

<p>Method/Media: PFAS Groundwater Sampling/Groundwater</p>	<p>Title: Groundwater Sample Collection for Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) Analysis</p>
<p>Revision No: Original Revision Date: 24 November 2020</p>	<p>Reference No: SOP-E2-07 Parent Document: BC Field Sampling Manual – Part E2</p>
<p>1. Introduction and Scope</p> <p>This Standard Operating Procedure (SOP) provides operating guidelines and instruction for the collection and handling of performing groundwater samples obtained for the analysis of perfluoroalkyl and polyfluoroalkyl substances (PFAS). PFAS are defined as synthetic fluorine containing chemical substances that do not occur naturally in the environment. PFAS are typically used in heat, stain, and water resistance products, firefighting foams, and products designed to reduce friction. Due to their persistence, toxicity, and bioaccumulation potential, PFAS are considered a compound of increased concern to the environment.</p> <p>Detection limits for PFAS are low and there are an abundance of potential sources of trace levels of PFAS. For this reason, this SOP provides information and procedures that must be incorporated in order to minimize cross-contamination during sample collection, handling, and storage.</p> <p>This SOP forms part of the British Columbia Field Sampling Manual (BCFSM). Additional information on groundwater sample Collection and handling for PFAS analysis is provided in Part E2 – Groundwater, which must be used in conjunction with the information provided in this SOP. Further guidance regarding groundwater is provided in the Water Sustainability Act (WSA) and the Groundwater Protection Regulation (GPR) which are available at:</p> <p>https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/laws-rules/groundwater-protection-regulation.</p> <p>The Environmental Management Act (EMA), the Contaminated Sites Regulation (CSR) and associated guidance documents provide information specific to groundwater monitoring wells installed to investigate and remediate contaminated sites; these documents are available at:</p> <p>https://www2.gov.bc.ca/gov/content/environment/air-land-water/site-remediation/contaminated-sites.</p> <p>Groundwater sampling and monitoring conducted for regulatory purposes within the provincial jurisdiction of BC must be carried out with consideration to the WSA, the GPR, the EMA, and the CSR, all as applicable, Part E2 of the BC Field Sampling Manual, and this document.</p>	
<p>2. Document Control</p> <p>This Standard Operating Procedure (SOP) is a controlled document. Document control provides a measure of assurance that the specifications and guidance it provides are based on current information that has been scrutinized by a qualified reviewer/s. Controlled documents are reviewed within a five year life cycle. Please ensure that the revision date listed in the header of this document does not exceed five years.</p>	
<p>3. Principle of the Sampling Method</p> <p>The steps involved in the collection of samples obtained for the analyses of PFAS compounds is similar to many other non-volatile analytes however, due to the abundance of these substances in the environment, strict procedures relating to field gear and equipment are required and emphasized in this SOP. Extreme care must be taken when preparing, collecting and handling groundwater samples for PFAS, as inadequate controls can result in detectable concentrations of PFAS compounds not present in the initial sample.</p>	

4. Quality Control

- Ensure instruments are calibrated and functioning properly.
- Record accurate field measurements and well described observations in the field.
- Any material entering the well must be fully decontaminated using PFAS-free water provided by the laboratory prior to use.
- Quality assurance is provided by submitting an appropriate number of blind field duplicate samples and blanks for laboratory analysis. The number of duplicates and the number and types of blanks will depend on the Data Quality Objectives developed for the project.
- Field duplicates are collected using the same sample procedure used to collect regular samples.
- The nomenclature used to generate unique sample identifications for duplicates must not reveal the samples duplicity or intent. Blank samples can be identified as such (i.e. BlankEquip-01).

5. Recommended Equipment and Materials

Field equipment should include the following:

- Pen (do not use gel ink based pens) or markers,
- Sample labels (note that the labels should be applied to sample containers by the lab and weighed by the lab after application),
- PFAS free plastic sheet to prevent sample contact with the ground,
- Multiparameter meter or individual meters to measure pH, electrical conductivity, temperature, dissolved oxygen, oxidation reduction potential, and turbidity. Use of a flow-through cell is recommended,
- Purging equipment, preferably a peristaltic pump using silicone or HDPE tubing or passive diffusion sampler (e.g., polypropylene HydraSleeves™) are preferred; other sampling equipment may be used (e.g., bailers, double valve pump, bladder pump, submersible pump, inertial pump) provided they are Teflon-free and do not result in turbid samples,
- Ziploc® bags,
- Ice packs (do not use reusable chemical or gel ice packs),
- Cooler,
- Appropriate field log using loose paper on a masonite or aluminium clip board,
- Laboratory-supplied 500 mL high density polyethylene (HDPE) bottles fitted with HDPE liner screw caps for analysis; and,
- Chain-of-custody form completed using a pen (not gel ink) or marker.

6. Sampling Considerations

Based on the presence of PFAS in several sources, sample collection considerations include the following:

- **Field clothing:** Wear natural fibers (preferably cotton). Non-synthetic clothing should be worn after being laundered a minimum of six times with minimal soap and without the use of fabric softener. Water resistant, waterproof, or stain-treated clothing (i.e., Gore-Tex™, coated Tyvek™ suits) must not be worn during the field program. Rain gear must be PFAS free (i.e., polyethylene, vinyl, or PVC rain gear can be worn).
- **Footwear:** Boots can be covered with non-coated Tyvek™ booties as safety footwear is typically treated to provide a degree of weatherproofing. If using waders, the waders must not have a fluorinated surface coating and field staff should stand downstream from the sampling station when collecting the sample. Ensure that gloves are changed if field staff come into contact with footwear (e.g. if they tie their shoes).
- **Personal hygiene recommendations:**
 - Field personnel should shower the night before sampling and rinse with water on the morning of the sampling event. Bar soap is acceptable; however, soap containing moisturizing lotions should be avoided. Personal hygiene products (e.g. non-coated dental floss, shampoo, conditioner, body gel, cosmetic or hand cream) should only be made from natural products.

- Sunscreen and insect repellants containing PFAS should be avoided; use only 100% natural sunscreen, and repellants containing DEET are acceptable. Field personnel may wear long sleeves, and light colored 100% natural shirts tucked into pants, and wide brimmed hats for insect and sun protection.
- During washroom breaks, field personnel should move at least 10 m away from the sampling area prior to removing nitrile gloves and, if donned, overalls, to minimize any risks of cross-contamination. Wash as normal; however, spend extra time rinsing with water after using soap. The use of an air dryer is preferred over paper towel, if possible.
- **Gloves:** Nitrile gloves must be worn at all times, including:
 - During decontamination of re-usable sampling equipment;
 - Prior to contact with sample bottles of “PFAS free” water containers;
 - Insertion of anything into sample ports (i.e., HDPE tubing);
 - Handling any QA/QC samples including field blanks and equipment blanks; and
 - After handling any non-dedicated sampling equipment, contact with non-decontaminated surfaces, or when field personnel deems it necessary.
- **Field notes:** Only loose paper (do not use all-weather waterproof paper (e.g. Rite in the Rain) on masonite or aluminum clip boards should be utilized along with a non-gel pen or marker. Do not use plastic clipboards, binders, or spiral hard cover notebooks. If a marker is used, wear a new pair of nitrile gloves prior to use and change gloves prior to placing the sample label on the bottles. Do not use sticky notes.
- **Field vehicle:** Ensure vehicle seats are covered with a well laundered cotton blanket for the entire duration of the field program to reduce direct contact between field clothing and the vehicle seats, which may be treated with stain resistant products.
- **Rain events:** Do not sample for PFAS if rainfall is consistent and saturating the ground, unless PFAS free gear is donned. Avoid contact between sample materials and containers and saturated ground and/or rain splashes. If sampling must occur during rain events, ensure that a shelter (PFAS free) is erected above the wells to be sampled.
- **Food:** Food should not be eaten in the field vehicle or within 10 m of the wells to be sampled. Remove sampling gloves and outer clothing prior to eating or drinking and move to an appropriate location (preferably downwind of the site). Avoid products packaged using aluminum foil (HDPE sheeting is acceptable), coated papers, and coated textiles (i.e., granola bar wrappers) as these have historically been treated with PFAS. Field personnel should also avoid bringing food in paper bags, or wrapped in paper packaging (i.e., paper wrapping on burgers, coffee in paper cups, etc.).
- **Sampling containers, tubing, and cleaning:**
 - Use high density polyethylene (HDPE) tubing for purging or sample collection. Do not use Teflon™ or low density polyethylene tubing. Always use new tubing for each well. Dispose of tubing in a heavy duty garbage bag for disposal.
 - Sampling should be completed using a HydraSleeve™ or a peristaltic pump and HDPE tubing. If the depth to groundwater is such that a bladder pump must be used, ensure that all internal parts (check balls, o-rings, compression fittings) are not made with Teflon™. Bladders and o-rings must then be changed between sample locations. Other purging and sampling equipment may be used if necessary, provided that the equipment is Teflon-free, however the equipment selected should be able to provide samples with minimal turbidity. If hydrogeological conditions permit, low-flow sampling procedures should be followed.
 - Ensure that samples are collected in polypropylene or high density polyethylene (HDPE) bottles fitted with an unlined (no Teflon™) or HDPE lined polypropylene screw cap. Ensure bottles are not glass.
 - Use a marker to write on labels after the caps have been placed on each bottle. If using a Sharpie/Marker, replace your nitrile gloves after use.
 - Use only Alconox™ or Liquinox™ to decontaminate sampling equipment between uses.
- Groundwater samples for PFAS analysis should not be field filtered to minimize the potential for cross contamination.

- To prevent cross-contamination, begin sampling at the known or suspected clean or most clean well and progress to wells installed closest to the source.

7. Procedures

The primary concern when sampling for PFAS is the high potential for contamination. For this reason, it is imperative that samplers minimize potential contact with PFAS containing materials.

- 1) Ensure that tools that may be coated in Teflon™ (e.g., tools used to open monitoring wells) and aluminum foil are placed at least 10 m from the sampling location.
- 2) Prior to sampling, field personnel must wash their hands with soap, rinse thoroughly and don a new pair of nitrile gloves.
- 3) Have the appropriate laboratory-supplied sample containers and sampling equipment at hand before retrieval of the groundwater sample.
- 4) Cover the ground area surrounding the monitoring well with a plastic sheet to provide a clean work area.
- 5) If low flow sampling techniques are to be deployed, follow the procedures presented in SOP E2-11 to purge the well prior to sampling. If a bladder pump is utilized, ensure that its internal parts are not made of Teflon™.
- 6) Monitor and record the well's indicator parameters (pH, EC, temperature, ORP, dissolved oxygen, and turbidity) at regular intervals during the purge; a flow through cell can be used for this task. When parameters stabilize, typically for a minimum of three consecutive readings, prepare for sample collection.
- 7) Don a new pair of nitrile gloves to collect the groundwater sample. Do not handle papers, pens, clothes, etc. prior to collecting the groundwater sample.
- 8) Fill the sample bottle to the brim leaving no headspace. Ensure that the sample tubing does not come into direct contact with the rim of the bottle. Tightly screw on the HDPE lined cap. **Do not filter the groundwater sample.**
- 9) Record visual observations and olfactory aspects of the sample such as (colour, presence of sediment, turbidity, odour, etc.).
- 10) If not already done, complete the label on the sample bottle. Identify the sample using an appropriate sample nomenclature and include the following information: sampler's initials, sample collection date and time, company name, sample site identification, project name or number and desired analytical parameters.
- 11) Enclose the sample container in a Ziploc® bag and place the sample in a cooler chilled with double-bagged (polyethylene plastic) ice for transport to the laboratory. Samples should be chilled to less than 6°C. Pack the cooler to prevent the sample bottles from shifting during transport.
- 12) Field and equipment blanks collected during the sampling event should satisfy site-specific or project specific quality assurance objectives and requirements. Field blanks should be filled with laboratory-supplied PFAS-free water.
- 13) An equipment blank should be prepared and submitted for analysis along with the regular samples. Equipment blanks should be filled with laboratory supplied PFAS-free water that passes through all of the same sampling equipment used to collect regular samples. The purpose of the equipment blank is to demonstrate that the equipment did not introduce PFAS into the sample.
- 14) Complete the sample submission and chain-of-custody forms using a non-gel ink pen or marker. Chain-of-custody forms should be filled out in their entirety and each cooler shipped should have its own chain-of-custody form listing only the samples stored in the particular cooler. It is a good practice to ensure that the information recorded on each sample label matches the information recorded on the chain-of-custody form prior to shipment. Remember to include all field, equipment and trip blanks in the chain-of-custody. Chain-of-custody forms should be enclosed in their own Ziploc® bag to protect them from possible water damage during shipment. Be sure to specify to the laboratory the analytical detection limit desired.
- 15) Dispose of all wastes (liquids, used gloves and materials) in an appropriate manner. Leave the site in a tidy condition.

8. References

- 1) Dillon Consulting Limited, 2015. Perfluorochemical (PFC) Sampling Methodology for 14 Wing Greenwood. Statement of Work, Detailed Testing Program: FFTA CFB Comox, 8 pp.
- 2) Government of Western Australia, Department of Environment Regulation. 2016. Interim Guidelines on the Assessment and Management of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS), Contaminated Sites Guidelines, Department of Environment Regulation, Perth, Western Australia, 22 pp.
- 3) National Ground Water Association (NGWA), 2017. Groundwater and PFAS: State of Knowledge and Practice, NGWA Paper 120 p.
- 4) Transport Canada. 2016. Per- and Polyfluoroalkyl Substances (PFAS) Field Sampling Guidance. 19p.

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Approval