3OUdS	ND		1	2.0	ug/kg	11/30/2021 1518
8:2 FTS	ND		1	2.0	ug/kg	11/30/2021 1518
6:2 FTS	ND		1	2.0	ug/kg	11/30/2021 1518
4:2 FTS	ND		1	2.0	ug/kg	11/30/2021 1518
GenX	ND		1	4.0	ug/kg	11/30/2021 1518
ADONA	ND		1	2.0	ug/kg	11/30/2021 1518
EtFOSA	ND		1	2.0	ug/kg	11/30/2021 1518
EtFOSAA	ND		1	2.0	ug/kg	11/30/2021 1518
EtFOSE	ND		1	2.0	ug/kg	11/30/2021 1518
MeFOSA	ND		1	2.0	ug/kg	11/30/2021 1518
MeFOSAA	ND		1	2.0	ug/kg	11/30/2021 1518
MeFOSE	ND		1	2.0	ug/kg	11/30/2021 1518
PFBS	ND		1	1.0	ug/kg	11/30/2021 1518
PFDS	ND		1	1.0	ug/kg	11/30/2021 1518
PFHpS	ND		1	1.0	ug/kg	11/30/2021 1518
PFNS	ND		1	1.0	ug/kg	11/30/2021 1518
PFOSA	ND		1	1.0	ug/kg	11/30/2021 1518
PFPeS	ND		1	1.0	ug/kg	11/30/2021 1518
PFDOS	ND		1	1.0	ug/kg	11/30/2021 1518
PFHxS	ND		1	1.0	ug/kg	11/30/2021 1518
PFBA	ND		1	1.0	ug/kg	11/30/2021 1518
PFDA	ND		1	1.0	ug/kg	11/30/2021 1518
PFDoA	ND		1	1.0	ug/kg	11/30/2021 1518
PFHpA	ND		1	1.0	ug/kg	11/30/2021 1518
PFHxA	ND		1	1.0	ug/kg	11/30/2021 1518
PFNA	ND		1	1.0	ug/kg	11/30/2021 1518
PFOA	ND		1	1.0	ug/kg	11/30/2021 1518
PFPeA	ND		1	1.0	ug/kg	11/30/2021 1518
PFTeDA	ND		1	1.0	ug/kg	11/30/2021 1518
PFTrDA	ND		1	1.0	ug/kg	11/30/2021 1518
PFUdA	ND		1	1.0	ug/kg	11/30/2021 1518
PFOS	ND		1	1.0	ug/kg	11/30/2021 1518

Surrogate	Q	% Rec	Acceptance Limit
13C2_4:2FTS		120	50-150
13C2_6:2FTS		117	50-150
13C2_8:2FTS		126	50-150
13C2_PFDoA		110	50-150
13C2_PFTeDA		109	50-150
13C3_PFBS		105	50-150
13C3_PFHxS		111	50-150
13C3-HFPO-DA		110	50-150

LOQ = Limit of Quantitation
ND = Not detected at or above the LOQ
N = Recovery is out of criteria
P = The RPD between two GC columns exceeds 40%
* = RSD is out of criteria
+ = RPD is out of criteria

Note: Calculations are performed before rounding to avoid round-off errors in calculated results

PFAS by LC/MS/MS - MB

Sample ID: WQ23612-101
Batch: 23612
Analytical Method: PFAS by ID SOP (3M)

Matrix: Solid
Prep Method: SOP SPE
Prep Date: 11/24/2021 1322

Surrogate	Q	% Rec	Acceptance Limit
13C4_PFBA		106	50-150
13C4_PFHpA		104	50-150
13C5_PFHxA		109	50-150
13C5_PFPeA		102	50-150
13C6_PFDA		109	50-150
13C7_PFUdA		113	50-150
13C8_PFOA		107	50-150
13C8_PFOS		112	50-150
13C8_PFOSA		120	50-150
13C9_PFNA		106	50-150
d-EtFOSA		108	50-150
d5-EtFOSAA		120	50-150
d9-EtFOSE		110	50-150
d-MeFOSA		102	50-150
d3-MeFOSAA		131	50-150
d7-MeFOSE		121	50-150

LOQ = Limit of Quantitation
ND = Not detected at or above the LOQ
N = Recovery is out of criteria
P = The RPD between two GC columns exceeds 40%
* = RSD is out of criteria
+ = RPD is out of criteria

Note: Calculations are performed before rounding to avoid round-off errors in calculated results

PFAS by LC/MS/MS - MB

Sample ID: WQ23612-201
Batch: 23612
Analytical Method: PFAS by ID SOP (3M)

Matrix: Solid
Prep Method: SOP SPE
Prep Date: 11/24/2021 1322

Parameter	Result	Q	Dil	LOQ	Units	Analysis Date
9Cl-PF3ONS	ND		1	2.0	ug/kg	11/30/2021 1529
11Cl-PF3OUdS	ND		1	2.0	ug/kg	11/30/2021 1529
8:2 FTS	ND		1	2.0	ug/kg	11/30/2021 1529
6:2 FTS	ND		1	2.0	ug/kg	11/30/2021 1529
4:2 FTS	ND		1	2.0	ug/kg	11/30/2021 1529
GenX	ND		1	4.0	ug/kg	11/30/2021 1529
ADONA	ND		1	2.0	ug/kg	11/30/2021 1529
EtFOSA	ND		1	2.0	ug/kg	11/30/2021 1529
EtFOSAA	ND		1	2.0	ug/kg	11/30/2021 1529
EtFOSE	ND		1	2.0	ug/kg	11/30/2021 1529
MeFOSA	ND		1	2.0	ug/kg	11/30/2021 1529
MeFOSAA	ND		1	2.0	ug/kg	11/30/2021 1529
MeFOSE	ND		1	2.0	ug/kg	11/30/2021 1529
PFBS	ND		1	1.0	ug/kg	11/30/2021 1529
PFDS	ND		1	1.0	ug/kg	11/30/2021 1529
PFHpS	ND		1	1.0	ug/kg	11/30/2021 1529
PFNS	ND		1	1.0	ug/kg	11/30/2021 1529
PFOSA	ND		1	1.0	ug/kg	11/30/2021 1529
PFPeS	ND		1	1.0	ug/kg	11/30/2021 1529
PFDOS	ND		1	1.0	ug/kg	11/30/2021 1529
PFHxS	ND		1	1.0	ug/kg	11/30/2021 1529
PFBA	ND		1	1.0	ug/kg	11/30/2021 1529
PFDA	ND		1	1.0	ug/kg	11/30/2021 1529
PFDoA	ND		1	1.0	ug/kg	11/30/2021 1529
PFHpA	ND		1	1.0	ug/kg	11/30/2021 1529
PFHxA	ND		1	1.0	ug/kg	11/30/2021 1529
PFNA	ND		1	1.0	ug/kg	11/30/2021 1529
PFOA	ND		1	1.0	ug/kg	11/30/2021 1529
PFPeA	ND		1	1.0	ug/kg	11/30/2021 1529
PFTeDA	ND		1	1.0	ug/kg	11/30/2021 1529
PFTrDA	ND		1	1.0	ug/kg	11/30/2021 1529
PFUdA	ND		1	1.0	ug/kg	11/30/2021 1529
PFOS	ND		1	1.0	ug/kg	11/30/2021 1529

Surrogate	Q	% Rec	Acceptance Limit
13C2_4:2FTS		120	50-150
13C2_6:2FTS		116	50-150
13C2_8:2FTS		123	50-150
13C2_PFDoA		107	50-150
13C2_PFTeDA		104	50-150
13C3_PFBS		105	50-150
13C3_PFHxS		110	50-150
13C3-HFPO-DA		110	50-150

LOQ = Limit of Quantitation
ND = Not detected at or above the LOQ
N = Recovery is out of criteria
P = The RPD between two GC columns exceeds 40%
* = RSD is out of criteria
+ = RPD is out of criteria

Note: Calculations are performed before rounding to avoid round-off errors in calculated results

PFAS by LC/MS/MS - MB

Sample ID: WQ23612-201
Batch: 23612
Analytical Method: PFAS by ID SOP (3M)

Matrix: Solid
Prep Method: SOP SPE
Prep Date: 11/24/2021 1322

Surrogate	Q	% Rec	Acceptance Limit
13C4_PFBA		104	50-150
13C4_PFHpA		105	50-150
13C5_PFHxA		105	50-150
13C5_PFPeA		104	50-150
13C6_PFDA		108	50-150
13C7_PFUdA		108	50-150
13C8_PFOA		105	50-150
13C8_PFOS		113	50-150
13C8_PFOSA		120	50-150
13C9_PFNA		103	50-150
d-EtFOSA		97	50-150
d5-EtFOSAA		120	50-150
d9-EtFOSE		107	50-150
d-MeFOSA		81	50-150
d3-MeFOSAA		120	50-150
d7-MeFOSE		102	50-150

LOQ = Limit of Quantitation
ND = Not detected at or above the LOQ
N = Recovery is out of criteria
P = The RPD between two GC columns exceeds 40%
* = RSD is out of criteria
+ = RPD is out of criteria

Note: Calculations are performed before rounding to avoid round-off errors in calculated results

PFAS by LC/MS/MS - LCS

Sample ID:	WQ23612-002	**Matrix:**	Solid
Batch:	23612	**Prep Method:**	SOP SPE
Analytical Method:	PFAS by ID SOP (3M)	**Prep Date:**	11/24/2021 1322

Parameter	Spike Amount (ug/kg)	Result (ug/kg)	Q	Dil	% Rec	%Rec Limit	Analysis Date
9Cl-PF3ONS	5.1	5.5		1	107	70-130	11/30/2021 1539
11Cl-PF3OUdS	5.2	5.6		1	108	70-130	11/30/2021 1539
8:2 FTS	5.3	4.7		1	90	70-130	11/30/2021 1539
6:2 FTS	5.2	5.4		1	104	70-130	11/30/2021 1539
4:2 FTS	5.1	4.8		1	93	70-130	11/30/2021 1539
GenX	11	11		1	97	70-130	11/30/2021 1539
ADONA	5.2	5.3		1	102	70-130	11/30/2021 1539
EtFOSA	5.5	5.4		1	98	70-130	11/30/2021 1539
EtFOSAA	5.5	5.3		1	96	70-130	11/30/2021 1539
EtFOSE	5.5	5.2		1	95	70-130	11/30/2021 1539
MeFOSA	5.5	5.0		1	91	70-130	11/30/2021 1539
MeFOSAA	5.5	4.9		1	90	70-130	11/30/2021 1539
MeFOSE	5.5	4.3		1	79	70-130	11/30/2021 1539
PFBS	4.9	4.6		1	95	70-130	11/30/2021 1539
PFDS	5.3	6.1		1	114	70-130	11/30/2021 1539
PFHpS	5.2	5.1		1	97	70-130	11/30/2021 1539
PFNS	5.3	5.6		1	107	70-130	11/30/2021 1539
PFOSA	5.5	5.2		1	95	70-130	11/30/2021 1539
PFPeS	5.2	5.0		1	97	70-130	11/30/2021 1539
PFDOS	5.3	5.8		1	110	70-130	11/30/2021 1539
PFHxS	5.0	5.1		1	101	70-130	11/30/2021 1539
PFBA	5.5	5.4		1	99	70-130	11/30/2021 1539
PFDA	5.5	5.3		1	96	70-130	11/30/2021 1539
PFDoA	5.5	4.8		1	87	70-130	11/30/2021 1539
PFHpA	5.5	5.8		1	105	70-130	11/30/2021 1539
PFHxA	5.5	5.6		1	101	70-130	11/30/2021 1539
PFNA	5.5	5.5		1	99	70-130	11/30/2021 1539
PFOA	5.5	5.7		1	104	70-130	11/30/2021 1539
PFPeA	5.5	5.7		1	104	70-130	11/30/2021 1539
PFTeDA	5.5	5.7		1	104	70-130	11/30/2021 1539
PFTrDA	5.5	4.8		1	88	70-130	11/30/2021 1539
PFUdA	5.5	5.0		1	92	70-130	11/30/2021 1539
PFOS	5.1	5.7		1	112	70-130	11/30/2021 1539

Surrogate	Q	% Rec	Acceptance Limit
13C2_4:2FTS		118	50-150
13C2_6:2FTS		116	50-150
13C2_8:2FTS		112	50-150
13C2_PFDoA		118	50-150
13C2_PFTeDA		104	50-150
13C3_PFBS		101	50-150
13C3_PFHxS		106	50-150
13C3-HFPO-DA		115	50-150

LOQ = Limit of Quantitation　ND = Not detected at or above the LOQ　N = Recovery is out of criteria

P = The RPD between two GC columns exceeds 40%

* = RSD is out of criteria　+ = RPD is out of criteria

Note: Calculations are performed before rounding to avoid round-off errors in calculated results

PFAS by LC/MS/MS - LCS

Sample ID: WQ23612-002
Batch: 23612
Analytical Method: PFAS by ID SOP (3M)

Matrix: Solid
Prep Method: SOP SPE
Prep Date: 11/24/2021 1322

Surrogate	Q	% Rec	Acceptance Limit
13C4_PFBA		99	50-150
13C4_PFHpA		99	50-150
13C5_PFHxA		99	50-150
13C5_PFPeA		101	50-150
13C6_PFDA		107	50-150
13C7_PFUdA		112	50-150
13C8_PFOA		105	50-150
13C8_PFOS		96	50-150
13C8_PFOSA		114	50-150
13C9_PFNA		102	50-150
d-EtFOSA		102	50-150
d5-EtFOSAA		120	50-150
d9-EtFOSE		105	50-150
d-MeFOSA		105	50-150
d3-MeFOSAA		115	50-150
d7-MeFOSE		117	50-150

LOQ = Limit of Quantitation
ND = Not detected at or above the LOQ
N = Recovery is out of criteria
P = The RPD between two GC columns exceeds 40%
* = RSD is out of criteria
+ = RPD is out of criteria

Note: Calculations are performed before rounding to avoid round-off errors in calculated results

PFAS by LC/MS/MS - LCS

Sample ID: WQ23612-102
Batch: 23612
Analytical Method: PFAS by ID SOP (3M)
Matrix: Solid
Prep Method: SOP SPE
Prep Date: 11/24/2021 1322

Parameter	Spike Amount (ug/kg)	Result (ug/kg)	Q	Dil	% Rec	%Rec Limit	Analysis Date
9Cl-PF3ONS	51	51		1	100	70-130	11/30/2021 1550
11Cl-PF3OUdS	52	56		1	107	70-130	11/30/2021 1550
8:2 FTS	53	49		1	94	70-130	11/30/2021 1550
6:2 FTS	52	50		1	95	70-130	11/30/2021 1550
4:2 FTS	51	44		1	85	70-130	11/30/2021 1550
GenX	110	100		1	95	70-130	11/30/2021 1550
ADONA	52	49		1	96	70-130	11/30/2021 1550
EtFOSA	55	45		1	82	70-130	11/30/2021 1550
EtFOSAA	55	54		1	98	70-130	11/30/2021 1550
EtFOSE	55	49		1	90	70-130	11/30/2021 1550
MeFOSA	55	56		1	101	70-130	11/30/2021 1550
MeFOSAA	55	49		1	89	70-130	11/30/2021 1550
MeFOSE	55	45		1	83	70-130	11/30/2021 1550
PFBS	49	48		1	98	70-130	11/30/2021 1550
PFDS	53	54		1	101	70-130	11/30/2021 1550
PFHpS	52	47		1	89	70-130	11/30/2021 1550
PFNS	53	49		1	93	70-130	11/30/2021 1550
PFOSA	55	51		1	93	70-130	11/30/2021 1550
PFPeS	52	52		1	101	70-130	11/30/2021 1550
PFDOS	53	55		1	103	70-130	11/30/2021 1550
PFHxS	50	48		1	96	70-130	11/30/2021 1550
PFBA	55	53		1	97	70-130	11/30/2021 1550
PFDA	55	52		1	95	70-130	11/30/2021 1550
PFDoA	55	52		1	95	70-130	11/30/2021 1550
PFHpA	55	56		1	103	70-130	11/30/2021 1550
PFHxA	55	51		1	93	70-130	11/30/2021 1550
PFNA	55	51		1	93	70-130	11/30/2021 1550
PFOA	55	55		1	100	70-130	11/30/2021 1550
PFPeA	55	55		1	99	70-130	11/30/2021 1550
PFTeDA	55	54		1	99	70-130	11/30/2021 1550
PFTrDA	55	54		1	99	70-130	11/30/2021 1550
PFUdA	55	55		1	100	70-130	11/30/2021 1550
PFOS	51	52		1	102	70-130	11/30/2021 1550

Surrogate	Q	% Rec	Acceptance Limit
13C2_4:2FTS		119	50-150
13C2_6:2FTS		111	50-150
13C2_8:2FTS		101	50-150
13C2_PFDoA		97	50-150
13C2_PFTeDA		104	50-150
13C3_PFBS		100	50-150
13C3_PFHxS		103	50-150
13C3-HFPO-DA		115	50-150

LOQ = Limit of Quantitation
ND = Not detected at or above the LOQ
N = Recovery is out of criteria
P = The RPD between two GC columns exceeds 40%
* = RSD is out of criteria
+ = RPD is out of criteria

Note: Calculations are performed before rounding to avoid round-off errors in calculated results

PFAS by LC/MS/MS - LCS

Sample ID: WQ23612-102
Batch: 23612
Analytical Method: PFAS by ID SOP (3M)

Matrix: Solid
Prep Method: SOP SPE
Prep Date: 11/24/2021 1322

Surrogate	Q	% Rec	Acceptance Limit
13C4_PFBA		96	50-150
13C4_PFHpA		98	50-150
13C5_PFHxA		104	50-150
13C5_PFPeA		98	50-150
13C6_PFDA		101	50-150
13C7_PFUdA		101	50-150
13C8_PFOA		98	50-150
13C8_PFOS		99	50-150
13C8_PFOSA		107	50-150
13C9_PFNA		103	50-150
d-EtFOSA		103	50-150
d5-EtFOSAA		111	50-150
d9-EtFOSE		103	50-150
d-MeFOSA		88	50-150
d3-MeFOSAA		115	50-150
d7-MeFOSE		107	50-150

LOQ = Limit of Quantitation
ND = Not detected at or above the LOQ
N = Recovery is out of criteria
P = The RPD between two GC columns exceeds 40%
* = RSD is out of criteria
+ = RPD is out of criteria

Note: Calculations are performed before rounding to avoid round-off errors in calculated results

PFAS by LC/MS/MS - LCS

Sample ID: WQ23612-202
Batch: 23612
Analytical Method: PFAS by ID SOP (3M)

Matrix: Solid
Prep Method: SOP SPE
Prep Date: 11/24/2021 1322

Parameter	Spike Amount (ug/kg)	Result (ug/kg)	Q	Dil	% Rec	% RSD	%Rec Limit	% RSD Limit	Analysis Date
9Cl-PF3ONS	140	140		1	99	4.3	70-130	20	11/30/2021 1600
11Cl-PF3OUdS	140	150		1	103	2.6	70-130	20	11/30/2021 1600
8:2 FTS	140	120		1	83	6.3	70-130	20	11/30/2021 1600
6:2 FTS	140	120		1	81	12	70-130	20	11/30/2021 1600
4:2 FTS	140	130		1	96	6.1	70-130	20	11/30/2021 1600
GenX	300	300		1	99	2.0	70-130	20	11/30/2021 1600
ADONA	140	140		1	99	3.5	70-130	20	11/30/2021 1600
EtFOSA	150	130		1	89	8.9	70-130	20	11/30/2021 1600
EtFOSAA	150	150		1	102	2.7	70-130	20	11/30/2021 1600
EtFOSE	150	150		1	99	5.1	70-130	20	11/30/2021 1600
MeFOSA	150	160		1	106	7.6	70-130	20	11/30/2021 1600
MeFOSAA	150	140		1	94	3.1	70-130	20	11/30/2021 1600
MeFOSE	150	120		1	83	3.0	70-130	20	11/30/2021 1600
PFBS	130	130		1	98	1.6	70-130	20	11/30/2021 1600
PFDS	140	140		1	99	7.7	70-130	20	11/30/2021 1600
PFHpS	140	140		1	97	4.5	70-130	20	11/30/2021 1600
PFNS	140	130		1	90	9.2	70-130	20	11/30/2021 1600
PFOSA	150	130		1	89	3.4	70-130	20	11/30/2021 1600
PFPeS	140	150		1	103	3.4	70-130	20	11/30/2021 1600
PFDOS	150	140		1	99	5.1	70-130	20	11/30/2021 1600
PFHxS	140	130		1	98	2.7	70-130	20	11/30/2021 1600
PFBA	150	150		1	97	1.2	70-130	20	11/30/2021 1600
PFDA	150	160		1	104	4.8	70-130	20	11/30/2021 1600
PFDoA	150	140		1	91	4.5	70-130	20	11/30/2021 1600
PFHpA	150	150		1	100	2.4	70-130	20	11/30/2021 1600
PFHxA	150	140		1	93	4.8	70-130	20	11/30/2021 1600
PFNA	150	140		1	94	3.6	70-130	20	11/30/2021 1600
PFOA	150	150		1	100	2.3	70-130	20	11/30/2021 1600
PFPeA	150	150		1	99	2.8	70-130	20	11/30/2021 1600
PFTeDA	150	140		1	96	4.0	70-130	20	11/30/2021 1600
PFTrDA	150	140		1	95	6.2	70-130	20	11/30/2021 1600
PFUdA	150	150		1	97	4.4	70-130	20	11/30/2021 1600
PFOS	140	140		1	99	6.3	70-130	20	11/30/2021 1600

Surrogate	Q	% Rec	Acceptance Limit
13C2_4:2FTS		106	50-150
13C2_6:2FTS		110	50-150
13C2_8:2FTS		107	50-150
13C2_PFDoA		104	50-150
13C2_PFTeDA		100	50-150
13C3_PFBS		97	50-150
13C3_PFHxS		97	50-150
13C3-HFPO-DA		103	50-150

LOQ = Limit of Quantitation   ND = Not detected at or above the LOQ   N = Recovery is out of criteria

P = The RPD between two GC columns exceeds 40%

* = RSD is out of criteria   + = RPD is out of criteria

Note: Calculations are performed before rounding to avoid round-off errors in calculated results

PFAS by LC/MS/MS - LCS

Sample ID: WQ23612-202
Batch: 23612
Analytical Method: PFAS by ID SOP (3M)

Matrix: Solid
Prep Method: SOP SPE
Prep Date: 11/24/2021 1322

Surrogate	Q	% Rec	Acceptance Limit
13C4_PFBA		93	50-150
13C4_PFHpA		97	50-150
13C5_PFHxA		97	50-150
13C5_PFPeA		94	50-150
13C6_PFDA		89	50-150
13C7_PFUdA		95	50-150
13C8_PFOA		91	50-150
13C8_PFOS		99	50-150
13C8_PFOSA		111	50-150
13C9_PFNA		98	50-150
d-EtFOSA		101	50-150
d5-EtFOSAA		103	50-150
d9-EtFOSE		98	50-150
d-MeFOSA		91	50-150
d3-MeFOSAA		115	50-150
d7-MeFOSE		114	50-150

LOQ = Limit of Quantitation
ND = Not detected at or above the LOQ
N = Recovery is out of criteria
P = The RPD between two GC columns exceeds 40%
* = RSD is out of criteria
+ = RPD is out of criteria

Note: Calculations are performed before rounding to avoid round-off errors in calculated results

PFAS by LC/MS/MS - MS

Sample ID: WK15017-004MS | **Matrix:** Solid
Batch: 23612 | **Prep Method:** SOP SPE
Analytical Method: PFAS by ID SOP (3M) | **Prep Date:** 11/24/2021 1322

Parameter	Sample Amount (ug/kg)	Spike Amount (ug/kg)	Result (ug/kg)	Q	Dil	% Rec	%Rec Limit	Analysis Date
9Cl-PF3ONS	ND	48	41		1	85	70-130	11/30/2021 1653
11Cl-PF3OUdS	ND	49	45		1	91	70-130	11/30/2021 1653
8:2 FTS	ND	50	37		1	75	70-130	11/30/2021 1653
6:2 FTS	ND	49	41		1	83	70-130	11/30/2021 1653
4:2 FTS	ND	49	38		1	79	70-130	11/30/2021 1653
GenX	ND	100	96		1	92	70-130	11/30/2021 1653
ADONA	ND	49	43		1	88	70-130	11/30/2021 1653
EtFOSA	ND	52	41		1	80	70-130	11/30/2021 1653
EtFOSAA	ND	52	43		1	83	70-130	11/30/2021 1653
EtFOSE	ND	52	40		1	77	70-130	11/30/2021 1653
MeFOSA	ND	52	52		1	99	70-130	11/30/2021 1653
MeFOSAA	ND	52	40		1	77	70-130	11/30/2021 1653
MeFOSE	ND	52	40		1	78	70-130	11/30/2021 1653
PFBS	ND	46	41		1	89	70-130	11/30/2021 1653
PFDS	5.5	50	49		1	86	70-130	11/30/2021 1653
PFHpS	1.4	50	45		1	87	70-130	11/30/2021 1653
PFNS	2.0	50	42		1	81	70-130	11/30/2021 1653
PFOSA	20	52	60		1	76	70-130	11/30/2021 1653
PFPeS	ND	49	42		1	87	70-130	11/30/2021 1653
PFDOS	9.1	50	51		1	83	70-130	11/30/2021 1653
PFHxS	16	47	54		1	81	70-130	11/30/2021 1653
PFBA	ND	52	46		1	88	70-130	11/30/2021 1653
PFDA	ND	52	42		1	81	70-130	11/30/2021 1653
PFDoA	1.1	52	45		1	86	70-130	11/30/2021 1653
PFHpA	ND	52	45		1	87	70-130	11/30/2021 1653
PFHxA	2.4	52	49		1	89	70-130	11/30/2021 1653
PFNA	ND	52	47		1	90	70-130	11/30/2021 1653
PFOA	2.3	52	45		1	83	70-130	11/30/2021 1653
PFPeA	ND	52	46		1	89	70-130	11/30/2021 1653
PFTeDA	ND	52	46		1	88	70-130	11/30/2021 1653
PFTrDA	ND	52	48		1	93	70-130	11/30/2021 1653
PFUdA	ND	52	42		1	80	70-130	11/30/2021 1653
PFOS	150	48	180	N	1	52	70-130	11/30/2021 1653

Surrogate	Q	% Rec	Acceptance Limit
13C2_4:2FTS		113	50-150
13C2_6:2FTS		109	50-150
13C2_8:2FTS		117	50-150
13C2_PFDoA		93	50-150
13C2_PFTeDA		101	50-150
13C3_PFBS		98	50-150
13C3_PFHxS		99	50-150
13C3-HFPO-DA		108	50-150

LOQ = Limit of Quantitation
ND = Not detected at or above the LOQ
N = Recovery is out of criteria
P = The RPD between two GC columns exceeds 40%
* = RSD is out of criteria
+ = RPD is out of criteria

Note: Calculations are performed before rounding to avoid round-off errors in calculated results

PFAS by LC/MS/MS - MS

Sample ID: WK15017-004MS
Batch: 23612
Analytical Method: PFAS by ID SOP (3M)

Matrix: Solid
Prep Method: SOP SPE
Prep Date: 11/24/2021 1322

Surrogate	Q	% Rec	Acceptance Limit
13C4_PFBA		95	50-150
13C4_PFHpA		99	50-150
13C5_PFHxA		95	50-150
13C5_PFPeA		96	50-150
13C6_PFDA		103	50-150
13C7_PFUdA		106	50-150
13C8_PFOA		98	50-150
13C8_PFOS		99	50-150
13C8_PFOSA		114	50-150
13C9_PFNA		91	50-150
d-EtFOSA		97	50-150
d5-EtFOSAA		112	50-150
d9-EtFOSE		99	50-150
d-MeFOSA		81	50-150
d3-MeFOSAA		125	50-150
d7-MeFOSE		100	50-150

LOQ = Limit of Quantitation
ND = Not detected at or above the LOQ
N = Recovery is out of criteria
P = The RPD between two GC columns exceeds 40%
* = RSD is out of criteria
+ = RPD is out of criteria

Note: Calculations are performed before rounding to avoid round-off errors in calculated results

PFAS by LC/MS/MS - MSD

Sample ID: WK15017-004MD
Batch: 23612
Analytical Method: PFAS by ID SOP (3M)

Matrix: Solid
Prep Method: SOP SPE
Prep Date: 11/24/2021 1322

Parameter	Sample Amount (ug/kg)	Spike Amount (ug/kg)	Result (ug/kg)	Q	Dil	% Rec	% RPD	%Rec Limit	% RPD Limit	Analysis Date
9Cl-PF3ONS	ND	47	41		1	86	1.8	70-130	30	11/30/2021 1704
11Cl-PF3OUdS	ND	48	40		1	84	11	70-130	30	11/30/2021 1704
8:2 FTS	ND	49	36		1	74	3.5	70-130	30	11/30/2021 1704
6:2 FTS	ND	48	42		1	87	2.6	70-130	30	11/30/2021 1704
4:2 FTS	ND	47	39		1	83	2.3	70-130	30	11/30/2021 1704
GenX	ND	100	84		1	83	13	70-130	30	11/30/2021 1704
ADONA	ND	48	40		1	84	6.6	70-130	30	11/30/2021 1704
EtFOSA	ND	51	39		1	77	6.5	70-130	30	11/30/2021 1704
EtFOSAA	ND	51	46		1	91	6.8	70-130	30	11/30/2021 1704
EtFOSE	ND	51	43		1	85	8.3	70-130	30	11/30/2021 1704
MeFOSA	ND	51	48		1	95	7.3	70-130	30	11/30/2021 1704
MeFOSAA	ND	51	41		1	81	2.6	70-130	30	11/30/2021 1704
MeFOSE	ND	51	38		1	76	5.2	70-130	30	11/30/2021 1704
PFBS	ND	45	40		1	88	3.2	70-130	30	11/30/2021 1704
PFDS	5.5	49	48		1	87	0.97	70-130	30	11/30/2021 1704
PFHpS	1.4	48	42		1	84	5.5	70-130	30	11/30/2021 1704
PFNS	2.0	49	43		1	85	2.7	70-130	30	11/30/2021 1704
PFOSA	20	51	64		1	86	6.1	70-130	30	11/30/2021 1704
PFPeS	ND	48	42		1	89	0.49	70-130	30	11/30/2021 1704
PFDOS	9.1	49	54		1	91	4.9	70-130	30	11/30/2021 1704
PFHxS	16	46	55		1	83	0.36	70-130	30	11/30/2021 1704
PFBA	ND	51	43		1	85	5.8	70-130	30	11/30/2021 1704
PFDA	ND	51	47		1	94	13	70-130	30	11/30/2021 1704
PFDoA	1.1	51	46		1	90	1.6	70-130	30	11/30/2021 1704
PFHpA	ND	51	45		1	89	0.064	70-130	30	11/30/2021 1704
PFHxA	2.4	51	45		1	85	7.8	70-130	30	11/30/2021 1704
PFNA	ND	51	43		1	85	7.7	70-130	30	11/30/2021 1704
PFOA	2.3	51	46		1	87	1.7	70-130	30	11/30/2021 1704
PFPeA	ND	51	45		1	89	3.2	70-130	30	11/30/2021 1704
PFTeDA	ND	51	46		1	90	0.77	70-130	30	11/30/2021 1704
PFTrDA	ND	51	45		1	90	6.2	70-130	30	11/30/2021 1704
PFUdA	ND	51	38		1	75	8.9	70-130	30	11/30/2021 1704
PFOS	150	47	190		1	82	7.3	70-130	30	11/30/2021 1704

Surrogate	Q	% Rec	Acceptance Limit
13C2_4:2FTS		101	50-150
13C2_6:2FTS		107	50-150
13C2_8:2FTS		110	50-150
13C2_PFDoA		93	50-150
13C2_PFTeDA		96	50-150
13C3_PFBS		94	50-150
13C3_PFHxS		96	50-150
13C3-HFPO-DA		102	50-150

LOQ = Limit of Quantitation
ND = Not detected at or above the LOQ
N = Recovery is out of criteria
P = The RPD between two GC columns exceeds 40%
* = RSD is out of criteria
+ = RPD is out of criteria

Note: Calculations are performed before rounding to avoid round-off errors in calculated results

PFAS by LC/MS/MS - MSD

Sample ID: WK15017-004MD
Batch: 23612
Analytical Method: PFAS by ID SOP (3M)

Matrix: Solid
Prep Method: SOP SPE
Prep Date: 11/24/2021 1322

Surrogate	Q	% Rec	Acceptance Limit
13C4_PFBA		93	50-150
13C4_PFHpA		92	50-150
13C5_PFHxA		94	50-150
13C5_PFPeA		94	50-150
13C6_PFDA		92	50-150
13C7_PFUdA		108	50-150
13C8_PFOA		87	50-150
13C8_PFOS		93	50-150
13C8_PFOSA		101	50-150
13C9_PFNA		88	50-150
d-EtFOSA		99	50-150
d5-EtFOSAA		100	50-150
d9-EtFOSE		97	50-150
d-MeFOSA		83	50-150
d3-MeFOSAA		105	50-150
d7-MeFOSE		101	50-150

LOQ = Limit of Quantitation
ND = Not detected at or above the LOQ
N = Recovery is out of criteria
P = The RPD between two GC columns exceeds 40%
* = RSD is out of criteria
+ = RPD is out of criteria

Note: Calculations are performed before rounding to avoid round-off errors in calculated results

Chain of Custody

and

Miscellaneous Documents

3M EHS Laboratory Managed Outsourced Testing

Shipping Address: Pace Analytical Services, LLC, 106 Vantage Point Drive, West Columbia, SC 29172

Telephone: Pace Project Manager: Cathy Dover

Chain of Custody / Request for Laboratory Analytical Services

Project ID/Project Name 3M Menomonie Environmental Release	
Template # NA	Final Report Due Date: Standard TAT
Project Lead Sue Wolf	Internal Due Date NA
Dept. # (main) 125962	Class/Job/Project # NA

3M EHS Lab Project # For Internal Use Only: **E21-2079**

Report Results to:

Contact Name Brad Luedtke	Date Available
Company 3M Menomonie	
Mailing Address	Date Due
City State, Zip	
Telephone # FAX #	Contract Lab

Special Instructions and/or Specific Regulatory Requirements: Questions regarding the analysis of these samples should be directed to the 3M Project Lead: Susan Wolf 651-733-6851, slwolf@mmm.com

For water samples, collect 2, 250-mL bottles.

Analysis Requested: Complete below. Attach any associated information.

Contact 3M EHS Lab project lead for target analytes, reporting limit and reporting units

(Enter an 'X' in the box below to indicate request)

WK15017

Item #	Client Sample Identification	3M LIMS #	Date Sampled	Time Sampled	Matrix/media	Preservatives: HNO_3	H_2SO_4	VOCs	None	Other	Total Number of Containers
						Enter the number of containers of each					
1.	101		11/8/21	10:45					X		
2.	102		11/8/21	10:48					X		
3.	103		11/8/21	11:00					X		
4.	104		11/8/21	12:03					X		
5.											
6.											
7.											
8.											
9.											
10.											

Chain of Custody

Collected by (print): Brad Luedtke Collector's signature: Brad L

Item #	Relinquished by/Affiliation	Time	Date	Shipped Via:	Received By/Affiliation	Time	Date
1-4	Brad Luedtke/3M	11:30	11/9/21	UPS			
	UPS	1000	[illegible]		[signature]	1000	[illegible]

Sample Condition Upon Receipt: O Acceptable O Other:

Temperature: °C O Received on Ice

Other Associated CoCs:

Copies to:

Comments: T= 6.°C

Page 1 Of 1 Original - Accompanying Samples Last Page - Originator See Reverse Side for Instructions

PaceAnalytical

Samples Receipt Checklist (SRC) (ME0018C-15)
Issuing Authority: Pace ENV - WCOL

Revised:9/29/2020
Page 1 of 1

Sample Receipt Checklist (SRC)

Client: 3M   Cooler Inspected by/date: KSC / 11/15/2021   Lot #: WK15017

Means of receipt: [ ] Pace [ ] Client [✓] UPS [ ] FedEx [ ] Other:

[ ] Yes	[✓] No		1. Were custody seals present on the cooler?
[ ] Yes	[ ] No	[✓] NA	2. If custody seals were present, were they intact and unbroken?

pH Strip ID: NA   Chlorine Strip ID: NA   Tested by: NA

Original temperature upon receipt / Derived (Corrected) temperature upon receipt   %Solid Snap-Cup ID: 21-2661

6.4 / 6.4 °C   NA / NA °C   NA / NA °C   NA / NA °C

Method: [ ] Temperature Blank [✓] Against Bottles   IR Gun ID: 5   IR Gun Correction Factor: 0 °C

Method of coolant: [✓] Wet Ice [ ] Ice Packs [ ] Dry Ice [ ] None

[ ] Yes	[ ] No	[✓] NA	3. If temperature of any cooler exceeded 6.0°C, was Project Manager Notified? PM was Notified by: phone / email / face-to-face (circle one).
[ ] Yes	[✓] No	[ ] NA	4. Is the commercial courier's packing slip attached to this form?
[✓] Yes	[ ] No		5. Were proper custody procedures (relinquished/received) followed?
[✓] Yes	[ ] No		6. Were sample IDs listed on the COC?
[✓] Yes	[ ] No		7. Were sample IDs listed on all sample containers?
[✓] Yes	[ ] No		8. Was collection date & time listed on the COC?
[✓] Yes	[ ] No		9. Was collection date & time listed on all sample containers?
[✓] Yes	[ ] No		10. Did all container label information (ID, date, time) agree with the COC?
[✓] Yes	[ ] No		11. Were tests to be performed listed on the COC?
[✓] Yes	[ ] No		12. Did all samples arrive in the proper containers for each test and/or in good condition (unbroken, lids on, etc.)?
[✓] Yes	[ ] No		13. Was adequate sample volume available?
[ ] Yes	[✓] No		14. Were all samples received within ½ the holding time or 48 hours, whichever comes first?
[ ] Yes	[✓] No		15. Were any samples containers missing/excess (circle one) samples Not listed on COC?
[ ] Yes	[ ] No	[✓] NA	16. For VOA and RSK-175 samples, were bubbles present >"pea-size" (¼"or 6mm in diameter) in any of the VOA vials?
[ ] Yes	[ ] No	[✓] NA	17. Were all DRO/metals/nutrient samples received at a pH of < 2?
[ ] Yes	[ ] No	[✓] NA	18. Were all cyanide samples received at a pH > 12 and sulfide samples received at a pH > 9?
[ ] Yes	[ ] No	[✓] NA	19. Were all applicable NH_3/TKN/cyanide/phenol/625.1/608.3 (< 0.5mg/L) samples free of residual chlorine?
[ ] Yes	[ ] No	[✓] NA	20. Were client remarks/requests (i.e. requested dilutions, MS/MSD designations, etc…) correctly transcribed from the COC into the comment section in LIMS?
[ ] Yes	[✓] No		21. Was the quote number listed on the container label? If yes, Quote #

Sample Preservation (Must be completed for any sample(s) incorrectly preserved or with headspace.)

Sample(s) NA were received incorrectly preserved and were adjusted accordingly in sample receiving with NA mL of circle one: H2SO4, HNO3, HCl, NaOH using SR # NA.
Time of preservation NA. If more than one preservative is needed, please note in the comments below.

Sample(s) NA were received with bubbles >6 mm in diameter.

Samples(s) NA were received with TRC > 0.5 mg/L (If #19 is *no*) and were adjusted accordingly in sample receiving with sodium thiosulfate ($Na_2S_2O_3$) with Shealy ID: NA.

SR barcode labels applied by: KSC   Date: 11/15/2021

Comments: ice was melted

Waste Manifest

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST	1. Generator ID Number	2. Page 1 of	3. Emergency Response Phone	4. Manifest Tracking Number
	WID078673084	1	(800) 483-3718	010502241 FLE

GENERATOR

5. Generator's Name and Mailing Address
3M Corp
1425 Stokke Pkwy Dept 128 Attn Karen Donnelly
Menomonie, WI 54751
Generator's Phone: (715) 578-2415 ATTN David Cotts

Generator's Site Address (if different than mailing address)
1425 Stokke Pkwy Dept 128
Menomonie, WI 54751
CKE100031492

6. Transporter 1 Company Name: ~~Clean Harbors Environmental Services, Inc~~ BASQ
U.S. EPA ID Number: ~~MAD039322250~~

7. Transporter 2 Company Name
U.S. EPA ID Number

8. Designated Facility Name and Site Address
Clean Harbors Environmental Services, Inc
2247 South Highway 71
Kimball, NE 69145
Facility's Phone: (308) 235-4012
U.S. EPA ID Number: NED981723513

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes
	1. NON-REGULATED SOLID, (LITE WATER)	1	CM	DRC 22,100	DRC Lbs	
	2.					
	3.					
	4.					

14. Special Handling Instructions and Additional Information

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: David R. Cotts
Signature: David R. Cotts
Month 01 Day 11 Year 2022

INT'L

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.:

TRANSPORTER

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: Ron Murphy
Signature: Ron Murphy
Month 1 Day 11 Year 22

Transporter 2 Printed/Typed Name
Signature
Month Day Year

DESIGNATED FACILITY

18. Discrepancy
18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:

18b. Alternate Facility (or Generator)
U.S. EPA ID Number
Facility's Phone:

18c. Signature of Alternate Facility (or Generator)
Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)

1.	2.	3.	4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name
Signature
Month Day Year

Appendix B
Laboratory Method Detection Limits

Pace Analytical Services, LLC
1700 Elm Street SE, Suite 200| Minneapolis, MN 55414
(Main Line) 612-607-1700
www.pacelabs.com

			Water		Soil		Low level Control limits			Medium level Control limits		
Analyte	**Acronym**	**CAS#**	**MDL (ng/L)**	**PRL (ng/L)**	**MDL (ng/Kg)**	**PRL (ng/Kg)**	**Lower**	**Upper**	**RPD**	**Lower**	**Upper**	**RPD**
Perfluorobutanoic acid	PFBA	375-22-4	0.498	2.00	28.3	100	50	150	30	60	135	30
Perfluoropentanoic acid	PFPeA	2706-90-3	0.821	2.00	28.5	100	50	150	30	60	135	30
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	0.493	2.00	27.8	100	50	150	30	60	135	30
Perfluorobutanesulfonic acid	PFBS	375-73-5	0.485	1.77	26.3	89	50	150	30	60	135	30
Perfluorohexanoic acid	PFHxA	307-24-4	0.910	2.00	27.5	100	50	150	30	60	135	30
Fluorotelomer sulphonic acid 4:2	4:2FTS	757124-72-4	0.466	1.87	23.1	94	50	150	30	60	135	30
Perfluoropentanesulfonic acid	PFPeS	2706-91-4	0.601	1.88	24.0	94	50	150	30	60	135	30
Perfluoroheptanoic acid	PFHpA	375-85-9	0.689	2.00	34.7	100	50	150	30	60	135	30
4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	0.918	1.89	36.3	95	50	150	30	60	135	30
Perfluorohexanesulfonic acid	PFHxS	355-46-4	0.531	1.82	21.9	91	50	150	30	60	135	30
Perfluorooctanoic acid	PFOA	335-67-1	0.860	2.00	31.1	100	50	150	30	60	135	30
Fluorotelomer sulphonic acid 6:2	6:2FTS	27619-97-2	0.675	1.90	41.4	95	50	150	30	60	135	30
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	0.668	1.90	27.8	95	50	150	30	60	135	30
Perfluorononanoic acid	PFNA	375-95-1	0.794	2.00	31.1	100	50	150	30	60	135	30
Perfluorooctanesulfonamide	PFOSAm	754-91-6	0.717	2.00	29.4	100	50	150	30	60	135	30
Perfluorooctanesulfonic acid	PFOS	1763-23-1	0.666	1.85	29.6	93	50	150	30	60	135	30
N-methylperfluorooctane sulfomide	N-MeFOSA	31506-32-8	0.552	2.00	27.2	100	50	150	30	60	135	30
Perfluorodecanoic acid	PFDA	335-76-2	0.608	2.00	22.8	100	50	150	30	60	135	30
N-ethylperfluorooctane sulfomide	N-EtFOSA	4151-50-2	0.574	2.00	25.6	100	50	150	30	60	135	30
Fluorotelomer sulphonic acid 8:2	8:2FTS	39108-34-4	0.504	1.93	43.9	97	50	150	30	60	135	30
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	0.470	1.86	25.1	93	50	150	30	60	135	30
Perfluorononanesulfonic acid	PFNS	68259-12-1	0.586	1.92	34.7	96	50	150	30	60	135	30
Perfluoroundecanoic acid	PFUdA or PFUnA	2058-94-8	0.486	2.00	30.2	100	50	150	30	60	135	30
N-methyl perfluorooctane sulfonamidoacetic acid	N-MeFOSAA	2355-31-9	0.694	2.00	28.1	100	50	150	30	60	135	30
N-ethyl perfluorooctane sulfonamidoacetic acid	N-EtFOSAA	2991-50-6	0.816	2.00	40.2	100	50	150	30	60	135	30
Perfluorodecanesulfonic acid	PFDS	335-77-3	0.641	1.93	28.2	97	50	150	30	60	135	30
Perfluorododecanoic acid	PFDoA	307-55-1	0.480	2.00	32.9	100	50	150	30	60	135	30
N-methylperfluorooctane sulfomidoethanol	N-MeFOSE	24448-09-7	0.521	2.00	30.3	100	50	150	30	60	135	30
10:2 Fluorotelomer sulfonic acid	10:2 FTS	120226-60-0	0.918	1.93	44.2	97	50	150	30	60	135	30
N-ethylperfluorooctane sulfomidoethanol	N-EtFOSE	1691-99-2	0.889	2.00	32.2	100	50	150	30	60	135	30
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	0.556	1.88	25.3	94	50	150	30	60	135	30
Perfluorotridecanoic acid	PFTrDA	72629-94-8	0.622	2.00	31.9	100	50	150	30	60	135	30
Perfluorododecanesulfonic acid	PFDoS	79780-39-5	0.591	1.94	26.1	97	50	150	30	60	135	30
Perfluorotetradecanoic acid	PFTeDA	376-06-7	0.600	2.00	34.3	100	50	150	30	60	135	30
Perfluorohexadecanoic acid	PFHxDA	67905-19-5	0.450	2.00	26.7	100	50	150	30	60	135	30
Perfluorooctadecanoic acid	PFODA	16517-11-6	0.616	2.00	32.7	100	50	150	30	60	135	30

			Control limits	
Extracted Internal Standard			**Lower**	**Upper**
Perfluoro-n-[13C4]butanoic acid	13C4_PFBA		50	150
Perfluoro-n-[13C5]pentanoic acid	13C5_PFPeA		50	150
Perfluoro-n-[2,3,4-13C3]butanesulfonic acid	13C3_PFBS		50	150
Fluorotelomer-n-[1,2-13C2] sulphonic acid 4:2	13C2_4:2FTS		50	150
Perfluoro-n-[1,2,3,4,6-13C5]hexanoic acid	13C5_PFHxA		50	150
Perfluoro-n-[1,2,3,4-13C4]heptanoic acid	13C4_PFHpA		50	150
Perfluoro-n-[1,2,3-13C3]hexanesulfonic acid	13C3_PFHxS		50	150
Fluorotelomer-n-[1,2-13C2] sulphonic acid 6:2	13C2_6:2FTS		50	150
Perfluoro-n-[13C8]octanoic acid	13C8_PFOA		50	150
Perfluoro-n-[13C9]nonanoic acid	13C9_PFNA		50	150
Perfluoro-n-[1,2-13C8]octanesulfonic acid	13C8_PFOS		50	150
Fluorotelomer-n-[1,2-13C2] sulphonic acid 8:2	13C2_8:2FTS		50	150

			Water		Soil		Low level Control limits			Medium level Control limits		
Analyte	**Acronym**	**CAS#**	**MDL (ng/L)**	**PRL (ng/L)**	**MDL (ng/Kg)**	**PRL (ng/Kg)**	**Lower**	**Upper**	**RPD**	**Lower**	**Upper**	**RPD**
Perfluoro-n-[1,2,3,4,5,6-13C6]decanoic acid	13C6_PFDA		50	150								
N-methyl-d3-perfluoro-1- perfluorooctane sulfonamidoacetic acid	d3-MeFOSAA		50	150								
Perfluoro-n-[13C8]octanesulfonamide	13C8_FOSA		50	150								
N-ethyl-d5-perfluoro-1-octanesulfonamidoacetic acid	d5-EtFOSAA		50	150								
Perfluoro-n-[1,2,3,4,5,6,7-13C7]undecanoic acid	13C7_PFUdA		50	150								
Perfluoro-n-[1,2-13C2]dodecanoic acid	13C2_PFDoA		50	150								
Perfluoro-n-[1,2-13C2]tetradecanoic acid	13C2_PFTeDA		50	150								
2,3,3,3-Tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)-13C3-propanoic acid	13C3_HFPO-DA		50	150								
Perfluoro-n-[1,2-13C2]hexadecanoic acid	13C2_PFHxDA		50	150								
2-(N-methyl-d3-perfluoro-1-octanesulfonamido)ethan-d4-ol	d7-N-MeFOSE		10	150								
2-(N-ethyl-d5-perfluoro-1-octanesulfonamido)ethan-d4-ol	d9-N-EtFOSE		10	150								
N-methyl-d3-perfluoro-1-octanesulfonamide	d3-N-MeFOSA		10	150								
N-ethyl-d5-perfluoro-1-octanesulfonamide	d5-N-EtFOSA		10	150								

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Associated SOP = ENV-SOP-MIN4-0178, most current revison.

Appendix C
Field Standard Operating Procedures for PFAS Sampling and Other Field Activities

SOP 1

Sample Acquisition for Per- and Polyfluoroalkyl Substances (PFAS)

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the methods and protocols to be used for collecting and handling samples to be analyzed for Per- and Polyfluoroalkyl substances (PFAS). PFAS are present in many consumer products including some typical sampling equipment and are ubiquitous in the environment. Because regulatory screening criteria are very low, measurements of very low PFAS concentrations are required. These two conditions make the collection of samples for accurate quantitation of PFAS concentrations difficult unless special precautions are taken to avoid introducing contaminants into the samples. Instructions are provided herein for collection of environmental samples without contaminating them. This SOP is designed to supplement but not replace existing sampling SOPs. In addition, some clients and/or projects may have specific PFAS-related sampling requirements that extend beyond the procedures described in this SOP.

2.0 SCOPE AND APPLICABILITY

This document provides information on proper sampling equipment and techniques for groundwater, surface water, sediment, and soil sampling for PFAS analysis. Sampling of air or biota is not addressed in this SOP, but the same principles would apply for those media.

3.0 BACKGROUND

PFAS have been used since the 1940s as manufacturer-applied oil and water repellants on products such as clothing, upholstery, paper, and carpets; and in making fluoropolymers for non- stick cookware. They are found in textiles and leather products, mist suppressants for metal plating, the photography industry, photolithography, semi-conductors, paper and packaging coatings, cleaning products, pesticides, and cosmetics. They have been used in well-known consumer products including Teflon®, StainMaster®, Scotchgard®, and GoreTex®. In the 1960s, aqueous film-forming foam (AFFF) containing PFAS was developed for fighting flammable liquid fires, particularly petroleum-fueled (Class B) fires (ATSDR, 2009). The two most researched and most prevalent PFAS in the environment are perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) (ATSDR, 2009).

PFAS are persistent in the environment, tend to bioaccumulate, and demonstrate toxicity in laboratory animals, enough to raise concerns about their presence in the environment. Some areas where PFAS may have been released to the environment include the following:

- Firefighting training areas
- Areas where firefighting products/materials are stored
- Aircraft crash sites

- Metal coating and plating facilities
- Water treatment systems and receiving water bodies
- Airport hangars and other facilities storing fire-fighting foams
- Fluorochemical manufacturing, use, and disposal facilities

PFAS are ubiquitous in consumer products and some materials used in environmental sampling (Teflon® tubing, waterproof logbooks, or GoreTex® field clothing). There are many potential sources of PFAS that are independent of media being sampled; therefore, it is essential to take special precautions to minimize the potential for contaminating environmental samples with PFAS during collection and handling. Laboratory detection limits are low for these compounds and contact of sample material or sampling equipment with any one of the multitude of PFAS sources could result in detectable contamination. In addition, PFAS tend to adsorb to glass so glass sample collection containers are inappropriate. Adsorption to glass sample containers may result in a low bias for measured PFAS concentrations.

Collection and analysis of Quality Control blanks is an important aspect of verifying that samples have not been contaminated during sample collection and handling. Use of additional blanks or blanks of a different type than usual may be required. Consult Section 7.7 of this SOP for instructions regarding collection of field reagent blanks (FRBs).

4.0 DEFINITIONS AND ABBREVIATIONS

AFFF – Aqueous film-forming foam.

FRB – Field Reagent Blank. A blank sample prepared in the field by transferring laboratory- supplied, chemically-preserved deionized water to an empty, laboratory-supplied collection bottle. FRBs are typically analyzed only for PFAS and are treated as a site sample in all respects, including shipment to the sampling site, exposure to sampling site conditions, storage, preservation, and all PFAS analytical procedures. The purpose of FRBs is to indicate whether PFAS measured in corresponding site samples may have been introduced during sample collection and handling.

PFAS – Per- and polyfluoroalkyl Substances. A reference term currently in use, replacing “PFCs” in recent scientific and other technical literature. The term is inclusive of both perfluorinated chemicals like PFOA and PFOS and polyfluoroalkyl substances like fluorinated telomers.

PFOA – Perfluorooctanoic Acid. PFOA is used as an aqueous dispersion agent and in the manufacture of fluoropolymers (including Teflon®) that are used in industrial components such as electrical wire casings, fire- and chemical-resistant tubing, and plumbing seal tape. PFOA is used in surface treatment products to impart oil, stain, grease, and water resistance. PFOA can also be produced by the breakdown of some fluorinated telomers.

PFOS – Perfluorooctane Sulfonate. PFOS was a key ingredient in Scotchgard® and used in the manufacture of Class B AFFF used per DoD military specifications.

5.0 SAFETY PRECAUTIONS

Sample acquisition activities shall be conducted in accordance health and safety requirements identified in the project-specific Health and Safety Plan (HASP), corporate health and safety policies, and individual sampling SOPs, as applicable.

6.0 PERSONNEL RESPONSIBILITIES, QUALIFICATIONS, AND TRAINING

Project Manager (PM) – The PM is responsible for determining sampling objectives, initial sampling locations, and field procedures used in the collection of samples of environmental media. Additionally, in consultation with other project personnel (geologist, hydrogeologist, etc.), the PM is responsible for selecting and detailing the specific sampling techniques, equipment to be used, and providing detailed input in this regard to the project planning documents. The PM has the overall responsibility for ensuring that sampling activities are properly conducted by appropriately trained staff.

Site Safety Officer (SSO) – The SSO (or a qualified designee) is responsible for providing the technical support necessary to implement the project HASP, AP or equivalent. The SSO or SSO designee may also be required to advise the Field Operations Leader (FOL) on safety-related matters regarding sampling, such as measures to mitigate potential hazards from hazardous objects or conditions. The SSO may be referred to as the Site Safety and Health Officer (SSHO).

Project Geologist/Sampler – The project geologist/sampler is responsible for the proper acquisition of samples in accordance with this SOP or other project-specific documents. In addition, this individual is responsible for the completion of all required paperwork (e.g., sample log sheets, field notebook, boring logs, container labels, custody seals, and chain-of-custody forms) associated with the collection of those samples.

Field Operations Leader (FOL) – This individual is primarily responsible for the execution of the field sampling program in accordance with the project planning documents. This is accomplished through management of a field sampling team for the proper acquisition of samples.

General personnel qualifications for environmental media sample collection include the following:

- Occupational Safety and Health Administration (OSHA) 40-hour HAZWOPER and applicable refresher training.

- Ability to perform field work under the expected physical and environmental (i.e., weather) conditions
- Familiarity with appropriate procedures for sample documentation, handling, packaging, and shipping
- Familiarity with chemical-specific requirements for collection and handling of samples for PFAS analysis as described in this procedure.
- Personnel implementing this SOP must read and understand this SOP prior to collection of samples designated for PFAS analysis.

7.0 PROCEDURES

All personnel involved in sample acquisition must strive to prevent contact of sample media with potential sources of PFAS contamination. Given the widespread use of PFAS in products including those typically preferred for environmental sampling, all samples for PFAS analysis are to be collected using precautions to avoid inadvertent contamination of the sample media. These precautions are identified below for selection of sampling equipment and general field equipment, field personnel clothing and protective gear, sample containers and sample handling activities.

7.1 Selection Of Equipment

It is important to research available equipment and materials at the planning stage to avoid last minute problems in the field; for example, ensuring compatibility of high-density polyethylene (HDPE) tubing with fittings for use in a peristaltic or other pump; or ensuring that equipment does not contain Teflon®.

Sampling Equipment:

- Avoid using any sampling equipment constructed of or containing polytetrafluoroethylene (PTFE) or Teflon® (DuPont brand name) or fluorinated ethylene propylene (FEP) during sample handling or mobilization/demobilization.
- Avoid using low-density polyethylene products (LDPE) if contamination from those products can be transferred to environmental samples or QC samples.
- Use sampling equipment made of stainless steel, acetate, silicone, high-density polyethylene (HDPE), or polypropylene. This applies to tubing, pumps and pump components, tape for plumbing fittings, trowels, mixing bowls or other equipment that could contact the sample media. Gasket and O-ring components of sampling equipment may contain fluoropolymers.

Non-Sampling Field Equipment:

- Avoid using waterproof field books or paper during sampling activities. Non-waterproof loose-leaf paper or notebooks are acceptable. Do not use plastic clipboards, binders, or spiral hard cover notebooks that may be coated; use Masonite or aluminum clipboards instead.
- Avoid using Post-it® notes or similar removable notes during sample handling or mobilization/demobilization activities.
- Avoid using Sharpies® or similar indelible markers; do use ball-point pens or pencils for note taking and sample bottle labeling.

Field Personnel Clothing and Protective Gear:

- Avoid wearing new clothing due to the possible treating of fabric with PFAS for stain resistance. Wear clothing made from natural fibers (e.g., cotton) to the extent possible. Clothing should have been washed at least several times between time of purchase and time of first use during sampling activities. Avoid using fabric softener when laundering clothing to be worn during sample collection.
- During wet weather, use rain gear made from polyurethane or wax-coated materials.
- Avoid wearing water-resistant (e.g., Gore-Tex® or similar material) clothing or footwear (i.e., boots) immediately prior to or during sample collection and management.
- Avoid wearing cosmetics, shampoos, moisturizers, or other similar personal hygiene products on the day of sampling.
- Use sunscreens and insect repellants with 100% natural ingredients. The following items are acceptable for use, but the suitability of these items has not been independently verified:
    - Sunscreens - Alba Organics Natural Sunscreen, Yes To Cucumbers, Aubrey Organics, Jason Natural Sun Block, Kiss my face, Baby sunscreens that are “free” or “natural.”
    - Insect Repellents - Jason Natural Quit Bugging Me, Repel Lemon Eucalyptus Insect repellant, Herbal Armor, California Baby Natural Bug Spray, BabyGanics
    - Sunscreen and insect repellant - Avon Skin So Soft Bug Guard Plus – SPF 30 Lotion
- Avoid wearing Tyvek® suits.
- Wear un-powdered nitrile gloves at all times while collecting and handling samples and change gloves often.

- Avoid unnecessary contact with automobile upholstery that may have been treated with PFAS. If practical, cover clothing and skin that has been in contact with such upholstery within non-fluorinated clothing.

Sample Containers and Shipping Materials

- Avoid the use of glass sample containers, which are believed to result in loss of PFAS from samples through adsorption to the container.
- Collect samples in laboratory-supplied plastic bottles only, typically polypropylene or HDPE.
- Confirm that Teflon®-lined caps are not used in sample containers; unlined polypropylene screw caps must be used.
- Avoid using Blue Ice® or similar items to cool samples and avoid placing such items in sample coolers for shipping. Use commercially available (e.g., from convenience stores or supermarkets) double-bagged ice instead.

7.2 Other Precautions for Sample Handling

- Avoid handling or bringing pre-wrapped food or snacks (e.g., fast food, candy bars, microwave popcorn, etc.) into the sampling area before or during sampling, because many food and snack products are packaged in wrappers treated with PFAS. Only water or hydrating drinks (e.g., Gatorade) should be brought onsite or allowed in vehicles used for PFAS sampling activities.
- Wash hands thoroughly after handling fast food, carryout food, or snacks, or other items that may contain PFAS.
- Assume that shipping tape used for securing coolers could contain PFAS; therefore, take care not to transfer PFAS from tape to samples.

These precautions should be observed during sampling activities, especially during water sample collection (groundwater and surface water), given the high solubility of PFAS in water. Examples of how these precautions may be applied to sampling of specific media are provided in the following sections.

7.3 Groundwater Sample Acquisition

The precautions and requirements identified in the previous sections must be observed for groundwater sampling. Do not proceed any further without reviewing each of those precautions and requirements.

- Collect groundwater samples for PFAS analyses in accordance with this SOP, and/or project- or client-specific requirements.

- If non-dedicated, non-disposable equipment is used between sampling locations, it should be decontaminated with Alconox® or Liquinox®, unless 1,4-dioxane (a potential component of these detergents) is also a contaminant of concern. In that case Liquinox® should not be used. Products such as Decon 90 should not be used.
- If samples are to be collected for analysis of PFAS and other analytes, determine whether the same equipment can be used for all sample analyses. If Teflon® or LDPE materials are required for the non-PFAS analytes, then use multiple sets of equipment and determine a suitable sample collection sequence and protocol for collecting the groundwater samples for the analyte groups of interest. For example, purge and sample a monitoring well for PFAS first using a peristaltic pump with HDPE and silicone tubing. Then use a bladder pump with Teflon® tape on air-line fittings to purge the well and sample for VOCs with Teflon tubing, if the VOC protocol requires it. Or use silicone tubing for all parameters, if appropriate. Protocols and order of sampling should be clearly identified in the SAPs. If the sampling sequence is unclear, consult the FOL or Project Manager and record the actual sequence in the field notes.
- If tasked to sample monitoring wells that have or had dedicated Teflon® or FEP tubing that potentially contained PFAS, after removing the tubing, evacuate at least one well volume prior to sampling using silicone or HDPE tubing. This will ensure that standing water that was in contact with the tubing is removed from the water column prior to sampling.

7.4 Soil Sample Acquisition

The precautions and requirements identified in Sections 7.1 and 7.2 must be observed for soil sampling. Do not proceed any further without reviewing each of those precautions and requirements.

- Collect soil samples for PFAS analyses in accordance with this SOP, and/or project- or client-specific requirements.
- Soil sampling equipment should not be constructed of or contain Teflon® materials. Acceptable materials for sampling include stainless steel, acetate, or polypropylene. If non-dedicated, non-disposable equipment is used between sample locations, it should be decontaminated with Alconox® or Liquinox®.
- Collect samples in laboratory-provided containers specifically designated for PFAS analysis. Do not use glass jars typically used for soil sample collection.

7.5 Surface Water and Sediment Sample Acquisition

The precautions and requirements identified in Sections 7.1 and 7.2 must be observed for surface water and sediment sampling. Do not proceed any further without reviewing each of those precautions and requirements.

- Collect surface water and sediment samples for PFAS analysis in accordance with this SOP, and/or project- or client-specific requirements.
- Surface water and sediment samples should be collected in laboratory-supplied bottleware specifically designated for PFAS analysis (not glass). If transfer bottles are required for collection of surface water samples, the transfer bottles used should be the same material as the containers designated for submission to the laboratory.
- Surface water and sediment sampling equipment should not be constructed of or contain Teflon® or LDPE materials. Acceptable materials for sampling include HDPE, silicone, stainless steel, acetate, or polypropylene. If non-dedicated, non-disposable equipment is used between sample locations, it should be decontaminated with Alconox® or Liquinox®.

7.6 Water Supply Sampling

This section applies to sampling from taps, spigots, faucets, or similar devices. The precautions and requirements identified in Sections 7.1 and 7.2 must be observed for water supply sampling. Do not proceed any further without reviewing each of those precautions and requirements.

- Collect water supply samples for PFAS analysis in accordance with applicable portions of this SOP, and/or project- or client-specific requirements.
- Water supply samples should be collected in laboratory-supplied bottles specifically designated for PFAS analysis (not glass).
- Ensure that sample bottles used to collect chlorinated water samples contain the proper preservative; non-chlorinated water does not require chemical preservatives designed to remove chlorine.
- Water supply sampling equipment (if needed) should not be constructed of or contain Teflon® or LDPE materials. Acceptable materials for sampling include HDPE, silicone, stainless steel, acetate, or polypropylene. If non-dedicated, non-disposable equipment is used between sample locations, it should be decontaminated with Alconox® or Liquinox®.
- Locate the sampling point. If a specific sampling point has already been designated (e.g., a kitchen tap), plan to collect the sample from that point; otherwise, identify a location in the water supply line that is as close as possible to the water's point of origination (e.g., a well or other

water source) and upstream of any local water treatment unit(s) that could affect PFAS levels (e.g., water softeners, activated carbon, or reverse osmosis treatment units). If a treatment unit is in use, a post-treatment sample may also be required in some cases, per project requirements.

Note: If treatment that could affect PFAS levels (e.g., carbon filtration or reverse osmosis) is part of the water distribution system, often a spigot will be present in the plumbing line between the water source and the treatment unit and this spigot should be used

- Remove any aerator/diffuser from the faucet, if possible. If removal is not possible, record this observation in the field notes.
- Allow the water to run freely from the tap until parameter stabilization per project-specific requirements is achieved, or as otherwise required by project-specific requirements. This will often require purging for 3 to 5 minutes.
- Reduce the water flow rate to minimize aeration of the sample. The water stream should be no wider than the diameter of a pencil.
- Fill the sample bottle (typically 250 mL) directly from the tap to the bottom of the neck of the bottle and cap the bottle immediately.
- After collecting the sample, cap the bottle and, if preservative is included, agitate by hand until the preservative is dissolved.

7.7 Field Reagent Blank Collection

Note: EPA Method 537 and modifications thereof for PFAS analysis require an FRB to be handled along with each sample set. A sample set is described as samples collected from the same sample site and at the same time, but “sample site” and “same time” are not precisely defined. Therefore, it is important to verify that the correct number of FRBs will be collected. *Collection of an FRB at every sampling point may be required.*

- Verify the number of FRBs to be collected for the project and where those samples must be collected. This should be described in the project planning documents such as work plans or sampling and analysis plans. If it is not, consult the PM.
- At the sampling site, when ready to collect an FRB, open the bottle of chemically preserved FRB reagent water provided by the laboratory and a corresponding empty bottle, also provided by the laboratory.

- Pour the preserved FRB reagent water into the empty sample bottle, close the cap, and label this filled bottle as the FRB.
- Pack and ship the FRB along with site samples and the required documentation (e.g., chain of custody form) to the laboratory.

Note: Although chain of custody forms will indicate that FRBs must be analyzed for PFAS, analysis of an FRB will be required only if site samples contain PFAS above a certain concentration. *If an FRB is analyzed and any PFAS concentration in the FRB exceeds 1/3 the laboratory MRL, then all samples collected with that FRB may be considered invalid and may require recollection and analysis* of the recollected samples*. Consult the project planning documents governing sample collection for specifics as to whether resampling is necessary. Care in collection and handling of site samples and FRBs in a way that avoids contamination cannot be overemphasized.*

SOP 2

Chain of Custody Procedures

1.0 PURPOSE

Chain-of-custody procedures are established to provide sample integrity. Sample custody protocols will be based on procedures as described in "NEIC Policies and Procedures", EPA-330/9-78-DD1-R, Revised June, 1985. This custody is in two parts: sample collection and laboratory analysis. A sample is under a person's custody if it meets the following requirements:

- It is in the person's possession;
- It is in the person's view, after being in the person's possession;
- It was in the person's possession and it was placed in a secured location; or
- It is in a designated secure area.

2.0 FIELD SPECIFIC CUSTODY PROCEDURES

The sample packaging and shipment procedures summarized below will assure that the samples will arrive at the laboratory with the chain-of-custody intact.

Field procedures are as follows:

(a) The field sampler is personally responsible for the care and custody of the samples until they are transferred or properly dispatched. As few people as possible should handle the samples.

(b) All bottles should be labeled with sample numbers and locations.

(c) Sample labels should be filled out using waterproof ink for each sample.

(d) The Project Manager should review all field activities to determine whether proper custody procedures were followed during the field work and decide if additional samples are required.

Transfer of Custody and Shipment Procedures are as follows:

(a) Samples should be accompanied by a properly completed chain-of-custody form. The sample numbers will be listed on the chain-of-custody form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents transfer of custody of samples from the sampler to another person, to a mobile laboratory, to the permanent laboratory, or to/from a secure storage area.

(b) Samples will be properly packaged for shipment and dispatched to the appropriate laboratory for analysis with a separate signed custody record enclosed in each sample box or cooler. Shipping containers will be locked and secured with strapping tape in at least two locations for shipment to the laboratory. Custody seals will be used for samples shipped to laboratories. When custody seals are used, two printed, numbered custody seals will be placed on each cooler and the numbers will also appear on the chain-of-custody forms, or two signed and dated seals will be placed on the cooler. Clear tape will be placed over the seals.

(c) Whenever samples are split with a source or government agency, a separate Sample Receipt is prepared for those samples and marked to indicate with whom the samples are being split. The person relinquishing the samples to the facility or agency should request the representative's signature acknowledging sample receipt. If the representative is unavailable or refuses, this is noted in the "Received By" space.

(d) If the samples are sent by common carrier, a bill of lading should be used. Receipts of bills of lading will be retained as part of the permanent documentation. If sent by mail, the package will be registered with return receipt requested. Commercial carriers are not required to sign off on the custody form as long as the custody forms are sealed inside the sample cooler. Air bill information will be recorded on chain-of-custody forms.

SOP 3

Field Equipment Use and Calibration

1.0 PURPOSE

The purpose of this procedure is to set criteria for field equipment use and calibration.

2.0 PROCEDURE

A significant number of field activities involve usage of electronic instruments to monitor for environmental screening and heath and safety purposes. It is imperative the instruments are used and maintained properly to optimize their performance and minimize the potential for inaccuracies in the data obtained, and to ensure worker's health and safety is not compromised.

This SOP provides guidance on the usage, maintenance and calibration of electronic field equipment, whether for equipment owned by the Consultant or Contractor, or equipment obtained from a rental agency.

2.1 FIELD PREPARATION

2.1.1 Forms

- Field Calibration Forms

2.1.2 Equipment

- Monitoring equipment specific to work plan tasks.
- Associated calibration gases, aqueous standards, etc.
- Appropriate shipping containers to facilitate transport without damage to equipment.

2.1.3 Documents

- Manufacturer's instructions, operation and maintenance information.

2.2 FIELD PROCEDURES

All monitoring equipment will be in proper working order, and operated for the purpose for which it was intended, in accordance manufacturer's recommendations.

Field personnel will be responsible for insuring the equipment is maintained and calibrated in the field to extent practical, or returned for office or manufacturer maintenance or calibration if warranted. Calibration is discussed in greater detail below.

A copy of the Operating Instructions, Maintenance and Service manual for each instrument used on a project will be kept on site at all times.

Instruments will be operated only by personnel trained in the proper usage and calibration. In the event certification of training is required, personnel will have documentation of such certification with them on site at all times.

Personnel must be aware that certain instruments are rated for operation within a limited range of conditions such as temperature and humidity. Usage of such instruments in conditions outside these ranges will only proceed with proper approval by a project manager and/or Health and Safety supervisor as appropriate.

Instruments that contain radioactive source material, such as x-ray fluorescence analyzers or moisture-density gauges require specific transportation, handling and usage procedures that are generally associated with a license from the Nuclear Regulatory Commission (NRC) or an NRC- Agreement State. Under no circumstance will operation of such instruments be allowed on site unless by properly authorized and trained personnel, using the proper personal dosimeter badges or monitoring instruments.

Calibration

Calibration of an electronic instrument is critical to insure it is operating properly for its intended use. Such instruments are often sensitive to changes in temperature or humidity, or chemical vapors in the working atmosphere, and as a result their response and ability to monitor conditions and provide data can change significantly.

Parameters

Calibration of instruments shall be performed in accordance with the manufacturer's recommendations. This includes the following parameters:

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

Calibration Gas Safety

Several instruments such as photoionization detectors (PIDs), flame ionization detectors @!IDS), oxygen meters, explosimeters, combustible gas indicators and many others require use of calibration gasses contained in compressed gas cylinders. Many of these gases are combustible or explosive. Care shall be taken to minimize the potential for injury from the use of such compressed gases. Transport, handling and storage of cylinders, where necessary, shall be performed in accordance with applicable DOT regulations and site requirements.

Calibration will only be performed in areas free of sources of spark, flame or excessive heat. Smoking will not be allowed in the vicinity of calibration gas usage areas.

Documentation of Calibration

Instrument Calibration activities will be documented on the field calibration form.

Intrinsically Safe Requirements

Certain work locations may be such that dangerous, ignitable or explosive conditions exist. In such cases, it may be necessary to utilize only equipment that is rated as "Intrinsically Safe." Intrinsically safe instrumentation is designed with limited electrical and thermal energy levels to eliminate the potential for ignition of hazardous mixtures.

For site work requiring operation of monitoring instruments in Class I, Division I locations (as defined by the National Fire Protection Agency (NFPA)) only instrumentation rated as Intrinsically Safe will be used. Such equipment (including all accessories and ancillary equipment) must be rated to conform to Underwriter's Laboratories (UL) Standard 91 3, for use in a Class I, Division 1 Groups A, B, C, and D locations. It is also recommended the equipment conform to CSA Standard 22.2, No. 157-92.

Upon completion of the field activities, equipment shall be returned to the possession of the Consultant, Contractor or Rental Agency accompanied by a written summary of any problems encountered with its use or calibration.

Equipment shall be properly prepared for shipping, including insuring that residual gases (if applicable) are removed from the instrument, and accompanying containers of compressed gases or fluids are properly labeled and sealed.

Equipment Decontamination

Equipment that comes in contact with Site media (water level meters, water quality meters) must be cleaned before removal from the site to ensure that chemicals are not transferred to other sites. It is the responsibility of the person who requisitioned the equipment to ensure appropriate cleaning before returning the equipment. Equipment decontamination procedures are typically site-specific for unique site compounds.

SOP 4

Soil Boring and Monitoring Well Installation

1.0 PURPOSE

The purpose of this procedure is to install a soil boring or groundwater monitoring well to obtain soil and groundwater data. Monitoring wells are constructed to ensure that groundwater accessed is representative of in-situ conditions.

2.0 PROCEDURE

2.1 FIELD PREPARATION

Call Digger's Hotline or equivalent more than 72 hours in advance of field activity commencement to identify buried utilities in the area of subsurface activity.

2.1.1 Forms

- Soil Boring and Monitoring Well Logs
- Tailgate Health and Safety
- *Daily Report* Sheets

2.1.2 Equipment

- Well caps - expanding, locking
- Locks (keyed alike)
- Latex or nitrile gloves
- *Typically provided by the drillers:*
- Well screen and casing
- Sand, bentonite chips/grout
- Concrete

2.1.3 Documents

- Site Access Agreements (if necessary)
- Site maps
- Workplan
- Health and Safety Plan

2.1.4 Other

- Cellular telephone
- First aid kit
- Personal comfort items
- Stakes and flagging to mark location

2.2 FIELD PROCEDURES

Build a berm or dike, if necessary, around the drilling area to divert surface water and run-off from the borehole and avoid entry of surface water and run-off into the hole during drilling and well installation. Boreholes should not be left open (unsupported by casing, auger, or drilling fluid) if advanced through contaminated material to prevent contaminated soils from caving to the area of the well screen.

Segregate all well materials and drilling tools from potential sources of contamination. The drilling contractor should use new well casing and screen that has been sealed at the factory, or decontaminated and wrapped before arrival at the site. Handle casing and screen only while wearing clean gloves (this is most important if the wells are not expected to be in an affected area). Be sure to decontaminate all drilling tools and equipment before each well installation using a high-pressure steam cleaner.

Soil boring and monitoring well depth should be determined before field activity commencement, if appropriate. Reference the Field Service Request Form for the method to be used for field depth determination.

If nested wells (two or more closely spaced wells, screened at different depths) are installed, the deepest well in the grouping should be installed first. This allows for complete vertical characterization of the geology and verification of the proper depths for any shallower well. It also reduces the possibility of grout intrusion into the shallower wells.

For installing groundwater monitoring wells in unconsolidated geologic materials, hollow stem auger drilling is the method of choice, as vertical cross-contamination between depth intervals and extraneous handling of contaminated materials is avoided.

- Determine position and depth of well to be installed.
- As soils are retrieved from the split spoon sampling tool (or Shelby tube), the borings must be characterized based on their color, moisture content, odor, cohesive properties, grain size, and lithology.

- Well materials may be schedule 40, 2” or 4” diameter with # 10 (or 0.010-inch) slot well screen with a schedule 40, 2” or 4” diameter PVC casing or a stainless-steel screen with galvanized steel casing.
- If the well hole is advanced too far, backfill the bottom with sand before positioning the screen (unless a confining unit has been breached - then seal the breach with bentonite and grout the boring). Deposit appropriate sand filter pack around the well screen until measured at one foot above the screen. Then seal the top of the sand pack with a bentonite slurry (approx. 1-1.5 feet), bentonite chips or a grout mixture to the surface.
- A well cap with a watertight seal and lock must be affixed to the well top. For flush-mounted wells, have the drillers use a neat cement grout to form the annular seal surrounding the well casing. They should bring the grout to within 3 inches of the top of the monitoring well casing, tapering the grout away from the monitoring well to the edge of the bore hole. Place and center the metal manhole cover (minimum diameter 8”) over the monitoring well casing. Cement the cover in place inside a square 2 x 2 foot (or 12” diameter round pad) 6-inch deep pad. Slope the concrete surface away from the well to promote surface drainage away from the monitoring well.
- Develop the well before conducting sampling or performing hydraulic conductivity tests by surging, pumping, or bailing, depending on the well depth, yield, diameter, contaminants present, and depth to water.

SOP 5

Safe Drilling Practices

This document establishes safe work practices (SWP) to follow during drilling operations. These SWPs are based on suggested safety procedures provided in the National Drilling Association's "Drilling Safety Guide." Procedures to follow before, during, and after drilling are listed below.

Before beginning any drill operation, each employee must conform to the following requirements:

- Wear a hard hat, safety glasses or goggles, steel-toed work boots, a shirt and full-length pants when working with or near the drill rig. Shirts must be tucked in at the belt.
- Do not wear loose or frayed clothing, loose long hair, or loose jewelry while working with rotating equipment.
- Do not eat, drink, or smoke near the drill rig.
- Identify all underground utility and buried structure locations before drilling.
- Ensure that drill masts or other projecting devices will be farther than 25 feet in any direction from overhead power lines.
- Ensure that the drill rig and any other machinery used is inspected daily by competent, qualified individuals. The site safety coordinator (SSC) will ensure compliance with this precaution.
- Drill rig operators will be instructed to report any abnormalities, such as equipment failure, oozing liquids, and unusual odors, to their supervisors or the SSC.
- Establish hand-signal communications for use when verbal communication is difficult. One person per work team will be designated to give hand signals to equipment operators.

While the drill rig is operating, employees must:

- Wear appropriate respiratory and personal protective equipment (PPE) when conditions warrant their use.
- Avoid direct contact with known or suspected contaminated surfaces.
- Move tools, materials, cords, hoses, and debris to prevent tripping hazards and contact with moving drill rig parts.
- Adequately secure tools, materials, and equipment subject to displacement or falling.
- Store flammable materials away from ignition sources and in approved containers.

- Maintain adequate clearance of the drill rig and mast from overhead transmission lines. The minimum clearance is 25 feet unless special permission is granted by the utility company. Call the local utility company for proper clearance.
- Only qualified and licensed personnel should operate drill rigs.
- Workers should not assume that the drill rig operator is keeping track of the rig's exact location. Workers should never walk directly behind or beside heavy equipment without the operator's knowledge.
- Workers should maintain visual contact with drill rig operators at all times.
- When an operator must maneuver equipment in tight quarters, the presence of a second person is required to ensure adequate clearance. If much backing is required, two ground guides will be used: one in the direction the equipment is moving, and the other in the operator's normal field of vision to relay signals.
- Auger sections and other equipment are extremely heavy. All lifting precautions should be taken before moving heavy equipment. Appropriate equipment, such as chains, hoists, straps, and other equipment, should be used to safely transport heavy equipment too heavy to safely lift.
- Proper personal lifting techniques will be used. Workers should lift using their legs, not their backs.
- Workers will not use equipment they are not familiar with. This precaution applies to heavy as well as light equipment.
- All personnel not essential to work activities will be kept out of the work area.
- Workers will be aware of their footing at all times.
- Workers will remain alert at all times.

After drilling operations are completed, employees should do the following:

- Shut down machinery before repairing or lubricating parts (except parts that must be in motion for lubrication).
- Shut down mechanical equipment prior to and during fueling operations. When refueling or transferring fuel, containers and equipment must be bonded to prevent the buildup of static electricity.

- Keep drill rigs in the exclusion zone until work has been completed. Such equipment should then be decontaminated within the designated decontamination area.
- Engage parking brakes when equipment is not in use.
- Implement an ongoing maintenance program for all tools and equipment. All tools and moving equipment should be inspected regularly to ensure that parts are secured, are intact, and have no cracks or areas of weakness. The equipment must turn smoothly without wobbling and must operate in accordance with manufacturer specifications. Defective items should be promptly repaired or replaced. Maintenance and repair logs will be kept.
- Store tools in clean, secure areas to prevent damage, loss, or theft.

SOP 5

Well Development

1.0 PURPOSE

The purpose of this procedure is to set criteria for well development after installation of new monitoring or production wells or wells than have not been sampled or used for an extended period of time.

2.0 PROCEDURE

This procedure is for the development of groundwater monitoring wells. Before a newly constructed well can be used for water-quality sampling, measuring water levels, or aquifer testing, it must be developed. Well development refers to the procedure used to clear the well and formation around the screen of fine-grained materials (sands, silts, and clays) produced during drilling or naturally occurring in the formation.

Well development is completed to remove fine grained materials from the well casing, well screen and gravel pack. The time allotted and techniques used for well development will vary by well and depend on drilling method, well construction, geological formation and intended use for the well. In general, well development should continue until the well responds to water level changes in the formation (i.e., a good hydraulic connection is established between the well and formation) and the well produces clear, sediment-free water to the extent practical. In general, the method (disturbance) used to develop the well should be more rigorous than the amount of disturbance the well will experience during its regular or intended use. For example, if a well develops clear, sediment free water using a bailer, it is very well developed for low-flow sampling using a peristaltic pump. Please note that well development is especially important when contaminants of concern are sensitive to suspended solids (e.g., metals, PCBs, SVOCs).

2.1 FIELD PREPARATION

2.1.1 Forms

- Daily Log
- Well Development Form

2.1.2 Equipment

- Required Health and Safety Equipment and PPE
- Well Keys
- General Tools: knife, socket set, vise grips, screwdriver, etc.
- Power Source: generator, extension cord
- Well Development Device: water truck with hoist, surge block, bailer, submersible pump
- Discharge Line: tubing or hose (suitable for expected flow rates and chemicals of concern)

- Purge Water Container: Clear glass jars (e.g., drillers' jars), graduated pail, 55- gallon drum, poly tank or frac tank
- Cleaning Supplies: non-phosphate soap, buckets, brushes, laboratory-supplied distilled/deionized water, tap water, cleaning solvent, aluminum foil, plastic sheeting, etc.
- Meters: water level, flow
- Water Quality Meter: pH, temperature, conductivity, turbidity, etc.

2.1.3 Documents

- Detailed Scope Work Summary
- Proposal
- Work Plan

2.2 FIELD PROCEDURES

All wells must be developed and well development generally occurs with a few days of installation (please remember that some grouts require time to cure). Well development methods and procedures will vary as described above. In most cases, a monitoring well can be developed in less than one hour using a bailer, submersible pump, surge block and/or check valve and tubing (waterra tubing). Production or extraction wells may need to be developed by more rigorous methods and may require a specialized subcontractor. The following presents the minimum steps required to complete well development for a monitoring well and is generally acceptable for all well development activities. More rigorous methods may be required and will be detailed in project specific SOP.

1. Review HASP and don appropriate safety equipment and set up appropriate air monitoring equipment as needed.
2. Prior to introduction to a well, all non-dedicated equipment used for development purposes must be cleaned using a soapy wash (laboratory grade), tap water rinse, isopropyl alcohol rinse and distilled/deionized water rinse as appropriate.
3. Uncap and gauge well, record initial water level.
4. Place well development device (pump, bailer, surge block) into the well.
5. Collect a baseline groundwater sample in a glass jar, or purge bucket to determine relative turbidity. Your project manager may also request that you measure and record the temperature, pH, turbidity, specific electrical conductance, and other water quality parameters.

6. Surge the well.

7. Purge the well. If the well runs dry, stop purging and allow the well to recover. Sometimes purge water or distilled water must be added to the well initially to help clear the screen. Additional surging of the screen with the recycled purge water (or distilled water) will allow formation water to flow into the screen. Please make sure that three times the amount of water added is removed during the purging of the well.

8. Repeat steps 5 through 7 until groundwater is relatively clear (less than 4 NTUs) and if required, the water quality parameters are stable within 10%.

9. After development, the well should be allowed to rest and should not be sampled immediately. The period of rest will vary depending on the hydraulic properties of the aquifer or targeted water bearing unit and the intended use of the sample results obtained from the well. In general, a minimum of 2 to 3 days of rest should be adequate.

Waste Disposal

- All waste generated will be disposed in accordance with the methods and procedures contained in the work plan or other SOP.
- All water generated during cleaning and development procedures will be collected and contained in accordance with the site specific disposal requirements.
- All PPE, such as gloves, disposable clothing, and other disposable equipment used or generated during the development process, will be placed in plastic bags. These bags will be transferred into appropriately labeled 55-gallon drums or a covered roll-off box for appropriate disposal.

SOP 7

Water Sampling

1.0 PURPOSE

The purpose of this procedure is to obtain representative groundwater samples from groundwater monitoring wells or piezometers with a bailer, peristaltic, submersible, or KeckTM pump. Site-specific groundwater sampling requirements, if necessary, will be described in work plans or field sampling plans.

2.0 PROCEDURE

2.1 FIELD PREPARATION

Notify client, property owner, and agency as necessary.

2.1.1 Forms

- Water Level Data *Sheet*
- *Daily Report* Sheets
- *Chain of Custodies*
- *Water Quality Data* Sheet
- Field Service Request
- Tailgate Health and Safety

2.1.2 Equipment

- Laboratory provided containers and labels
- Laboratory-cleaned cooler
- Well keys
- Electronic water level indicator
- Interface probe (if free-product is expected at the site)
- Calculator
- Latex or nitrile gloves
- Tools to access wells
- metal detector, turkey baster or plastic cup
- Decontamination equipment including deionized or distilled water, Alconox, graduated cylinders, and paper towel

- Knife or scissors
- Garbage bags
- Two graduated 5-gallon pails to collect purge water
- pH, temperature, and specific conductivity meter

One of:

- Disposable high-density polyethylene sampling bailers and bailer rope
- Peristaltic pump and sufficient disposable Silicon (approximately 10 inches per sample) and Tygon tubing (length measured from pump head to sampling depth)
- Submersible pump and Tygon tubing
- Keck™ pump

If needed:

- DOT-approved sealed drums for storage of purged well water, or a suitable location to disperse of liquid (i.e., on-site treatment system)
- Quantab ™ and Hach™ Titration kits

2.1.3 Documents

- Well Construction Log
- Well location map/site map
- Work Plan
- Health and Safety Plan
- Signed site access agreement

2.1.4 Other

- Cellular phone
- Replacement locks
- Writing implements and an indelible marker
- Crushed ice
- Bubble wrap if required to protect samples during shipment to the laboratory

- First aid kit
- Personal comfort items
- Machete or other vegetation-clearing tools

2.2 FIELD PROCEDURES

2.2.1 Well Purge

Don a new pair of latex or nitrile gloves

First sample those wells with the lowest historical or suspected concentrations, and then advance to the wells more likely to be contaminated. Set plastic sheeting or a garbage bag near the well to set sample bottles on and to rest sampling equipment.

Obtain the water level measurement, noting any occurrence of LNAPL or DNAPL.

Calculate three or five times the volume of groundwater present in the well casing, as indicated on the *Field Service Request Form.*

Purge the well using a dedicated HDPE disposable bailer and a new length of clean rope, a peristaltic pump with new Teflon and Tygon tubing, a submersible pump with new Tygon tubing, or a Keck™ pump. Purge the groundwater monitoring well of a minimum of 3 to 5 well casing volumes prior to collecting the samples. Measure the volume of purged water using a graduated pail, or other container of known volume. Purging and sampling should be conducted using slow and steady motions to avoid excessive agitation, increased sample turbidity, and sample volatilization. Empty purge water onto the ground, away from the well, or in the event containerizing is required, transfer purged water from the pail into the appropriate storage container for storage until disposal is arranged.

NOTE: If well goes dry before 3 well volumes can be purged from the well, allow groundwater to recharge, then collect sample.

2.2.2 Field Measured Parameters

After at least 3 well volumes have been purged from the well, measure temperature, pH, conductivity, and any other field parameters as specified in the Field Service Request Form. Once three measurements are obtained within 10-percent of each other, the groundwater quality may be considered representative of the groundwater as it exists in the formation.

If well goes dry before 3 well volumes can be purged from the well, a single round of field parameter measurements will be obtained following recharge of a sufficient amount of groundwater to complete the sampling activities.

2.2.3 Bottle Preparation

Prior to sample collection, label all appropriate fields on the sample container labels with an indelible marker. Apply labels to appropriate containers.

2.2.4 Sample Collection

2.2.4.1 Bailers

Samples will be collected using the same HDPE disposable bailer used for purging. Transfer groundwater samples from the bailer to their appropriate sample bottle, minimizing turbulent flow between the bailer and the sample bottles. Place samples in the appropriate containers in decreasing order of volatility (e.g., purgeables and aromatics first, then PNAs and phenols, then cyanides, and lastly, nitrate, sulfate and metals). Samples for dissolved metals analysis may be field filtered. If there is insufficient sample volume to provide all sampling needs, retrieve additional bailer volumes until all samples are collected.

2.2.4.2 Peristaltic, Submersible, or Keck™ Pump

Samples for laboratory analysis of parameters, other than VOCs, will be collected directly from the pump tubing following purging of 3 to 5 well volumes, and stabilization of field parameter measurements. A 0.45 μm filter will be used to field filter samples for dissolved metals into a preserved laboratory container.

2.2.5 Sample Preservation

Tighten lids of sample containers and place in coolers

Wrap all glass containers in bubble wrap or foam; then place into large 1-2 gallon zip-lock bags; label the outside of the bag, and place into the coolers.

Completely fill out the Chain-of-Custody. When shipping samples, seal Chain-of-Custody in a watertight zip-lock bag, and attach to the underside of the cooler lid with packaging tape. Ship coolers or arrange delivery to the laboratory as soon as possible and before the sample “hold- time” expires.

2.2.6 Decontamination

Decontaminate electronic water level indicator, pH, temperature, and specific conductivity meter between sampling points.

If peristaltic pump is used, dispose used flow-through tubing and filters.

If submersible or Keck™ pump is used, place pump in a graduated cylinder filled with a solution of Alconox and deionized or distilled water. Allowing the soap and water solution to re-circulate through the pump and tubing for a maximum of five minutes. Rinse cylinder and outside of pump and tubing with deionized or distilled water. Fill cylinder with deionized or distilled water and allow at least 4 liters to run though the pump and tubing and onto the ground away from the well.

NOTE: During pump use and decontamination, take care to assure tubing and pump does not come in contact with the ground or other surfaces. Following sampling of the last well, remove and throw away submersible pump tubing prior to decontamination of the pump.

Dispose of all gloves, bailers, rope/string, tubing, and filters used to collect the sample prior to accessing the next well.

3.0 QUALITY ASSURANCE

Avoid cross-contamination of wells with the water level indicator, and sampling equipment by conducting proper decontamination procedures described above.

Take care in labeling the samples, and the corresponding Chain-of-Custody with the correct sample date, time and well identification. All labeling must be consistent between samples and the Chain of Custody.

Keep samples on ice following collection, and be conscience of “hold-times” for the samples. It is imperative that samples are submitted to the laboratory prior to the exceedance of hold times.

SOP 8

EPA Low Flow (Minimum Drawdown) Groundwater Sampling Procedures

United States Environmental Protection Agency
Office of Research and Development
Office of Solid Waste and Emergency Response
EPA/540/S-95/504
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Ground Water Issue

LOW-FLOW (MINIMAL DRAWDOWN) GROUND-WATER SAMPLING PROCEDURES

by Robert W. Puls[1] and Michael J. Barcelona[2]

Background

The Regional Superfund Ground Water Forum is a group of ground-water scientists, representing EPA's Regional Superfund Offices, organized to exchange information related to ground-water remediation at Superfund sites. One of the major concerns of the Forum is the sampling of ground water to support site assessment and remedial performance monitoring objectives. This paper is intended to provide background information on the development of low-flow sampling procedures and its application under a variety of hydrogeologic settings. It is hoped that the paper will support the production of standard operating procedures for use by EPA Regional personnel and other environmental professionals engaged in ground-water sampling.

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I. Introduction

The methods and objectives of ground-water sampling to assess water quality have evolved over time. Initially the emphasis was on the assessment of water quality of aquifers as sources of drinking water. Large water-bearing units were identified and sampled in keeping with that objective. These were highly productive aquifers that supplied drinking water via private wells or through public water supply systems. Gradually, with the increasing awareness of subsurface pollution of these water resources, the understanding of complex hydrogeochemical processes which govern the fate and transport of contaminants in the subsurface increased. This increase in understanding was also due to advances in a number of scientific disciplines and improvements in tools used for site characterization and ground-water sampling. Ground-water quality investigations where pollution was detected initially borrowed ideas, methods, and materials for site characterization from the water supply field and water analysis from public health practices. This included the materials and manner in which monitoring wells were installed and the way in which water was brought to the surface, treated, preserved and analyzed. The prevailing conceptual ideas included convenient generalizations of ground-water resources in terms of large and relatively homogeneous hydrologic *units*. With time it became apparent that conventional water supply generalizations of *homogeneity* did not adequately represent field data regarding pollution of these subsurface resources. The important role of *heterogeneity* became increasingly clear not only in geologic terms, but also in terms of complex physical,

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chemical and biological subsurface processes. With greater appreciation of the role of heterogeneity, it became evident that subsurface pollution was ubiquitous and encompassed the unsaturated zone to the deep subsurface and included unconsolidated sediments, fractured rock, and *aquitards* or low-yielding or impermeable formations. Small-scale processes and heterogeneities were shown to be important in identifying contaminant distributions and in controlling water and contaminant flow paths.

It is beyond the scope of this paper to summarize all the advances in the field of ground-water quality investigations and remediation, but two particular issues have bearing on ground-water sampling today: aquifer heterogeneity and colloidal transport. Aquifer heterogeneities affect contaminant flow paths and include variations in geology, geochemistry, hydrology and microbiology. As methods and the tools available for subsurface investigations have become increasingly sophisticated and understanding of the subsurface environment has advanced, there is an awareness that in most cases a primary concern for site investigations is characterization of contaminant flow paths rather than entire aquifers. In fact, in many cases, plume thickness can be less than well screen lengths (e.g., 3-6 m) typically installed at hazardous waste sites to detect and monitor plume movement over time. Small-scale differences have increasingly been shown to be important and there is a general trend toward smaller diameter wells and shorter screens.

The hydrogeochemical significance of colloidal-size particles in subsurface systems has been realized during the past several years (Gschwend and Reynolds, 1987; McCarthy and Zachara, 1989; Puls, 1990; Ryan and Gschwend, 1990). This realization resulted from both field and laboratory studies that showed faster contaminant migration over greater distances and at higher concentrations than flow and transport model predictions would suggest (Buddemeier and Hunt, 1988; Enfield and Bengtsson, 1988; Penrose et al., 1990). Such models typically account for interaction between the mobile aqueous and immobile solid phases, but do not allow for a mobile, reactive solid phase. It is recognition of this third *phase* as a possible means of contaminant transport that has brought increasing attention to the manner in which samples are collected and processed for analysis (Puls et al., 1990; McCarthy and Degueldre, 1993; Backhus et al., 1993; U. S. EPA, 1995). If such a phase is present in sufficient mass, possesses high sorption reactivity, large surface area, and remains stable in suspension, it can serve as an important mechanism to facilitate contaminant transport in many types of subsurface systems.

Colloids are particles that are sufficiently small so that the surface free energy of the particle dominates the bulk free energy. Typically, in ground water, this includes particles with diameters between 1 and 1000 nm. The most commonly observed mobile particles include: secondary clay minerals; hydrous iron, aluminum, and manganese oxides; dissolved and particulate organic materials, and viruses and bacteria. These reactive particles have been shown to be mobile under a variety of conditions in both field studies and laboratory column experiments, and as such need to be included in monitoring programs where identification of the *total* mobile contaminant loading (dissolved + naturally suspended particles) at a site is an objective. To that end, sampling methodologies must be used which do not artificially bias *naturally* suspended particle concentrations.

Currently the most common ground-water purging and sampling methodology is to purge a well using bailers or high speed pumps to remove 3 to 5 casing volumes followed by sample collection. This method can cause adverse impacts on sample quality through collection of samples with high levels of turbidity. This results in the inclusion of otherwise immobile artifactual particles which produce an overestimation of certain analytes of interest (e.g., metals or hydrophobic organic compounds). Numerous documented problems associated with filtration (Danielsson, 1982; Laxen and Chandler, 1982; Horowitz et al., 1992) make this an undesirable method of rectifying the turbidity problem, and include the removal of potentially mobile (contaminant-associated) particles during filtration, thus artificially biasing contaminant concentrations low. Sampling-induced turbidity problems can often be mitigated by using low-flow purging and sampling techniques.

Current subsurface conceptual models have undergone considerable refinement due to the recent development and increased use of field screening tools. So-called hydraulic *push* technologies (e.g., cone penetrometer, Geoprobe®, QED HydroPunch®) enable relatively fast screening site characterization which can then be used to design and install a monitoring well network. Indeed, alternatives to conventional monitoring wells are now being considered for some hydrogeologic settings. The ultimate design of any monitoring system should however be based upon adequate site characterization and be consistent with established monitoring objectives.

If the sampling program objectives include accurate assessment of the magnitude and extent of subsurface contamination over time and/or accurate assessment of subsequent remedial performance, then some information regarding plume delineation in three-dimensional space is necessary prior to monitoring well network design and installation. This can be accomplished with a variety of different tools and equipment ranging from hand-operated augers to screening tools mentioned above and large drilling rigs. Detailed information on ground-water flow velocity, direction, and horizontal and vertical variability are essential baseline data requirements. Detailed soil and geologic data are required prior to and during the installation of sampling points. This includes historical as well as detailed soil and geologic logs which accumulate during the site investigation. The use of borehole geophysical techniques is also recommended. With this information (together with other site characterization data) and a clear understanding of sampling objectives, then appropriate location, screen length, well diameter, slot size, etc. for the monitoring well network can be decided. This is especially critical for new in situ remedial approaches or natural attenuation assessments at hazardous waste sites.

In general, the overall goal of any ground-water sampling program is to collect water samples with no alteration in water chemistry; analytical data thus obtained may be used for a variety of specific monitoring programs depending on the regulatory requirements. The sampling methodology described in this paper assumes that the monitoring goal is to sample monitoring wells for the presence of contaminants and it is applicable whether mobile colloids are a concern or not and whether the analytes of concern are metals (and metalloids) or organic compounds.

II. Monitoring Objectives and Design Considerations

The following issues are important to consider prior to the design and implementation of any ground-water monitoring program, including those which anticipate using low-flow purging and sampling procedures.

A. Data Quality Objectives (DQOs)

Monitoring objectives include four main types: detection, assessment, corrective-action evaluation and resource evaluation, along with *hybrid* variations such as site-assessments for property transfers and water availability investigations. Monitoring objectives may change as contamination or water quality problems are discovered. However, there are a number of common components of monitoring programs which should be recognized as important regardless of initial objectives. These components include:

1) Development of a conceptual model that incorporates elements of the regional geology to the local geologic framework. The conceptual model development also includes initial site characterization efforts to identify hydrostratigraphic units and likely flow-paths using a minimum number of borings and well completions;

2) Cost-effective and well documented collection of high quality data utilizing simple, accurate, and reproducible techniques; and

3) Refinement of the conceptual model based on supplementary data collection and analysis.

These fundamental components serve many types of monitoring programs and provide a basis for future efforts that evolve in complexity and level of spatial detail as purposes and objectives expand. High quality, reproducible data collection is a common goal regardless of program objectives.

High quality data collection implies data of sufficient accuracy, precision, and completeness (i.e., ratio of valid analytical results to the minimum sample number called for by the program design) to meet the program objectives. Accuracy depends on the correct choice of monitoring tools and procedures to minimize sample and subsurface disturbance from collection to analysis. Precision depends on the repeatability of sampling and analytical protocols. It can be assured or improved by replication of sample analyses including blanks, field/lab standards and reference standards.

B. Sample Representativeness

An important goal of any monitoring program is collection of data that is truly representative of conditions at the site. The term *representativeness* applies to chemical and hydrogeologic data collected via wells, borings, piezometers, geophysical and soil gas measurements, lysimeters, and temporary sampling points. It involves a recognition of the statistical variability of individual subsurface physical properties, and contaminant or major ion concentration levels, while explaining extreme values. Subsurface temporal and spatial variability are facts. Good professional practice seeks to maximize representativeness by using proven accurate and reproducible techniques to define limits on the distribution of measurements collected at a site. However, measures of representativeness are dynamic and are controlled by evolving site characterization and monitoring objectives. An evolutionary site characterization model, as shown in Figure 1, provides a systematic approach to the goal of consistent data collection.

Figure 1. Evolutionary Site Characterization Model

The model emphasizes a recognition of the causes of the variability (e.g., use of inappropriate technology such as using bailers to purge wells; imprecise or operator-dependent methods) and the need to control avoidable errors.

1) Questions of Scale

A sampling plan designed to collect representative samples must take into account the potential scale of changes in site conditions through space and time as well as the chemical associations and behavior of the parameters that are targeted for investigation. In subsurface systems, physical (i.e., aquifer) and chemical properties over time or space are not statistically independent. In fact, samples taken in close proximity (i.e., within distances of a few meters) or within short time periods (i.e., more frequently than monthly) are highly auto-correlated. This means that designs employing high-sampling frequency (e.g., monthly) or dense spatial monitoring designs run the risk of redundant data collection and misleading inferences regarding trends in values that aren't statistically valid. In practice, contaminant detection and assessment monitoring programs rarely suffer these *over-sampling* concerns. In corrective-action evaluation programs, it is also possible that too little data may be collected over space or time. In these cases, false interpretation of the spatial extent of contamination or underestimation of temporal concentration variability may result.

2) Target Parameters

Parameter selection in monitoring program design is most often dictated by the regulatory status of the site. However, background water quality constituents, purging indicator parameters, and contaminants, all represent targets for data collection programs. The tools and procedures used in these programs should be equally rigorous and applicable to all categories of data, since all may be needed to determine or support regulatory action.

C. Sampling Point Design and Construction

Detailed site characterization is central to all decision-making purposes and the basis for this characterization resides in identification of the geologic framework and major hydro-stratigraphic units. Fundamental data for sample point location include: subsurface lithology, head-differences and background geochemical conditions. Each sampling point has a proper use or uses which should be documented at a level which is appropriate for the program's data quality objectives. Individual sampling points may not always be able to fulfill multiple monitoring objectives (e.g., detection, assessment, corrective action).

1) Compatibility with Monitoring Program and Data Quality Objectives

Specifics of sampling point location and design will be dictated by the complexity of subsurface lithology and variability in contaminant and/or geochemical conditions. It should be noted that, regardless of the ground-water sampling approach, few sampling points (e.g., wells, drive-points, screened augers) have zones of influence in excess of a few feet. Therefore, the spatial frequency of sampling points should be carefully selected and designed.

2) Flexibility of Sampling Point Design

In most cases *well-point* diameters in excess of 1 7/8 inches will permit the use of most types of submersible pumping devices for low-flow (minimal drawdown) sampling. It is suggested that *short* (e.g., less than 1.6 m) screens be incorporated into the monitoring design where possible so that comparable results from one device to another might be expected. *Short*, of course, is relative to the degree of vertical water quality variability expected at a site.

3) Equilibration of Sampling Point

Time should be allowed for equilibration of the well or sampling point with the formation after installation. Placement of well or sampling points in the subsurface produces some disturbance of ambient conditions. Drilling techniques (e.g., auger, rotary, etc.) are generally considered to cause more disturbance than *direct-push* technologies. In either case, there may be a period (i.e., days to months) during which water quality near the point may be distinctly different from that in the formation. Proper development of the sampling point and adjacent formation to remove fines created during emplacement will shorten this water quality *recovery* period.

III. Definition of Low-Flow Purging and Sampling

It is generally accepted that water in the well casing is non-representative of the formation water and needs to be purged prior to collection of ground-water samples. However, the water in the screened interval may indeed be representative of the formation, depending upon well construction and site hydrogeology. Wells are purged to some extent for the following reasons: the presence of the air interface at the top of the water column resulting in an oxygen concentration gradient with depth, loss of volatiles up the water column, leaching from or sorption to the casing or filter pack, chemical changes due to clay seals or backfill, and surface infiltration.

Low-flow purging, whether using portable or dedicated systems, should be done using pump-intake located in the middle or slightly above the middle of the screened interval. Placement of the pump too close to the bottom of the well will cause increased entrainment of solids which have collected in the well over time. These particles are present as a result of well development, prior purging and sampling events, and natural colloidal transport and deposition. Therefore, placement of the pump in the middle or toward the top of the screened interval is suggested. Placement of the pump at the top of the water column for sampling is only recommended in unconfined aquifers, screened across the water table, where this is the desired sampling point. Low-flow purging has the advantage of minimizing mixing between the overlying stagnant casing water and water within the screened interval.

A. Low-Flow Purging and Sampling

Low-flow refers to the velocity with which water enters the pump intake and that is imparted to the formation pore water in the immediate vicinity of the well screen. It does not necessarily refer to the flow rate of water discharged at the surface which can be affected by flow regulators or restrictions. Water level drawdown provides the best indication of the stress imparted by a given flow-rate for a given hydrological situation. The objective is to pump in a manner that minimizes stress (drawdown) to the system to the extent practical taking into account established site sampling objectives. Typically, flow rates on the order of 0.1 - 0.5 L/min are used, however this is dependent on site-specific hydrogeology. Some extremely coarse-textured formations have been successfully sampled in this manner at flow rates to 1 L/min. The effectiveness of using low-flow purging is intimately linked with proper screen location, screen length, and well construction and development techniques. The reestablishment of natural flow paths in both the vertical and horizontal directions is important for correct interpretation of the data. For high resolution sampling needs, screens less than 1 m should be used. Most of the need for purging has been found to be due to passing the sampling device through the overlying casing water which causes mixing of these stagnant waters and the dynamic waters within the screened interval. Additionally, there is disturbance to suspended sediment collected in the bottom of the casing and the displacement of water out into the formation immediately adjacent to the well screen. These disturbances and impacts can be avoided using dedicated sampling equipment, which precludes the need to insert the sampling device prior to purging and sampling.

Isolation of the screened interval water from the overlying stagnant casing water may be accomplished using low-flow minimal drawdown techniques. If the pump intake is located within the screened interval, most of the water pumped will be drawn in directly from the formation with little mixing of casing water or disturbance to the sampling zone. However, if the wells are not constructed and developed properly, zones other than those intended may be sampled. At some sites where geologic heterogeneities are sufficiently different within the screened interval, higher conductivity zones may be preferentially sampled. This is another reason to use shorter screened intervals, especially where high spatial resolution is a sampling objective.

B. Water Quality Indicator Parameters

It is recommended that water quality indicator parameters be used to determine purging needs prior to sample collection in each well. Stabilization of parameters such as pH, specific conductance, dissolved oxygen, oxidation-reduction potential, temperature and turbidity should be used to determine when formation water is accessed during purging. In general, the order of stabilization is pH, temperature, and specific conductance, followed by oxidation-reduction potential, dissolved oxygen and turbidity. Temperature and pH, while commonly used as purging indicators, are actually quite insensitive in distinguishing between formation water and stagnant casing water; nevertheless, these are important parameters for data interpretation purposes and should also be measured. Performance criteria for determination of stabilization should be based on water-level drawdown, pumping rate and equipment specifications for measuring indicator parameters. Instruments are available which utilize in-line flow cells to continuously measure the above parameters.

It is important to establish specific well stabilization criteria and then consistently follow the same methods thereafter, particularly with respect to drawdown, flow rate and sampling device. Generally, the time or purge volume required for parameter stabilization is independent of well depth or well volumes. Dependent variables are well diameter, sampling device, hydrogeochemistry, pump flow rate, and whether the devices are used in a portable or dedicated manner. If the sampling device is already in place (i.e., dedicated sampling systems), then the time and purge volume needed for stabilization is much shorter. Other advantages of dedicated equipment include less purge water for waste disposal, much less decontamination of equipment, less time spent in preparation of sampling as well as time in the field, and more consistency in the sampling approach which probably will translate into less variability in sampling results. The use of dedicated equipment is strongly recommended at wells which will undergo routine sampling over time.

If parameter stabilization criteria are too stringent, then minor oscillations in indicator parameters may cause purging operations to become unnecessarily protracted. It should also be noted that turbidity is a very conservative parameter in terms of stabilization. Turbidity is always the last parameter to stabilize. Excessive purge times are invariably related to the establishment of too stringent turbidity stabilization criteria. It should be noted that natural turbidity levels in ground water may exceed 10 nephelometric turbidity units (NTU).

C. Advantages and Disadvantages of Low-Flow (Minimum Drawdown) Purging

In general, the advantages of low-flow purging include:

- samples which are representative of the *mobile* load of contaminants present (dissolved and colloid-associated);
- minimal disturbance of the sampling point thereby minimizing sampling artifacts;
- less operator variability, greater operator control;

- reduced stress on the formation (minimal drawdown);
- less mixing of stagnant casing water with formation water;
- reduced need for filtration and, therefore, less time required for sampling;
- smaller purging volume which decreases waste disposal costs and sampling time;
- better sample consistency; reduced artificial sample variability.

Some disadvantages of low-flow purging are:

- higher initial capital costs,
- greater set-up time in the field,
- need to transport additional equipment to and from the site,
- increased training needs,
- resistance to change on the part of sampling practitioners,
- concern that new data will indicate a *change in conditions* and trigger an *action*.

IV. Low-Flow (Minimal Drawdown) Sampling Protocols

The following ground-water sampling procedure has evolved over many years of experience in ground-water sampling for organic and inorganic compound determinations and as such summarizes the authors' (and others) experiences to date (Barcelona et al., 1984, 1994; Barcelona and Helfrich, 1986; Puls and Barcelona, 1989; Puls et. al. 1990, 1992; Puls and Powell, 1992; Puls and Paul, 1995). High-quality chemical data collection is essential in ground-water monitoring and site characterization. The primary limitations to the collection of *representative* ground-water samples include: mixing of the stagnant casing and *fresh* screen waters during insertion of the sampling device or ground-water level measurement device; disturbance and resuspension of settled solids at the bottom of the well when using high pumping rates or raising and lowering a pump or bailer; introduction of atmospheric gases or degassing from the water during sample handling and transfer, or inappropriate use of vacuum sampling device, etc.

A. Sampling Recommendations

Water samples should not be taken immediately following well development. Sufficient time should be allowed for the ground-water flow regime in the vicinity of the monitoring well to stabilize and to approach chemical equilibrium with the well construction materials. This lag time will depend on site conditions and methods of installation but often exceeds one week.

Well purging is nearly always necessary to obtain samples of water flowing through the geologic formations in the screened interval. Rather than using a general but arbitrary guideline of purging three casing volumes prior to sampling, it is recommended that an in-line water quality measurement device (e.g., flow-through cell) be used to establish the stabilization time for several parameters (e.g. , pH, specific conductance, redox, dissolved oxygen, turbidity) on a well-specific basis. Data on pumping rate, drawdown, and volume required for parameter stabilization can be used as a guide for conducting subsequent sampling activities.

The following are recommendations to be considered before, during and after sampling:

- use low-flow rates (<0.5 L/min), during both purging and sampling to maintain minimal drawdown in the well;
- maximize tubing wall thickness, minimize tubing length;
- place the sampling device intake at the desired sampling point;
- minimize disturbances of the stagnant water column above the screened interval during water level measurement and sampling device insertion;
- make proper adjustments to stabilize the flow rate as soon as possible;
- monitor water quality indicators during purging;
- collect unfiltered samples to estimate contaminant loading and transport potential in the subsurface system.

B. Equipment Calibration

Prior to sampling, all sampling device and monitoring equipment should be calibrated according to manufacturer's recommendations and the site Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP). Calibration of pH should be performed with at least two buffers which bracket the expected range. Dissolved oxygen calibration must be corrected for local barometric pressure readings and elevation.

C. Water Level Measurement and Monitoring

It is recommended that a device be used which will least disturb the water surface in the casing. Well depth should be obtained from the well logs. Measuring to the bottom of the well casing will only cause resuspension of settled solids from the formation and require longer purging times for turbidity equilibration. Measure well depth after sampling is completed. The water level measurement should be taken from a permanent reference point which is surveyed relative to ground elevation.

D. Pump Type

The use of low-flow (e.g., 0.1-0.5 L/min) pumps is suggested for purging and sampling all types of analytes. All pumps have some limitation and these should be investigated with respect to application at a particular site. Bailers are inappropriate devices for low-flow sampling.

1) General Considerations

There are no unusual requirements for ground-water sampling devices when using low-flow, minimal drawdown techniques. The major concern is that the device give consistent results and minimal disturbance of the sample across a range of *low* flow rates (i.e., < 0.5 L/min). Clearly, pumping rates that cause minimal to no drawdown in one well could easily cause *significant* drawdown in another well finished in a less transmissive formation. In this sense, the pump should not cause undue pressure or temperature changes or physical disturbance on the water sample over a reasonable sampling range. Consistency in operation is critical to meet accuracy and precision goals.

2) Advantages and Disadvantages of Sampling Devices

A variety of sampling devices are available for low-flow (minimal drawdown) purging and sampling and include peristaltic pumps, bladder pumps, electrical submersible pumps, and gas-driven pumps. Devices which lend themselves to both dedication and consistent operation at definable low-flow rates are preferred. It is desirable that the pump be easily adjustable and operate reliably at these lower flow rates. The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and some volatiles loss. Gas-driven pumps should be of a type that does not allow the gas to be in direct contact with the sampled fluid.

Clearly, bailers and other *grab* type samplers are ill-suited for low-flow sampling since they will cause repeated disturbance and mixing of *stagnant* water in the casing and the *dynamic* water in the screened interval. Similarly, the use of inertial lift foot-valve type samplers may cause too much disturbance at the point of sampling. Use of these devices also tends to introduce uncontrolled and unacceptable operator variability.

Summaries of advantages and disadvantages of various sampling devices are listed in Herzog et al. (1991), U. S. EPA (1992), Parker (1994) and Thurnblad (1994).

E. Pump Installation

Dedicated sampling devices (left in the well) capable of pumping and sampling are preferred over <u>any</u> other type of device. Any portable sampling device should be slowly and carefully lowered to the middle of the screened interval or slightly above the middle (e.g., 1-1.5 m below the top of a 3 m screen). This is to minimize excessive mixing of the stagnant water in the casing above the screen with the screened interval zone water, and to minimize resuspension of solids which will have collected at the bottom of the well. These two disturbance effects have been shown to directly affect the time required for purging. There also appears to be a direct correlation between size of portable sampling devices relative to the well bore and resulting purge volumes and times. The key is to minimize disturbance of water and solids in the well casing.

F. Filtration

Decisions to filter samples should be dictated by sampling objectives rather than as a *fix* for poor sampling practices, and field-filtering of certain constituents should not be the default. Consideration should be given as to what the application of field-filtration is trying to accomplish. For assessment of truly dissolved (as opposed to operationally *dissolved* [i.e., samples filtered with 0.45 μm filters]) concentrations of major ions and trace metals, 0.1 μm filters are recommended although 0.45 μm filters are normally used for most regulatory programs. Alkalinity samples must also be filtered if significant particulate calcium carbonate is suspected, since this material is likely to impact alkalinity titration results (although filtration itself may alter the CO_2 composition of the sample and, therefore, affect the results).

Although filtration may be appropriate, filtration of a sample may cause a number of unintended changes to occur (e.g. oxidation, aeration) possibly leading to filtration-induced artifacts during sample analysis and uncertainty in the results. Some of these unintended changes may be unavoidable but the factors leading to them must be recognized. Deleterious effects can be minimized by consistent application of certain filtration guidelines. Guidelines should address selection of filter type, media, pore size, etc. in order to identify and minimize potential sources of uncertainty when filtering samples.

In-line filtration is recommended because it provides better consistency through less sample handling, and minimizes sample exposure to the atmosphere. In-line filters are available in both disposable (barrel filters) and non-disposable (in-line filter holder, flat membrane filters) formats and various filter pore sizes (0.1-5.0 μm). Disposable filter cartridges have the advantage of greater sediment handling capacity when compared to traditional membrane filters. Filters must be pre-rinsed following manufacturer's recommendations. If there are no recommendations for rinsing, pass through a minimum of 1 L of ground water following purging and prior to sampling. Once filtration has begun, a filter cake may develop as particles larger than the pore size accumulate on the filter membrane. The result is that the effective pore diameter of the membrane is reduced and particles smaller than the stated pore size are excluded from the filtrate. Possible corrective measures include prefiltering (with larger pore size filters), minimizing particle loads to begin with, and reducing sample volume.

G. Monitoring of Water Level and Water Quality Indicator Parameters

Check water level periodically to monitor drawdown in the well as a guide to flow rate adjustment. The goal is minimal drawdown (<0.1 m) during purging. This goal may be difficult to achieve under some circumstances due to geologic heterogeneities within the screened interval, and may require adjustment based on site-specific conditions and personal experience. In-line water quality indicator parameters should be continuously monitored during purging. The water quality indicator parameters monitored can include pH, redox potential, conductivity, dissolved oxygen (DO) and turbidity. The last three parameters are often most sensitive. Pumping rate, drawdown, and the time or volume required to obtain stabilization of parameter readings can be used as a future guide to purge the well. Measurements should be taken every three to five minutes if the above suggested rates are used. Stabilization is achieved after all parameters have stabilized for three successive readings. In lieu of measuring all five parameters, a minimum subset would include pH, conductivity, and turbidity or DO. Three successive readings should be within ± 0.1 for pH, ± 3% for conductivity, ± 10 mv for redox potential, and ± 10% for turbidity and DO. Stabilized purge indicator parameter trends are generally obvious and follow either an exponential or asymptotic change to stable values during purging. Dissolved oxygen and turbidity usually require the longest time for stabilization. The above stabilization guidelines are provided for rough estimates based on experience.

H. Sampling, Sample Containers, Preservation and Decontamination

Upon parameter stabilization, sampling can be initiated. If an in-line device is used to monitor water quality parameters, it should be disconnected or bypassed during sample collection. Sampling flow rate may remain at established purge rate or may be adjusted slightly to minimize aeration, bubble formation, turbulent filling of sample bottles, or loss of volatiles due to extended residence time in tubing. Typically, flow rates less than 0.5 L/min are appropriate. The same device should be used for sampling as was used for purging. Sampling should occur in a progression from least to most contaminated well, if this is known. Generally, volatile (e.g., solvents and fuel constituents) and gas sensitive (e.g., Fe^{2+}, CH_4, H_2S/HS^-, alkalinity) parameters should be sampled first. The sequence in which samples for most inorganic parameters are collected is immaterial unless filtered (dissolved) samples are desired. Filtering should be done last and in-line filters should be used as discussed above. During both well purging and sampling, proper protective clothing and equipment must be used based upon the type and level of contaminants present.

The appropriate sample container will be prepared in advance of actual sample collection for the analytes of interest and include sample preservative where necessary. Water samples should be collected directly into this container from the pump tubing.

Immediately after a sample bottle has been filled, it must be preserved as specified in the site (QAPP). Sample preservation requirements are based on the analyses being performed (use site QAPP, FSP, RCRA guidance document [U. S. EPA, 1992] or EPA SW-846 [U. S. EPA, 1982]). It may be advisable to add preservatives to sample bottles in a controlled setting prior to entering the field in order to reduce the chances of improperly preserving sample bottles or introducing field contaminants into a sample bottle while adding the preservatives.

The preservatives should be transferred from the chemical bottle to the sample container using a disposable polyethylene pipet and the disposable pipet should be used only once and then discarded.

After a sample container has been filled with ground water, a Teflon™ (or tin)-lined cap is screwed on tightly to prevent the container from leaking. A sample label is filled out as specified in the FSP. The samples should be stored inverted at $4^{o}C$.

Specific decontamination protocols for sampling devices are dependent to some extent on the type of device used and the type of contaminants encountered. Refer to the site QAPP and FSP for specific requirements.

I. Blanks

The following blanks should be collected:

(1) field blank: one field blank should be collected from each source water (distilled/deionized water) used for sampling equipment decontamination or for assisting well development procedures.

(2) equipment blank: one equipment blank should be taken prior to the commencement of field work, from each set of sampling equipment to be used for that day. Refer to site QAPP or FSP for specific requirements.

(3) trip blank: a trip blank is required to accompany each volatile sample shipment. These blanks are prepared in the laboratory by filling a 40-mL volatile organic analysis (VOA) bottle with distilled/deionized water.

V. Low-Permeability Formations and Fractured Rock

The overall sampling program goals or sampling objectives will drive how the sampling points are located, installed, and choice of sampling device. Likewise, site-specific hydrogeologic factors will affect these decisions. Sites with very low permeability formations or fractures causing discrete flow channels may require a unique monitoring approach. Unlike water supply wells, wells installed for ground-water quality assessment and restoration programs are often installed in low water-yielding settings (e.g., clays, silts). Alternative types of sampling points and sampling methods are often needed in these types of environments, because low-permeability settings may require extremely low-flow purging (<0.1 L/min) and may be technology-limited. Where devices are not readily available to pump at such low flow rates, the primary consideration is to avoid dewatering of the well screen. This may require repeated recovery of the water during purging while leaving the pump in place within the well screen.

Use of low-flow techniques may be impractical in these settings, depending upon the water recharge rates. The sampler and the end-user of data collected from such wells need to understand the limitations of the data collected; i.e., a strong potential for underestimation of actual contaminant concentrations for volatile organics, potential false negatives for filtered metals and potential false positives for unfiltered metals. It is suggested that comparisons be made between samples recovered using low-flow purging techniques and samples recovered using passive sampling techniques (i.e., two sets of samples). Passive sample collection would essentially entail acquisition of the sample with no or very little purging using a dedicated sampling system installed within the screened interval or a passive sample collection device.

A. Low-Permeability Formations (<0.1 L/min recharge)

1. Low-Flow Purging and Sampling with Pumps

a. "portable or non-dedicated mode" - Lower the pump (one capable of pumping at <0.1 L/min) to mid-screen or slightly above and set in place for minimum of 48 hours (to lessen purge volume requirements). After 48 hours, use procedures listed in Part IV above regarding monitoring water quality parameters for stabilization, etc., but do not dewater the screen. If excessive drawdown and slow recovery is a problem, then alternate approaches such as those listed below may be better.

b. "dedicated mode" - Set the pump as above at least a week prior to sampling; that is, operate in a dedicated pump mode. With this approach significant reductions in purge volume should be realized. Water quality parameters should stabilize quite rapidly due to less disturbance of the sampling zone.

2. Passive Sample Collection

Passive sampling collection requires insertion of the device into the screened interval for a sufficient time period to allow flow and sample equilibration before extraction for analysis. Conceptually, the extraction of water from low yielding formations seems more akin to the collection of water from the unsaturated zone and passive sampling techniques may be more appropriate in terms of obtaining "representative" samples. Satisfying usual sample volume requirements is typically a problem with this approach and some latitude will be needed on the part of regulatory entities to achieve sampling objectives.

B. Fractured Rock

In fractured rock formations, a low-flow to zero purging approach using pumps in conjunction with packers to isolate the sampling zone in the borehole is suggested. Passive multi-layer sampling devices may also provide the most "representative" samples. It is imperative in these settings to identify flow paths or water-producing fractures prior to sampling using tools such as borehole flowmeters and/or other geophysical tools.

After identification of water-bearing fractures, install packer(s) and pump assembly for sample collection using low-flow sampling in "dedicated mode" or use a passive sampling device which can isolate the identified water-bearing fractures.

VI. Documentation

The usual practices for documenting the sampling event should be used for low-flow purging and sampling techniques. This should include, at a minimum: information on the conduct of purging operations (flow-rate, drawdown, water-quality parameter values, volumes extracted and times for measurements), field instrument calibration data, water sampling forms and chain of custody forms. See Figures 2 and 3 and "Ground Water Sampling Workshop -- A Workshop Summary" (U. S. EPA, 1995) for example forms and other documentation suggestions and information. This information coupled with laboratory analytical data and validation data are needed to judge the "useability" of the sampling data.

VII. Notice

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VIII. References

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Appendix D
Field Sampling Forms and Logs

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Revelopment ☐ Other ☐ ______________

Page _____ of _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number

Boring Drilled By: Name of crew chief (first, last) and Firm First Name: Last Name: Firm:	Date Drilling Started _ _/_ _/_ _ _ _ m m d d y y y y	Date Drilling Completed _ _/_ _/_ _ _ _ m m d d y y y y	Drilling Method

WI Unique Well No. _ _ _ _ _ _	DNR Well ID No. _ _ _	Well Name	Final Static Water Level ______Feet MSL	Surface Elevation ______Feet MSL	Borehole Diameter ______ inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐ State Plane ______________ N, ______________ E _____ 1/4 of _____ 1/4 of Section _____, T _____ N, R _____	Lat ____ ° ____ ' ____ " Long ____ ° ____ ' ____ "	Local Grid Location ☐ N ☐ E ______ Feet ☐ S ______ Feet ☐ W

Facility ID	County	County Code ____ ____	Civil Town/City/ or Village

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

Sample		Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/ Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	

State of Wisconsin
Department of Natural Resources

Instructions
Soil Boring Log Information Forms
Form 4400-122, Form 4400-l22A

General Instructions:

Fill out a Soil Boring Log Information Form for every boring drilled. Be sure to indicate the page number and boring number in the blanks at the top of each page. All applicable portions of the Soil Boring Log Information Form must be properly completed. The form must be signed. Form 4400-122A must only be used as an attachment to form 4400-122.

Routing:

Return this form to the project manager or plan reviewer for the Department program that required the boring. If the project manager/plan reviewer is in a Regional Office, send the original to the Regional Office and a copy to the Central Office in Madison. If the project manager/plan reviewer is in the Central Office, send the original form there and a copy to the Regional Office. If your project does not have a project manager or plan reviewer or you do not know who it is, send the form to the appropriate program in the Central Office. Check the appropriate box at the top of the form to assure proper routing once the form reaches the Department.

Facility/Project Name: List the name of the landfill, wastewater treatment facility, surface impoundment, spill or project.

License/Permit/Monitoring Number: The number assigned by the Department to the facility where the boring was drilled. If unknown, leave blank.

Boring Number: The site boring number or name (e.g., B-1).

Boring Drilled By: The name (first and last) of the drilling crew chief and the drilling firm name.

Date Drilling Started: The date the boring was started in month/day/year (mm/dd/yyyy) format.

Date Drilling Completed: The date the boring was completed in month/day/year (mm/dd/yyyy) format.

Drilling Method: List drilling method used: solid stem auger, hollow stem auger, rotary (air or mud), reverse rotary, cable tool, wash boring, vibratory, etc.

Wisconsin Unique Well Number: If a well is to be set in the boring, fill in the 2 alphabetic 3 numeric Wisconsin Unique Well Number (WUWN) on this form. In addition, attach a WUWN tag to the inside of the protective cover pipe and record that number on the Monitoring Well Construction Form 4400-113A and Monitoring Well Development Form 4400-113B. WUWN tags are available from the DNR Central or Regional Offices.

DNR Well ID Number: The 3 digit number assigned to the well by the Department.

Well Name: If a well is constructed, fill in common well name, such as B-ll, OW-13A, or MW-5R. (Use the suffix "R" for a replacement well.)

Final Static Water Level: The static water level in the borehole in tenths (0.1) of feet above mean sea level prior to abandonment or well construction.

Surface Elevation: The surface elevation of the ground surface at the borehole in tenths (0.1) of feet above mean sea level referenced to the closest USGS benchmark.

Borehole Diameter: The diameter of the borehole in tenths (0.1) of inches.

Local Grid Origin or Boring Location: Check the appropriate box behind the Local Grid Origin or the Boring Location text. Locate the grid origin at a permanent feature near the waste or source of contamination. Give the location in State Plane Coordinates or Latitude and Longitude in degrees, minutes and seconds (using 1927 North American Datum). If State Plane Coordinates are used, circle the appropriate letter for south, central, or north zone. Alternately, an acceptable method for providing this information without surveying is to locate the Grid Origin on a USGS 7.5 minute quadrangle map. The Location of the Grid Origin can then be interpolated (estimated) using standard cartographic techniques. If the Grid Origin location is estimated, check the estimated box.

The boring location can be determined by surveying or by Global Positioning System (GPS) (with processing to be accurate within 1 foot and reported with precision to hundredths of a second). If the exact location or the boring is given in State Plane Coordinates, then leave the Local Grid Location fields blank.

Section Location of Waste/Source: Enter the quarter quarter section, quarter section, section, township, range and range direction.

Local Grid Location: The location of the boring to the nearest foot, in relation to the grid origin established for the site. If the exact location or the boring is given in State Plane Coordinates, then leave these fields blank.

Facility ID: Fill in the Facility ID (FID) assigned to the site.

County: The county in which the boring is located.

County Code: The two-digit Department county code. (The code is based alphabetically with Adams County 01 and Wood County 72 and can be found on the map included with the Monitoring Well Construction form instructions.)

Civil Town/City/or Village: The municipality in which the boring is located.

Sample Number: The number used to identify the sample. Indicate the type of sampling apparatus used (i.e. split spoon/ss, Shelby tube/st, grab/gs, piston sampler/ps, core/cs, cuttings/cu). Note the diameter of the sampler in Comments column.

Sample Length Attempted and Recovered: The length of sample attempted and the length of sample recovered reported in inches.

Blow Counts: The number of blow counts per specified length.

Depth: Indicate the depth (below ground surface) of sample collection and depth of any changes in the soil or rock type encountered.

Soil/Rock Description and Geologic Origin: List visual characteristics of soil/rock noted during boring along with any pertinent descriptive remarks. Each major soil unit and bedrock formation shall be described using both subsurface investigations and regional information. Indicate likely geologic origin and Munsell color of the material.
USCS: Indicate the Unified Soil Classification System classification of any unconsolidated units or rock type encountered during boring.

Graphic Log: Graphically illustrate soil/rock types encountered through the depth of boring and provide a key for the symbols used. Indicate the total depth of the boring on the log.

Well Diagram: Graphically show the well casing, well screen length(s), and the location of the top of the filter pack(s) if the boring is converted into a well.

PID/FID: Measurements performed on samples using a Photo-Ionization Detector or a Flame Ionization Detector. Indicate in the Comments column the type of detector and the method used.

Soil Properties:

Compressive Strength - Standard measurements in tons/ft. Indicate in the Comments column the type of test used.
Moisture Content - Laboratory measurements of percent moisture content.
Liquid Limit - Measurement in percent.
Plasticity Index - Measurement in percent.
P 200 - Measurement of percentage of soils smaller than the #200 sieve.

RQD/Comments: Where boring penetrates bedrock, indicate the Rock Quality Designation of the sample. Otherwise, place all comments or remarks in this column and the adjacent margin.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☐ Other ☐ ______

MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 7-98

Facility/Project Name	Local Grid Location of Well ______ ft. ☐ N. ☐ S. ______ ft. ☐ E. ☐ W.	Well Name	
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ___ ° ___ ' ___ " Long. ___ ° ___ ' ___ " or	Wis. Unique Well No.	DNR Well ID No.
Facility ID _ _ _ _ _ _ _ _ _ _	St. Plane ______ ft. N, ______ ft. E. S/C/N	Date Well Installed _ _ / _ _ / _ _ _ _ m m d d y y y y	
Type of Well Well Code ____/____	Section Location of Waste/Source ____1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E ☐ W	Well Installed By: Name (first, last) and Firm	
Distance from Waste/ Source ______ ft. / Enf. Stds. Apply ☐	Location of Well Relative to Waste/Source u ☐ Upgradient s ☐ Sidegradient d ☐ Downgradient n ☐ Not Known / Gov. Lot Number		

A. Protective pipe, top elevation _ _ _ _ . _ _ ft. MSL

B. Well casing, top elevation _ _ _ _ _ _ _ ft. MSL

C. Land surface elevation _ _ _ _ _ _ _ ft. MSL

D. Surface seal, bottom _ _ _ _ _ _ ft. MSL or _ _ _ _ ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☐ No

14. Drilling method used: Rotary ☐ 5 0
Hollow Stem Auger ☐ 4 1
______ Other ☐

15. Drilling fluid used: Water ☐ 0 2 Air ☐ 0 1
Drilling Mud ☐ 0 3 None ☐ 9 9

16. Drilling additives used? ☐ Yes ☐ No

Describe ______

17. Source of water (attach analysis, if required):

______

E. Bentonite seal, top _ _ _ _ _ _ ft. MSL or _ _ _ _ _ ft.

F. Fine sand, top _ _ _ _ _ _ ft. MSL or _ _ _ _ _ ft.

G. Filter pack, top _ _ _ _ _ _ ft. MSL or _ _ _ _ _ ft.

H. Screen joint, top _ _ _ _ _ _ ft. MSL or _ _ _ _ _ ft.

I. Well bottom _ _ _ _ _ _ ft. MSL or _ _ _ _ _ ft.

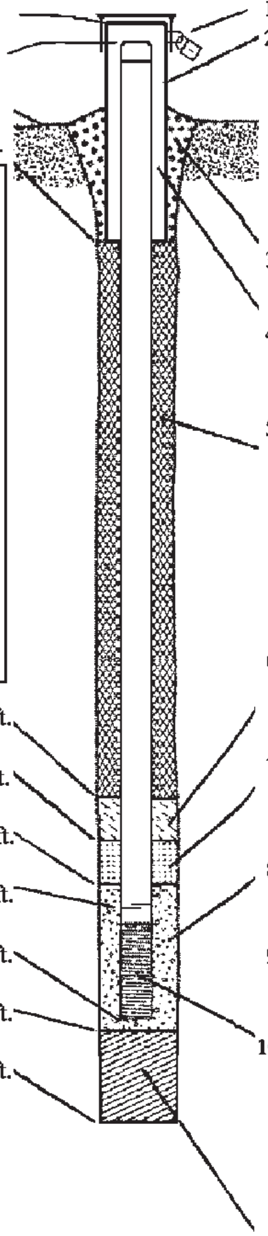
J. Filter pack, bottom _ _ _ _ _ _ ft. MSL or _ _ _ _ _ ft.

K. Borehole, bottom _ _ _ _ _ _ ft. MSL or _ _ _ _ _ ft.

L. Borehole, diameter _ _ _ _ in.

M. O.D. well casing _ _ _ _ in.

N. I.D. well casing _ _ _ _ in.



1. Cap and lock? ☐ Yes ☐ No
2. Protective cover pipe:
   a. Inside diameter: _ _ _ in.
   b. Length: _ _ _ ft.
   c. Material: Steel ☐ 0 4
   ______ Other ☐
   d. Additional protection? ☐ Yes ☐ No
   If yes, describe: ______
3. Surface seal: Bentonite ☐ 3 0
   Concrete ☐ 0 1
   ______ Other ☐
4. Material between well casing and protective pipe:
   Bentonite ☐ 3 0
   ______ Other ☐
5. Annular space seal: a. Granular/Chipped Bentonite ☐ 3 3
   b. ____Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 3 5
   c. ____Lbs/gal mud weight . . . . . Bentonite slurry ☐ 3 1
   d. ____ % Bentonite . . . . . . Bentonite-cement grout ☐ 5 0
   e. ______ Ft^3 volume added for any of the above
   f. How installed: Tremie ☐ 0 1
   Tremie pumped ☐ 0 2
   Gravity ☐ 0 8
6. Bentonite seal: a. Bentonite granules ☐ 3 3
   b. ☐1/4 in. ☐3/8 in. ☐1/2 in. Bentonite chips ☐ 3 2
   c. ______ Other ☐
7. Fine sand material: Manufacturer, product name & mesh size
   a. ______
   b. Volume added ______ ft^3
8. Filter pack material: Manufacturer, product name & mesh size
   a. ______
   b. Volume added ______ ft^3
9. Well casing: Flush threaded PVC schedule 40 ☐ 2 3
   Flush threaded PVC schedule 80 ☐ 2 4
   ______ Other ☐
10. Screen material: ______
    a. Screen type: Factory cut ☐ 1 1
    Continuous slot ☐ 0 1
    ______ Other ☐
    b. Manufacturer ______
    c. Slot size: 0. _ _ _ in.
    d. Slotted length: _ _ _ _ ft.
11. Backfill material (below filter pack): None ☐ 1 4
    ______ Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☐ Other ☐ ________

Facility/Project Name	County Name	Well Name

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
	__ __	__ __ __ __ __ __ __	__ __ __

1. Can this well be purged dry? ☐ Yes ☐ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☐ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other ________ ☐ __

3. Time spent developing well __ __ __ __ min.

4. Depth of well (from top of well casisng) __ __ __ . __ ft.

5. Inside diameter of well __ __ . __ __ in.

6. Volume of water in filter pack and well casing __ __ __ . __ gal.

7. Volume of water removed from well __ __ __ . __ gal.

8. Volume of water added (if any) __ __ __ . __ gal.

9. Source of water added ________

10. Analysis performed on water added? ☐ Yes ☐ No
    (If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. __ __ __ . __ __ ft.	__ __ __ . __ __ ft.
Date	b. __ __ / __ __ / __ __ __ __ (m m d d y y y y)	__ __ / __ __ / __ __ __ __ (m m d d y y y y)
Time	c. __ __ : __ __ ☐ a.m. ☐ p.m.	__ __ : __ __ ☐ a.m. ☐ p.m.
12. Sediment in well bottom	__ __ . __ inches	__ __ . __ inches
13. Water clarity	Clear ☐ 10 Turbid ☐ 15 (Describe)	Clear ☐ 20 Turbid ☐ 25 (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	__ __ __ __ . __ mg/l	__ __ __ __ . __ mg/l
15. COD	__ __ __ __ . __ mg/l	__ __ __ __ . __ mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Last Name:
Firm:

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: ________ Last Name: ________

Facility/Firm: ________

Street: ________

City/State/Zip: ________

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: ________

Print Name: ________

Firm: ________

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

INSTRUCTIONS
Monitoring Well Construction Form 4400-113A

General Instructions: Fill out both a monitoring well construction form (4400-113A) and a monitoring well development form (4400-113B) for each well installed. Sign each form. Please note that these forms are subject to change. (Personally identifiable information on these forms is not intended to be used for any other purpose.)

Routing: Return these forms to the project manager or plan reviewer for the DNR program who required the well installation. If the project manager/plan reviewer is in the Regional Office, send the original forms to the Regional Office and a copy to the Central Office in Madison. If the project manager/plan reviewer is in the Central Office, send the original forms there and a copy to the Regional Office. If your project does not have a project manager or plan reviewer or you don't know who it is, send the forms to the appropriate program in the Central Office. The addresses of the DNR offices are provided on the attached map.

Check the appropriate routing box at the top of the forms to assure proper routing once the forms reach DNR.

Time-saving tip: When filling out many forms at once, you can save time by using a photocopier. Fill out one form (the "original") with any information that is the same for all wells, such as facility name, section location, grid origin location, drilling method and well casing type. Photocopy both sides of the "original", making as many copies as there are wells. On the separate copies, fill in the details that are unique for each well.

TOP LEFT

Facility/Project Name: Fill in the name of landfill, wastewater treatment facility, surface impoundment, spill or project.

Facility License, Permit, or Monitoring Number: Fill in number assigned to facility by the Department. If unknown, leave blank.

Facility ID: Fill in the nine digit Facility ID (FID) assigned to the site.

Type of Well: Record the type of well code (number/initials) from the following list:

11/mw	Water table observation well (monitoring well screen intersecting the water table) (non Subtitle D well)
12/pz	Piezometer (monitoring well with screen sealed below the water table) (non Subtitle D well)
17/gc	Gradient control
18/at	Aquifer test
24/lh	Leachate head well
26/ew	Groundwater extraction well
27/he	Horizontal groundwater extraction well
28/hw	Horizontal monitoring well
29/ha	Horizontal vapor extraction well
51/gp	Gas probe
53/ge	Gas extraction well
57/sv	Soil venting wells (includes both soil vapor extraction and bioventing, includes both extraction and unsaturated zone gas phase injection wells installed in soil or fill, but not refuse
61/ij	Injection well (injection of liquids not gases)
62/as	In situ air sparging well (injection well to inject gases into the aquifer
63/uv	Unterdruck Verdampfer Brunnen (UVB) wells (sparging wells where the gases remain in the well and are not injected into the aquifer)
64/le	Groundwater and light non-aqueous phase liquid (LNAPL) extraction wells
65/de	Groundwater and dense non-aqueous phase liquid (DNAPL) extraction wells
66/ve	Vacuum enhanced groundwater extraction wells
67/vi	Vacuum enhanced groundwater and LNAPL extraction wells
68/vd	Vacuum enhanced groundwater and DNAPL extraction wells
71/dw	Subtitle D water table observation well (see 11/mw above)
72/dp	Subtitle D piezometer (see 12/pz above)
99/Ot	Other

Distance From Waste/Source: Enter distance in feet from the monitoring well to the edge of a facility waste storage or discharge structure, e.g., from the edge of a wastewater lagoon or the approved waste fill boundary for a landfill. For a contaminant source which is not a facility, e.g., a spill, enter the distance the well is from the contaminant source.

Enf. Stds. Apply: Check this box only if enforcement standards apply at this well. Enforcement standards apply at any well beyond the Design Management Zone or the property boundary of the facility or at a water supply well. For spills, enforcement standards apply at every point at which groundwater is monitored. (For more information, see s. NR 140.22, Wis. Adm. Code.)

TOP CENTER

Local Grid Location: The location of the well to the nearest foot, in relation to the grid origin established for the site. If the exact location of the well is given in State Plane Coordinates, then leave these fields blank.

Local Grid Origin or Well Location: Check the appropriate box behind the Local Grid Origin or the Well Location text. Locate the grid origin at a permanent feature near the waste or source of contamination. Give the location in State Plane Coordinates or Latitude and Longitude in degrees, minutes and seconds (using 1927 North American Datum). If State Plane Coordinates are used, circle the appropriate letter for south, central or north zone. Alternately, an acceptable method for providing this information without surveying is to locate the Grid Origin on a USGS 7.5 minute quadrangle map. The Location of the Grid Origin can then be interpolated (estimated) using standard cartographic techniques. If the Grid Origin location is estimated, check the estimated box.

The Well Location can be determined directly by surveying or by Global Positioning System (GPS) (with processing to be accurate within 1 foot and reported with precision to hundredths of a second). If the exact location of the well is given in State Plane Coordinates, then leave the Local Grid Location fields blank.

Section Location of Waste/Source: Fill in the quarter quarter and quarter section, section, township, range and range direction of the waste or source.

Location of Well Relative to Waste/Source: Check the box which describes the location of the well in the groundwater flow system relative to the disposal site, spill, etc. If groundwater flow directions are unknown, check "not known."

Gov. Lot Number: Provide the government lot number for the property if applicable. (Government lot numbers are the legal description of a tract of land adjacent to a lake or stream where a proper quarter or quarter quarter section corner could not be established.)

TOP RIGHT

Well Name: Fill in common well name, such as B-ll, OW-13A, or MW-5R. (Use the suffix "R" for a replacement well.)

Wis. Unique Well Number: Fill in the 2 alphabetic and 3 numeric Wisconsin Unique Well Number (WUWN) on this form. In addition, attach the WUWN tag to the inside of the protective cover pipe and record that number on the Soil Boring Log Information form 4400-122 and Monitoring Well Development form 4400-113B. WUWN tags are available from the DNR Central or Regional Offices.

DNR Well ID Number: The 3 digit number assigned to the well by the Department.

Date Well Installed: List Month/Day/Year (mm/dd/yyyy) the well was installed.

Well Installed By: Fill in name (first and last) and firm of the person who supervised the drilling. The person must be a hydrogeologist, a drilling crew chief or experienced engineering technician.

LEFT SIDE

Numerical Specifications: Fill in data for letters A through N which refer to design elements on the figure on the form. Letters A, B and C must be reported as elevations in feet above mean sea level (MSL), surveyed to the nearest 0.01 foot. Letters D through K may be either elevation above MSL or depth below land surface, accurate to the nearest 0.1 foot.

A. **Protective pipe, top elevation**. With cap off. Referenced to Mean Sea Level (MSL).

B. **Well casing, top elevation**. With cap off. Referenced to MSL.

C. **Land surface elevation**. Referenced to MSL.

D. **Surface seal, bottom**. Fill in elevation, MSL or depth below land surface.

E. **Bentonite seal, top**. MSL or depth below land surface. (See NR 141.13(1) to determine if this seal is required)

F. **Fine sand, top**. MSL or depth below land surface. Cross out if not installed.

G. **Filter pack, top**. MSL or depth below land surface.

H. **Screen joint, top**. MSL or depth below land surface. (Top of the entire screen section, NOT the top slot)

L. **Well bottom**. MSL or depth below land surface.

J. **Filter pack, bottom**. MSL or depth below land surface.

K. **Borehole, bottom**. MSL or depth below land surface.

L. **Borehole, diameter**: Diameter to nearest 0.1 inch.

M. **O.D. well casing**: Outside diameter to nearest 0.01 inch.

N. **I.D. well casing**: Inside diameter to nearest 0.01 inch.

LEFT CENTER INSERT (BOX)

12. **USCS classification of soil near screen**: Check boxes for all soil types (or bedrock) found at the depths spanned by the well screen, using the Unified Soil Classification System symbols. Refer to the native soil near the screen, not to the filter pack material.

13. **Sieve analysis performed?**: Check box. A sieve analysis for soil near the screen is required for all wells.

14. **Drilling method used**: Choose from among the choices on the form or check "Other" and write in one of the choices below:

Reverse rotary	Solid stem auger	Cable tool	Driven point
Vibratory	Casing hammer	Wash boring	

15. **Drilling fluid used**: Check appropriate box or boxes.

16. **Drilling additives used**: Check box. If yes, describe.

17. **Source of water**: Cite source(s) of any water used to drill the well OR to hydrate dry bentonite OR to mix annular space sealant. Cite exact source so that a sample of the water can be obtained later, if necessary. If the well is at a solid waste facility, attach an analysis of the water according to s. NR 507.06(1), Wis. Adm. Code.

RIGHT SIDE

1. **Cap and Lock**: Check box.

2. **Protective pipe**: Provide the information below.

   a. **Inside diameter**: Give to nearest 0.1 inch.
   b. **Length**: Give to nearest 0.1 foot
   c. **Material**: Check box. If "Other", describe.
   d. **Additional protection?**: Check box. If 'Yes', describe.

3. **Surface seal**: Check box for the material used to prevent surface water from entering the borehole. If "Other," describe.

4. **Material between well casing and protective pipe**: Check box. If "Other", describe.

5. **Annular space seal**: Check boxes for both materials used and how installed, and fill in volume used.

   Material: If dry bentonite, list source of water used for hydration on line #17. For wells installed at a solid waste site, attach an analysis of water (see s. NR 507.06(1), Wis. Adm. Code.) For other choices, fill in pounds per gallon mud weight or percent bentonite as appropriate.

   e. **Volume**: Fill in volume used in cubic feet.
   f. **How installed**: Check box for how the annular space seal was installed. If dropped from the land surface, check "Gravity."

6. **Bentonite seal**: If bentonite pellets were used, also check the pellet diameter. If material installed was the same as the annular space seal, or if no filter pack seal was installed, write "none."

7. **Fine sand material**: Fine sand is used to prevent migration of annular space seal material into the filter pack.
   a. Indicate manufacturer, product name, and mesh size.
   b. Indicate volume added.

8. **Filter pack material**: General description of filter pack material, e.g., "430 grit sand," and name of filter pack manufacturer, product name or number, and volume added. Attach grain size analysis of filter pack and state quantity used.

9. **Well casing**: Check box for PVC type. If "Other", describe. Examples of "Other" include stainless steel, steel, and Teflon ©.

10. **Screen material**: If same as well casing, write "same."

    a. **Screen type**: Check box. If "Other", describe the design.
    b. **Manufacturer**: List name of manufacturer.
    c. **Slot size**: Give width of slot in thousandths (0.001) of an inch.
    d. **Slotted length**: Give distance from top slot to bottom slot to nearest 0.1 foot.

11. **Backfill material**: Check "None" or, if "Other", describe any backfill installed below the filter pack.

FAR BOTTOM

"I hereby certify that the information on this form is true and correct to the best of my knowledge.": Sign the form and indicate name of firm.

MONITORING WELL DEVELOPMENT FORM 4400-113B

TOP TWO LINES

Facility/Project Name: Fill in the name of landfill, wastewater treatment facility, surface impoundment, spill or project.

Facility License Permit, or Monitoring Number: Enter number assigned to facility by the DNR. If unknown, leave blank.

County Name: Fill in the name of the county in which the well is installed.

County Code: Fill in the two digit county code number.

1 . Adams	16. Douglas	31. Kewaunee	46. Ozaukee	61. Taylor
2. Ashland	17. Dunn	32. La Crosse	47. Pepin	62. Trempealeau
3. Barron	18. Eau Claire	33. Lafayette	48. Pierce	63. Vernon
4. Bayfield	19. Florence	34. Langlade	49. Polk	64. Vilas
5. Brown	20. Fond Du Lac	35. Lincoln	50. Portage	65. Walworth
6. Buffalo	21. Forest	36. Manitowoc	51. Price	66. Washburn
7. Burnett	22. Grant	37. Marathon	52. Racine	67. Washington
8. Calumet	23. Green	38. Marinette	53. Richland	68. Waukesha
9. Chippewa	24. Green Lake	39. Marquette	54. Rock	69. Waupaca
10. Clark	25. Iowa	40. Menominee	55. Rusk	70. Waushara
11. Columbia	26. Iron	41. Mlwaukee	56. St. Croix	71. Winnebago
12. Crawford	27. Jackson	42. Monroe	57. Sauk	72. Wood
13. Dane	28 Jefferson	43. Oconto	58. Sawyer	
14. Dodge	29. Juneau	44. Oneida	59. Shawano	
15. Door	30. Kenosha	45. Outagamie	60. Sheboygan	

Well Name: Fill in common well name, such as P-11, OW-13A, or MW-5R. (Use the suffix "R" for a replacement well.)

Wis. Unique Well Number: Record the Wisconsin Unique Well Number assigned to the well.

DNR Well ID Number: The 3 digit number assigned to the well by the Department.

LEFT COLUMN

1. **Can this well be purged dry?** Check whether well can or cannot be purged dry (all water removed).

2. **Well development method**: Check appropriate box. If "Other", describe. Note that a well shall be surged and purged for a minimum of 30 minutes.

3. **Time spent developing well**: In minutes.

4. **Depth of well**: In tenths (0.1) of feet, <u>from top of well casing</u>.

5. **Inside diameter of well**: In hundredths (0.01) of inches.

6. **Volume of water in filter pack and well casing**: In tenths (0.1) of gallons.

7. **Volume of water removed from well**: In tenths (0.1) of gallons.

8. **Volume of water added, if any**: In tenths (0.1) of gallons.

9. **Source of water added**: Cite exact source so that a sample of the water can be obtained later, if necessary.

10. **Analysis performed on water added?** Check appropriate box. If well is installed at a solid waste facility, attach analysis of water according to s. NR 507.06(1), Wis. Adm. Code.

RIGHT COLUMN

11. **Depth to water**:

    a. Enter distance from top of well casing to water level in well, in hundredths (0.01) of a foot, both before and after development.

    b. **Date**: Enter month/day/year (mm/dd/yyyy) development began and ended.

    c. **Time**: Enter according to a twelve hour clock the time development began and ended.

12. **Sediment in well bottom**: Compute to tenths (0.1) of inches, both before and after development.

13. **Water clarity**: Check box and describe.

14. **Total suspended solids**: Total Suspended Solids, as determined by a certified or registered analytical laboratory. Required only for wells near solid waste facilities when drilling fluids were used.

15. **COD**: Chemical oxygen demand, as determined by a certified or registered analytical laboratory. Required only for wells near solid waste facilities when drilling fluids were used.

16. **Well developed by**: Enter the name (first and last) and firm of the person who supervised the development This person must be a hydrogeologist, the drilling crew chief, or an experienced engineering technician.

BOTTOM SECTION

17. **Additional comments on development**: Describe any of the above in more detail or add information such as the relative recovery rates of wells or the amount of drilling fluid lost to the formation and the amount of water removed to account for lost drilling fluid. For example, if 150 gallons of drilling water were, lost, you should remove the volume of water in the filter pack and well casing plus 150 gallons as part of development.

Name and Address of Facility/Owner/Responsible Party Contact: Enter a contact name (first and last), or a firm name or facility name, street address, city, state, and zip code of the facility or site.

Signature, Print Name, and Firm: Signature and printed name of the person filling out the form and name of firm for which the person works.

Tetra Tech, Inc. Ground Water Sampling Log

Project ______________ **Site** ______________ **Well No.** ____________ **Date** ________________________

Well Depth ___________ **Screen Length** _________ **Well Diameter** ________ **Casing Type** ___________

Sampling Device ______________ **Tubing type** ____________________ **Water Level** ________________

Measuring Point __________________ **Other Infor** ____

____

Sampling Personnel ____

Time	pH	Temp	Cond.	Dis.O_2	Turb.	[ ]Conc	Pump Rate		Notes

Type of Samples Collected

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: Vol = $\pi r^2 h$, Vol = $4/3 \pi r^3$