**Tesoro Alaska Company LLC**

Kenai Refinery
54741 Tesoro Road
Kenai, AK 99611
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November 15, 2023

Pete Campbell
Environmental Specialist.
Alaska Department of Environmental Conservation
43335 K-Beach Road, Suite 11
Soldotna, Alaska 99669

Submitted via email:
Peter.Campbell@alaska.gov

**Re: PFAS Investigation Work Plan**

Dear Mr. Campbell:

Enclosed is a per- and polyfluoroalkyl substances (PFAS) investigation Work Plan (Work Plan) in response to a letter request dated September 12, 2023.

The objective of this Work Plan is to assess the presence of PFAS at the Refinery. Work will be performed in two phases:

- Phase I will include historical investigation and an initial round of soil and groundwater sampling in the south fence area, which is known to have had a one-time fire training event and have been an AFFF storage area.
- Phase II will include soil sampling at a subset of locations sampled during Phase I to assess the presence of PFAS vertically in soil. Sample locations will target Phase I locations with PFAS concentrations above the project screening level.

If you have any questions, please contact me at (907) 776-4225.

Sincerely,

Maya Lehl
Environmental Specialist

Enclosure (1)

# PFAS INVESTIGATION WORK PLAN

## TESORO ALASKA COMPANY, LLC

## MARATHON KENAI REFINERY

## KENAI, ALASKA

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**November 15, 2023**

**Project #: 0039B-003-0090**


**PREPARED BY:** Trihydro Corporation

312 Tyee Street, Soldotna, AK 99669


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**SUBMITTED BY:** Tesoro Alaska Company, LLC

54741 Energy Way, Kenai, AK 99611

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# List of Abbreviations and Acronyms

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|---|---|
| ADEC | Alaska Department of Environmental Conservation |
| AFFF | aqueous film-forming foam |
| bgs | below ground surface |
| Eurofins | Eurofins Lancaster Laboratory |
| ft | feet |
| KLNG | Kenai Liquid Natural Gas |
| LCS | laboratory control sample |
| LCSD | laboratory control sample duplicate |
| MB | method blank |
| µg/L | micrograms per liter |
| µg/g | micrograms per gram |
| mL/min | milliliters per minute |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| ng/L | nanograms per liter |
| ng/g | nanograms per gram |
| QC | quality control |
| PFAS | per- and polyfluoroalkyl substances |
| ppm | parts per million |
| RPD | relative percent differences |
| SOP | PFAS Sampling Standard Operating Procedure |
| USEPA | United States Environmental Protection Agency |

# 1.0 INTRODUCTION

This per- and polyfluoroalkyl substances (PFAS) investigation Work Plan (Work Plan) was prepared by Trihydro Corporation (Trihydro) on behalf of Marathon Petroleum Company (Marathon) in response to a request by the Alaska Department of Environmental Conservation (ADEC) in a letter dated September 12th, 2023. The letter requested that Marathon both assess the historical use of Aqueous Film-Forming Foam (AFFF) at the Kenai Refinery (Refinery) and conduct an investigation of potentially impacted soils and groundwater.

## 1.1 OBJECTIVES

The objective of this Work Plan is to assess the presence of PFAS at the Refinery. Data will be compared to the ADEC Table C Groundwater Human Health Cleanup Level and the ADEC Table B-1 Migration to Groundwater Cleanup Level from 18 AAC 75 as show in Tables 1 and 2 (ADEC 2023). Work will be performed in two phases.

- Phase I will include historical investigation and an initial round of soil and groundwater sampling in the south fence area, which is known to have had a one-time fire training event and have been an AFFF storage area.
- Phase II will include soil sampling at a subset of locations sampled during Phase I to assess the presence of PFAS vertically in soil. Sample locations will target Phase I locations with PFAS concentrations above the project screening level.

An investigation report will be prepared and will include a summary of results, conclusions, and recommendations.

# 2.0 SITE HISTORY

## 2.1 REFINERY SITE HISTORY

The Refinery first started operating in 1969 as Tesoro Corporation, which has since been acquired by Marathon. The Refinery is located near mile 20 of the Kenai Spur Highway, some 60 miles southwest of Anchorage, Alaska (Figure 1). It currently has a process capacity of approximately 68,000 barrels of oil per day (Marathon, 2019). Groundwater is currently being monitored and remediated from petroleum product impacts under a Resource Conservation and Recovery Act (RCRA) Post-Closure Permit first issued in 1995. Groundwater monitoring and recovery wells are shown on Figure 2.

## 2.2 SITE HYDROGEOLOGY

The Refinery borders Cook Inlet in the Kenai Lowland physiographical province. According to Karlsotrm (1964), Pleistocene glaciers occurred in the Kenai Lowland and shaped both her modern topography and shallow subsurface sedimentary sequences. A persistent glacial lake is believed by the same source to have received sediments from both the Alaska Range (west) and Kenai Range (east). Stratified layers of sand and gravel were deposited in the proglacial fluvial and fluvial delta environments during periods of low lake water. In periods or great lake water, silt and clay were deposited. This sequence of gravel and clay covers most of the Refinery area and was proposed by Nelson (1981) to be at least 500 feet thick. The ground water system consists of two unconfined aquifers (A-aquifer and B-aquifer) along with both upper and lower confined aquifers. At the south fence area, A-aquifer and B-aquifer merge and act as a single unconfined aquifer (Figure 3).

The Pleistocene sediments, and deformation thereof, complicate site hydrogeology. Through most of the refinery, water in the A-aquifer moves west towards Cook Inlet. At the northeastern side of the Refinery, water tends to move south-southwest. Groundwater in the A-aquifer moves southwest, before turning west toward Cook Inlet in the southeastern corner of the Refinery (Figure 4). A benzene plume exists in both the A and B aquifers in the central refinery and to the west across the highway in the Kenai Liquid Natural Gas (KLNG) plant.

## 2.3 PFAS-CONTAINING MATERIALS AND POTENTIAL IMPACTS

Since the 1950s, PFAS have been incorporated into many consumer and industrial products. One of the many historical uses is in firefighting foams ("Aqueous Film Forming Foams," or AFFF). AFFF products may be used for fire suppression at facilities where Class B fires (i.e., those involving flammable liquids and gases) may be a concern, including airports, firefighting training areas, and other facilities where flammable hydrocarbons are present. AFFF formulations include hundreds to thousands of individual fluorinated and non-fluorinated surfactant compounds.

Perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) are potential PFAS constituents in AFFF products, particularly in those produced between the 1960s and 1990s (ITRC 2018). Modern AFFF products contain little to no PFOA or PFOS but may contain short-chain PFAS compounds such as perfluorobutane sulfonate (PFBS).

Firefighting and firefighting training is an activity of petroleum refinery management. AFFF stored and historically used for fire suppression at the Refinery is a potential source of PFAS. The historical inquiry will focus primarily on identifying historical fire suppressant storage areas and locations where fire suppressants were used.

## 2.4 POTENTIAL SOURCE AREAS

Based on preliminary inquiry, Marathon has identified two locations where AFFF was used or stored: (1) location on the south fencing area of the Refinery, where AFFF may have been released during what is currently understood to be where a one-time fire training event occurred; and (2) an AFFF storage area (Figure 5).

If additional potential source areas are identified in the ongoing historical inquiry, an additional investigation may be proposed either through an amendment to this work plan or a future work plan.

# 3.0 PROPOSED PFAS INQUIRY

Prior to the start of the field work Trihydro will continue to work with Marathon staff to conduct an inquiry of other historical PFAS uses on the Refinery. AFFF from the Refinery's fire prevention systems are the primary potential sources of PFAS. The inquiry will utilize personnel experiences, interviews, historical documents, maps, and other sources, as practicable, toward the goal of locating potential PFAS use, storage, release, or firefighting training locations.

The purpose of this inquiry is to assess the need for additional PFAS sampling beyond the locations identified for field investigation in this Work Plan.

# 4.0 SAMPLING APPROACH

While the historical PFAS use inquiry is ongoing, Trihydro will implement a surface soil and groundwater characterization in the vicinity of the areas currently known to have had AFFF storage or use (the south fencing area). The characterization will consist of two phases. If additional areas of known AFFF use, storage, or release are identified as part of the ongoing historical-use inquiry, additional sample locations may be proposed to the ADEC as an addendum to this work plan or a follow-on work plan.

## 4.1 PHASE I

Phase I sampling is intended to assess the presences of PFAS in surface soil from 0 to 6 inches below ground surface (bgs) and in groundwater at the south fencing area (Figure 5). Further evaluation of the vertical extent of PFAS in soil will be completed in Phase II.

Trihydro proposes a grid of 10 sampling locations at the south fencing area where a one-time training event was known to have occurred and 2 locations near the AFFF storage area (See Figure 5). These locations may be adjusted (based on site utilities, field observations, and new information such as photos or interviews) to target the areas where AFFF may have most likely been released as well as to investigate the boundaries of release. Sample locations will be surveyed using a Real Time Kinematics (RTK) GPS to facilitate returning to the sample location for follow-up sampling, if necessary.

Groundwater samples will be collected from five nearby existing monitoring wells (Figure 5) including E-117, E-208, E-094, E-073, and TPZ-4. Sampling will be performed as described in section 4.3.

## 4.2 PHASE II

Phase II sampling will assess vertical PFAS impacts in soil up to a maximum depth of ten feet bgs near the PFAS training and storage locations. Samples will target a subset of locations sampled in Phase I which have PFAS concentrations in surface soil above the project screening level. The project screening level is reported in Tables 1 and 2. Phase II is contingent upon Phase I analytical results. Phase II seeks to refine and expand the information provided by Phase I.

Phase II will begin after the data from Phase I sampling is received from the lab. Sampling will be performed at up to 6 locations found to have surface soil impacts of PFAS greater than project screening level from the Phase I effort. Phase I soil sample locations with the highest PFAS detections will be targeted during Phase II. Composite soil

samples will be collected from 0 to 2 feet (ft) bgs and grab samples at 3 ft bgs and the maximum soil depth achievable with a hand auger, no more than 10 ft bgs. Trihydro will use a hand auger for sampling as long as a waiver from excavation pre-clearing can be obtained. If a waiver cannot be obtained, vacuum truck preclearing will be completed up to 10 feet bgs and sidewall samples will be collected at appropriate depths with trowels attached to stainless steel extension rods. Sampling will be performed as described in section 4.3.

Additionally, if necessary, Trihydro will expand the surface soil sample grid around or outside of locations where PFAS in the surface soil samples were above the project screening level in Phase I, with the goal of delineating the lateral extent of PFAS in soil.

## 4.3 PFAS SAMPLING

Many types of clothing, personal protective equipment (PPE), sunscreens, insect repellent, rain-repellent gear, and other sampling equipment pose a risk of PFAS cross-contamination. These are described as 'PFAS-incompatible', items which pose no risk of cross-contamination may be described as 'PFAS-free' or 'PFAS-compatible.' Some common PFAS-incompatible and PFAS-compatible materials items are detailed in Table 1 of the PFAS Sampling Standard Operating Procedure (SOP). Although PFAS-compatible materials are preferable to use, it is not always possible to do so exclusively. Sampling procedures will be reviewed prior to field activities to identify potential conflicts between site PPE requirements and PFAS-compatible materials. If conflicts are identified, procedures will be developed to minimize PFAS cross-contamination risks without compromising the facility's health and safety procedures such as requiring flame resistant clothing. See the SOP section 3.5 for additional techniques that may be used to provide valid sampling.

In addition to working with PFAS compatible materials, the following practices will be observed: A fresh pair of powderless nitrile gloves will be worn at each location; gloves will be changed frequently and immediately before collecting each sample, in accordance with the SOP.

### 4.3.1 SOIL SAMPLE COLLECTION

In Phase I, each surface soil sample will be collected from 0-6 inches below ground surface (bgs). Reusable stainless steel or HDPE hand tools will be used and decontaminated as outlined in 4.4. Each sample will be composite. Composite samples will be taken by removing vegetative material then collecting soils from the targeted depth range and then thoroughly mixing those soils in a stainless-steel bowl. Pebbles larger than pea sized as well as vegetative material will be removed and then a portion of the mixed soil will be placed in the laboratory supplied sample

container. Employees will only use hand-digging tools. Sample collection will be documented on the surface sample log included in Appendix B.

Each sub-surface soil sample will be collected in Phase II using a hand auger. Composite samples will be collected from 0-2 ft bgs and grab samples at 3 ft bgs and at the maximum boring depth achieved using a hand auger, no more than 10 ft bgs. Samplers will only use hand tools, primarily a hand auger. Sample collection tools, including the hand auger bucket, stainless steel mixing bowl, and trowel, will be decontaminated collected as outlined in section 4.4 prior to each sample interval. If use of a hand auger is not permitted, preclearing with a vacuum truck will be used and side wall samples will be collected from the pre-cleared hole at the same depths. Sample collection will be documented on a soil boring log included in Appendix B. Write in the rain paper will not be used for field forms and as needed, electronic field forms may be used on a waterproof field tablet.

Sample bottle information, preservation, and hold times are shown on Figure 3.

### 4.3.2 GROUNDWATER SAMPLE COLLECTION

To minimize cross-contamination from equipment and construction material containing Teflon® or PFAS, special precautions will be taken when preparing for groundwater sampling. No Teflon® or other PFAS-incompatible sampling equipment will be used during sampling activities. It is not expected that any PFAS-incompatible tubing will be found in existing wells.

Wells will be sampled using low flow (minimal drawdown) techniques with the goal of maintaining minimum/stabilized drawdown (<0.3 feet) during purging. Stabilized drawdown means groundwater is recharging the screened interval at a rate that is equivalent to the purge rate and that stagnant casing water is not affecting the quality of the sample. Wells will be purged and sampled using only PFAS-compatible equipment.

Trihydro plans to use a monsoon pump and air bladder pump to collect samples with the pump selection dependent upon the well diameter. If necessary, a certified PFAS-free HDPE bailer may be used to collect a grab sample and if so, this will be noted in the final report. Sample bottle information, preservation, and hold times are shown on Figure 3.

The water level of each well will be measured before the start of purging, and if the well total depth is unknown, total well depth will be measured after sampling to minimize disturbance of settled solids in the bottom of the well casing

during sampling. The pump intake will be set one foot below the water table for wells screened across the water table and will be set at the midpoint of the well screen for wells with submerged screen intervals.

Measurements of water quality parameters will be collected using a multi-parameter water quality meter. Water quality parameters will include pH, specific conductance, turbidity, temperature, ORP, and DO. They will be collected during purging and recorded on field forms (Appendix B). Write in the rain paper will not be used for field forms and as needed, electronic field forms may be used on a waterproof field tablet. Measurements will be taken when purging begins and every 3 to 5 minutes thereafter. During purging, the flow rate will remain between 50 and 500 milliliters per minute (mL/min). Flow will be measured by dividing the volume of a measuring cup into the time taken to fill said cup.

The groundwater will be sampled after water quality parameters stabilize. Water quality parameters are considered stable when a minimum of three (four if using temperature) of the parameters stabilize, that is, remain within the applicable following margins for three successive readings:

- ± 3% for temperature (minimum of ± 0.2 °C).
- ± 0.1 for pH.
- ± 3% for conductivity.
- ± 10 mv for redox potential.
- ± 10% for DO.
- ± 10% for turbidity (or less than 10 NTUs is achieved).

Parameters must be stable and will be recorded prior to sample collection.

If water quality parameter stabilization cannot be achieved upon purging for 60 minutes or 3 well volumes, this will be documented in the field logs and a sample will be collected. If a well is low yield and purges dry, then the well will be allowed to recharge to approximately 80% of the pre-purge volume or for up to 24 hours (whichever occurs first) and then sampled.

Purge water removed from the wells will be discharged to the Refinery wastewater treatment system consistent with current groundwater sampling purge water management practices at the Refinery.

## 4.4 DECONTAMINATION PROCEDURES

PFAS have a tendency to adhere to sampling materials and have been noted in certain detergents. To the extent practical, disposable materials will be used for each monitoring well. The dedicated, disposable, sampling equipment will include HDPE and silicone tubing; HDPE or PFAS-free disposable pump bladders, powderless nitrile gloves; and laboratory-supplied HDPE sample containers.

Standard PFAS-free drinking water from Alaska Pure Water Products will be used for non-final decontamination wash and rinse step(s). The final rinse will be conducted with PFAS-free Laboratory supplied water. The decontamination process is detailed as follows.

### 4.4.1 HAND TOOLS

- Scrape or brush caked soils or other solids from the equipment.
- Wash in Alconox detergents.
- Rinse the instrument in PFAS-free Laboratory supplied water.
  - Collect equipment blanks as required.
- Place the instrument on or in clean, plastic, PFAS-free sheeting, in Ziplock® bags, or on decontaminated surfaces to prevent contact with potential PFAS contaminated soil and allow the equipment to air dry.

### 4.4.2 DOWN-WELL EQUIPMENT (WATER LEVEL METERS, PUMPS, ETC.)

- Wash thoroughly in Alconox, use PFAS-free potable water. Scrape all sand and sediments from pump.
- Rinse the instrument in PFAS-free drinking water.
- Rinse the instrument in PFAS-free Laboratory DI water.
  - Collect equipment blank as required.
- Place the instrument on or in clean, plastic, PFAS-free sheeting, in Ziplock® bags, or on decontaminated surfaces to prevent contact with potential PFAS contaminated soil and allow the equipment to air dry.

Sampling equipment that will come into contact with the sample will be PFAS-free (e.g., water level indicators, sample pumps, etc.) and will be decontaminated prior to sampling and between samples using the process above. Alconox or Liquinox are the only acceptable cleaning products to be used for equipment that may come into contact with sample

media. Cleaning of equipment is performed to prevent cross-contamination between samples and to maintain a clean working environment for personnel.

## 4.5 FIELD DOCUMENTATION

Field activities will be properly recorded in ink or ultra fine sharpies. No other sharpies or other similar indelible markers will be used per the SOP. No erasures will be made. If an incorrect entry is made, striking a single line through the incorrect information will make the correction; the person making the correction will initial and date the change. Field forms will be included in the final report.

## 4.6 SAMPLE IDENTIFICATION

Each soil sample will be given a unique identification (ID) number containing information about its general location, location number, sample type and depth according to the following pattern: the first three characters are an area identifier. The next two after the first dash indicate the sample type, followed by a two-digit location number. After the second dash the sample depth (maximum sample depth in the case of specific samples is indicated by another two-digit number. Surface samples require no depth indicators. In the case that multiple samples are taken in the same spot, both the location indicators will be the same. See the examples below:

SFA-SS01

Where: SFA = Area Identifier (South Fence Area)

SS = Sample Type (SS – Surface Soil)

01 = Location number

SFA-SB01-03

Where: SFA = Area Identifier (South Fence Area),

SB = Sample Type (SB – Soil Boring)

01 = Location number

03 = Sample depth denoted as the top of the sample interval

Monitoring wells will be sampled using their existing monitoring well ID.

# 5.0 ANALYTICAL METHODS

PFAS analysis will be conducted by Eurofins Lancaster Laboratory (Eurofins), an ADEC approved laboratory. Samples will be analyzed via the United States Environmental Protection Agency (USEPA) Method 537, modified. The PFAS analyte list, associated project screening levels, and laboratory reporting limits are found in Tables 1 and 2 for soil and groundwater, respectively.

# 6.0 QUALITY ASSURANCE AND QUALITY CONTROL

This section addresses the qualitative and quantitative criteria that will be used to evaluate the quality of the field and analytical data collected during the field activities.

## 6.1 FIELD QUALITY ASSURANCE AND QUALITY CONTROL SAMPLES

The following quality assurance and quality control samples (QA/QC) will be collected during the sampling event as described below.

1. Field Duplicate Samples. Duplicate samples will be collected to evaluate precision associated with the reproducibility of sampling techniques and the homogeneity of sample matrices. Duplicate samples will be collected at a minimum frequency of 10%, or one for every 10 samples. The duplicate sample will be "blind" to the laboratory; therefore, it will have a coded identity on its label and on the chain of custody (COC). The actual sampling location and identification will be recorded on the sampling log.
2. Equipment Blanks. Equipment blanks will be prepared and submitted for laboratory analysis to assess sampling equipment for potential PFAS impacts and to verify that equipment decontamination procedures are effective. Following ADEC guidance, Trihydro will take a minimum of one equipment blank per set of 20 samples collected using reusable sampling equipment.

QA/QC samples will be analyzed by Eurofins. The laboratory will follow proper QA/QC procedures, including laboratory blanks and duplicates. Data from the QC samples are used as a measure of performance and as an indicator of potential sources of cross-contamination. QC data generated by the laboratory will be submitted with the report.

## 6.2 LABORATORY ASSURANCE AND QUALITY CONTROL SAMPLES

Eurofins will follow proper QA/QC procedures, including laboratory blanks, duplicates, and spiked samples for calibration and identification of potential matrix effects. Data from the QC samples are used as a measure of performance and as an indicator of potential sources of cross-contamination. These data are submitted in the data packages provided by Eurofins.

## 6.3 DATA VALIDATION

Analytical data received from the laboratory will undergo Trihydro's data validation process. Data will be evaluated by the Tier I and Tier II data validation process and the *ADEC Contaminated Sites Program Laboratory Data Review Checklist* will be completed and attached to Trihydro's report.

Precision, accuracy, method compliance, and completeness of the data packages will be assessed during the data validation process. Precision is determined by evaluating the calculated relative percent difference (RPD) values from: laboratory duplicate pairs, matrix spike/matrix spike duplicate (MS/MSD) pairs, and laboratory control sample/laboratory control sample duplicate (LCS/LCSD) pairs. Laboratory accuracy is established by reviewing the demonstrated percent recoveries of the following items to identify potential biases in the analytical data: MS/MSD samples, LCS/LCSD samples, and organic system monitoring compounds (surrogates). Field accuracy is established by collecting and analyzing field QA/QC samples to monitor for possible ambient or cross-contamination during sampling and transportation. Method compliance is established by reviewing sample integrity, holding times, detection limits, surrogate recoveries, laboratory blanks, initial and continuing calibrations (where applicable), and the LCS/LCSD percent recoveries against method-specific requirements. Completeness is evaluated by determining the overall ratio of the number of samples and analyses planned versus the number of samples with valid analyses. Determination of completeness includes a review of the COC, laboratory analytical methods, and other laboratory and field documents associated with the analytical data set.

# 7.0 INVESTIGATION DERIVED WASTE

Investigation derived waste (IDW) are soils, waters, or other native martials, which may contain contaminants, which are permanently displaced by an investigation event.

## 7.1 WATER IDW

IDW water will include both purge water from monitoring well sampling and water collected in the decontamination process. Although PFAS compounds are new analytes for the Refinery, chemistry of purged groundwater will be similar to that of water generated during semiannual sampling events. Therefore, IDW water will be handled following normal Refinery procedures by being transported to the Refinery's wastewater recovery unit for processing. The sampling consumables and other disposable sampling material, such as PPE, will be discarded as standard trash.

## 7.2 SOIL IDW

Soil IDW is not anticipated for this investigation. Soil will be visually screened for evidence of petroleum impacts and if petroleum impacts are expected the soil will be field screened with a PID. If soil does not have evidence of petroleum impacts (visually or PID greater than 50 parts per million) then the soil will be returned to the sample location or borehole. Soil with evidence of petroleum will be considered IDW and disposed of following normal Refinery procedures.

# 8.0 REPORTING

A final investigation report will be prepared after the investigation is complete. The report will be submitted to the ADEC and the EPA to summarize the work performed as part of this site investigation. The report will include a summary of the field activities, results of analysis, figures, analytical data tables, and recommendations for future work. Deviations from this work plan will be included in the report. The following schedule outlines the estimated timeframe to implement this work plan.

| Event | Approximate Timeframe |
|---|---|
| Historical Inquiry | December 2023 – May 2024 |
| Phase I Sampling Events | May – June 2024 |
| Phase II Sampling Events | July 2024 |
| Report to ADEC | October – December 2024 |

# 9.0 REFERENCES


Alaska Department of Environmental Conservation (ADEC). 2022. *Field Sampling Guidance* (March 2022).

ADEC. 2023. 18 AAC 75 Oil and Other Hazardous Substances Pollution Control. October.

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Nelson, G. (1981). Hydrology and the Effects of Industrial Pumping in the Nikiski Area, Alaska. *U.S. Geological Survey, Open File Report 81-685*, 22.

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# TABLES

## TABLE 1. PFAS ANALYTE LIST, MDLs, AND ADEC CLEANUP LEVELS FOR SOIL SAMPLES

| Analyte | Acronym | CAS Number | ADEC Screening Level[1] (µg/kg) | MDL (µg/kg) | Analytical Method |
|---|---|---|---|---|---|
| 4:2 Fluorotelomer sulfonic acid | 4:2-FTS | 757124-72-4 | -- | 0.6 | 537 IDA[2] |
| 6:2 Fluorotelomer sulfonic acid | 6:2-FTS | 27619-97-2 | -- | 0.6 | |
| 8:2 Fluorotelomer sulfonic acid | 8:2-FTS | 39108-34-4 | -- | 0.6 | |
| N-Ethylperfluorooctane-sulfonamidoacetic acid | NEtFOSAA | 2991-50-6 | -- | 0.2 | |
| N-methylperfluorooctane-sulfonamide | NMeFOSAA | 31506-32-8 | -- | 0.2 | |
| Perfluorobutane sulfonic acid | PFBS | 375-73-5 | -- | 0.4 | |
| Perfluorobutanoic acid | PFBA | 375-22-4 | -- | 0.8 | |
| Perfluorodecanesulfonic acid | PFDS | 335-77-3 | -- | 0.2 | |
| Perfluorodecanoic acid | PFDA | 335-76-2 | -- | 0.2 | |
| Perfluorododecanoic acid | PFDoA | 307-55-1 | -- | 0.2 | |
| Perfluoroheptanesulfonic acid | PFHpS | 375-92-8 | -- | 0.2 | |
| Perfluoroheptanoic acid | PFHpA | 375-85-9 | -- | 0.2 | |
| Perfluorohexanesulfonic acid | PFHxS | 355-46-4 | -- | 0.2 | |
| Perfluorohexanoic acid | PFHxA | 307-24-4 | -- | 0.2 | |
| Perfluorononanesulfonic acid | PFNS | 68259-12-1 | -- | 0.2 | |
| Perfluorononanoic acid | PFNA | 375-95-1 | -- | 0.2 | |
| Perfluorooctane sulfonamide | PFOSA | 754-91-6 | -- | 0.2 | |
| Perfluorooctane sulfonic acid | PFOS | 1763-23-1 | 3.0 | 0.2 | |
| Perfluorooctanoic acid | PFOA | 335-67-1 | 1.7 | 0.2 | |
| Perfluoropentane sulfonic acid | PFPeS | 2706-91-4 | -- | 0.2 | |
| Perfluoropentanoic acid | PFPeA | 2706-90-3 | -- | 0.2 | |
| Perfluorotetradecanoic acid | PFTeDA | 376-06-7 | -- | 0.2 | |
| Perfluorotridecanoic acid | PFTrDA | 72629-94-8 | -- | 0.2 | |
| Perfluoroundecanoic acid | PFUnA | 2058-94-8 | -- | 0.2 | |

Notes:

1 18 AAC 75 Table B1 (ADEC 2023)

2 Modified EPA 537 (Isotope Dilution)

ADEC Alaska Department of Enviormental Conservation

MDL Eurofin Lancaster Method Detection Limit

µg/kg micrograms per kilogram

## TABLE 2. PFAS ANALYTE LIST, MDLS, AND ADEC CLEANUP LEVELS FOR GROUNDWATER SAMPLES

| Analyte | Acronym | CAS Number | ADEC Cleanup Level[1] (µg/L) | MDL (µg/L) | Analytical Method |
|---|---|---|---|---|---|
| 4:2 Fluorotelomer sulfonic acid | 4:2-FTS | 757124-72-4 | -- | 0.0005 | 537 IDA[2] |
| 6:2 Fluorotelomer sulfonic acid | 6:2-FTS | 27619-97-2 | -- | 0.0005 | |
| 8:2 Fluorotelomer sulfonic acid | 8:2-FTS | 39108-34-4 | -- | 0.0006 | |
| N-Ethylperfluorooctane-sulfonamidoacetic acid | NEtFOSAA | 2991-50-6 | -- | 0.0005 | |
| N-methylperfluorooctane-sulfonamide | NMeFOSAA | 31506-32-8 | -- | 0.0004 | |
| Perfluorobutane sulfonic acid | PFBS | 375-73-5 | -- | 0.0003 | |
| Perfluorobutanoic acid | PFBA | 375-22-4 | -- | 0.001 | |
| Perfluorodecane sulfonic acid | PFDS | 335-77-3 | -- | 0.0003 | |
| Perfluorodecanoic acid | PFDA | 335-76-2 | -- | 0.0003 | |
| Perfluorododecanoic acid | PFDoA | 307-55-1 | -- | 0.0004 | |
| Perfluoroheptanesulfonic acid | PFHpS | 375-92-8 | -- | 0.0003 | |
| Perfluoroheptanoic acid | PFHpA | 375-85-9 | -- | 0.0003 | |
| Perfluorohexanesulfonic acid | PFHxS | 355-46-4 | -- | 0.0002 | |
| Perfluorohexanoic acid | PFHxA | 307-24-4 | -- | 0.001 | |
| Perfluorononane sulfonic acid | PFNS | 68259-12-1 | -- | 0.0003 | |
| Perfluorononanoic acid | PFNA | 375-95-1 | -- | 0.0002 | |
| Perfluorooctane sulfonamide | PFOSA | 754-91-6 | -- | 0.0003 | |
| Perfluorooctane sulfonic acid | PFOS | 1763-23-1 | 0.4 | 0.0005 | |
| Perfluorooctanoic acid | PFOA | 335-67-1 | 0.4 | 0.0003 | |
| Perfluoropentane sulfonic acid | PFPeS | 2706-91-4 | -- | 0.0003 | |
| Perfluoropentanoic acid | PFPeA | 2706-90-3 | -- | 0.0003 | |
| Perfluorotetradecanoic acid | PFTeDA | 376-06-7 | -- | 0.0004 | |
| Perfluorotridecanoic acid | PFTrDA | 72629-94-8 | -- | 0.0004 | |
| Perfluoroundecanoic acid | PFUnA | 2058-94-8 | -- | 0.0003 | |

Notes:
1 18 AAC 75 Table C (ADEC 2023)
2 Modified EPA 537 (Isotope Dilution)
ADEC Alaska Department of Enviormental Conservation
MDL Eurofins Lancaster Method Detection Limit
µg/L micrograms per liter

## TABLE 3. PFAS SAMPLE METHODS, BOTTLE TYPE, PRESERVATIVE AND HOLDING TIME

| Parameter | Sample Medium | Analytical Method | Sample Container | Minimum Quantity Required Per Sample | Preservative | Arrival Temperature | Holding Time |
|---|---|---|---|---|---|---|---|
| **PFAS Compounds** | Groundwater | 537 IDA | 2x 250 ml HDPE Jar | 500 ml | None | 0-6 °C | 28 days |
| **PFAS Compounds** | Soil | 537 IDA | 1x 4 oz HDPE Jar | 100 g | None | 0-6 °C | 28 days |
| **Percent Moisture** | Soil | | 1x 4 oz Clear Glass Jar | 10 g | None | 0-6 °C | -- |

Notes:

ADEC Alaska Department of Environmental Conservation
°C Degrees Celsius
g gram
ml mililiter
oz ounce
PFAS per- and polyfluoroalkyl substances
PFOS Perfluorooctane sulfonic acid
PFOA Perfluorooctanoic acid

# FIGURES


N

0 2,000'

SOURCE: USGS 7.5' QUAD SHEET
KENAI (C-4) NW, AK
PROVISIONAL EDITION 1986

Trihydro CORPORATION

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Laramie, WY 82070
www.trihydro.com
(P) 307/745.7474 (F) 307/745.7729

**FIGURE 1**

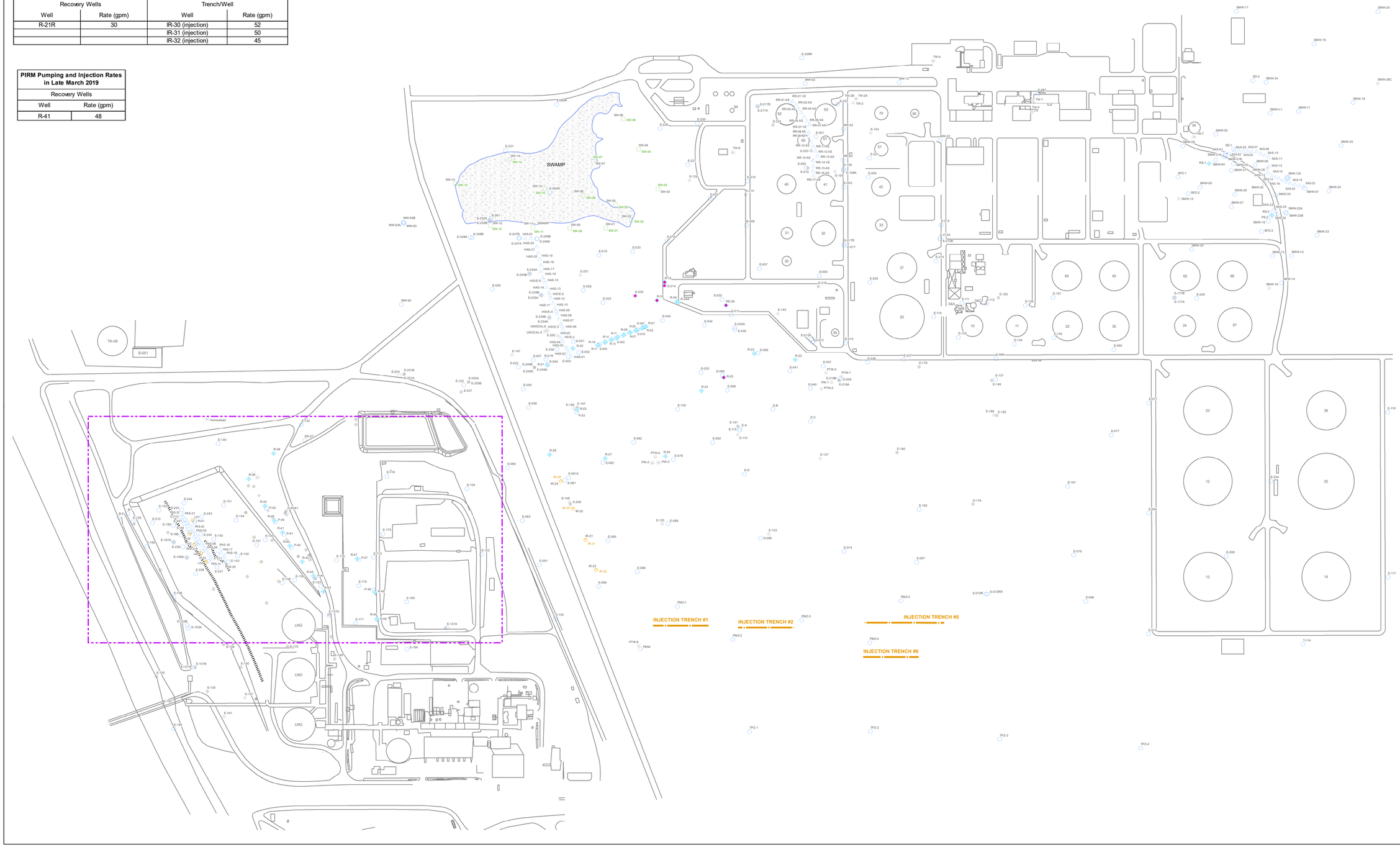
**SITE LOCATION MAP**

**QUARTERLY PROGRESS REPORT**
**TESORO KENAI REFINERY**
**KENAI, ALASKA**

| Drawn By: DH | Checked By: SP | Scale: 1" = 2,000' | Date: 11/21/16 | File: Fig1_Kenai_Site_Location.mxd |
|---|---|---|---|---|

| PM Pumping and Injection Rates in Late March 2019 | | | |
|---|---|---|---|
| Recovery Wells | | Trench/Well | |
| Well | Rate (gpm) | Well | Rate (gpm) |
| R-21R | 30 | IR-30 (injection) | 52 |
| | | IR-31 (injection) | 50 |
| | | IR-32 (injection) | 45 |

| PIRM Pumping and Injection Rates in Late March 2019 | |
|---|---|
| Recovery Wells | |
| Well | Rate (gpm) |
| R-41 | 48 |




## EXPLANATION

- UNCONFINED AQUIFER MONITORING WELL LOCATION
- RECOVERY WELL LOCATION
- B-UNCONFINED AQUIFER MONITORING WELL LOCATION
- B-AQUIFER RECOVERY WELL
- B-AQUIFER INJECTION WELL LOCATION
- UPPER CONFINED AQUIFER MONITORING WELL LOCATION
- AIR SPARGE WELL
- SURFACE WATER SAMPLE
- INJECTION TRENCH
- HYDRAULIC BARRIER

N

0 200 400'

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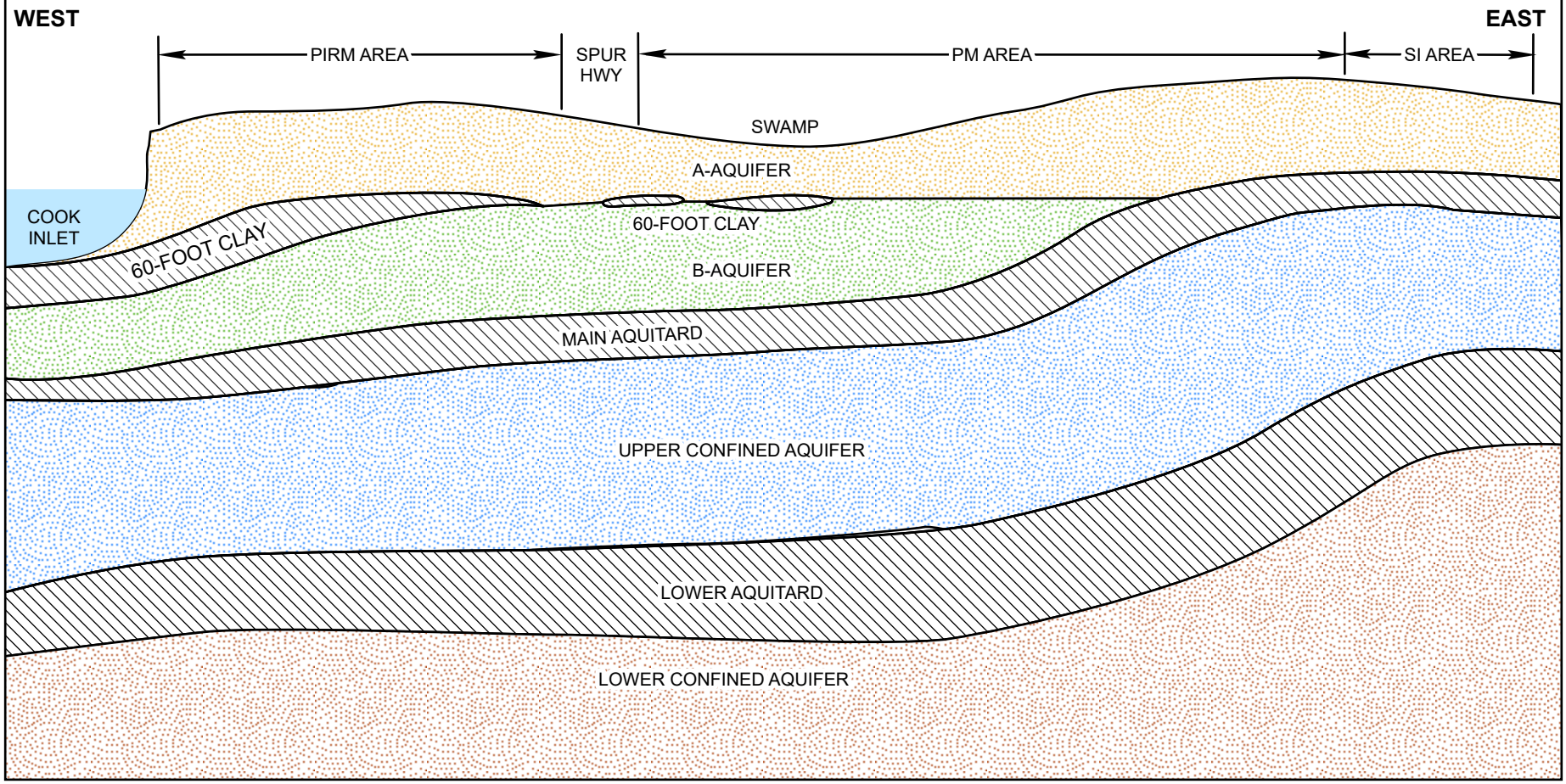
**FIGURE 2**

**SITE MAP**

**TESORO KENAI REFINERY**
**NIKISKI, ALASKA**

| Drawn By: DH | Checked By: PC | Scale: 1 " = 200 ' | Date: 11/7/23 | File: Fig-2_SiteMap.mxd |
|---|---|---|---|---|




**NOTE:**

NOT TO SCALE

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**FIGURE 3**

**AQUIFER CROSS SECTIONS**

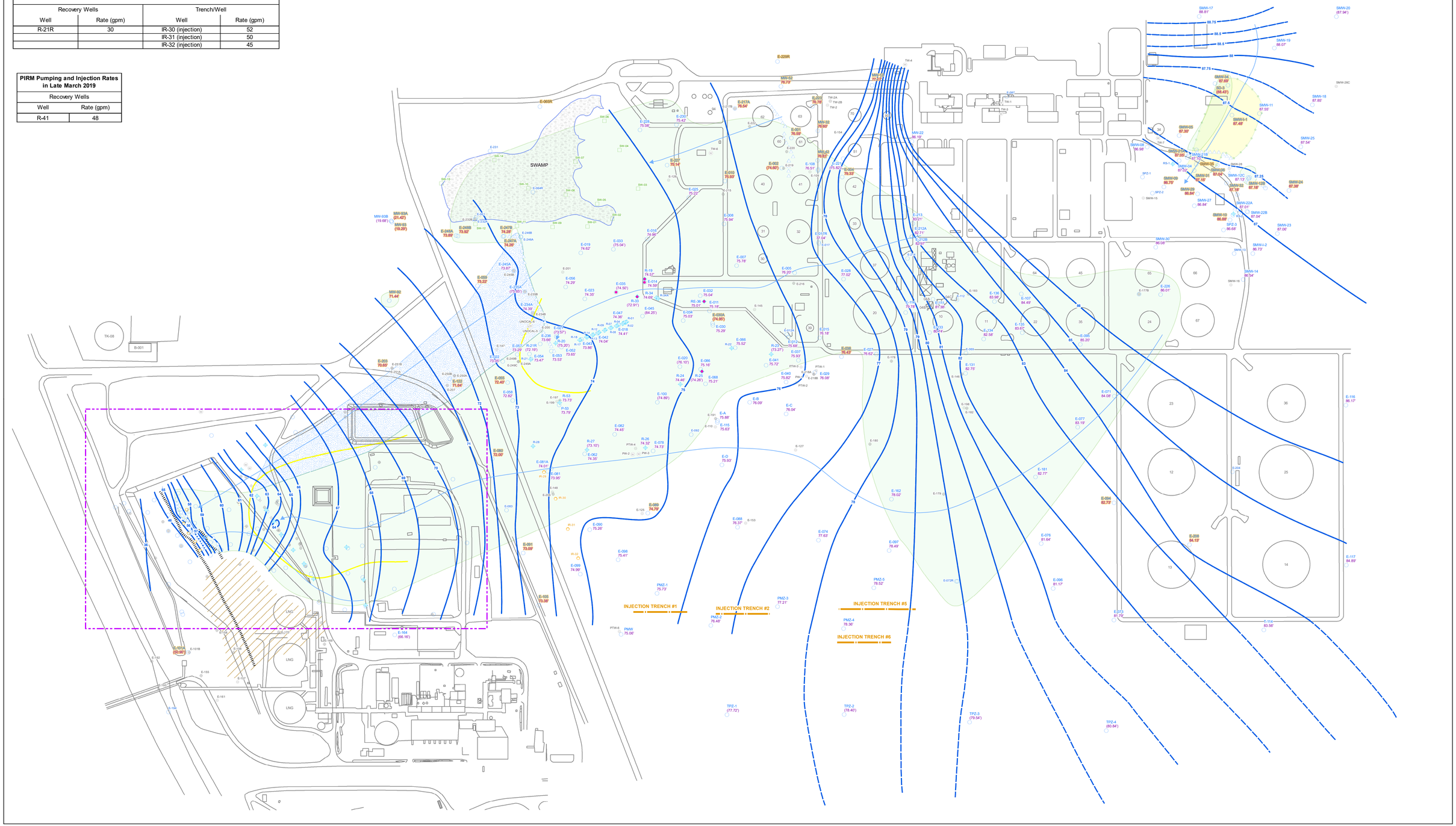
**TESORO KENAI REFINERY, LLC**
**NIKISKI, ALASKA**

| Drawn By: DH | Checked By: SP | Scale: Not to Scale | Date: 11/6/23 | File: ATG_GeneralUse.mxd |
|---|---|---|---|---|

C:\USERS\TGALLAGHER\ONEDRIVE - TRIHYDRO\DOCUMENTS\ARCGIS\PROJECTS\ATG_GENERALUSE\ATG_GENERALUSE.APRX

| PM Pumping and Injection Rates in Late March 2019 | | | |
|---|---|---|---|
| Recovery Wells | | Trench/Well | |
| Well | Rate (gpm) | Well | Rate (gpm) |
| R-21R | 30 | IR-30 (injection) | 52 |
| | | IR-31 (injection) | 50 |
| | | IR-32 (injection) | 45 |

| PIRM Pumping and Injection Rates in Late March 2019 | |
|---|---|
| Recovery Wells | |
| Well | Rate (gpm) |
| R-41 | 48 |




## EXPLANATION

- UNCONFINED AQUIFER MONITORING WELL LOCATION
- RECOVERY WELL LOCATION
- B-UNCONFINED AQUIFER MONITORING WELL LOCATION
- B-AQUIFER RECOVERY WELL
- B-AQUIFER INJECTION WELL LOCATION
- UPPER CONFINED AQUIFER MONITORING WELL LOCATION
- AIR SPARGE WELL
- SURFACE WATER SAMPLE
- WELL CONTAINING LNAPL > 0.02 FT THICK
- INJECTION TRENCH
- WATER LEVEL CONTOUR (1 FT INTERVAL)
- WATER LEVEL CONTOUR (IRREGULAR INTERVAL)
- GROUNDWATER FLOW DIRECTION
- APPROXIMATE EXTENT OF GROUNDWATER RECOVERY CAPTURE ZONE
- HYDRAULIC BARRIER
- ESTIMATED EXTENT OF BENZENE CONCENTRATIONS GREATER THAN 4.6 µg/L
- ESTIMATED EXTENT OF TCE CONCENTRATIONS GREATER THAN 2.8 µg/L
- ESTIMATED EXTENT OF SPARGE-TREATED GROUNDWATER FROM HIGHWAY AS/SVE SYSTEM
- DRY ZONE

## NOTES:

1. MLLW = MEAN LOWER LOW WATER
2. µg/L = MICROGRAMS PER LITER

E-099 / 74.99' — WELL ID AND POTENTIOMETRIC SURFACE ELEVATION MEASURED IN FEBRUARY AND MARCH 2019 (IN FEET MLLW), IN PARENTHESES IF NOT USED TO CONTOUR, WELLS HIGHLIGHTED IN ORANGE WERE SAMPLED AND ANALYZED FOR VOLATILE ORGANIC COMPOUNDS (VOCs)

N

0 200 400'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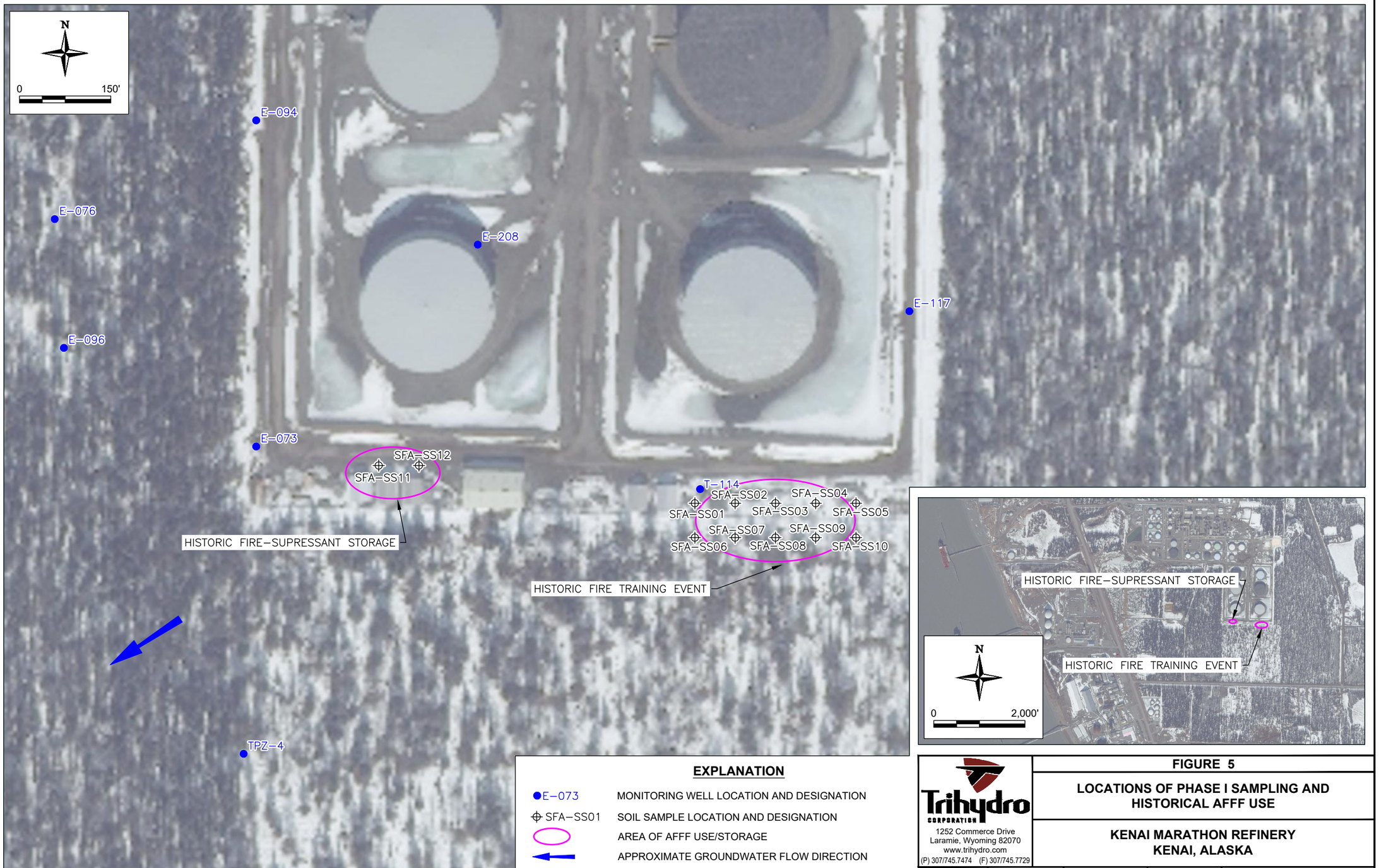
# FIGURE 4

## POTENTIOMETRIC SURFACE MAP

## BASED ON Q19-2 REPORT
## TESORO KENAI REFINERY
## NIKISKI, ALASKA

| Drawn By: DH | Checked By: BLM | Scale: 1 " = 200 ' | Date: 11/7/23 | File: Fig-4_GWE_Q19-2.mxd |
|---|---|---|---|---|




**EXPLANATION**

| | |
|---|---|
| ●E-073 | MONITORING WELL LOCATION AND DESIGNATION |
| ⊕ SFA-SS01 | SOIL SAMPLE LOCATION AND DESIGNATION |
| ⬭ | AREA OF AFFF USE/STORAGE |
| ➡ | APPROXIMATE GROUNDWATER FLOW DIRECTION |

Image Citation: ©2023 Microsoft Corporation ©2023 Maxar ©CNES (2023) Distribution Airbus DS Bing Image

M:\STOV\TESORO\CADD\KENAREFINERY\GENERAL_SUPPORT\PFAS_INVESTIGATION\39B_PFAS-SITE

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**FIGURE 5**

**LOCATIONS OF PHASE I SAMPLING AND HISTORICAL AFFF USE**

**KENAI MARATHON REFINERY**
**KENAI, ALASKA**

| Drawn By: JLP | Checked By: JM | Scale: AS SHOWN | Date: 11/8/2023 | File: 39B_PFAS-SITE |
|---|---|---|---|---|

# APPENDIX A

# PFAS SAMPLING STANDARD OPERATING PROCEDURE

# memorandum

**To:** Trihydro Employees
**From:** Mitch Olson
**Date:** September 2, 2022
**Re:** PFAS Sampling Standard Operating Procedure

---

## 1.0 INTRODUCTION

This standard operating procedure (SOP) establishes protocols for Trihydro employees and subcontractors to be followed when collecting samples for per- and polyfluoroalkyl substances (PFAS). This SOP includes general PFAS sampling procedures as well as procedures for specific activities including sampling of drinking water, groundwater, surface water/sediment, soils, and other media.

This PFAS SOP is divided into the following Sections:

1.0 Introduction

2.0 PFAS Sampling Training Requirements

3.0 General PFAS Sampling Procedures

4.0 Drinking Water and Supply Well Sampling

5.0 Groundwater Sampling

6.0 Surface Water and Sediment Sampling

7.0 Surface and Subsurface Soil Sampling

8.0 Other Sampling Matrices

9.0 PFAS Laboratory Requirements

10.0 References

Although PFAS sampling procedures are generally similar to conventional sampling, several aspects of sampling and analysis for PFAS are unique, and following these PFAS-specific procedures is critical. PFAS-specific procedures are necessary due to their high tendency for sample cross-contamination, which is related to the following characteristics:

- Extremely low environmental concentrations of interest
- Large numbers of individual analytes that may be present in environmental samples
- Potential presence in many standard sampling materials, especially in Teflon® or polytetrafluoroethylene (PTFE)
- Presence in everyday materials including food packaging and clothing
- Greater scrutiny of results than for other contaminants

The objective of this SOP is to establish general PFAS sampling procedures to guide PFAS sampling events across the company, provide defensible PFAS data, and remain consistent with current PFAS sampling guidance and best practices.

**Due to anticipated/ongoing changes in procedures and the state of the science for PFAS, this SOP will be reviewed and/or updated annually, at a minimum, during the first quarter of each calendar year. Project teams need to use the most recent version of this document before planning and implementation of field work.**

## 1.1 PFAS BACKGROUND

Since the 1950s, PFAS have been incorporated into many consumer and industrial products. One of the many historical uses is in firefighting foams ("Aqueous Film Forming Foams," or AFFF). AFFF products may be used for fire suppression at facilities where Class B fires (i.e., those involving flammable liquids and gases) may be a concern, including airports, firefighting training areas, and other facilities where flammable hydrocarbons are present. PFAS have also been used for widespread industries including non-stick material (e.g., Teflon®) manufacturing, metal plating, paper/fabric production, plastics, semiconductors, aerospace industries, and in processes such as mist/dust suppression. Environmental releases of PFAS compounds have resulted from their historical uses in AFFF and industrial processes.

In total, the chemical class of PFAS includes thousands of individual compounds. The most well-known and widely regulated of these compounds include perfluorooctanoic acid (PFOA) and perfluoroalkyl sulfonate (PFOS). The United States Environmental Protection Agency (EPA) released final Health Advisory (HA) levels for these compounds of 70 parts per trillion (ppt) (i.e., 0.070 parts per billion); in June 2022, the EPA released updated interim HA levels of 0.004 ppt and 0.020 ppt for PFOA and PFOS, respectively. The EPA also released final HA values for two additional PFAS compounds, perfluorobutane sulfonate (PFBS) and hexafluoropropylene oxide (HFPO) dimer acid (otherwise known as GenX) of 10 and 2,000 ppt, respectively. Furthermore, several states have established their own standard values for PFAS in drinking water, surface water, and soils (ITRC 2022). Many states have adopted values lower than the EPA HA levels.

PFAS also exhibit unique chemical and physical properties, with important implications for sample collection. The molecular structure includes a nonpolar/fluorinated tail and a non-fluorinated head. The polar/nonpolar structure makes PFAS function as surfactants (e.g., substances that decrease a liquid's surface tension), and are prone to accumulate at air/water interfaces (especially where foam may be formed). Because of this tendency to accumulate at interfaces, surface/stormwater sampling should avoid interfaces, if possible, to avoid high-biased sample data. In terms of sampling, PFAS are considered to be "sticky" in that they may temporarily sorb to sampling materials, which increases the risk of cross contamination if procedures described herein are not strictly observed.

## 1.2 PFAS SAMPLING GUIDANCE DOCUMENTS

The SOP presented herein has been developed in consideration of select state-specific guidance documents as well as the Interstate Regulatory Guidance Council (ITRC). Additional guidance may need to be referenced for site-specific circumstances, for example, several states have published independent guidance documents (in addition to the California and Michigan documents noted herein). PFAS sampling and analytical guidance documents include the following:

- Per- and Polyfluoroalkyl Substances (PFAS) Sampling Guidelines for Non-Drinking Water published by the California State Water Quality Control Board (The Water Boards) Division of Water Quality in September 2020 (The Water Boards 2020).
- General PFAS Sampling Guidance published by the Michigan Department of Environmental Quality (MDEQ) in October 2018 (MDEQ 2018).
- ITRC's guidance document, *Technical Resources for Addressing Environmental Releases of Per- and Polyfluorinated Compounds (PFAS)*, Chapter 11, Sampling and Analytical Methods, provides detailed information on sampling protocols (ITRC 2022).

## 2.0 PFAS SAMPLING TRAINING REQUIREMENTS

Due to the need for specialized procedures used for PFAS sampling, only personnel who have completed Trihydro's training program should collect environmental samples for PFAS. Trihydro's PFAS sampling training program includes the following elements:

- Initial office-based training conducted by one or more members of the Trihydro PFAS technical team, including PFAS background, overview of this SOP, and discussion of unique aspects of PFAS sampling with a detailed discussion of the material compatibility table. Training should include discussion of procedures commensurate with sampling to be conducted. Office-based training will cover items in the checklist (Attachment A) and is anticipated to require 1 hour for drinking/waste-water sampling conducted above ground (e.g., from spigots) and 1-2 hours for environmental sampling including soils, sediment, surface water, groundwater. The office-based training is considered sufficient for personnel collecting tapwater/spigot sampling; personnel conducting environmental sampling (e.g., groundwater, surface water, soils, and sediment) must complete on-site training.
- On-site training will be led by an experienced PFAS sampler. Experienced PFAS samplers will use the Field Training Checklist included as Attachment B of this SOP to ensure that the applicable aspects of PFAS field techniques are discussed during the on-site training event.
- Annual refreshers will consist of office-based training/discussion to share information learned throughout the company during PFAS sampling events, updates in terms of standard methods, and to provide feedback on lessons learned.

## 3.0 General PFAS Sampling Procedures

This section provides general information on PFAS sampling procedures, to be used for all PFAS sampling activities. In general, collection of PFAS samples follows similar procedures to those employed for conventional sampling; however, due to the unique properties of PFAS discussed in Section 1, there are several key aspects of PFAS sampling that warrant additional attention. This SOP focuses on areas where PFAS sampling requires different considerations than conventional sampling procedures. PFAS may be present in a wide variety of commercial products including common household items (e.g., food wrappers, Gore-Tex® or other waterproof fabrics, stain-resistant fabrics, cosmetics, sunscreens, and moisturizing lotions). Table 1 presents a list of sampling materials that are prohibited or acceptable, following The California Water Boards 2020, MDEQ 2018, and ITRC 2022 guidance. **It is very important that PFAS-compatible materials are used and that sampling procedures follow protocols to minimize risk of cross contamination.** This section provides guidance on how to manage sampling to minimize risks of PFAS contamination. PFAS sampling procedures for specific media types are provided in subsequent sections.

While planning for PFAS sampling, the following guidelines should be kept in mind:

- Plan ahead to ensure materials and procedures can be properly vetted for PFAS compatibility
- For PFAS field sampling, include extra time, such that the field crew does not have to rush
- Simplify procedures and minimize clutter to reduce cross-contamination risks

### 3.1 CLOTHING AND PERSONAL CARE PRODUCTS

The sample collection team should be aware of clothing compatibility (per Table 1) with PFAS sampling. PFAS are present in waterproof and stainproof fabrics, and may be present in new clothing, regardless of whether clothing is considered "waterproof". Clothing worn during PFAS sampling should meet the following criteria:

- All clothing should be well-laundered, i.e., washed at least six times after purchase.
- Before sampling, clothing should be laundered without fabric softener or dryer sheets.
- For clothing and jackets worn during PFAS sampling, cotton or synthetic fabrics are acceptable, if the fabrics are not treated to be water/stain resistant (and all clothing regardless of material must be well laundered).
- Clothing containing Gore-Tex® (or similar waterproofing) should not be present at the field site; if traveling, such clothing should not be packed next to clothing that will be worn for sampling.
- Waterproof clothing made with polyurethane, PVC, wax-coated fabrics, rubber, or neoprene (e.g., *Helly Hansen Storm Waterproof Rain Jacket*, with a shell made of PVC) is acceptable.

- Do not use unnecessary personal care products on the day of sampling (e.g., nail polish, cologne/perfume, lotions); wash hands with soap and water after applying personal care products on the day of sampling.

### 3.2 PFAS SAMPLING HEALTH AND SAFETY CONSIDERATIONS

In some circumstances, personal protective equipment (PPE) requirements may create conflicts with the PFAS sampling compatible materials shown in Table 1. Such conflicts should be identified during the planning/work-plan development process so they can be managed. **Do not sacrifice PPE requirements for PFAS sample collection.** Through planning, a solution can generally be found. For example, waterproof steel-toed workboots may be covered by overshoes made of polyvinyl chloride (PVC) or similar PFAS-compatible materials. Sunblock, insect repellant, and/or related materials should be applied ahead of time and hands washed with soap and water after these are applied.

Potential health-and-safety/PFAS conflicts and resolutions should be documented in field notes. The sampler should be conscientious about potential pathways between these products and the sample, and look for ways to eliminate these pathways.

### 3.3 SAMPLING EQUIPMENT AND MATERIALS

PFAS are potentially present in many common sampling materials; Table 1 provides a summary of materials that are compatible/incompatible with PFAS sampling. Many common sampling materials are not compatible with PFAS, thus it is important that the sampling team is familiar with this table.

Materials that are useful to have on-site for PFAS sampling include the following:

- Polyethylene (PE) sheeting (and scissors to cut the sheeting)
- Packing tape to attach sheeting to sample preparation surfaces (optional)
- Sample staging table (optional)
- Nitrile gloves - excess quantity for frequent changing of gloves
- Ziploc bags - excess quantity for sample containers, double-bagged ice, and separating/containing sampling equipment
- Untreated paper towels - excess quantity for general use
- Waste containers (e.g., contractor bags) to ensure that waste materials may be removed from the sample processing area immediately after being generated, thus avoiding unnecessary clutter
- Loose leaf paper, pre-printed for recording sample log information
- PFAS-compatible pens, such as a Uni-ball Power Tank RT Retractable Ballpoint Pen

If decontamination is required, purchase PFAS-free water from the laboratory along with the sample container order. PFAS-free water may be expected to cost approximately $20 per liter. If a large volume (e.g., multiple gallons) of decontamination water is required, a local water source may be used only if tested and verified to be 'PFAS-free' ahead of time.

### 3.4 SAMPLING CONTAINERS

Sampling containers provided by the laboratory for PFAS analysis consist of polypropylene or high-density polyethylene (HDPE). Glass containers are never suitable for PFAS analysis of water samples, as PFAS can adsorb onto glass; glass containers are not ideal for soil sampling, but may be used if nothing else is available. Teflon-lined lids are not acceptable for PFAS sampling. Before sampling, confirm PFAS compatibility, including sample-container composition with the selected analytical laboratory. For drinking water samples, USEPA method 537.1 requires 250 milliliters (mL) per sample container and USEPA Method 533 requires 100-250 mL per sample container; laboratories generally require two containers per sample. Volume requirements may vary per laboratory requirements; confirm with laboratory before sampling. Requirements for preservatives (Trizma® buffer or ammonium acetate) are discussed in Section 8.3.

For non-drinking water matrices, the absence of USEPA-promulgated analytical methods allows for flexibility in the sample quantity and preservation; required quantities, bottles, and preservatives should be confirmed with the analytical laboratory prior to field activities.

### 3.5 SAMPLING AREA PREPARATION

To minimize the potential for cross contamination, designate separate sampling and preparation spaces within the work area. For PFAS sampling of all media types, the following area preparation steps can facilitate successful PFAS sampling:

- Remove unnecessary materials from the sampling area. This includes materials that are part of the sampling event but are not needed for sample collection (e.g., field notes).
- Under certain circumstances (e.g., residential water sampling), a Ziploc bag may be used to transport/store sampling containers and sampling materials. These materials must be disposed of after a single use and are <u>not</u> to be used at multiple locations.
- Consider using disposable PE sheeting to setup a workspace for sampling equipment. For small, localized sample collection (e.g., from a spigot) use PE sheeting or untreated paper towels to setup a workspace.
- For certain types of sampling, a portable/collapsible table may be used, with PE sheeting used to cover the table. Packaging tape is acceptable to secure PE sheeting, as long as the tape is applied beneath the table surface and does not contact sample containers during processing. The top of a

cooler may also be used for equipment storage, if covered by PE/untreated paper towels or thoroughly decontaminated.

- Have an excess quantity of nitrile gloves accessible; gloves are to be changed frequently, including as a last step before sample collection. Gloves should be kept in the box (or in a clean Ziploc bag) until use and should not be carried in a pocket, or in a similar uncontrolled manner. Avoid handling of the nitrile glove box after donning clean nitrile gloves.
- Make sure personnel that are not equipped for PFAS sampling remain outside of the immediate sampling area (at least 6 feet away).

Preparing sample containers and coolers before the event:

- Always wear clean nitrile gloves while handling sample containers and PFAS-free water containers, even when organizing before the sampling event.
- Preparing bottle sets before the sampling event is helpful to minimize handling of containers required in the field. Preparation might include grouping of bottle sets in Ziploc bags. Sample container labels may be filled out (with all information except sample time) and applied ahead of time. Ziploc bags can be labeled using an Ultra-Fine point sharpie or Uni-ball Power Tank RT Retractable Ballpoint Pen.
- Ensure that sample containers are controlled through the entire preparation process. They may be in a cooler, placed in Ziploc bags, or placed on PE sheeting. Sample containers should be stored in a liner-bag or Ziploc bag within the cooler. Do not place sample containers on 'uncontrolled' surfaces, such as the exposed lid of a cooler, the tailgate of a truck, or a carpeted floor, unless the surface is decontaminated or covered with PE sheeting or clean, untreated paper towels.
- Prepare separate coolers for clean/empty sample containers and filled containers such that clean/empty and filled containers are not mixed in a single cooler.

### 3.6 SAMPLE COLLECTION AND HANDLING

PFAS are sticky, in that they tend to adhere to solid surfaces, and therefore may be transferred from source to sample during the handling process. The following presents a list of sampling dos and don'ts that mitigate this cross-contamination risk.

| Do | Don't |
|---|---|
| **Change gloves** frequently, including immediately before sampling. | Touch anything besides sample containers with final pair of nitrile gloves. |
| **Keep sample containers controlled** through the entire sampling process, and keep containers closed/sealed until filling with a sample. | Put sample containers or sampling equipment on the ground or in contact with any surface that cannot be shown to be free of PFAS. |
| **Have at least two coolers**, one for unused sampling containers and one for the PFAS samples. | Put PFAS samples in a cooler with unused sampling containers. |
| **Practice good housekeeping** by keeping sample collection area clean and free of used paper towels, gloves, sampled media (soil and water). | Bring items into the sample collection area that are not necessary to the process of sample collection (notebooks, work plans, food/drink containers, etc.). Water bottles for hydration are allowable at the sampling site, but should be kept in the car and out of the sampling/staging area. |
| **When sampling liquids**, fill the container to the shoulder. Some headspace is preferred. | Field filter the PFAS sample. If filtration is required, notify the laboratory. |
| **Collect PFAS samples first**, then other samples. This minimizes contact of PFAS samples with the handling of other sampling containers. | Intermingle PFAS and non-PFAS sample containers. |
| **Remove excess sample media** (soil, sediment or water) to the extent practicable from the exterior of sample containers to minimize cross contamination in cooler and at laboratory. | Rinse reusable sampling equipment with regular tap water. After a thorough decontamination, rinse with PFAS free water. |

### 3.7 SAMPLE SHIPMENT

PFAS samples also have unique requirements for packaging and shipment. Additional considerations for PFAS sample shipment include use of additional Ziploc bags to mitigate cross-contamination potential during sample handling or during shipment. All sample sets should be packaged in separate Ziploc bags; the two (or more) containers filled for each sample set can be placed in a single sealed bag. If high PFAS concentrations are expected, samples containers may be double-bagged to minimize cross-contamination risk in the cooler (under such circumstances a trip blank should be included, as described in Section 8.4). PFAS samples are shipped to the analytical laboratory in a cooler, via expedited delivery or overnight shipping if possible, following similar protocols used for conventional sampling. Finally, as with conventional sampling, the samples must be received by the laboratory at 4±2 degrees Celsius (°C) or as required by the sample method specified in the work plan. For cooling of samples during shipment, use water-based ice instead of gel ice (e.g., Blue Ice). Under circumstances where gel ice may be needed, make sure the gel ice is double bagged in Ziploc bags and/or properly decontaminated, with an equipment blank collected. Even water-based ice is a potential PFAS source within the coolers, therefore the ice

must be double-bagged in Ziploc (or similar) bags. Clean nitrile gloves should be worn while handling ice, and should be changed prior to handling sample containers.

Additional considerations for PFAS sampling in specific matrices (drinking water, groundwater, surface water/sediment, and other media types) are provided in the following sections:

- Section 4 Drinking Water and Supply Well Sampling
- Section 5 Groundwater Sampling
- Section 6 Surface Water and Sediment Sampling
- Section 7 Surface and Subsurface Soil Sampling
- Section 8 Other Sampling Matrices

## 3.8 DECONTAMINATION

- To reduce/minimize investigation-derived waste (IDW) a spray-bottle method of decontamination may be used where adequate. Zepp® brand spray bottles are recommended.
- Decontamination should use a phosphate-based detergent, such as Alconox® or Liquinox® Note that Simple Green® has not been confirmed to be PFAS free, and is therefore not approved for PFAS sampling decontamination at this time.
- PFAS-free water (lab supplied is preferable) should be used for a final rinse. If a large volume of decontamination water is needed, a local water source may be used, but the water source should be tested and verified as being PFAS-free. Best practice is to use lab-supplied PFAS-free water for a final rinse.
- Equipment blanks should be collected from non-dedicated equipment that contacts the sampled media to validate decontamination procedures.
- Decontaminated equipment may be stored in fresh Ziploc bags, in decontaminated equipment cases, on HDPE sheeting, or similar, until immediately prior to sampling, to minimize risk of contamination.
- Additional decontamination considerations for sampling of different media types are provided in Sections 4 through 7.

## 3.9 INVESTIGATION DERIVED WASTE

IDW may include purge water, soils, disposable tubing from groundwater sampling, purge water from spigot/sample port sampling, spent PPE, or other solid waste generated during the collection of PFAS samples. Although PFAS compounds are new analytes for many facilities where sampling is conducted, the chemistry of purged groundwater will be similar to that of water generated during regular sampling events. Therefore, depending on local, state, or site-specific requirements, all IDW water may be handled

following normal site-sampling procedures. Other solid waste will be discarded in an appropriate on-site container, following standard site procedures for solid waste. Potential PFAS-impacted IDW will need to be profiled and managed in accordance with local/state or client requirements.

### 3.10 FIELD DOCUMENTATION

The information documented during the field activities should include, at a minimum:

- Photo-documentation (if allowable – photo documentation can be helpful for documenting unconventional site conditions for potential PFAS impacts)
- Descriptions of sample matrices
- Descriptions of sampling locations
- Sample collection dates and times
- Sample container sizes, amounts, types, and preservatives
- Sampling methodology
- Deviations from this SOP or site-specific work plans

An example field documentation form used for PFAS sampling is provided in Attachment C.

### 3.11 SITE DATA MANAGEMENT

Due to the prolific nature of PFAS, its status as an emerging contaminant, and the high degree of uncertainty surrounding environmental liability associated with PFAS, many PFAS sites are the subject of potential or ongoing litigation. As such, additional care should be used when managing site data. This may include various best practices that should be discussed with the client prior to initiating sampling activities, including:

- Determining what documentation to collect for sample procedures to verify that samples are representative of site conditions.
- Determining if existing judicial orders are present which may direct sample activities, notifications, or document retention and production requirements.
- Being thorough, yet careful to only record data observations (as opposed to including qualitative speculation, judgement, or opinion) when producing field notes, sample logs, sample figures, and other documentation.
- Determining whom may receive/respond to inquiries from members of the public.
- Discussing with field staff and project managers what information can and cannot be disclosed about site activities.

- Evaluating potential conflicts of interest and making staffing and project selection determinations accordingly.

## 4.0 DRINKING WATER AND SUPPLY WELL SAMPLING

This section provides PFAS sampling considerations for drinking water and supply well matrices. This section is not intended to teach water sampling fundamentals, but rather to provide instruction on differences in procedures and considerations specific to PFAS sampling. Procedures discussed in this section are additional considerations to the general PFAS sampling guidelines provided in Section 3. Due to the potential sensitivity to low-level detections in drinking water samples, drinking water and supply well sampling should be undertaken with the utmost consideration of cross contamination risk, materials used, and planning of sampling procedure.

### 4.1 EQUIPMENT/MATERIALS

In addition to the general and decontamination supplies listed in Sections 3.3 and 3.8, respectively, additional sample materials and supplies may include:

- Purge water collection buckets (optional), in the event that purge water needs to be contained, or a sample tap is located in a vault or other undrained location.
- A garden hose (optional) may be used to direct purge water from an exterior spigot, if needed to direct drainage to a suitable location; however, the hose must be removed prior to sampling such that a sample is collected directly from the spigot.

### 4.2 SAMPLING PROCEDURES

Sample collection for PFAS should generally follow these procedures. During most steps, samplers should don new (unused) nitrile gloves, even if it is not expressly identified below. New gloves should always be donned before handling sample containers, at any time.

- Using appropriate pen or ultra-fine Sharpie, fill out sample labels with all information except sample time and apply labels to sample containers. Pre-labeled sample containers may be stored in labeled 1-gallon Ziploc bags prior to sampling.
- Prepare a clean workspace for the sample staging area, using a decontaminated surface, clean PE sheeting, or untreated paper towels.
- Prepare the sampling area, removing moveable/unnecessary materials from the sampling area, including unnecessary hoses, aerators, filters, or other attachments/extensions of the tap (as noted, a hose may be in place during purging from an exterior spigot, only if needed to direct purge water, but must be removed prior to sampling).
- Don new nitrile gloves, changing as needed. Identify the sample port and open to allow purging and stabilization of the water flow for at least 3 minutes (purge time may vary based on project objectives) at a moderate to high flow.

- After purging is complete, reduce the discharge rate to a slow stream (generally less than 1 liter per minute) to minimize potential sample aeration.
- Don new nitrile gloves and collect the sample, filling each sample container to the shoulder.
- After closing sample containers, remove excess water from sample container surface with a fresh, untreated paper towel (excess water can facilitate cross-contamination) and place sample containers inside a new Ziploc bag. Double bag samples if they come from an area with known elevated PFAS levels.
- Place the samples in a cooler with ice, separate from any cooler with empty sample bottles.
- After sample handling is complete, close the sample spigot.

### 4.3 DECONTAMINATION AND IDW MANAGEMENT

The need for decontamination of reusable sampling equipment is not anticipated for water sampling from spigots. If reusable equipment such as a portable table for sample staging is used, which cannot be covered with PE sheeting, decontaminate using Alconox or similar and PFAS-free water.

Use a plastic contractor's bag (or similar) to contain solid IDW, including PE sheeting, nitrile gloves, Ziploc baggies, and other sampling materials, to minimize risks of cross contamination.

### 4.4 OTHER NOTES

- If a hose is used to direct water during purging, it must be removed prior to sampling.
- If Teflon® tape is visible at the sample port locations where water exists the port, document on the field forms. Although PFAS are associated with Teflon® tape production, experience to date suggests that it isn't a significant source of PFAS contamination in samples collected; nevertheless, its presence should be noted.

Domestic water may flow through a pressure tank or treatment system (e.g., water softener) before being discharged from a tap. For domestic wells, depending on sampling objectives, it may be necessary to collect water samples pre-treatment, post-treatment, or both. Pre-treatment sampling may be best if sampling is being conducted to evaluate local source-water impacts, but post-treatment may be best if sampling is conducted to evaluate drinking water exposure.

## 5.0 GROUNDWATER SAMPLING

This section provides PFAS sampling considerations specific to groundwater matrices. This section assumes general understanding of basic groundwater sampling procedures, and is not intended to teach groundwater sampling fundamentals, but rather to provide instruction on differences in procedures and considerations specific to PFAS sampling. Groundwater sampling typically requires purging of groundwater from wells using standard ("high-volume") or low-flow methods; alternatively, no-purge

methods such as HydraSleeves are available. Where appropriate, Trihydro's preferred groundwater sampling method for PFAS is no-purge sampling using HydraSleeves, to limit risk of cross-contamination and minimize risk of bias in sampling results due to artificially mobilizing PFAS in groundwater during purging. If no-purge sampling is not feasible, or is not accepted by regulatory agencies, low-flow sampling is recommended. Standard, high-volume purging methods should be avoided if possible, but may be required due to deep groundwater or other location-specific needs. Regardless of sampling method, sampling materials should be screened for PFAS compatibility. Additional considerations for sampling materials associated with these methods are provided in this section. The procedures discussed in this section are additional considerations to the general PFAS sampling guidelines provided in Section 3.

## 5.1 EQUIPMENT/MATERIALS

In addition to the general and decontamination supplies listed in Sections 3.3 and 3.8, respectively, additional sample materials and supplies required for PFAS sampling via no-purge sampling, low-flow sampling, bailer sampling, and submersible pump sampling are described below.

*No-purge sampling (preferred).* No-purge sampling may be conducted using HydraSleeve or other passive samplers constructed of HDPE or similar PFAS-compatible material. Passive diffusion samplers are also available for PFAS sampling. When ordering HydraSleeves (or similar no-purge sampling devices), communicate with the vendor that they are to be used for PFAS sampling, and materials must be PFAS compatible. PFAS-compatible rope (e.g., cotton or nylon) must be used for HydraSleeve deployment; it is recommended (but not required) to procure the PFAS-compatible rope from the HydraSleeve vendor. Deployment of no-purge sampling equipment can generally follow manufacturer's instructions but should also follow the general PFAS sampling approach described herein.

The HydraSleeve samplers consist of collapsible HDPE plastic sleeves that are deployed in a well at a fixed depth within the screened interval (typically near the bottom of the screened interval). A check valve at the top of the sleeve prevents groundwater from entering the sleeve during deployment. After deployment, the samplers are left in place for a prescribed amount of time (typically a week) to allow groundwater within the well to equilibrate with the formation. For sample collection and recovery, the HydraSleeve sampler is pulled upward, which opens the check valve and allows water to fill the sleeve. The HydraSleeve sampler is then recovered to the surface, and a sample collected from the sleeve. The sleeves are available in 1-liter, 2-inch well diameter size ('Super/SkinnySleeve 1-Liter', part number PFCHDSS-1L) and 2-liter, 2-inch well diameter size ('Super/SkinnySleeve 2-Liter', part number PFCHDSS-2L). For groundwater sampling in 4-inch wells, the HydraSleeve sampler may be deployed with a 4- to 2-inch reducer and spring clip, which is available from the vendor. Non-disposable components (dedicated materials) associated with the HydraSleeves (i.e., reducer, spring clip, and weight) should be dedicated to each well.

*Low-flow sampling.* Low-flow sampling involves well-purging at a limited flow rate (e.g., <500 mL/min) until parameters stabilize (EPA 1996). A peristaltic pump is recommended for PFAs sampling, if water depth can accommodate a peristaltic pump, to reduce/eliminate the need for equipment decontamination between sampling locations. If needed (e.g., for water too deep for a peristaltic pump), bladder pumps or electric submersible pumps may be used. Dedicated pumps are preferred, otherwise PFAS-compatible decontamination procedures must be completed between locations. For a bladder pump, the pump body should be constructed of stainless steel (or other PFAS compatible material), and the bladder and O-rings must be constructed of polyethylene or similar PFAS-compatible materials, and be replaced between sample locations. If an electric submersible pump is selected, evaluate that the pump is free of PTFE and other fluoropolymer fittings. Additional considerations for low-flow PFAS sampling are as follows:

- For a rental pump used for PFAS sampling, verify with the vendor that the pump is designed and constructed to be PFAS compatible.
- Downhole tubing should be either disposable or dedicated to a single location, and constructed of HDPE or a similar PFAS-compatible material; tubing constructed of Teflon, PTFE, or similar fluoropolymers cannot be used.
- Standard silicone tubing may be used for a peristaltic pump, but the tubing should be replaced between sample locations.
- A flow-through cell with a multi-parameter meter may be used to track parameters stabilization during low-flow purging. The flow-through cell does not need to be completely constructed of PFAS-compatible materials, but the meter/flow-through-cell must be removed from the flow path before sample containers are filled.

*Bailer sampling*. Samples can also be collected via bailer, though it is generally not preferred due to sample agitation and potential mixing with the air-water interface. Bailer materials are available that are compatible with PFAS sampling, such as HDPE. PFAS-compatible rope (e.g., cotton or nylon) must be used for bailer sampling. When used for PFAS sampling, bailers should be gently lowered across the water surface to minimize turbidity, and should be lowered sufficiently below the water surface such that the sample represents formation water rather than interfacial water.

*Submersible pump sampling*. High-flow purging with a submersible pump is generally not recommended for PFAS sampling, due to potential for PFAS contamination by pump components, cross-contamination between wells, and the possibility of mobilizing PFAS in a non-representative manner (e.g., via air bubbles) during high-volume purging. However, submersible pumps may be the only practical sampling device for deep wells. When practicable, use dedicated pump systems to eliminate cross contamination. The purge-water flow rate should be kept low, to eliminate or minimize entrained air bubbles in the water stream while purging and sampling.

*Additional groundwater sampling considerations.*

- Sampling materials should never be placed directly on the ground. Use a clean surface or PE sheeting for work space.
- If turbidity is noted, do not field-filter samples as filtration may affect PFAS concentrations. The laboratory should be informed of highly turbid samples; under certain circumstances, the laboratory may use centrifugation to prepare the sample for analysis.
- Purge water may generally be collected in standard 5-gallon buckets.
- Fluid level or interface probes may be used to monitor water levels before/during sampling. PFAS-compatible decontamination procedures must be followed between locations. Unless necessary, measurement of in-well total depth is not recommended during PFAS sampling to minimize cross-contamination risks.
- PFAS-compatible rope/twine (typically cotton or nylon) may be used for securing HydraSleeves, submersible pumps, or bailers.
- Equipment that contacts water within the well (e.g., pumping equipment and water meters) should not contain or be coated with Teflon®, unless the Teflon® is internal to the equipment and does not contact the external environment. Often, equipment suppliers will label products as "PFAS Testing Approved" or "PFAS-free." It is highly recommended that equipment and supplies be identified as PFAS-free. If unsure whether a product is suitable for collecting a PFAS sample, contact the supplier and/or collect an equipment blank.

## 5.2 SAMPLING PROCEDURES

Sample collection for PFAS should generally follow these procedures. During most steps, samplers should don new nitrile gloves, even if it is not expressly identified below. New gloves should always be donned before handling sample containers, at any time.

- Decontaminate reusable equipment that will contact groundwater prior to use. Gauge depth to water and determine targeted pump-intake or screened interval for sampling.
- Using appropriate pen or ultra-fine Sharpie, fill out sample labels with all information except sample time (which can be added after the sample is collected and the lid replaced) and apply labels to sample containers. Pre-labeled sample containers may be stored in labeled 1-gallon Ziploc bags prior to sampling.
- Prepare a clean workspace for the sample staging area, using a decontaminated surface, clean PE sheeting, or untreated paper towels.
- Prepare the sample collection area, removing any moveable/unnecessary materials from the sampling area. Deploy PE sheeting as needed for staging of sampling materials, providing workspace to keep materials off the ground.

- Lower the pump, intake tubing, bailer, or passive sampler to the desired sample interval. Importantly, the sample interval should be several feet below the groundwater-air interface to ensure the collection of a representative groundwater sample and avoid sampling of PFAS accumulated at the interface.
- If low-flow purging is performed, connect the water quality meter to the flow path and initiate purging. Collect purge-water in a dedicated container (e.g., plastic 5-gallon bucket) and make sure that water does not splash or come into contact with the sample staging area and sample bottles. Record parameters at regular intervals, in accordance with standard practice for low-flow purging. After groundwater parameters have stabilized, disconnect the water quality meter before sampling.
- Collect the sample - don new nitrile gloves and fill the sample containers without touching other equipment or surfaces, including the sample tubing.
- It is preferable to have two personnel for sampling, one person to handle the sample device (e.g., HydraSleeve) and pour, and the other person to manage the sample containers, without needing to set down the sampling device and containers and risk potential cross-contamination.
- After sample containers are filled and closed, use clean, untreated paper towels to remove excess water from the exterior of the sample containers (excess water poses a cross-contamination risk during sample handling). Immediately place sealed sample containers in Ziploc bags, and place the bags in a sample cooler. Always have at least two dedicated coolers, one for clean sample bottles, and one for collected samples, to further minimize risk of cross-contamination during sample collection and handling.

## 5.3 EQUIPMENT DECONTAMINATION

Ideally, sampling should use disposable or dedicated equipment that does not require decontamination. Rental equipment should be treated as potentially contaminated, and be decontaminated before initial use. If a bladder pump is utilized, the bladder should be changed between sample locations and the pump body thoroughly decontaminated. Reusable equipment, including a pump or water-level meter, should be decontaminated using a Alconox, Liquinox, or Citrinox wash and a final, triple-rinse using laboratory-supplied water that is certified PFAS-free. Note that Simple Green® has not been confirmed to be PFAS free, and is therefore not approved for PFAS sampling decontamination at this time.

## 5.4 OTHER NOTES

If existing sample tubing is present in the well, unless the tubing composition is known, it should be assumed to be PFAS-containing (e.g., Teflon). In this case, it is highly recommended that the tubing be removed from the well, and at least one well volume of water purged from the well prior to sampling. Greater fluid volumes can be removed from the well if deemed necessary, however removal of at least one well volume is required before sampling.

Samples should not be collected from wells with measurable light non-aqueous phase liquids (LNAPL), due to the tendency of PFAS to accumulate at oil/water interfaces (e.g., Brusseau 2018). Similarly, PFAS will also preferentially tend to accumulate at air-water interfaces. To ensure representative sample collection, do not collect groundwater samples directly from the groundwater-air interface, where practicable.

## 6.0 SURFACE WATER AND SEDIMENT SAMPLING

This section provides PFAS sampling considerations specific to surface water and sediment matrices. This section assumes general understanding of basic surface water and sediment sampling procedures, and is not intended to teach surface water and sediment sampling fundamentals, but rather to provide instruction on differences in procedures and considerations specific to PFAS sampling. The procedures discussed in this section are additional considerations to the general PFAS sampling guidelines provided in Section 3.

### 6.1 EQUIPMENT/MATERIALS

In addition to the general and decontamination supplies listed in Sections 3.3 and 3.8, respectively, additional sample materials and supplies may include:

- Waders that have not been treated with waterproof coating (Table 1)
- Transfer containers, such as beakers or dippers, and extension rods
- Stainless-steel sample spoons, sample augers, or sample core barrels
- Disposable sample spoons constructed of PFAS-compatible material
- Single-use PVC or acetate sediment sampler liners (as needed)
- HDPE core-liner caps (preferred) or LDPE liner caps (if HDPE are not available) as needed
- Self-retracting utility knife with hook blades (decontaminated)
- Hacksaw with uncoated blade (decontaminated)
- Wrist- or elbow-length nitrile or PVC gloves for sediment sampling beneath shallow surface water

### 6.2 SURFACE WATER SAMPLING PROCEDURES

Where surface water and sediment samples are to be co-located, surface water samples should be collected first, to minimize potential for suspended sediment in the water sample. Surface-water samples should be collected below the surface and avoid water from the surface film, to avoid sample bias due to PFAS accumulation at air-water interfaces. During most steps, samplers should don new nitrile gloves, even if it is not expressly identified below. New nitrile gloves should always be donned before handling sample containers, at any time. Sample collection for PFAS should generally be conducted in accordance with the following procedures:

1. Before use, decontaminate reusable equipment that will contact surface water or sediment.
2. Using appropriate pen or ultra-fine Sharpie, fill out sample labels with all information except sample time (which can be added after the sample is collected and the lid replaced) and apply labels to sample containers. Pre-labeled sample containers may be stored in labeled 1-gallon Ziploc bags prior to sampling.
3. Prepare a clean workspace for the sample staging area, using a decontaminated surface, clean PE sheeting, or untreated paper towels.
4. Select a location where a sample can be collected from a depth of at least 10 centimeters (cm) (4 inches) from the sediment bed, at least 10 cm below the surface-water level, and as close to the center of the channel as practicable.
5. Where surface water can be collected by hand, samplers should approach the sample location from downstream.
6. Keeping the lid in place, submerge the sample container to the target sample depth.
7. Orient the sample container upstream; remove the cap to fill the container. The container should be filled to the shoulder, some headspace is preferred, if practical while filling underwater.
8. Replace the cap while the container is still submerged and close tightly before bringing the container above the water's surface.
9. Remove excess water from the outside of the sample container with a clean, untreated paper towel, add sample time to label, and immediately place inside a clean Ziploc bag, and place in the sample cooler.

Use of a transfer container is not recommended for PFAS sampling, but under certain circumstances may be required. A transfer container may be needed where sample locations are not directly accessible, such that extension rods or dippers are needed, or if sample containers require preservation and cannot be submerged. Transfer containers may be used under such circumstances, but must be clean and constructed of PFAS-compatible materials.

## 6.3 SEDIMENT SAMPLING PROCEDURES

Surface water sampling should be completed before sediment sampling. Spoons or scoops may be used to sample shallow sediments, however these methods may not be ideal due to agitation of the sample, mixing and washing during collection, and the inability to accurately determine sediment interval. For deeper/depth-discrete sampling, the preferred sediment sample collection method is to use a sediment sample auger (or similar). General sample collection procedures are as follows:

1. Before use, decontaminate reusable equipment that will contact surface water or sediment.
2. Using appropriate pen or ultra-fine Sharpie, fill out sample labels with all information except sample time (which can be added after the sample is collected and the lid replaced) and apply labels to sample containers. Pre-labeled sample containers may be stored in labeled 1-gallon Ziploc bags prior to sampling.
3. Prepare a clean workspace for the sample staging area, using a decontaminated surface, clean PE sheeting, or untreated paper towels.
4. If sediment sampling beneath shallow surface water using a spoon/scoop, don wrist-length nitrile or PVC gloves to avoid contact between skin and surface water, reducing risk potential for cross-contamination.
5. Approach the desired sediment sampling location from downstream if using waders. Sample should be collected from the midpoint of the channel, where practicable.
6. Drive the sediment sampler into the sediment. It is best to 'overshoot' the target sample depth, so that organics and debris overlying the sediment can be discarded, allowing collection of a representative sample.
7. Remove the sediment sampler, and place the sediment on an PE-lined sample table. Be sure to note the top and bottom of the sediment interval.
   - If using a sediment sampler with an acetate liner:
     - The liner can be opened using the self-retracting knife, to identify the desired sample interval. Change gloves after handling the knife. Discard organic material and debris on the surface, and transfer target sample intervals to HDPE sample containers. The samples can be transferred using a decontaminated stainless-steel scoop or disposable scoop. Use a fresh scoop and change nitrile gloves if collecting samples from more than one interval.
     - Alternatively, the liner can be cut into segments, capped with a liner cap, and placed into Ziploc bags for shipping to the analytical laboratory. Remove excess silt and debris from the exterior of the liners before cutting. Place each liner section in its own separate bag.
   - If using a sediment sampler without a liner:
     - Place the sampler on a clean, PE-lined table. Identify the desired sample interval. Do not allow organic material and debris on the surface to be entrained in the sample. Transfer target sample intervals to HDPE sample containers. The samples can be transferred using a decontaminated stainless-steel scoop or disposable scoop. Use a new scoop and change nitrile gloves if collecting samples from more than one interval. Fill the sample container and replace the cap.
8. Clean the outside of the sample container with a untreated paper towel, add the time sampled, and place into a Ziploc bag and then directly into the sample cooler.

## 6.4 EQUIPMENT DECONTAMINATION

Ideally, sampling should use disposable or dedicated equipment that does not require decontamination. Rental equipment should be treated as potentially contaminated, and be decontaminated before first use. Reusable equipment, including a sediment sample spoon or hand-auger, should be decontaminated using a Alconox, Liquinox, or Citrinox wash and a triple-rinse using laboratory-supplied water that is certified PFAS-free. Note that Simple Green® has not been confirmed to be PFAS free, and is therefore not approved for PFAS sampling decontamination at this time.

# 7.0 SURFACE AND SUBSURFACE SOIL SAMPLING

This section provides sampling considerations specific to surface and subsurface matrices. This section assumes general understanding of basic soil sampling procedures, and is not intended to teach soil sampling fundamentals, but rather to provide instruction on differences in procedures and considerations specific to PFAS sampling. Surface soil sampling may be conducted using hand tools or drill equipment. Generally, standard soil sampling and/or drilling equipment is compatible with PFAS sampling, with certain considerations noted in this section. When subcontracting a driller for soil sampling, it is important to communicate PFAS requirements early in the process, so they are able to prepare and plan accordingly. Procedures discussed in this section are additional considerations to the general PFAS sampling guidelines provided in Section 3.

## 7.1 EQUIPMENT/MATERIALS

In addition to the general and decontamination supplies listed in Sections 3.3 and 3.8, respectively, additional sample materials and supplies may include:

1. Disposable polyvinyl chloride (PVC), high density polyethylene (HDPE), or acetate liners
2. HDPE liner caps (preferred) or LDPE liner caps (if HDPE are not available) as needed
3. Self-retracting utility knife with uncoated hook blades or uncoated razor blades
4. Hacksaw with uncoated blade
5. Stainless-steel hand auger, trowel, or shovel
6. Polyethylene or polyvinyl brush to remove particles during decontamination

Equipment that contacts soil should not contain or be coated with Teflon® (or other PFAS incompatible material) unless the Teflon® is internal to the equipment and does not contact the external environment. If uncertain, contact the supplier and/or an equipment blank may be collected.

## 7.2 SAMPLING PROCEDURES

Surface and subsurface soil samples may be collected to delineate surficial and vertical extent of impacts where PFAS are potentially or known to be released to land/soil. Overall, sampling procedures used for PFAS are similar to those used for conventional soil sampling, with certain material limitations and

precautions against cross-contamination as noted herein. Surface and shallow soil samples can be collected using a decontaminated stainless-steel hand auger, trowel, or shovel; a disposable plastic scoop may also be used. If sampling from a hand auger, the sample material may be removed from the auger into a decontaminated stainless-steel bowl. Soil samples collected using a trowel or shovel may be transferred directly into the sample container using a disposable scoop, decontaminated spoon, or a new nitrile glove. Care should be taken to ensure the samples avoid contact with uncontrolled surfaces such as the ground, contaminated equipment, cooler-top, or tailgate.

Several methods are available for PFAS-related subsurface soil sampling, including hand-auger, direct-push, hollow-stem auger/split-spoon sampler, or continuous core collection via sonic drill rig or other drill method. Direct push and split spoon samplers, which generate cores in acetate, HDPE, or PVC liners, are preferred due to the minimization of sample contact with drilling equipment, as well as minimization of agitation. For accurate assessment of subsurface PFAS impacts, collection of cores with minimal disturbance is preferred. Drilling methods that produce loose cuttings such as those obtained by auger and rotary drilling processes should be avoided if possible. Additional considerations for drilling are provided in the following section.

After collection, soil core liners may be cut open using a decontaminated stainless-steel cutting device, such as a retractable-blade utility knife. Soil core samples may be transferred to a decontaminated stainless-steel bowl for consolidation and subsampling, or samples may be collected directly from the core liners and transferred to laboratory-provided HDPE or polypropylene sample bottles. Soil samples should be transferred from the core liners using disposable scoops, decontaminated spoons, or new nitrile gloves. If other analytical suites are to be collected (e.g., metals, volatile organic compounds), collect the PFAS samples first and secure the PFAS samples in coolers before collecting other analytical suites to prevent container cross-contamination. Do not touch other sample containers, which may have PTFE-containing septa or lids, prior to collecting the PFAS sample. Place PFAS samples in separate bags or separate coolers from other analytical samples for shipping. When collecting samples, the sample container cap should never be placed directly on the ground during sampling; sample container caps/lids should be held, or only placed on surfaces that are known to be PFAS-free. Once collected, soil sample containers should be stored in their own Ziploc bags within the sample cooler, and placed on double-bagged ice to begin the cooling process in accordance with the procedures in Section 3.7. Soil samples stored in bags should be double bagged.

Alternatively, soil core samples may remain in the PVC, HDPE, or acetate liners for shipping to the analytical laboratory. Full soil cores inside the sample liners should be cut crosswise using a decontaminated, untreated hook blade knife or hacksaw, into the target sample intervals. The core-liner segments can be capped on both ends using HDPE liner caps. LDPE liner caps may be used if HDPE caps are unavailable; however, PFAS compounds may adsorb to LDPE liner caps. Bulk soil on the exterior of each core-liner segments should be removed using clean, untreated paper towels and each core segment should be placed in a Ziploc bag (core segments should be double-bagged if elevated PFAS

concentrations are suspected). The capped/bagged core segments can then be placed in a sample cooler on double-bagged ice.

## 7.3 DRILLING PROCEDURES

Subsurface soil sampling necessarily involves the use of non-dedicated equipment such as drill rods, core barrels, split spoons, augers, trowels, shovels, and other drilling related equipment. These equipment can be a potential source of cross contamination both from boring to boring as well as between vertical intervals within a single boring. Lubricants used during drilling should not be labeled as containing PTFE or other fluoropolymer. Thorough decontamination of the exterior and interior surfaces of drill rods, core barrels, and other drill rig tooling should be conducted between every boring location. Due to the size and quantity of this equipment, it may not be practical to use laboratory supplied PFAS-free water for decontamination purposes. Therefore, a source of clean decontamination water may be identified and confirmed as PFAS-free by laboratory analysis prior to the field event.

Beyond drilling equipment, there are additional cross-contamination risks inherent to the drilling process. Drillers handle drilling equipment manually when advancing the drilling tooling. Work gloves, boots, and clothing worn by the drillers can pose a cross-contamination risk. Clothing requirements discussed in Section 3 should be communicated to drill crews in advance of the field event. Drill crews should avoid wearing waterproof, water resistant, or stain proof clothing. Nitrile gloves should be worn outside work gloves and changed often when handling drill tooling. Work boot overshoes, PVC coveralls, and other mitigation measures may be considered to limit cross-contamination risks. However, personnel safety is paramount and should not be sacrificed for cross-contamination mitigation. Cross-contamination risks can also be mitigated using procedural measures such as ensuring that drillers do not touch the internal surfaces of drilling equipment (e.g., inside of core barrels) or other surfaces which might come in direct contact with the soil sample. For this reason, it is recommended that PFAS considerations be communicated with the drilling contractor and also included in a kickoff meeting, held with the drill crew in advance of the event where detailed procedures and cross-contamination mitigation best practices are discussed. Selection of a drilling contractor with PFAS-specific experience is also recommended.

## 7.4 EQUIPMENT DECONTAMINATION

Where possible, sampling should use disposable or dedicated equipment that does not require decontamination. Decontamination of soil-drilling and soil-sampling equipment (cores, grab samples) can be conducted via pressure-washing or using Alconox, Liquinox, and Citranox solutions (see Table 1). Equipment should be scrubbed with a plastic brush and rinsed thoroughly in tap water to wash away debris or material on exposed surfaces. Replace decontamination solution if sediment has accumulated or between locations where high PFAS concentrations may be expected. As a final decontamination step, triple rinse equipment in laboratory-supplied PFAS-free water. Use a spray bottle for the PFAS-free water rinse, to avoid contaminating decon rinse water. PVC or acetate liners should be discarded and not decontaminated between sampling sites.

## 8.0 OTHER SAMPLING MATRICES

PFAS sampling may be required in other matrices, such as sludge/biosolids, air, non-aqueous phase liquids (NAPLs), asphalt, concrete, and plant or animal tissues. This SOP does not include protocols for these matrices. The general PFAS sampling guidelines should be followed, and a laboratory consulted for specific guidelines on sample requirements. Consult a member of Trihydro's PFAS sampling team for assistance.

## 9.0 PFAS LABORATORY REQUIREMENTS

This section includes procedures and considerations for initial laboratory communications, PFAS analytical methods, container preservation requirements, and sample quality control/quality analysis (QA/QC) requirements.

### 9.1 LABORATORY COMMUNICATION

Communication is recommended with the selected analytical laboratory before sampling, or during pre-project communications with candidate analytical laboratories, to confirm the following:

1. Does the laboratory have the necessary accreditation?
2. Can the laboratory meet the required reporting limits <u>for all PFAS analytes</u>?
3. Do the laboratory-specific methods (e.g., 537-MOD) use isotope dilution for quantification?
4. Can the laboratory accommodate project-specific needs, such as high concentrations or unusual matrices?
5. Can the laboratory provide certified PFAS-free water for decontamination and QA/QC samples?
6. Can the laboratory meet the required turnaround time? What is the current backlog for PFAS samples?

### 9.2 ANALYTICAL METHODS

As of July 2022, the EPA has published the following PFAS analytical methods:

1. Method 533: drinking water, 24 analytes
2. Method 537.1: drinking water, 18 analytes
3. Method 8327: non-drinking water aqueous samples, 24 analytes
4. DRAFT Method 1633: wastewater, surface water, groundwater, soil, biosolids, sediment, landfill leachate, and fish tissue; 40 analytes
5. DRAFT Method 1621: aqueous matrices, adsorbable organic fluorine (AOF) (i.e., total organic fluorine)

For non-drinking-water matrices, most laboratories have established independent methods for PFAS analysis, typically involving isotope dilution to account for matrix interference and including both branched and linear isomers. Although often referred to as 'modified 537' or '537-MOD' these laboratory-independent methods are in fact unrelated to EPA 537.1. To ensure consistent and repeatable analysis for non-drinking water samples, the laboratory should have proper accreditation and have capability to perform analysis that is consistent with U.S. Department of Defense (DoD) Quality System Manual (QSM) Version 5.1 or later (5.3 is the most recent version), Table B-15. QSM 5.3 Table B-15 is not an analytical method, per se, but provides a standardized set of laboratory quality control procedures. Compliance with QSM Table B-15 protocol has generally been required for regulatory-ordered PFAS samples, although this requirement may change as the EPA finalizes more methods. Trihydro's PFAS team recommends that samples be analyzed in compliance with QSM Table B-15 protocol to ensure data quality, even if not specifically required. PFAS analytes associated with each of these methods are provided on Table 2.

1. **EPA 537.1**: Determination of Selected Per-and Polyfluorinated Alkyl Substances in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry. November 2018. Drinking water method for 18 analytes, does not use isotope dilution*.
2. **EPA 533**: Determination of Per- and Polyfluoroalkyl Substances in Drinking Water by Isotope Dilution Anion Exchange Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry. November 2019. Drinking water method for 25 analytes, uses isotope dilution*.
3. **EPA 8327**: Per- and Polyfluoroalkyl Substances by Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS). July 2021. Aqueous, non-drinking water matrices (groundwater, surface water, waste water), considered as a screening-level method, does not use isotope dilution*.
4. **DRAFT EPA 1633**: Analysis of Per- and Polyfluoroalkyl Substances (PFAS) in Aqueous, Solid, Biosolids, and Tissue Samples by LC-MS/MS. August 2021. DRAFT method for ground water, surface water, waste water, soil and sediment matrices, using isotope dilution*. This method has not been finalized as of March 2022. Despite "draft" status, the method is being used and required by some states in monitoring permits. Unless required for a specific sampling event, this method is not recommended at this time by Trihydro's PFAS team.
5. **DRAFT Method 1621**: Screening Method for the Determination of Adsorbable Organic Fluorine (AOF) in Aqueous Matrices by Combustion Ion Chromatography (CIC). Provides a single result ("AOF") representing total PFAS concentration.
6. **DoD QSM 5.3 Table B-15**: DoD Quality Systems Manual Version 5.3. May 2019. Table B-15: Per- and Polyfluoroalkyl Substances (PFAS) Using Liquid Chromatography Tandem Mass Spectrometry (LC/MS/MS) With Isotope Dilution or Internal Standard. As of March 2022, this is recommended as a standardized method for groundwater, surface water, waste water, soils, and sediment samples. Can be referenced in work plans as "the samples will be analyzed at a certified laboratory using methods compliant with DoD QSM Table B-15" (uses isotope dilution*).

**Note regarding isotope dilution*: the descriptions above indicate which methods use isotope dilution to quantify analytes. Isotope dilution is an internal standard, and methods that do not use isotope dilution use external standards. Isotope dilution increases detection accuracy, which can be very important to quantify and control matrix interference, which can be very important for complex environmental matrices.

The specific analyte list is an important consideration for PFAS site investigation. PFOA, PFOS, perfluorobutane sulfonate (PFBS), and GenX are the only PFAS compounds with USEPA Health Advisory Levels (as of July 2022), but hundreds to thousands of additional PFAS compounds are also present in the environment. Typical laboratory methods quantify a relatively small fraction of these compounds. The specific analyte list for each project should be determined based on method requirements, sampling objectives, and client needs. PFAS analytes associated with the above methods are shown on Table 2. Unless a USEPA method is referenced for a compound list, a list of target PFAS analytes should be attached to the chain of custody (COC) form. State-issued sampling orders may require other PFAS or non-PFAS analytes.

## 9.3 USE OF PRESERVATIVE

For drinking water samples, each 250 mL sample bottle may be required to contain a preservative. EPA method 537.1 a small amount (1.25 g) of Trizma® and method 533 requires 1 g/L ammonium acetate, both of which are included to remove free chlorine from chlorinated drinking water (USEPA 2015). Before sampling drinking water for PFAS analysis, confirm the need for the Trizma® or ammonium acetate with the selected analytical laboratory. For groundwater samples or other water matrices, inclusion of Trizma® is not required but is considered harmless (in terms of potential effects on measured PFAS concentrations) and may be included.

**The Trizma® and ammonium acetate buffers are required for samples analyzed via EPA Method 537.1 and EPA Method 533, respectively. The buffer is required regardless of whether the water being sampled is chlorinated.**

## 9.4 FIELD QUALITY ASSURANCE AND QUALITY CONTROL SAMPLES

Field quality-assurance / quality-control (QA/QC) samples are imperative for PFAS analysis. Five different types of QA/QC samples may be collected during the sampling event as described below. Each type of QA/QC sample listed below is provided a "Required" or "Optional" label. QA/QC sampling needs may be determined in a Quality Assurance Project Plan (QAPP).

<u>Field Blanks (Required)</u>: Field blanks (or field reagent blanks) are collected to verify that the sampling environment and site-required PPE worn during the sampling event do not contaminate samples. At a minimum, one field blank should be collected for each site, with each sampling event that involves collecting an aqueous sample. Field blanks are analyzed for the same list of PFAS constituents as

analyzed for associated field samples. The field blank is collected by pouring PFAS-free reagent water received from the laboratory into an empty, clean sample container at the sampling site. Generally, two laboratory-provided sample containers are filled for each field-blank sample.

Equipment Blanks (Required): Equipment blanks will be prepared and submitted for laboratory analysis to verify that equipment decontamination procedures are effective, and to verify that sampling equipment is PFAS-free and not causing contamination. Equipment blanks are analyzed for the same PFAS constituents as required for the field samples. Minimally, equipment blanks should be collected for sampling equipment that may contact the sample matrix, such as HDPE core liners, bailers, pump tubing, using PFAS-free water provided by the laboratory. Equipment blanks should be collected at a rate of at least 1 per event per piece of equipment used for sampling. Equipment blanks are not required for tapwater sampling, where sample containers are filled directly from source water.

Blind Duplicates (Recommended): Blind Duplicate samples can be collected to evaluate reproducibility of analytical techniques and the homogeneity of sample matrices. Duplicate samples are submitted for the same PFAS analyses that are required for the field samples. Duplicate samples will be collected at a frequency of 10%, or one for every 10 samples for aqueous sampling matrices. If less than 10 samples are collected during a particular sampling event, one blind duplicate sample will be collected. The duplicate sample will be "blind" to the laboratory, therefore will have a coded identity on its label and on the COC. The actual sampling location and identification will be recorded on the sampling log.

Trip Blanks (Optional): Trip blanks are laboratory-prepared bottles containing PFAS-free water that travel from the laboratory to the site, and then transported back to the laboratory with the samples in the sample coolers. A set of trip blanks can accompany each cooler that contains PFAS samples. Trip blanks should be supplied by the laboratory and will accompany the sample containers throughout the sampling event. Trip blanks will only be analyzed by the laboratory for PFAS if instructed to do so by the PM; these samples should otherwise be held once received by the laboratory. Trip blanks are generally not required for PFAS samples but may be helpful to identify sources of contamination, should they occur.

Matrix Spikes/Matrix Spike Duplicates (MS/MSD) (Optional): MS/MSDs can be prepared and analyzed by the laboratory for each matrix sampled. MS/MSDs are samples in which known quantities of specific PFAS compounds are added before extraction and analyses. The recoveries for spiked compounds can be used to assess how well the method for analysis recovers target compounds. MS/MSD samples are submitted for the same PFAS analyses that are required for the field samples.

## 10.0 REFERENCES

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# TABLES

**TABLE 1. PFAS SAMPLING ITEMS[1]**
**SOP FOR CHARACTERIZATION OF PFAS AT BULK FUEL STORAGE TERMINALS AND REFINERIES**

| Prohibited Items/Materials | Acceptable Items/Materials |
|---|---|
| **Sampling Equipment[1]** | |
| Polytetrafluoroethylene (PTFE), including Teflon® and Hostaflon®-containing materials (tubing, bailers, tape, and plumbing paste) | High-density polyethylene (HDPE) materials including polypropylene[2] |
| Polyvinylidene fluoride (PVDF), including Kynar®-containing materials (tubing, coatings on aluminum and steel, lithium-ion batteries) | Stainless steel |
| Polychlorotrifluoroethylene (PCTFE), including Neoflon®-containing materials (valves, seals, gaskets, food packaging) | Nylon or cotton |
| Ethylene-tetrafluoro-ethylene (ETFE), including Tefzel® (wire/cable insulation, pipe liners) | Polyvinyl chloride (PVC) |
| Fluorinated ethylene propylene (FEP), including Teflon® FEP and Hostaflon® FEP-containing materials (wire/cable insulation, pipe liners) | Acetate liners |
| Low-density polyethylene (LDPE) | Silicone tubing |
| Aluminum foil | Natural rubber |
| **Sample Labeling and Field Documentation** | |
| Waterproof field books | Loose paper (non-waterproof) |
| Plastic clipboards, binders, spiral hard cover notebooks | Aluminum field clipboards or with Masonite®; Rite-in-the-Rain is acceptable in staging area if gloves are changed after note taking. |
| Post-It Notes | Ballpoint pens |
| Regular/thick size markers (Sharpie®) | Fine and Ultra-Fine point Sharpie® markers are acceptable to label empty sample bottles while in staging area provided the lid is on the sample bottle and gloves are changed following sample bottle labeling. |
| Re-usable chemical (blue) ice packs | Water-based ice in polyethylene bags (double bagged) |
| **Clothing and Personal Protective Equipment (PPE) used by Field Personnel[3]** | |
| Clothing laundered using fabric softener | Synthetic or cotton clothing that has been well-laundered clothing, defined as clothing that has been washed 6 or more times after purchase |
| New cotton clothing or synthetic water-resistant/ waterproof clothing or dirt/stain-resistant treated clothing, clothing containing GORE-TEX™, Scotchgard™, and RUCO® | Waterproof clothing made with polyurethane, PVC, wax-coated fabrics, rubber, or neoprene |
| Boots containing GORE-TEX™ | Boots made with polyurethane and/or PVC |
| Latex gloves | Powderless nitrile gloves |
| Clothes chemically treated for insect resistance and ultraviolet protection | |
| Coated Tyvek® | |

**TABLE 1. PFAS SAMPLING ITEMS[1]**
**SOP FOR CHARACTERIZATION OF PFAS AT BULK FUEL STORAGE TERMINALS AND REFINERIES**

| Prohibited Items/Materials | Acceptable Items/Materials |
|---|---|
| **Personal Care Products, Sun/Biological Protection** | |
| No cosmetics, moisturizers, fragrances, hand cream, or other related products as part of personal cleaning showering routine on the day of sampling, and 24 hours prior to sampling. | **Sunscreens** - Alba Organics Natural Sunscreen, Yes To Cucumbers, Aubrey Organics, Jason Natural Sun Block, Kiss my face, Baby sunscreens that are "free" or "natural" -- **Insect Repellents** - Jason Natural Quit Bugging Me, Repel Lemon Eucalyptus Insect repellant, Herbal Armor, California Baby Natural Bug Spray, BabyGanics -- **Sunscreen and insect repellent** - Avon Skin So Soft Bug Guard Plus – SPF 30 Lotion |
| **Sample Containers** | |
| LDPE or glass containers | HDPE or polypropylene |
| Teflon®-lined caps | Unlined polypropylene caps |
| **Rain Events** | |
| Waterproof or water-resistant rain gear | Gazebo tent that is only touched or moved before and following sampling activities |
| **Equipment Decontamination** | |
| Decon 90®, Simple Green® | Alconox®, Liquinox®, or Citranox® |
| | Laboratory supplied PFAS-free water |
| | Commercially available deionized water if verified to be PFAS-free |
| Water from an on-site well | Potable water from municipal drinking-water supply if known to be PFAS-free |
| **Food Considerations** | |
| All food and drink, with exceptions noted herein. Note that fast-food and prepackaged food containers may contain PFAS. | Bottled water and hydration drinks (i.e., Gatorade® and Powerade®) to be brought and consumed only in the staging area |

Notes:
1. PFAS sampling-item restrictions apply to the entire sample collection and processing area, including vehicles used by sampling personnel
2. The United States Environmental Protection Agency (USEPA) and American Society for Testing and Materials (ASTM) method for the analysis of PFAS in solid and liquids specify polypropylene or HDPE with polypropylene lids. Check with the laboratory regarding their polypropylene or HPDE preference.
3. Sampling personnel includes all personnel who:
   - Are directly involved in the collection, handling, and/or processing of samples before the samples leave the site.
   - Handle any part of equipment that directly contacts surface water or stormwater.
   - Are within 2 to 3 meters (i.e., 6 to 9 feet) of the borehole during soil sampling.

Personnel are not included as sampling personnel if they remain at least 2 to 3 meters away from sample-collection areas before and during sampling.

**TABLE 2. PFAS REFERENCE TABLE - CHEMICAL NAMES, ACRONYMS, AND ANALYTICAL METHODS**
**PFAS SAMPLING STANDARD OPERATING PROCEDURES**
**TRIHYDRO CORPORATION**

**This table presents a select subset of the 3,000+ compounds classified as PFAS.**

| Classification | Family | Class | Group | PFAS Compound | Acronym | Chemical Abstract Service (CAS) # | Mol. Wt. | Chemical Formula fluorinated tail (red) head (blue) | Analytical methods: EPA 537.1 | EPA 533 | EPA 8327 | DoD QSM 5.1 | EPA 1633 (draft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Per and Poly Fluoroalkyl Substances (PFAS) | Perfluorinated Compounds | Perfluoroalkyl Acid (PFAA) | 1 | Perfluorobutanoic acid * | PFBA | 375-22-4 | 214.0 | $C_3F_7COOH$ | | X | X | X | X |
| | | | | Perfluoropentanoic acid * | PFPeA | 2706-90-3 | 264.1 | $C_4F_9COOH$ | | X | X | X | X |
| | | | | Perfluorohexanoic acid * | PFHxA | 307-24-4 | 314.1 | $C_5F_{11}COOH$ | X | X | X | X | X |
| | | | | Perfluoroheptanoic acid * | PFHpA | 375-85-9 | 364.1 | $C_6F_{13}COOH$ | X | X | X | X | X |
| | | | | Perfluorooctanoic acid ** | PFOA | 335-67-1 | 414.1 | $C_7F_{15}COOH$ | X | X | X | X | X |
| | | | | Perfluorononanoic acid ** | PFNA | 375-95-1 | 464.1 | $C_8F_{17}COOH$ | X | X | X | X | X |
| | | | | Perfluorodecanoic acid ** | PFDA | 335-76-2 | 514.1 | $C_9F_{19}COOH$ | X | X | X | X | X |
| | | | | Perfluoroundecanoic acid ** | PFUnA | 2058-94-8 | 564.1 | $C_{10}F_{21}COOH$ | X | X | X | X | X |
| | | | | Perfluorododecanoic acid ** | PFDoA | 307-55-1 | 614.1 | $C_{11}F_{23}COOH$ | X | X | X | X | X |
| | | | | Perfluorotridecanoic acid ** | PFTriA | 72629-94-8 | 664.1 | $C_{12}F_{25}COOH$ | X | | X | X | X |
| | | | | Perfluorotetradecanoic acid ** | PFTeA | 376-06-7 | 714.1 | $C_{13}F_{27}COOH$ | X | | X | X | X |
| | | | 2 | Perfluorobutane sulfonic acid * | PFBS | 375-73-5 | 300.1 | $C_4F_9SO_3H$ | X | X | X | X | X |
| | | | | Perfluoropentane sulfonic acid * | PFPeS | 2706-91-4 | 350.1 | $C_5F_{11}SO_3H$ | | X | X | X | X |
| | | | | Perfluorohexane sulfonic acid ** | PFHxS | 355-46-4 | 400.1 | $C_6F_{13}SO_3H$ | X | X | X | X | X |
| | | | | Perfluoroheptane sulfonic acid ** | PFHpS | 375-92-8 | 450.1 | $C_7F_{15}SO_3H$ | | X | X | X | X |
| | | | | Perfluorooctane sulfonic acid ** | PFOS | 1763-23-1 | 500.1 | $C_8F_{17}SO_3H$ | X | X | X | X | X |
| | | | | Perfluorononane sulfonic acid ** | PFNS | 68259-12-1 | 550.1 | $C_9F_{19}SO_3H$ | | | X | X | X |
| | | | | Perfluorodecane sulfonic acid ** | PFDS | 335-77-3 | 600.1 | $C_{10}F_{21}SO_3H$ | | | X | X | X |
| | | | | Perfluorododecane sulfonic acid ** | PFDoS | 79780-39-5 | 600.1 | $C_{11}F_{23}SO_3H$ | | | | | X |
| | | FASA | | Perfluorooctane sulfonamide | PFOSA | 754-91-6 | 499.1 | $C_8F_{17}SO_2NH_2$ | | | X | X | X |
| | | | | N-methyl perfluorooctane sulfonamide | N-MeFOSA | 31506-32-8 | 513.2 | $C_8F_{17}SO_2N(CH_3)H$ | | | | | X |
| | | | | N-ethyl perfluorooctane sulfonamide | N-EtFOSA | 4151-50-2 | 527.2 | $C_8F_{17}SO_2N(C_2H_5)H$ | | | | | X |
| | Replacement Compounds | Fluoroalkyl Ethers | | Hexafluoropropylene oxide dimer acid (GenX) | HFPO-DA | 13252-13-6 | 330.2 | $C_3F_7O(CF_2)_2COOH$ | X | X | | | X |
| | | | | 4,8-dioxa-3H-perfluorononanoic acid | ADONA | 919005-14-4 | 378.1 | $CF_3O(CF_2)_3OC_2HF_3COOH$ | X | X | | | X |
| | | | | Nonafluoro-3,6-dioxaheptanoic acid | NFDHA | 151772-58-6 | 296.0 | $CF_3O(CF_2)_2OCF_2COOH$ | | X | | | X |
| | | | | Perfluoro(2-ethoxyethane)sulfonic acid | PFEESA | 113507-82-7 | 316.1 | $C_2F_5O(CF_2)_2SO_3H$ | | X | | | X |
| | | | | Perfluoro-3-methoxypropanoic acid | PFMPA | 377-73-1 | 230.0 | $CF_3O(CF_2)_2COOH$ | | X | | | X |
| | | | | Perfluoro-4-methoxybutanoic acid | PFMBA | 863090-89-5 | 280.0 | $CF_3O(CF_2)_3COOH$ | | X | | | X |
| | | | | 11-Chloroeicosafluoro-3-oxaundecade-1-sulfonic acid | 11Cl-PF3OUdS | 763051-92-9 | 632.6 | $Cl(CF_2)_8O(CF_2)_2SO_3H$ | X | X | | | X |
| | | | | 9-Chlorohexadecafluoro-3-oxanone-1-sulfonic acid | 9Cl-PF3ONS | 756426-58-1 | 532.6 | $Cl(CF_2)_6O(CF_2)_2SO_3H$ | X | X | | | X |
| | Polyfluorinated / Precursors | Fluorotelomers | 3 | 4:2 Fluorotelomer sulfonic acid | 4:2 FTSA | 757124-72-4 | 328.2 | $C_4F_9(CH_2)_2SO_3H$ | | X | X | X | X |
| | | | | 6:2 Fluorotelomer sulfonic acid | 6:2 FTSA | 27619-97-2 | 428.2 | $C_6F_{13}(CH_2)_2SO_3H$ | | X | X | X | X |
| | | | | 8:2 Fluorotelomer sulfonic acid | 8:2 FTSA | 39108-34-4 | 528.2 | $C_8F_{17}(CH_2)_2SO_3H$ | | X | X | X | X |
| | | | 4 | 6:2 Fluorotelomer alcohol | 6:2 FTOH | 647-42-7 | 364.1 | $C_6F_{13}(CH_2)_2OH$ | | | | | |
| | | | | 8:2 Fluorotelomer alcohol | 8:2 FTOH | 678-39-7 | 464.1 | $C_8F_{17}(CH_2)_2OH$ | | | | | |
| | | Perfluoroalkane Sulfonamido | 5 | N-ethyl perfluorooctanesulfonamido acetic acid | N-EtFOSAA | 2991-50-6 | 585.2 | $C_8F_{17}SO_2N(C_2H_5)CH_2CO_2H$ | X | | X | X | X |
| | | | | N-methyl perfluorooctanesulfonamido acetic acid | N-MeFOSAA | 2355-31-9 | 571.2 | $C_8F_{17}SO_2N(CH_3)CH_2CO_2H$ | X | | X | X | X |
| | | | 6 | N-ethyl perfluorooctane sulfonamido ethanol | EtFOSE | 1691-99-2 | 571.3 | $C_8F_{17}SO_2N(C_2H_5)(CH_2)_2OH$ | | | | | X |
| | | | | N-methyl perfluorooctane sulfonamido ethanol | MeFOSE | 24448-09-7 | 557.2 | $C_8F_{17}SO_2N(CH_3)(CH_2)_2OH$ | | | | | X |
| | | Fluorotelomer Carboxylic Acids | | 3-Perfluoropropyl propanoic acid | 3:3 FTCA | 356-02-5 | 242.1 | $C_3F_7C_2H_4COOH$ | | | | | X |
| | | | | *2H,2H,3H,3H*-Perfluorooctanoic acid | 5:3 FTCA | 914637-49-3 | 342.1 | $C_5F_{11}C_2H_4COOH$ | | | | | X |
| | | | | 3-Perfluoroheptyl propanoic acid | 7:3 FTCA | 812-70-4 | 442.1 | $C_7F_{15}C_2H_4COOH$ | | | | | X |

Notes:
* denotes short chain perfluoroalkyl acid
** denotes long chain perfluoroalkyl acid

**PFAS Class Acronyms**
PFAA: Perfluoroalkyl acid
FASA: Perfluoroalkane sulfonamide

**PFAS Group Names and Acronyms**
1. PFCA: Perfluoroalkyl carboxylic acid
2. PFSA: Perfluoroalkane sulfonic acid
3. FTSA: Fluorotelomer sulfonic acid
4. FTOH: Fluorotelomer alcohols
5. FASAA: Perfluoroalkyl sulfonamido acetic acids
6. FASE: Perfluoroalkane sufonamido ethanols

References:
ITRC guidance document, Chapter 2. https://pfas-1.itrcweb.org/2-pfas-chemistry-and-naming-conventions-history-and-use-of-pfas-and-sources-of-pfas-releases-to-the-environment-overview/
EPA working list of PFAS compounds: https://www.epa.gov/chemical-research/ord-subset-pfas-research

# ATTACHMENT A

# OFFICE TRAINING CHECKLIST

**ATTACHMENT A. OFFICE TRAINING CHECKLIST**
**PFAS SAMPLING STANDARD OPERATING PROCEDURES**
**TRAINING PROGRAM**
**TRIHYDRO CORPORATION**

(development/review in progress)

1. PFAS Overview – basic information to understand rationale for PFAS sampling approaches and to address basis questions
    a. Chemistry
    b. PFAS uses/environmental sources
    c. Regulatory status
2. Unique elements of PFAS sampling
    a. Hundreds/thousands of compounds
    b. Presence in common materials
    c. Highly scrutinized results
3. Standard Operating Procedures Overview
    a. Table of Contents overview/key elements
    b. Material compatibility table
    c. General PFAS sampling steps
4. Project Sampling Discussion
    a. Types of sampling
    b. Additional training needs
    c. Project specific preparation needs/focus on relevant SOP sections

# ATTACHMENT B

# FIELD TRAINING CHECKLIST

**ATTACHMENT B. FIELD TRAINING CHECKLIST**
**PFAS SAMPLING STANDARD OPERATING PROCEDURES**
**TRAINING PROGRAM**
**TRIHYDRO CORPORATION**

(development/review in progress)

1. Allowable materials
    a. Clothing/PPE
    b. Gloves
    c. Paper Towels
    d. Buckets
    e. Sampling Materials
    f. Pens/Sharpies
    g. Field Notes
2. Prohibited Materials
    a. Area Inspection
    b. Clothing/PPE
    c. Food wrappers
3. Site Preparation and Area Management
    a. Staging Area
    b. Sampling Area
    c. Personnel
    d. Coolers
    e. Housekeeping
4. Hands
    a. Awareness
    b. Changing gloves
5. Sampling considerations
    a. Groundwater pumps, tubing, supplies
    b. Soil Sampling: drilling and hand-auger
6. Sample Container Management
    a. Pre-collection
    b. During collection
    c. Post-collection
7. Decontamination
    a. Plastic brush
    b. Spray bottles

# ATTACHMENT C

# EXAMPLE FIELD SAMPLING DOCUMENTATION FORM

### ATTACHMENT C. EXAMPLE FIELD SAMPLING DOCUMENTATION FORM

**Client / Project # :**

Boring / Sample ID
Sample Date/Time:
Analysis: 537.1 / 537 MOD / Other _____________
QC samples:
Sample Depth:
Sample Recovery:
Sample Description:

Boring / Sample ID
Sample Date/Time:
Analysis: 537.1 / 537 MOD / Other _____________
QC samples:
Sample Depth:
Sample Recovery:
Sample Description:

Boring / Sample ID
Sample Date/Time:
Analysis: 537.1 / 537 MOD / Other _____________
QC samples:
Sample Depth:
Sample Recovery:
Sample Description:

Boring / Sample ID
Sample Date/Time:
Analysis: 537.1 / 537 MOD / Other _____________
QC samples:
Sample Depth:
Sample Recovery:
Sample Description:

Boring / Sample ID
Sample Date/Time:
Analysis: 537.1 / 537 MOD / Other _____________
QC samples:
Sample Depth:
Sample Recovery:
Sample Description:

Sampling Equipment:
Field Personnel:

# APPENDIX B

# FIELD FORMS

Trihydro Corporation
1252 Commerce Drive
Laramie, WY 82070

# SURFACE SOIL
# FIELD DATA LOG SHEET - SAMPLING

DATE _____

PROGRAM NAME _____
SITE NAME / NUMBER _____
SAMPLE MATRIX _____
SAMPLER'S SIGNATURE _____

**SURFACE SOIL DATA**

LOCATION I.D. _____
SAMPLE I.D. _____
DUPLICATE I.D. _____
SAMPLE TIME _____
DUP TIME _____

SAMPLING METHOD _____
MS/MSD (Y/N) _____

| Time (hhmm) | Activity | Depth (in) | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | Arrived | - | - | - |
| | Observe | | | |
| | | | | |
| | | | | |
| | | | | |
| | Sample | | | |
| | | | | |

Comments:

# LOW-FLOW GROUNDWATER SAMPLING LOG

**MONITORING WELL ID:** _____

**Client:** Marathon/Tesoro
**Project Number:** 0039B-003-0090
**Project Name:** Marathon Kenai Refinery
**Project Location:** Nikiski, AK

**Sample Date:** _____
**Weather:** _____
**Field Personnel:** _____

**Static Water Level:** _____
**Well Diameter (in):** 2”
**Depth to Bottom (ft BTOC):** _____
**Pump Depth:** _____
**Approx. Screen Interval (ft bgs):** _____
**Expected Purge Rate (mL/min):** _____
**Expected Purge Volume to Stability (gal):** _____
**Laboratory Analysis:** _____
**Containers/Preservatives:** _____

**SAMPLE ID:** _____ **Duplicate Sample?** (yes) (no)

**SAMPLE TIME:** _____ **Duplicate ID:** _____ **Time:** _____

**Total Volume of Water Purged (gal):** _____

| Time | Pumping Rate (mL/min) | Depth to Water (ft-bmp) < 0.33 ft Δ | Temp (deg C) --- | Sp. Con. (mS/cm[C]) +/- 3% | DO (mg/L) +/- 10% | pH (S.U.) +/- 0.1 | ORP (mV) +/- 10mV | Turbidity (NTU) +/- 10% | Comments Groundwater appearance, odor, NAPL, purge interruptions, etc. |
|---|---|---|---|---|---|---|---|---|---|
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## CONTINUED…

| TIME | Pumping Rate (mL/min) --- | Depth to Water (ft-bmp) < 0.33 ft Δ | Temp (deg C) --- | Sp. Con. (mS/cm$^{C}$) +/- 3% | DO (mg/L) +/- 10% | pH (S.U.) +/- 0.1 | ORP (mV) +/- 10mV | Turbidity (NTU) +/- 10% | Comments Groundwater appearance, odor, NAPL, purge interruptions, etc. |
|---|---|---|---|---|---|---|---|---|---|
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Trihydro CORPORATION

# Lithology Log

Sheet 1 of ___

| Project Name | Project Number | Borehole ID |
|---|---|---|
| | | |

| Drilling Company | Driller | Ground Elevation | Total Drilled Depth |
|---|---|---|---|
| | | | __ feet-bgs |

| Drilling Equipment | Drilling Method | Borehole Diameter | Date/Time Drilling Started | Date/Time Stopped |
|---|---|---|---|---|
| | | | | |

| Type of Sampling Device | Water Level (bgs) |
|---|---|
| | __ feet-bgs Final |

| PID/FID (make, model, serial no.) | Geologist | Checked by/Date |
|---|---|---|
| | | |

| Location Description (include sketch in field logbook) | Weather Conditions (temp., clear, rain, wind) |
|---|---|
| | |

| 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 | | | | | | | | | | |
| 5 | | | | | | | | | | |
| 10 | | | | | | | | | | |
| 15 | | | | | | | | | | |
| 20 | | | | | | | | | | |
| 25 | | | | | | | | | | |
| 30 | | | | | | | | | | |
| 35 | | | | | | | | | | |
| 40 | | | | | | | | | | |
| 45 | | | | | | | | | | |
| 50 | | | | | | | | | | |

Trihydro CORPORATION

**Lithology Log (continued)** Sheet 2 of ____.

BOREHOLE ID

| 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 | | | | | | | | | | |
| 55 | | | | | | | | | | |
| 60 | | | | | | | | | | |
| 65 | | | | | | | | | | |
| 70 | | | | | | | | | | |
| 75 | | | | | | | | | | |
| 80 | | | | | | | | | | |
| 85 | | | | | | | | | | |
| 90 | | | | | | | | | | |
| 95 | | | | | | | | | | |
| 100 | | | | | | | | | | |
| 105 | | | | | | | | | | |
| 110 | | | | | | | | | | |
| 115 | | | | | | | | | | |