Mr. Peter Campbell
Environmental Program Specialist
Alaska Department of Environmental Conservation
43335 Kalifornsky Beach Road, Suite 11
Soldotna, Alaska 99669

ENVIRONMENT

Date:
June 30, 2021

Contact:
Steve Rice

Phone:
303.710.7537

Email:
Steve.Rice@arcadis.com

Our ref:
30024488

Subject:

Per- and Polyfluoroalkyl Substances Sampling Work Plan
Former Chevron Kenai Refinery
Nikiski, Alaska

Dear Mr. Campbell:

On behalf of Chevron Environmental Management Company (CEMC), Arcadis U.S., Inc. (Arcadis) has prepared this Per- and Polyfluoroalkyl Substances (PFAS) Sampling Work Plan (Work Plan) to comply with a request from the Alaska Department of Environmental Conservation (ADEC) for the former Chevron Kenai Refinery located in Nikiski, Alaska (Site; **Figure 1**). A PFAS Sampling Work Plan was developed preliminarily by Trihydro Corporation (Trihydro) in response to ADEC's request to sample groundwater for PFAS compounds in the historical fire training area (FTA) at the Site dated August 1, 2018 (**Attachment A**). Although the preliminary Trihydro work plan outlined sample collection from groundwater monitoring wells CMW-17 and CMW-56, and is included as **Attachment B**, the presence of non-aqueous phase liquid (NAPL) in these wells on the day of planned sampling could preclude their locations as representative. The workplan was conditionally approved for the Site by ADEC on September 24, 2018 (**Attachment C**), with subsequent revised guidance regarding analyte focus to perfluorooctane sulfonate and perfluorooctanoic acid (PFOS and PFOA) issued October 2019 (ADEC 2019).

The purpose of this Work Plan is to incorporate ADEC's conditional approval requirements into the sampling effort. A select number of existing Site monitoring wells will be sampled for PFAS in response to this request, as described below. The location of the historical FTA at the Site is shown on **Figure 2**.

1 MONITORING WELL SELECTION

ADEC initially requested that a select number of existing groundwater monitoring wells be sampled for PFAS within the historical FTA. However, no groundwater monitoring wells currently exist within the boundaries of the historical FTA. Proposed representative groundwater sample locations have been selected jointly with ADEC conditional approval and are located within approximately 200 feet of the FTA as shown on **Figure 2**.

The generalized groundwater flow direction at the Site is to the southwest (Trihydro 2020). CMW-12 will be sampled as an upgradient location and CMW-17, 28R, and 56 will be sampled as downgradient locations to the historical FTA, so long as NAPL is absent on the date of PFAS sampling. ADEC's conditional approval requested that CMW-28 be included in the PFAS sampling effort; however, the monitoring well was in a damaged state at the time the conditional workplan approval was received. As a result, CMW-28 was abandoned and reinstalled and developed in October 2019 as CMW-28R. **Table 1** below presents the construction data of the proposed monitoring wells to be sampled. **Table 2** below presents the sampling locations and sampling methodology. Well completion information and boring logs are presented in **Attachment D**. All four wells proposed for sampling were constructed using Schedule 40 Polyvinyl Chloride (PVC) casing and do not contain dedicated pumps or tubing which would potentially interfere with sample results.

Table 1. Details of Monitoring Wells Proposed for Sampling

Monitoring Well	Well Diameter (inches)	Well Depth (ft btoc)	Top of Casing Elevation (ft amsl)	Screen Interval (ft btoc)	Depth to Water (ft btoc) [1]
CMW-12	3	72.92	142.23	50-70	56.15
CMW-17*	4	78.41	140.51	61-76	65.88
CMW-28R(2)	2	78.56	142.06	66.5-76.5	74.16
CMW-56*	2	79.85	143.43	66.5- 76.5	73.82

Notes:

[1] Depth to groundwater measured on August 17-18, 2020 (Trihydro 2020). **(2) Replacement monitoring well**

Asterisk denotes wells will only be sampled if free product is absent.

amsl – above mean sea level

btoc - below top of casing

ft – feet

Table 2. Sampling Locations and Methods

Sample Type	Medium	Location ID	Sample Collection Location	Sample Method	Sample Type	Number of Samples*	Analytes
Former Kenai Refinery	Groundwater	CMW-12	Middle of screened interval or water column in monitoring well	Low-flow sampling	N, FD, MS/MSD	4	PFOA, PFOS, field parameters
		CMW-17**			N	1	
		CMW-28R			N	1	
		CMW-56**			N	1	
Equipment Blanks	PFAS-Free Water	EB-01	New HDPE Tubing via Bladder Pump	See text	EB	1	PFOA and PFOS
		EB-02	Decontaminated Water Level Meter (before use)			1	
Field Blank(s)	PFAS-Free Water	FB-01	N/A	N/A	FB	1	PFOA and PFOS

Notes:

EB = equipment blank	MS/MSD = matrix spike/matrix spike duplicate
FB = field blank	N = normal
FD = field duplicate	N/A = not applicable

* = represents number of samples to be submitted for analysis. Volume and bottles will be doubled per ITRC guidance (Attachment C, ADEC 2018b)
HDPE = high-density polyethylene
** = double asterisk indicates wells to be sampled only if free product is absent due to interference with PFAS representative measurements.

2 SAMPLING METHODOLOGY

Field personnel will follow the standard CEMC-required health and safety plan and job safety analyses, modified to ensure that the required personal protective equipment (PPE) are free from interfering chemical treatments. The prescribed nitrile gloves will be worn while sampling (and changed frequently as per **Attachment E**) and prohibited clothing will be avoided. Field log notes will be made available, and photographs will be taken to document appropriate equipment and sampling. The proposed monitoring wells will be gauged for depth to water and depth to the bottom of the well using an oil-water interface probe. Prior to insertion into each well, the probe will be decontaminated using PFAS-specific protocols. If NAPL is encountered in CMW-17 and/or -56 this will be noted in the field log (with thickness measurements), but such conditions may interfere with a representative measurement of PFAS and are not ideal. Samples will not be collected from wells with NAPL and will instead be replaced with a sample from an alternate nearby location(s). Suggested alternate locations include CMW-65 instead of CME-17 and CMW-57 instead of CMW-56, if needed.

Monitoring well PFAS sampling will be performed via a low-flow sampling method using a stainless-steel bladder pump and HDPE or silicone tubing, in accordance with the Arcadis guidance on PFAS Sampling Procedures and Low-Flow Groundwater Purging for Monitoring Wells, and the Chevron PFAS Sampling and Analysis Guidance (Arcadis 2021; **Attachment E).** The low-flow sampling method will consist of purging the well until three consecutive readings indicate water quality field parameters have stabilized. Water quality field parameters will be measured using a flow-through cell (**Table 3** below).

Table 3. Field Parameter List Applicable to Groundwater Samples

Field Parameters
Depth to Water
DO
Temperature
Electrical Conductivity
pH
Turbidity

ADEC's conditional approval required that PFAS sampling at the site follow Interstate Technology Regulatory Council (ITRC) guidance on the topic. Chevron PFAS Sampling Guidance (Arcadis 2021; **Attachment E**) is consistent with the ITRC Site Characterization Considerations, Sampling Precautions, and Laboratory Analytical Methods for PFAS (**Attachment C**). The Chevron PFAS Sampling Guidance includes, but is not limited to, restrictions on the use of materials that can introduce PFAS through cross-contamination, use of PFAS-free equipment and decontamination procedures.

The analytical laboratory will provide appropriate polypropylene or HDPE containers without PFAS components, such as bottle cap liners with a polytetrafluoroethylene layer. Consistent with ITRC guidance, two sample volumes and containers will be collected from each sample location. Because the concentration level of PFAS in aqueous samples determines whether the whole sample or an aliquot is used in the laboratory preparation, the sampler will collect an additional volume of each sample in a separate container. Then, the laboratory can screen the extra sample for high concentrations without affecting the final sample result, if needed. Samples will be placed in an ice-chilled cooler and shipped and handled with chain of custody documentation. The samples will be shipped from the authorized FedEx Ship Center located at the Kenai, AK airport by priority overnight to Eurofins Lancaster Laboratories (Eurofins) in Lancaster, Pennsylvania.

2.1 Quality Assurance/Quality Control

As part of the field quality assurance/quality control (QA/QC), matrix spike/matrix spike duplicate (MS/MSD) samples and field duplicate samples will be collected. The groundwater MS/MSD will be collected from well CMW-12, the upgradient well, to verify that the MS is conducted on the sample that is most unlikely to require dilution at the laboratory to achieve PFAS concentrations in the range of calibration (**Table 2**). In addition, a field blank will be collected.

As indicated in Table 2, two equipment blanks will be collected during the field event. One equipment blank will be collected from the decontaminated depth to water meter using laboratory-supplied “PFAS-free” water before use in the first well. For the water level meter, the equipment blank will be collected by pouring PFAS-free water provided by the laboratory down the decontaminated depth to water meter into a laboratory-supplied container One equipment blank will be collected from new tubing from the stainless-steel pump. For pump tubing, laboratory supplied “PFAS-free” water shall be poured into a clean HDPE sample bottle and then pumped through new HDPE tubing using the stainless-steel pump (with new HPDE and/or silicone tubing) for collection and analysis. New tubing will be used to sample each monitoring well location.

2.2 Investigation-Derived waste

Investigation-derived waste (IDW), including decontamination water and purge water will be containerized. IDW purge water will be placed in the existing poly tank onsite containing monitoring well purge water and disposed of in accordance with PFAS guidance. PPE and other sampling supplies will be removed from the Site immediately upon completion of each day’s field activities. A post-activity inspection will be conducted by the field team lead to ensure the location is left tidy and clear of trash and debris.

3 LABORATORY ANALYSES

Samples will be analyzed for the following PFAS analytes in **Table 4** below:

Table 4. PFAS Analyte List

Group	Chemical Name	Abbreviation
Perfluoroalkyl sulfonates	Perfluorooctanesulfonic acid	PFOS
Perfluoroalkyl carboxylates	Perfluorooctanoic acid	PFOA

All groundwater samples will be sent to Eurofins in Lancaster, Pennsylvania, which holds a ADEC certification for chemical analysis using a modified drinking water method. All samples will be analyzed for the PFAS listed in **Table 4** using a method that is compliant with QSM 5.1 (or later) Table B-15. The Eurofins ADEC certification is provided in **Attachment F**. The Eurofins standard operating procedures (SOPs) for PFAS analysis, which detail sample preparation procedures and extraction methods, are included as **Attachment G**.

Target reporting limits are 2 nanograms per liter (ng/L) for PFOA and PFOS. The laboratory will provide a Level IV data deliverable. Environmental Standards, Inc. will perform a third-party data validation.

A CEMC-developed Quality Assurance Project Plan (QAPP) which will provide data quality objectives (DQOs) and additional QA/QC protocols to be used in data collection activities will be utilized during the project execution and data evaluation.

4 REPORTING

After the investigation is complete and laboratory data are received and validated, Arcadis will prepare a concise letter report summarizing the sampling results.

5 SCHEDULE

The PFAS groundwater sampling event is tentatively scheduled to be performed in late summer, 2021, weather permitting.

Please direct any questions, comments, or correspondence regarding this project to Steve Rice, Arcadis Project Manager and copy James Kiernan of CEMC on all written correspondences.

Sincerely,

Arcadis U.S., Inc.

Steve Rice
Certified Project Manager

Copies:
Atique ur Rehman, CEMC
James Kiernan, CEMC

Enclosures:

Figures

1 Site Location

2 Site Map and Proposed Sampling Locations

Attachments

A ADEC Review Comments and Work Plan Requirement

B 2018 Southern Plume Well Installation and PFAS Sampling Work Plan

C 2018 Southern Plume Well Installation and PFAS Sampling Work Plan: ADEC Conditional Approval and ITRC Site Characterization Considerations, Sampling Precautions, and Laboratory analytical Methods for Per- and Polyfluoroalkyl Substances.

D Well Completion Information and Boring Logs

E Arcadis PFAS Sampling Guidance
  - Poly- and Perfluoroalkyl Substance (PFAS) Sampling and Analysis Guidance
  - PFAS Sampling Procedures and Low-Flow Groundwater Purging for Monitoring Wells

F Eurofins ADEC Certification

G Eurofins PFAS SOP

References

ADEC. 2018a. ADEC Review Comments & Work Plan Requirement. ADEC Hazard ID: 313. 2017 Annual Site Status Report. Chevron USA Refinery – Nikiski. August 1.

ADEC. 2018b. ADEC Conditional Approval. ADEC Hazard ID: 313. 2018 Southern Plume Well Installation and PFAS Sampling Work Plan. Chevron USA Refinery – Nikiski. September 24.

ADEC. 2019. ADEC Technical Memorandum. Action Levels for PFAS in Water and Guidance on Sampling Groundwater and Drinking Water. Updated October 2.

Arcadis. 2018a. PFAS Sampling Procedures and Low-Flow Groundwater Purging for Monitoring Wells. June 19.

Arcadis. 2021. Poly- and Perfluoroalkyl Substance (PFAS) Sampling and Analysis Guidance. Revision 4. June 30.

Trihydro. 2018. 2018 Southern Plume Well Installation and PFAS Sampling Work Plan. ADEC Hazard ID 25935. Chevron USA Refinery – Nikiski, Alaska. September 17.

Trihydro. 2020. Annual Site Status Report. January – December 2020. Former Chevron Refinery. Kenai, Alaska. December 18.

FIGURES

TOPOGRAPHIC SOURCE:
U.S. Geological Survey
https://ngmdb.usgs.gov/topoview/
REFERENCES:
USGS Topographic Quadrangle:
Seal Beach, California
7.5-Minute Series
PROJECTIONS:
NAD 1983 State Plane California VI Feet

N

0 1,000 2,000

SCALE IN FEET

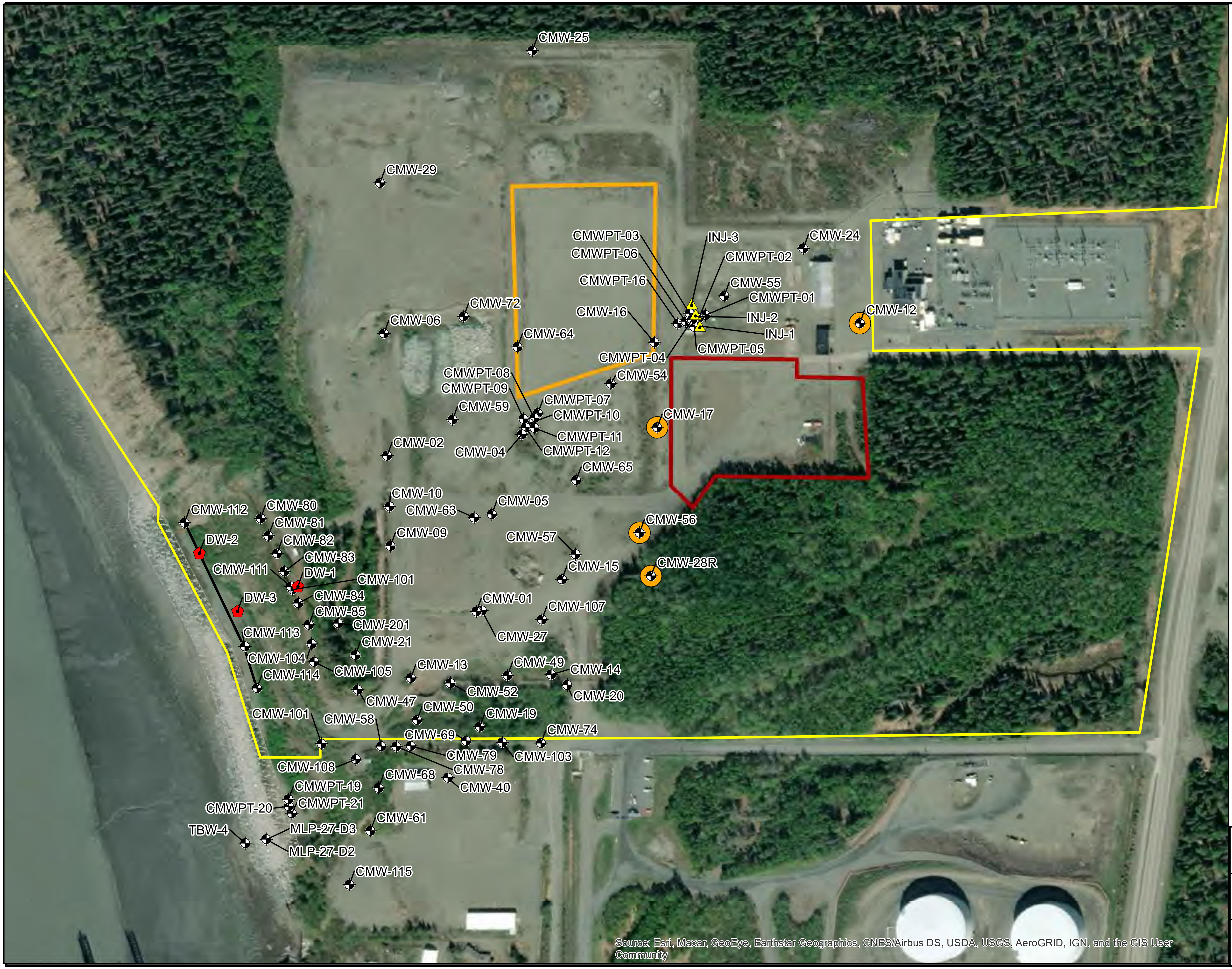
FORMER CHEVRON KENAI REFINERY
55310 CHEVRON RD
KENAI, AK 99611

SITE LOCATION MAP

ARCADIS

FIGURE
1

User Name: mai00749 DATE: 6/25/2021 3:19:32 PM
PATH: T:\ ENV\Chevron Alaska\MXD\Figure1 Site Location Map.mxd



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

N

⊕	MONITORING WELL
⬟	EXTRACTION WELL
▲	INJECTION WELL
●	MONITORING WELL TO BE SAMPLED FOR PFAS COMPOUNDS
—	SLURRY WALL
☐	PROPERTY BOUNDARY
▨	ROCK REVETMENT (COMPLETED 2010 - 2012)
☐	AS-BUILT LAND TREATMENT UNIT (4.1 ACRES)
☐	FORMER FIRE TRAINING AREA (APPROXIMATE LOCATION)

0 500 1,000

SCALE IN FEET

FORMER CHEVRON KENAI REFINERY
CHEVRON RD
KENAI, AK 99611

**SITE MAP WITH
PROPOSED SAMPLING LOCATIONS**

ARCADIS

FIGURE
2

CITY:(KNOXVILLE) DIV/GROUP:(ENV/GIS) LD:(B.ALTOM) PIC:(M.FLEISCHNER) PM:(A.JUST) TM:(M.MILLER) PROJECT: B0048212.0000
PATH: T:_ENV\CHEVRON_ALASKA\MXD\FIGURE2_SITE MAP WITH PROPOSED SAMPLING LOCATIONS_V1.MXD SAVED: 6/25/2021 BY: MAI00749

ATTACHMENT A

ADEC Review Comments and Work Plan Requirement

THE STATE
of ALASKA
GOVERNOR BILL WALKER

Department of Environmental Conservation

DIVISION OF SPILL PREVENTION AND RESPONSE
Contaminated sites Program

43335 Kalifornsky Beach Road, Suite 11
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Main: 907-262-5210
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www.dec.alaska.gov

File: 2323.38.006

August 1, 2018

Jean Wong
Chevron Environmental Management Company
6101 Bollinger Canyon C2052
San Ramon, California 94583

Re: Chevron USA Refinery-Nikiski
2017 Annual Site Status Report
ADEC Hazard ID: 313
ADEC Review Comments & Work Plan Requirement

Dear Ms. Wong,

The Alaska Department of Environmental Conservation Contaminated Sites Program (ADEC), would like to thank you for submitting the December 2017, Former Chevron Kenai Refinery 2017 Annual Site Status Report. This report was prepared by Trihydro Corporation and was received in our office on January 2, 2018. The report is approved.

We have reviewed the Annual Site Status Report and provide the following comments, concerns, and requirements at this time:

1) Thank you for demonstrating the repeatability of the sample results using the purge and no purge sample technique. We approve continued no purge sampling for site wells with the exception of well CMW-103 which will be sampled using both methods.
2) Comparing the benzene plume boundary between the years 2003, 2007, and 2015, it appears that the dissolved-phase plume is expanding at both the northern and southern edges near the bluff, with no monitoring wells/data points in proximity to delineate the current plume boundaries. Considering the draft Beach Sample Locations and First Triannual Analytical Results (7/25/2018), it appears that the groundwater recovery system is capturing enough of the northern groundwater to not directly impact the beach at this time. We are requiring

Chevron to develop and submit a work plan to address the southern deficiencies. Figure 9, Dissolved Benzene Plume August 2017, is cited as providing evidence that no further monitoring wells are required to the south. However, no data was provided for wells MW-71 and MW-90, the wells that are closest to the plume. Groundwater contours shown on Figure 6 depict flow in the area of monitoring well CMW-61 to the south south-east. The location of Tesoro well MW-73 doesn't adequately delineate the boundary of Chevron's hydrocarbon plume. We understand that the Chevron plume extends off property to the south onto the ASRC property. The compliance point for groundwater to the south is Chevron's southern property boundary. The benzene plume in particular is not delineated between monitoring wells CMW-61 and MPL-27-D4. We require that your work plan provide for a monitoring well network that can delineate the boundary of the plume and demonstrate that the plume is not discharging into the Inlet outside of the air sparge system treatment boundary and delineates the southern edge on ASRC property.

3) We are requiring Chevron sample representative monitoring wells in the historical fire training site, and test groundwater for PFAS compounds.

We are requiring under 18 AAC 75.335, that Chevron prepare and submit a site characterization work plan by September 18, 2018, for ADEC review and approval. The goal of this work plan is to demonstrate through additional groundwater investigation and groundwater data points, that the applicable water quality standards are not exceeded below the mean high water elevation datum, and to define the northern and southern limits of the groundwater plume.

If you have questions about this letter, or any other aspect of this project, please contact me at (907) 262-3412, or via e-mail at peter.campbell@alaska.gov

Sincerely,

Pete Campbell

Peter Campbell
Environmental Program Specialist

Cc: Cassidy Birdsong, Trihydro Corporation

ATTACHMENT B

2018 Southern Plume Well Installation and PFAS Sampling Work Plan

Jean Wong
Project Manager

Downstream EM
Chevron Environmental Management Company
6001 Bollinger Canyon Road, C2052
San Ramon, CA 94583
Tel 925 842 5845
JeanWong@chevron.com

September 17, 2018

Mr. Peter Campbell, Environmental Program Specialist
Division of Spill Prevention and Response, Contaminated Sites Program
Alaska Department of Environmental Conservation
43335 Kalifornsky Beach Road, Suite 11
Soldotna, AK 99669

RE: 2018 Southern Plume Well Installation and PFAS Sampling Work Plan
ADEC Hazard ID 25935
Chevron USA Refinery-Nikiski, Alaska

Dear Mr. Campbell:

This letter work plan describes the southern plume well installation and PFAS groundwater sampling work to be performed by Trihydro Corporation (Trihydro) on behalf of Chevron Environmental Management Company (Chevron) at the former Chevron Kenai Refinery (site) in Kenai, Alaska. This work plan was requested by ADEC on August 1, 2018 in the *ADEC Review Comments and Work Plan Requirement* Letter. The work outlined in this work plan will be conducted to define the southern limits of the groundwater plume and to determine the presence of any PFAS in the historical fire training site.

Southern Monitoring Well Installation

Chevron plans to install a southern plume boundary monitoring well in the location indicated on Figure 1. The proposed monitoring well is located on Arctic Slope Regional Corporation (ASRC) property and will require Chevron to obtain written approval form ASRC prior to installation of the well. Chevron currently has an access agreement with ASRC for existing remedial activities such as operation of the air sparge system and accessing existing groundwater monitoring wells. However, this existing access agreement does not include the installation of new groundwater monitoring wells. Chevron anticipates the process of getting an access agreement in place with ASRC for the new groundwater monitoring well installation may take a significant portion of time. As such, Chevron plans to install the new well during the Summer of 2019, pending ASRC approval.

Historical Fire Training Site Groundwater Sampling

The location of the historical fire training site is shown on Figure 2. Chevron currently does not have any existing groundwater monitoring wells in the historical Fire Training Site. However, groundwater monitoring wells CMW-17 and CMW-56 are located downgradient of the Fire Training Area. Chevron plans to sample CMW-17 and CMW-56 for PFAS compounds during the 2019 annual groundwater sampling event.

Schedule

The proposed schedule for the groundwater monitoring well installation and groundwater sampling events is as follows:

- Summer 2019 – installation of the southern groundwater well location indicated in Figure 1. Installation of this well is pending approval from ASRC.
- August 2019 – Collect groundwater sample from the newly installed well as part of the annual groundwater sampling event. Additionally, collect groundwater samples for PFAS from representative monitoring wells indicated on Figure 2 in the historical fire training site.
- December 2019– Include the results for in the Annual Site Report.

If you have any questions regarding this submittal, please call me at (925) 842-5845 or Cassady Birdsong at (307) 755-4912.

Sincerely,

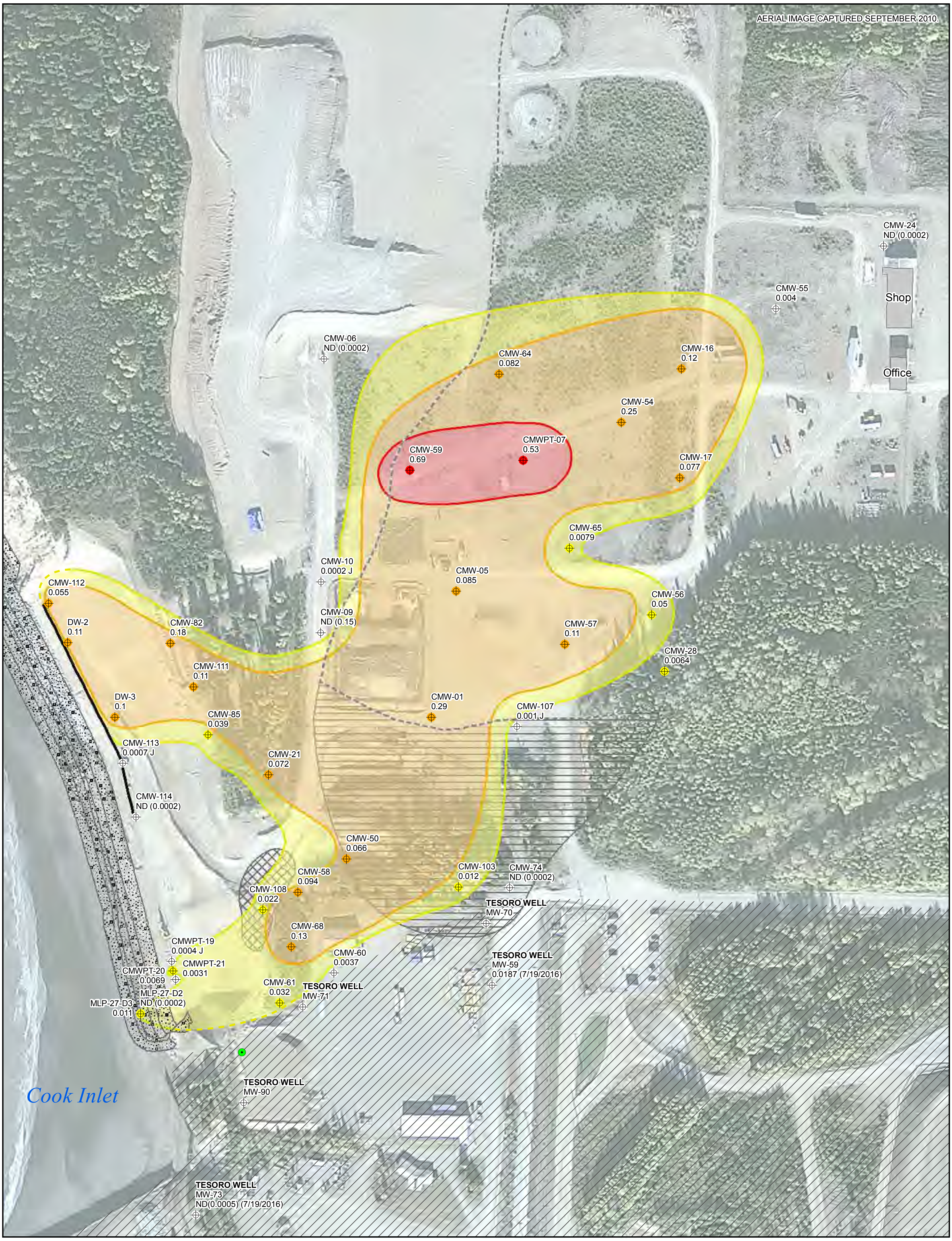
[redacted]

Jean Wong
Project Manager

154-047-009

Attachment

cc: Cassady Birdsong, Trihydro



EXPLANATION

● PROPOSED MONITORING WELL LOCATION

BENZENE SAMPLE LOCATION CONCENTRATIONS (mg/L)

- ⊕ ND - 0.0046
- ⊕ 0.0046 - 0.05
- ⊕ 0.05 - 0.5
- ● 0.5+

- - - - APPROXIMATE UPPER UNCONFINED AQUIFER BOUNDARY

━━ SLURRY WALL

BENZENE PLUME - 2017

- 🟨 0.0046 - 0.05 (DASHED WHERE INFERRED)
- 🟧 0.05 - 0.5
- 🟥 0.5+

▤ HYDROGEOLOGIC BARRIER IN UPPER AQUIFER

▦ EPHEMERALLY UNSATURATED

▒ ROCK REVETMENT (COMPLETED 2010 - 2012)

▨ GROUNDWATER MONITORING PROGRAM MANAGED BY TESORO ALASKA COMPANY (2016 GROUNDWATER MONITORING REPORT, KENAI PIPELINE COMPANY, TESORO ALASKA COMPANY, LLC)

N

0 200 '

Trihydro
CORPORATION
1252 Commerce Drive
Laramie, WY 82070
www.trihydro.com
(P) 307/745.7474 (F) 307/745.7729

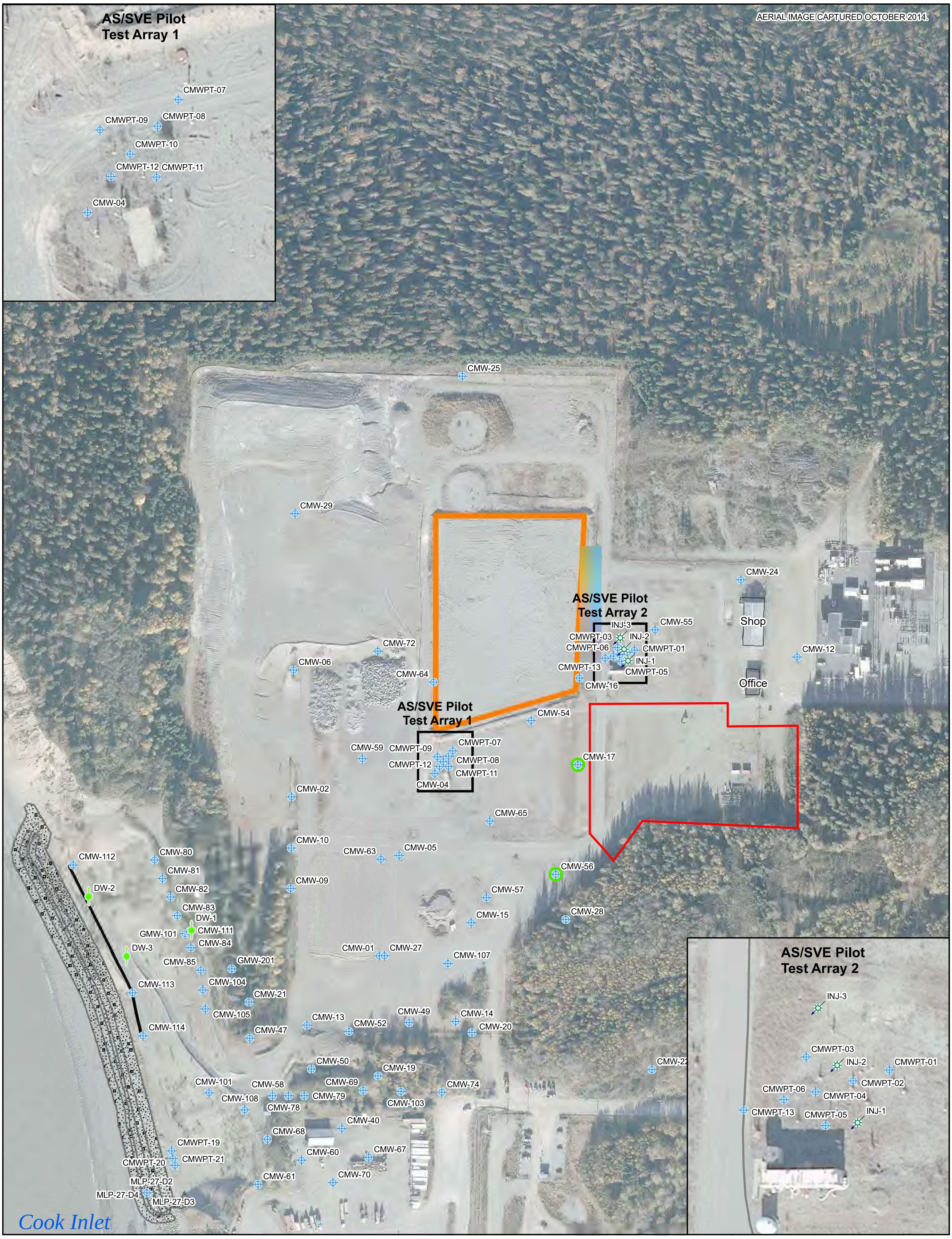
FIGURE 1

PROPOSED MONITORING WELL LOCATION

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER KENAI REFINERY
NIKISKI, ALASKA

Drawn By: DH	Checked By: SP	Scale: 1 " = 200 '	Date: 8/20/18	File: Fig1_Kenai_ProposedMW.mxd

M:\CHEVRON\KENAI\GIS\PROJECTS\MAPPING\ANNUAL_REPORT\2018\FIG1_KENAI_PROPOSEDMW.MXD



EXPLANATION

- ⌖ MONITORING WELL
- ● EXTRACTION WELL
- ✲ INJECTION WELL
- ● MONITORING WELL TO BE SAMPLED FOR PFAS COMPOUNDS
- ▬ SLURRY WALL
- ▨ ROCK REVETMENT (COMPLETED 2010 - 2012)
- 🟧 AS-BUILT LAND TREATMENT UNIT (4.1 ACRES)
- 🟥 FORMER FIRE TRAINING AREA (APPROXIMATE LOCATION)

N

0 250'

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(P) 307/745.7474 (F) 307/745.7729

FIGURE 2

GROUNDWATER MONITORING WELLS TO BE SAMPLED FOR PFAS COMPOUNDS

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER KENAI REFINERY
NIKISKI, ALASKA

Drawn By: DH	Checked By:SP	Scale: 1" = 250'	Date: 9/14/18	File: Fig2_Kenai_FireTrainingCenter.mxd

ATTACHMENT C

2018 Southern Plume Well Installation and PFAS Sampling Work Plan: ADEC Conditional Approval and ITRC Site Characterization Considerations, Sampling Precautions, and Laboratory

Analytical Methods for Per- and Polyfluoroalkyl Substances.

THE STATE
of ALASKA
GOVERNOR BILL WALKER

Department of Environmental Conservation

DIVISION OF SPILL PREVENTION AND RESPONSE
Contaminated sites Program

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www.dec.alaska.gov

File: 2323.38.006

September 24, 2018

Jean Wong
Chevron Environmental Management Company
6101 Bollinger Canyon C2052
San Ramon, California 94583

Re: Chevron USA Refinery-Nikiski
2018 Southern Plume Well Installation and PFAS Sampling Work Plan
ADEC Hazard ID: 313
ADEC Conditional Approval

Dear Ms. Wong,

The Alaska Department of Environmental Conservation Contaminated Sites Program (ADEC), would like to thank you for submitting the September 17, 2018 Southern Plume Well Installation and PFAS Sampling Work Plan. This report was prepared by Trihydro Corporation and was received in our office on September 17, 2018. The work plan is approved with the following conditions:

1) Please include monitoring well CMW-28 in the PFAS sampling to assure that wells down gradient from the fire training area have been sampled.
2) Follow the ITRC Site Characterization Considerations, Sampling Precautions, and Laboratory analytical Methods for Per- and Polyfluoroalkyl Substances for sampling (attached).

If you have questions about this letter, or any other aspect of this project, please contact me at (907) 262-3412, or via e-mail at peter.campbell@alaska.gov

Sincerely,

Peter Campbell
Environmental Program Specialist

Cc: Cassidy Birdsong, Trihydro Corporation

Attachment: ITRC Site Characterization Considerations, Sampling Precautions, and Laboratory analytical Methods for Per- and Polyfluoroalkyl Substances

Site Characterization Considerations, Sampling Precautions, and Laboratory Analytical Methods for Per- and Polyfluoroalkyl Substances (PFAS)

1 Introduction

ITRC has developed a series of fact sheets that summarize the latest science and emerging technologies regarding PFAS. This fact sheet describes methods for evaluating PFAS in the environment, including:

- site characterization considerations
- sampling precautions
- laboratory analytical methods

PFAS contamination poses site characterization, sampling, and analytical challenges. PFAS have unique chemical and physical properties and they often occur in complex mixtures that can change over time. At environmental investigation sites, very low concentrations of several different PFAS must be sampled and analyzed. Many materials used in the course of environmental investigation can potentially contain PFAS. There is limited published research or guidance on how certain materials used by field staff affect sample results.

USEPA has compiled an online resource for PFAS that includes topics such as policy and guidance, chemistry and behavior, occurrence, toxicology, site characterization, and remediation technologies (USEPA 2017h). The National Groundwater Association (NGWA) has also published a resource on PFAS that includes information about sampling and analytical methods (NGWA 2017).

2 Site Characterization Considerations

The purpose of site characterization is to understand the sources of contamination, site-specific contaminant fate and transport, and potential exposures and risks posed by a site. The site characterization techniques and study principles for PFAS-contaminated sites are generally the same as for any other site contaminated by hazardous substances. General site investigation principles and techniques will not be covered in this fact sheet, as these are well described in many existing guidance documents (for example, ASTM International 2011, 2013a, 2013b, 2014a, 2014b; Intergovernmental Data Quality Task Force (IDQTF) 2005; USEPA 1987, 1988a, 2000a, 2006c, 2013a, 2016i).

The unique chemical characteristics, uses, and transport mechanisms of PFAS should be accounted for when characterizing a contaminated site. PFAS sources (including ambient sources) pose many challenges, including their frequent occurrence as mixtures, the role of precursors, and the persistence and mobility of PFAS relative to other environmental contaminants.

2.1 Sources and Site Identification

The *Environmental Fate and Transport* fact sheet contains conceptual site models, including descriptions and figures, for four different common source scenarios. Phase 1 site characterization investigations (ASTM 2013c) may miss the potential for PFAS contamination at a site because these chemicals historically were not considered hazardous. Comparing timelines of site history (for example, processes, layout, chemical use, and release history) with the timeline of PFAS use and with existing drinking water data (for example, the UCMR3 data [USEPA 2017f]) can be helpful in determining source identification. A solid understanding of historical uses and the past presence of PFAS is critical to identifying PFAS that may have been released at a site. See the *History and Use* fact sheet for more information.

Another challenge is that commercial products and industrial releases may consist of complex PFAS mixtures that change over time through fate and transport mechanisms and may include unidentified PFAS. Changes in manufacturing practices as well as formula modifications also complicate the source identification. When characterizing source areas, there is often a focus on only perfluoroalkyl acids (PFAAs), particularly perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA), which are the current chemicals of concern. These and other chemicals of concern were often released as part of original PFAS mixtures, but also may be transformation products of PFAA precursors. The focus on PFAAs means that significant portions of the total PFAS contamination might be missed, leading to underestimates of plume life expectancy for groundwater and mass flux as well as PFAS contaminant mass.

The variation in mixtures of PFAS, associated with different processes and products, may provide signatures that help identify source areas and distinguish between multiple sources. However, careful analysis is needed to distinguish between signatures associated with differing sources and those due to environmental partitioning or multiple releases over time.

Knowledge of PFAS fate, transport, and mode of release is essential to placing sampling locations. Some PFAS released at aqueous film-forming foam (AFFF) training or application sites or by industrial air emissions may result in large, diffuse areas of soil contamination (rather than point sources) that act as sources of groundwater contamination. Air emissions from industries using PFAS may result in releases to soil and surface water, with subsequent infiltration to groundwater (Davis et al. 2007; Shin et al. 2011).

2.2 Development of Initial Conceptual Site Model (CSM)

Conceptual site models for four different common source scenarios are included in the *Environmental Fate and Transport* fact sheet. These may be useful in developing a site-specific CSM. The CSM should include sources, site history, transport and exposure pathways, and receptor identification for a specific site. Any information pertaining to potential off-site PFAS contributors, such as landfills, wastewater treatment facilities, industrial sites, fire training areas and other sources, should be considered when determining possible secondary sources of PFAS.

2.2.1 Atmospheric, Geologic, and Hydrogeologic Framework

As with all contaminated sites, characterization relies upon an adequate understanding of the geology and hydrogeology of the site. Several PFAS, including the PFAAs of current regulatory concern, are relatively mobile in groundwater. Studies have reported both biotic and abiotic transformations of some polyfluorinated substances, referred to as precursors, which may form PFAAs. However, there is no evidence that PFAAs degrade or otherwise transform under ambient environmental conditions. Thus, PFAS plumes in groundwater may travel for several miles from the original source. At sites with highly permeable, low-organic matter soils, PFAS plumes can be extensive.

Partitioning behavior of perfluorocarboxylates (PFCAs) and perfluorosulfonates (PFSAs) has been studied more than that of other PFAS. PFCAs and PFSAs are organic anions at all environmentally relevant pH values and tend to be mobile in groundwater (Xiao et al. 2015). However, these compounds, especially those with longer carbon chains, often associate with the organic carbon fraction of soil or sediment (Higgins and Luthy 2006; Guelfo and Higgins 2013) when present in the saturated zone. See the *Environmental Fate and Transport* fact sheet for more information.

At sites where PFAS are detected in surface water, the CSM should address the potential for PFAS transport by surface water and infiltration of the PFAS to groundwater in areas downstream of the site. Some PFAS are highly soluble and resistant to breakdown in the environment, which means they may be transported significant distances in surface water (Awad et al. 2011; Kwadijk, Kotterman, and Koelmans 2014). In Minnesota, PFAS-contaminated surface water moving through a natural and manmade drainage system was found to have infiltrated to groundwater in multiple locations (losing streams, lakes, ditches, and stormwater ponds) creating large, discreet areas of groundwater contamination several miles from the original source areas (ATSDR 2008; MDH 2017).

A thorough understanding of the geology and hydrogeology of a site (including groundwater-surface water interactions and air-surface water interactions) can make selection of sampling locations more efficient and reduce the number of required samples. Without careful preparation, multiple, and sometimes redundant, field efforts can make site characterization costly.

2.2.2 Investigation Strategies

Many PFAS sites consist of releases that occurred decades before PFAS were regulated. As a result, contaminant plumes have had years to develop, and in some cases, stabilize. Therefore, site characterization should not necessarily proceed the same way as for newer sites with more recent releases. At these sites, sampling begins near the source area and steps outward to determine extent. For PFAS releases, however, contamination may have occurred in areas upgradient of drinking water sources, thus drinking water supply sampling should be a top priority to ensure that human receptors are protected. Data from private drinking water supply wells may be useful in determining the extent of contaminant plumes, if the well construction and characteristics information are available.

After evaluating drinking water, soils should be characterized to determine the three-dimensional extent of soil and groundwater contamination. Soil and groundwater sampling locations should be informed by fate and transport characteristics of the site type and source (see *Environmental Fate and Transport* fact sheet). Tools for determining the extent of established plumes may include transect surveys using direct push technology, followed by installation of monitoring wells, or other appropriate techniques such as high-resolution site characterization (USEPA 2016i). Potential secondary sources should be identified, for example, from irrigation or biosolids application, and other anthropogenic factors affecting fate and transport of PFAS-contaminated media.

Certain PFAS are present in ambient air, and may be elevated near sources such as landfills, WWTFs, fire training facilities, and manufacturing plants. Typical air sampling methods for PFAS include either glass fiber or quartz fiber filters and a sorbent material such as polymeric resin or polyurethane foam to collect both the particle and gas phases. Most methodologies in the literature collect the particle phase and then the gas phase; however, some studies developed a method to collect the gas phase first followed by the particle phase in efforts to not overestimate the particle phase concentration (Barber et al. 2007; Jahnke 2007b, 2009; Ahrens et al. 2011a, 2012).

2.2.3 Risk Assessment

Site-specific risk assessment is informed by data and information iteratively collected in the site characterization. Of the many PFAS that may be found at contaminated sites, the toxicity of PFOA and PFOS has been studied the most thoroughly. A substantial database of toxicity information is also available for some other PFAS including PFBA, PFBS, PFHxA, PFNA, and GenX, while there is limited publicly available information on toxicity of other PFAS that may be present at PFAS-contaminated sites. USEPA has established a Health Advisory for protection from a lifetime exposure to PFOA and PFOS from drinking water of 70 ppt for each compound individually, or the total of both. While many states use these USEPA Health Advisories as guidance for PFOA and PFOS, several states have developed more stringent levels for these compounds; some states have also developed standards or guidance for other PFAS of local concern (see the *Regulations, Guidance, and Advisories* fact sheet). Given that PFAS typically occur in complex mixtures, and human and environmental receptors are exposed to some PFAS-forming complex mixtures, evaluating the true risks at a site can be particularly challenging. In the absence of risk-based values for some of the PFAS that are detected and because additional PFAS not detected by the analytical method may be present, the investigation team should identify data gaps and communicate the impact that these gaps have on risk analyses. Data gaps and scientific uncertainty must be documented so that as site cleanup progresses and more information becomes available, the project team can reassess potential risks from the site and better communicate to the public how site decisions are made.

2.2.3.1 Human Receptors

The presence of PFAS in the environment and consumer product has resulted in detectable levels (most frequently PFOA, PFNA, PFOS and PFHxS) in the blood serum of most of the U.S. population (CDC 2017b). The total body burden of these PFAS results from exposure to the PFAS themselves and formation from precursors through metabolism in the body (Olsen et al. 2017; D'eon and Mabury 2011). Blood serum levels of these PFAS in the general population have generally decreased over time (CDC 2017a). Risk assessment of PFAS exposure for humans near contaminated sites must include both exposures prevalent in the general population, such as from the food supply and consumer products, and exposures from the contaminated site, such as drinking water, house dust, ambient air, and locally caught fish. Exposures from even relatively low levels (for example, below 70 ng/L) of long-chain PFAS in drinking water are much higher than total exposures in the general population not impacted by a contaminated site (Bartell 2017).

The tendency of some PFAS to bioaccumulate (ATSDR 2015a) is also a critical component in evaluating potential health effects; food chain routes of exposure should be considered. For example, PFOS and longer-chain perfluorinated sulfonates, and PFNA and longer-chain perfluorinated carboxylates, are known to bioaccumulate in fish, including in species used for food (Conder et al. 2008). Also, as a result of chronic ingestion of water and exposure to other materials containing PFAS, women may carry PFAS in their blood and breast milk. These PFAS are transferred to their baby during pregnancy and through breast feeding. Serum levels of long-chain PFAS rapidly increase in breast fed infants due to the PFAS levels present in breast milk and the higher fluid consumption rates of infants (Mogensen et al. 2015; Winkens et al. 2017; Fromme et al. 2010; Verner et al. 2016a, b).

2.2.3.2 Ecological Receptors

PFAS present a potential hazard to wildlife by direct and dietary exposure on both individual and population levels (Environment Canada 2006, 2012). Numerous studies have shown PFAAs, particularly PFSAs, are globally present in wildlife and may bioaccumulate in birds, fish, and mammals (including livestock); other animal classes are less studied (Houde et al. 2011; Lupton et al. 2014; OECD 2013). Biomagnification (in which concentrations increase with increasing trophic level) appears to be more complicated, occurring in some food webs but not others (Franklin 2016; Fang et al. 2014). Effects of PFAS exposure on wildlife vary widely by species and PFAS compound. Ecological toxicity information for many PFAS compounds is currently unavailable, while for others, data is limited and still evolving. Therefore, as site characterization activities for PFAS occur, the current state of the science should be reviewed before calculating ecological risk. More information is included in the *Environmental Fate and Transport* fact sheet.

3 Sampling

Sampling conducted to determine PFAS concentrations in water, soil, sediment, air, biota and other sources is similar to that for other chemical compounds, but with several additional specific considerations and protocols. If regulatory procedures, methods, or guidelines are inconsistent with the needs of a PFAS sampling program, then the governing agency should be contacted directly to determine an alternate approach or if an exception can be made. Other considerations for PFAS sampling include low laboratory detection limits, state and federal screening levels, and in some cases, cleanup criteria and potential for background concentrations of PFAS in the environment.

3.1 Equipment and Supplies

Many materials used in the course of environmental investigation can potentially contain PFAS. There is limited published research or guidance on how certain materials used by field staff affect sample results. Therefore, a conservative approach is recommended to exclude materials known to contain PFAS. Obtain and review all Safety Data Sheets (SDSs) before considering materials for use during PFAS sampling. Materials to avoid include:

- Teflon, polytetrafluoroethylene (PTFE)
- waterproof coatings containing PFAS
- food containers
- anything with fluoro in the name
- fluorinated ethylene propylene (FEP)
- ethylene tetrafluoroethylene (ETFE)
- low density polyethylene (LDPE), polyvinylidene fluoride (PVDF)

Many waterproof coatings contain PFAS, such as Gore-tex treated PPE or most waterproof papers, but some products are waterproofed with acceptable materials such as polyurethane, rubber, or PVC. Individual product specifications should be examined closely. In the case of Tyvek PPE, plain Tyvek does not contain PFAS while coated Tyvek does. In addition, materials incidentally transported to sites may contain PFAS. For example, fast food wrappers may contain PFAS. Due to the ubiquitous nature of PFAS, sampling crews must review all materials used to avoid contamination. Collection of quality assurance and quality control (QA/QC) samples is a useful tool to assess field contamination.

Two guidance documents identify materials and equipment that can be used in PFAS-focused investigations, as well as materials that should be avoided because they are known or suspected to be potential sources of PFAS:

- *Bottle Selection and other Sampling Considerations When Sampling for Per-and Poly-Fluoroalkyl Substances (PFAS)* (USDOD EDQW 2017b)
- *Interim Guideline on the Assessment and Management of Perfluoroalkyl and Polyfluoralkyl Substances (PFAS), Contaminated Sites Guidelines*, (Government of Western Australia, Department of Environment Regulation 2016)

Sometimes it is impossible to eliminate materials that affect PFAS results in samples. For example, these materials might be needed at sites where hazards warrant the use of specific personal protective equipment (PPE), where PFAS are the secondary or co-contaminant and the primary contaminant requires specific materials for proper sampling, or where the opportunity to collect a sample occurs before a proper sampling program is developed. When PFAS-containing equipment and supplies cannot be eliminated, increasing the equipment rinse blank samples will more thoroughly document the PFAS concentrations. In these situations, a thorough QA/QC program becomes even more important.

Not all PFAS are hydrophilic, and some are volatile. As a result, these chemicals may sorb to sampling equipment and supplies or be lost from samples during sample collection. Preliminary data suggest that sorption may occur quickly. Additionally, volatile losses have not yet been characterized. Until they are better quantified, sampling efforts should consider whether these losses would affect project objectives and adjust accordingly.

3.2 Bottle Selection and Sample Amount

Containers should be specified in the analytical method, provided by the laboratory selected to perform the analyses, and should be certified by the laboratory to be PFAS-free. The term *PFAS-free* is a method or project-defined concentration level (for example, < 1/2 the limit of quantitation for the specific compound of interest). USEPA Method 537, Version 1.1 (September 2009) requires the use of 250 mL polypropylene containers and caps/lids for drinking water sampling (Shoemaker, Grimmett, and Boutin 2009). Currently, USEPA has not issued guidance or analytical methods for any sample media other than drinking water. Depending on the analytical method used or program (for example state or DOD) requirements, polypropylene or high-density polyethylene (HDPE) bottles with unlined plastic caps are typically used (USDOD EDQW 2017b).

Best practices in sample preparation must be used when selecting the size, volume, and representativeness of samples. To minimize effects from analyte sorption on sample containers, the laboratory must analyze the entire sample, including the sample container rinsate. The project screening or applicable regulatory levels, and the expected or potential concentration of the analytes, are also relevant. If the sample is known to contain high concentrations of PFAS (for example, AFFF formulations), loss is negligible and therefore the entire sample does not need to be used.

Because the concentration level of PFAS in aqueous samples determines whether the whole sample or an aliquot is used in the laboratory preparation, the sampler should collect an additional volume of each sample in a separate container. Then, the laboratory can screen the extra sample for high concentrations without affecting the final sample result. For soil or sediment, obtaining a representative subsample in the laboratory is critical, so the entire sample should be homogenized in the laboratory prior to subsampling. Coordinating with the laboratory is crucial to determine the appropriate sample container volumes for environmental media other than drinking water.

3.3 Sample Preservation, Shipping, Storage, and Hold Times

USEPA Method 537, Version 1.1 contains specific requirements for drinking water sample preservation, shipping, storage, and holding times (Shoemaker, Grimmett, and Boutin 2009). Currently, there is no USEPA guidance or requirement for other sample media. The chemical preservation required by Method 537, Trizma, is added for buffering and free chlorine removal and applicable to DW samples only. Until additional information is available, the thermal preservation, shipping, storage, and holding times contained in USEPA Method 537, Version 1.1 should be used for all other sample media except biota. For biota samples (for example, vegetation, fish), the samples should be frozen to limit microbial growth until sample preparation is performed at the laboratory. Microbial growth may result in PFAAs values biased high due to biodegradation of precursor compounds; however, these effects have not been well studied.

3.4 Decontamination Procedures

Field sampling equipment, including oil/water interface meters, water level indicators, and other nondedicated equipment used at each sample location, require cleaning between use. The SDSs of detergents or soaps used in decontamination procedures should be reviewed to ensure fluoro-surfactants are not listed as ingredients. Use laboratory-certified PFAS-free water for the final rinse during decontamination of sampling equipment. Decontaminate larger equipment (for example, drill rigs and large downhole drilling and sampling equipment) with potable water using a high-pressure washer or steam. To the extent practical, rinse parts of equipment coming in direct contact with samples with PFAS-free water. Heavy equipment is best cleaned within a decontamination facility or other means of containment (for example, a bermed, lined pad and sump, or a portable, self-contained decontamination booth). Potable water sources should be analyzed in advance for PFAS. Wherever possible, rinse equipment with PFAS-free water immediately before use.

3.5 Field QC

Field quality control (QC) samples are a means of assessing quality from the point of collection. Such QC samples include, but are not limited to, field reagent blanks, equipment rinse blanks, and sample duplicates. USEPA Method 537, Version 1.1 contains specific requirements for the QC samples that must accompany drinking water samples. Collection and analysis of QC samples are important for PFAS analyses because of very low detection limits and widespread commercial use (historical and current) of PFAS containing products.

3.6 Sampling Precautions

Standard sampling procedures can be used at most PFAS sites. However, there may be some exceptions and additional considerations related to PFAS behavior, and issues associated with potential use of PFAS-containing or adsorbing sampling equipment and supplies.

3.6.1 Groundwater

The most inert material (for example, stainless steel, silicone, and HDPE), with respect to known or anticipated contaminants in wells should be used whenever possible. Dedicated sampling equipment installed in existing wells prior to investigation should be thoroughly checked to ensure that the equipment is PFAS-free. For long-term investigations, samples may be collected in duplicate with and without existing dedicated equipment. If PFAS analyses show that the equipment does not affect results, the equipment may be kept and used long term. This determination depends on project-specific requirements, however, and should only be used by a project team with full disclosure to all stakeholders.

3.6.2 Surface Water

To avoid cross-contamination from sampling materials to sample media, the outside of all capped sample containers should be rinsed multiple times with the surface water being sampled before filling the containers. When site conditions require, remote sampling into sample containers can be accomplished by clamping the container onto the end of a clean extension rod. The extension rod must be made of PFAS-free material and have been decontaminated. Within the context of sample collection objectives, the sample location in the water column should consider the potential stratification of PFAS in solution and their tendency to accumulate at the air/water interface. For more information on stratification, see the *Environmental Fate and Transport* fact sheet.

3.6.3 Porewater

Peristaltic pumps with silicone and HDPE tubing are typically used for porewater sample collection, along with push point samplers, porewater observation devices (PODs), or drive point piezometers. Push point samples and drive point piezometers are made of stainless steel, while PODs consist of slotted PVC pipe and silicone tubing. These samplers should be dedicated and not reused across a site or multiple sites.

3.6.4 Soil/Sediment

Most core and grab sampling devices are constructed of stainless steel. Some core samplers include an HDPE sleeve inserted in the core barrel to retain the sample. PPE such as waders and personal flotation devices may be required. Ensure that materials that contact the media to be sampled do not have water-resistant coatings which contain PFAS.

3.6.5 Fish

The species of fish collected, as well as the portion of fish sampled (whole versus fillet), depends on the project goals (for example, ecological risk or human health). Studies have shown the majority of the PFAS in fish are stored in the organs, not the flesh (Martin et al. 2004; Yamada et al. 2014). Communicating project objectives to the laboratory is important prior to field work in order to determine the necessary quantity and quality of tissue, fish handling requirements, laboratory sample preparation (including single fish or composite fish samples, and whole or fillet preparation), and packing and shipping requirements.

3.6.6 Potential high concentration samples

The CSM or previous sampling may indicate areas of high concentrations of PFAS for which single-use, disposable equipment is recommended. If single-use is not possible, take additional precautions such as implementing a greater frequency of decontamination blanks and not reusing equipment to sample potentially low PFAS concentration samples. High concentration samples should be segregated during shipping to the laboratory.

Some projects may require the analysis of AFFF product that has been used at the site. All AFFF product samples must be considered high concentration samples. These samples should be segregated from other samples during sampling and shipping to avoid cross contamination. Samples that may contain high concentrations of PFAS should be clearly identified on the *Sample Chain of Custody* that is shipped with the samples. Field test kits are available for PFAS but have not been fully evaluated. While these kits cannot achieve low detection limits, they could be helpful in screening for potential high concentrations of PFAS in the field.

4 Quantitative Analysis

USEPA Method 537, Version 1.1 contains specific requirements for sample preparation and analysis of drinking water samples. Currently, there are no USEPA methods for the preparation and analysis of other sample media. However, other published methods may apply:

- ISO Method 25101 (ISO 2009)
- ASTM D7979 (ASTM 2017b)
- ASTM D7968 (ASTM 2017a)

To evaluate the laboratory's ability to meet the needs of a project, the laboratory's analytical procedure should be reviewed as part of the laboratory selection process. In addition, performance data such as concentrations observed in lab blanks and matrix spike recovery are necessary.

4.1 Sample Preparation

The sample preparation procedure should be specified in the sample analysis procedure and should be included as part of the sample and analysis plan (SAP) or quality assurance project plan (QAPP). This procedure should demonstrate that extreme care is taken to prevent sample contamination during preparation and extraction. All supplies must be checked and confirmed as PFAS-free prior to sample preparation. Intermittent contamination can occur due to vendor supply or manufacturing changes; therefore, each lot of supplies should be verified and documented prior to use.

Because sample preparation may vary in different analytical procedures, the laboratory should document its preparation process for the samples. A critical step in the laboratory's preparation process is ensuring a representative sample or subsample is used for analysis. For all media, sample transfers should be minimized. Sample filtration to eliminate solid particulate from aqueous samples is not recommended because PFAS losses can occur due to adsorption of PFAS onto filters.

The entire aqueous sample received should be prepared and the sample container appropriately rinsed. Aqueous samples that are prepared using the whole sample must be extracted using SPE. The exception to this practice is samples containing high concentrations of PFAS, because each type of solid phase extraction cartridge has a defined capacity to retain PFAS analytes. Exceeding this capacity results in a low bias in PFAS results. In these instances, to prevent this bias, samples can be prepared using serial dilution techniques or analyzed using direct injection (for example, ASTM D7979). Most laboratories screen samples using a small volume sample to determine if it contains PFAS at concentrations too high for SPE sample preparation and analysis. For solid samples, the laboratory homogenizes the sample before subsampling and extraction.

To account for biases resulting from preparation steps, internal standards should be added to all samples (preferably extracted internal standards that are isotopically-labeled analogs of each analyte, if commercially available). The addition of internal standards to the sample should be clearly documented. Internal standards should be added to the sample at different steps in the process, depending on the sample preparation process used. Internal standards should also be added to whole field samples in the field container (SPE extraction samples) after subsampling, prior to addition of extraction solvent for soil or sediment samples, and after final dilution for serial dilution prepared samples (USDOD 2017a).

Depending on the analytical method used, cleanup procedures (for example, graphitized carbon) may be used on samples when matrix interferences (for example, bile salts and gasoline range organics) could be present. ENVI-Carb cleanup removes cholic acids, a known interference in fish tissue sample. The procedure should clearly state what type of cleanup process is used and in what instances.

The analytical procedure should describe what batch QC samples are prepared with each media type. Batch QC samples might include method blank (MB), laboratory control sample (LCS), laboratory control sample duplicate (LCSD), sample duplicate (SD), matrix spike (MS), and matrix spike duplicate (MSD). Additional QC may also be included. For samples with high concentrations of PFAS, in addition to an MS and an MSD, an LCSD and an SD may be warranted. The SD should be prepared using a different aliquot from the same sample bottle to create a second set of serial dilutions. Review of the laboratory's procedure should ensure that the laboratory is capable of using the batch QC needed for the project, including meeting the project's QC acceptance criteria.

4.2 Sample Analysis

Currently, the analytical detection method of choice for PFAS analysis is liquid chromatography-mass spectrometry-mass spectrometry (LC/MS/MS), which is especially suited for analysis of ionic compounds, such as the PFSAs and PFCAs. Gas chromatography-mass spectrometry (GC/MS) can also be used for PFAS analysis, specifically the neutral and nonionic analytes, such as the fluorotelomer alcohols (FTOHs), perfluoroalkane sulfonamides, and perfluoroalkane sulfonamido ethanols. Currently, LC/MS/MS analysis of PFAS is widely available, whereas GC/MS analysis has limited commercial availability.

LC/MS/MS methods developed by laboratories may be based on USEPA Method 537, Version 1.1. The USEPA method does not contain steps to alleviate matrix interference issues potentially found in other sample media and does not contain steps to prepare solid sample media. Methods for other sample media may include extraction or sample preparation procedures for other matrices, use of isotope dilution, the addition of other PFAS analytes, and confirmation using confirmatory ions and ion ratios. Because these modifications are not standardized, analytical methods can result in greatly varied data, precision, and accuracy. Laboratories should provide performance data for the relevant media for each project. The USDOD EDQW has attempted to standardize many of these modifications through requirements contained in the USDOD Environmental Laboratory Accreditation Program (USDOD ELAP) document, the DOD *Quality Systems Manual for Environmental Laboratories* (DOD QSM), Version 5.1, Appendix B, Table B-15 (USDOD 2017a).

Certified analytical standards are available from several manufacturers. Products may have variable purity and isomer profiles, which may compromise the accuracy, precision, and reproducibility of data. Only certified standards of the highest purity available, for example, American Chemical Society grade, can be used for accurate quantitation. Standards containing linear and branched isomers are not commercially available for all applicable analytes. Currently, such standards are only available for PFOS and perfluorohexane sulfonic acid (PFHxS). Technical grades which contain branched and linear isomers are available for other PFAS, but these standards do not have the accuracy needed for quantitation purposes. These standards may, however, be qualitatively useful for verifying which peaks represent the branched isomers. Methods should specify the isomers quantified as well as the isomers included in standards used for quantitation purposes.

Isotope dilution is a quantitation technique that considers sample matrix effects on each individual PFAS quantitation in the most precise manner possible. This technique quantifies analytes of interest against the isotopically labeled analogs of the analytes, which are added to the sample prior to and after sample preparation. Addition prior to preparation helps account for loss of analyte during the preparation process, while addition after preparation to an aliquot of the sample extract accounts for the bias associated with the instrumentation. Methods using isotope dilution should include isotope recovery for each sample and analyte in data reports. Isotope analog recoveries should be reported, and minimum/maximum isotope recoveries may be required by specific analytical procedures. Low isotope recovery may indicate that quantitation was inadequate; the data are then reported as estimated values.

Mass calibration should occur at the frequency recommended by the instrument manufacturer and as needed based on QC indicators, such as calibration verifications. The instrument blanks, calibration curve, and initial and continual calibration verification requirements should be consistent with those published for other LC/MS/MS methods. The lowest calibration point should be a concentration at or below the limit of quantitation. A standard at the limit of quantitation concentration should be analyzed with each analytical batch to document the instrument's ability to accurately quantitate down to that concentration. Instrument blanks are critical in determining if the instrument is potentially affecting PFAS concentrations in samples.

Quantification by LC/MS/MS may be accomplished using a variety of techniques. For relatively simple matrices such as drinking water, Method 537 quantifies analytes by comparing the product ion of one precursor ion and retention time in samples to calibration standards. For more complex matrices, additional product ions and their ion ratios can be used to distinguish analytes from matrix interference. In an MS/MS system, an analyte can be fractured into more than one ion. By monitoring the area of each ion and comparing the ratio of those area counts, a more definitive identification can be made. This identification allows the analyst to distinguish true target analytes from false positives. This more detailed quantification is not required for drinking water matrices, but it is useful for more complex matrices.

As part of the laboratory selection process, the laboratory's analytical procedure should be evaluated to ensure these parameters are addressed in the documentation provided. In addition, the acceptance criteria for all the analytical QC elements should be evaluated to ensure that they are set at levels that meet the project's measurement quality objectives (MQOs). For DOD projects, these criteria can be found in the DOD QSM, Version 5.1, Appendix B, Table B-15 (USDOD 2017a).

4.3 Data Evaluation

Data evaluation is a critical step in any project; however, it becomes even more important when nonstandard methods are used, such as for PFAS. Without a standard method for media other than drinking water, laboratories' methods may vary greatly in their precision and accuracy. Over time, these methods become optimized based on new knowledge about sampling and analytical biases. Advances in instrumentation and analytical supplies (such as standards availability and improved analytical columns) often occur as well because of commercial demand. As a result, the precision and accuracy of the data generated by laboratories can change significantly over time, making it difficult to compare data generated over an extended time period. Thus, data evaluation should be performed using the most current knowledge on the state of science of PFAS.

Precision, accuracy, representativeness, comparability, completeness, and sensitivity (PARCCS) parameters should be assessed because they guide data evaluation (field collection and laboratory information). Data are reviewed in a systematic way by looking at the results of each QC indicator of the PARCCS parameters (for example, spike recoveries and method blanks) to obtain an understanding of the overall quality of the data. The most important goal of data evaluation is to ensure that any limitations to the PFAS data generated are understood, which establishes confidence that the data meet site-specific needs. More information is available in the IDQTF (2005) and USEPA (2000a) Quality Assurance Project Plan documents.

5 Qualitative Analysis

Several methods employing indirect measurement have been developed that more comprehensively assess the range of PFAS contamination at a site. Two techniques are available to measure organofluorine (Dauchy et al. 2017; Willach, Brauch, and Lange 2016; Ritter et al. 2017):

- Adsorbable organic fluorine (AOF) paired with combustion ion chromatography (CIC) measure the combusted organofluorine content of a sample as fluoride on an IC.
- Proton induced gamma-ray emission (PIGE) spectroscopy measures elemental fluorine isolated on a thin surface.

Both techniques isolate organofluorine material on a sorptive material such as activated carbon or an anion exchange cartridge prior to measurement; neither technique is currently commercially available. A third technique, total oxidizable precursor assay (TOP assay or TOPA) converts PFAA precursor compounds to PFAAs through an oxidative digestion. The increase in PFAAs measured after the TOP assay, relative to before, is a conservative estimate of the total concentration of PFAA precursors present in a sample, because not all PFAS present will be subject to quantitation or reaction, and will remain as undetected PFAS. The PFAAs generated have perfluoroalkyl chain lengths equal to, or shorter than, the perfluoroalkyl chain lengths present in the precursors (Houtz et al. 2013; Houtz and Sedlak 2012; Weber et al. 2017; Dauchy et al. 2017). Finally, quantitative time of flight mass spectrometry (QTOF-MS) can be used to determine both the chemical formula and structure of unknown PFAS in a sample, but analytical standards are required for unequivocal structural identification.

Library research, preliminary identification of potential PFAS sources, and information gathered from patents can assist in the identification of PFAS using QTOF-MS (Newton et al. 2017; Moschet et al. 2017; Barzen-Hanson et al. 2017). These methods are not standardized through a published USEPA method and range in commercial availability. To date, these methods have not undergone multilaboratory validation. As a result, TOP assay, the most widely commercially available of the techniques, is typically accepted as a means of determining PFAS load on remediation substances to estimate the replacement cycle, but not for site characterization.

6 References and Acronyms

The references cited in this fact sheet, and the other ITRC PFAS fact sheets, are included in one combined list that is available on the ITRC web site. The combined acronyms list is also available on the ITRC web site.

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March 2018

ATTACHMENT D

Well Completion Information and Boring Logs

Observation Well No. **MW-12**

Project ALASKA REFINERY Location KENAI ALASKA

pe of Rig CME 55 Installed By ANCHOR POINT DRILLING Date 7/21/82 Time

hod of Installation DRILL TO T.D. USING 4½" I.D. HOLLOW AUGERS SAMPLE CUTTINGS, SAMPLE WITH SPLIT SPOON WHEN REQUIRED, COMPLETE WELL INSIDE AUGER, PULL AUGER.

LOG OF BORING AND OBSERVATION WELL

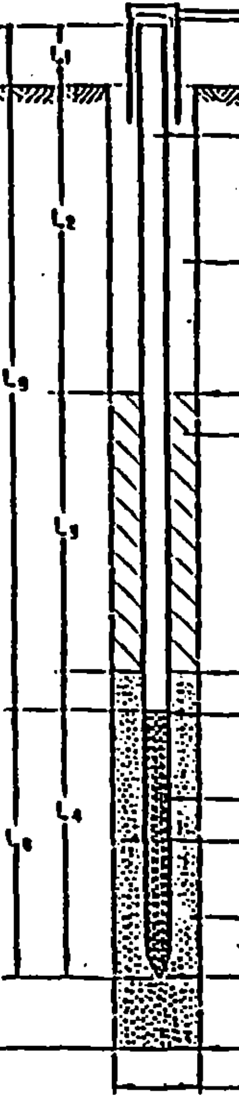
BORING

Depth in ft.	Cored Interval	Description
0		0-60' POORLY SORTED SAND + GRAVEL, SILTY. (GLACIAL TILL MATERIAL) PERMEABLE, CLAY LAYERS ARE NOT APPARENT, NO HYDROCARBON ODOR.
-20		
		7/22/87 (35')
40		DAMP, LITHOLOGY AS ABOVE, NO HYDROCARBON ODOR.
-60		ENCOUNTERED WATER AT 60' NO H.C. ODOR.
X		TOTAL DEPTH 70'
80		

OBSERVATION WELL

Type of Observation Well

Ground Elev. 139.31 Top of ~~Riser~~ PVC CASING Elev. 142.23 (Protective Casing)



L1 = 1'
L2 = 45
L3 = 2'
L4 = 23'
L5 = 50'
L6 = 20'
L7 = 70'

I.D. of Riser Pipe 3"

Type of Pipe SCHED 40 PVC

Type of Backfill Around Riser BENTONITE/ CEMENT GROUT

Top of Seal Elev.

Type of Seal Material BENTONITE PELLETS

Top of Filter Elev.

Elev. of Perforations

Size of Openings .020

Diameter of Casing Tip 3"

Type of Filter Material #16 SILICA SAND

Bottom of Csg. Elev.

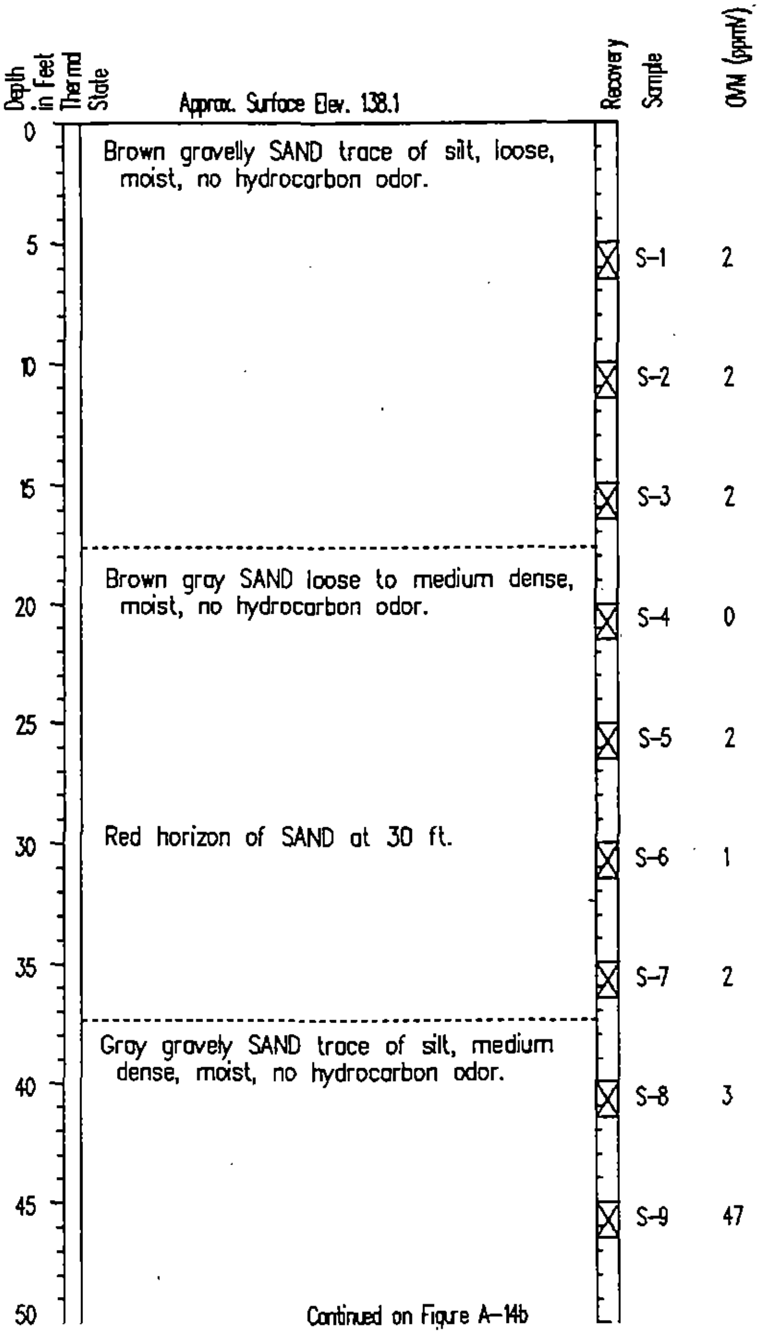
Bottom of Boring Elev.

Diameter of Boring

Remarks Sampled well 7/21/87. Well contained no sign of hydroca
Clean.

Inspected By

Boring Log and Well Construction Data for MW-17 (0'-50').



Approx. Surface Elev. 138.1

Brown gravelly SAND trace of silt, loose, moist, no hydrocarbon odor.

Brown gray SAND loose to medium dense, moist, no hydrocarbon odor.

Red horizon of SAND at 30 ft.

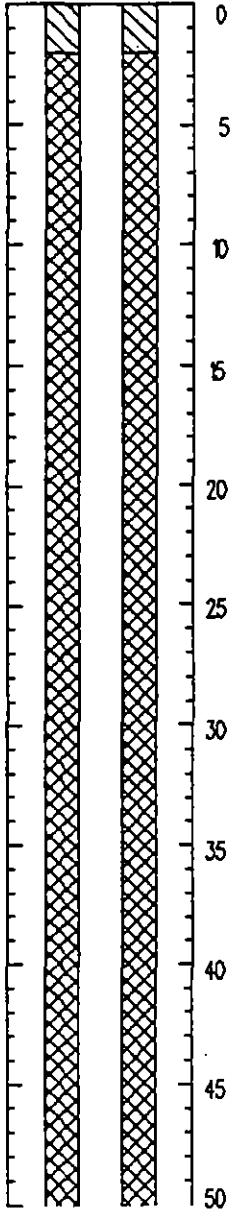
Gray gravelly SAND trace of silt, medium dense, moist, no hydrocarbon odor.

Sample	OVM (ppmV)	Total BTEX (mg/Kg)	EPH (mg/Kg)
S-1	2		
S-2	2		
S-3	2		
S-4	0		
S-5	2		
S-6	1		
S-7	2		
S-8	3		
S-9	47		

Continued on Figure A-14b

Well Design

Completion Type: Surface Casing
Reference Elev.: 140.51 ft.
Casing Stickup: 3 ft.



NOTES:

1. Soil descriptions are interpretative and actual changes may be gradual.
2. Water level is for date indicated and may vary with time of year. (ATD - At Time of Drilling)
3. Refer to Figure A-1 for explanation.

HARTCROWSER

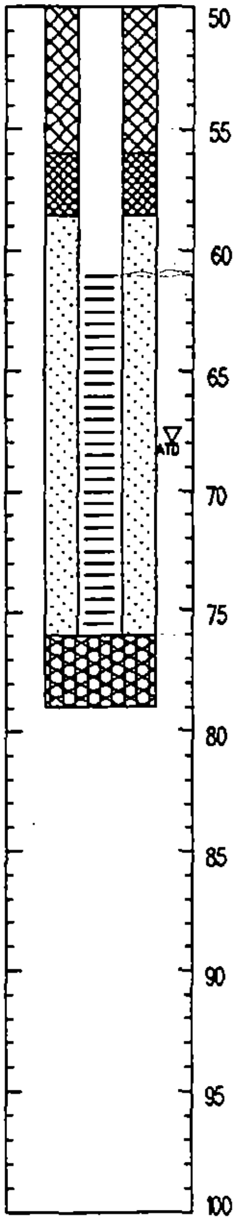
A-8215-02 September, 1991
Figure A-14a

Boring Log and Well Construction Data for MW-17 (50'-79').

Continued from Figure A-14a

Depth in Feet	Soil Description	Sample	OVM (ppmV)	Total BTEX (mg/Kg)	EPH (mg/Kg)
50	Brown gray SAND trace of gravel, medium dense, moist, little to no hydrocarbon odor.	S-10	28		
55		S-11	18		
60	Gray SAND trace of gravel. medium dense, moist, strong hydrocarbon odor near the groundwater interface.	S-12	228	0.04	ND(5)
65		S-13	507	2.5	1600
	Thick sheen on sediments at 68 ft. ATD	S-14	99	0.03	ND(5)
70	Approxiumately 4" of gray silty CLAY at 71'.	S-15	12		
	Gray gravelly SAND medium dense, saturated slight hydrocarbon odor.	S-16	3		
75		S-17	17 2	0.05	ND(5)
	Gray silty CLAY medium stiff, damp to moist, no hydrocarbon odor.	S-18	3		
80	Total depth 79 feet at 13:40 on 8/6/91. Groundwater at 68 ft. ATD.				

Well Design



NOTES:

1. Soil descriptions are interpretative and actual changes may be gradual.
2. Water level is for date indicated and may vary with time of year. (ATD - At Time of Drilling)
3. Refer to Figure A-1 for explanation.

HARTCROWSER

A-8215-02 September, 1991

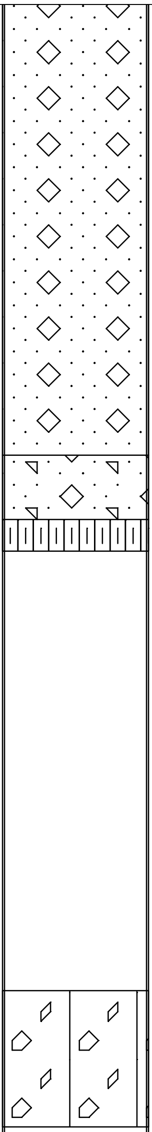
Figure A-14b

BORING LOCATION **Light Fuel Loading Rack**
GROUND ELEVATION **140.6 MLLW**
GROUNDWATER EL. **67.2**
DATE **05-06-2004** EASTING **250965.50**
DATE (START / FINISH) **05-06-2004 / 05-06-2004**
DRILLED BY **Pat Kelley / Hughes Drilling**
LOGGED BY **EMJ**
NORTHING **2447609.00** TOTAL DEPTH (FT) **78.7**

Boring Log for

CMW-56

Page **1** of **6**



EL. FT.	DEPTH FT.	SAMPLE TYPE and NO.	SAMPLE BLOWS PER 6 IN.	SAMPLE PEN IN.	SAMPLE REC. IN.	PID and REMARKS	GRAPHIC LOG	SOIL and ROCK DESCRIPTIONS
140	0 2 4							0' - 4.7': Logged from auger cuttings. NARROWLY GRADED SAND WITH GRAVEL (SP) Mostly medium to fine grained sand, 30-40% fine to coarse gravel to 2-1/2" max size, ~5% fines, loose, moist, brown, no hydrocarbon odor. (fill)
	6	S-1	5 7 5 3	24	12	PID = 0.0 TIME =14:26		S-1 @ 4.7' - 6.7': Upper 8": WIDELY GRADED SAND WITH GRAVEL (SW) Similar to 0' - 4.7', except fine to coarse-grained sand, no odor (fill). Lower 4": ORGANIC SOIL WITH GRAVEL (OL) Mostly low plastic to non-plastic fines, 20-35% fine gravel to 5/8" max size, 5% coarse sand, trace lignite bits, stiff, moist, brown, no odor.
	8							
130	10	S-2	3 1 2 2	24	17	PID = 0.0 TIME =14:34		S-2 @ 9.7' - 11.7': NARROWLY GRADED GRAVEL WITH SILT AND SAND (GP-GM) Mostly fine gravel with 1 coarse piece to 1" max size, 25-40% coarse to fine sand, 8-12% non-plastic fines, very loose, very moist, brown, no odor.
	12 14							

NOTES: **1) Boring drilled using CME-75 Naudwell mounted drill rig with 4-1/4" I.D./ 8-1/4" O.D. hollow stem augers.**
2) Sampled using 2.5" I.D/ 3.0" O.D. split spoon with 2' barrel length and brass liners for taking geotechnical samples.
3) Sample driven using 340 lb. hammer falling 30"/blow.
4) Upon completion, installed 2" I.D. schedule PVC piezometer with 10' screen length.

S = SPLIT SPOON SAMPLE U = UNDISTURBED SAMPLE ▽ = GROUNDWATER

PROJECT NAME
Chevron - Kenai Remediation
PROJECT NUMBER
C03341A

BORING LOCATION **Light Fuel Loading Rack**
GROUND ELEVATION **140.6 MLLW**
GROUNDWATER EL. **67.2**
DATE **05-06-2004** EASTING **250965.50**
DATE (START / FINISH) **05-06-2004 / 05-06-2004**
DRILLED BY **Pat Kelley / Hughes Drilling**
LOGGED BY **EMJ**
NORTHING **2447609.00** TOTAL DEPTH (FT) **78.7**

Boring Log for

CMW-56

Page **2** of **6**

EL. FT.	DEPTH FT.	SAMPLE TYPE and NO.	SAMPLE BLOWS PER 6 IN.	SAMPLE PEN IN.	SAMPLE REC. IN.	PID and REMARKS	GRAPHIC LOG	SOIL and ROCK DESCRIPTIONS
		S-3	6 10 11 14	24	18	PID = 0.0 TIME =14:41		S-3 @ 14.7' - 16.7': Upper 3": Slough Middle 12": NARROWLY GRADED SAND WITH GRAVEL (SP) Mostly coarse to medium grained sand, 25-40% fine gravel to 3/4" max size, trace fines, medium dense, moist, brown, no odor. Lower 3": NARROWLY GRADED SAND (SP) Mostly medium grained sand, trace fines, medium dense, very moist, gray-brown, no odor.
	16							
	18							
	20	S-4	5 8 8 7	24	19	PID = 0.0 TIME =14:52		S-4 @ 19.7' - 21.7': Upper 3": Slough Lower 16": NARROWLY GRADED SAND WITH GRAVEL (SP) Mostly medium grained sand with some fine and coarse, 15-25% fine gravel to 3/4" max size, trace fines, medium dense, very moist, brown, no odor.
120								
	22							
	24							
		S-5	5 8 6 4	24	18	PID = 0.0 TIME =15:07		S-5 @ 24.7' - 26.7': Upper 3": Slough Middle 12": NARROWLY GRADED SAND (SP) Mostly medium grained sand, occasional coarse sand and fine gravel pieces to 1/2" max size, trace fines, medium dense, very moist, gray-brown, no odor. Lower 6": WIDELY GRADED GRAVEL WITH SAND (GW) Mostly coarse to fine gravel to > 2-1/2" max size, 25-35% coarse to medium grained sand, trace fines, medium dense, moist, brown, no odor.
	26							
	28							

NOTES:
1) Boring drilled using CME-75 Naudwell mounted drill rig with 4-1/4" I.D./ 8-1/4" O.D. hollow stem augers.
2) Sampled using 2.5" I.D/ 3.0" O.D. split spoon with 2' barrel length and brass liners for taking geotechnical samples.
3) Sample driven using 340 lb. hammer falling 30"/blow.
4) Upon completion, installed 2" I.D. schedule PVC piezometer with 10' screen length.

PROJECT NAME
Chevron - Kenai Remediation
PROJECT NUMBER
C03341A

S = SPLIT SPOON SAMPLE U = UNDISTURBED SAMPLE ▽ = GROUNDWATER

BORING LOCATION **Light Fuel Loading Rack**
GROUND ELEVATION **140.6 MLLW**
GROUNDWATER EL. **67.2**
DATE **05-06-2004** EASTING **250965.50**
DATE (START / FINISH) **05-06-2004 / 05-06-2004**
DRILLED BY **Pat Kelley / Hughes Drilling**
LOGGED BY **EMJ**
NORTHING **2447609.00** TOTAL DEPTH (FT) **78.7**

Boring Log for

CMW-56

EL. FT.	DEPTH FT.	SAMPLE TYPE and NO.	SAMPLE BLOWS PER 6 IN.	SAMPLE PEN IN.	SAMPLE REC. IN.	PID and REMARKS	GRAPHIC LOG	SOIL and ROCK DESCRIPTIONS
110	30	S-6	4 7 8 9	24	16	PID = 0.0 TIME =15:17		S-6 @ 29.7' - 31.7': Upper 3": Slough. Middle 10": NARROWLY GRADED GRAVEL WITH SAND (GP) Mostly fine gravel to 5/8" max size, 35-40% coarse to medium grained sand, medium dense, moist, brown, no odor. Lower 3": NARROWLY GRADED SAND (SP) Mostly medium to fine grained sand, trace fines, medium dense, moist to very moist, gray-brown, no odor.
	32							
	34							
	36	S-7	4 7 10 11	24	18	PID = 58.0 TIME =15:49		S-7 @ 34.7' - 36.7': Upper 3": Slough. Middle 9": NARROWLY GRADED SAND (SP) Mostly fine grained sand with some medium and coarse sand grains, trace fines, medium dense, very moist, gray-brown, moderate hydrocarbon odor. Lower 6": NARROWLY GRADED SAND WITH GRAVEL (SP) Mostly coarse to medium grained sand, 15-25% fine gravel to 3/4" max size, trace fines, medium dense, moist, gray-brown, moderate hydrocarbon odor.
	38							
100	40	S-8	8 14 13 11	24	18	PID = 8.7 TIME =16:00		S-8 @ 39.7' - 41.7': Upper 4": Slough. Lower 14": NARROWLY GRADED SAND WITH GRAVEL (SP) Mostly medium to coarse grained sand, 15-25% fine gravel to 5/8" max size, trace fines, medium dense, moist, gray-brown, slight hydrocarbon odor.
	42							

NOTES: **1) Boring drilled using CME-75 Naudwell mounted drill rig with 4-1/4" I.D./ 8-1/4" O.D. hollow stem augers.**
2) Sampled using 2.5" I.D/ 3.0" O.D. split spoon with 2' barrel length and brass liners for taking geotechnical samples.
3) Sample driven using 340 lb. hammer falling 30"/blow.
4) Upon completion, installed 2" I.D. schedule PVC piezometer with 10' screen length.

S = SPLIT SPOON SAMPLE U = UNDISTURBED SAMPLE ▽ = GROUNDWATER

PROJECT NAME
Chevron - Kenai Remediation
PROJECT NUMBER
C03341A

BORING LOCATION **Light Fuel Loading Rack**	DATE (START / FINISH) **05-06-2004 / 05-06-2004**		**Boring Log for**
GROUND ELEVATION **140.6 MLLW**	DRILLED BY **Pat Kelley / Hughes Drilling**		**CMW-56**
GROUNDWATER EL. **67.2**	LOGGED BY **EMJ**		
DATE **05-06-2004** EASTING **250965.50**	NORTHING **2447609.00**	TOTAL DEPTH (FT) **78.7**	Page **4** of **6**

EL. FT.	**DEPTH** FT.	**SAMPLE** TYPE and NO.	**SAMPLE** BLOWS PER 6 IN.	**SAMPLE** PEN IN.	**SAMPLE** REC. IN.	**PID and REMARKS**	**GRAPHIC LOG**	**SOIL and ROCK DESCRIPTIONS**
	44							
		S-9	7 10 7 6	24	15	PID = 14.0 TIME =16:14	◇ ⁘	S-9 @ 44.7' - 46.7': Upper 3": Slough. Lower 12": NARROWLY GRADED SAND WITH GRAVEL (SP) Mostly medium to coarse grained sand, 15-30% fine to coarse gravel to > 2-1/2" max size, trace fines, medium dense, very moist, gray-brown, slight hydrocarbon odor.
	46							
	48							
	50	S-10	10 14 17 26	24	18	PID = 27.9 TIME =16:29	◇ ⁘	S-10 @ 49.7' - 51.7': NARROWLY GRADED SAND WITH GRAVEL (SP) Mostly coarse to medium grained sand, 20-35% fine gravel to 3/4" max size, trace fines, dense, moist, gray-brown, slight hydrocarbon odor.
90								
	52							
	54							
		S-11	9 13 17 20	24	18	PID = 3110 TIME =16:45	⁘	S-11 @ 54.7' - 56.7': Upper 4": Slough. Lower 14": NARROWLY GRADED SAND (SP) Mostly medium to fine grained sand, occasional fine gravel pieces, trace fines, dense, very moist, gray, very strong hydrocarbon odor.
	56							

NOTES: **1) Boring drilled using CME-75 Naudwell mounted drill rig with 4-1/4" I.D./ 8-1/4" O.D. hollow stem augers.**
2) Sampled using 2.5" I.D/ 3.0" O.D. split spoon with 2' barrel length and brass liners for taking geotechnical samples.
3) Sample driven using 340 lb. hammer falling 30"/blow.
4) Upon completion, installed 2" I.D. schedule PVC piezometer with 10' screen length.

PROJECT NAME
Chevron - Kenai Remediation
PROJECT NUMBER
C03341A

S = SPLIT SPOON SAMPLE U = UNDISTURBED SAMPLE ▽ = GROUNDWATER

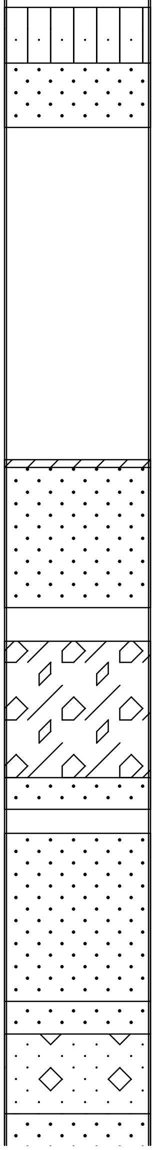
BORING LOCATION **Light Fuel Loading Rack**
GROUND ELEVATION **140.6 MLLW**
GROUNDWATER EL. **67.2**
DATE **05-06-2004** EASTING **250965.50**
DATE (START / FINISH) **05-06-2004 / 05-06-2004**
DRILLED BY **Pat Kelley / Hughes Drilling**
LOGGED BY **EMJ**
NORTHING **2447609.00** TOTAL DEPTH (FT) **78.7**

Boring Log for

CMW-56

EL. FT.	DEPTH FT.	SAMPLE TYPE and NO.	SAMPLE BLOWS PER 6 IN.	SAMPLE PEN IN.	SAMPLE REC. IN.	PID and REMARKS
	58					
						drilling tight @ 59' driller notes silt
	60	S-12	6 11 18 28/5	23	19	PID = 3.2 TIME =17:00
80						
	62					
	64					
		S-13	9 17 30 32/4	22	21	PID = 1.0 TIME =17:22
	66					
		S-14	8 16 26 26	24	23	PID = 5.6 TIME =17:38
	68					
		S-15	7 14 16 24	24	24	PID = 41.7 TIME =17:58 spoon bouncing last 16"
	70					
70						
		S-16	18 30 21 27	24	25	PID = 2350 TIME =18:20 spoon bouncing entire interval
	72					

GRAPHIC LOG



SOIL and ROCK DESCRIPTIONS

S-12 @ 59.7' - 61.6':
Upper 4": Slough.

Middle 7": SILT WITH SAND (ML) Mostly non-plastic fines, 10-20% very fine grained sand, very stiff, very moist, dark gray, moderate hydrocarbon odor.

Lower 8": NARROWLY GRADED SAND (SP) Mostly fine to medium grained sand, trace fines, dense, slightly moist, gray, moderate hydrocarbon odor.

S-13 @ 64.7' - 66.6':
Upper 3": Slough.

Next 1/2": LEAN CLAY (CL) Mostly low plastic fines, very stiff, very moist, dark gray, iron staining on top and lignite bits on bottom.

Lower 17-1/2": NARROWLY GRADED SAND (SP) Similar to Lower 8" S-12.

S-14 @ 66.7' - 68.7':
Upper 2": Slough.

Middle 17": NARROWLY GRADED GRAVEL WITH SAND AND CLAY (GP-GC) Mostly fine gravel to 3/4" max size, 25-35% coarse to medium grained sand, 10-15% non-plastic fines, dense, moist, gray, slight hydrocarbon odor (till).

Lower 4": NARROWLY GRADED SAND (SP) Similar to Lower 8" S-12, slight hydrocarbon odor.

S-15 @ 68.7' - 70.7':
Upper 3": Slough.

Lower 21": NARROWLY GRADED SAND (SP) Mostly medium to fine grained sand, trace fines, dense, moist to very moist, gray, moderate hydrocarbon odor.

S-16 @ 70.7' - 72.7':
Upper 2": Slough.

Next 3": NARROWLY GRADED SAND (SP) Similar to Lower 21" S-15.

Next 10": NARROWLY GRADED SAND WITH GRAVEL (SP) Mostly coarse to medium grained sand, 20-35% fine gravel to 3/4" max size, very dense, moist, gray, strong hydrocarbon odor.

Lower 10": NARROWLY GRADED SAND (SP) Similar to Lower 21" S-15, except very moist, very strong hydrocarbon odor.

NOTES: **1) Boring drilled using CME-75 Naudwell mounted drill rig with 4-1/4" I.D./ 8-1/4" O.D. hollow stem augers.**
2) Sampled using 2.5" I.D/ 3.0" O.D. split spoon with 2' barrel length and brass liners for taking geotechnical samples.
3) Sample driven using 340 lb. hammer falling 30"/blow.
4) Upon completion, installed 2" I.D. schedule PVC piezometer with 10' screen length.

PROJECT NAME
Chevron - Kenai Remediation
PROJECT NUMBER
C03341A

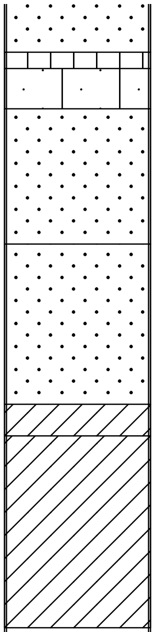
S = SPLIT SPOON SAMPLE U = UNDISTURBED SAMPLE ▽ = GROUNDWATER

BORING LOCATION **Light Fuel Loading Rack**
GROUND ELEVATION **140.6 MLLW**
GROUNDWATER EL. **67.2**
DATE **05-06-2004** EASTING **250965.50**
DATE (START / FINISH) **05-06-2004 / 05-06-2004**
DRILLED BY **Pat Kelley / Hughes Drilling**
LOGGED BY **EMJ**
NORTHING **2447609.00** TOTAL DEPTH (FT) **78.7**

Boring Log for

CMW-56

Page **6** of **6**

EL. FT.	DEPTH FT.	SAMPLE TYPE and NO.	SAMPLE BLOWS PER 6 IN.	SAMPLE PEN IN.	SAMPLE REC. IN.	PID and REMARKS	GRAPHIC LOG	SOIL and ROCK DESCRIPTIONS
▽	74	S-17	12 11 11 23	24	25	water table @ 73.4' bgs ATD PID = 178 TIME =18:36 sample compromised higher PID expected		S-17 @ 72.7' - 74.7': Upper 2": NARROWLY GRADED SAND (SP) Mostly medium grained sand, trace fines, medium dense, wet, gray, very strong hydrocarbon odor. Next 1": SANDY SILT (ML) Mostly non-plastic fines, 20-30% very fine grained sand, very stiff, wet, dark gray. Next 5": NARROWLY GRADED SAND WITH SILT (SP-SM) Mostly fine to very fine grained sand, 10-15% non-plastic fines, medium dense, wet, gray, very strong hydrocarbon odor. Lower 17": NARROWLY GRADED SAND (SP) Mostly medium to fine grained sand, ~5% non-plastic fines, medium dense, wet, gray, very strong hydrocarbon odor.
	76	S-18	5 13 14 13	24	25	PID = 726 TIME =19:12		S-18 @ 74.7' - 76.7': Upper 22": NARROWLY GRADED SAND (SP) Mostly medium grained sand with some coarse and fine-grained sand, trace fines, medium dense, wet, gray, strong hydrocarbon odor at top and weak odor at bottom. Lower 4": LEAN CLAY (CL) Mostly low plastic to non-plastic fines, occasional coarse sand grains, very stiff, very moist, dark gray, no odor.
	78	S-19	2 5 6 10	24	24	PID = 8.6 TIME =19:35		S-19 @ 76.7' - 78.7': LEAN CLAY (CL) Mostly low plastic fines, occasional coarse sand grains and fine gravel pieces to 5/8" max size, stiff, very moist, dark gray, no odor.
	80							
60								
	82							
	84							
	86							

NOTES:
1) Boring drilled using CME-75 Naudwell mounted drill rig with 4-1/4" I.D./ 8-1/4" O.D. hollow stem augers.
2) Sampled using 2.5" I.D/ 3.0" O.D. split spoon with 2' barrel length and brass liners for taking geotechnical samples.
3) Sample driven using 340 lb. hammer falling 30"/blow.
4) Upon completion, installed 2" I.D. schedule PVC piezometer with 10' screen length.

PROJECT NAME
Chevron - Kenai Remediation
PROJECT NUMBER
C03341A

S = SPLIT SPOON SAMPLE U = UNDISTURBED SAMPLE ▽ = GROUNDWATER

Monitoring Well Construction Log

Geomega Project Number: **C03341**

Boring/Well ID: CMW-56

Project Name: **Chevron - Kenai Remediation**

Top of Casing Elevation (at Mark): **143.43'**

Project Location: **Old Nikiski Refinery**

Ground Surface Elevation: **140.6'**

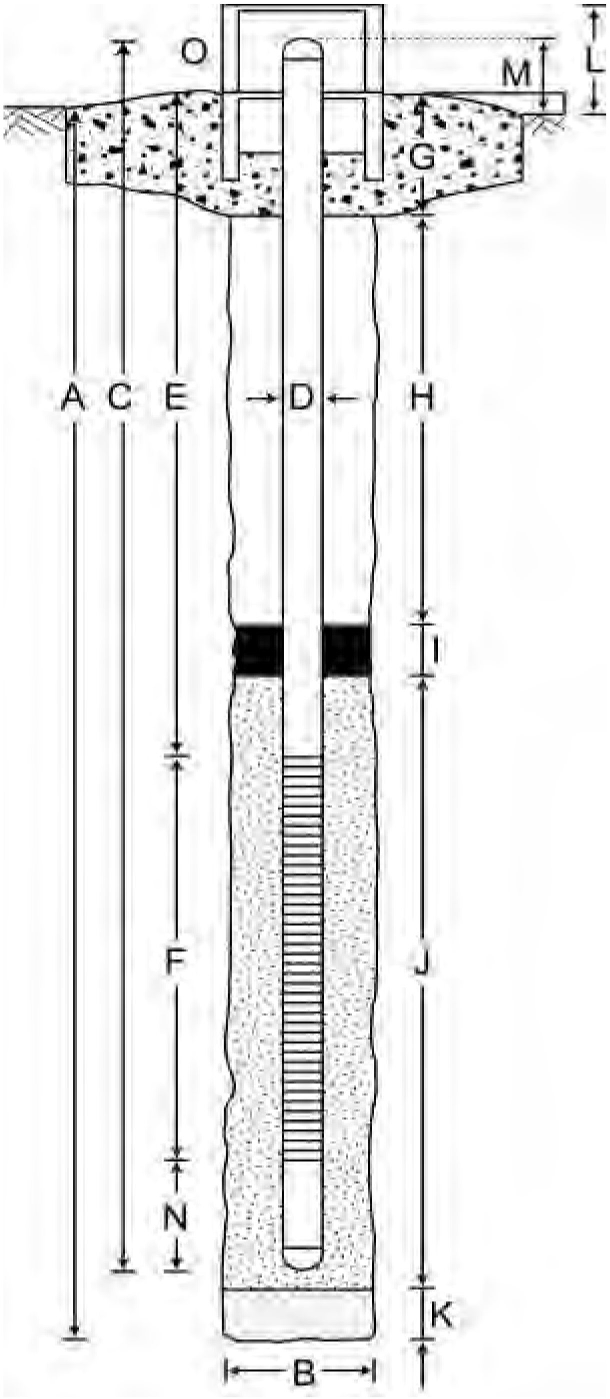
Well Permit Number:

Datum: **MLLW**

Date Started: **5/7/2004**

Date Finished: **5/7/2004**

Notes:



Exploratory Boring

A. Total Depth (feet): **78.7**

B. Diameter (inches): **8-1/4 O.D.**

Drilling Method: **Hollow Stem Auger**

Well Construction

C. Casing Length (feet): **79.8**

Material: **Sch 40 PVC**

D. Diameter (inches): **2.0 I.D.**

E. Depth to Top of Perforations (feet): **66.4**

F. Perforated Interval (from/to-feet): **66.4 - 76.4**

Perforated Type: **slotted**

Perforated Size (inches): **0.020**

G. Surface Grout (from/to-feet): **0.0 - 4.0**

Materials: **concrete**

H. Backfill (from/to-feet): **4.0 - 61.0**

Backfill Material: **Volclay Bentonite Grout**

I. Bentonite Seal (from/to-feet): **61.0 - 63.6**

Material: **Pure Gold Bentonite Chips**

J. Filter Pack (from/to-feet): **63.6 - 78.7**

Pack Material/Size: **10/20 silica sand**

K. Bottom Zone if Needed (from/to-feet): **n/a**

Material: **n/a**

L. Surface Monument Height above Grade (feet): **3.0**

M. Well Casing Height above Grade (feet): **2.9**

N. Silt Trap Length (feet): **0.5**

O. Type of Surface Monument: **7" O.D. round steel casing**

P. Well Centralizer Locations (feet):

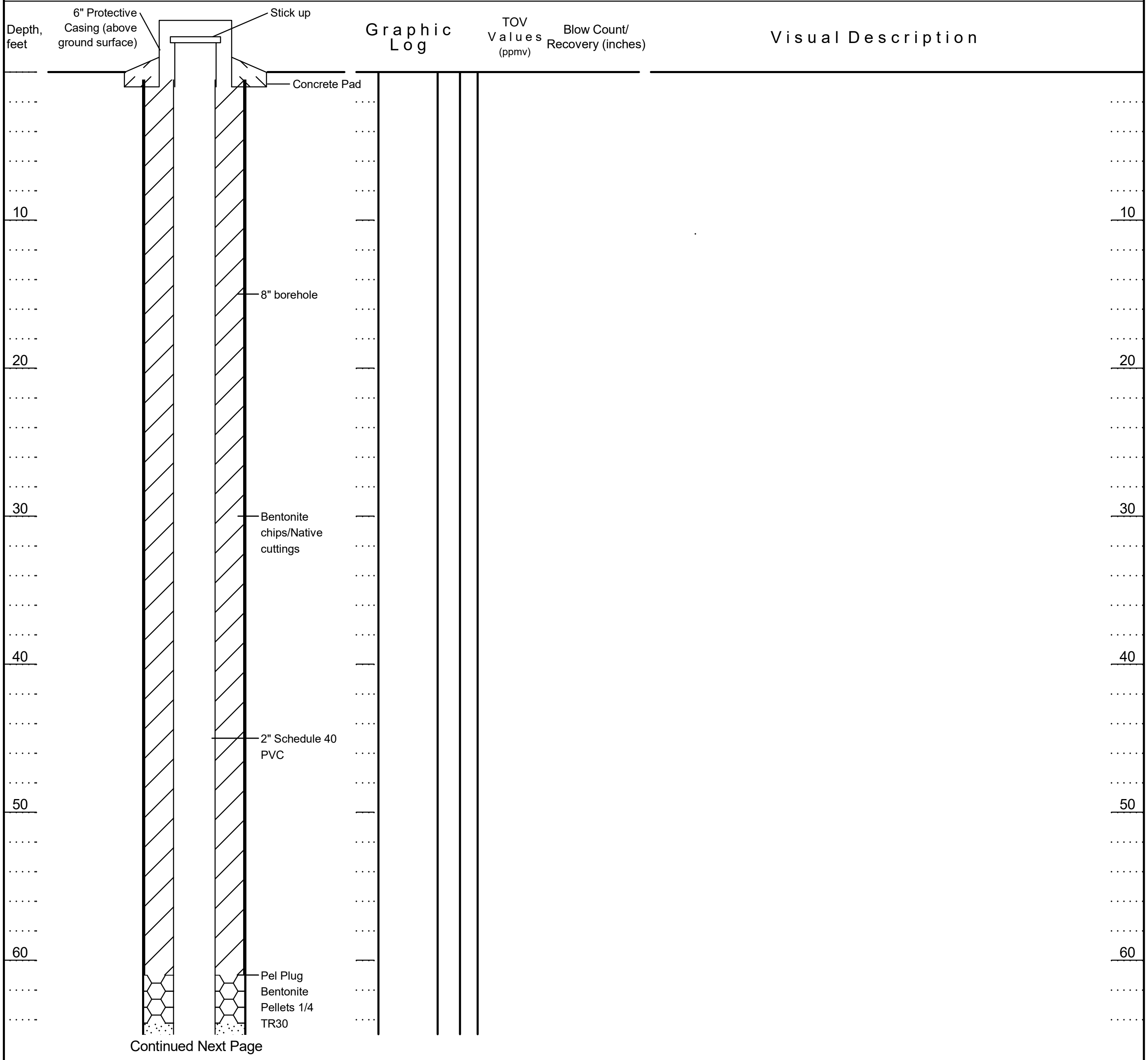
Well Construction Log

Well:**CMW-28R**

Client: **Chevron CMW-28R Kenai Chevron**		
Date Started: **10/9/2019**	Date Completed: **10/10/2019**	Permit Number:
Logged By: **Brianna Force**	Driller: **Jeremy Cromwell**	1/4, 1/4, S, T, R:
Drilling Co.: **Discovery Drilling**	Drilling Rig: **CME 75**	Borehole Diameter: **8"**
Method: **Hollow stem auger**	Measuring Point Elev. (ft.-msl):	Sample Type: **2.5" Split Spoon**
Total Depth (ft): **77.5**	Ground Surface Elev. (ft.-msl):	Location:

N

CONSTRUCTION **SAMPLING DATA** **LITHOLOGY**



Continued Next Page

Well Construction Log

Well:**CMW-28R**

Page 2 of 2

Client:

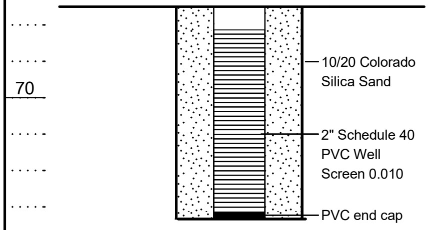
Chevron CMW-28R Kenai Chevron

CONSTRUCTION

SAMPLING DATA

LITHOLOGY

Depth, feet	Continued	Graphic Log	TOV Values (ppmv)	Blow Count/ Recovery (%)	Visual Description



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Trihydro
CORPORATION

Lithology Log

Sheet 1 of

Project Name Chevron Drilling		Project Number	Borehole ID CMW-28R
Drilling Company Discovery Drilling	Driller Jeremy Cromwell	Ground Elevation	Total Drilled Depth 77 feet-bgs
Drilling Equipment Nodwell CME-85	Drilling Method Hollow Stem Aug	Borehole Diameter ~8"	Date/Time Drilling Started 10/9/19
			Date/Time Stopped 10/10/19
Type of Sampling Device Macro Core 5' intervals			Water Level (bgs) 72 feet-bgs Final
PID/FID (make, model, serial no.) Mini Rae 3000			Geologist Brianna Force
			Checked by/Date
Location Description (include sketch in field logbook) Outside Fence			Weather Conditions (temp., clear, rain, wind) Rain, 40°

Depth	Interval	Recovery	Blow Counts	Description (USCS, Munsell color, grain size, SECONDARY, PRIMARY, tertiary, (stiffness of clay or density of sand), (moisture), detail (sorting, angularity, minerology, bedding, plasticity, consistency, etc.)	Water Content	% Gravel	% Sand	% Fines	PID (ppm)	Remarks (Include all sample types & depth, odor, etc.)
0										
				overburden/organics						
5		4.5	#1	#1 GW, light brown Sandy GRAVEL. Subangular Fine-Coarse gravel with, med-coarse Sand Occassional ~~large~~ cobble, no odor	dry moist	60	35	5	0	
10		3.0	#2	#2 GW, same as above, with occassional Fe staining, less gravel	dry moist	50	45	5	0	
15		3.5	#3	#3 GP, Sandy GRAVEL. bimodal, md sand + Fine gravel w/ occ. cobble, Thin silt lense @ 15.2' (~1" thick), dry-moist subangular	dry moist+	50	45	5	0	
20		4.0	#4	#4 GP, Same as above 20-22'	dry moist	50	45	5	0	
				SP, olive SAND, md grained, moist, no odor, tr gravel 22-23'		5	95	0	0	
				GP, SAA 23'-24' bgs		50	45	5	0	
25		4.8	#5	#5 GP, SAA, 25 26		50	45	5	0	
				SP, olive SAND, fine grained, dry, No odor,	dry	0	100	0	0	
30		4.5	#6	#6 SP, Same as above, 30-31.5		0	100	0	0	
				GW, Brown/Red Sandy GRAVEL, Fn-coarse gravel w/ med-coarse Sand dry, Fe staining	dry	55	45	0	0	
35		4.0	#7	#7 GW, Same as above, w/ occ. cobble	dry moist+	55	45	0	0	
40		3.5	#8	#8 ML, organic rich silt lense, 4" thick with gravel	moist+	10	5	85	0	
				40.5 42 GW SAA		55	45	0	0	
				42-43 SP, olive SAND, md grained w/ sparse-none gravel	moist	15	85	0	0	
45		3.0	#9	#9 GW, Brown-Gray, subangular Fn-coarse gravel with md-coarse Sand, no odor, wet 1" silt lense @ 46' bgs. Brown	wet	60	40	0	0	
50										

Trihydro
CORPORATION

Lithology Log (continued)

Sheet 2 of 2

BOREHOLE ID
CMW-28R

Depth	Interval	Recovery	Blow Counts	Description (USCS, Munsell color, grain size, SECONDARY, PRIMARY, tertiary, (stiffness of clay or density of sand), (moisture), detail (sorting, angularity, minerology, bedding, plasticity, consistency, etc.)	Water Content	% Gravel	% Sand	% Fines	PID (ppm)	Remarks (Include all sample types & depth, odor, etc.)
50		4.5	#10	#10 - GW, Same as above 50-53.5, damp						
				SP, 53.5-54.5. SAND, olive med grained tr gravel, subrounded, no odor	damp	<5	95	0	0	
55		4.5	#11	#11 55-58 SW, Gravelly SAND, med sand w/ Fn gravel	damp wet	25	75	0	0	
				58-59.5 SP, SAND Fine Sand, no odor subrounded	wet	<5	95	0	0	
60		3	#12	#12 60-61.5 ML, Sandy SILT, Grey grading to brown w/ Fe staining at Soil Contact Silt w/ very Fine Sand no odor	wet	0	30	70	0	-Non plastic, soft -Sharp contact b/w Silt + Sand layers
65		4.5	#13	61.5-63 SW, Gravelly SAND, olive, Med. coarse Sand w/ Fine gravel subrounded	wet	30	70	0	0	
70		3.4	#14	#13 SP, Olive SAND, fine grained, damp. no gravel, no silt						
▽				#14 SP, SAA 70-72, w/ thin Silt lense	damp	<5	95	0	0	
				GW, 72-73, Sandy Gravel, coarse Sand Fn-coarse gravel	damp	<5	95	0	0	-Refusal @ 73'
75		5.0	#15	75-77.5 #15 SW, Grey, SAND with med-coarse Sand and 10% fines, Sat., subrounded No odor	Sat	65	35	0	0	-water @ 72' bgs
					Sat	0	90	10	0	
80				77.5-80 CL, grey Clay, med plasticity, Stiff to very Stiff, no odor, damp	damp	0	0	100	0	
85										
90				-Stopped drilling @ 77' bgs + Set well						
95										
100										
105										
110										
115										

ATTACHMENT E

Arcadis PFAS Sampling Guidance

ARCADIS Design & Consultancy for natural and built assets

POLY- AND PERFLUOROALKYL SUBSTANCE (PFAS) SAMPLING AND ANALYSIS GUIDANCE PREPARED FOR CHEVRON CORPORATION

June 25, 2021

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	April 27, 2017	All	Initial Release	Erica Kalve Erika Houtz Sue Tauro
1	June 19, 2018	1 through 4 and 17	Update Information on Sampling Materials	Erica Kalve Erika Houtz
2	October 29, 2018	various	Modifications for Chevron	Erika Houtz
3	February 26, 2020	Significant updates to Pages 4, 5, and 17 to 22	Removed Sharpies from acceptable field writing implements; Removed Citranox from acceptable Decon solutions in Table 1a, added all fluoropolymer containing materials to prohibited items in Table 1b. Made a correction that Liquinox contains trace levels of 1,4 Dioxane, not Alconox. Minor updates to Section 3.2 (Laboratories). Updates to methods information in Section 10.1, including addition of Table 3.	Jeffrey McDonough, Kammy Sra
4	June 25, 2021	All	Added additional QA/QC procedures for the COC prior to submittal to the lab, request pre-printed COC from the laboratory, and updated equipment blank/dedicated equipment blank section. Fine/Ultra fine tipped sharpies allowable. Revised soil, groundwater, stormwater, sediment, and surface water sampling sections. Added in Wastewater/biosolids, foam concentrate, solid waste, and sample labelling sections. Alternative methods section removed. Minor modifications throughout based off lessons learned and method updates.	Steve Rice Johnsie Lang Stephanie Fiorenza Loretta Kwong Kammy Sra

APPROVAL SIGNATURES

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6/25/2021

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Date:

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6/25/2021

Stephanie Fiorenza, Ph.D.

Date:

Principal Scientist

Contents

1 INTRODUCTION

This document describes procedures, methods, actions, steps, and considerations to be used and observed by a Chevron supplier/contractor when performing actions under the scope and relevancy of this document – the field sampling of poly- and perfluoroalkyl substances (PFASs). This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Chevron supplier/contractor lead to provide this document to the persons conducting services that fall under the scope and purpose of this guidance. The Chevron supplier/contractor lead will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein and inquire to the Chevron supplier/contractor lead regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to any and all projects. It is the Chevron supplier/contractor lead’s responsibility to determine the proper scope and personnel required for each project, in communication with the Chevron project manager/operations lead. There may be project- and/or state-specific requirements that may be more or less stringent than what is described herein. The Chevron supplier/contractor lead is responsible for informing Chevron of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the Chevron supplier/contractor lead if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project’s scope of work based upon site conditions, staffing expertise, state-specific requirements, health and safety concerns, etc. Staff are required to consult with the Chevron supplier/contractor lead when or if a deviation or omission from this document is required that has not already been previously approved by the Chevron supplier/contractor. Upon approval by the Chevron supplier/contractor lead, the staff can perform the deviation or omission.

2 SCOPE AND APPLICATION

The purpose of this Technical Guidance Instruction (TGI) is to provide guidance on field sampling to be used for poly-and perfluoroalkyl substances (PFASs). This protocol was adapted from various published sources and from Arcadis’ international experience implementing sampling for PFASs. In general, sampling techniques used for PFAS site characterization are consistent with conventional sampling techniques used in the environmental industry, but special consideration is made regarding PFAS-containing materials and cross-contamination potential. **Table 1a** provides a summary of materials that have been approved for site investigation; this list is expected to grow longer as industry experience increases. **Table 1b** provides a summary of field equipment and materials that have available testing information and/or industry knowledge regarding PFAS cross-contamination potential and it is recommended that these materials be prohibited for sample collection. For materials that are suspected of containing PFASs and/or to retain PFASs, these recommendations are considered preliminary and subject to change.

Table 1a: Summary of Acceptable Sampling Equipment and Materials for PFAS Site Investigations

Sampling Materials	Additional Considerations	References
Water Sampling Materials		
High density polyethylene (HDPE) or silicone tubing materials (including bladders)	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
HDPE HydraSleeves^{TM}	Low density polyethylene (LDPE) HydraSleeves^{TM} are not recommended	USACE 2016; MassDEP 2017
Drilling and Soil Sampling Materials		
PFAS-free drilling fluids	--	DER 2016
PFAS-free makeup water	Provided by lab Confirm PFAS-free water source via laboratory analysis prior to investigation	--
Acetate liners	For use in soil sampling	USACE 2016
Stainless-steel/metal sampling devices (i.e. trowel, hand auger, core barrel, ponar grab sampler, etc.)	For use in soil sampling	--
Sample Containers and Storage		
HDPE sample containers with HDPE lined lids for soil and water samples	Provided by lab. whole bottle analysis of aqueous samples combined with a solvent rinse of bottle is recommended (this is for the lab, not really necessary here)	DER 2016, MassDEP 2017
Ice contained in plastic (polyethylene) bags (double bagged)	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Field Documentation		
Ball point pens	--	MassDEP 2017
Standard paper and paper labels	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Fine/Ultra-Fine point Sharpies®	Larger point Sharpies® should be avoided	MDEQ 2018, CA 2020
Decontamination		
PFAS-free Water-only decontamination	Provided by lab. Confirm PFAS-free water source via laboratory analysis prior to investigation	DER 2016
Alconox® or Liquinox® followed by deionized water or PFAS-free water rinse	Liquinox® known to contain trace levels of 1,4-dioxane	NHDES 2016; USACE 2016; MassDEP 2017
Methanol, isopropanol, or acetone	Special health and safety precautions are necessary	UNEP 2015; USACE 2016

Note: This list is considered preliminary and additional materials may be added as additional information becomes available. Project teams are expected to follow a methodical evaluation process of materials to be used and confirm acceptance prior to implementation of field activities.

Table 1b: Summary of Sampling Equipment and Materials Not Recommended for PFAS Site Investigations.

Sampling Materials	Known PFAS-Containing Materials	Suspected PFAS-Containing Materials	Materials with Potential to Retain PFASs	References
Water Sampling Materials				
Teflon®, PTFE-containing or other fluoropolymer coated or containing field equipment (e.g., tubing, bailers, liners, tape, plumbing paste, pump parts)	x			DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Passive diffusion bags			x	MassDEP 2017
LDPE HydraSleeves ™			x	USACE 2016; MassDEP 2017
Water particle filters			x	MassDEP 2017
Drilling and Soil Sampling Materials				
Aluminum foil			x	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Drilling fluid containing PFASs	x	x		DER 2016
Sample Containers and Storage				
Glass sample containers with lined lids			x	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
LDPE containers and lined lids			x	USACE 2016
Teflon® or PTFE- lined lids on containers (e.g., sample containers, rinsate water storage containers)	x			DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Reusable chemical or gel ice packs (e.g., BlueIce®)		x		DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Field Documentation				
Self-sticking notes and similar office products (e.g., 3M Post-it-notes)		x		DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Waterproof paper, notebooks, and labels	x			DER 2016, MassDEP 2017
Markers		x		NHDES 2016
Decontamination				
[Some] detergents and decontamination solutions (e.g., Decon 90® Decontamination Solution)	x	x		DER 2016; NHDES 2016; MassDEP 2017

Note: For materials that are suspected of containing PFASs, or have the potential to retain PFASs, project specific considerations may provide adequate justification for use during the field event. For example, further evaluation may be conducted in the form of pre-field equipment blank sample analysis.

Given the extremely low detection limits associated with PFAS analysis and the many potential sources of trace levels of PFASs, field personnel are advised to err on the side of caution by strictly following these protocols, frequently replacing nitrile gloves, and rinsing field equipment to help mitigate the potential for false detections of PFASs. A summary of other specific items related to field sampling for PFASs are discussed in the sections below.

This TGI applies to all Chevron supplier and subcontractor personnel involved in field sampling for PFASs.

3 QUALIFICATIONS

3.1 Sampling Personnel

Field personnel must have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, and site-specific training, as needed. In addition, field personnel will be versed in the other relevant Standard Operating Procedures (SOPs) (e.g., low flow sampling) and will possess the skills and experience necessary to successfully complete the desired field work. The site Health and Safety Plan (HASP) and other documents will identify any other training requirements such as site-specific safety training or access control requirements. Sampling personnel are required to establish defined roles prior to the field event (i.e., identify who will fill out the COC and who will review the COC to compare it to the sampling matrix provided in the work plan and/or work request package. A pre-field kick off call will be scheduled to discuss the scope of work and specify the sampling method analysis required for the work.

3.2 Laboratories

These laboratories offer analysis of environmental media for PFASs:

- United States: Eurofins Lancaster[1], Eurofins TestAmerica[1], Shealy Pace Analytical, SGS, Vista, ALS, RTI
- Canada: Axys-SGS and Maxxam Laboratories

Chevron's preferred analytical laboratory for all PFAS analysis is Eurofins Lancaster. If Eurofins Lancaster is backlogged with samples, or unable to meet project requirements, then Eurofins TestAmerica in Sacramento, CA will serve as Chevron's preferred secondary analytical services provider. Other laboratories may be used if they are accredited for PFAS analysis according to any project requirements. It is recommended that laboratories are Environmental Laboratory Accreditation Program (ELAP)-accredited for PFAS analysis in accordance with the Department of Defense Quality Systems Manual (QSM) 5.1 Table B-15 or later. It is also recommended that the PFAS laboratory would have undergone Chevron laboratory audit and at a minimum provided lab analytical method SOPs for Chevron's review.

Chevron's supplier/contractor lead will plan to contact the laboratory two months prior to sampling to arrange for receipt/certificate of PFAS-free water to be used during the field event. The analysis will be on the batch of water to be used during the field event. A sample of the PFAS-free water will be

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[1] Chevron and / or Chevron's supplier has audited the lab for PFAS analytical work, as of the drafting of this SOP.

submitted for analysis during the sampling event to be sure it is PFAS-free. The field program will be discussed with the lab to ensure the accurate number of QC blanks needed and appropriate bottle ware for the field program is provided.

4 EQUIPMENT LIST

The following equipment and materials must be available for sampling:

- Site plan of sampling locations, relevant work plan (or equivalent; confirm sampling matrix has the correct analytical methods and ensure document is bulleted and/or checklist so that it is easier to read by the field teams), and this TGI;
- Appropriate health and safety equipment, as specified in the site HASP;
- Sufficient length of new disposable high-density polyethylene (HDPE) tubing to enable single-use (PFAS-free) access to groundwater without reusing between wells (consult workplan for estimated depths to water). New lengths of tubing shall be used for each sampling location.
- Dedicated plastic sheeting (preferably high-density polyethylene [HDPE]) or other clean surface to prevent sample contact with the ground.
- Conductivity/temperature/pH meter, with known/recorded serial number, calibration, and PFAS-free decontamination prior to use;
- Dissolved oxygen meter, oxidation reduction potential meter, and turbidity meter with known/recorded serial number, calibration, and PFAS-free decontamination prior to use;
- Depth to water meter with known/recorded serial number, calibration, and PFAS-free decontamination prior to use;
- If using low-flow groundwater sampling techniques, peristaltic pump (groundwater sampling)/bladder pump (with PFAS free bladder/ HDPE bladder), flow through cell, and accompanying sufficient supply of single-use HDPE and silicone tubing;
- Hydrasleeves, if using Hydrasleeves for groundwater sampling;
- Metal trowel or other acceptable soil sampling tools for soil samples; specialized soil/sediment sampling equipment as required;
- Brushes (made of metal, HDPE or other acceptable materials) for scrubbing sampling equipment;
- Pens, pencils, and/or fine/ultra-fine point Sharpies® for writing;
- Clipboards, field binders, and field note pages that are not waterproof;
- Labeled sample bottles:
  - Water: HDPE bottles fitted with polypropylene screw cap only. The laboratory will specify the sample bottle volume.
  - Include sufficient bottles for all field QCs, including matrix spikes and blanks.
  - Some types of PFAS samples (primarily drinking water) may require preservative – which will be indicated by the laboratory.
- If high concentrations of PFASs related to class B firefighting foams are expected, bring additional small vials to conduct field-based shaker tests for foaming;
- Ziploc® bags to hold ice and sample bottles.
- Bottles containing “PFAS-free” water used for field and equipment blanks;
- Labeled coolers for samples with ice; Blue ice® is not permitted;
- Deionized water for decontamination rinsing;
- “PFAS-free” water provided by the laboratory for final decontamination rinsing and for collecting equipment blanks (i.e. additional water in addition to the field blanks);

- Methanol, isopropanol, or acetone if able to be brought safely to field site; especially important for decontamination during soil sampling;
- Alconox® or Liquinox® for decontamination rinsing;
- Packing and shipping materials;
- Respective media sampling logs; and
- Chain-of-Custody (COC) Forms (request pre-printed COC Forms from the laboratory and confirm which PFAS analytes, reporting limits, level of data package required and method with the laboratory; confirm the COC Form is consistent with the approved work plan and/or work request package).
- Heavy-duty garbage bags for collection of IDW
- Sealable pail for decontamination water (to transfer to on-site investigation-derived waste barrel)

Specialty Stormwater Sampling Equipment:

- Wrench, socket, manhole cover hook or magnetic manhole cover remover for access (
- Approximately 1-inch outer diameter Lexan™ pipe long enough to extend from bottom of storm drain to at least 2 feet above the manhole.

5 CAUTIONS

5.1 Food Packaging

Some food packaging may be treated with PFAS-containing chemicals to prevent permeation of oil and water in the food outside of the packaging. To avoid potential food packaging-related PFAS contact:

- Do not bring any food outside of the field vehicles onsite and eat snacks and meals offsite.
- Wash hands after eating.
- Remove any field garments or outer layers prior to eating. Do not put them back on until done eating and hands are washed.
- Gloves should be donned prior to field work eliminating contact between fingers and sampling vials.

5.2 Field Gear

5.2.1 Clothing

Many types of clothing are treated with PFASs for stain and water resistance, in particular outdoor performance wear under brand names including but not limited to Gore-Tex®. To avoid potential clothing-related PFAS contamination of samples:

- Most importantly, avoid contacting your clothing with sampling equipment, bottles, and samples.
- Generally, do not wear any outdoor performance wear that is water, dirt, or stain resistant or appears to be. Err on the side of caution.
- Examples of prohibited materials include water / stain / dirt-resistant treated clothes (including but not limited to Gore-Tex™, Scotchgard™, RUCO®), new unwashed clothing, clothes recently washed with fabric softeners, clothes chemically treated for insect resistance and ultraviolet protection, and coated Tyvek®.

- Examples of some acceptable water-proof clothing may include clothing made with polyurethane, PVC, wax-coated fabrics, rubber or neoprene.
- Wear pre-laundered (multiple washings, i.e., 6+ without use of fabric softeners).
- Natural fabrics such as cotton are preferred. Synthetic fabrics may also be acceptable if there is no indication on the label that the fabric is water, dirt, and stain-resistant.

5.2.2 Personal Protective Equipment

General Consideration for PPE

Each site may have specific PPE requirements based on potential hazards at the working location. It is imperative to comply with all safety requirements when entering the site. In many cases, using PPEs that are known to contain PFAS, or uncertain whether they contain PFAS, may be unavoidable. In such cases, equipment blanks should be collected with the samples, and all used PPEs should be documented and discussed in the analysis report. Safety should not be compromised in any situation.

Types of PPE that are commonly required onsite but not yet confirmed to be PFAS-free, and therefore, need to be documented include, but not limited to:

- Flame resistant clothing;
- Hard hat;
- Cut resistant gloves;
- Safety glasses; and
- Ear plugs

Safety Footwear

Examples of acceptable footwear include boots made of polyurethane and / or PVC. However, some safety footwear has been treated to provide a degree of waterproofing and increased durability and may represent a source of trace PFASs. For the health and safety of field personnel, footwear must be protected at all times to avoid potential PFAS contamination. To do this:

- Do not contact your footwear with equipment, bottles, or samples in any way.
- Do not allow gloves used for sampling to come in contact with safety footwear.

Nitrile Gloves

Do not wear latex gloves. Wear disposable powderless nitrile gloves (referred to as “nitrile gloves” hereafter) at all times. Don a new pair of nitrile gloves **before** the following activities at each sample location:

- Decontamination of re-usable sampling equipment;
- Contact with sample bottles or “PFAS-free” water bottles;
- Insertion of anything into the sample ports (e.g., HDPE tubing); and
- Handling of any quality assurance/quality control (QA/QC) samples including field blanks and equipment blanks.

Don a new pair of nitrile gloves **after** the following activities:

- Eating or drinking outside of the sampling area
- Recording data on paperwork or other non-sampling activities (collecting waste, etc.)
- Handling of any non-dedicated sampling equipment (often when moving to new sample location);

- Contact with potentially PFAS-contacted or contaminated surfaces; or
- When judged necessary by field personnel.

5.3 Personal Hygiene

- Shower at night before the day of sampling and during multi-day sampling events. Avoid showering the morning of.
- Do not use personal care products after showering such as lotions, makeup, and perfumes, UNLESS medically necessary. In general, use of personal products should be avoided 24 hours prior to sampling.
- Use sunscreen and insect repellent ONLY if necessary, for health and safety. If they are necessary, apply sunscreen and repellant prior to initiating field sampling. If sunscreen and/or repellant need to be reapplied, ensure it is conducted at a safe distance away from the sampling locations and equipment (i.e., more than 10 m away). Wash hands after application and don new pair of nitrile gloves.

5.4 Visitors

Visitors to the site are asked to remain at least 10 m from sampling areas.

5.5 Rain Events

Special care should be taken when rain is falling at the project site:

- Do not perform field sampling when rainfall is persistent at a consistent rate that saturates the ground (i.e., formation of puddles) because rain gear is not permitted while sampling. Intermittent showers or fog are acceptable conditions to proceed. If rain showers occur, field gear must be removed from the monitoring well location until the rain subsides.
- Do not perform soil sampling during rain events to avoid potential PFAS contamination from surface runoff.
- If project timelines are tight, consider the use of a gazebo tent that can be erected over the top of the monitoring well to provide shelter from the rain. The canopy material is possibly a PFAS-treated surface and should be managed as such; therefore, wear gloves when moving the tent, change them immediately after moving the tent, and avoid further contact with the tent until all sampling activities have been finished and the team is ready to move on to the next site.

6 HEALTH AND SAFETY CONSIDERATIONS

- Field activities must be performed in accordance with the site HASP, a copy of which will be present onsite during such activities.
- The ability to safely access surface water sampling locations, if relevant, must be verified before sampling.
- Safety hazards associated with sampling surface water include fast-moving water, deep water, and steep slopes close to sampling sites. Use extreme caution when approaching sampling sites.
- If thunder or lightning is present while working outdoors, discontinue sampling and take cover until 30 minutes have passed after the last occurrence of thunder or lighting.

- Use caution when removing well caps as well may be under pressure and the cap can dislodge forcefully and cause injury.

7 PROCEDURE

7.1 Site Visit

Prior to mobilizing to the field, a site visit is recommended to be conducted to confirm site access, location of the wells, well integrity, and identify any outstanding questions/details needed to complete the field work. At some sites, Arcadis may not have been to the site before and gathering site-specific information will provide ease to the sampling event. If the site is not currently managed by Arcadis, consider having the current supplier meet Arcadis onsite for kickoff and review of monitoring well locations.

7.2 Field Equipment Cleaning

Field sampling equipment will require cleaning between uses. For groundwater sampling, between uses, decontaminate the flow-through cell and any non-dedicated equipment (i.e., interface probe of depth to water meter, bladder pump, etc.) that comes into contact with well water. Trowels and other materials used to sample soil samples will also require thorough decontamination, although dedicated, single use equipment such as liners should be used where possible.

Consult the sampling plan Quality Assurance Project Plan (QAPP) to ensure thorough understanding of which decontamination rinsate is to be preserved separately for laboratory analysis as equipment blanks and plan to reserve that volume separately from other decontamination liquid wastes.

After donning a new pair of nitrile gloves:

- Note that the last round of decontamination rinsate with “PFAS-free” water may also need to be collected for equipment blanks using lab-provided bottles at planned sampling locations per the sampling and analysis workplan or QAPP. Consult the QAPP to pre-plan what rinsate will need to be required to be sampled and when.
- Rinse sampling equipment with Alconox or Liquinox® cleaning solution; Scrub equipment with a HDPE or metal brush if needed;
- Rinse two times with distilled water or deionized water;
- Rinse one time with “PFAS-free” water or once with methanol/acetone/isopropanol, if it is available, and once with “PFAS-free” water; organic solvents are especially useful for decontaminating soil sampling equipment. If organic cleaning solvents cannot be brought to site, scrub equipment a second time after a single distilled or deionized water rinse, then rinse two times with distilled or deionized water and once with “PFAS-free” water (i.e., two scrubbings and four water rinsings total); and
- Collect all rinsate in a sealable pail for disposal. Do not reuse decontamination solutions between sampling locations.

Clean all field equipment used at locations that are suspected of containing class B firefighting foam (i.e., those that foam during shaking or are known to be near a class B firefighting foam source zone) using each of the above steps repeated twice.

7.3 Borehole/Monitoring Well Development

If a drill rig is being used to drill for soil cores or to install monitoring wells, wear clean nitrile gloves before collecting each continuous soil sample. Additional requirements include the following:

- Verify in writing with the manufacturer that single-use liners used to collect each sample are made of a material that does not contain PFAS.
- Collect soil samples in laboratory-supplied HDPE bottles.
- Pre-label the bottles.
- Store the sample bottles in coolers and keep at a temperature of 0 to 6ºC until transported to the laboratory.
- Use ice double-bagged in LDPE-Ziploc© storage bags.

7.3.1 Well Condition Survey/ Water Level Monitoring

Using equipment that has been thoroughly decontaminated according to the procedures in Section 7.1 (including collection of equipment blank[s] according to the accompanying QAPP), conduct the well condition surveys and water level monitoring:

- Conduct monitoring well inspections and record water levels, decontaminating the water level meter in between wells as per Section 7.2.
- If NAPL is suspected/expected, use an (decontaminated per Section 7.1) interface probe to evaluate presence/absence of non-aqueous phase liquid (NAPL).
- Measure the depth to water from the top of the polyvinyl chloride (PVC) riser and the total depth of the well.
- Record information in the field notes.
- Decontaminate as per Section 7.1 and change gloves before moving to the next sampling location.
- Record compliance with decontamination protocols in field notes.

7.3.2 Monitoring Well Development and Purging

Follow these requirements for monitoring well development and purging:

- Do not use Teflon™ tubing for purging or sample collection. Dedicated or new single-use HDPE tubing is acceptable.
- Do not re-use materials between wells. Upon completion of use, remove all disposable materials (such as HDPE and/or silicone tubing) and place in heavy duty garbage bags for disposal.
- During development of the well, create sufficient energy to agitate the water column and create flow reversals in the well screen, filter pack and formation to loosen fine-grained materials and draw them into the well. The pumping or bailing action should then draw all drilling fluids and fine-grained material out of the borehole and adjacent formation and then out of the well. Review the Chevron contractor/ supplier's monitoring well development guidance for more detailed procedural information.
- Follow the low-flow purge and sampling techniques per the U.S. Protection Agency's (EPA's) guidance document titled *Low Stress (Low Flow) purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells* (2010) and ASTM's standard titled *Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality*

Investigations (2002). The Chevron contractor/supplier's internal guidance documents on low flow sampling must also be reviewed.

- To purge the well, if using dedicated or single-use HDPE tubing and a peristaltic pump, insert the end of the tubing to the approximate depth of the midpoint of the screened section of the monitoring wells, or of the midpoint of the water column, whichever is lower. Measure the length of HDPE tubing to be inserted into each monitoring well and pre-cut it to approximate lengths (such as the previously measured arm span of a field technician) to avoid contact with any materials other than the monitoring well and peristaltic pump. Flow rates should be as low as can be reasonably achieved. Collect and appropriately dispose of purge water according to Section 8.
- Silicone tubing should direct the purge water through a flow-through cell for field parameter measurements of pH, conductivity, temperature, dissolved oxygen, and turbidity. Calibrate the instrument in the field prior to use. Decontaminate the instrument and flow-through cell at each monitoring well location before purging.
- Record field parameters in intervals (generally of 3-minute duration) to ensure purge water has cycled through the flow-through cell. Sample the wells after field parameter measurements indicate stabilization, which allows collection of representative formation water (generally acceptable standards are three consecutive pH readings to within ±0.1 units, and three consecutive conductivity, temperature and dissolved oxygen measurements to within 3%). Turbidity must be monitored but does not need to be used as a stabilization indicator of purge completion. Record field parameter measurements at each well. Drawdown should be monitored throughout the purge.
- If wells are suspected to be dewatering throughout the purge (i.e., reduced flow rate/difficulty pumping water or bubbles begin to come through the flow through cell), turn off the pump and allow the water level to recover for ½ hour, followed by sample collection. Document these activities in the field notes.

7.4 Sample Collection

Different laboratories may supply sample collection bottles of varying sizes depending on the type of media to be sampled.

7.4.1 Sample Containers

- Collect samples in HDPE bottles fitted with an unlined (no Teflon™), polypropylene screw cap.
- Complete bottle labels after the caps have been placed back on each bottle.
- Do not use glass bottles due to potential loss of analyte through adsorption. This is particularly important for aqueous samples.
- Review with analytical lab the sample size, sample container, etc. depending upon the type of PFAS analysis that is being requested.

7.4.2 Soil Sampling

Before Sample Collection

- Place HDPE (or other permitted material) sheeting adjacent to the sample location for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
- Trowels or drilling equipment that will come into contact with a sample should be decontaminated prior to sample collection, preferably with methanol, isopropanol, or acetone;

- Collect equipment blanks from decontaminated equipment **before** sample collection. Refer to the QAPP for additional guidance on equipment blank collection.
- Don a new set of nitrile gloves. Do not use gloved hands to subsequently handle papers, pens, clothes, etc., before collecting samples.
- Use the HDPE bottles that are supplied by the laboratory. Make sure that the caps remain on the bottle until immediately prior to sample collection. Do not place the sampling container cap or lid on the ground or any surface unless it is PFAS-free.
- Make sure all sampling equipment/materials are known PFAS-free or at least materials are acceptable for PFAS sampling.

During Sample Collection

- Always start collecting samples from the least contaminated area, if information is available to determine the anticipated extent of contamination.
- Collect soil samples using a clean stainless-steel trowel (for collecting loose soil samples) or with single-use PFAS-free soil sampling corer with PFAS-free liners, such as acetate liners, (for collecting soil cores);
- Pick out roots, pebbles, or stones if there are any.
- Do not homogenize soil samples and place soil samples in labeled HDPE bottles supplied by the laboratory; Make sure enough samples are collected for all required sample analysis (follow instructions from the lab)
- If cores are collected, retrieve the soil core and cap with PFAS-free core caps and place soil cores in cooler for storage.
- Collect any necessary QA/QC samples such as field blanks, field duplicates/co-located samples and matrix spikes (verify by consulting the QAPP and confirm with laboratory whether they need to be collected in the field and need to be in separate sample bottles), following the proper protocols. Field blank samples should be collected after field staff return from an offsite break (e.g., lunch) to capture any potential cross-contamination from field personnel
- If disposable, single-use sampling equipment can’t be used in high concentration areas, increase the frequency of equipment blanks. Note suspected high concentration samples on the chain of custody and segregate them by using a separate cooler.
- Note the time, sample location and sample ID on the sample label using PFAS-free pens such as ballpens or using pre-labelled sample bottles.
- Decontaminate sample equipment that are deemed to be re-used after sampling at each location and at the end of the workday; follow Section 7.2 for decontamination of field equipment.
- Dispose one-time-use equipment in the designated area at this time for final proper disposal.

After Sample Collection

- Place soil sample bottles in sealed Ziploc© bags, double bagging is recommended (optional).
- Record the label information and time of sampling in the field notes.
- Place soil sample bottles (or soil cores) in coolers that are durable in transportation and keep the temperature between 0 and 6ºC until transported to the laboratory. Do not use blue ice.
- Treat all disposable sampling materials as single use and dispose of them appropriately (Section 8) after sampling at each sampling location
- Fill out and check COC forms against the labels on the sample bottles progressively after each sample is collected.

- Following completion of sampling, take a photo of the COC and send to the project team for review and approval prior to submittal to the laboratory (or prior to preparing the cooler for shipment, if applicable).

7.4.3 Groundwater Sampling

Before Sample Collection

- Collect equipment blanks from decontaminated equipment **before** sample collection (see section 11.1 for suggested equipment blank sources). Refer to the QAPP for additional guidance on equipment blank collection.
- Place plastic sheeting adjacent to the sample port for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
- Don a new set of nitrile gloves. Do not use gloved hands to subsequently handle papers, pens, clothes, etc., before collecting samples.
- Use the labeled HDPE bottles that are supplied by the laboratory. Make sure that the caps remain on the bottle until immediately prior to sample collection.
- Measure depth to water and field parameters. Turbidity and the physical appearance of the purged water should be noted on the Groundwater Sampling Log.

During Sample Collection

- Start groundwater sample collection upon stabilization of field parameters (refer to low-flow sampling guidance).
- If low-flow groundwater sampling techniques are being used, disconnect the silicone tubing from the flow-through cell, enabling collection of groundwater samples prior to passing through the cell.
- Hydrasleeves are also considered acceptable for sampling of PFASs in groundwater – consult the project manager to determine which technique should be used. In general, low flow sampling is preferable.
- Collect groundwater samples (to the neck of the bottle, some headspace is acceptable) from the dedicated sampling ports at the center of the well screen. While collecting the sample, make sure the bottle cap remains in the other hand of the sampler, until replaced on the bottle. Do not insert or let tubing or any materials inside the sample bottle.
- To mitigate cross contamination, collect groundwater samples in a pre-determined order from least impacted to greater impacted based on previous analytical data or knowledge about past activities at the site. If no analytical data are available, samples are to be collected in the following order:
    1. First sample the upgradient well(s).
    2. Next, sample the well located furthest downgradient of the interpreted or known source.
    3. The remaining wells should be progressively sampled in order from downgradient to upgradient, such that the wells closest to the interpreted or known source are sampled last.
- NOTE: If high concentrations of PFASs related to class B firefighting foams are expected in a groundwater sample, conduct a Shaker test by collecting and shaking a small portion of the sample (~10 to 25 mL) on site in a small disposable vial. If foaming is noted within the sample, document the foaming when samples are submitted for analysis; the 'shaker test' vial can then be disposed. This shaker test provides information about how each of the samples should be handled analytically.

- After collecting the sample, tightly screw on the polypropylene cap (snug, but not too tight). This will minimize leaking or cross contamination of the sample. Most PFASs, including all analytes measured by USEPA Methods 537.1 and 533, are not volatile at environmental pH.
- Note the time and date on the sample label.
- Collect any necessary QA/QC samples such as field blanks, field duplicates/co-located samples and matrix spikes (verify with laboratory whether they need to be collected in the field and need to be in separate sample bottles), following the proper protocols. Field blank samples should be collected after field staff return from an offsite break (e.g., lunch) to capture any potential cross-contamination from field personnel. As the laboratory should be analyzing the entire aqueous sample rather than sub-sampling, separate bottles will be required for these samples.
- If disposable, single-use sampling equipment can't be used in high concentration areas, increase the frequency of equipment blanks. Note suspected high concentration samples on the chain of custody and segregate them by using a separate cooler.
- Do not rinse PFAS sample bottles during sampling. Do not filter samples.

After Sample Collection

- Place groundwater sample bottles in a sealed Ziploc© bag. Another brand of LDPE bag is acceptable.
- Record the label information and date / time of sampling in the field notes and COC. Note 'shaker test' results if appropriate.
- Place groundwater samples in coolers that are durable in transportation and keep the temperature between 0 and 6ºC until transported to the laboratory. Do not use blue ice. Use ice double-bagged in LDPE-Ziploc© baggies.
- Store PFAS samples in a separate cooler from other types of samples.
- Treat all disposable sampling materials as single use and dispose of them appropriately (Section 8) after sampling at each monitoring well.
- Fill out and check COC forms against the labels on the sample bottles progressively after each sample is collected.
- Following completion of sampling, take a photo of the COC and send to the project team for review and approval prior to submittal to the laboratory (or prior to preparing the cooler for shipment, if applicable).

7.4.4 Surface Water Sampling

Before Sample Collection

- Place HDPE (or other permitted material) sheeting adjacent to the sample port for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
- Don a new set of nitrile gloves. Do not use gloved hands to subsequently handle papers, pens, clothes, etc., before collecting samples.
- Use the HDPE bottles that are supplied by the laboratory. Make sure that the caps remain on the bottle until immediately prior to sample collection.
- If purging/pumping equipment is used for surface water sampling, collect equipment blanks from decontaminated equipment ***before*** sample collection (see section 11.1 for suggested equipment blank sources). Refer to the QAPP for additional guidance on equipment blank collection.

During Sample Collection

- Avoid sampling the surface layer of the water body or surface scums, since PFAS are expected to accumulate on the air/water interface and may bias the analytical results.
- For Shallow surface water (less than 1 foot deep) to avoid sampling from the surface, cut a length of new HDPE tubing to the appropriate size for desired sampling depth and pump location and attach to stainless steel rod using HDPE zip ties. Insert a new length of silicon tubing into the peristaltic pump and connect HDPE tubing on intake side and a shorter length of new HDPE tubing on discharge side.
- For general PFAS investigation, lower the HPDE tubing on intake side of pump to the desired depth in the water column. For water depths < 1 ft, place tubing intake at approximately mid-depth of the water column.
- For deeper surface water (greater than 1 foot in depth) facing the upstream direction (if the surface water body is flowing), place sample container in freshly gloved hand and gently submerge the sample container beneath the water surface with the cap on.
- Tilt the container so the mouth is angled slightly upward, then with the other gloved hand gently unscrew the cap, open it a crack and allow water to flow slowly down the inner wall of the container filling it.
- When the sample container is full, replace and tighten the cap while the container is still submerged, then remove it from the water.
- Where surface water samples and sediment samples are collected at the same location, collect surface water samples first to minimize siltation.
- Collect surface water samples directly into laboratory-supplied bottles; wide-mouth bottles may be preferable to narrow mouth bottles for ease of surface water collection.
- Collect any necessary QA/QC samples such as field blanks, field duplicates/co-located samples and matrix spikes (verify with laboratory whether they need to be collected in the field and need to be in separate sample bottles), following the proper protocols. Field blank samples should be collected after field staff return from an offsite break (e.g., lunch) to capture any potential cross-contamination from field personnel. As the laboratory should be analyzing the entire aqueous sample rather than sub-sampling, separate bottles will be required for these samples.
- If disposable, single-use sampling equipment can’t be used in high concentration areas, increase the frequency of equipment blanks. Note suspected high concentration samples on the chain of custody and segregate them by using a separate cooler.
- Make sure bottle caps remain in the gloved hand of the sampler until sampling is complete and caps are replaced on the bottle.
- Note the time and date on the sample bottle.

After Sample Collection

- Place sample bottles in a sealed Ziploc© bag. Another brand of LDPE bag is acceptable
- Record the label information and time / date of sampling in the field notes.
- Place samples in coolers that are durable in transportation and keep the temperature between 0 and 6ºC until transported to the laboratory. Do not use blue ice. Use ice double-bagged in LDPE-Ziploc© baggies.
- Store PFAS samples in a separate cooler from other types of samples.
- Measure surface water pH, conductivity, temperature, and TDS at each location **<u>after</u>** both surface water and sediment sampling.

- Fill out and check COC forms against the labels on the sample bottles progressively after each sample is collected.
- Following completion of sampling, take a photo of the COC and send to the project team for review and approval prior to submittal to the laboratory (or prior to preparing the cooler for shipment, if applicable).
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7.4.5 Sediment Sampling

Before Sample Collection

- Place HDPE (or other permitted material) sheeting adjacent to the sample area for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
- Don a new set of nitrile gloves. Do not use gloved hands to subsequently handle papers, pens, clothes, etc., before collecting samples.
- Use the HDPE bottles that are supplied by the laboratory for loose sediment samples or use a PFAS-free sediment corer with acceptable liners and caps (such as acetate or stainless-steel liners) for sediment core samples. Make sure that the caps remain on the bottle until immediately prior to sample collection.
- Make sure all sampling equipment/materials are known PFAS-free or at least materials are acceptable for PFAS sampling.
- Collect equipment blanks from decontaminated equipment **before** sample collection. Refer to the QAPP for additional guidance on equipment blank collection.

During Sample Collection

- Always start collecting samples from the least contaminated area, if prior information is available to determine the extent of contamination.
- Where surface water samples and sediment samples are collected at the same location, collect surface water samples first to minimize siltation.
- Collect sediment samples either manually using a stainless-steel trowel (for shallow water depth where staff can wade close to the sediment sampling locations) or using a ponar grab sampler (for surface sediment sampling below a certain depth of water) or using a sediment core device (for sediment core sampling), depending on field conditions at each sampling location during sampling program.
  For surface sediment sampling:
- Collect sediment samples from the upper 10 cm of sediment for surface sediment sampling.
- For a sample to be acceptable overlying, low turbidity water must be present.
- Decant the overlying water and use a stainless-steel trowel to collect only the upper portion (such as top 5 centimeters (cm)) of sediment.
- Pick out roots, pebbles or stones if there are any present.
- Do not homogenize samples and collect sediment samples directly into laboratory-supplied bottles that are suitable in both material and size. Make sure enough samples are collected for all required sample analysis (follow instructions from the lab).
- Do not overfill the sample bottle.
- Make sure that the sample does not contain vegetation, and that the sampler shows no signs of winnowing or leaking.

- Make sure bottle caps remain in the gloved hand of the sampler until sampling is complete and caps are replaced on the bottle.
- Collect any necessary QA/QC samples such as field blanks, field duplicates/co-located samples and matrix spikes (verify with laboratory whether they need to be collected in the field and need to be in separate sample bottles), following the proper protocols. Field blank samples should be collected after field staff return from an offsite break (e.g., lunch) to capture any potential cross-contamination from field personnel.
- If disposable, single-use sampling equipment can't be used in high concentration areas, increase the frequency of equipment blanks. Note suspected high concentration samples on the chain of custody and segregate them by using a separate cooler.
- Note the time, sample location and sample ID on the sample label using PFAS-free pens such as ballpens or using pre-labelled sample bottles.
- Decontaminate sample equipment that are deemed to be re-used after sampling at each location and at the end of the workday; follow Section 7.2 for decontamination of field equipment.
- Dispose one-time-use equipment/materials in the designated area at this time for final proper disposal.

After Sample Collection

- Place sample bottles in a sealed Ziploc© bag. Another brand of LDPE bag is acceptable. Double-bagging is recommended.
- Record the label information and time of sampling in the field notes.
- Place samples in coolers that are durable in transportation and keep the temperature between 0 and 6ºC until transported to the laboratory. Do not use blue ice. Use ice double-bagged in LDPE-Ziploc© baggies.
- Store PFAS samples in a separate cooler from other types of samples.
- Measure surface water pH, conductivity, temperature, and total dissolved solids (TDS) at each location **after** both surface water and sediment sampling is completed. Treat all disposable sampling materials as single use and dispose of them appropriately (Section 8) after sampling at each sampling location.
- Fill out and check COC forms against the labels on the sample bottles progressively after each sample is collected.
- Following completion of sampling, take a photo of the COC and send to the project team for review and approval prior to submittal to the laboratory (or prior to preparing the cooler for shipment, if applicable).

7.4.6 Wastewater and Biosolids Sampling

Before Sample Collection

- Place HDPE (or other permitted material) sheeting adjacent to the sample port for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
- Don a new set of nitrile gloves. Do not use gloved hands to subsequently handle papers, pens, clothes, etc., before collecting samples.
- Use the HDPE bottles that are supplied by the laboratory. Make sure that the caps remain on the bottle until immediately prior to sample collection.

- Flush the sample port line before taking the sample. Open sample port valve enough time to exchange 3 to 4 volumes of the entire line. The flushed water will be captured and containerized as IDW.
- Plan to take samples in increasing concentration order to minimize cross contamination. Start at the lowest expected concentration, effluent, moving upstream of treatment to the influent. Leave biosolids at the end, as these are expected to contain the highest concentration.
- Collect equipment blanks from decontaminated equipment **before** sample collection (see section 11.1 for suggested equipment blank sources). Refer to the QAPP for additional guidance.

During Sample Collection

- Avoid sampling the surface, since PFAS are expected to accumulate in the air/water interface and may bias the analytical results.
- For Shallow wastewater (less than 1 foot deep) to avoid sampling from the surface, cut a length of new HDPE tubing to the appropriate size for desired sampling depth and pump location and attach to stainless steel rod using HDPE zip ties. Insert a new length of silicon tubing into the peristaltic pump and connect HDPE tubing on intake side and a shorter length of new HDPE tubing on discharge side.
- For general PFAS investigation, lower the HPDE tubing on intake side of pump to the desired depth in the water column. For water depths < 1 ft, place tubing intake at approximately mid-depth of the water column.
- For deeper wastewater (greater than 1 foot in depth) facing the upstream direction (if the surface water body is flowing), place sample container in freshly gloved hand and gently submerge the sample container beneath the water surface with the cap on. If the wastewater is known to contain high concentrations of harmful chemicals, then the shallow collection can be used (pump tubing attached to stainless steel rod). If there is uncertainty in chemical concentration, or health and Safety is a concern, utilize the shallow sample collection method.
- Tilt the container so the mouth is angled slightly upward, then with the other gloved hand gently unscrew the cap, open it a crack and allow water to flow slowly down the inner wall of the container filling it.
- Where surface water samples and solids samples are collected at the same location (i.e., clarifier), collect surface water samples first to minimize siltation.
- If possible, collect 24-hr composite samples to obtain representative samples from each stream. If not possible, grab samples during peak flow.
- Collect surface wastewater samples (i.e. samples taken from the top of an open tank/sump/container) directly into laboratory-supplied bottles; wide-mouth bottles may be preferable to narrow mouth bottles for ease of surface water collection.
- Collect any necessary QA/QC samples such as field blanks, field duplicates/co-located samples and matrix spikes (verify with laboratory whether they need to be collected in the field and need to be in separate sample bottles), following the proper protocols. Field blank samples should be collected after field staff return from an offsite break (e.g., lunch) to capture any potential cross-contamination from field personnel. As the laboratory should be analyzing the entire aqueous sample rather than sub-sampling, separate bottles will be required for these samples.
- If disposable, single-use sampling equipment can’t be used in high concentration areas, increase the frequency of equipment blanks. Note suspected high concentration samples on the chain of custody and segregate them by using a separate cooler.

- Make sure bottle caps remain in the gloved hand of the sampler until sampling is complete and caps are replaced on the bottle.

Biosolids Sampling considerations

- Biosolids samples will typically contain a combination of both solids and water. As a general guidance, solids samples with the least water content should be prioritized. For example, dewatered biosolids should be prioritized over thickened sludge. Or, if no dewatering exists in the plant, thickened sludge should be prioritized over waste or return activated sludge (WAS/RAS).
- Measure, in parallel, the solids concentration in the sample. Report concentration in mass of analyte per unit mass of dry solids (i.e., ng/kg).
- If biosolids piles are heterogeneous, consider taking composite samples, if possible. Ask the laboratory if the composite can be prepared in the lab, to avoid doing it on-site.
- Coordinate with laboratory to make sure the sample contains enough solids to perform the analysis and the solids and water content.

After Sample Collection

- Place sample bottles in a sealed Ziploc© bag (optional).
- Record the label information and time of sampling in the field notes.
- Place samples in coolers that are durable in transportation and keep the temperature between 0 and 6ºC until transported to the laboratory. Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.
- Treat all disposable sampling materials as single use and dispose of them appropriately (Section 8) after sampling at each sampling location.
- Fill out and check COC forms against the labels on the sample bottles progressively after each sample is collected.
- Following completion of sampling, take a photo of the COC and send to the project team for review and approval prior to submittal to the laboratory (or prior to preparing the cooler for shipment, if applicable).

7.4.7 Foam Concentrate Sampling

Before Sample Collection

- Plan to sample foam concentrates after completing collection of all other samples. The PFAS concentrations in foam concentrates are very high, and hence, any cross-contamination can substantially impact other samples.
- Lay down impervious (e.g., HDPE) sheeting to prevent spill onto the ground and to use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
- Don a new set of nitrile gloves. Do not use gloved hands to subsequently handle papers, pens, clothes, etc., before collecting samples.
- Use the HDPE bottles that are supplied by the laboratory. Make sure that the caps remain on the bottle until immediately prior to sample collection.
- Prepare sampling spoons made with acceptable material if samples are to be collected by scooping directly from its container.

- Prepare funnels made with acceptable material if sample should be poured or drained from a container into sampling bottles. The rim of the funnel must be larger in diameter than the opening or drain of the container.
- If sample is too viscous to pass through a funnel, prepare wide rim containers and sampling spoons. Pour sample into wide rim containers first, and then scoop into the sampling bottles using sampling spoons.
- Prepare a drum pump or drum sampler made with acceptable material if samples are to be collected from a drum or vessel that the content cannot be easily poured or drained out (e.g., fixed structure or a container over 50 lbs. in weight and that does not have a sidewall or bottom sampling port).
- If collecting sample from a sample port, flush the sample port line before taking the sample. Open sample port valve enough time to exchange 3 – 4 volumes of the entire line. Properly store collected flush material so that it can be either disposed or poured back into original vessel after sampling is completed.

During Sample Collection

- All sampling activities should be conducted in an area where impervious sheets are laid down.
- If possible, gently stir or agitate sample before sampling to ensure homogeneity.
- If samples should be collected by pouring or draining out from a container into a sampling bottle, a funnel must be used to prevent spill. One person should hold the sampling bottle and funnel while another person pours the sample. Pouring sample into an unsecured bottle should be avoided.
- Avoid direct contact of container outlets or sampling ports with the sampling bottles.
- When using a funnel, drum pumps, or drum sampler, allow sufficient time for sample to completely drain in order to prevent spill of droplets.
- Used sampling tools (e.g., funnels, containers, spoon, pump, sampler) should never be reused unless used for preparing duplicates of the same sample.
- Collect any necessary duplicates and matrix spikes. As the laboratory should be analyzing the entire aqueous sample rather than sub-sampling, separate bottles will be required for these samples.
- Make sure bottle caps remain in the gloved hand of the sampler until sampling is complete and caps are replaced on the bottle.

After Sample Collection

- Place sample bottles in a sealed Ziploc© bag.
- Record the label information and time of sampling in the field notes.
- Place samples in coolers that are durable in transportation and keep the temperature between 0 and 6ºC until transported to the laboratory. Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.
- Collect all IDW that has been in contact with foam concentrate and place in a waste bag separate from other IDWs. Label waste bag properly and inform waste disposal facility of the waste content. Treat all disposable sampling materials as single use and dispose of them appropriately (Section 8) after sampling at sampling location.
- Fill out and check COC forms against the labels on the sample bottles progressively after each sample is collected.

- Following completion of sampling, take a photo of the COC and send to the project team for review and approval prior to submittal to the laboratory (or prior to preparing the cooler for shipment, if applicable).

7.4.8 Solid Wastes from Water Treatment Units* Sampling

(* These include water filter, ion exchange resins, and activated carbon. For sludge sampling, refer to section 7.4.6, biosolids sampling consideration.)

Before Sample Collection

- Coordinate with the water treatment system operator to schedule the best time for sampling. Confirm that the units can be put offline. Communicate with all stakeholders on how the sampling may affect the water treatment system during and after the sampling operation.
- Check the configuration of the water treatment units (e.g., water inlets and outlets, water flow direction, interior structure). Consult with manufacturer for instructions on how to open, close and/or detach units (if needed).
- Determine sampling location of resin and activated carbon within the vessel. In a typical bottom-up flow configuration, resin and activated carbon that are on the bottom of the vessel would be more saturated with contaminants compared to the top. Depending on the purpose of sampling, collection of samples may be done either at the top, middle, bottom, or a combination of locations.
- Shut off all water inflow to water treatment units. Drain remaining water in the units and check pressure, if applicable.
- Prepare tools required to open pipe fittings, filter casings, resin vessels or activated carbon vessels.
- Prepare replacement materials or parts (e.g., new filter, resin, activated carbon).
- Prepare mechanical lifting device (e.g., forklift, hoist) if lifting or transporting of any object that is over 90 lbs. (40 kg) in weight is required.
- Place plastic sheeting adjacent to the sampling site for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
- Don a new set of nitrile gloves. Do not use gloved hands to subsequently handle papers, pens, clothes, etc., before collecting samples.
- Use the HDPE bottles that are supplied by the laboratory. Make sure that the caps remain on the bottle until immediately prior to sample collection. For sampling of water filters, sampling bottles should be large enough to hold the whole filter.
- Prepare sampling spoons made with acceptable material if samples (i.e., resins and activated carbon) should be collected by scooping directly from their containers. If samples cannot be scooped from the container, prepare a secondary wide-rim container or an impervious sheet with berms on all sides to pour the samples from the vessel before scooping into sampling bottles.
- Prepare trays that can be used as means of secondary containment of any spillage that may occur while detaching units from piping and opening them.
- Prepare disposable tongs if needed to take out filter from casing.
- Prepare disposable towel or rag to wipe excess water on gloves, equipment, and/or units during and after sample collection to prevent dripping of water.

During Sample Collection

- All units and piping must be opened slowly as they may be pressurized. Make sure all spillages are collected in trays.

- Sample whole filter intact. Do not cut or fold filter.
- Resins and activated carbons can be scooped with a sampling spoon.
- When lifting an object (e.g., AC vessels), at least two people should lift together if the weight exceeds 50 lbs., and a mechanical lifting device should be utilized if the weight exceeds 90 lbs.
- Collect any necessary duplicates and matrix spikes. As the laboratory should be analyzing the entire aqueous sample rather than sub-sampling, separate bottles will be required for these samples.
- Make sure bottle caps remain in the gloved hand of the sampler until sampling is complete and caps are replaced on the bottle.

After Sample Collection

- Place sample bottles in a sealed Ziploc© bag (optional).
- Record the label information and time of sampling in the field notes.
- Place samples in coolers that are durable in transportation and keep the temperature between 0 and 6ºC until transported to the laboratory. Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.
- Replace to new filter or add resin and activated carbon as needed.
- Reassemble unit and reinstall back to the water treatment system. Test if all units are working properly. Inspect for any leaks.
- Collect all spillage in spill trays and either store in a separate container for offsite disposal or dispose upstream of water treatment system.
- Fill out and check COC forms against the labels on the sample bottles progressively after each sample is collected.
- Following completion of sampling, take a photo of the COC and send to the project team for review and approval prior to submittal to the laboratory (or prior to preparing the cooler for shipment, if applicable).

7.5 Sample Labeling

In order to enhance reporting capabilities across sites and portfolios, the following standard naming conventions have been developed in order to better identify data sets more quickly and easily. The following nomenclature should be considered a guideline and best practice but is not a requirement of the Locus EIM system. For those sites that currently utilize well-defined and standardized nomenclature for specific data attributes, it recommended that these standards continue to be used for historical reporting purposes.

Location ID Standard Naming Conventions

At each sampling point within a particular site, a “Location ID” should be created within the Locus EIM system. This identifier is used to provide specific information about where a field sample was collected. The following naming conventions for Location ID have been established to set consistency within all sites across Chevron EMC. Each Location ID should begin with a location type abbreviation followed by a dash and ending with a unique number to identify the sampling point location. It is recommended that locations be numbered in the order for which they were created beginning with “01” and increasing. The following nomenclature should be used unless other naming conventions have been designated by a regulatory agency.

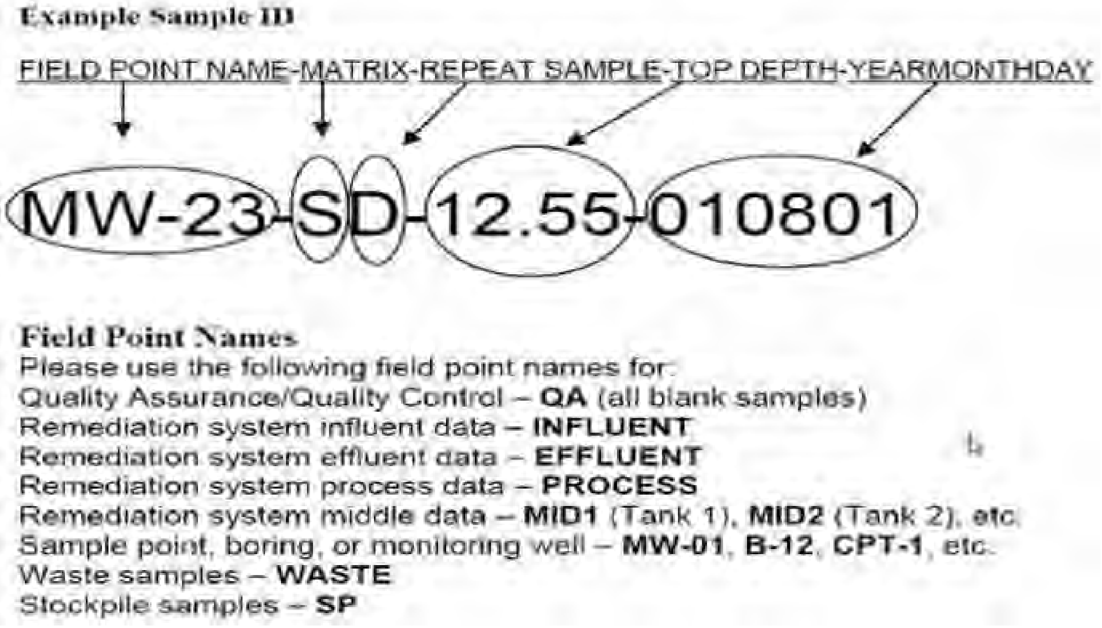
Table 2a: Location Naming Conventions

Location Type	Location Type Abbreviation	Location ID Example
Solid Samples		
- Soil/Soil Boring	S/SB	S-#####
- Repeated Soil Boring	S/SB	S-####R1 S-####R2
- Sediment	SED	SED-####
- Sludge	SL	SL-####
- Post Excavation	PE	PE-####
- Geotechnical Boring	GB	GB-####
- Cone Penetrometer Test	CPT	CPT-####
Liquid Samples		Location ID Example
- GW Sample (Monitoring)	MW	MW-####
- Hydro punch GW Sample (Temp)	H	H-#####
- Recovery Well	RW	RW-####
- Temporary Piezometer	TPZ	TPZ-####
- LNAPL Sample (Fingerprint)	FP	FP-####
- Surface Water	SW	SW-####
- Wastewater	WW	WW-####
Gaseous Sample		Location ID Example
- Vapor Monitoring Points	VP	VP-####
- Surface Flux Sample	SF	SF-####
- Sparge Point	SP	SP-####
QA/QC Sample		Location ID Example
- Field Blanks	FB	Field Blank
- Equipment Blanks	EB	Equipment Blank
- Trip Blanks	TB	Trip Blank
- Field Duplicates	FD	Same as Parent

- Matrix Spikes (MS)	MS	Same as Parent
- Matrix Spike Duplicates (MSD)	MSD	Same as Parent
- Methanol Blank	MB	Methanol Blank

Field Sample ID Standard Naming Conventions:

Similar to Location ID’s, standard naming conventions for Field Sample ID’s should be followed to maintain consistency and quality across all project sites within Chevron EMC. Field Sample ID’s within Locus EIM have a maximum character length of 25. The standard nomenclature should begin with the Location ID (or field point name) followed by the sample matrix, repeat sample (if applicable), top depth (if applicable) and the date the sample was collected in “YYMMDD” format. The following nomenclature should be used unless other naming conventions have been designated by a regulatory agency.



Field Point Names

Please use the following field point names for:
Quality Assurance/Quality Control – **QA** (all blank samples)
Remediation system influent data – **INFLUENT**
Remediation system effluent data – **EFFLUENT**
Remediation system process data – **PROCESS**
Remediation system middle data – **MID1** (Tank 1), **MID2** (Tank 2), etc.
Sample point, boring, or monitoring well – **MW-01**, **B-12**, **CPT-1**, etc.
Waste samples – **WASTE**
Stockpile samples – **SP**

- Confirm sample nomenclature with sampling matrix.
- An example sample naming convention is below:

Table 2b: Example Sample ID Naming Convention

Site Location	Medium	Sample ID	Depth Interval (Approximate)	Sample Method	Sample Type	Number of Samples	Analytes
EXAMPLE: MW-09 SW-09	Sediment	SW-09-SED-10-YYMMDD SW-09-SEDD-10-YYMMDD	0-10 centimeters	Grab	N, FD, MS/MSD	4	PFAS
	Surface Water	SW-09-SW-YYMMDD	Mid-Stream Depth	Grab	N	1	PFAS, field parameters[1]
	Groundwater	MW-09-GW-YYMMDD	Mid-Saturated Screen	Grab	N	1	PFAS, field parameters
		MW-09-GWEB- YYMMDD	(Water Level Meter)	N/A	EB	1	PFAS

Notes:

1. Field parameters will be collected by field staff upon sample collection, not analyzed in a laboratory. Field parameters include temperature, pH, specific conductivity, dissolved oxygen, turbidity, oxidation-reduction potential.

EB = equipment blank

FB = field blank

FD = field duplicate

MS = matrix spike

MSD = matrix spike duplicate

N = normal (parent)

N/A = not applicable

SED = sediment

SW = surface water

Table 2c: Sample ID Naming Conventions

Location ID - Matrix - Repeat Sample - Top Depth - Year/Month/Day	
Location ID (Field Point Name)	*See Table Above for Location Naming Conventions*
Matrix	Soil/Soil Boring: S/SB Ground Water: GW Surface Water: SW Waste Water: WW Sediment: SED Air: A Tissue: T Other: O
Repeat Sample (If Applicable)	Field Duplicate: FD Triplicate: T Pre-Purge: N Post-Purge: P Duplicate trip blank: T1 Duplicate field blank: F1
Top Depth (If Applicable)	Top depth (ft. bgs) of soil or water sample if applicable. Value to two decimal places
YearMonthDay	Year: 2 Digits Month: 2 Digits Day: 2 Digits

In some instances, where field or trip blanks are involved, this naming convention could result in duplicate Field Sample ID’s for two separate field crews on the same day. Therefore, it is recommended that in such instances, the initials of the field sample collector be appended to the Field Sample ID after the date.

7.6 Shipping

- If samples cannot be shipped the same day as collected, arrange an appropriate means of keeping the samples cool overnight such that temperature does not exceed 10°C for the first 48 hours after collection, and then between 0 and 6°C thereafter.
- Store samples in appropriate coolers with ice (Ziploc© bags for use as ice containers) with appropriate labeling. Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.
- Complete the appropriate procedures for COC, handling, packing, and shipping.
- Fill out and check COC Forms against the labels on the sample bottles progressively after each sample is collected. Take a photo of the COC and send to the project team for review and approval prior to preparing the cooler for shipment.
- After confirming COC, place inside Ziploc© bag and affix to the underside of cooler top.
- Place all disposable sampling materials (such as plastic sheeting, and health and safety equipment) in appropriate containers.
- Ship samples via courier service with priority overnight delivery. Tracking numbers for all shipments should be provided and recorded after they have been sent out to ensure their timely delivery.
- Confirm with courier service when the latest samples can be dropped off for priority overnight delivery.
- Do not ship samples for Saturday or weekend delivery.

8 WASTE MANAGEMENT

This section provides a stepwise approach to manage investigative derived waste (IDW) as it pertains to this guidance.

- In general, IDW should be managed in a way that it follows all applicable state and/or federal requirements, protective of human health and the environment, and isolates the IDW from the weather (ideally to prevent degradation of the container and label) with minimal onsite storage. When there are multiple waste streams (e.g., waste media, PPE, decontamination fluids), it is recommended to not mix different IDWs together in a same container. Each waste should be contained and staged separately by type. Containers must be labeled at the time of collection. Labels will include date, location(s), site name, city, state, and description of matrix contained (e.g., soil, groundwater, PPE).

- Following the investigative activities and containerizing of the IDW, the IDW may be required to be characterized via laboratory analysis to understand the appropriate disposal requirements. Depending on site, this may include analysis of PFAS. In such case, it is important to abide with the sampling and analytical guidelines provided by the applicable regulatory agency.

- To dispose IDW in landfills, it is important to first identify which type of landfill the waste can be disposed based on the waste characterization results and relevant regulations that apply. Several things to consider when selecting the disposal option are the hazardous waste designation, physical phase (i.e., liquid, solid), and PFAS level of the waste. If any constituents of the IDW render it as a hazardous waste it may be required to be disposed at a hazardous waste landfill or a landfill with equivalent environmental protection. Depending on type of waste, leachate testing may be required for further characterization. Some landfills may have restrictions on liquid phase wastes and may only accept after solidification. Also, it is important to check with state and/or federal agencies on whether there are any landfill acceptance criteria established for PFAS. Although screening waste by PFAS level and/or content at landfills is uncommon at this moment, there are locations (e.g., Australia) that do have PFAS criteria (i.e., leachable concentration and total concentration) on landfill wastes. It is worth to note that landfill facilities may require analytical results for PFAS of the disposed waste regardless of regulatory requirements, and future liability of PFASs in landfill leachate may apply.

- An alternative to disposal of IDW in landfills is combustion-based thermal oxidation (i.e., incineration). Incineration can be implemented at an approved incineration facility that is designed and operated in a way that can sufficiently destruct PFAS and capture potential air pollutants. Detailed performance and design criteria for appropriate incinerators are described in a separate document: ‘Guidance on handling PFAS-containing firefighting foam (Chevron, 2020)’. Onsite incineration of IDW should be done only if the incinerator meets the performance and design criteria specified in the above document and approval from the legal group has been obtained. Complete incineration-based destruction eliminates future PFAS liability and may be preferable for solid IDW (e.g., soil, sediment, PPE) when compared to deposition in a landfill. For liquid IDW, incineration is available, but it may be cost prohibitive or inappropriate. Alternative options for liquid IDW include underground injection at properly permitted facility, and onsite treatment using commercially available adsorbents or membrane/filtration technologies, while paying close attention to the effectiveness of this treatment against the larger class of PFASs. Incineration of exhausted adsorption media or concentrated filtrate completes the process.

Emerging contaminants such as PFAS pose a unique challenge for disposal because acceptance of such waste will be based on the local facility and their permit restrictions. Project teams will be required to identify appropriate facilities based on the facility’s legal ability to accept the waste and the team should confirm that the facility is meeting the regulatory requirements for accepting waste containing PFAS. In general, facilities will then provide the definitive laboratory analysis requirements needed to meet their permit requirements for waste classification.

9 DATA RECORDING AND MANAGEMENT

9.1 Field Notes

Waterproof field books must not be used for field notes. Instead, field notes should be on loose paper on Masonite, plastic, or aluminum clip boards. If feasible for the Chevron supplier/contractor lead, field notes and sampling logs can be collected electronically (i.e. Arcadis’ FieldNow platform). Other requirements for field notes include:

- Pens, pencils, and fine/ultra-fine point Sharpies® may be used.
- Keep field notes and writing implements away from samples and sampling materials.
- One person should conduct sampling while another records field notes.
- Do not write on sampling bottles unless they are closed.

9.2 Other Project Documentation

- Complete Pre- and Post-Field Sampling Procedure/Checklist and/or Chevron Project/Field Work Preparation Checklist.
- Complete Field Sampling Checklist – Groundwater (if applicable)

- Complete Field Sampling Checklist – Soil (if applicable)
- Complete Field Sampling Checklist – Surface Water (if applicable)
- Complete Field Sampling Checklist – Sediment (if applicable)
- Complete Groundwater Sampling Logs (if applicable).
- Complete Soil Sampling Logs (if applicable).
- Complete Surface Water Sampling Logs (if applicable).
- Complete Sediment Sampling Logs (if applicable).
- Make sure COC Forms are properly completed. Verify which PFAS analytes (e.g., just PFOS and PFOA, some or all of the 537.1 list, a specific analyte list such as the one required by the California Water Boards, etc.) are required for analysis and note on the COC.
- Take a photo of the COC and send to the project team for review and approval prior to submittal to the laboratory (or prior to preparing the cooler for shipment, if applicable).

10 ANALYTICAL METHODS

In response to the California order WQ 2021-0006-DWQ, the analytical laboratory must be accredited by the California Environmental Laboratory Accreditation Program (ELAP) to perform the method compliant with Department of Defense (DoD) Table B-15 of Quality Systems Manual (QSM) (https://denix.osd.mil/edqw/documents/), dated 2019 version 5.3 or later. The current version of the QSM is 5.3, published in May 2019 (USDoD 2019). In addition to outlining some specific laboratory procedures, QSM Versions 5.1 to 5.3 stipulate ranges of acceptable recovery limits on extracted internal standard analytes and relative percent differences (RPDs) on matrix spike duplicates (USDoD 2019). These limits offer a guarantee that individual laboratory SOPs with differing procedures will generate defensible PFAS concentration data in spite of the lack of identical methodology.

In response to the New York State Department of Environmental Conservation request for sampling of emerging contaminants, the analytical laboratory must hold ELAP accreditation in accordance with Department of Defense Quality Systems Manual 5.1 for PFOS and PFOA in drinking water by United States Environmental Protection Agency (USEPA) Method 537, according to the Division of Environmental Remediation’s requirements. Note that because these are groundwater samples, the method used for analysis of PFAS is a modified version of USEPA Method 537 V1.1 that is compatible with a groundwater matrix.

QSM Versions 5.1 to 5.3 do not govern a specific set of PFAS analytes nor are they a method. They are a set of QA/QC criteria. The laboratory must be capable of quantifying the target PFAS analytes listed in Table 3a for sites in California, and 3b for New York. Under their ELAP accreditation, laboratories will be accredited for all 18 PFASs found in USEPA Method 537.1 (Table 3a/3b), and often another five to fifteen more analytes.

Table 3a: List of CA Required PFASs Analyzed Using EPA 537.1 Isotope Dilution (ID) in compliance with the DOD QSM (v 5.3 or later) Table B-15 requirements

Name	Abbreviation	Chemical Abstract Service (CAS) Number
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1

4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4
Hexafluoropropylene oxide dimer acid	HFPO-DA/GenX	13252-13-6
1H,1H, 2H, 2H-Perfluorohexane sulfonic acid	4:2 FtS	757124-72-4
1H,1H, 2H, 2H-Perfluorooctane sulfonic acid	6:2 FtS	27619-97-2
1H,1H, 2H, 2H-Perfluorodecane sulfonic acid	8:2 FtS	39108-34-4
Perfluorobutanoic acid	PFBA	375-22-4
Perfluoropentanoic acid	PFPeA	2706-90-3
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic	PFHxA	307-24-4
Perfluoroheptanoic acid	PFHpA	375-85-9
Perfluorooctanoic acid	PFOA	335-67-1
Perfluorononanoic acid	PFNA	375-95-1
Perfluorodecane sulfonic acid	PFDS	335-77-3
Perfluorooctanesulfonamide	PFOSA	754-91-6
N-Ethyl perfluorooctane sulfonamido ethanol	ETFOSE	1691-99-2
N-Methyl perfluorooctane sulfonamido ethanol	MEFOSE	4151-50-2
N-Ethyl perfluorooctane sulfonamide	ETFOSA	4151-50-2
N-Methyl perfluorooctane sulfonamide	MEFOSA	31506-32-8
Perfluorodecanoic acid	PFDA	335-76-2
Perfluoroundecanoic acid	PFUnA	2058-94-8
Perfluorododecanoic acid	PFDoA	307-55-1
Perfluorobutanesulfonic acid	PFBS	375-73-5
Perfluoropentanesulfonic acid	PFPeS	2706-91-4
Perfluorohexanesulfonic acid	PFHxS	355-46-4
Perfluoroheptanesulfonic acid	PFHpS	375-92-8
Perfluorooctanesulfonic acid	PFOS	1763-23-1
Perfluorotridecanoic acid	PFTrA	72629-94-8
Perfluorotetradecanoic acid	PFTeA	376-06-7
N-ethyl perfluorooctanesulfonamidoacetic acid	N-EtFOSAA	2991-50-6
N-methyl perlfuorooctanesulfonamidoacetic acid	N-MeFOSAA	2355-31-9

Table 3b: List of NY Required PFASs Analyzed Using EPA 537.1 Isotope Dilution (ID) in compliance with the DOD QSM (v 5.3 or later) Table B-15 requirements

Name	Abbreviation	Chemical Abstract Service (CAS) Number
1H,1H, 2H, 2H-Perfluorooctane sulfonic acid	6:2 FtS	27619-97-2
1H,1H, 2H, 2H-Perfluorodecane sulfonic acid	8:2 FtS	39108-34-4
Perfluorobutanoic acid	PFBA	375-22-4
Perfluoropentanoic acid	PFPeA	2706-90-3
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic	PFHxA	307-24-4
Perfluoroheptanoic acid	PFHpA	375-85-9

Perfluorooctanoic acid	PFOA	335-67-1
Perfluorononanoic acid	PFNA	375-95-1
Perfluorodecane sulfonic acid	PFDS	335-77-3
Perfluorooctanesulfonamide	PFOSA	754-91-6
Perfluorodecanoic acid	PFDA	335-76-2
Perfluoroundecanoic acid	PFUnA	2058-94-8
Perfluorododecanoic acid	PFDoA	307-55-1
Perfluorobutanesulfonic acid	PFBS	375-73-5
Perfluorohexanesulfonic acid	PFHxS	355-46-4
Perfluoroheptanesulfonic acid	PFHpS	375-92-8
Perfluorooctanesulfonic acid	PFOS	1763-23-1
Perfluorotridecanoic acid	PFTrA	72629-94-8
Perfluorotetradecanoic acid	PFTeA	376-06-7
N-ethyl perfluorooctanesulfonamidoacetic acid	N-EtFOSAA	2991-50-6
N-methyl perlfuorooctanesulfonamidoacetic acid	N-MeFOSAA	2355-31-9

11 QUALITY CONTROL

Refer to quality control requirements for the project to ensure that appropriate quality assurance and quality control (QA/QC) samples are collected. When collecting QA/QC samples, the same guidelines apply as when collecting regular samples – specifically that:

- Samples should be collected in laboratory-supplied HDPE bottles;
- Bottle caps must remain in the hand of the sampler until replaced on the bottle;
- Labels must be completed after the caps have been placed back on each bottle; and
- Samples must be stored in appropriate coolers with ice (Ziploc© bags for use as ice containers) with appropriate labeling. Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.
- Confirm COC Forms are properly completed. Verify which PFAS analytes (e.g., just PFOS and PFOA, some or all of the 537.1 list, etc.) are required for analysis and note on the COC.
- Take a photo of the COC and send to the project team for review and approval prior to submittal to the laboratory (or prior to preparing the cooler for shipment, if applicable).

11.1 Equipment Blanks

QA/QC sampling includes collection of equipment blanks using the laboratory-supplied “PFAS-free” water. Equipment blanks will be collected at a frequency of one per up to 20 samples/matrix. Consider increasing the frequency if sampling is in a high PFAS concentration area. Equipment blanks will be collected after decontamination but prior to sampling to confirm that sampling equipment will not introduce PFAS to the sample. An equipment blank is collected by passing or pouring PFAS-free water through the sampling equipment or other equipment used during collection of field samples to evaluate introduction of contamination from use of dedicated sampling equipment, the adequacy of decontamination process and assess cross-contamination between sampling locations from reuse of sampling equipment. Following decontamination of non-dedicated sampling equipment, equipment blank should be collected from the rinsate from the last decontamination step. Multiple equipment blanks may be necessary if multiple sampling locations are suspected to have high PFAS concentrations.

For groundwater, wastewater, and/or surface water sampling, the following can be used to collect equipment blanks (if used at the site):

- Decontaminated water level meter: laboratory supplied “PFAS-free” water will be poured down the water level meter into laboratory supplied sample containers.
- HDPE tubing for peristaltic pump: laboratory supplied “PFAS-free” water will pumped using the peristaltic pump and new silicone tubing into laboratory supplied sample containers.
- HDPE tubing for bladder pump: laboratory supplied “PFAS-free” water will be poured into a small piece of HDPE and into laboratory supplied sample containers.
- HDPE bladder for bladder pump: laboratory supplied “PFAS-free” water will be poured into the HDPE bladder then poured into laboratory supplied sample containers.
- Hydrasleeve: laboratory supplied “PFAS-free” water will be poured into a hydrasleeve then poured into laboratory supplied sample containers.
- Surface water sampler (HDPE sampler): laboratory supplied “PFAS-free” water will be poured into a HDPE surface water sampler container then poured into laboratory supplied sample containers.

For soil and/or sediment sampling, the following can be used to collect equipment blanks (if used at the site):

- Decontaminated metal trowel: laboratory supplied “PFAS-free” water will be poured down the metal trowel into laboratory supplied sample containers.
- Decontaminated metal hand auger: laboratory supplied “PFAS-free” water will be poured down the metal hand auger into laboratory supplied sample containers.
- Acetate liner: laboratory supplied “PFAS-free” water will be poured down the acetate liner into laboratory supplied sample containers.

11.2 Dedicated Equipment Background

If the existing monitoring wells planned to be sampled as part of the PFAS investigation have dedicated, down-hole equipment, a dedicated equipment background (DEB) will be collected at a frequency of one DEB per equipment type and analyzed for PFAS. The DEB will be used to evaluate if dedicated equipment is impacting PFAS results at the groundwater monitoring wells as it is unknown if the equipment has PFAS-containing components. However, it should be noted that if PFAS impacts are observed in the DEB, they may also be from PFAS impacts to groundwater which has become entrained in the sampling equipment. The DEB will be collected from the selected monitoring well when water is first produced during the initial purging of the equipment (i.e., before 1 equipment [pump and tubing] volume has been purged). The monitoring well selected for the DEB sample collection will then be sampled for the normal parent groundwater sample via low-flow purge methods following stabilization of field parameters.

11.3 Field Duplicates

QA/QC sampling will include the collection of one field duplicate per sampling event 20 samples/matrix collected. Each duplicate sample will be collected immediately after the initial sample of which it is a duplicate into a separate laboratory-provided sample bottle. Do not indicate to the laboratory which sample the duplicate replicates, i.e., it should be given a blind reference on the COC and sample name such as "duplicate". Document in field notes not accessible to the lab as to the sampling location where field duplicate was collected.

11.4 Field Blanks

QA/QC sampling for PFAS includes the submission of one laboratory supplied field blank per day. The field blank sample is brought to the site in a laboratory-supplied sample bottle. Field staff transfer the laboratory-supplied field blank to an empty sample bottle. This field blank should be placed in the same cooler as the other PFAS samples.

11.5 Matrix Spikes/ Matrix Spike Duplicates

QA/QC sampling includes submitting a sample to be used as a matrix spike and matrix spike duplicate, especially if non-drinking water samples will be collected. Separate laboratory-supplied sample bottles will be collected immediately after the initial sample. QSM Versions 5.1 to 5.3 requires the collection of matrix spikes and matrix spike duplicates of environmental samples at the same frequency as the collection of duplicates (1 per up to 20 samples/matrix), so two extra sample bottles must be collected for MS/MSD per 20 samples/matrix. Contact the lab beforehand for more detailed instruction for these samples.

11.6 Laboratory Analytical QA/QC

- Project team to review laboratory log-ins to confirm that the number of PFAS analytes and analysis method is consistent with the work plan and/or work request package.
- Arcadis recommends that any request for PFAS analysis in groundwater or soil should be conducted by an ELAP-accredited method compliant with a recent version of the QSM, Table B-15. Requirements laid out in Table B-15 strictly govern acceptable laboratory data quality for PFAS analysis in environmental samples.
- Laboratory QA/QC should consist of one laboratory blank and one laboratory control sample (or blank spike) per batch of samples, and additional QA/QC as indicated by the SOP used for the requested analysis by the laboratory QA/QC procedures.
- Isotope dilution should be used for quantification with isotope-labeled surrogate standards, as available, according to the guidelines of the QSM Table B-15. USEPA Method 537.1 does not allow for isotope dilution when it is used for drinking water; when the method is modified for other matrices such as groundwater or soil, it might use isotope dilution. As written for drinking water, USEPA Method 533 requires isotope dilution.
- It is also important to understand how the laboratory quantifies branched and linear isomers because Methods 537.1 and 533 have different requirements than DoD's QSM.
- For drinking water, groundwater, and surface water samples, laboratories must extract the entire sample and include a solvent rinse of the bottle for analysis. Aqueous samples should generally not

be sub-sampled prior to analysis, unless they are high concentration and require serial dilution (US DoD 2019).

- Soil samples should be analyzed in their entirety or thoroughly homogenized before extraction and analysis.
- As part of the contractor QA/QC of laboratory results, relative percent difference (RPD) should be calculated between samples and corresponding field or laboratory duplicates. The laboratory quality assurance portion of the laboratory's SOPs should be compared with the case narrative and data package to verify that all calculations/recoveries were within acceptable limits as established by the laboratory and guidelines in Table B-15 of the QSM (USDoD 2019).
- Confirm that the number of PFAS analytes reported in the laboratory report is consistent with what was proposed in the work plan.

12 REFERENCES

ASTM. 2002. ASTM D6771-02 - Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations (Withdrawn 2011). Available at: https://www.astm.org/Standards/D6771.htm.

American Society for Testing and Materials (ASTM). 2014. Designation: D7968-14. Standard Test method for Determination of Perfluorinated Compounds in Soil by Liquid Chromatography Tandem Mass Spectrometry (LC/MS/MS).

ASTM. 2015. Designation: D7979-15. Standard Test Method for Determination of Perfluorinated Compounds in Water, Sludge, Influent, Effluent and Wastewater by Liquid Chromatography Tandem Mass Spectrometry (LC/MS/MS).

Barzen-Hanson, K.A., Roberts, S.C., Choyke, S., Oetjen, K., McAlees, A., Riddell, N., McCrindle, R., Ferguson, P.L., Higgins, C.P. and Field, J.A. 2017a. Discovery of 40 Classes of Per-and Polyfluoroalkyl Substances in Historical Aqueous Film-Forming Foams (AFFFs) and AFFF-Impacted Groundwater. Environ. Sci. Technol., 51(4), pp.2047-2057.

Chen, L.D., Lai, C.Z., Granda, L.P., Fierke, M.A., Mandal, D., Stein, A., Gladysz, J.A. and Bühlmann, P. 2013. Fluorous membrane ion-selective electrodes for perfluorinated surfactants: trace-level detection and in situ monitoring of adsorption. Analytical Chemistry, 85(15), pp.7471-7477.

Chevron. 2020. Guidance on Handling PFAS-containing Firefighting Foam. February.

CA, 2020. Per- and Polyfluoroalkyl Substances (PFAS) Sampling Guidelines for Non-Drinking Water: Available at: Per- and Polyfluoroalkyl Substances (PFAS) Sampling Guidelines for Non-Drinking Water (ca.gov), California Water Boards.

Department of Environment Regulation (DER). Government of Western Australia. 2016. Interim Guideline on the Assessment and Management of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS). Contaminated Sites Guidelines. February.

Massachusetts Department of Environmental Protection (MassDEP). 2017. DRAFT Fact Sheet, Guidance on Sampling and Analysis for PFAS at Disposal Sites Regulated under the Massachusetts Contingency Plan. January.

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

New Hampshire Department of Environmental Services (NHDES). 2016. Perfluorinated Compound (PFC) Sample Collection Guidance. November.

Newton, S., McMahen, R., Stoeckel, J.A., Chislock, M., Lindstrom, A. and Strynar, M., 2017. Novel polyfluorinated compounds identified using high resolution mass spectrometry downstream of manufacturing facilities near Decatur, Alabama. *Environmental science & technology*, *51*(3), pp.1544-1552.

Ritter, E.E., Dickinson, M.E., Harron, J.P., Lunderberg, D.M., DeYoung, P.A., Robel, A.E., Field, J.A. and Peaslee, G.F., 2017. PIGE as a screening tool for Per-and polyfluorinated substances in papers and textiles. *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms*, *407*, pp.47-54.

United Nations Environment Programme (UNEP). 2015. PFAS analysis in water for the Global Monitoring Plan of the Stockholm Convention, Set-up and guidelines for monitoring. Jana Weiss, Jacob de Boer, Urs Berger, Derek Muir, Ting Ruan, Alejandra Torre, Foppe Smedes, Branislav Vrana, Fabrice Clavient, and Heidelore Fiedler. Division of Technology, Industry and Economics. Geneva. April.

United States Army Corps of Engineers (USACE). 2016. DRAFT – Standard Operating Procedure 047: Per/Poly Fluorinated Alkyl Substances (PFAS) Field Sampling. Revision: 1. March.

U.S. Army Corps of Engineers – Omaha District. 2016. Chemistry Requirements – PFAS.

U.S. Department of Defense (DoD). 2017. Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, Version 5.1. In conjunction with the U.S. Department of Energy. January.

U.S. Department of Defense (DoD). 2019. Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, Version 5.3. In conjunction with the U.S. Department of Energy. May.

U.S. Environmental Protection Agency. 2010. Low Stress (Low Flow) purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells. Available at: https://www.epa.gov/quality/low-stress-low-flow-purging-and-sampling-procedure-collection-groundwater-samples-monitoring.

U.S. Environmental Protection Agency. 2018. USEPA Method 537.1: Determination of Selected Per- and Polyfluorinated Alkyl Substances in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS), November. National Exposure Research Laboratory, Office of Research and Development.

U.S. Environmental Protection Agency. Validated Test Method 8327: Per-and Polyfluoroalkyl Substances (PFAS) Using External Standard Calibration and Multiple Reaction Monitoring (MRM) Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS). June.

U.S. Environmental Protection Agency. Method 533: Determination of Per- and Polyfluoroalkyl Substances in Drinking Water by Isotope Dilution Anion Exchange Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry. December.

Willach, S., Brauch, H.J. and Lange, F.T., 2016. Contribution of selected perfluoroalkyl and polyfluoroalkyl substances to the adsorbable organically bound fluorine in German rivers and in a highly contaminated groundwater. *Chemosphere*, *145*, pp.342-350.

POLY- AND PERFLUOROALKYL SUBSTANCE (PFAS) FIELD SAMPLING GUIDANCE

Rev Date: June 25, 2021

PFAS SAMPLING PROCEDURES AND LOW-FLOW GROUNDWATER PURGING FOR MONITORING WELLS

Rev. # 0

Date 6/19/2018

PFAS SAMPLING PROCEDURES AND LOW-FLOW GROUNDWATER PURGING FOR MONITORING WELLS

REV. # 0

[redacted]

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June 19, 2018

CONTENTS

1 SCOPE AND APPLICATION

The protocol presented in this methods and procedures document describes the procedures recommended to purge monitoring wells and collect groundwater samples for per- and polyfluoroalkyl substances (PFASs) using low flow sampling with a peristaltic pump. Samples will be analyzed for a specified list of PFASs using a modified version of United States (U.S.) Environmental Protection Agency (USEPA) method 537 following the U.S. Department of Defense and U.S. Department of Energy Quality Systems Manual 5.1 methods and procedures set forth in Table B-15.

This protocol has been developed in accordance with the USEPA Region I Low Stress (Low-Flow) Purging and Sampling Procedures for the Collection of Groundwater Samples from Monitoring Wells (EQASOP-GW4; September 19, 2017). PFAS sampling guidelines are incorporated from various guidance documents including the United States Army Corps of Engineers (2016), Department of Environment Regulation, Western Australia (2016), New Hampshire Department of Environmental Services (2016), and Massachusetts Department of Environmental Protection (2017). Staff should also review the Arcadis Technical Guidance Instruction (TGI) titled, Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2018).

The project team should determine the last time the wells were developed and if additional development is necessary prior to sample collection. Groundwater samples should not be collected within one week following well development.

2 PERSONNEL QUALIFICATIONS

Arcadis personnel providing assistance to groundwater sample collection and associated activities should have a minimum of six months of related experience or an advanced degree in environmental sciences, engineering, hydrogeology, or geology. The supervisor of the groundwater sampling team should have at least one year of previous supervised groundwater sampling experience, preferably with PFAS related experience. Prior to mobilizing to the field, the groundwater sampling team should review and be thoroughly familiar with relevant site-specific documents including but not limited to the site work plan, field sampling plan, Health and Safety Plan (HASP), historical information, and site relevant documents. Additionally, the groundwater sampling team should review and be thoroughly familiar with documentation provided by equipment manufacturers for all equipment that will be used in the field prior to mobilization, in particular to confirm the sample materials that will be in contact with the water sample are compatibile with PFAS sample collection**.**

3 EQUIPMENT LIST

Specific to this activity, the following materials (or equivalent) should be available:

- Health and safety documents and equipment (as identified in the Programmatic Accident Prevention Plan and Site Safety and Health Plan)
- Site Plan, well construction records, prior groundwater sampling records (if available)

- Peristaltic pump (e.g., ISCO Model 150) or bladder pump (e.g., Geotech PFC-Free Portable Bladder Pumps)
- A power supply for the peristaltic pump; peristaltic pumps require electric power from either a generator or a deep cell battery.
- High Density Polyethylene (HDPE) tubing and/or silicon tubing of an appropriate size for the pump being used. When collecting samples for PFASs, Teflon® or polytetrafluoroethylene-containing or coated components or tubing are prohibited.
- HDPE bailers (if necessary)
- Water-level probe with fluorine-free materials (e.g., Geotech ET 3/8” with Delrin tip and Buna-N O-ring)
- Water-quality (temperature/pH/specific conductivity/oxidation reduction potential [ORP]/turbidity/dissolved oxygen [DO]) meter, flow-through measurement cell, and appropriate calibration standards. Several brands may be used, including:
    - YSI 6-Series Multi-Parameter Instrument
    - Horiba U-22 Multi-Parameter Instrument
    - Hydrolab Series 3 or Series 4a Multiprobe and Display
- Supplemental turbidity meter (e.g., Horiba U-10, Hach 2100P, LaMotte 2020). Turbidity measurements collected with multi-parameter meters have sometimes been shown to be unreliable due to fouling of the optic lens of the turbidity meter within the flow-through cell. A supplemental turbidity meter should be used to verify turbidity data during purging if such fouling is suspected. An in-line tee and valve should allow for collection of water for turbidity measurements before the pump discharge enters the flow-through cell. Note that industry improvements may eliminate the need for these supplemental measurements in the future.
- HDPE water sample containers (supplied by the laboratory) fitted with an unlined (no Teflon™), polypropylene screw cap. Sample bottles for standard groundwater sampling should not contain Trizma® preservative. If sample bottles with Trizma® are provided by the laboratory, request new sample bottles prior to sample collection.
- Appropriate blanks (field reagent blanks supplied by the laboratory)
- Fluorine-free cleaning equipment
- Groundwater sampling log
- Dedicated plastic sheeting (preferably HDPE) or other clean surface to prevent sample contact with the ground
- Clipboards, field binders, and field note pages that are not waterproof and are fluorine-free
- If high concentrations of PFAS related to class B firefighting foams are expected, bring ‘shaker test’ vials
- Ziploc® bags to hold ice and samples

- Appropriate blanks (field reagent blanks supplied by the laboratory)
- Appropriate transport containers (coolers) with ice and appropriate labeling, no blue ice should be used
- "PFAS-free" water provided by the laboratory for decontamination rinsing
- Alconox® or Liquinox®; note that Alconox® is known to contain trace levels of 1,4-dioxane
- Packing and shipping materials
- Chain-of-Custody (COC) Forms

Note the specific make/model of the equipment used during each sampling event on the groundwater sampling log. The maintenance requirements for the above equipment generally involve decontamination or periodic cleaning, battery charging, calibration, and proper storage, as specified by the manufacturer. For operational difficulties, the equipment should be serviced by a qualified technician.

4 CAUTIONS

- Do not perform field sampling when rain fall is persistent at a consistent rate that saturates the ground (i.e., formation of puddles) because rain gear is not permitted while sampling. Intermittent showers or fog are acceptable conditions to proceed. If rain showers occur; field gear must be removed from the monitoring well location until the rain subsides. If project timelines are tight, consider the use of a gazebo tent that can be erected over the top of the monitoring well to provide shelter from the rain. The canopy material is possibly a PFAS-treated surface and should be managed as such; therefore, wear gloves when moving the tent, change them immediately after moving the tent, and avoid further contact with the tent until all sampling activities have been finished and the team is ready to move on to the next sample location. Ensure that the canopy will not leak into the sampling area prior to use.
- Do not wear any outdoor performance wear that is water or stain resistant or appears to be. Performance wear such as Gore-Tex® or eVent™ are examples of clothing brands to avoid. Natural fabrics such as cotton are preferred. Synthetic fabrics may also be acceptable if there is no indication on the label that the fabric is water and stain resistant. Avoid contacting clothing with sampling equipment, bottles, and samples.
- Waterproof field books must not be used for field notes. Use loose paper on Masonite, plastic, or aluminum clip boards. Pens, pencils, and Sharpies may be used but should be kept away from sampling materials. One person should conduct the sampling while another records the field notes.
- To avoid potential food packaging-related PFAS contact, do not bring any food outside of the field vehicles onsite. Wash your hands after eating and remove any field garments or outer layers prior to eating.
- Safety footwear is often treated to provide a degree of waterproofing and increased durability and may represent a source of trace PFAS. For the health and safety of field personnel, footwear must be protected at all times to avoid potential PFAS contamination. To do this, do not touch your safety footwear in the immediate vicinity of the sampling location and do not allow gloves used for sampling to come in contact with safety footwear.

- Wear disposable nitrile gloves at all times.
    - Don a new pair of nitrile gloves before the following activities at each sample location:
        - Decontamination of re-usable sampling equipment;
        - Contact with sample bottles or “PFAS-free” water bottles;
        - Insertion of anything into the sample ports (e.g., HDPE tubing); and
        - Handling of any quality assurance/quality control samples including field blanks and equipment blanks.
    - Don a new pair of nitrile gloves after the following activities:
        - Handling of any non-dedicated sampling equipment;
        - Contact with contaminated surfaces; or
        - When judged necessary by field personnel.
- Shower at night. Do not use personal care products after showering such as lotions, makeup, and perfumes, UNLESS medically necessary.
- Use sunscreen and insect repellent ONLY if necessary for health and safety. If they are necessary, apply sunscreen and repellant prior to initiating field sampling. If sunscreen and/or repellant need to be reapplied, ensure a safe distance away from the sampling locations and equipment (i.e., more than 10 meters away). Wash hands after application. Don a new pair of gloves as noted above.
- Visitors are asked to remain at least 30 feet from sampling areas.

5 HEALTH AND SAFETY CONSIDERATIONS

Review all site-specific and procedural hazards as they are provided in the HASP, and review Job Safety Analysis (JSA) documents in the field each day prior to beginning work. The HASP and JSA documents should be present onsite during all field activities. Generators and cord and plug equipment should employ an overcurrent protection device such as an integrated ground fault circuit interrupter cord. If thunder or lighting is present, discontinue sampling and take cover until 30 minutes have passed after the last occurrence of thunder or lighting. Use caution when removing well caps as the well may be under pressure and the cap can dislodge forcefully and cause injury.

6 PROCEDURE

If a round of water level measurements for all site monitoring wells are planned as part of the project scope, the site-wide water level measurements should be collected in such a manner to avoid potential cross-contamination between the wells. Follow appropriate decontamination procedures for collection of water level measurements.

Peristaltic pumps are preferred when sampling for PFASs to minimize potential cross-contamination. If the depth to water is below the sampling range of a peristaltic pump (approximately 25 feet), a PFAS-free bladder pump is acceptable. Purge water should be collected and containerized according to the direction of the project team.

1. Calibrate field instruments according to manufacturer procedures for calibration and document.
2. Place plastic sheeting (preferably HDPE) adjacent to the sample port for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
3. If required in the HASP, use a photoionization detector (PID) to measure the headspace before sampling. Open the well cover while standing upwind of the well. Remove the well cap and place it on the plastic sheeting. Insert the PID probe approximately 4 to 6 inches into the casing or the well headspace and cover it with a gloved hand. Record the PID reading in the field log. Perform air monitoring in the breathing zone according to the HASP and/or JSA.
4. Measure the initial depth to groundwater prior to placing the HDPE tubing.
5. Prepare and install the pump in the well: when using a peristaltic pump, slowly lower the HDPE sampling tubing into the well to a depth corresponding to the approximate center of the saturated screen section of the well. Any dedicated tubing in the well should be replaced with new HDPE tubing. The sampling tube must be kept at least 2 feet above the bottom of the well to prevent mobilization of any sediment present in the bottom of the well. If using a weight on the tubing ensure the material is PFAS free and has been deconned according to the procedures described in this document.
6. Measure the water level again with the pump in the well before starting the pump to ensure that it has stabilized. Start pumping the well at 200 to 500 milliliters (mL) per minute (or at a lower site-specific rate if specified). Adjust the pump rate to cause little or no water level drawdown in the well (less than 0.3 foot below the initial static depth to water measurement), and the water level should stabilize; however, this is not always possible. If the recovery rate is less than 50 mL per minute, or the well is being essentially dewatered during purging, the well should be sampled as soon as the water level has recovered sufficiently to collect the volume needed for all anticipated samples. Contact the project manager or other appropriate personnel to discuss.

   The water level should be monitored every 3 to 5 minutes (or as appropriate, lower flow rates may require longer time between readings) during pumping if the well diameter is of sufficient size to allow such monitoring. Do not break pump suction or cause entrainment of air in the sample. Record pumping rate adjustments and depths to water. If necessary, reduce pumping rates to the minimum capabilities of the pump to avoid pumping the well dry and/or to stabilize indicator parameters. Maintain a steady flow rate to the extent practicable. Review groundwater sampling records from previous sampling events (if available) prior to mobilization to estimate the optimum pumping rate and anticipated drawdown for the well in order to more efficiently reach a stabilized pumping condition.

   If the recharge rate of the well is very low, use approved alternative purging techniques, which will vary based on the well construction and screen position. For wells screened across the water table, the well may be pumped dry and sampling can commence as soon as the volume in the well has recovered sufficiently to permit collection of samples. For wells screened entirely below the water table, the well can be pumped until a stabilized level (which may be greater than the maximum displacement goal of 0.3 foot) is maintained and monitoring for stabilization of field indicator parameters can commence. If a lower stabilization level cannot be maintained, the well may be pumped until the drawdown is at a level slightly higher than top of the well screen. Sampling may commence after one well volume has been removed and the well has recovered sufficiently to permit collection of samples.

During purging, monitor the field indicator parameters (e.g., turbidity, temperature, specific conductance, pH, ORP, and DO) every 3 to 5 minutes (or after each volume of the flow-through cell has been purged). Measure field indicator parameters using a flow-through analytical cell or a clean container such as a glass beaker. Record field indicator parameters on the groundwater sampling log. The well is considered stabilized and ready for sample collection when turbidity values remain within 10% (or within 1 nephelometric turbidity unit [NTU] if the turbidity reading is less than 5 NTU), the specific conductance and temperature values remain within 3%, ORP readings remain within ± 10 mV, DO values remain within 10%, and pH remains within 0.1 unit for three consecutive readings collected at 3- to 5-minute intervals (or other appropriate interval, alternate stabilization goals may exist in different geographic regions, consult the site-specific Work Plan for stabilization criteria). If the field indicator parameters do not stabilize within 1 hour of the start of purging, but the groundwater turbidity is below the goal of 10 NTU and the values for all other parameters are within 10%, the well can be sampled. If the parameters have stabilized but the turbidity is not in the range of the 5 NTU goal, the pump flow rate may be decreased to a minimum rate of 100 mL/min to reduce turbidity levels as low as possible.

DO is extremely susceptible to various external influences (including temperature or the presence of bubbles on the DO meter); care should be taken to minimize the agitation or other disturbance of water within the flow-through cell while collecting these measurements. If air bubbles are present on the DO probe or in the discharge tubing, remove them before taking a measurement. If DO values are not within acceptable range for the temperature of groundwater then again check for and remove air bubbles on the probe before re-measuring. If the DO value is 0.00 or less, then the meter should be serviced and re-calibrated. If the DO values are above possible results, then the meter should be serviced and re-calibrated.

During extreme weather conditions, stabilization of field indicator parameters may be difficult to attain. Modifications to the sampling procedures to alleviate these conditions (e.g., measuring the water temperature in the well adjacent to the pump intake) should be documented in the field notes. If other field conditions preclude stabilization of certain parameters, an explanation of why the parameters did not stabilize should also be documented on the groundwater sampling log.

7. After the indicator parameters have stabilized, collect groundwater samples by diverting flow out of the unfiltered discharge tubing into the appropriate labeled sample container. If a flow-through analytical cell is being used to measure field parameters, the flow-through cell should be disconnected after stabilization of the field indicator parameters and prior to groundwater sample collection. Under no circumstances should analytical samples be collected from the discharge of the flow-through cell.

8. Make sure the sample bottle caps have remained on the bottle until immediately prior to sample collection.

9. Don a new set of nitrile gloves prior to sample collection. While collecting the sample, make sure the bottle cap remains in the other hand of the sampler until replaced on the bottle. When the container is full (fill to the neck of the bottle, some headspace is acceptable), firmly screw on the cap (snug but

not too tight so that the screw cap is stripped). Do not use gloved hands to subsequently handle papers, pens, clothes, etc. before collecting the sample.

10. Collect any necessary duplicates and matrix spikes. As the laboratory should be analyzing the entire aqueous sample rather than sub-sampling, separate bottles will be required for these samples.
11. Do not rinse PFAS sample bottles during sampling. Do not filter samples.
12. Complete and attach the sample label(s) after sample collection and after the caps have been placed back on each container. Pre-printed labels are preferred, but pens and Sharpies® may be used.
13. Place sample bottles in a sealed Ziploc® bag. Place samples in coolers that are durable in transportation and keep the temperature between 0 and 4ºC until transported to the laboratory.
14. Record the sample name and time of sampling on the sample bottle label, in the field notes and note observations (e.g., physical appearance and the presence or lack of odors or sheens), and record on the COC form.
15. NOTE: If high concentrations of PFAS related to class B firefighting foams are expected in a groundwater sample, collect and shake a small portion of the sample (~10 to 25 mL) on site. If foaming is noted within the sample, document the foaming when samples are submitted for analysis; the 'shaker test' vial can then be disposed. This shaker test provides information about how each of the samples should be handled analytically. Therefore, note ‘shake test’ results on the COC form if appropriate.
16. Turn off the pump. Slowly remove the tubing from the well. If the tubing will be dedicated, store the tubing in an appropriate storage container. Do not allow the tubing or lines to touch the ground or any other surfaces which could contaminate them.
17. Complete the procedures for packaging, shipping, and handling with the associated COC.
18. Between uses, complete decontamination procedures for flow-through analytical cell and water level meter, and any equipment that comes into contact with well water (see decontamination procedures described in Section 9 below).
19. At the end of the day, perform a calibration check of field instruments.
20. The general procedures listed in this document can be used for collection of samples from groundwater treatment systems or other similar sampling of water. In order to collect samples from a sampling port on a groundwater treatment system or for a similar situation follow the safety and quality procedures listed in this document. As a general note on sampling ports, ensure that there is no indication of Teflon™ tape or other Teflon™ containing material.

7 WASTE MANAGEMENT

Materials generated during groundwater sampling activities, including disposable equipment, should be placed in appropriate containers. PFAS containing waste requires special considerations and containerized waste will be stored onsite for future management by the responsible party.

8 DATA RECORDING AND MANAGEMENT

Initial field logs and COC records should be transmitted to the Arcadis Project Manager at the end of each day unless otherwise directed. The groundwater team leader retains copies of the groundwater sampling logs until they are relinquished to the project file.

9 QUALITY ASSURANCE

In addition to the quality control samples to be collected in accordance with these methods and procedures, the following quality control procedures should be observed in the field:

- Collect samples from monitoring wells, in order of increasing concentration, to the extent known based on review of historical site information if available. If no analytical data are available, collect samples in order of upgradient, then furthest downgradient to source area locations.
- Bottle caps must remain in the hand of the sampler until replaced on the bottle.
- Labels must be completed after the caps have been placed back on each bottle.
- Equipment blanks should be collected from various sampling equipment including the pump, water level meter (following decontamination procedures), disposable tubing, and nitrile gloves.
- Collect equipment blanks using laboratory supplied “PFAS-free” water after wells with higher concentrations (if known) have been sampled.
- Field duplicates, matrix spike, and matrix spike duplicates will be collected at a frequency in accordance with the QAPP and applicable QAPP Addenda.
- Samples must be stored in appropriate transport containers (coolers) with ice (Ziploc© bags for use as ice containers) with appropriate labeling. Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples. Samples should be maintained at temperatures between 0 and 4°C until transported to the laboratory.
- Operate all monitoring instrumentation in accordance with manufacturer’s instructions and calibration procedures. Calibrate instruments at the beginning of each day and verify the calibration at the end of each day. Record all calibration activities on calibration log sheets.
- Clean all groundwater sampling equipment prior to use in the first well and after each subsequent well following the procedure for PFAS equipment decontamination noted below. Clean all field equipment used at locations that are suspected of containing class B firefighting foam (i.e., those that foam during shaking or are known to be near a class B firefighting foam source zone) using each of the below steps repeated twice.
- The steps for PFAS equipment decontamination are as follows:
  - Donning a new pair of nitrile gloves;
  - Rinse sampling equipment with Alconox or Liquinox® cleaning solution; Scrub equipment with a plastic brush if needed;
  - Rinse two times with distilled water or deionized water;

- Rinse one time with “PFAS-free” water; and
- Collect all rinsate in a sealed pail for disposal. Do not reuse decontamination solutions between sampling locations

10 REFERENCES

Arcadis U.S., Inc. (Arcadis). 2018. Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance. Rev. 1. June 19.

Department of Environment Regulation (DER). Government of Western Australia. 2016. Interim Guideline on the Assessment and Management of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS). Contaminated Sites Guidelines. February.

Massachusetts Department of Environmental Protection (MassDEP). 2017. DRAFT Fact Sheet, Guidance on Sampling and Analysis for PFAS at Disposal Sites Regulated under the Massachusetts Contingency Plan. January.

New Hampshire Department of Environmental Services (NHDES). 2016. Perfluorinated Compound (PFC) Sample Collection Guidance. November.

United States Army Corps of Engineers (USACE). 2016. Draft Standard Operating Procedure 047: Per/Poly Fluorinated Alkyl Substances (PFAS) Field Sampling. Revision: 1. March.

United States Environmental Protection Agency (USEPA). 1986. RCRA Groundwater Monitoring Technical Enforcement Guidance Document (September 1986).

USEPA Region I. 2017. Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Sample from Monitoring Wells. September 19.

USEPA. 1991. Handbook Groundwater, Volume II Methodology, Office of Research and Development, Washington, DC. USEPN62S, /6-90/016b (July, 1991).

U.S. Geological Survey (USGS). 1977. National Handbook of Recommended Methods for Water-Data Acquisition: USGS Office of Water Data Coordination. Reston

ATTACHMENT F

Eurofins ADEC Certification

THE STATE OF ALASKA

Department of Environmental Conservation

Laboratory Certification Program

Certification of Chemical Analysis in Drinking Water

Eurofins Lancaster Laboratories Environmental, LLC

Lancaster, PA

PA00009

has complied with the provisions set forth in 18 AAC 80 and is hereby recognized by the Department of Environmental Conservation as Fully Certified for the methods and parameters as listed on the accompanying Scope of Accreditation.
This certificate is effective **07/01/2020** and expires **06/30/2021** .

Patryce D. McKinney

Patryce D. McKinney, M.B.A.
State of Alaska Certification Authority

Shera Hickman

Shera Hickman
SDWA Chemistry Certification Officer

THE STATE OF ALASKA

Department of Environmental Conservation

Laboratory Certification Program

Scope of Accreditation **Expiration: 06/30/2021**

Eurofins Lancaster Laboratories Environmental, LLC PA00009
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is certified by the State of Alaska Department of Environmental Conservation, pursuant to 18 AAC 80, to perform analysis for the parameters listed below using the analytical methods indicated. Accreditation for all parameters is final unless indicated in a note. Accreditation is for the latest version of a method unless specified otherwise. EPA refers to the U.S. Environmental Protection Agency. SM refers to American Public Health Association publication, Standard Methods for the Examination of Water and Wastewater, 20th, 21st, 22nd or 23rd edition unless otherwise noted. ASTM refers to the American Society for Testing and Materials.

Drinking Water Chemistry

Method/Test Name	Reference	Analyte	Status
200.7	EPA	Barium	Fully Certified
200.7	EPA	Calcium	Fully Certified
200.7	EPA	Chromium	Fully Certified
200.7	EPA	Copper	Fully Certified
200.7	EPA	Iron	Fully Certified
200.7	EPA	Magnesium	Fully Certified
200.7	EPA	Manganese	Provisionally Certified
200.7	EPA	Nickel	Fully Certified
200.7	EPA	Potassium	Fully Certified
200.7	EPA	Silver	Fully Certified
200.7	EPA	Sodium	Fully Certified
200.7	EPA	Vanadium	Fully Certified
200.7	EPA	Zinc	Fully Certified
200.8	EPA	Aluminum	Fully Certified
200.8	EPA	Antimony	Fully Certified
200.8	EPA	Arsenic	Fully Certified
200.8	EPA	Barium	Fully Certified

200.8	EPA	Beryllium	Fully Certified
200.8	EPA	Cadmium	Fully Certified
200.8	EPA	Chromium	Fully Certified
200.8	EPA	Copper	Fully Certified
200.8	EPA	Lead	Fully Certified
200.8	EPA	Manganese	Fully Certified
200.8	EPA	Nickel	Fully Certified
200.8	EPA	Selenium	Fully Certified
200.8	EPA	Thallium	Fully Certified
200.8	EPA	Zinc	Fully Certified
245.1	EPA	Mercury	Fully Certified
524.2	EPA	1,1,1,2-Tetrachloroethane-U	Fully Certified
524.2	EPA	1,1,1-Trichloroethane-R	Fully Certified
524.2	EPA	1,1,2,2-Tetrachloroethane-U	Fully Certified
524.2	EPA	1,1,2-Trichloroethane-R	Fully Certified
524.2	EPA	1,1-Dichloroethane-U	Fully Certified
524.2	EPA	1,1-Dichloroethylene-R	Fully Certified
524.2	EPA	1,1-Dichloropropene-U	Fully Certified
524.2	EPA	1,2,3-Trichlorobenzene-U	Fully Certified
524.2	EPA	1,2,3-Trichloropropane-U	Fully Certified
524.2	EPA	1,2,4-Trichlorobenzene-R	Fully Certified
524.2	EPA	1,2,4-Trimethylbenzene-U	Fully Certified
524.2	EPA	1,2-Dichlorobenzene-R	Fully Certified
524.2	EPA	1,2-Dichloroethane-R	Fully Certified
524.2	EPA	1,2-Dichloropropane-R	Fully Certified
524.2	EPA	1,3,5-Trimethylbenzene-U	Fully Certified
524.2	EPA	1,3-Dichlorobenzene-U	Fully Certified
524.2	EPA	1,3-Dichloropropane-U	Fully Certified
524.2	EPA	1,4-Dichlorobenzene-R	Fully Certified
524.2	EPA	2,2-Dichloropropane-U	Fully Certified
524.2	EPA	2-Chlorotoluene-U	Fully Certified

524.2	EPA	4-Chlorotoluene-U	Fully Certified
524.2	EPA	4-Isopropyltoluene-U	Fully Certified
524.2	EPA	Benzene-R	Fully Certified
524.2	EPA	Bromobenzene-U	Fully Certified
524.2	EPA	Bromodichloromethane-T	Provisionally Certified
524.2	EPA	Bromoform-T	Provisionally Certified
524.2	EPA	Bromomethane-U	Fully Certified
524.2	EPA	Carbon Tetrachloride-R	Fully Certified
524.2	EPA	Chlorobenzene-R	Fully Certified
524.2	EPA	Chloroethane-U	Fully Certified
524.2	EPA	Chloroform-T	Provisionally Certified
524.2	EPA	Chloromethane-U	Fully Certified
524.2	EPA	cis-1,2-Dichloroethylene-R	Fully Certified
524.2	EPA	cis-1,3-Dichloropropene-U	Fully Certified
524.2	EPA	Dibromochloromethane-T	Provisionally Certified
524.2	EPA	Dibromomethane-U	Fully Certified
524.2	EPA	Dichloromethane (Methylene Chloride)-R	Fully Certified
524.2	EPA	Dichlorodifluoromethane-U	Fully Certified
524.2	EPA	Ethylbenzene-R	Fully Certified
524.2	EPA	Fluorotrichloromethane-U	Fully Certified
524.2	EPA	Hexachlorobutadiene (HCB)-U	Fully Certified
524.2	EPA	Isopropylbenzene-U	Fully Certified
524.2	EPA	MTBE-U	Fully Certified
524.2	EPA	Naphthalene-U	Fully Certified
524.2	EPA	n-Butylbenzene-U	Fully Certified
524.2	EPA	n-Propylbenzene-U	Fully Certified
524.2	EPA	sec-Butylbenzene-U	Fully Certified
524.2	EPA	Styrene-R	Fully Certified
524.2	EPA	tert-Butylbenzene-U	Fully Certified

524.2	EPA	Tetrachloroethylene-R	Fully Certified
524.2	EPA	Toluene-R	Fully Certified
524.2	EPA	Total THM-T	Provisionally Certified
524.2	EPA	Total Xylenes-R	Fully Certified
524.2	EPA	trans-1,2 Dichloroethylene-R	Fully Certified
524.2	EPA	trans-1,3-Dichloropropene-U	Fully Certified
524.2	EPA	Trichloroethylene-R	Fully Certified
524.2	EPA	Vinyl Chloride-R	Fully Certified
537	EPA	Perfluorooctanoic acid (PFOA)	Fully Certified
537	EPA	Perfluorooctanesulfonic acid (PFOS)	Fully Certified
537.1	EPA	perfluorobutanesulfonic acid (PFBS)	Fully Certified
537.1	EPA	perfluoroheptanoic acid (PFHpA)	Fully Certified
537.1	EPA	perfluorohexanesulfonic acid (PFHxS)	Fully Certified
537.1	EPA	perfluorononanoic acid (PFNA)	Fully Certified
537.1	EPA	Perfluorooctanoic acid (PFOA)	Fully Certified
537.1	EPA	Perfluorooctanesulfonic acid (PFOS)	Fully Certified
2340B	SM	Hardness	Provisionally Certified
2340C	SM	Hardness	Fully Certified
2540C	SM 22nd ed	TDS	Fully Certified
5310C	SM 22nd ed	Total Organic Carbon (TOC)	Fully Certified

THE STATE of ALASKA

Department of Environmental Conservation

DIVISION OF SPILL PREVENTION AND RESPONSE
Contaminated Sites Program
Laboratory Approval Program

555 Cordova Street
Anchorage, Alaska 99501
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June 30, 2020

Duane Luckenbill
Eurofins Lancaster Laboratories Environmental, LLC
2425 New Holland Pike
Lancaster, PA 17601

RE: Contaminated Sites Laboratory Approval **17-027**

Thank you for submitting an application to the Alaska Department of Environmental Conservation's Contaminated Sites Laboratory Approval Program (CS-LAP), on December 23, 2019. Based on your lab's National Environmental Laboratory Accreditation Program (NELAP) approval through the Pennsylvania Department of Environmental Protection (PA DEP) and Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP) approval through the American Association for Laboratory Accreditation (A2LA), Eurofins Lancaster Laboratories Environmental, LLC, located at the above address, is granted ***Approved*** status to perform the analyses listed in the attached *Scope of Approval*, for Alaska contaminated sites projects, including underground storage tanks and leaking underground storage tank sites (UST/LUST), under the July 1, 2017 amendments to 18 AAC 78. This approval is effective January 31, 2020 and expires on ***February 28, 2021***.

Be aware that **any** changes in your NELAP or DoD-ELAP approval status must be reported to the CS program within 3 business days. Failure to do so will result in revocation of **all** CS-LAP approvals for a period of one year. Notification should be in writing sent to cs.lab.cert@alaska.gov. We recommend also contacting the CS-LAP by telephone to verify that the message was received.

Please remember to include the laboratory's ID number, listed above, on all correspondence concerning the laboratory. To apply for renewal of your approval, please complete the application found on the CS-LAP webpage and submit to cs.submittals@alaska.gov. The required documentation must be submitted for renewal no later than 30 days before your date of expiration.

If you have any questions, please contact the CS-LAP at (907) 465-5390, or by email at cs.lab.cert@alaska.gov.

Respectfully,

Brian Englund

Brian Englund

Attachment: Scope of Approval

Scope of Approval

CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
96-63-6	Water	1,2,4-Trimethylbenzene	524.2	PA DEP
108-67-8	Water	1,3,5-Trimethylbenzene	524.2	PA DEP
120226-60-0	Soil	10:2 Fluorotelomersulfonate (10:2-FTS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
120226-60-0	Water	10:2 Fluorotelomersulfonate (10:2-FTS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
N/A	Soil	2-(N-ethylperfluoro-1-octanesulfonamido)-ethanol (NEtPFOSAE)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
N/A	Water	2-(N-ethylperfluoro-1-octanesulfonamido)-ethanol (NEtPFOSAE)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
N/A	Soil	2-(N-methylperfluoro-1-octanesulfonamido)-ethanol (NMePFOSAE)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
N/A	Water	2-(N-methylperfluoro-1-octanesulfonamido)-ethanol (NMePFOSAE)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
1746-01-6	Water	2,3,7,8-TCDD	8290A	PA DEP
757124-72-4	Soil	4:2 Fluorotelomersulfonate (4:2-FTS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
757124-72-4	Water	4:2 Fluorotelomersulfonate (4:2-FTS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
108-10-1	Water	4-Methyl-2-pentanone	524.2	PA DEP
27619-97-2	Soil	6:2 Fluorotelomersulfonate (6:2-FTS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
27619-97-2	Water	6:2 Fluorotelomersulfonate (6:2-FTS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
39108-34-4	Soil	8:2 Fluorotelomersulfonate (8:2FTS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA

Scope of Approval

CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
39108-34-4	Water	8:2 Fluorotelomersulfonate (8:2FTS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
83-32-9	Water	Acenaphthene	625.1	PA DEP
83-32-9	Soil	Acenaphthene	8270D	PA DEP
83-32-9	Water	Acenaphthene	8270D	PA DEP
83-32-9	Soil	Acenaphthene	8270D-SIM	PA DEP
83-32-9	Water	Acenaphthene	8270D-SIM	PA DEP
208-96-8	Water	Acenaphthylene	625.1	PA DEP
208-96-8	Soil	Acenaphthylene	8270D	PA DEP
208-96-8	Water	Acenaphthylene	8270D	PA DEP
208-96-8	Soil	Acenaphthylene	8270D-SIM	PA DEP
208-96-8	Water	Acenaphthylene	8270D-SIM	PA DEP
67-64-1	Water	Acetone	524.2	PA DEP
67-64-1	Water	Acetone	624.1	PA DEP
67-64-1	Soil	Acetone	8260C	PA DEP
67-64-1	Water	Acetone	8260C	PA DEP
67-64-1	Soil	Acetone	8260D	PA DEP
67-64-1	Water	Acetone	8260D	PA DEP
309-00-2	Water	Aldrin	608.3	PA DEP
309-00-2	Soil	Aldrin	8081B	PA DEP
309-00-2	Water	Aldrin	8081B	PA DEP
120-12-7	Water	Anthracene	625.1	PA DEP
120-12-7	Soil	Anthracene	8270D	PA DEP
120-12-7	Water	Anthracene	8270D	PA DEP
120-12-7	Soil	Anthracene	8270D-SIM	PA DEP
120-12-7	Water	Anthracene	8270D-SIM	PA DEP
7440-36-0	Water	Antimony (metallic)	200.7	PA DEP
7440-36-0	Water	Antimony (metallic)	200.8	PA DEP
7440-36-0	Soil	Antimony (metallic)	6010D	PA DEP
7440-36-0	Water	Antimony (metallic)	6010D	PA DEP
7440-36-0	Soil	Antimony (metallic)	6020B	PA DEP
7440-36-0	Water	Antimony (metallic)	6020B	PA DEP
7440-38-2	Water	Arsenic, Inorganic	200.7	PA DEP
7440-38-2	Water	Arsenic, Inorganic	200.8	PA DEP
7440-38-2	Soil	Arsenic, Inorganic	6010D	PA DEP
7440-38-2	Water	Arsenic, Inorganic	6010D	PA DEP

Scope of Approval

CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
7440-38-2	Soil	Arsenic, Inorganic	6020B	PA DEP
7440-38-2	Water	Arsenic, Inorganic	6020B	PA DEP
7440-39-3	Water	Barium	200.7	PA DEP
7440-39-3	Water	Barium	200.8	PA DEP
7440-39-3	Soil	Barium	6010D	PA DEP
7440-39-3	Water	Barium	6010D	PA DEP
7440-39-3	Soil	Barium	6020B	PA DEP
7440-39-3	Water	Barium	6020B	PA DEP
56-55-3	Water	Benz[a]anthracene	625.1	PA DEP
56-55-3	Soil	Benz[a]anthracene	8270D	PA DEP
56-55-3	Water	Benz[a]anthracene	8270D	PA DEP
56-55-3	Soil	Benz[a]anthracene	8270D-SIM	PA DEP
56-55-3	Water	Benz[a]anthracene	8270D-SIM	PA DEP
100-52-7	Soil	Benzaldehyde	8270D	PA DEP
100-52-7	Water	Benzaldehyde	8270D	PA DEP
71-43-2	Water	Benzene	524.2	PA DEP
71-43-2	Water	Benzene	624.1	PA DEP
71-43-2	Soil	Benzene	8260C	PA DEP
71-43-2	Water	Benzene	8260C	PA DEP
71-43-2	Soil	Benzene	8260D	PA DEP
71-43-2	Water	Benzene	8260D	PA DEP
50-32-8	Water	Benzo[a]pyrene	625.1	PA DEP
50-32-8	Soil	Benzo[a]pyrene	8270D	PA DEP
50-32-8	Water	Benzo[a]pyrene	8270D	PA DEP
50-32-8	Soil	Benzo[a]pyrene	8270D-SIM	PA DEP
50-32-8	Water	Benzo[a]pyrene	8270D-SIM	PA DEP
205-99-2	Water	Benzo[b]fluoranthene	625.1	PA DEP
205-99-2	Soil	Benzo[b]fluoranthene	8270D	PA DEP
205-99-2	Water	Benzo[b]fluoranthene	8270D	PA DEP
205-99-2	Soil	Benzo[b]fluoranthene	8270D-SIM	PA DEP
205-99-2	Water	Benzo[b]fluoranthene	8270D-SIM	PA DEP
191-24-2	Water	Benzo[g,h,i]perylene	625.1	PA DEP
191-24-2	Soil	Benzo[g,h,i]perylene	8270D	PA DEP
191-24-2	Water	Benzo[g,h,i]perylene	8270D	PA DEP
191-24-2	Soil	Benzo[g,h,i]perylene	8270D-SIM	PA DEP
191-24-2	Water	Benzo[g,h,i]perylene	8270D-SIM	PA DEP
207-08-9	Water	Benzo[k]fluoranthene	625.1	PA DEP

Scope of Approval

CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
207-08-9	Soil	Benzo[k]fluoranthene	8270D	PA DEP
207-08-9	Water	Benzo[k]fluoranthene	8270D	PA DEP
207-08-9	Soil	Benzo[k]fluoranthene	8270D-SIM	PA DEP
207-08-9	Water	Benzo[k]fluoranthene	8270D-SIM	PA DEP
65-85-0	Soil	Benzoic Acid	8270D	PA DEP
65-85-0	Water	Benzoic Acid	8270D	PA DEP
100-51-6	Soil	Benzyl Alcohol	8270D	PA DEP
100-51-6	Water	Benzyl Alcohol	8270D	PA DEP
7440-41-7	Water	Beryllium and compounds	200.7	PA DEP
7440-41-7	Water	Beryllium and compounds	200.8	PA DEP
7440-41-7	Soil	Beryllium and compounds	6010D	PA DEP
7440-41-7	Water	Beryllium and compounds	6010D	PA DEP
7440-41-7	Soil	Beryllium and compounds	6020B	PA DEP
7440-41-7	Water	Beryllium and compounds	6020B	PA DEP
111-44-4	Water	Bis(2-chloroethyl)ether	625.1	PA DEP
111-44-4	Soil	Bis(2-chloroethyl)ether	8270D	PA DEP
111-44-4	Water	Bis(2-chloroethyl)ether	8270D	PA DEP
117-81-7	Water	Bis(2-ethylhexyl)phthalate (DEHP)	625.1	PA DEP
117-81-7	Soil	Bis(2-ethylhexyl)phthalate (DEHP)	8270D	PA DEP
117-81-7	Water	Bis(2-ethylhexyl)phthalate (DEHP)	8270D	PA DEP
108-86-1	Water	Bromobenzene	624.1	PA DEP
108-86-1	Soil	Bromobenzene	8260C	PA DEP
108-86-1	Water	Bromobenzene	8260C	PA DEP
108-86-1	Soil	Bromobenzene	8260D	PA DEP
108-86-1	Water	Bromobenzene	8260D	PA DEP
75-27-4	Water	Bromodichloromethane	624.1	PA DEP
75-27-4	Soil	Bromodichloromethane	8260C	PA DEP
75-27-4	Water	Bromodichloromethane	8260C	PA DEP
75-27-4	Soil	Bromodichloromethane	8260D	PA DEP
75-27-4	Water	Bromodichloromethane	8260D	PA DEP
75-25-2	Water	Bromoform	624.1	PA DEP
75-25-2	Soil	Bromoform	8260C	PA DEP
75-25-2	Water	Bromoform	8260C	PA DEP
75-25-2	Soil	Bromoform	8260D	PA DEP
75-25-2	Water	Bromoform	8260D	PA DEP
74-83-9	Water	Bromomethane	624.1	PA DEP
74-83-9	Soil	Bromomethane	8260C	PA DEP

Scope of Approval

CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
74-83-9	Water	Bromomethane	8260C	PA DEP
74-83-9	Soil	Bromomethane	8260D	PA DEP
74-83-9	Water	Bromomethane	8260D	PA DEP
106-99-0	Water	Butadiene, 1,3-	8260C	PA DEP
106-99-0	Water	Butadiene, 1,3-	8260D	PA DEP
71-36-3	Soil	Butanol, N-	8260C	PA DEP
71-36-3	Water	Butanol, N-	8260C	PA DEP
71-36-3	Soil	Butanol, N-	8260D	PA DEP
71-36-3	Water	Butanol, N-	8260D	PA DEP
85-68-7	Water	Butyl Benzyl Phthalate	625.1	PA DEP
85-68-7	Soil	Butyl Benzyl Phthalate	8270D	PA DEP
85-68-7	Water	Butyl Benzyl Phthalate	8270D	PA DEP
104-51-8	Water	Butylbenzene, n-	524.2	PA DEP
104-51-8	Water	Butylbenzene, n-	624.1	PA DEP
104-51-8	Soil	Butylbenzene, n-	8260C	PA DEP
104-51-8	Water	Butylbenzene, n-	8260C	PA DEP
104-51-8	Soil	Butylbenzene, n-	8260D	PA DEP
104-51-8	Water	Butylbenzene, n-	8260D	PA DEP
135-98-8	Water	Butylbenzene, sec-	524.2	PA DEP
135-98-8	Water	Butylbenzene, sec-	624.1	PA DEP
135-98-8	Soil	Butylbenzene, sec-	8260C	PA DEP
135-98-8	Water	Butylbenzene, sec-	8260C	PA DEP
135-98-8	Soil	Butylbenzene, sec-	8260D	PA DEP
135-98-8	Water	Butylbenzene, sec-	8260D	PA DEP
98-06-6	Water	Butylbenzene, tert-	624.1	PA DEP
98-06-6	Soil	Butylbenzene, tert-	8260C	PA DEP
98-06-6	Water	Butylbenzene, tert-	8260C	PA DEP
98-06-6	Soil	Butylbenzene, tert-	8260D	PA DEP
98-06-6	Water	Butylbenzene, tert-	8260D	PA DEP
7440-43-9	Water	Cadmium	200.7	PA DEP
7440-43-9	Water	Cadmium	200.8	PA DEP
7440-43-9	Soil	Cadmium	6010D	PA DEP
7440-43-9	Water	Cadmium	6010D	PA DEP
7440-43-9	Soil	Cadmium	6020B	PA DEP
7440-43-9	Water	Cadmium	6020B	PA DEP
75-15-0	Water	Carbon Disulfide	624.1	PA DEP
75-15-0	Soil	Carbon Disulfide	8260C	PA DEP

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CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
75-15-0	Water	Carbon Disulfide	8260C	PA DEP
75-15-0	Soil	Carbon Disulfide	8260D	PA DEP
75-15-0	Water	Carbon Disulfide	8260D	PA DEP
56-23-5	Water	Carbon Tetrachloride	624.1	PA DEP
56-23-5	Soil	Carbon Tetrachloride	8260C	PA DEP
56-23-5	Water	Carbon Tetrachloride	8260C	PA DEP
56-23-5	Soil	Carbon Tetrachloride	8260D	PA DEP
56-23-5	Water	Carbon Tetrachloride	8260D	PA DEP
5103-71-9	Water	Chlordane, α-	608.3	PA DEP
5103-71-9	Soil	Chlordane, α-	8081B	PA DEP
5103-71-9	Water	Chlordane, α-	8081B	PA DEP
5103-74-2	Water	Chlordane, γ-	608.3	PA DEP
5103-74-2	Soil	Chlordane, γ-	8081B	PA DEP
5103-74-2	Water	Chlordane, γ-	8081B	PA DEP
12789-03-6	Water	Chlordane, Total	608.3	PA DEP
12789-03-6	Soil	Chlordane, Total	8081B	PA DEP
12789-03-6	Water	Chlordane, Total	8081B	PA DEP
143-50-0	Soil	Chlordecone (Kepone)	8081B	PA DEP
143-50-0	Water	Chlordecone (Kepone)	8081B	PA DEP
106-47-8	Soil	Chloroaniline, p-	8270D	PA DEP
106-47-8	Water	Chloroaniline, p-	8270D	PA DEP
108-90-7	Water	Chlorobenzene	524.2	PA DEP
108-90-7	Water	Chlorobenzene	624.1	PA DEP
108-90-7	Soil	Chlorobenzene	8260C	PA DEP
108-90-7	Water	Chlorobenzene	8260C	PA DEP
108-90-7	Soil	Chlorobenzene	8260D	PA DEP
108-90-7	Water	Chlorobenzene	8260D	PA DEP
67-66-3	Water	Chloroform	524.2	PA DEP
67-66-3	Water	Chloroform	624.1	PA DEP
67-66-3	Soil	Chloroform	8260C	PA DEP
67-66-3	Water	Chloroform	8260C	PA DEP
67-66-3	Soil	Chloroform	8260D	PA DEP
67-66-3	Water	Chloroform	8260D	PA DEP
74-87-3	Water	Chloromethane	624.1	PA DEP
74-87-3	Soil	Chloromethane	8260C	PA DEP
74-87-3	Water	Chloromethane	8260C	PA DEP
74-87-3	Soil	Chloromethane	8260D	PA DEP

Scope of Approval

CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
74-87-3	Water	Chloromethane	8260D	PA DEP
91-58-7	Soil	Chloronaphthalene, Beta-	8270D	PA DEP
91-58-7	Water	Chloronaphthalene, Beta-	8270D	PA DEP
91-58-7	Water	Chlorophenol, 2-	625.1	PA DEP
95-57-8	Soil	Chlorophenol, 2-	8270D	PA DEP
95-57-8	Water	Chlorophenol, 2-	8270D	PA DEP
7440-47-3	Water	Chromium (Total)	200.7	PA DEP
7440-47-3	Water	Chromium (Total)	200.8	PA DEP
7440-47-3	Soil	Chromium (Total)	6010D	PA DEP
7440-47-3	Water	Chromium (Total)	6010D	PA DEP
7440-47-3	Soil	Chromium (Total)	6020B	PA DEP
7440-47-3	Water	Chromium (Total)	6020B	PA DEP
18540-29-9	Soil	Chromium (VI)	7199	PA DEP
18540-29-9	Water	Chromium (VI)	7199	PA DEP
18540-29-9	Soil	Chromium (VI)	7196A	PA DEP
18540-29-9	Water	Chromium (VI)	7196A	PA DEP
18540-29-9	Water	Chromium (VI)	SM 3500-CR B	PA DEP
218-01-9	Water	Chrysene	625.1	PA DEP
218-01-9	Soil	Chrysene	8270D	PA DEP
218-01-9	Water	Chrysene	8270D	PA DEP
218-01-9	Soil	Chrysene	8270D-SIM	PA DEP
218-01-9	Water	Chrysene	8270D-SIM	PA DEP
7440-50-8	Water	Copper	200.7	PA DEP
7440-50-8	Water	Copper	200.8	PA DEP
7440-50-8	Soil	Copper	6010D	PA DEP
7440-50-8	Water	Copper	6010D	PA DEP
7440-50-8	Soil	Copper	6020B	PA DEP
7440-50-8	Water	Copper	6020B	PA DEP
N/A	Water	Cresol, m- (3-Methylphenol) + Cresol, p- (4-Methylphenol)	625.1	PA DEP
N/A	Soil	Cresol, m- (3-Methylphenol) + Cresol, p- (4-Methylphenol)	8270D	PA DEP
N/A	Water	Cresol, m- (3-Methylphenol) + Cresol, p- (4-Methylphenol)	8270D	PA DEP
95-48-7	Water	Cresol, o- (2-Methylphenol)	625.1	PA DEP
95-48-7	Soil	Cresol, o- (2-Methylphenol)	8270D	PA DEP
95-48-7	Water	Cresol, o- (2-Methylphenol)	8270D	PA DEP
98-82-8	Soil	Cumene (Isopropylbenzene)	8260C	PA DEP
98-82-8	Water	Cumene (Isopropylbenzene)	8260C	PA DEP
98-82-8	Soil	Cumene (Isopropylbenzene)	8260D	PA DEP

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CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
98-82-8	Water	Cumene (Isopropylbenzene)	8260D	PA DEP
57-12-5	Soil	Cyanide (CN-)	9012B	PA DEP
57-12-5	Water	Cyanide (CN-)	9012B	PA DEP
110-82-7	Water	Cyclohexane	624.1	PA DEP
110-82-7	Soil	Cyclohexane	8260C	PA DEP
110-82-7	Water	Cyclohexane	8260C	PA DEP
110-82-7	Soil	Cyclohexane	8260D	PA DEP
110-82-7	Water	Cyclohexane	8260D	PA DEP
72-54-8	Water	DDD, 4,4’-	608.3	PA DEP
72-54-8	Soil	DDD, 4,4’-	8081B	PA DEP
72-54-8	Water	DDD, 4,4’-	8081B	PA DEP
72-55-9	Water	DDE, 4,4’-	608.3	PA DEP
72-55-9	Soil	DDE, 4,4’-	8081B	PA DEP
72-55-9	Water	DDE, 4,4’-	8081B	PA DEP
50-29-3	Water	DDT, 4,4’-	608.3	PA DEP
50-29-3	Soil	DDT, 4,4’-	8081B	PA DEP
50-29-3	Water	DDT, 4,4’-	8081B	PA DEP
53-70-3	Water	Dibenz[a,h]anthracene	625.1	PA DEP
53-70-3	Soil	Dibenz[a,h]anthracene	8270D	PA DEP
53-70-3	Water	Dibenz[a,h]anthracene	8270D	PA DEP
53-70-3	Soil	Dibenz[a,h]anthracene	8270D-SIM	PA DEP
53-70-3	Water	Dibenz[a,h]anthracene	8270D-SIM	PA DEP
132-64-9	Soil	Dibenzofuran	8270D	PA DEP
132-64-9	Water	Dibenzofuran	8270D	PA DEP
124-48-1	Water	Dibromochloromethane	624.1	PA DEP
124-48-1	Soil	Dibromochloromethane	8260C	PA DEP
124-48-1	Water	Dibromochloromethane	8260C	PA DEP
124-48-1	Soil	Dibromochloromethane	8260D	PA DEP
124-48-1	Water	Dibromochloromethane	8260D	PA DEP
106-93-4	Water	Dibromoethane, 1,2- (Ethylene Dibromide)	624.1	PA DEP
106-93-4	Soil	Dibromoethane, 1,2- (Ethylene Dibromide)	8011	PA DEP
106-93-4	Water	Dibromoethane, 1,2- (Ethylene Dibromide)	8011	PA DEP
106-93-4	Soil	Dibromoethane, 1,2- (Ethylene Dibromide)	8260C	PA DEP
106-93-4	Water	Dibromoethane, 1,2- (Ethylene Dibromide)	8260C	PA DEP
106-93-4	Soil	Dibromoethane, 1,2- (Ethylene Dibromide)	8260D	PA DEP
106-93-4	Water	Dibromoethane, 1,2- (Ethylene Dibromide)	8260D	PA DEP
74-95-3	Water	Dibromomethane (Methylene Bromide)	624.1	PA DEP

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74-95-3	Soil	Dibromomethane (Methylene Bromide)	8260C	PA DEP
74-95-3	Water	Dibromomethane (Methylene Bromide)	8260C	PA DEP
74-95-3	Soil	Dibromomethane (Methylene Bromide)	8260D	PA DEP
74-95-3	Water	Dibromomethane (Methylene Bromide)	8260D	PA DEP
84-74-2	Water	Dibutyl Phthalate	625.1	PA DEP
84-74-2	Soil	Dibutyl Phthalate	8270D	PA DEP
84-74-2	Water	Dibutyl Phthalate	8270D	PA DEP
95-50-1	Water	Dichlorobenzene, 1,2-	524.2	PA DEP
95-50-1	Water	Dichlorobenzene, 1,2-	624.1	PA DEP
95-50-1	Water	Dichlorobenzene, 1,2-	625.1	PA DEP
95-50-1	Soil	Dichlorobenzene, 1,2-	8260C	PA DEP
95-50-1	Water	Dichlorobenzene, 1,2-	8260C	PA DEP
95-50-1	Soil	Dichlorobenzene, 1,2-	8260D	PA DEP
95-50-1	Water	Dichlorobenzene, 1,2-	8260D	PA DEP
95-50-1	Soil	Dichlorobenzene, 1,2-	8270D	PA DEP
95-50-1	Water	Dichlorobenzene, 1,2-	8270D	PA DEP
541-73-1	Water	Dichlorobenzene, 1,3-	624.1	PA DEP
541-73-1	Water	Dichlorobenzene, 1,3-	625.1	PA DEP
541-73-1	Soil	Dichlorobenzene, 1,3-	8260C	PA DEP
541-73-1	Water	Dichlorobenzene, 1,3-	8260C	PA DEP
541-73-1	Soil	Dichlorobenzene, 1,3-	8260D	PA DEP
541-73-1	Water	Dichlorobenzene, 1,3-	8260D	PA DEP
541-73-1	Soil	Dichlorobenzene, 1,3-	8270D	PA DEP
541-73-1	Water	Dichlorobenzene, 1,3-	8270D	PA DEP
106-46-7	Water	Dichlorobenzene, 1,4-	624.1	PA DEP
106-46-7	Water	Dichlorobenzene, 1,4-	625.1	PA DEP
106-46-7	Soil	Dichlorobenzene, 1,4-	8260C	PA DEP
106-46-7	Water	Dichlorobenzene, 1,4-	8260C	PA DEP
106-46-7	Soil	Dichlorobenzene, 1,4-	8260D	PA DEP
106-46-7	Water	Dichlorobenzene, 1,4-	8260D	PA DEP
106-46-7	Soil	Dichlorobenzene, 1,4-	8270D	PA DEP
106-46-7	Water	Dichlorobenzene, 1,4-	8270D	PA DEP
91-94-1	Water	Dichlorobenzidine, 3,3'-	625.1	PA DEP
91-94-1	Soil	Dichlorobenzidine, 3,3'-	8270D	PA DEP
91-94-1	Water	Dichlorobenzidine, 3,3'-	8270D	PA DEP
75-71-8	Water	Dichlorodifluoromethane (Freon-12)	524.2	PA DEP
75-71-8	Water	Dichlorodifluoromethane (Freon-12)	624.1	PA DEP

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75-71-8	Soil	Dichlorodifluoromethane (Freon-12)	8260C	PA DEP
75-71-8	Water	Dichlorodifluoromethane (Freon-12)	8260C	PA DEP
75-71-8	Soil	Dichlorodifluoromethane (Freon-12)	8260D	PA DEP
75-71-8	Water	Dichlorodifluoromethane (Freon-12)	8260D	PA DEP
75-34-3	Water	Dichloroethane, 1,1-	624.1	PA DEP
75-34-3	Soil	Dichloroethane, 1,1-	8260C	PA DEP
75-34-3	Water	Dichloroethane, 1,1-	8260C	PA DEP
75-34-3	Soil	Dichloroethane, 1,1-	8260D	PA DEP
75-34-3	Water	Dichloroethane, 1,1-	8260D	PA DEP
107-06-2	Water	Dichloroethane, 1,2-	524.2	PA DEP
107-06-2	Water	Dichloroethane, 1,2-	624.1	PA DEP
107-06-2	Soil	Dichloroethane, 1,2-	8260C	PA DEP
107-06-2	Water	Dichloroethane, 1,2-	8260C	PA DEP
107-06-2	Soil	Dichloroethane, 1,2-	8260D	PA DEP
107-06-2	Water	Dichloroethane, 1,2-	8260D	PA DEP
75-35-4	Water	Dichloroethylene, 1,1-	624.1	PA DEP
75-35-4	Soil	Dichloroethylene, 1,1-	8260C	PA DEP
75-35-4	Water	Dichloroethylene, 1,1-	8260C	PA DEP
75-35-4	Soil	Dichloroethylene, 1,1-	8260D	PA DEP
75-35-4	Water	Dichloroethylene, 1,1-	8260D	PA DEP
156-59-2	Water	Dichloroethylene, 1,2-cis-	624.1	PA DEP
156-59-2	Soil	Dichloroethylene, 1,2-cis-	8260C	PA DEP
156-59-2	Water	Dichloroethylene, 1,2-cis-	8260C	PA DEP
156-59-2	Soil	Dichloroethylene, 1,2-cis-	8260D	PA DEP
156-59-2	Water	Dichloroethylene, 1,2-cis-	8260D	PA DEP
156-60-5	Water	Dichloroethylene, 1,2-trans-	624.1	PA DEP
156-60-5	Soil	Dichloroethylene, 1,2-trans-	8260C	PA DEP
156-60-5	Water	Dichloroethylene, 1,2-trans-	8260C	PA DEP
156-60-5	Soil	Dichloroethylene, 1,2-trans-	8260D	PA DEP
156-60-5	Water	Dichloroethylene, 1,2-trans-	8260D	PA DEP
120-83-2	Water	Dichlorophenol, 2,4-	625.1	PA DEP
120-83-2	Soil	Dichlorophenol, 2,4-	8270D	PA DEP
120-83-2	Water	Dichlorophenol, 2,4-	8270D	PA DEP
94-75-7	Soil	Dichlorophenoxy Acetic Acid, 2,4- (2,4-D)	8151A	PA DEP
94-75-7	Water	Dichlorophenoxy Acetic Acid, 2,4- (2,4-D)	8151A	PA DEP
78-87-5	Water	Dichloropropane, 1,2-	624.1	PA DEP
78-87-5	Soil	Dichloropropane, 1,2-	8260C	PA DEP

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78-87-5	Water	Dichloropropane, 1,2-	8260C	PA DEP
78-87-5	Soil	Dichloropropane, 1,2-	8260D	PA DEP
78-87-5	Water	Dichloropropane, 1,2-	8260D	PA DEP
542-75-6	Soil	Dichloropropene, 1,3- (cis + trans)	8260C	PA DEP
542-75-6	Water	Dichloropropene, 1,3- (cis + trans)	8260C	PA DEP
542-75-6	Soil	Dichloropropene, 1,3- (cis + trans)	8260D	PA DEP
542-75-6	Water	Dichloropropene, 1,3- (cis + trans)	8260D	PA DEP
60-57-1	Water	Dieldrin	608.3	PA DEP
60-57-1	Soil	Dieldrin	8081B	PA DEP
60-57-1	Water	Dieldrin	8081B	PA DEP
N/A	Soil	Diesel Range Organics (C10 – C25)	AK 102	PA DEP
N/A	Water	Diesel Range Organics (C10 – C25)	AK 102	PA DEP
84-66-2	Water	Diethyl Phthalate	625.1	PA DEP
84-66-2	Soil	Diethyl Phthalate	8270D	PA DEP
84-66-2	Water	Diethyl Phthalate	8270D	PA DEP
105-67-9	Water	Dimethylphenol, 2,4-	625.1	PA DEP
105-67-9	Soil	Dimethylphenol, 2,4-	8270D	PA DEP
105-67-9	Water	Dimethylphenol, 2,4-	8270D	PA DEP
131-11-3	Water	Dimethylphthalate	625.1	PA DEP
131-11-3	Soil	Dimethylphthalate	8270D	PA DEP
131-11-3	Water	Dimethylphthalate	8270D	PA DEP
99-65-0	Soil	Dinitrobenzene, 1,3-	8270D	PA DEP
99-65-0	Water	Dinitrobenzene, 1,3-	8270D	PA DEP
99-65-0	Soil	Dinitrobenzene, 1,3-	8330B	PA DEP
99-65-0	Water	Dinitrobenzene, 1,3-	8330B	PA DEP
51-28-5	Water	Dinitrophenol, 2,4-	625.1	PA DEP
51-28-5	Soil	Dinitrophenol, 2,4-	8270D	PA DEP
51-28-5	Water	Dinitrophenol, 2,4-	8270D	PA DEP
121-14-2	Water	Dinitrotoluene, 2,4- (2,4-DNT)	625.1	PA DEP
121-14-2	Soil	Dinitrotoluene, 2,4- (2,4-DNT)	8270D	PA DEP
121-14-2	Water	Dinitrotoluene, 2,4- (2,4-DNT)	8270D	PA DEP
121-14-2	Soil	Dinitrotoluene, 2,4- (2,4-DNT)	8330B	PA DEP
121-14-2	Water	Dinitrotoluene, 2,4- (2,4-DNT)	8330B	PA DEP
606-20-2	Water	Dinitrotoluene, 2,6- (2,6-DNT)	625.1	PA DEP
606-20-2	Soil	Dinitrotoluene, 2,6- (2,6-DNT)	8270D	PA DEP
606-20-2	Water	Dinitrotoluene, 2,6- (2,6-DNT)	8270D	PA DEP
606-20-2	Soil	Dinitrotoluene, 2,6- (2,6-DNT)	8330B	PA DEP

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606-20-2	Water	Dinitrotoluene, 2,6- (2,6-DNT)	8330B	PA DEP
35572-78-2	Soil	Dinitrotoluene, 2-Amino-4,6-	8330B	PA DEP
35572-78-2	Water	Dinitrotoluene, 2-Amino-4,6-	8330B	PA DEP
19406-51-0	Soil	Dinitrotoluene, 4-Amino-2,6-	8330B	PA DEP
19406-51-0	Water	Dinitrotoluene, 4-Amino-2,6-	8330B	PA DEP
123-91-1	Soil	Dioxane, 1,4-	8260C	PA DEP
123-91-1	Water	Dioxane, 1,4-	8260C	PA DEP
123-91-1	Soil	Dioxane, 1,4-	8260C-SIM	PA DEP
123-91-1	Water	Dioxane, 1,4-	8260C-SIM	PA DEP
123-91-1	Soil	Dioxane, 1,4-	8260D	PA DEP
123-91-1	Water	Dioxane, 1,4-	8260D	PA DEP
123-91-1	Soil	Dioxane, 1,4-	8270D	PA DEP
123-91-1	Water	Dioxane, 1,4-	8270D	PA DEP
123-91-1	Soil	Dioxane, 1,4-	8270D-SIM	PA DEP
123-91-1	Water	Dioxane, 1,4-	8270D-SIM	PA DEP
122-39-4	Soil	Diphenylamine	8270D	PA DEP
122-39-4	Water	Diphenylamine	8270D	PA DEP
959-98-8	Water	Endosulfan I	608.3	PA DEP
959-98-8	Soil	Endosulfan I	8081B	PA DEP
959-98-8	Water	Endosulfan I	8081B	PA DEP
33213-65-9	Water	Endosulfan II	608.3	PA DEP
33213-65-9	Soil	Endosulfan II	8081B	PA DEP
33213-65-9	Water	Endosulfan II	8081B	PA DEP
1031-07-8	Water	Endosulfan sulfate	608.3	PA DEP
1031-07-8	Soil	Endosulfan sulfate	8081B	PA DEP
1031-07-8	Water	Endosulfan sulfate	8081B	PA DEP
72-20-8	Water	Endrin	608.3	PA DEP
72-20-8	Soil	Endrin	8081B	PA DEP
72-20-8	Water	Endrin	8081B	PA DEP
75-00-3	Water	Ethyl Chloride	624.1	PA DEP
75-00-3	Soil	Ethyl Chloride	8260C	PA DEP
75-00-3	Water	Ethyl Chloride	8260C	PA DEP
75-00-3	Soil	Ethyl Chloride	8260D	PA DEP
75-00-3	Water	Ethyl Chloride	8260D	PA DEP
100-41-4	Water	Ethylbenzene	524.2	PA DEP
100-41-4	Water	Ethylbenzene	624.1	PA DEP
100-41-4	Soil	Ethylbenzene	8260C	PA DEP

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100-41-4	Water	Ethylbenzene	8260C	PA DEP
100-41-4	Soil	Ethylbenzene	8260D	PA DEP
100-41-4	Water	Ethylbenzene	8260D	PA DEP
107-21-1	Soil	Ethylene Glycol	8015C	PA DEP
107-21-1	Water	Ethylene Glycol	8015C	PA DEP
206-44-0	Water	Fluoranthene	625.1	PA DEP
206-44-0	Soil	Fluoranthene	8270D	PA DEP
206-44-0	Water	Fluoranthene	8270D	PA DEP
206-44-0	Soil	Fluoranthene	8270D-SIM	PA DEP
206-44-0	Water	Fluoranthene	8270D-SIM	PA DEP
86-73-7	Water	Fluorene	625.1	PA DEP
86-73-7	Soil	Fluorene	8270D	PA DEP
86-73-7	Water	Fluorene	8270D	PA DEP
86-73-7	Soil	Fluorene	8270D-SIM	PA DEP
86-73-7	Water	Fluorene	8270D-SIM	PA DEP
50-00-0	Water	Formaldehyde	8315A	PA DEP
N/A	Soil	Gasoline Range Organics (C6 – C10)	AK 101	PA DEP
N/A	Water	Gasoline Range Organics (C6 – C10)	AK 101	PA DEP
76-44-8	Water	Heptachlor	608.3	PA DEP
76-44-8	Soil	Heptachlor	8081B	PA DEP
76-44-8	Water	Heptachlor	8081B	PA DEP
1024-57-3	Water	Heptachlor Epoxide	608.3	PA DEP
1024-57-3	Soil	Heptachlor Epoxide	8081B	PA DEP
1024-57-3	Water	Heptachlor Epoxide	8081B	PA DEP
118-74-1	Water	Hexachlorobenzene	625.1	PA DEP
118-74-1	Soil	Hexachlorobenzene	8270D	PA DEP
118-74-1	Water	Hexachlorobenzene	8270D	PA DEP
87-68-3	Water	Hexachlorobutadiene	624.1	PA DEP
87-68-3	Water	Hexachlorobutadiene	625.1	PA DEP
87-68-3	Soil	Hexachlorobutadiene	8260C	PA DEP
87-68-3	Water	Hexachlorobutadiene	8260C	PA DEP
87-68-3	Soil	Hexachlorobutadiene	8260D	PA DEP
87-68-3	Water	Hexachlorobutadiene	8260D	PA DEP
87-68-3	Soil	Hexachlorobutadiene	8270D	PA DEP
87-68-3	Water	Hexachlorobutadiene	8270D	PA DEP
319-84-6	Water	Hexachlorocyclohexane, Alpha- (α-BHC)	608.3	PA DEP
319-84-6	Soil	Hexachlorocyclohexane, Alpha- (α-BHC)	8081B	PA DEP

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319-84-6	Water	Hexachlorocyclohexane, Alpha- (α-BHC)	8081B	PA DEP
319-85-7	Water	Hexachlorocyclohexane, Beta- (β-BHC)	608.3	PA DEP
319-85-7	Soil	Hexachlorocyclohexane, Beta- (β-BHC)	8081B	PA DEP
319-85-7	Water	Hexachlorocyclohexane, Beta- (β-BHC)	8081B	PA DEP
319-86-8	Water	Hexachlorocyclohexane, Delta- (δ-BHC)	608.3	PA DEP
319-86-8	Soil	Hexachlorocyclohexane, Delta- (δ-BHC)	8081B	PA DEP
319-86-8	Water	Hexachlorocyclohexane, Delta- (δ-BHC)	8081B	PA DEP
58-89-9	Water	Hexachlorocyclohexane, Gamma- (Lindane)	608.3	PA DEP
58-89-9	Soil	Hexachlorocyclohexane, Gamma- (Lindane)	8081B	PA DEP
58-89-9	Water	Hexachlorocyclohexane, Gamma- (Lindane)	8081B	PA DEP
77-47-4	Water	Hexachlorocyclopentadiene	625.1	PA DEP
77-47-4	Soil	Hexachlorocyclopentadiene	8270D	PA DEP
77-47-4	Water	Hexachlorocyclopentadiene	8270D	PA DEP
67-72-1	Water	Hexachloroethane	625.1	PA DEP
67-72-1	Soil	Hexachloroethane	8270D	PA DEP
67-72-1	Water	Hexachloroethane	8270D	PA DEP
121-82-4	Soil	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	8330B	PA DEP
121-82-4	Water	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	8330B	PA DEP
110-54-3	Soil	Hexane, N-	8260C	PA DEP
110-54-3	Water	Hexane, N-	8260C	PA DEP
110-54-3	Soil	Hexane, N-	8260D	PA DEP
110-54-3	Water	Hexane, N-	8260D	PA DEP
591-78-6	Soil	Hexanone, 2-	8260C	PA DEP
591-78-6	Water	Hexanone, 2-	8260C	PA DEP
591-78-6	Soil	Hexanone, 2-	8260D	PA DEP
591-78-6	Water	Hexanone, 2-	8260D	PA DEP
35822-46-9	Soil	HPCDD, 1,2,3,4,6,7,8-	1613B	PA DEP
35822-46-9	Water	HPCDD, 1,2,3,4,6,7,8-	1613B	PA DEP
35822-46-9	Soil	HPCDD, 1,2,3,4,6,7,8-	8290A	PA DEP
35822-46-9	Water	HPCDD, 1,2,3,4,6,7,8-	8290A	PA DEP
37871-00-4	Water	HpCDD, Total	1613B	PA DEP
37871-00-4	Soil	HpCDD, Total	8290A	PA DEP
37871-00-4	Water	HpCDD, Total	8290A	PA DEP
67562-39-4	Soil	HPCDF, 1,2,3,4,6,7,8-	1613B	PA DEP
67562-39-4	Water	HPCDF, 1,2,3,4,6,7,8-	1613B	PA DEP
67562-39-4	Soil	HPCDF, 1,2,3,4,6,7,8-	8290A	PA DEP
67562-39-4	Water	HPCDF, 1,2,3,4,6,7,8-	8290A	PA DEP

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55673-89-7	Soil	HPCDF, 1,2,3,4,7,8,9-	1613B	PA DEP
55673-89-7	Water	HPCDF, 1,2,3,4,7,8,9-	1613B	PA DEP
55673-89-7	Soil	HPCDF, 1,2,3,4,7,8,9-	8290A	PA DEP
55673-89-7	Water	HPCDF, 1,2,3,4,7,8,9-	8290A	PA DEP
38998-75-3	Water	HpCDF, Total	1613B	PA DEP
38998-75-3	Soil	HpCDF, Total	8290A	PA DEP
38998-75-3	Water	HpCDF, Total	8290A	PA DEP
39227-28-6	Soil	HXCDD, 1,2,3,4,7,8-	1613B	PA DEP
39227-28-6	Water	HXCDD, 1,2,3,4,7,8-	1613B	PA DEP
39227-28-6	Soil	HXCDD, 1,2,3,4,7,8-	8290A	PA DEP
39227-28-6	Water	HXCDD, 1,2,3,4,7,8-	8290A	PA DEP
57653-85-7	Soil	HXCDD, 1,2,3,6,7,8-	1613B	PA DEP
57653-85-7	Water	HXCDD, 1,2,3,6,7,8-	1613B	PA DEP
57653-85-7	Soil	HXCDD, 1,2,3,6,7,8-	8290A	PA DEP
57653-85-7	Water	HXCDD, 1,2,3,6,7,8-	8290A	PA DEP
19408-74-3	Soil	HXCDD, 1,2,3,7,8,9-	1613B	PA DEP
19408-74-3	Water	HXCDD, 1,2,3,7,8,9-	1613B	PA DEP
19408-74-3	Soil	HXCDD, 1,2,3,7,8,9-	8290A	PA DEP
19408-74-3	Water	HXCDD, 1,2,3,7,8,9-	8290A	PA DEP
34465-46-8	Water	HxCDD, Total	1613B	PA DEP
34465-46-8	Soil	HxCDD, Total	8290A	PA DEP
34465-46-8	Water	HxCDD, Total	8290A	PA DEP
70648-26-9	Soil	HXCDF, 1,2,3,4,7,8-	1613B	PA DEP
70648-26-9	Water	HXCDF, 1,2,3,4,7,8-	1613B	PA DEP
70648-26-9	Soil	HXCDF, 1,2,3,4,7,8-	8290A	PA DEP
70648-26-9	Water	HXCDF, 1,2,3,4,7,8-	8290A	PA DEP
57117-44-9	Soil	HXCDF, 1,2,3,6,7,8-	1613B	PA DEP
57117-44-9	Water	HXCDF, 1,2,3,6,7,8-	1613B	PA DEP
57117-44-9	Soil	HXCDF, 1,2,3,6,7,8-	8290A	PA DEP
57117-44-9	Water	HXCDF, 1,2,3,6,7,8-	8290A	PA DEP
72918-21-9	Soil	HXCDF, 1,2,3,7,8,9-	1613B	PA DEP
72918-21-9	Water	HXCDF, 1,2,3,7,8,9-	1613B	PA DEP
72918-21-9	Soil	HXCDF, 1,2,3,7,8,9-	8290A	PA DEP
72918-21-9	Water	HXCDF, 1,2,3,7,8,9-	8290A	PA DEP
60851-34-5	Soil	HXCDF, 2,3,4,6,7,8-	1613B	PA DEP
60851-34-5	Water	HXCDF, 2,3,4,6,7,8-	1613B	PA DEP
60851-34-5	Soil	HXCDF, 2,3,4,6,7,8-	8290A	PA DEP

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60851-34-5	Water	HXCDF, 2,3,4,6,7,8-	8290A	PA DEP
55684-94-1	Water	HxCDF, Total	1613B	PA DEP
55684-94-1	Soil	HxCDF, Total	8290A	PA DEP
55684-94-1	Water	HxCDF, Total	8290A	PA DEP
193-39-5	Water	Indeno[1,2,3-cd]pyrene	625.1	PA DEP
193-39-5	Soil	Indeno[1,2,3-cd]pyrene	8270D	PA DEP
193-39-5	Water	Indeno[1,2,3-cd]pyrene	8270D	PA DEP
193-39-5	Soil	Indeno[1,2,3-cd]pyrene	8270D-SIM	PA DEP
193-39-5	Water	Indeno[1,2,3-cd]pyrene	8270D-SIM	PA DEP
78-59-1	Water	Isophorone	625.1	PA DEP
78-59-1	Soil	Isophorone	8270D	PA DEP
78-59-1	Water	Isophorone	8270D	PA DEP
67-63-0	Soil	Isopropanol	8260C	PA DEP
67-63-0	Water	Isopropanol	8260C	PA DEP
67-63-0	Soil	Isopropanol	8260D	PA DEP
67-63-0	Water	Isopropanol	8260D	PA DEP
7439-92-1	Water	Lead, Total	200.7	PA DEP
7439-92-1	Water	Lead, Total	200.8	PA DEP
7439-92-1	Soil	Lead, Total	6010D	PA DEP
7439-92-1	Water	Lead, Total	6010D	PA DEP
7439-92-1	Soil	Lead, Total	6020B	PA DEP
7439-92-1	Water	Lead, Total	6020B	PA DEP
7439-96-5	Soil	Manganese	6010D	PA DEP
7439-96-5	Water	Manganese	6010D	PA DEP
7439-97-6	Water	Mercury (elemental)	245.1	PA DEP
7439-97-6	Water	Mercury (elemental)	7470A	PA DEP
7439-97-6	Soil	Mercury (elemental)	7471B	PA DEP
67-56-1	Soil	Methanol	8015C	PA DEP
67-56-1	Water	Methanol	8015C	PA DEP
72-43-5	Water	Methoxychlor	608.3	PA DEP
72-43-5	Soil	Methoxychlor	8081B	PA DEP
72-43-5	Water	Methoxychlor	8081B	PA DEP
78-93-3	Soil	Methyl Ethyl Ketone (2-Butanone)	8260C	PA DEP
78-93-3	Water	Methyl Ethyl Ketone (2-Butanone)	8260C	PA DEP
78-93-3	Soil	Methyl Ethyl Ketone (2-Butanone)	8260D	PA DEP
78-93-3	Water	Methyl Ethyl Ketone (2-Butanone)	8260D	PA DEP
108-10-1	Water	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	624.1	PA DEP

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108-10-1	Soil	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	8260C	PA DEP
108-10-1	Water	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	8260C	PA DEP
108-10-1	Soil	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	8260D	PA DEP
108-10-1	Water	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	8260D	PA DEP
1634-04-4	Water	Methyl tert-Butyl Ether (MTBE)	624.1	PA DEP
1634-04-4	Soil	Methyl tert-Butyl Ether (MTBE)	8260C	PA DEP
1634-04-4	Water	Methyl tert-Butyl Ether (MTBE)	8260C	PA DEP
1634-04-4	Soil	Methyl tert-Butyl Ether (MTBE)	8260D	PA DEP
1634-04-4	Water	Methyl tert-Butyl Ether (MTBE)	8260D	PA DEP
75-09-2	Water	Methylene Chloride	524.2	PA DEP
75-09-2	Water	Methylene Chloride	624.1	PA DEP
75-09-2	Soil	Methylene Chloride	8260C	PA DEP
75-09-2	Water	Methylene Chloride	8260C	PA DEP
75-09-2	Soil	Methylene Chloride	8260D	PA DEP
75-09-2	Water	Methylene Chloride	8260D	PA DEP
90-12-0	Soil	Methylnaphthalene, 1-	8270D	PA DEP
90-12-0	Water	Methylnaphthalene, 1-	8270D	PA DEP
90-12-0	Soil	Methylnaphthalene, 1-	8270D-SIM	PA DEP
90-12-0	Water	Methylnaphthalene, 1-	8270D-SIM	PA DEP
91-57-6	Soil	Methylnaphthalene, 2-	8270D	PA DEP
91-57-6	Water	Methylnaphthalene, 2-	8270D	PA DEP
91-57-6	Soil	Methylnaphthalene, 2-	8270D-SIM	PA DEP
91-57-6	Water	Methylnaphthalene, 2-	8270D-SIM	PA DEP
91-20-3	Water	Naphthalene	524.2	PA DEP
91-20-3	Water	Naphthalene	624.1	PA DEP
91-20-3	Water	Naphthalene	625.1	PA DEP
91-20-3	Soil	Naphthalene	8260C	PA DEP
91-20-3	Water	Naphthalene	8260C	PA DEP
91-20-3	Soil	Naphthalene	8260D	PA DEP
91-20-3	Water	Naphthalene	8260D	PA DEP
91-20-3	Soil	Naphthalene	8270D	PA DEP
91-20-3	Water	Naphthalene	8270D	PA DEP
91-20-3	Soil	Naphthalene	8270D-SIM	PA DEP
91-20-3	Water	Naphthalene	8270D-SIM	PA DEP
2991-50-6	Water	n-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	537	PA DEP
2991-50-6	Water	n-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	537.1	PA DEP

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2991-50-6	Soil	N-ethyl Perfluorooctane-Sulfonamidoacetic Acid (NetFOSSA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
2991-50-6	Water	N-ethyl Perfluorooctane-Sulfonamidoacetic Acid (NetFOSSA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
N/A	Soil	N-ethylperfluoro-1-octanesulfonamide (NEtPFOSA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
N/A	Water	N-ethylperfluoro-1-octanesulfonamide (NEtPFOSA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
110-54-3	Water	n-Hexane	524.2	PA DEP
7440-02-0	Water	Nickel, Total	200.7	PA DEP
7440-02-0	Water	Nickel, Total	200.8	PA DEP
7440-02-0	Soil	Nickel, Total	6010D	PA DEP
7440-02-0	Water	Nickel, Total	6010D	PA DEP
7440-02-0	Soil	Nickel, Total	6020B	PA DEP
7440-02-0	Water	Nickel, Total	6020B	PA DEP
98-95-3	Water	Nitrobenzene	625.1	PA DEP
98-95-3	Soil	Nitrobenzene	8270D	PA DEP
98-95-3	Water	Nitrobenzene	8270D	PA DEP
98-95-3	Soil	Nitrobenzene	8330B	PA DEP
98-95-3	Water	Nitrobenzene	8330B	PA DEP
55-63-0	Soil	Nitroglycerin	8330B	PA DEP
55-63-0	Water	Nitroglycerin	8330B	PA DEP
62-75-9	Water	Nitrosodimethylamine, N-	625.1	PA DEP
62-75-9	Soil	Nitrosodimethylamine, N-	8270D	PA DEP
62-75-9	Water	Nitrosodimethylamine, N-	8270D	PA DEP
621-64-7	Water	Nitroso-di-N-propylamine, N-	625.1	PA DEP
621-64-7	Soil	Nitroso-di-N-propylamine, N-	8270D	PA DEP
621-64-7	Water	Nitroso-di-N-propylamine, N-	8270D	PA DEP
86-30-6	Water	Nitrosodiphenylamine, N-	625.1	PA DEP
86-30-6	Soil	Nitrosodiphenylamine, N-	8270D	PA DEP
86-30-6	Water	Nitrosodiphenylamine, N-	8270D	PA DEP
99-08-1	Soil	Nitrotoluene, m-	8330B	PA DEP
99-08-1	Water	Nitrotoluene, m-	8330B	PA DEP

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88-72-2	Soil	Nitrotoluene, o-	8330B	PA DEP
88-72-2	Water	Nitrotoluene, o-	8330B	PA DEP
99-99-0	Soil	Nitrotoluene, p-	8330B	PA DEP
99-99-0	Water	Nitrotoluene, p-	8330B	PA DEP
2355-31-9	Soil	N-methyl Perfluoroctane-Sulfonamidoacetic Acid (NMeFOSAA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
2355-31-9	Water	N-methyl Perfluoroctane-Sulfonamidoacetic Acid (NMeFOSAA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
2355-31-9	Water	n-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	537	PA DEP
2355-31-9	Water	n-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	537.1	PA DEP
N/A	Soil	N-methylperfluoro-1-octanesulfonamide (NMePFOSA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
N/A	Water	N-methylperfluoro-1-octanesulfonamide (NMePFOSA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
3268-87-9	Soil	OCDD	1613B	PA DEP
3268-87-9	Water	OCDD	1613B	PA DEP
3268-87-9	Soil	OCDD	8290A	PA DEP
3268-87-9	Water	OCDD	8290A	PA DEP
39001-02-0	Soil	OCDF	1613B	PA DEP
39001-02-2	Water	OCDF	1613B	PA DEP
39001-02-2	Soil	OCDF	8290A	PA DEP
39001-02-2	Water	OCDF	8290A	PA DEP
2691-41-0	Soil	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	8330B	PA DEP
2691-41-0	Water	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	8330B	PA DEP
117-84-0	Water	Octyl Phthalate, di-N-	625.1	PA DEP
117-84-0	Soil	Octyl Phthalate, di-N-	8270D	PA DEP
117-84-0	Water	Octyl Phthalate, di-N-	8270D	PA DEP
12674-11-2	Water	PCB - Aroclor-1016	608.3	PA DEP
12674-11-2	Soil	PCB - Aroclor-1016	8082A	PA DEP
12674-11-2	Water	PCB - Aroclor-1016	8082A	PA DEP
11104-28-2	Water	PCB - Aroclor-1221	608.3	PA DEP
11104-28-2	Soil	PCB - Aroclor-1221	8082A	PA DEP
11104-28-2	Water	PCB - Aroclor-1221	8082A	PA DEP

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CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
11141-16-5	Water	PCB - Aroclor-1232	608.3	PA DEP
11141-16-5	Soil	PCB - Aroclor-1232	8082A	PA DEP
11141-16-5	Water	PCB - Aroclor-1232	8082A	PA DEP
53469-21-9	Water	PCB - Aroclor-1242	608.3	PA DEP
53469-21-9	Soil	PCB - Aroclor-1242	8082A	PA DEP
53469-21-9	Water	PCB - Aroclor-1242	8082A	PA DEP
12672-29-6	Water	PCB - Aroclor-1248	608.3	PA DEP
12672-29-6	Soil	PCB - Aroclor-1248	8082A	PA DEP
12672-29-6	Water	PCB - Aroclor-1248	8082A	PA DEP
11097-69-1	Water	PCB - Aroclor-1254	608.3	PA DEP
11097-69-1	Soil	PCB - Aroclor-1254	8082A	PA DEP
11097-69-1	Water	PCB - Aroclor-1254	8082A	PA DEP
11096-82-5	Water	PCB - Aroclor-1260	608.3	PA DEP
11096-82-5	Soil	PCB - Aroclor-1260	8082A	PA DEP
11096-82-5	Water	PCB - Aroclor-1260	8082A	PA DEP
37324-23-5	Soil	PCB - Aroclor-1262	8082A	PA DEP
37324-23-5	Water	PCB - Aroclor-1262	8082A	PA DEP
11100-14-4	Soil	PCB - Aroclor-1268	8082A	PA DEP
11100-14-4	Water	PCB - Aroclor-1268	8082A	PA DEP
N/A	Soil	PCB – Total	8082A	PA DEP
N/A	Water	PCB – Total	8082A	PA DEP
40321-76-4	Soil	PECDD, 1,2,3,7,8-	1613B	PA DEP
40321-76-4	Water	PECDD, 1,2,3,7,8-	1613B	PA DEP
40321-76-4	Soil	PECDD, 1,2,3,7,8-	8290A	PA DEP
40321-76-4	Water	PECDD, 1,2,3,7,8-	8290A	PA DEP
36088-22-9	Water	PeCDD, Total	1613B	PA DEP
36088-22-9	Soil	PeCDD, Total	8290A	PA DEP
36088-22-9	Water	PeCDD, Total	8290A	PA DEP
57117-41-6	Soil	PECDF, 1,2,3,7,8-	1613B	PA DEP
57117-41-6	Water	PECDF, 1,2,3,7,8-	1613B	PA DEP
57117-41-6	Soil	PECDF, 1,2,3,7,8-	8290A	PA DEP
57117-41-6	Water	PECDF, 1,2,3,7,8-	8290A	PA DEP
57117-31-4	Soil	PECDF, 2,3,4,7,8-	1613B	PA DEP
57117-31-4	Water	PECDF, 2,3,4,7,8-	1613B	PA DEP
57117-31-4	Soil	PECDF, 2,3,4,7,8-	8290A	PA DEP
57117-31-4	Water	PECDF, 2,3,4,7,8-	8290A	PA DEP
30402-15-4	Water	PeCDF, Total	1613B	PA DEP

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30402-15-4	Soil	PeCDF, Total	8290A	PA DEP
30402-15-4	Water	PeCDF, Total	8290A	PA DEP
87-86-5	Water	Pentachlorophenol	625.1	PA DEP
87-86-5	Soil	Pentachlorophenol	8151A	PA DEP
87-86-5	Water	Pentachlorophenol	8151A	PA DEP
87-86-5	Soil	Pentachlorophenol	8270D	PA DEP
87-86-5	Water	Pentachlorophenol	8270D	PA DEP
78-11-5	Soil	Pentaerythritol tetranitrate (PETN)	8330B	PA DEP
78-11-5	Water	Pentaerythritol tetranitrate (PETN)	8330B	PA DEP
14797-73-0	Soil	Perchlorate and Perchlorate Salts	6850	PA DEP
14797-73-0	Water	Perchlorate and Perchlorate Salts	6850	PA DEP
375-73-5	Water	Perfluorobutanesulfonic acid (PFBS)	537	PA DEP
N/A	Soil	Perfluorobutanesulfonic Acid (PFBS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
N/A	Water	Perfluorobutanesulfonic Acid (PFBS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
375-22-4	Soil	Perfluorobutyric acid (PFBA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
375-22-4	Water	Perfluorobutyric acid (PFBA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
335-77-3	Soil	Perfluorodecane sulfonic acid (PFDS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
335-77-3	Water	Perfluorodecane sulfonic acid (PFDS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
335-76-2	Water	Perfluorodecanoic acid (PFDA)	537	PA DEP
335-76-2	Water	Perfluorodecanoic acid (PFDA)	537.1	PA DEP
335-76-2	Soil	Perfluorodecanoic acid (PFDA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA

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CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
335-76-2	Water	Perfluorodecanoic acid (PFDA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
79780-39-5	Soil	Perfluorododecanesulfonate (PFDoDS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
79780-39-5	Water	Perfluorododecanesulfonate (PFDoDS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
307-55-1	Water	Perfluorododecanoic acid (PFDoA)	537	PA DEP
307-55-1	Water	Perfluorododecanoic acid (PFDoA)	537.1	PA DEP
307-55-1	Soil	Perfluorododecanoic acid (PFDoA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
307-55-1	Water	Perfluorododecanoic acid (PFDoA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
375-92-8	Soil	Perfluoroheptanesulfonic acid (PFHpS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
375-92-8	Water	Perfluoroheptanesulfonic acid (PFHpS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
375-85-9	Water	Perfluoroheptanoic acid (PFHpA)	537	PA DEP
N/A	Soil	Perfluoroheptanoic Acid (PFHpA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
N/A	Water	Perfluoroheptanoic Acid (PFHpA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
67905-19-5	Soil	Perfluorohexadecanoic acid (PFHxDA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
67905-19-5	Water	Perfluorohexadecanoic acid (PFHxDA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
355-46-4	Water	Perfluorohexanesulfonic acid (PFHxS)	537	PA DEP

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N/A	Soil	Perfluorohexanesulfonic Acid (PFHxS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
N/A	Water	Perfluorohexanesulfonic Acid (PFHxS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
307-24-4	Water	Perfluorohexanoic acid (PFHxA)	537	PA DEP
307-24-4	Water	Perfluorohexanoic acid (PFHxA)	537.1	PA DEP
307-24-4	Soil	Perfluorohexanoic acid (PFHxA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
307-24-4	Water	Perfluorohexanoic acid (PFHxA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
68259-12-1	Soil	Perfluorononane sulfonic acid (PFNS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
68259-12-1	Water	Perfluorononane sulfonic acid (PFNS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
375-95-1	Water	Perfluorononanoic acid (PFNA)	537	PA DEP
N/A	Soil	Perfluorononanoic Acid (PFNA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
N/A	Water	Perfluorononanoic Acid (PFNA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
2706-90-3	Soil	Perfluoro-n-pentanoic Acid (PFPeA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
2706-90-3	Water	Perfluoro-n-pentanoic Acid (PFPeA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
16517-11-6	Soil	Perfluorooctadecanoic acid (PFODA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA

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16517-11-6	Water	Perfluorooctadecanoic acid (PFODA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
1763-23-1	Water	Perfluorooctane Sulphonic Acid (PFOS)	537	PA DEP
N/A	Soil	Perfluorooctanesulfonamide (PFOSA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
N/A	Water	Perfluorooctanesulfonamide (PFOSA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
N/A	Soil	Perfluorooctanesulfonic Acid (PFOS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
N/A	Water	Perfluorooctanesulfonic Acid (PFOS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
335-67-1	Water	Perfluorooctanoic acid (PFOA)	537	PA DEP
N/A	Soil	Perfluorooctanoic Acid (PFOA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
N/A	Water	Perfluorooctanoic Acid (PFOA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
2706-91-4	Soil	Perfluoropentane sulfonic acid (PFPeS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
2706-91-4	Water	Perfluoropentane sulfonic acid (PFPeS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
376-06-7	Water	Perfluorotetradecanoic acid (PFTA)	537	PA DEP
376-06-7	Water	Perfluorotetradecanoic acid (PFTA)	537.1	PA DEP
376-06-7	Soil	Perfluorotetradecanoic Acid (PFTeDa)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
376-06-7	Water	Perfluorotetradecanoic Acid (PFTeDa)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA

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CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
72629-94-8	Water	Perfluorotridecanoic acid (PFTrDA)	537	PA DEP
72629-94-8	Water	Perfluorotridecanoic acid (PFTrDA)	537.1	PA DEP
72629-94-8	Soil	Perfluorotridecanoic acid (PFTrDA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
72629-94-8	Water	Perfluorotridecanoic acid (PFTrDA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
2058-94-8	Water	Perfluoroundecanoic acid (PFUnA)	537	PA DEP
2058-94-8	Water	Perfluoroundecanoic acid (PFUnA)	537.1	PA DEP
2058-94-8	Soil	Perfluoroundecanoic Acid (PFUnDA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
2058-94-8	Water	Perfluoroundecanoic Acid (PFUnDA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	A2LA
85-01-8	Water	Phenanthrene	625.1	PA DEP
85-01-8	Soil	Phenanthrene	8270D	PA DEP
85-01-8	Water	Phenanthrene	8270D	PA DEP
85-01-8	Soil	Phenanthrene	8270D-SIM	PA DEP
85-01-8	Water	Phenanthrene	8270D-SIM	PA DEP
108-95-2	Water	Phenol	625.1	PA DEP
108-95-2	Soil	Phenol	8270D	PA DEP
108-95-2	Water	Phenol	8270D	PA DEP
7723-14-0	Soil	Phosphorus, White	365.1	PA DEP
7723-14-0	Water	Phosphorus, White	365.1	PA DEP
99-87-6	Water	p-Isopropyltoluene	524.2	PA DEP
103-65-1	Water	Propyl benzene	524.2	PA DEP
103-65-1	Water	Propyl benzene	624.1	PA DEP
103-65-1	Soil	Propyl benzene	8260C	PA DEP
103-65-1	Water	Propyl benzene	8260C	PA DEP
103-65-1	Soil	Propyl benzene	8260D	PA DEP
103-65-1	Water	Propyl benzene	8260D	PA DEP
129-00-0	Water	Pyrene	625.1	PA DEP
129-00-0	Soil	Pyrene	8270D	PA DEP
129-00-0	Water	Pyrene	8270D	PA DEP
129-00-0	Soil	Pyrene	8270D-SIM	PA DEP

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CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
129-00-0	Water	Pyrene	8270D-SIM	PA DEP
N/A	Soil	Residual Range Organics (C25 – C36)	AK 103	PA DEP
7782-49-2	Water	Selenium	200.8	PA DEP
7782-49-2	Water	Selenium	200.7	PA DEP
7782-49-2	Soil	Selenium	6010D	PA DEP
7782-49-2	Water	Selenium	6010D	PA DEP
7782-49-2	Soil	Selenium	6020B	PA DEP
7782-49-2	Water	Selenium	6020B	PA DEP
7440-22-4	Water	Silver	200.7	PA DEP
7440-22-4	Water	Silver	200.8	PA DEP
7440-22-4	Soil	Silver	6010D	PA DEP
7440-22-4	Water	Silver	6010D	PA DEP
7440-22-4	Soil	Silver	6020B	PA DEP
7440-22-4	Water	Silver	6020B	PA DEP
100-42-5	Water	Styrene	624.1	PA DEP
100-42-5	Soil	Styrene	8260C	PA DEP
100-42-5	Water	Styrene	8260C	PA DEP
100-42-5	Soil	Styrene	8260D	PA DEP
100-42-5	Water	Styrene	8260D	PA DEP
1746-01-6	Soil	TCDD, 2,3,7,8-	1613B	PA DEP
1746-01-6	Water	TCDD, 2,3,7,8-	1613B	PA DEP
1746-01-6	Soil	TCDD, 2,3,7,8-	8290A	PA DEP
41903-57-5	Water	TCDD, Total	1613B	PA DEP
41903-57-5	Soil	TCDD, Total	8290A	PA DEP
41903-57-5	Water	TCDD, Total	8290A	PA DEP
51207-31-9	Soil	TCDF, 2,3,7,8-	1613B	PA DEP
51207-31-9	Water	TCDF, 2,3,7,8-	1613B	PA DEP
51207-31-9	Soil	TCDF, 2,3,7,8-	8290A	PA DEP
51207-31-9	Water	TCDF, 2,3,7,8-	8290A	PA DEP
55722-27-5	Water	TCDF, Total	1613B	PA DEP
55722-27-5	Soil	TCDF, Total	8290A	PA DEP
55722-27-5	Water	TCDF, Total	8290A	PA DEP
630-20-6	Water	Tetrachloroethane, 1,1,1,2-	624.1	PA DEP
630-20-6	Soil	Tetrachloroethane, 1,1,1,2-	8260C	PA DEP
630-20-6	Water	Tetrachloroethane, 1,1,1,2-	8260C	PA DEP
630-20-6	Soil	Tetrachloroethane, 1,1,1,2-	8260D	PA DEP
630-20-6	Water	Tetrachloroethane, 1,1,1,2-	8260D	PA DEP

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CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
79-34-5	Water	Tetrachloroethane, 1,1,2,2-	624.1	PA DEP
79-34-5	Soil	Tetrachloroethane, 1,1,2,2-	8260C	PA DEP
79-34-5	Water	Tetrachloroethane, 1,1,2,2-	8260C	PA DEP
79-34-5	Soil	Tetrachloroethane, 1,1,2,2-	8260D	PA DEP
79-34-5	Water	Tetrachloroethane, 1,1,2,2-	8260D	PA DEP
127-18-4	Water	Tetrachloroethylene	624.1	PA DEP
127-18-4	Soil	Tetrachloroethylene	8260C	PA DEP
127-18-4	Water	Tetrachloroethylene	8260C	PA DEP
127-18-4	Soil	Tetrachloroethylene	8260D	PA DEP
127-18-4	Water	Tetrachloroethylene	8260D	PA DEP
479-45-8	Soil	Tetryl (Trinitrophenylmethylnitramine)	8330B	PA DEP
479-45-8	Water	Tetryl (Trinitrophenylmethylnitramine)	8330B	PA DEP
7440-28-0	Water	Thallium, Total	200.8	PA DEP
7440-28-0	Soil	Thallium, Total	6010D	PA DEP
7440-28-0	Water	Thallium, Total	6010D	PA DEP
7440-28-0	Soil	Thallium, Total	6020B	PA DEP
7440-28-0	Water	Thallium, Total	6020B	PA DEP
108-88-3	Water	Toluene	524.2	PA DEP
108-88-3	Water	Toluene	624.1	PA DEP
108-88-3	Soil	Toluene	8260C	PA DEP
108-88-3	Water	Toluene	8260C	PA DEP
108-88-3	Soil	Toluene	8260D	PA DEP
108-88-3	Water	Toluene	8260D	PA DEP
N/A	Soil	Total Organic Carbon	Lloyd Kahn	PA DEP
N/A	Water	Total Organic Carbon	SM 5310 C	PA DEP
8001-35-2	Water	Toxaphene	608.3	PA DEP
8001-35-2	Soil	Toxaphene	8081B	PA DEP
8001-35-2	Water	Toxaphene	8081B	PA DEP
76-13-1	Soil	Trichloro-1,2,2-trifluoroethane, 1,1,2- (Freon 113)	8260C	PA DEP
76-13-1	Water	Trichloro-1,2,2-trifluoroethane, 1,1,2- (Freon 113)	8260C	PA DEP
76-13-1	Soil	Trichloro-1,2,2-trifluoroethane, 1,1,2- (Freon 113)	8260D	PA DEP
76-13-1	Water	Trichloro-1,2,2-trifluoroethane, 1,1,2- (Freon 113)	8260D	PA DEP
87-61-6	Water	Trichlorobenzene, 1,2,3-	624.1	PA DEP
87-61-6	Soil	Trichlorobenzene, 1,2,3-	8260C	PA DEP
87-61-6	Water	Trichlorobenzene, 1,2,3-	8260C	PA DEP
87-61-6	Soil	Trichlorobenzene, 1,2,3-	8260D	PA DEP
87-61-6	Water	Trichlorobenzene, 1,2,3-	8260D	PA DEP

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CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
120-82-1	Water	Trichlorobenzene, 1,2,4-	624.1	PA DEP
120-82-1	Water	Trichlorobenzene, 1,2,4-	625.1	PA DEP
120-82-1	Soil	Trichlorobenzene, 1,2,4-	8260C	PA DEP
120-82-1	Water	Trichlorobenzene, 1,2,4-	8260C	PA DEP
120-82-1	Soil	Trichlorobenzene, 1,2,4-	8260D	PA DEP
120-82-1	Water	Trichlorobenzene, 1,2,4-	8260D	PA DEP
120-82-1	Soil	Trichlorobenzene, 1,2,4-	8270D	PA DEP
120-82-1	Water	Trichlorobenzene, 1,2,4-	8270D	PA DEP
71-55-6	Water	Trichloroethane, 1,1,1-	624.1	PA DEP
71-55-6	Soil	Trichloroethane, 1,1,1-	8260C	PA DEP
71-55-6	Water	Trichloroethane, 1,1,1-	8260C	PA DEP
71-55-6	Soil	Trichloroethane, 1,1,1-	8260D	PA DEP
71-55-6	Water	Trichloroethane, 1,1,1-	8260D	PA DEP
79-00-5	Water	Trichloroethane, 1,1,2-	624.1	PA DEP
79-00-5	Soil	Trichloroethane, 1,1,2-	8260C	PA DEP
79-00-5	Water	Trichloroethane, 1,1,2-	8260C	PA DEP
79-00-5	Soil	Trichloroethane, 1,1,2-	8260D	PA DEP
79-00-5	Water	Trichloroethane, 1,1,2-	8260D	PA DEP
79-01-6	Water	Trichloroethylene	624.1	PA DEP
79-01-6	Soil	Trichloroethylene	8260C	PA DEP
79-01-6	Water	Trichloroethylene	8260C	PA DEP
79-01-6	Soil	Trichloroethylene	8260D	PA DEP
79-01-6	Water	Trichloroethylene	8260D	PA DEP
75-69-4	Water	Trichlorofluoromethane	624.1	PA DEP
75-69-4	Soil	Trichlorofluoromethane	8260C	PA DEP
75-69-4	Water	Trichlorofluoromethane	8260C	PA DEP
75-69-4	Soil	Trichlorofluoromethane	8260D	PA DEP
75-69-4	Water	Trichlorofluoromethane	8260D	PA DEP
95-95-4	Water	Trichlorophenol, 2,4,5-	625.1	PA DEP
95-95-4	Soil	Trichlorophenol, 2,4,5-	8270D	PA DEP
95-95-4	Water	Trichlorophenol, 2,4,5-	8270D	PA DEP
88-06-2	Water	Trichlorophenol, 2,4,6-	625.1	PA DEP
88-06-2	Soil	Trichlorophenol, 2,4,6-	8270D	PA DEP
88-06-2	Water	Trichlorophenol, 2,4,6-	8270D	PA DEP
93-76-5	Soil	Trichlorophenoxyacetic Acid, 2,4,5- (2,4,5-T)	8151A	PA DEP
93-76-5	Water	Trichlorophenoxyacetic Acid, 2,4,5- (2,4,5-T)	8151A	PA DEP
93-72-1	Soil	Trichlorophenoxypropionic acid, 2,4,5- (2,4,5-TP)	8151A	PA DEP

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CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
93-72-1	Water	Trichlorophenoxypropionic acid, 2,4,5- (2,4,5-TP)	8151A	PA DEP
96-18-4	Water	Trichloropropane, 1,2,3-	624.1	PA DEP
96-18-4	Soil	Trichloropropane, 1,2,3-	8011	PA DEP
96-18-4	Soil	Trichloropropane, 1,2,3-	8260C	PA DEP
96-18-4	Water	Trichloropropane, 1,2,3-	8260C	PA DEP
96-18-4	Soil	Trichloropropane, 1,2,3-	8260D	PA DEP
96-18-4	Water	Trichloropropane, 1,2,3-	8260D	PA DEP
95-63-6	Water	Trimethylbenzene, 1,2,4-	524.2	PA DEP
95-63-6	Water	Trimethylbenzene, 1,2,4-	624.1	PA DEP
95-63-6	Soil	Trimethylbenzene, 1,2,4-	8260C	PA DEP
95-63-6	Water	Trimethylbenzene, 1,2,4-	8260C	PA DEP
95-63-6	Soil	Trimethylbenzene, 1,2,4-	8260D	PA DEP
95-63-6	Water	Trimethylbenzene, 1,2,4-	8260D	PA DEP
108-67-8	Water	Trimethylbenzene, 1,3,5-	524.2	PA DEP
108-67-8	Water	Trimethylbenzene, 1,3,5-	624.1	PA DEP
108-67-8	Soil	Trimethylbenzene, 1,3,5-	8260C	PA DEP
108-67-8	Water	Trimethylbenzene, 1,3,5-	8260C	PA DEP
108-67-8	Soil	Trimethylbenzene, 1,3,5-	8260D	PA DEP
108-67-8	Water	Trimethylbenzene, 1,3,5-	8260D	PA DEP
99-35-4	Soil	Trinitrobenzene, 1,3,5- (1,3,5-TNB)	8270D	PA DEP
99-35-4	Water	Trinitrobenzene, 1,3,5- (1,3,5-TNB)	8270D	PA DEP
99-35-4	Soil	Trinitrobenzene, 1,3,5- (1,3,5-TNB)	8330B	PA DEP
99-35-4	Water	Trinitrobenzene, 1,3,5- (1,3,5-TNB)	8330B	PA DEP
118-96-7	Soil	Trinitrotoluene, 2,4,6-	8330B	PA DEP
118-96-7	Water	Trinitrotoluene, 2,4,6-	8330B	PA DEP
7440-62-2	Water	Vanadium, Total	200.7	PA DEP
7440-62-2	Water	Vanadium, Total	200.8	PA DEP
7440-62-2	Soil	Vanadium, Total	6010D	PA DEP
7440-62-2	Water	Vanadium, Total	6010D	PA DEP
7440-62-2	Soil	Vanadium, Total	6020B	PA DEP
7440-62-2	Water	Vanadium, Total	6020B	PA DEP
108-05-4	Water	Vinyl Acetate	624.1	PA DEP
108-05-4	Soil	Vinyl Acetate	8260C	PA DEP
108-05-4	Water	Vinyl Acetate	8260C	PA DEP
108-05-4	Soil	Vinyl Acetate	8260D	PA DEP
108-05-4	Water	Vinyl Acetate	8260D	PA DEP
75-01-4	Water	Vinyl Chloride	624.1	PA DEP

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CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
75-01-4	Soil	Vinyl Chloride	8260C	PA DEP
75-01-4	Water	Vinyl Chloride	8260C	PA DEP
75-01-4	Soil	Vinyl Chloride	8260D	PA DEP
75-01-4	Water	Vinyl Chloride	8260D	PA DEP
N/A	Water	Xylene, m+p-	524.2	PA DEP
N/A	Water	Xylene, m+p-	624.1	PA DEP
N/A	Soil	Xylene, m+p-	8260C	PA DEP
N/A	Water	Xylene, m+p-	8260C	PA DEP
N/A	Soil	Xylene, m+p-	8260D	PA DEP
N/A	Water	Xylene, m+p-	8260D	PA DEP
95-47-6	Water	Xylene, o-	524.2	PA DEP
95-47-6	Water	Xylene, o-	624.1	PA DEP
95-47-6	Soil	Xylene, o-	8260C	PA DEP
95-47-6	Water	Xylene, o-	8260C	PA DEP
95-47-6	Soil	Xylene, o-	8260D	PA DEP
95-47-6	Water	Xylene, o-	8260D	PA DEP
1330-20-7	Water	Xylene, Total	624.1	PA DEP
1330-20-7	Soil	Xylene, Total	8260C	PA DEP
1330-20-7	Water	Xylene, Total	8260C	PA DEP
1330-20-7	Soil	Xylene, Total	8260D	PA DEP
1330-20-7	Water	Xylene, Total	8260D	PA DEP
7440-66-6	Water	Zinc, Total	200.7	PA DEP
7440-66-6	Water	Zinc, Total	200.8	PA DEP
7440-66-6	Soil	Zinc, Total	6010D	PA DEP
7440-66-6	Water	Zinc, Total	6010D	PA DEP
7440-66-6	Soil	Zinc, Total	6020B	PA DEP
7440-66-6	Water	Zinc, Total	6020B	PA DEP

ATTACHMENT G

Eurofins PFAS SOP

Document number: **T-PFAS-WI36458**	Always check on-line for validity. **Polyfluorinated Alkyl Substances (PFAS) in Aqueous Samples by Method 537 Version 1.1 Modified QSM5.3 Table B-15 Using LC/MS/MS**	Level: **Work Instruction**
Old Reference:		
Version: **1**		Organisation level: **5-Sub-BU**
Approved by: **UDM6** Effective Date **28-JAN-2021**	Document users: **5_EUUSLA_PFAS_Manager, 6_EUUSLA_PFAS_Analyst, 6_EUUSLA_PFAS_Data_Reviewers, 6_EUUSLA_PFAS_Management_Team, 6_EUUSLA_PFAS_Sample_Prep**	Responsible: **5_EUUSLA_PFAS_Manager**

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Revision Log

	Revision: 01	**Effective date:** This version
Section	**Justification**	**Changes**
	New document	

Reference

1. Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LCMSMS), EPA 537 Version 1.1, September 2009. Department of Defense Quality System Manual Version 5.3, Table B-15.

2. US EPA Method 537 Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LCMSMS), Version 1.1, September 2009.

3. Standard Test Method for Determination of Perfluorinated Compounds in Soil by Liquid Chromatography Tandem Mass Spectrometry (LC/MS/MS), ASTM Method D7968, 2014.

4. ISO 25101:2009(E) Water quality - Determination of perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA) - Method for unfiltered samples using solid phase extraction and liquid chromatography/mass spectrometry, March 2009.

5. Method for Trace Level Analysis of C8, C9, C10, C11, and C13 Perfluorocarbon Carboxylic Acids in Water. Karen Risha, John Flaherty, Roice Wille, Warren Buck, Francesco Morandi, and Tsuguhide Isemura. Anal. Chem. 2005, 77, 1503-1508.

6. *Chemical Hygiene Plan*, current version.

Cross Reference

Document	Document Title
T-PEST-WI9847	Common Equations Used During Chromatographic Analyses
T-PFAS-WI13881	Standards Management in the PFAS Laboratory
QA-SOP11178	Demonstrations of Capability
QA-SOP11892	Determining Method Detection Limits and Limits of Quantitation

Scope

This method is applicable for the determination of selected per- and polyfluorinated alkyl substances (PFAS) in aqueous samples to include non-potable waters and non-regulatory potable water when directed by the client. The compounds analyzed in this method are listed in the table below. The most current MDLs and LOQs are listed in the LIMS.

Analyte	Acronym	CAS#
Perfluorobutanesulfonic acid	PFBS	375-73-5
Perfluorodecanoic acid	PFDA	335-76-2
Perfluorododecanoic acid	PFDoDA	307-55-1
Perfluoroheptanoic acid	PFHpA	375-85-9
Perfluorohexanesulfonic acid	PFHxS	355-46-4
Perfluorohexanoic acid	PFHxA	307-24-4
Perfluorononanoic acid	PFNA	375-95-1
Perfluorooctanesulfonic acid	PFOS	1763-23-1
Perfluorooctanoic acid	PFOA	335-67-1
Perfluorotetradecanoic acid	PFTeDA	376-06-7

Perfluorotridecanoic acid	PFTrDA	72629-94-8
Perfluoroundecanoic acid	PFUnDA	2058-94-8
Perfluoro-n-butanoic acid	PFBA	375-22-4
Perfluoro-n-pentanoic acid	PFPeA	2706-90-3
8:2 - Fluorotelomersulfonic acid	8:2FTS	39108-34-4
N-methylperfluoro-1-octanesulfonamidoacetic acid	NMeFOSAA	2355-31-9
N-ethylperfluoro-1-octanesulfonamidoacetic acid	NEtFOSAA	2991-50-6
4:2-Fluorotelomersulfonic acid	4:2-FTS	757124-72-4
Perfluoropentanesulfonic acid	PFPeS	2706-91-4
6:2-Fluorotelomersulfonic acid	6:2-FTS	27619-97-2
Perfluoroheptanesulfonic acid	PFHpS	375-92-8
Perfluorononanesulfonic acid	PFNS	68259-12-1
Perfluorodecanesulfonic acid	PFDS	335-77-3
10:2-Fluorotelomersulfonic acid	10:2-FTS	120226-60-0
Perfluorododecanesulfonic acid	PFDoDS	79780-39-5
Perfluorohexadecanoic acid	PFHxDA	67905-19-5
Perfluorooctadecanoic acid	PFODA	16517-11-6
Perfluorooctanesulfonamide	PFOSA	754-91-6
2-(N-methylperfluoro-1-octanesulfonamido)-ethanol	NMePFOSAE	24448-09-7
N-methylperfluoro-1-octanesulfonamide	NMePFOSA	31506-32-8
2-(N-ethylperfluoro-1-octanesulfonamido)-ethanol	NEtPFOSAE	1691-99-2
N-ethylperfluoro-1-octanesulfonamide	NEtPFOSA	4151-50-2
2,3,3,3-Tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)-propanoic acid	HFPODA	13252-13-6
4,8-Dioxa-3H-perfluorononanoic acid	DONA **	919005-14-4 *
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1 *
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9 *

* = CAS number for the free acid form of the analyte.

** = The acronym for the free acid form of the analyte.

Basic Principles

A 250-mL aqueous sample is fortified with isotopically-labeled extraction standards and is passed through a solid phase extraction (SPE) cartridge to extract the analytes. The compounds are eluted from the solid phase with a combination of solvents. The extract is concentrated to ~400-500µl with nitrogen in a heated water bath, and then reconstituted to 1ml with methanol. The sample extract is analyzed by LC/MS/MS operated in negative electrospray ionization (ESI) mode for detection and quantification of the analytes. Quantitative analysis is performed using isotope dilution.

Reference Modifications

EPA Method 537 is written specifically for the analysis of drinking water samples. The following modifications to the method have been made to accommodate all aqueous samples.

1. A labeled isotopic analog is spiked into samples for all compounds where an isotopic analog is commercially available. These isotopic compounds are referred to as extraction standards. For those compounds, an isotope dilution calibration model is used. Where labeled isotopes are not available, an internal standard calibration model using the extraction standards is used.

2. Field reagent blanks are not processed as listed in EPA 537 Version 1.1 section 8.3.

3. Trizma is not used for waters except in the cases where the water comes from a chlorinated water source.

4. Peak asymmetry factors are not calculated.

5. MRL confirmation is not performed.

6. Spike concentrations are not rotated between low, medium and high levels.

7. SPE is used for sample preparation. Cartridge types and elution profiles differ from EPA 537 Version 1.1.

MDL studies and IDOCs have been performed to validate method performance.

Interferences

Compounds which have similar structures to the compounds of interest and similar molecular weights would potentially interfere. Method interferences may be caused by contaminants in solvents, reagents (including reagent water), sample bottles and caps, and other sample processing hardware that lead to discrete artifacts and/or elevated baselines in the chromatograms. The analytes in this method can also be found in many common laboratory supplies and equipment, such as PTFE (polytetrafluoroethylene) products, LC solvent lines, methanol, aluminum foil, etc. A laboratory blank is performed with each batch of samples to demonstrate that the extraction system is free of contaminants.

Precaution to Minimize Method Interference

1. LC system components may contain the target analytes. To minimize the background PFAS peaks, PTFE solvent frits and tubing are placed by PEEK solvent frits and tubing where possible.

2. PROPRIETARY

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

Safety Precautions and Waste Handling

See *Chemical Hygiene Plan* for general information regarding employee safety, waste management, and pollution prevention.

The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined. PFOA has been described as “likely to be carcinogenic to humans”. Each chemical should be treated as a potential health hazard and exposure to these chemicals should be minimized.

Exposure to these chemicals must be reduced to the lowest possible level by whatever means available, such as fume hoods, lab coats, safety glasses, and gloves. Gloves, lab coats, and safety glasses should be worn when preparing standards and handling samples. Avoid inhaling solvents and chemicals and getting them on the skin. Wear gloves when handling neat materials. When working with acids and bases, take care not to come in contact and to wipe any spills. Always add acid to water when preparing reagents containing concentrated acids.

All laboratory waste is accumulated, managed, and disposed of in accordance with all Federal, State, and local laws and regulations. All solvent waste and extracts are collected in approved solvent waste containers in the laboratory and subsequently emptied by personnel trained in hazardous waste disposal into the lab-wide disposal facility. HPLC vials are disposed of in the lab container for waste vials, and subsequently lab packed. Any solid waste material (disposable pipettes and broken glassware, etc.) may be disposed of in the normal solid waste collection containers.

Personnel Training and Qualifications

All personnel performing this procedure must have documentation of reading, understanding, and agreeing to follow the current version of this SOP and an annual documented Demonstration of Capability (DOC).

Each chemist performing the extraction must work with an experienced employee for a period of time until they can independently perform the extraction. Also, several batches of sample extractions must be performed under the direct observation of another experienced chemist to assure the trainee is capable of independent preparation. Proficiency is measured through a documented Initial Demonstration of Capability (IDOC).

Each LC/MS/MS analyst must work with an experienced employee for a period of time until they can independently calibrate the LC/MS/MS, review and process data, and perform maintenance procedures. Proficiency is measured through a documented Initial Demonstration of Capability (IDOC).

The IDOC and DOC consist of four laboratory control samples (or alternatively, one blind sample for the DOC) that is carried through all steps of the extraction and meets the defined acceptance criteria. The criteria include the calculation of mean accuracy and standard deviation.

See *QA-SOP11178* for additional information on IDOC and DOC.

Sample Collection, Preservation, and Handling

A. Sample Collection

The samples are collected in 250-mL polyethylene bottles. Keep the sample sealed from time of collection until extraction.

NOTE: PFAS contamination during sampling can occur from a number of common sources, such as food packaging and certain foods and beverages. Proper hand washing and wearing nitrile gloves will aid in minimizing this type of accidental contamination of the samples.

B. Sample Storage and Shipment

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

2. Samples stored in the lab must be held at a temperature of 0° to 6°C, not frozen, until extraction.

3. Water samples must be extracted within 14 days. Extracts must be analyzed within 28 days after extraction. Extracts are stored at room temperature.

Apparatus and Equipment

A. Apparatus

1. 250mL HDPE bottles: Scientific Specialties; # 334008-blk-1, or equivalent.

2. Centrifuge tubes – 15-mL conical polypropylene with polypropylene screw caps; Fisher Scientific, Cat. No. 05-539-5 or equivalent

3. 10-mL polypropylene volumetric flask, class A – Fisher Scientific, Inc., Cat. No. S02288 or equivalent.

4. HPDE bottles for extraction fluid storage: L; Environmental Sampling Supply, Cat. No. 1000-1902-PC

5. Analytical Balance – Capable of weighing to 0.0001 g

6. Top-Loading Balance – Capable of weighing to 0.01 g

7. PROPRIETARY

8. PROPRIETARY

9. PROPRIETARY

10. SPE vacuum extraction manifold –“Resprep” 24-port manifold; Restek Corp catalogue # 26080, or equivalent.

11. PROPRIETARY

12. Centrifuge – "Q-Sep 3000"; Restek Corp. Cat. No. 26230, or equivalent, capable of a minimum rotational speed of 3000 rpm.

13. Disposable polyethylene pipette – Fisher Scientific, Cat. No. S30467-1 or equivalent

14. Auto Pipettes – Eppendorf; capable of accurately dispensing 10- to 1000-µL. Fisher Scientific cat # 14-287-150, or equivalent.

15. Polypropylene pipette tips: 0-200µl. Fisher; Cat. No. 02-681-135

16. Polypropylene pipette tips: 101-1000µl. Fisher, Cat. No. 02-707-508

17. Pipettes – Disposable transfer. Fisher Scientific, Cat. No. 13-711-7M

18. Vortex mixer, variable speed, Fisher Scientific or equivalent

19. N-Evap sample extract concentrator with N_2 supply and water bath for temperature control. Organomation, Inc. Cat. #11250, or equivalent.

20. Reagent Water Purification System: Capable of producing ultrapure "Type 1/Milli-Q"-grade water from in-house deionized water system. Millipore SAS; Cat. No. FTPF08831.

21. Thermo Target PP Polyspring inserts, catalog number C4010-630P

22. Agilent 9mm vial kit pack, catalog number 5190-2278, or equivalent

23. Centrifuge tubes – 50 mL conical polypropylene with polypropylene screw caps; Fisher Scientific, Cat. No. 06-443-21 or equivalent

24. Polypropylene bottles for standard storage - 4 mL; Fisher Scientific, Cat. No. 2006-9125

B. Equipment

1. AB Sciex Triple Quad 4500/5500/5500 Plus Turbo V Ion Source
   ExionLC Controller
   ExionLC AC Pump
   ExionLC AC Autosampler
   Exion AC Column Oven
   Data system –Analyst 1.7

2. HPLC columns

   PROPRIETARY

Reagents and Standards

All solvents, acids, and bases are stored in glass bottles in flammable proof cabinets or pressure resistant steel drums. Solvents, acids, and bases are stored at ambient temperature for up to 1 year. All non-solvents are stored according to manufacturer's storage conditions.

A. Reagents:

1. Methanol (MeOH) – Honeywell Burdick and Jackson "Chromasolv LC-MS" grade Cat. No. BJ34966-4L or equivalent

2. Through 8. – PROPRIETARY

B. Standards: See SOP *T-PFAS-WI13881*.

Calibration

A. Initial Calibration

1. A minimum of five calibration standards are required. In general, Cal1, Cal2, Cal3, Cal4, Cal5, Cal6, and Cal 7 are included in the initial calibration. The calibration standards contain the branched isomers for PFHxS, PFOS, NMeFOSAA and NEtFOSAA. S/N ratio must be greater than or equal to 10:1 for all ions used for quantification.

2. Analyze a Cal3 level standard that contains linear and branch chained isomers of PFOA. The analysis of this standard is used to demonstrate where the branch chained isomers elute and not included in the calibration curve. This will assist the chemist in identifying and properly integrating this compound in samples.

3. Isotopically-labeled compounds are not available for PFPeS, PFHpS, PFNS, PFDS, PFDoS, 10:2-FTS, PFTrA, PFHxDA, PFODA, DONA, 9Cl-PF3ONS, and 11Cl-PF3OUdS. See below for referenced extraction standards. See *Attachment 2* for additional information about compound relationships.

Compound	Extraction standard
10:2-FTS	13C2-8:2-FTS
PFTrDA	13C2-PFDoDA
PFHxDA	13C2-PFTeDA
PFODA	
PFPeS	13C3-PFBS
PFHpS	13C3-PFHxS
DONA	13C4-PFHpA
PFNS	13C8-PFOS
PFDS	
PFDoS	
9Cl-PF3ONS	
11Cl-PF3OUdS	

4. Fit the curve

a. If the % RSD for the response factors is less than or equal to 20%, the average response factor (Ave RRF) can be used to quantitate the data.

b. If the %RSD is greater than 20%, then a linear regression with a concentration weighing factor of 1/x forced through zero is tried for the compounds not meeting the criteria in 4.a. R^2 for each analyte using the linear regression must be greater than or equal to 0.99.

c. If the linear regression curve fails, then a quadratic regression with a concentration weighing factor $1/x^2$ is tried for the compounds not meeting 4.a or 4.b. R^2 for each analyte using the quadratic regression must be greater than or equal to 0.99. A minimum or six standards must be analyzed to use a quadratic fit.

d. For all curve fits, each calibration point is calculated back against the curve. The back calculated concentration should be within ±30% of its true value.

e. If the criteria are not met, the source of the problem must be determined and corrected. Situations may exist where the initial calibration can be used. In those cases, the data will be reported with a qualifying comment.

NOTE: The concentrations referenced for the sulfonate salts, (for example PFBS, PFHxS and PFOS) have already been corrected to the acid form by the standards supplier as noted in the example Certificate of Analysis (CofA). See *Attachment 4*.

5. Initial Calibration Verification (ICV)

A check standard prepared from a second source (ICV) is injected to confirm the validity of the calibration curve/standard. If a second source is not available, a separate preparation from the same stock may be used. The calculated amount for each analyte must be within ± 30% of the true value. If this criteria is not met, re-inject or remake the standard. If the criteria is still not met, recalibration is necessary. Instrument maintenance may be needed prior to recalibrating.

B. Continuing Calibration

1. Once the calibration curve has been established, the continuing accuracy must be verified by analysis of a continuing calibration verification (CCV) standard every ten field samples and at the end of the analysis sequence.

a. The CCV run after the initial calibration must be at the CAL3 level.

b. The CCV standards must alternate between the CAL2, CAL3, and CAL4 levels.

2. Acceptance criteria

a. The calculated amount for each native compound in the CCV standard must be within ±30% of the true value. Samples that are not bracketed by acceptable CCV analyses must be reanalyzed. The exception to this would be if the CCV recoveries are high, indicating increased sensitivity, and there are no positive detections in the associated samples, the data may be reported with a qualifying comment.

b. The absolute areas of the extraction standards for the opening CCV on the day following the ICAL should be within 50-150% of the areas measured during the initial calibration CAL3 standard. On subsequent days where an ICAL is not performed, the absolute areas of the extraction standards from the opening CCV are compared to the absolute areas of the extraction standards from the previous day's opening CCV and should be within 50-150%.

c. If acceptance criteria are not met, immediately analyze two additional consecutive CCVs. If both pass acceptance criteria, samples may be reported without reanalysis. If either fails, or two consecutive CCVs cannot be run, repeat CCV and reanalyze all samples since last successful CCV.

Procedure

A. Sample Preparation

1. Weigh sample container with contents on a calibrated top loading balance and record the first reading in the automated prep entry system.

a. For all samples, the full bottle must be extracted.

b. If the sample matrix is such that SPE extraction cannot be performed, the client must be contacted to determine if using a reduced volume is an acceptable alternative. If the client directive is to use a reduced sample volume, see Procedure C.

c. If the sample has dissolved and/or settleable solid content (i.e; is cloudy or has a layer of sediment/solids at the bottom of the bottle), the sample must be centrifuged in order to minimize the difficulty of passing through the SPE sorbent bed. In order to preserve the integrity of the sample and ensure the full volume of the container is used, see Procedure D.

2. Use a 250-mL HDPE bottle for the method blank and the laboratory control sample (LCS) and LCSD if needed. Fill each bottle with 250 ml of Milli-Q water. Record 250 mL as the volume for the batch QC samples on the batchlog.

B. Solid Phase Extraction (SPE)

1. Through 16. – PROPRIETARY

17. Reconstitute to 1.0 mL with 100% methanol. Vortex to mix. Centrifuge 15 mL collection tubes for one full cycle.

18. Place each empty sample bottle on the top-loading balance and weigh. Record the second reading in the automated prep entry system. The prep entry system will calculate the sample weight. Record the calculated weight as the sample volume on the batchlog.

Note: The instrument lab chemist performs the next steps.

19. Transfer 400 µL of the final extract to the corresponding labeled auto-sampler vial. Cap and vortex the auto-sampler vial. Samples are now ready for analysis.

20. Cap the centrifuge tube. Store the remaining centrifuged extracts at room temperature for dilution or reinjection if needed.

C. Reduced Sample Volume

1. Determine the aliquot to be used for extraction (i.e.; 50 mL, 100 mL).

2. Label a clean 250-mL HDPE bottle with the associated ELLE sample number.

3. Label the appropriate number of 50-mL centrifuge tubes with the associated ELLE sample number. The number required will be determined by the volume to be used for extraction.

4.Shake/invert the sample bottle to thoroughly mix the sample before pouring aliquot(s).

5. Pour sample from original bottle into centrifuge tubes. Cap tubes and centrifuge for 5 minutes at full speed (one full cycle).

6. On a calibrated, top-loading balance, place labeled empty 250 mL PP wide-mouthed bottle.

7. Decant centrifuged sample aliquot(s) from centrifuge tube(s) to the 250 mL bottle until desired volume (weight in grams) is reached. 100 g = 100 mL, 50 g = 50 mL, etc. If the weight is exceeded, remove excess volume with a disposable pipette and discard to a waste container.

8. Add Milli-Q water to the bottle until a weight of 250 g (total of 250 mL) is reached.

9. Shake/invert several times to mix thoroughly.

10. Record the aliquot taken from the original bottle (50 mL, 100 mL) as the sample volume.

11. Extract sample beginning with Procedure B.

D. Samples Containing Dissolved and/or Settleable Solids

1. Spike sample with appropriate spikes as in Procedure B.5.

2. Centrifuge the full bottle.

3. DO NOT SHAKE BOTTLE FOLLOWING THE CENTRIFUGE STEP.

4. Follow steps in Procedure B, 1 through 3.

5. Attach a 25-mL SPE reservoir to each cartridge. Decant centrifuged sample onto its respective SPE cartridge. Allow full volume to pass through each cartridge by gravity, if possible. Apply light vacuum if necessary. The drip rate should be approximately 1-2 drops per second.

6. Rinse the sample bottle with 5 mL of Milli-Q water, add the rinseate to the cartridge, and repeat.

7. Continue extraction process with Procedure B. 7.

E. LC/MS/MS Analysis

1. Mass Calibration and Tuning

a. At instrument set up and installation and after the performance of major maintenance, calibrate the mass scale of the MS with calibration compounds and procedures described by the manufacturer. The entire mass range must be calibrated.

b. When masses fall outside of the ±0.5 amu of the true value, the instrument must be retuned using PPG according to the manufacturer's specifications. Mass assignments of the tuning standard must be within 0.5 amu of the true value. Refer to the instrument manufacturer’s instructions for tuning and conditions. These values are stored in the tune file for future reference.

2. The mass spectral acquisition rate must include a minimum of 10 spectra scans across each chromatographic peak. See the AB Sciex (4500/5500/5500 plus) Acquisition, Quantitation, Gradient, and detector condition files for the most up to date chromatographic conditions. Modifications to these conditions can be made at the discretion of the analyst to improve resolution or the chromatographic process.

3. Acquisition method: PROPRIETARY

4. Two ion transitions and the ion transition ratio per analyte shall be monitored and documented with the exception of PFBA, PFPeA, PFOSA, NMePFOSAE, NMEPFOSA, NEtPFOSAE, and NEtPFOSA. See *Attachment 1*.

5. Instrument Sensitivity Check (ISC) and Instrument Blanks

a. Prior to sample analysis and at least every 12 hours, an instrument sensitivity check (ISC) must be performed. The ISC standard concentration must be at the LOQ. The CAL2 standard's concentration is at the LOQ. The CAL2 standard will be analyzed. All analyte concentrations must be within ±30% of their true values. If the criteria is not met, correct problem and rerun ISC. If problem persists, repeat the ICAL. No samples can be analyzed until the ISC meets acceptance criteria.

b. Instrument blanks need to be analyzed immediately following the highest standard analyzed and daily or at the start of a sequence. The concentration of all analytes must be less than or equal to 1/2 the LOQ. If acceptance criteria are not met the calibration must be performed using a lower concentration standard for the high standard until the criteria are met.

6. Load sample vials containing standards, quality control samples, and sample extracts into autosampler tray. Allow the instrument adequate time to equilibrate to ensure the mass spec and LC have reached operating conditions (approximately 5 minutes) before the first injection. Analyze several solvent blanks to clean the instrument prior to sample acquisition.

7. After the initial calibration, inject an instrument blank, followed by the ICV, Linear Branched (L/B) standard, closing Cal3 level CCV, extraction batch QC, and samples. Bracket each set of ten samples with a CCV standard, alternating between the Cal2, Cal3, and Cal4 levels.

8. After injections are completed, check all CCV recoveries and absolute areas to make sure they are within method control limits. See Calibration section B.2 for acceptance criteria. Process each chromatogram and closely evaluate all integrations, baseline anomalies, and retention time differences. If manual integrations are performed, they must be documented and a reason given for the change in integrations. The manual integrations are documented during data processing and all original integrations are reported at the end of the sample PDF file with the reason for manual integration clearly listed.

9. Quantitate results for the extraction blank. No target analytes detected greater than 1/2 the LOQ or greater than 1/10 the regulatory limit, whichever is greater. If criteria is exceeded, reextract all samples with positive detections associated with the method blank. If the target analyte in the sample is detected at a concentration greater than 10 times the amount detected in the method blank, the data is reported.

10. Calculate the recoveries of spiked analytes for the LCS, matrix spike and matrix spike duplicate (MS/MSD) by comparing concentrations observed to the true values.

a. Method defined limits are used for the evaluation of the LCS and MS/MSD recoveries. Where there are no limits stated an advisory window of 70-130% will be used until sufficient data points are available to generate statistical windows. The QC acceptance limit for the relative percent difference (%RPD) between LCS/LCSD and MS/MSD is less than or equal to 30%.

b. If LCS and/or LCSD recoveries are acceptable, proceed to sample quantitation.

c. If the LCS recoveries are above QC acceptance criteria and there are no detections for the compound(s) in the associated sample(s), the data can be reported with a qualifying comment. In all other cases, the samples associated with the LCS must be reextracted.

d. If MS/MSD recoveries are outside QC acceptance criteria, the associated data will be flagged or noted in the comments section of the report.

11. Isotopically-labeled extraction standards are added to all samples, extraction blank, LCS/LCSD, and MS/MSD prior to extraction. The absolute areas of the extraction standards must be within ±50% of the areas measured in the ICAL mid-point standard (CAL3 standard). On days when an ICAL is not performed, the absolute areas must be within ±50% of the absolute areas measured in the daily opening initial CCV. If the extraction standards fall outside the acceptance window, analyze a second aliquot of the extract. If none

remains, reanalyze the first aliquot.

Refer to *Attachment 5* for the Eurofins DOD variances for isotopically labeled recoveries. If these variances are accepted by the client, the laboratory will follow these guidelines in determining when to re-extract samples. If the client does not accept these variances, samples with recoveries that are outside the ±50% of the true value acceptance criteria must be re-extracted.

12. Compare the retention times of all of the analytes and extraction standards to the retention time from the initial calibration. The retention times should not vary from the expected retention time by more than:

a. 0.4 minutes for isotopically-labeled compounds

b. 0.1 minutes from their analog for native compounds with an exact isotopically-labeled compound

c. 0.4 minutes from their assigned analog for native compounds without an exact isotopically-labeled compound.

If the retention time is outside of the criteria, the compound is considered a false positive unless it is a compound with branched isomers. Compounds with branched isomers can vary in intensity of the individual isomers that are used for reporting and must be reviewed and compared to the preceding CCV to determine if it should be reported.

13. Two ion transitions and the ion transition ratio per analyte shall be monitored and documented with the exception of PFBA, PFPeA, PFOSA, NMePFOSAE, NMEPFOSA, NEtPFOSAE, and NEtPFOSA. The expected ion ratio for each compound is calculated by using the average of ion ratios of each compound from initial calibration standards. When an ion ratio for a compound differs from the expected ion ratio by more than 50%, a qualifier is placed on the raw data and on the sample report. No corrective action is required.

14. The linear/branch chain standard is used when assessing the correctness of the computer generated peak integrations for PFOA.

15. If the calculated concentration exceeds the calibration range of the system, determine the appropriate dilution required and dilute the extract with MeOH. If the sample dilution required exceeds 100 fold, the client must be contacted to determine if the data can be reported with result(s) that exceed the calibration range or if the sample should be re-prepped at a reduced volume.

Dilution Example 1/10: Mix 900 µL of MeOH with 100 µL of sample extract. Vortex to mix. Using an auto-pipette, transfer 400 µL of the mixed solution into a labeled auto-sampler vial containing a plastic insert. Cap and vortex thoroughly to mix.

Calculations

A. Peak Area Ratio

$$\text{Peak Area Ratio} = \frac{\text{Analyte Response}}{\text{Labeled Analyte Response}}$$

B. On-Column Analyte Concentration using linear through zero curves

On-column Concentration = (peak area ratio x Isotope Dilution Analyte concentration) ÷ slope

C. Sample Concentration

Sample concentration (ng/l) = (On-column concentration x Final Sample volume x DF) ÷ Sample weight

D. Ion Ratio

ion ration = (peak area or height of quantifier)/(peak area or height of qualifier)

E. See *T-PEST-WI9847* for additional calculations used to evaluate the calibrations and quality control samples.

Statistical Information / Method Performance

The LCS should contain all compounds of interest. LCS, MS, extraction standard recoveries and RPD are compared to the limits stored on the LIMS. These limits are defined by the method. For compounds not defined by the method, these limits are statistically derived when sufficient data points are available. If sufficient data points are not available to generate statistical windows, an advisory window of 70% to 130% will be used. Historical data for MS/Ds, LCS/Ds, measurement of uncertainty, is reviewed at least annually. Reporting limits including method detection limits (MDLs) and limits of quantitation (LOQs) are set according to EPA method requirements and are evaluated annually. Refer to *QA-SOP11892* for specific guidelines and procedures. Updates to the LIMS are made as needed by the QA Department and only as directed by the supervisor.

Quality Assurance / Quality Control

For each batch of 20 samples extracted, a method blank and an LCS/LCSD (Milli Q water spiked with all compounds to be determined carried through the entire procedure) must be extracted and analyzed. If an MS/MSD is submitted then an LCSD would not be extracted. A batch is defined as the samples to be extracted on any given day, but not to exceed 20 field samples. If more than 20 samples are prepared in a day, an additional batch must be prepared. If any client, state, or agency has more stringent QC or batching requirements, these must be followed.

Attachment:
Attachment 1 - Mass Transitions (.doc)
Attachment 2 - Compound Relationships (.docx)
Attachment 3 - PROPRIETARY
Attachment 4 - Example Certificate of Analysis (.pdf)
Attachment 5 - Eurofins DoD Variances (.doc)

G-DC-FRM23907 Redacted SOPs
QA-SOP11178 Demonstrations of Capability
QA-SOP11892 Determining Method Detection Limits and Limits of Quantitation
T-PEST-WI9847 Common Equations Used During Chromatographic Analyses
T-PFAS-WI13881 Standards Management in the PFAS Laboratory
Attachment: Attachment 1 - Mass Transitions (doc)
Attachment: Attachment 2 - Compound Relationships (docx)
Attachment: Attachment 3 - PROPRIETARY
Attachment: Attachment 4 - Example Certificate of Analysis (pdf)
Attachment: Attachment 5 - Eurofins DoD Variances (doc)

End of document

Version history

Version	Approval	Revision information
1	28.JAN.2021	

Attachment 1

Mass Transitions AB Sciex 4500

Compound	Parent Ion	Daughter Ion
13C3-PFBA	216	172
13C4-PFBA	217	172
PFBA	213	169
13C5-PFPeA	268	223
PFPeA	263	219
13C3-PFBS	302	80
PFBS	299	80
PFBS (2)	299	99
13C2-4:2-FTS	329	81
4:2-FTS	327	307
4:2-FTS (2)	327	81
13C5-PFHxA	318	273
PFHxA	313	269
PFHxA (2)	313	119
PFPeS	349	80
PFPeS (2)	349	99
13C3-PFHxS	402	80
PFHxS	399	80
PFHxS (2)	399	99
13C4-PFHpA	367	322
PFHpA	363	319
PFHpA (2)	363	169
13C2-6:2-FTS	429	81
6:2-FTS	427	407
6:2-FTS (2)	427	81
PFHpS	449	80
PFHpS (2)	449	99
13C2-PFOA	415	370
13C8-PFOA	421	376
PFOA	413	369
PFOA (2)	413	169
13C4-PFOS	503	80
13C8-PFOS	507	80
PFOS	499	80
PFOS (2)	499	99
13C9-PFNA	472	427
PFNA	463	419

Attachment 1

Compound	Parent Ion	Daughter Ion
PFNA (2)	463	169
13C8-PFOSA	506	78
PFOSA	498	78
PFNS	549	80
PFNS (2)	549	99
13C2-PFDA	515	470
13C6-PFDA	519	474
PFDA	513	469
PFDA (2)	513	169
13C2-8:2-FTS	529	81
8:2-FTS	527	507
8:2-FTS (2)	527	81
d7-NMePFOSAE	623	59
NMePFOSAE	616	59
d3-NMePFOSA	515	169
NMEPFOSA	512	169
d3-NMeFOSAA	573	419
NMeFOSAA	570	419
NMeFOSAA (2)	570	483
d9-NEtPFOSAE	639	59
NEtPFOSAE	630	59
d5-NETPFOSA	531	169
NEtPFOSA	526	169
PFDS	599	80
PFDS (2)	599	99
13C7-PFUnDA	570	525
PFUnDA	563	519
PFUnDA (2)	563	169
d5-NEtFOSAA	589	419
NEtFOSAA	584	419
NEtFOSAA (2)	584	526
13C2-PFDoDA	615	570
PFDoDA	613	569
PFDoDA (2)	613	169
10:2-FTS	627	607
10:2-FTS (2)	627	81
PFDoS	699	80
PFDoS (2)	699	99
PFTrDA	663	619
PFTrDA (2)	663	169

Attachment 1

Compound	Parent Ion	Daughter Ion
13C2-PFTeDA	715	670
PFTeDA	713	669
PFTeDA (2)	713	169
PFHxDA	813	769
PFHxDA (2)	813	169
PFODA	913	869
PFODA (2)	913	169
13C3-HFPODA	332	287
HFPODA	329	285
HFPODA (2)	329	169
DONA	377	251
DONA (2)	377	85
9Cl-PF3ONS	531	351
9Cl-PF3ONS (2)	531	83
11Cl-PF3OUdS	631	451
11Cl-PF3OUdS (2)	631	99

Attachment 2

PFAS Native Compounds/Extraction Standards

Native PFAS Compounds

Native	Extraction Standard
PFBA	13C4-PFBA
PFPeA	13C5-PFPeA
PFBS	13C3-PFBS
PFPeS	
4:2-FTS	13C2-4:2-FTS
PFHxA	13C5-PFHxA
PFHxS	13C3-PFHxS
PFHpS	
PFHpA	13C4-PFHpA
DONA	
6:2-FTS	13C2-6:2-FTS
PFOA	13C8-PFOA
PFOS	13C8-PFOS
PFNS	
PFDS	
9Cl-PF3ONS	
11Cl-pf3OUdS	
PFDoS	
PFNA	13C9-PFNA
PFOSA	13C8-PFOSA
PFDA	13C6-PFDA
8:2-FTS	13C2-8:2-FTS
10:2-FTS	
NMePFOSAE	d7-NMePFOSAE
NMePFOSA	d3-NMePFOSA
NMeFOSAA	d3-NMeFOSAA
NEtPFOSAE	d9-NEtPFOSAE
NEtPFOSA	d5-NEtPFOSA

Native	**Extraction Standard**
PFUnDA	13C7-PFUnDA
NEtFOSAA	d5-NEtFOSAA
PFDoDA	13C2-PFDoDA
PFTrDA	
PFTeDA	13C2-PFTeDA
PFHxDA	
PFODA	
HFPODA	13C3-HFPODA

ATTACHMENT 4 ST1927333A

WELLINGTON
LABORATORIES

CERTIFICATE OF ANALYSIS
DOCUMENTATION

PFAC-MXC

Native Perfluorinated Compound Solution/Mixture

PRODUCT CODE:	PFAC-MXC
LOT NUMBER:	PFACMXC0617
SOLVENT(S):	Methanol / Water (<1%)
DATE PREPARED: (mm/dd/yyyy)	06/14/2017
LAST TESTED: (mm/dd/yyyy)	03/19/2019
EXPIRY DATE: (mm/dd/yyyy)	03/19/2024
RECOMMENDED STORAGE:	Store ampoule in a cool, dark place

DESCRIPTION:

PFAC-MXC is a solution/mixture of thirteen native perfluoroalkylcarboxylic acids (C_4-C_{14}, C_{16}, and C_{18}) and eight native perfluoroalkylsulfonates (C_4-C_{10} and C_{12}). The full name, abbreviation and concentration for each of the components are given in Table A.

The individual perfluoroalkylcarboxylic acids and perfluoroalkylsulfonates all have chemical purities of >98%.

DOCUMENTATION/ DATA ATTACHED:

Table A: Components and Concentrations of the Solution/Mixture
Figure 1: LC/MS Data (SIR)
Figure 2: LC/MS/MS Data (Selected MRM Transitions)

ADDITIONAL INFORMATION:

- See page 2 for further details.
- Contains 4 mole eq. of NaOH to prevent conversion of the carboxylic acids to their respective methyl esters.

FOR LABORATORY USE ONLY: NOT FOR HUMAN OR DRUG USE

ATTACHMENT 4

INTENDED USE:

The products prepared by Wellington Laboratories Inc. are for laboratory use only. This certified reference material (CRM) was designed to be used as a standard for the identification and/or quantification of the specific chemical compounds it contains.

HANDLING:

This product should only be used by qualified personnel familiar with its potential hazards and trained in the handling of hazardous chemicals. Due care should be exercised to prevent unnecessary human contact or ingestion. All procedures should be carried out in a well-functioning fume hood and suitable gloves, eye protection, and clothing should be worn at all times. Waste should be disposed of according to national and regional regulations. Safety Data Sheets (SDSs) are available upon request.

SYNTHESIS / CHARACTERIZATION:

Our products are synthesized using single-product unambiguous routes whenever possible. They are then characterized, and their structures and purities confirmed, using a combination of the most relevant techniques, such as NMR, GC/MS, LC/MS/MS, SFC/UV/MS/MS, x-ray crystallography, and melting point. Isotopic purities of mass-labelled compounds are also confirmed using HRGC/HRMS and/or LC/MS/MS.

HOMOGENEITY:

Prior to solution preparation, crystalline material is tested for homogeneity using a variety of techniques (as stated above) and its solubility in a given diluent is taken into consideration. Duplicate solutions of a new product are prepared from the same crystalline lot and, after the addition of an appropriate internal standard, they are compared by GC/MS, LC/MS/MS, and/or SFC/UV/MS/MS. The relative response factors of the analyte of interest in each solution are required to be <5% RSD. New solution lots of existing products, as well as mixtures and calibration solutions, are compared to older lots in a similar manner. This further confirms the homogeneity of the crystalline material as well as the stability and homogeneity of the solutions in the storage containers. In order to maintain the integrity of the assigned value(s), and associated uncertainty, the dilution or injection of a subsample of this product should be performed using calibrated measuring equipment.

UNCERTAINTY:

The maximum combined relative standard uncertainty of our reference standard solutions is calculated using the following equation:

The combined relative standard uncertainty, $u_c(y)$, of a value y and the uncertainty of the independent parameters $x_1, x_2, \ldots x_n$ on which it depends is:

$$u_c(y(x_1, x_2, \ldots x_n)) = \sqrt{\sum_{i=1}^{n} u(y, x_i)^2}$$

where x is expressed as a relative standard uncertainty of the individual parameter.

The individual uncertainties taken into account include those associated with weights (calibration of the balance) and volumes (calibration of the volumetric glassware). An expanded maximum combined percent relative uncertainty of ±5% (calculated with a coverage factor of 2 and a level of confidence of 95%) is stated on the Certificate of Analysis for all of our products.

TRACEABILITY:

All reference standard solutions are traceable to specific crystalline lots. The microbalances used for solution preparation are regularly calibrated by an external ISO/IEC 17025 accredited laboratory. In addition, their calibration is verified prior to each weighing using calibrated external weights traceable to an ISO/IEC 17025 accredited laboratory. All volumetric glassware used is calibrated, of Class A tolerance, and traceable to an ISO/IEC 17025 accredited laboratory. For certain products, traceability to international interlaboratory studies has also been established.

EXPIRY DATE / PERIOD OF VALIDITY:

Ongoing stability studies of this product have demonstrated stability in its composition and concentration, until the specified expiry date, in the unopened ampoule. Monitoring for any degradation or change in concentration of the listed analyte(s) is performed on a routine basis.

LIMITED WARRANTY:

At the time of shipment, all products are warranted to be free of defects in material and workmanship and to conform to the stated technical and purity specifications.

QUALITY MANAGEMENT:

This product was produced using a Quality Management System registered to the latest versions of ISO 9001 by SAI Global, ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA; A 1226), and ISO 17034 by ANSI-ASQ National Accreditation Board (ANAB; AR-1523).

For additional information or assistance concerning this or any other products from Wellington Laboratories Inc., please visit our website at www.well-labs.com or contact us directly at info@well-labs.com

ATTACHMENT 4

Table A: **PFAC-MXC; Components and Concentrations (ng/ml, ± 5% in Methanol / Water (<1%))**

Compound	Abbreviation	Concentration (ng/ml)*	Peak Assignment in Figure 1
Perfluoro-n-butanoic acid	PFBA	2000	A
Perfluoro-n-pentanoic acid	PFPeA	2000	B
Perfluoro-n-hexanoic acid	PFHxA	2000	D
Perfluoro-n-heptanoic acid	PFHpA	2000	F
Perfluoro-n-octanoic acid	PFOA	2000	H
Perfluoro-n-nonanoic acid	PFNA	2000	J
Perfluoro-n-decanoic acid	PFDA	2000	L
Perfluoro-n-undecanoic acid	PFUdA	2000	N
Perfluoro-n-dodecanoic acid	PFDoA	2000	P
Perfluoro-n-tridecanoic acid	PFTrDA	2000	Q
Perfluoro-n-tetradecanoic acid	PFTeDA	2000	S
Perfluoro-n-hexadecanoic acid	PFHxDA	2000	T
Perfluoro-n-octadecanoic acid	PFODA	2000	U

Compound	Abbreviation	Concentration (ng/ml)*		Peak Assignment in Figure 1
		As the salt	As the anion	
Potassium perfluoro-1-butanesulfonate	L-PFBS	2000	1770	C
Sodium perfluoro-1-pentanesulfonate	L-PFPeS	2000	1880	E
Sodium perfluoro-1-hexanesulfonate	L-PFHxS	2000	1890	G
Sodium perfluoro-1-heptanesulfonate	L-PFHpS	2000	1900	I
Sodium perfluoro-1-octanesulfonate	L-PFOS	2000	1910	K
Sodium perfluoro-1-nonanesulfonate	L-PFNS	2000	1920	M
Sodium perfluoro-1-decanesulfonate	L-PFDS	2000	1930	O
Sodium perfluoro-1-dodecanesulfonate	L-PFDoS	2000	1940	R

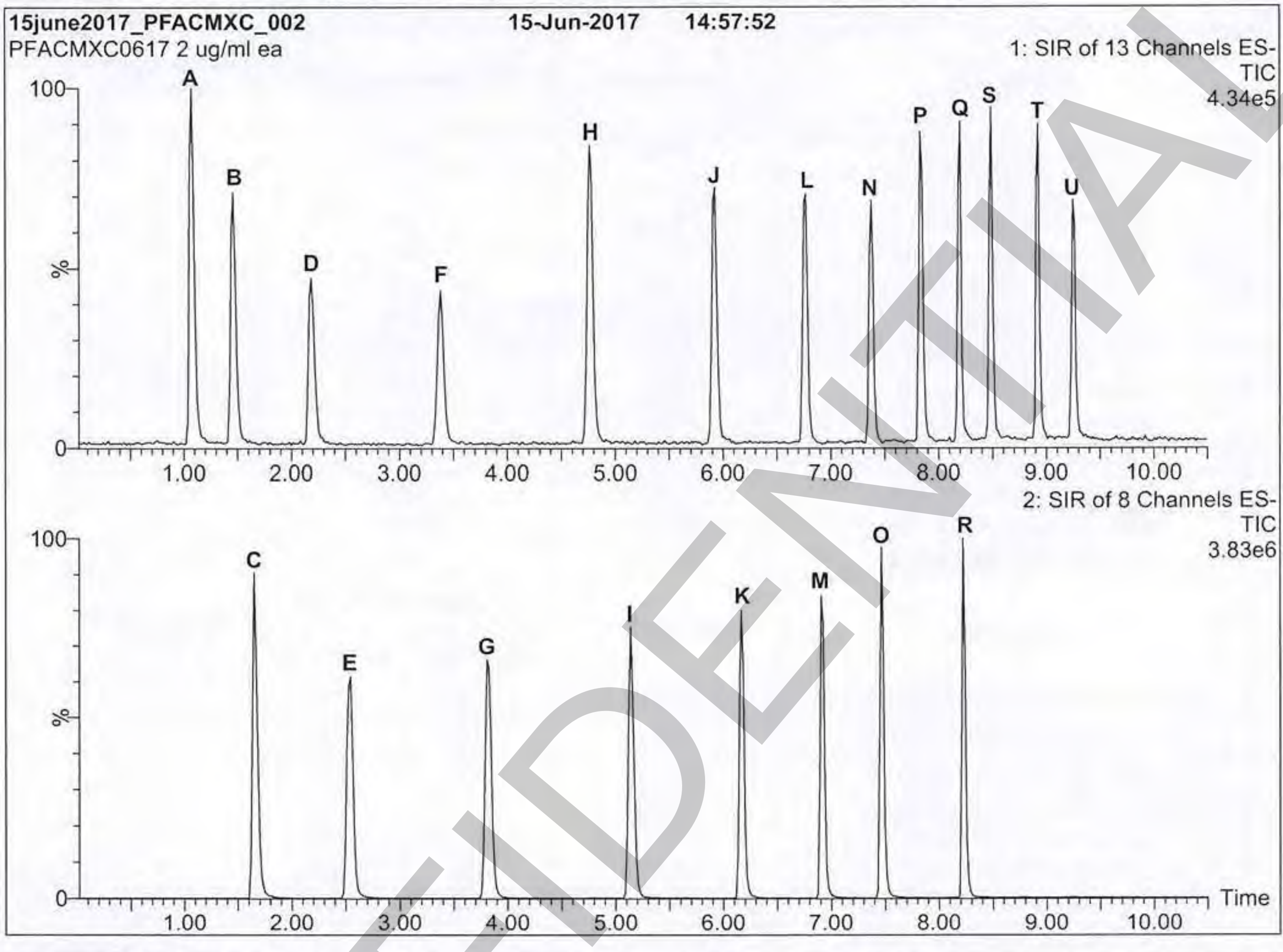
* Concentrations have been rounded to three significant figures.

Certified By: ____________________
B.G. Chittim, General Manager

Date: 06/06/2019
(mm/dd/yyyy)

ATTACHMENT 4

Figure 1: PFAC-MXC; LC/MS Data (Total Ion Current Chromatogram; SIR)



Conditions for Figure 1:

LC: **Waters Acquity Ultra Performance LC**
MS: **Micromass Quattro *micro* API MS**

Chromatographic Conditions

Column: Acquity UPLC BEH Shield RP_{18}
1.7 µm, 2.1 x 100 mm

Mobile phase: Gradient
Start: 50% H_2O / 50% (80:20 MeOH:ACN)
(both with 10 mM NH_4OAc buffer)
Ramp to 90% organic over 8 min and hold for 2 min
before returning to initial conditions in 1 min.

Time: 12 min

Flow: 300 µl/min

MS Parameters

Experiment: SIR of 21 Channels

Source: Electrospray (negative)
Capillary Voltage (kV) = 3.00
Cone Voltage (V) = variable (10-80)
Cone Gas Flow (l/hr) = 50
Desolvation Gas Flow (l/hr) = 750

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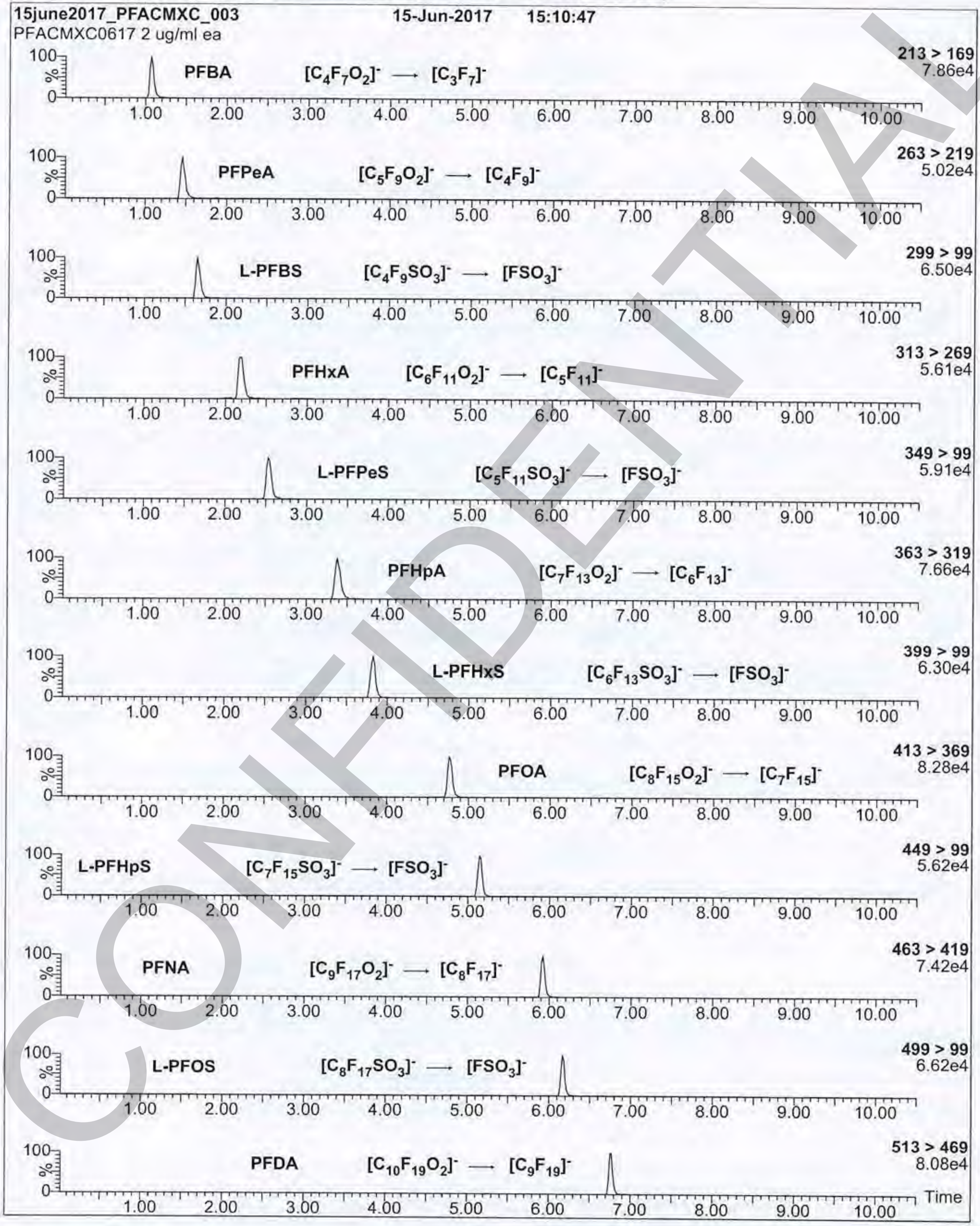
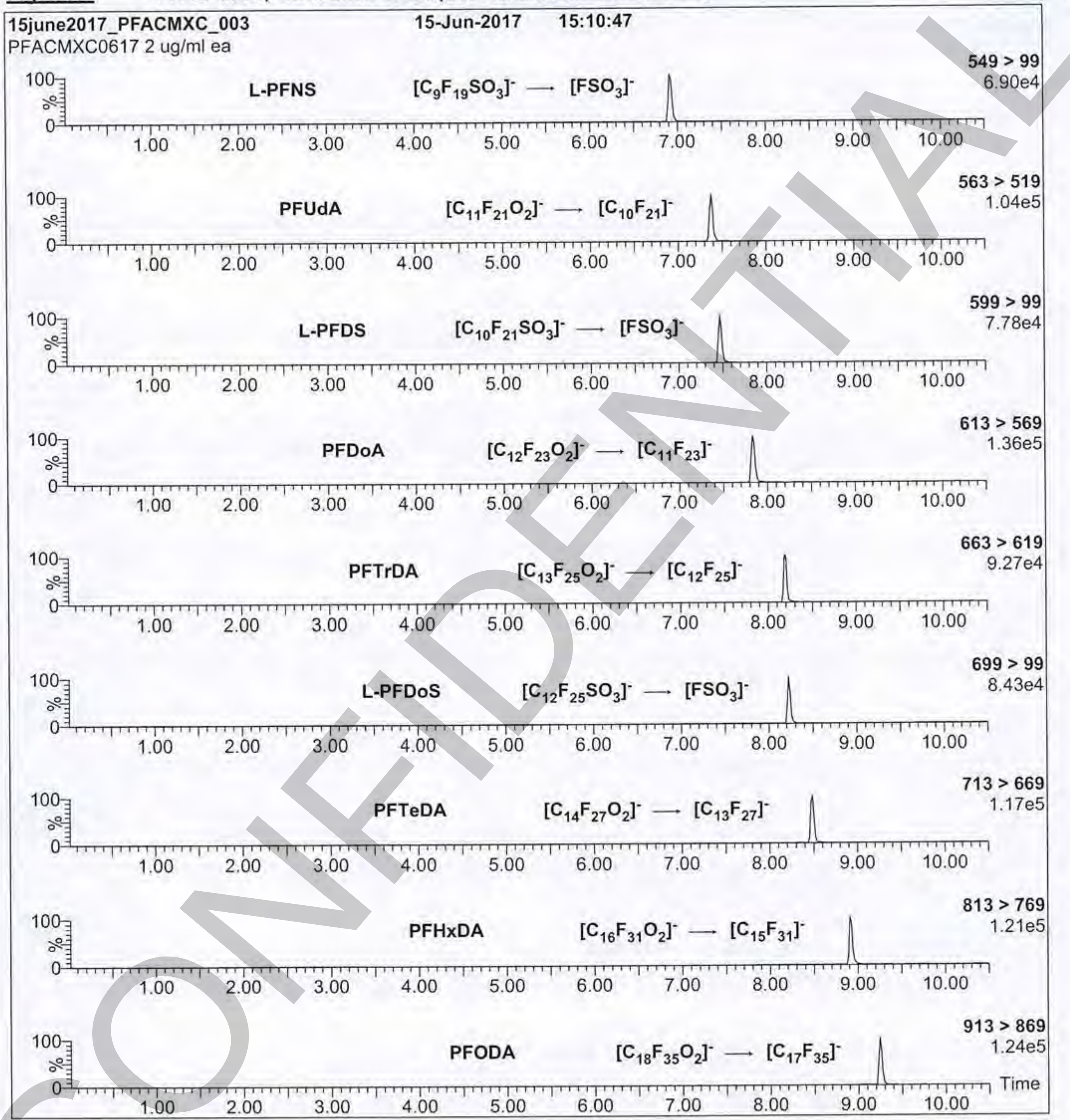
Figure 2: **PFAC-MXC; LC/MS/MS Data (Selected MRM Transitions)**



ATTACHMENT 4

Figure 2: PFAC-MXC; LC/MS/MS Data (Selected MRM Transitions)



Conditions for Figure 2:

Injection: On-column (PFAC-MXC)

Mobile phase: Same as Figure 1

Flow: 300 µl/min

MS Parameters

Collision Gas (mbar) = 3.46e-3
Collision Energy (eV) = 8-50 (variable)

Eurofins Lancaster Laboratories Environmental, LLC Variance Requests

Item	Parameter	Scope of Work	ELLE SOP	Approval
1	QSM 5.3 Table B-15 PFAS Using LC/MS/MS	Extraction internal standard (EIS) recovery criteria of 50-150%	For all PFAS compounds if EIS recovery is <50%, we will check for laboratory error and correct if identified. If no laboratory error is identified, additional corrective action will be performed if EIS recovery is <10%. If EIS recovery is >10% and samples have detections above the reporting limit, no additional corrective action is performed. If EIS recovery is >10% and samples have no detections for associated native analytes, the native analyte response will be evaluated to confirm the validity of the reporting limit. Reporting limits will be proportionately increased as necessary and appropriate to ensure that reported values accurately reflect the sensitivity of the analysis.	
2	QSM 5.3 Table B-15 PFAS Using LC/MS/MS	Extraction internal standard (EIS) recovery criteria of 50-150%	For all PFAS compounds, if EIS recovery is >150%, we will check for laboratory error and correct if identified. If no laboratory error is identified, additional corrective action will be performed only when field samples have detections above the reporting limits for the associated native target analytes and EIS recovery is >200%.	
3	QSM 5.3 Table B-15 PFAS Using LC/MS/MS	Sample Preparation	If persistent matrix effects are observed for multiple samples from a given project that necessitate a high rate of additional corrective actions, these matrix effects will be mitigated prior to sample preparation and analysis, typically by processing a smaller sample mass or volume.	