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ECOLOGY
State of Washington

Standard Operating Procedure EAP098, Version 1.1

Collecting Groundwater Samples for Metals Analysis from Water Supply Wells

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Purpose of this document

The Washington State Department of Ecology develops Standard Operating Procedures (SOPs) to document agency practices related to sampling, field and laboratory analysis, and other aspects of the agency's technical operations.

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Please note that the Washington State Department of Ecology's Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical and administrative experts. Their primary purpose is for internal Ecology use, although sampling and administrative SOPs may have a wider utility. Our SOPs do not supplant official published methods. Distribution of these SOPs does not constitute an endorsement of a particular procedure or method.

Any reference to specific equipment, manufacturer, or supplies is for descriptive purposes only and does not constitute an endorsement of a particular product or service by the author or by the Department of Ecology.

Although Ecology follows the SOP in most instances, there may be instances in which Ecology uses an alternative methodology, procedure, or process.

SOP Revision History

Revision Date	Rev number	Summary of changes	Sections	Reviser(s)
10/23/18	1.1	Updated links, added MSDS	All	Marti
1/25/19	1.1	Accessibility and formatting updates	All	Froese

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1.0 Purpose and Scope

- 1.1 This document is the Environmental Assessment Program (EAP) Standard Operating Procedure (SOP) for Collecting Groundwater Samples for Metals Analysis from Water Supply Wells.
- 1.2 Heavy metals, metalloids, and inorganic trace elements (e.g. aluminum, antimony, arsenic, cadmium, copper, iron, lead, manganese, nickel, selenium, and zinc) are collectively referred to here as metals.
- 1.3 The goals of collecting groundwater samples from water supply wells, both public and private, can include characterizing ambient groundwater conditions, defining the nature and extent of groundwater problems, or defining and sampling water supply wells at-risk from groundwater contamination.
- 1.4 In order to avoid bias in sampling results, groundwater measurements and samples must be as representative of in situ conditions as possible. The in situ geochemical condition of the groundwater at the time of sampling, as well as turbidity and atmospheric exposure of the sample, are some of the critical factors to consider when sampling for metals. This SOP summarizes the general procedures and practices that EAP staff use to collect representative groundwater samples for metals analysis from water supply wells with permanently installed pumps.

2.0 Applicability

- 2.1 This SOP applies to EAP staff collecting groundwater metals samples from supply wells. Variations from the procedures outlined in this SOP may be justified based on a project's technical objectives and field conditions, and should be documented in both the project work plan and final project report. Projects that include analysis of metals at ultra-low concentrations (e.g. below standard Manchester Environmental Laboratory reporting limits) may require specialized field techniques and ultra-clean equipment; these methods are not discussed here.

3.0 Definitions

- 3.1 Aquifer – A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield usable quantities of water to wells and springs.
- 3.2 Dissolved oxygen – The relative amount of oxygen that is dissolved or carried in a given medium.
- 3.3 Data Quality Objectives (DQO's) – Data Quality Objectives are qualitative and quantitative statements derived from systematic planning processes that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions (USEPA, 2006).
- 3.4 Depth-to-Water - also referred to in this SOP as water level measurement.
- 3.5 EAP – Environmental Assessment Program
- 3.6 Ecology – Washington State Department of Ecology
- 3.7 EIM – Environmental Information Management System. A searchable database developed and maintained by the Washington State Department of Ecology.

- 3.8 Field Data Sheets – Weather resistant sheets (e.g. “Rite in the Rain” ® writing paper) used to document all field activities, sample data, methods, and observations for each collection site.
- 3.9 GPS - Global Positioning System
- 3.10 Measuring Point – Established point on a well casing from which depth-to-water/water level measurements are collected to ensure data comparability.
- 3.11 ORP - Oxidation-Reduction Potential. The electric potential required to transfer electrons from one compound or element (the oxidant) to another compound (the reductant). Used as a qualitative measure of the state of oxidation in water.
- 3.12 pH - A measure of the acidity or alkalinity of water. A pH value of 0 to 7 indicates that an acidic condition is present, while a pH value of 7 to 14 indicates a basic or alkaline condition. A pH of 7 is considered to be neutral. Since the pH scale is logarithmic, a water sample with a pH of 8 is ten times more basic than one with a pH of 7.
- 3.13 Specific Conductance (SC) – A measure of the water’s ability to conduct an electrical current. Specific conductance is related to the concentration and charge of dissolved ions in water.
- 3.14 Quality assurance project plan (QAPP) – A written plan that describes how a study will be conducted and its results assessed.

4.0 Personnel Qualifications/Responsibilities

- 4.1 EAP staff who conduct groundwater sampling are responsible for following this SOP, and EAP077, the Standard Operating Procedure for Purging and Sampling Water Supply Wells. Additionally, EAP staff must follow the requirements of the EAP Safety Manual - particularly Chapter 1 ‘General Field Work’ and the following section of Chapter 2: ‘Groundwater Sampling and Water-Level Measurements’ (Ecology, 2017).
- 4.2 Documents such as the USGS National Field Manual for the Collection of Water-Quality Data (USGS, 1997) or the Essential Handbook of Groundwater Sampling (Nielsen and Nielsen, 2007) have additional detailed explanations of what factors to consider when sampling supply wells.
- 4.3 Users seeking additional technical information specific to groundwater metals sampling procedures are encouraged to review the benchmark publications on these topics, including: Puls and Barcelona, 1989, Puls et al., 1990, Puls et al., 1991; Puls et al., 1992, Puls and Powell, 1992, Gibbons and Sara, 1993, McLean and Bledsoe, 1992; Pohlmann et al., 1994, and Puls and Barcelona, 1995. In addition, EAP staff must read and be familiar with the considerations explained in Appendix A of this SOP prior to initiating sampling.
- 4.4 Field staff should have a detailed working knowledge of the project QAPP to ensure that credible and useable data are collected, and should be briefed by the field lead on the sampling goals and objectives prior to arriving at the site.

4.5 This document supplements but does not replace the need for on-the-job training. All field staff should be familiar with the sampling equipment and instruments being used. The field lead is responsible for ensuring that all field staff adhere to prescribed sampling methods when conducting field work.

5.0 General List of Equipment and Supplies

5.1 Sample Measuring and Collecting Equipment

5.1.1 Field data sheets

5.1.2 Water level measuring equipment (calibrated electric water level meter, graduated steel tape, sonic water level meter)

5.1.3 Water quality meters and probes (pH, SC, DO, temperature, ORP)

5.1.4 Probe calibration standards/reagents

5.1.5 Flow cell

5.1.6 Faucet sampling attachment (see Figure 1 for example)

5.1.7 Tubing and connectors

5.1.8 Sample containers/bottles

5.1.9 Sample preservatives

5.1.10 Filters (analyte specific)

5.1.11 Coolers with ice or ice packs

5.2 Cleaning and Disinfecting Supplies

5.2.1 Deionized water

5.2.2 Laboratory grade soap (Liquinox®)

5.2.3 Dilute chlorine bleach solution

5.2.4 Cleaning solvents, if applicable

5.2.5 Butane lighter or propane torch

5.3 Safety Equipment

5.3.1 Nitrile gloves

5.3.2 First aid kit

5.3.3 Orange vest, Ecology issued

5.3.4 Wasp spray (avoid using if sampling for organics/insecticides)

5.3.5 Employee photo ID

5.4 Miscellaneous Equipment

5.4.1 Well location map

5.4.2 All applicable SOPs

5.4.3 Field paper work: well owner contact information, field data sheets, sample bottle labels and tags, chain-of-custody sheets.

5.4.4 Pencils, pens, etc.

5.4.5 Permanent marking pen or paint stick (for marking measuring point)

5.4.6 Calculator

5.4.7 Keys for wells or gates, if applicable

5.4.8 Compass

5.4.9 GPS unit

5.4.10 Digital camera

5.4.11 Paper towels or clean rags

5.4.12 Plastic garbage bags

- 5.4.13 Plastic sheeting for ground cover
- 5.4.14 Buckets, plastic 5-gallon (to calibrate purge volume/rate)
- 5.4.15 1-liter container (to calibrate slower purge volume/rate)
- 5.4.16 Stop watch
- 5.4.17 Field bag (containing rain gear, rubber boots, work gloves, etc.)
- 5.4.18 Hand cleaner
- 5.5 Tools
 - 5.5.1 Steel hand measuring tape (engineer scale)
 - 5.5.2 Socket wrench set
 - 5.5.3 Allen wrench set
 - 5.5.4 Pipe wrenches
 - 5.5.5 Crescent wrenches
 - 5.5.6 Set of screwdrivers
 - 5.5.7 File
 - 5.5.8 Knife
 - 5.5.9 Hammer
 - 5.5.10 Pliers
 - 5.5.11 Crow bar/manhole hook
 - 5.5.12 Shovel
 - 5.5.13 Machete
 - 5.5.14 Whiskbroom
 - 5.5.15 Spare well cover bolts/nuts
 - 5.5.16 Spare well caps/plugs
 - 5.5.17 Wire brush
 - 5.5.18 WD-40
 - 5.5.19 Flashlight
 - 5.5.20 Spare batteries (e.g. electric-tape, GPS, flashlight)
 - 5.5.21 Tape (duct tape/electrical tape)
 - 5.5.22 Well tagging equipment

6.0 Summary of Procedure

6.1 Project Planning

6.1.1 A Quality Assurance Project Plan (QAPP) must be completed and approved before collecting water quality samples for analysis. The QAPP details project goals, data quality objectives, quality assurance program procedures, sample handling requirements (container requirements, preservation, holding times), and field and laboratory procedures. A QAPP can reference SOPs for standard field monitoring or measurement procedures; however, non-standard procedures or deviations should be described in detail in the QAPP.

6.1.2 Before a water supply well can be sampled, field staff need to gain permission from the well owner or operator. Discuss with each well owner which sampling activities will be permitted at the well (well tagging, water level measurement, alterations to the water system, etc.). Field staff should be sensitive to the fact that they are sampling someone's water supply and only perform activities for which they've been granted permission.

- 6.1.3 Detailed information should be collected for each well location whenever practical, including well construction logs, water level data, pump setting information, sample faucet location relative to pressure tanks, water treatment systems, etc., site access agreements, and any other relevant information about the wells to be sampled.
- 6.1.4 When sampling water supply wells, field reconnaissance is usually necessary to determine a well's appropriateness for the project. If a well is selected, draw a diagram showing where the sample faucet is located with respect to the well and any pressure or storage tanks or treatment systems. An example of a well reconnaissance field form is included in Appendix B.
- 6.1.5 Well location and construction information for wells that are sampled are required to be entered into Ecology's Environmental Information Management (EIM) system database.
- 6.1.6 If the well hasn't been previously inventoried, use a GPS receiver when visiting the well to define preliminary latitude and longitude coordinates. The field-collected coordinates can be refined using mapping tools when entering the well into the EIM system.
- 6.1.7 If the well hasn't been assigned a Department of Ecology unique well ID tag, then it should be tagged. Only tag water supply wells when permission has been granted by the well owner. Procedures on how to tag a well are described in SOP EAP081 *Procedures for Tagging Wells*. Well tags are available from Ecology's Water Resources Program. Securely attach the tag to the well casing, or any other permanent, easily-seen fixture of the well. Once a well is tagged, complete the well tag form and submit to Ecology's Water Resource Program along with a copy of the well log.
- 6.1.8 Collecting samples from water supply wells with permanently installed pumps requires specific considerations, preparations, and precautions. Characteristics of the well, operation of the pump, and selection of the sample point must be considered to obtain data that will meet the project objectives and data quality requirements.
- 6.1.9 Factors to consider when selecting a water supply well for sampling include: physical characteristics of the well and water delivery system (location of screened interval, location of the sample point relative to pressure tanks, aerators, water softeners, etc.), and compatibility of analytes being sampled with well, pump, and delivery system construction and operation. Documents such as the USGS National Field Manual for the Collection of Water-Quality Data have detailed explanations of what factors to consider when selecting water supply wells for sampling. Considerations for well construction and equipment selection and installation that are specific to sampling for metals are discussed in Appendix A.

- 6.2 Field Work Preparation
 - 6.2.1 Prior to sampling, inventory consumable field supplies such as disposable gloves, calibration standards, tubing, filters, etc. Order necessary supplies. Allow ample time for delivery.
 - 6.2.2 Arrangements must be made with Ecology's Manchester Environmental Laboratory before sampling. The Manchester Environmental Laboratory (MEL) Lab Users Manual (Ecology, 2016) contains detailed guidance on the planning steps necessary to request, track, ship, and analyze water quality samples collected in the field.
 - 6.2.2.1 To notify the lab submit a Pre-sampling Notification Form and a Sample Container Request Form a minimum of 2 weeks prior to sampling. For large projects the lab should be informed 4-6 weeks prior to sampling. Examples of the lab forms are provided in Appendix B.
 - 6.2.2.2 Coordinate with the lab regarding any special arrangements such as contract lab analysis, special courier or delivery of samples.
 - 6.2.2.3 Inventory sample bottles when they arrive to ensure the lab provided the correct type and number.
 - 6.2.3 Establish the order the wells will be sampled. Sample order is either based on logistics or the known or suspected water quality of a sample location.
 - 6.2.3.1 Obtain permission for site access. Contact the well owner, operator, or property resident to confirm the sampling date and time and to discuss any site access issues. Be sure to get specific instructions on what activities are allowed at the well. For example many well owners will allow water samples to be collected, but do not want their wells opened for water level measurements.
 - 6.2.3.2 Before going in the field prepare field data sheets for each well location. It can be helpful to bring previous sample data for each well such as pump rate, total purge time, stabilized field parameter values, etc. Other sample paperwork should also be filled out as much as possible. Sample paperwork typically includes: bottle labels and tags, as well as Manchester Labs Chain-of-Custody/Lab Analysis Required Form (LAR) for the project sample event. Examples of field data sheets are provided in Appendix B.
 - 6.2.4 Inspect all equipment and verify that water quality field meters are in good working order, calibrated properly, and are fully charged. Calibrate field water quality meters according to the manufacturer's instructions.
 - 6.2.5 Field equipment, especially equipment being placed in a well, must be properly cleaned, disinfected, or decontaminated prior to and after use in each well. This is especially important when placing equipment in water supply wells. In most cases unfiltered samples collected from water supply wells can be collected directly from

a water system faucet or tap to the sample container, without the need for additional sample collection equipment that requires decontamination.

- 6.2.5.1 It is recommended that gloves (Nitrile) be worn when cleaning sample equipment. This will help maintain sanitary conditions of the cleaned equipment and will protect the sampler from the cleaning products being used. When not in use, equipment should be placed on a clean surface, such as a clean plastic sheet. If the equipment is not re-used immediately it should be wrapped in plastic sheeting and/or aluminum foil. Equipment should never be placed on bare soil prior to using it in a well.
- 6.2.5.2 Water level measuring equipment: disinfect probe and any potentially submerged tape with dilute chlorine bleach. Depending on how much of the tape is submerged the equipment can be sprayed with disinfectant, soaked in a bucket of disinfectant or wiped with a clean disinfectant soaked towel. Rinse equipment with deionized water. Dry equipment with a clean paper towel or air dry.
- 6.2.5.3 Water quality field probes may be rinsed with deionized water between sample locations. If the probes are slow to respond and additional cleaning is needed, then the probes should be cleaned and maintained according to the manufacturer's instructions.
- 6.2.5.4 Non-dedicated sample equipment such as the Y-split flow controller/Y-fitting that is attached to the sample faucet/tap should be washed in a laboratory grade soap (e.g. Liquinox) solution after use. Use a brush to scrub the sample equipment if needed. Rinse the equipment with tap water, followed by a deionized water rinse.
- 6.2.5.5 Equipment that sample water contacts that is difficult to clean, such as pump tubing or tube fittings, should be replaced between sample locations.

6.3 Sampling Procedure

- 6.3.1 After measurement of the static water level (see SOP EAP052), connect a clean apparatus, such as a Y-split flow controller/Y-fitting to the faucet selected for sampling. Attach a hose or tubing to one arm of the Y-fitting. This will be the main purge water discharge. To the other arm of the Y-fitting, connect a closed-atmosphere flow cell. Instrument the flow cell with probes for the measurement of temperature, pH, specific conductance, DO, and ORP. Open the faucet to begin purging the well, directing most of the water through the discharge valve side of the Y-fitting. Adjust the flow to the flow cell to a rate ≤ 0.3 L/min using the purge and sample valve on the Y-fitting (Figure 1A).¹ Once the well purge process has begun, discharge from the supply faucet must be maintained until purging is

¹ Water supply wells may be purged at higher flow rates, but flow rates for the purpose of field parameter measurement (including turbidity) and sample collection should be maintained at ≤ 0.3 L/min.

complete. Do your best to avoid stopping and starting the water flow during the purge and sample process.

- 6.3.2 Purge the well until standard metals-sample field parameters (temperature, pH, specific conductance, dissolved oxygen, and ORP) equilibrate (stabilize).

Field parameters are considered stable when 3 consecutive readings fall within the following stabilization criteria:

pH	± 0.1 standard units
Specific Conductance	± 10.0 µmhos/cm for values < 1000 µmhos/cm ± 20.0 µmhos/cm for values > 1000 µmhos/cm
Dissolved Oxygen ²	± 0.05 mg/L for values < 1 mg/L ± 0.2 mg/L for values > 1 mg/L
Temperature	± 0.1° Celsius
ORP	± 10 millivolts

- 6.3.3 After the field parameters listed above have equilibrated, collect a turbidity measurement, per Figure 2 instructions. Follow the manufacturer's instructions for turbidity meter/probe calibration and measurement procedures.

- 6.3.3.1 If measuring turbidity in a closed-atmosphere flow cell, watch for sediment build up in the flow cell chamber that could bias the measurement. If using separate flow cells for the measurement of turbidity and standard field parameters, make sure to place the turbidity cell upstream of the remaining equipment.

- 6.3.3.2 If using a standalone, cuvette-based turbidimeter, maintain flow through the discharge side of the Y-fitting, close the purge and sample-side valve, and remove the flow cell. Reopen the purge and sample valve (≤ 0.3 L/min) and collect your sample for turbidity. Conduct the turbidity analysis as soon as possible after filling the cuvette.

- 6.3.3.3 Record the turbidity value to the closest 0.1 NTU.

- 6.3.3.4 If the turbidity measurement at this point is > 10 NTU, refer to Figure 2 for further guidance. If the turbidity measurement is ≤ 10 NTU, proceed to the next step of the sampling process.

- 6.3.4 Maintaining flow through the discharge side of the Y-fitting, next collect and analyze samples for field-sensitive parameters, as necessary (low concentration DO, ferrous iron, manganese; see Appendix A for detailed instructions). Do this by closing the sample-side valve of the Y-fitting, connecting a short section of clean sample tubing and a sample cone, and then re-opening the valve (< 0.3 L/min) to allow use of vacuum vials for water collection and testing.

² If using an optical probe care must be taken to protect the probe from UV light.

- 6.3.5 Keeping the sample cone in an upright position, submerge the vacuum vial in the flowing discharge. Allow the temperature of the vial to equilibrate briefly with the water discharge, then snap the vial and proceed with spectrophotometric measurement (Figure 3; see further instructions in spectrophotometer operating manual).
- 6.3.6 Once all field analyses are complete, collect samples destined for laboratory analysis.³ Refer to the decision-tree shown on Figure 4 to determine the need for sample filtration.
- 6.3.6.1 For unfiltered metals samples, maintain flow through the discharge side of the Y-fitting, shut off the sample-side valve, and remove the sample cone and tubing. Reopen the sample-side valve (≤ 0.3 L/min), and collect water directly into a pre-preserved sample container. Label sample containers and immediately place the sample on ice for transport to the laboratory.
- 6.3.6.2 For filtered metals samples:
- 6.3.6.2.1 Use the decision-tree shown on Figure 4 as guidance for appropriate filtering procedures and filter sizes.
- 6.3.6.2.2 Close the sample-side valve and attach the necessary filtering equipment to the sample-side of the Y-fitting. Avoid use of metal-based connections; clean Teflon or HDPE parts are preferred when sampling metals (Figure 1B).
- 6.3.6.2.3 Attach the appropriate filter to the discharge end of the tubing (e.g. Figure 1B).
- 6.3.6.2.4 Reopen the sample-side valve (≤ 0.3 L/min), hold the filter upright, with the outlet facing upward (to purge air from the filter). Discard the first 500-1000 mL of the filtrate before collecting the sample.
- 6.3.6.2.5 Collect the filtered sample directly into a pre-preserved container. Be careful not to allow water on the outside surface of the filter to enter the container (this is best accomplished by pointing the filter outlet upward at an angle and arcing the filter discharge into the container; Figure 5).
- 6.3.6.2.6 Label sample containers and immediately place the sample on ice for transport to the laboratory.
- 6.3.7 Record sample date and time, and total purge volume on the field data sheet. If the pump is equipped with a flow meter, record the flow volume. Record any final observations or comments related to sample collection.

³ See Section 6.3.20 of SOP EAP077 for further guidance on sampling order if sampling for additional analytes groups.

- 6.3.8 Follow the procedures in the project QAPP or Manchester Lab Manual for sample handling and management (e.g. chain of custody, sample courier service or any special shipping requirements or restrictions).
- 6.3.9 Be conscious of analytical holding times and minimize the time between sampling and delivery to the laboratory.
- 6.3.10 When all work at the well site is complete, replace any removed aerators, filters, or hoses. Properly close and secure the well.
- 6.3.11 Note any physical changes to the well or sample point on the field data sheets.
- 6.3.12 All equipment used to collect groundwater samples should be cleaned or disinfected as previously described. Store the equipment for transport to the next sample location or at the conclusion of the field study.
- 6.3.13 Before leaving the site make certain that all the appropriate quality control samples have been collected. These may include a field replicate, and field blanks (e.g. filter, equipment, transport). The types and number of quality control samples should be specified in the project QAPP.

7.0 Records Management

- 7.1 Water supply wells that EAP samples must be documented to enable information about their location, construction, and subsequent monitoring data to be archived in Ecology's Environmental Information Management (EIM) system and well log imaging databases. Consult the EIM help documents for a list of the well specific metadata required by EIM.
- 7.2 Station information and monitoring notes should be documented, during each site visit on site specific field data sheets. Examples are presented in Appendix B. All field entries should be neat and concise. The field lead is responsible for reviewing the form(s) for completeness before leaving a field site.
- 7.3 EAP staff have developed a number of data analysis spreadsheets, field forms, and other tools to standardize data collection and processing for groundwater monitoring projects. See the EAP Groundwater Assessment SharePoint site for the most up-to-date version of these tools. Examples of some of the field forms are provided in Appendix B.
- 7.4 All hardcopy documentation, such as well reports and field data sheets, are kept and maintained by the project lead. At the completion of a project, hardcopies are boxed and moved to EAP archives.

8.0 Quality Control and Quality Assurance

- 8.1 To ensure that good quality data are obtained throughout a project, a Quality Assurance Project Plan (QAPP) must be completed and approved before performing any field work. The QAPP details project goals, data quality

objectives, quality assurance program procedures, sample handling requirements, and field and laboratory procedures.

- 8.2 Both the equipment and procedures used in collecting and handling groundwater samples have limitations that introduce a certain level of error, variability and bias into the final analytical results. To minimize the level of error, all field staff should follow these general QA/QC procedures when collecting samples:
 - 8.2.1 Follow the project QAPP and any applicable standard operating procedures (SOP) when collecting and handling samples.
 - 8.2.2 Calibrate field water quality meters according to the manufacturer's instructions.
 - 8.2.3 Use equipment to purge and sample that is compatible with the characteristics of the well and analytes being sampled. Operate equipment in accordance with the manufacturer instructions, unless otherwise specified in the project QAPP.
 - 8.2.4 Properly collect, handle and store samples.
 - 8.2.5 Collect the appropriate quality control samples. These may include a field replicate, and field blanks (e.g. filter, equipment, transport). The types and numbers of quality control samples should be specified in the project QAPP.
 - 8.2.6 Follow the procedures in the project QAPP or Manchester Lab Manual for sample handling and management (e.g. chain of custody).
 - 8.2.7 Document all data, observations, notes, deviations from project QAPP, etc. on the field data sheets and other project paperwork.
 - 8.2.8 Properly clean, maintain, and store all field equipment after use.
 - 8.2.9 Use consistent procedures from well to well.

9.0 Safety

- 9.1 Proper safety precaution must be observed when collecting groundwater samples. Field work should follow protocols described in the Environmental Assessment Program Safety Manual (Ecology 2017). A working knowledge of sections ‘Groundwater Sampling and Water-Level Measurements’ in Chapter 2 is expected. Protocols in the EAP Safety Manual should be used to complement the judgment of an experienced field professional.
- 9.2 A Field Work Plan Form must be completed to document field personnel, sampling locations, overnight lodging, planned itinerary, contact person(s), and emergency contacts.
- 9.3 Always consider the safety situations when accessing a water supply well. If entering a pump house watch for objects stored in the pump house, including hazardous chemicals. Be aware of any possible animal hazards at the sample site such as dogs, mice, snakes, wasps, and spiders. Consult the EAP Safety Manual for further guidance when working at a well site.
- 9.4 All EA Program staff who work in the field are required to complete and maintain certification in FIRST AID/CPR.
- 9.5 Chemical Safety Data Sheets (SDSs) for all chemicals used in the procedures outlined in this SOP can be found on the [EAP SharePoint site](#) hyperlinked. Also, binders containing SDSs can be found in all field vehicles, vessels, Ecology buildings, or other locations where potentially hazardous chemicals may be handled. EAP staff that follow Ecology SOPs are required to familiarize themselves with these SDSs and take the appropriate safety measures for these chemicals.

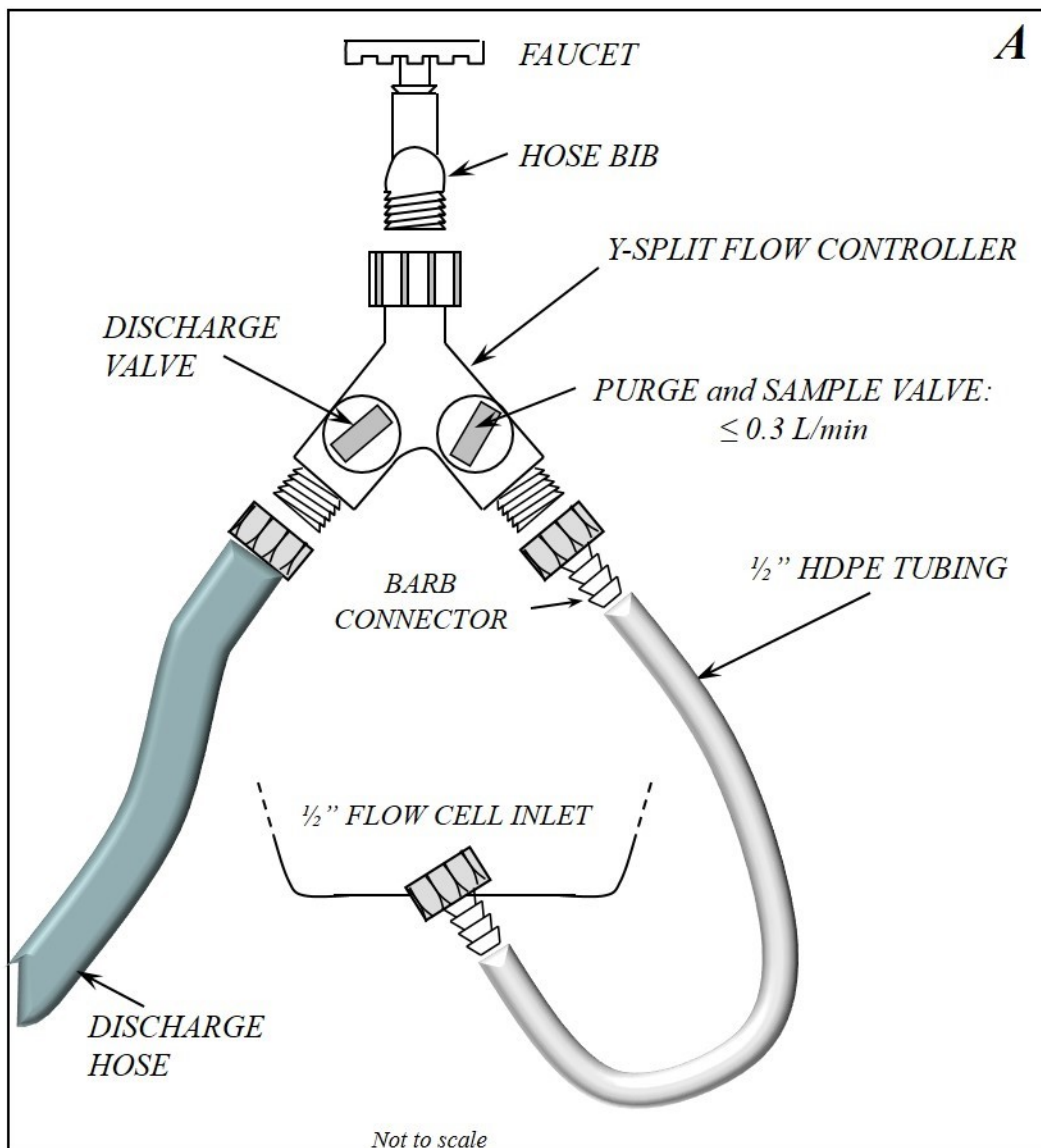
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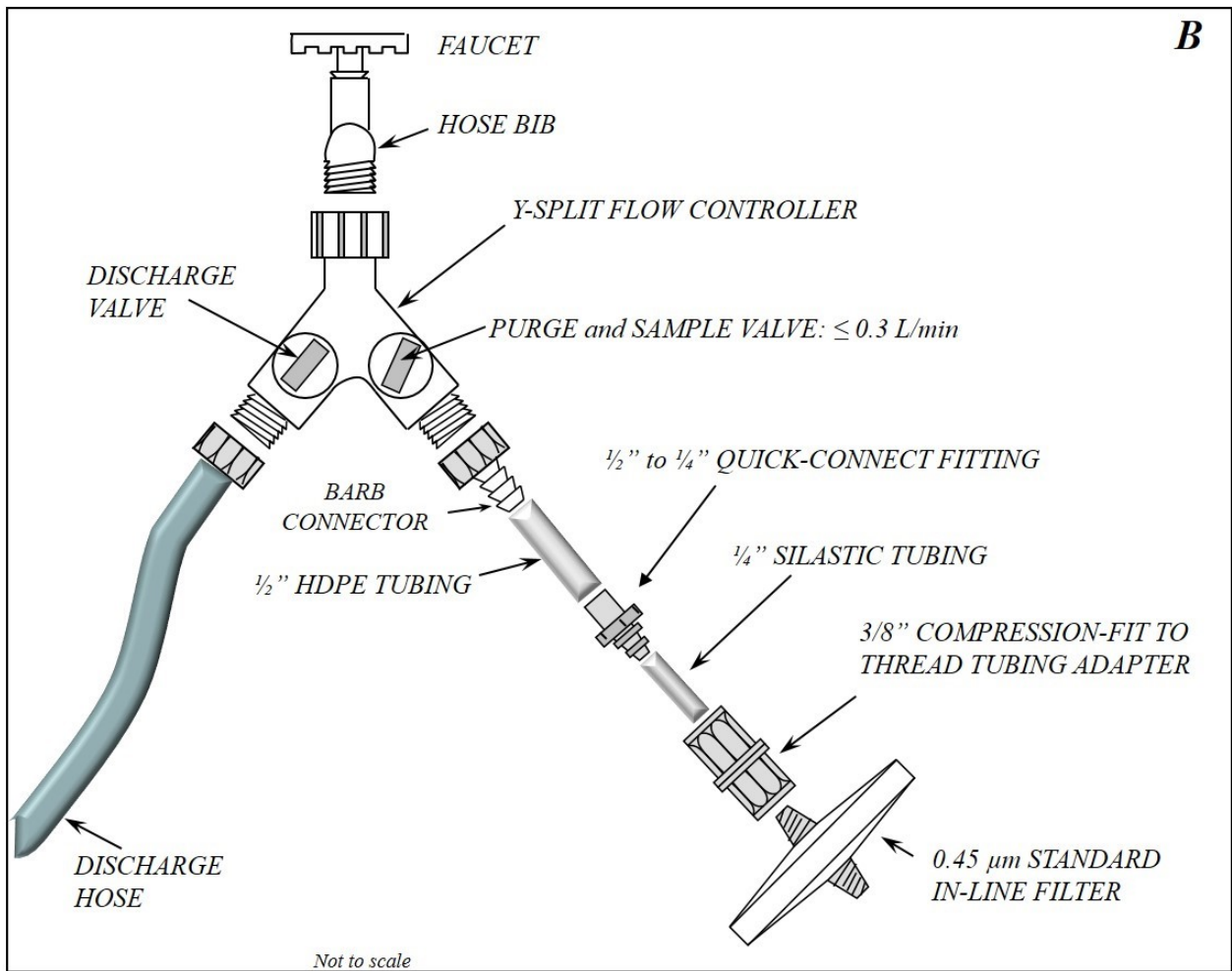


Figure 1. Schematic for Typical Water Supply Well Purge and Sampling – A) example apparatus for measurement of purge parameters, B) example apparatus for sampling.

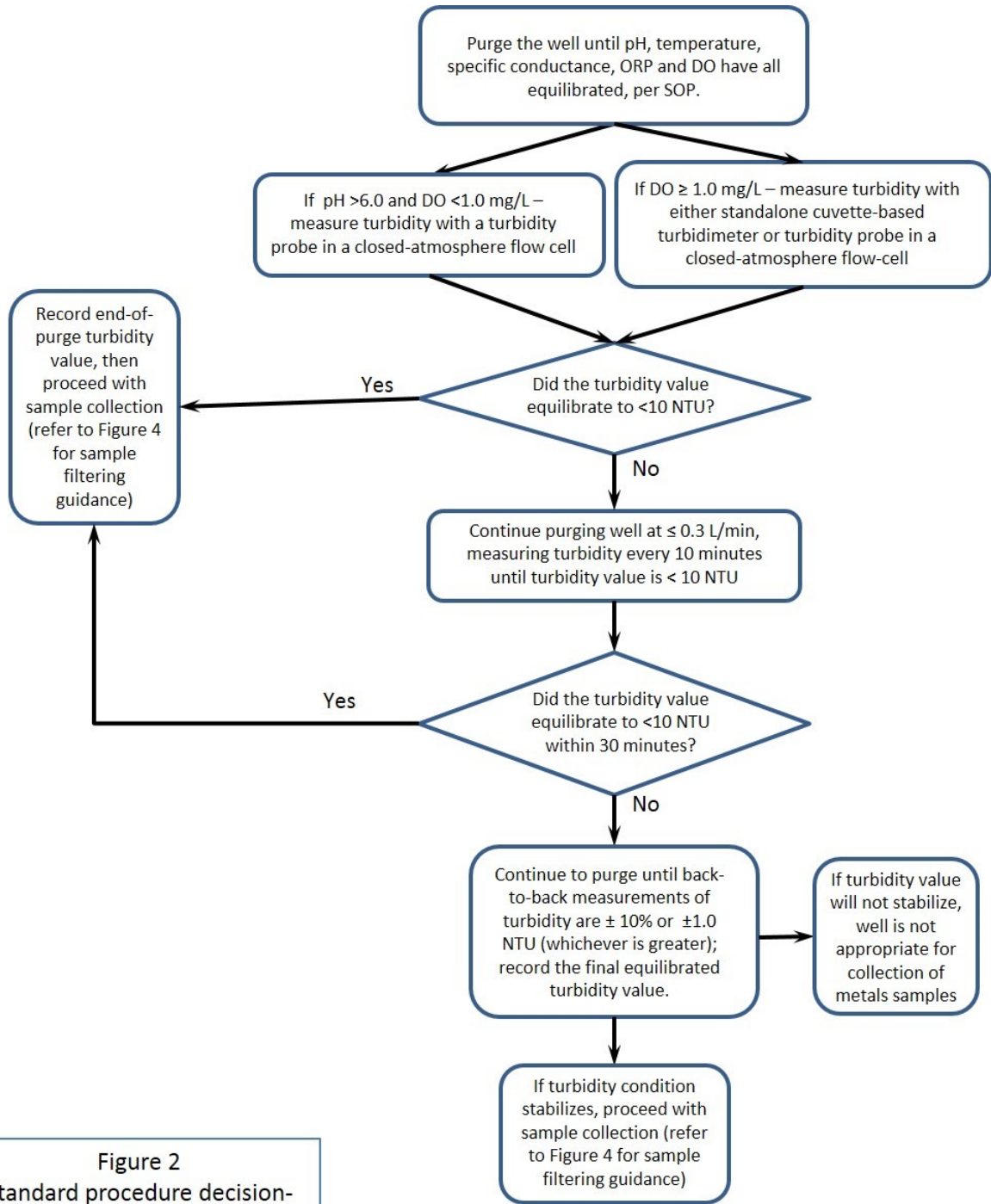


Figure 2
Standard procedure decision-tree for turbidity measurement when sampling water supply wells for metals

Note: Turbidity calibration and measurement procedures are specific to the measurement device. Follow instrument manufacturer instructions.

Figure 2. Standard procedure decision tree for turbidity measurement when sampling water supply wells for metals.



Figure 3. Using a sampling cone to fill a vacuum vial for spectrophotometric analysis.

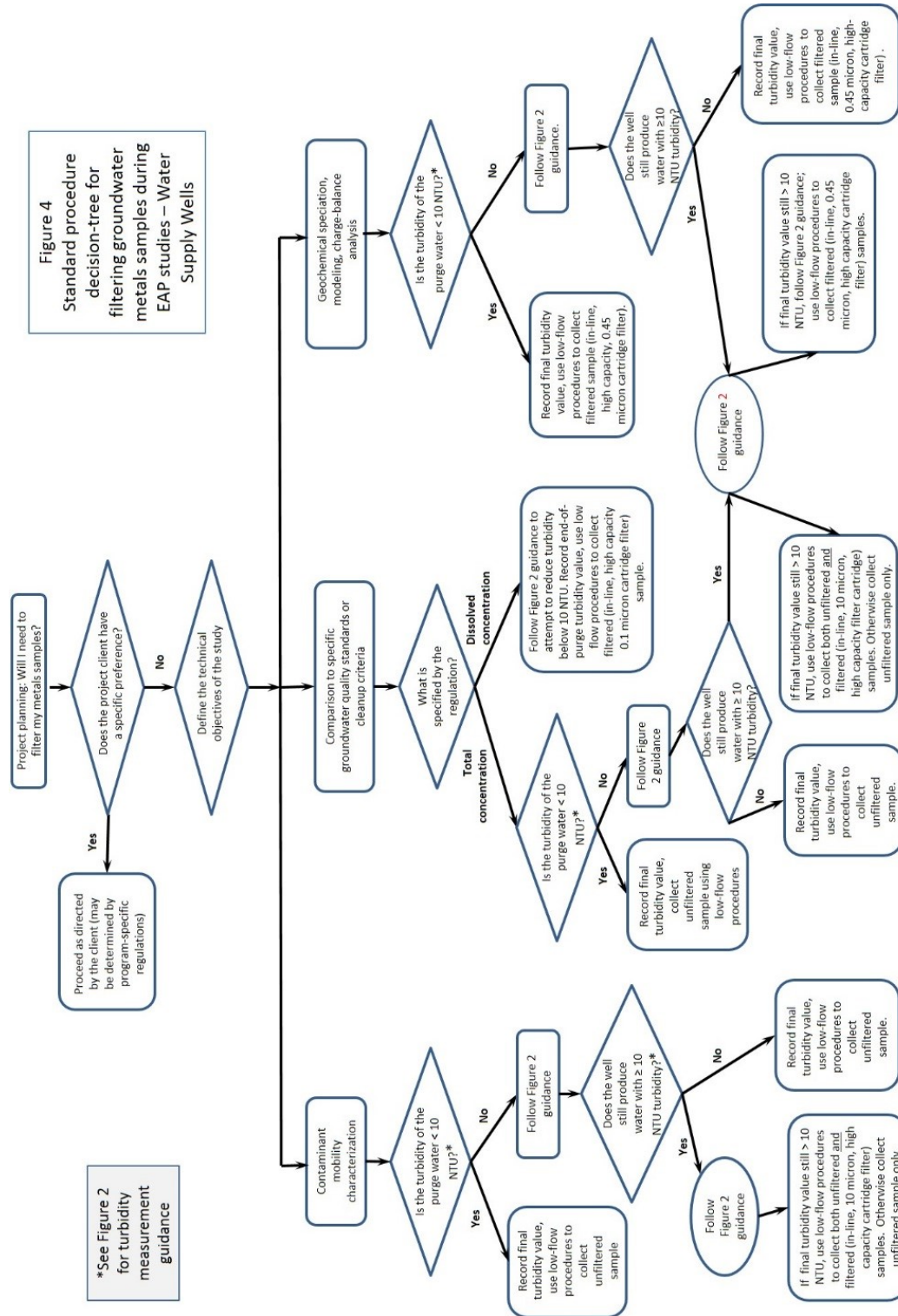


Figure 4. Standard procedure decision tree for filtering groundwater metals samples during EAP studies (water supply wells).

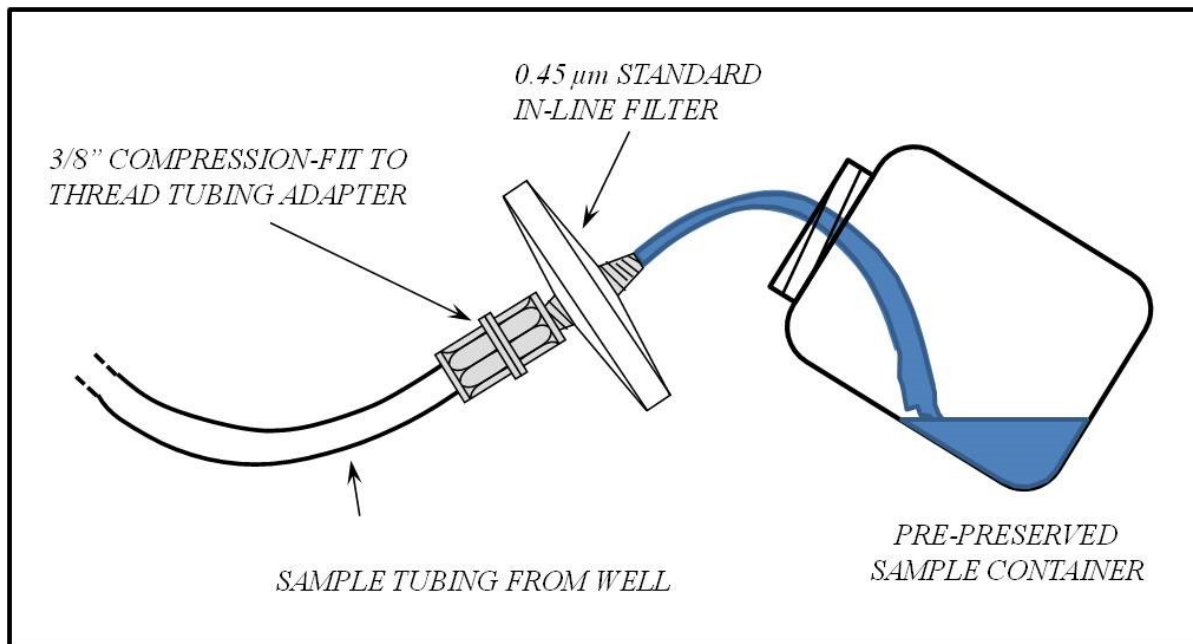


Figure 5. Angling the filter discharge into a sample container.

11.0 **Appendix A: Considerations for Collecting Groundwater Samples for Metals Analysis from Water Supply Wells**

Procedures for collecting representative groundwater samples for metals have been a subject of scientific research and debate for many years. EAP staff members seeking additional technical information are encouraged to review the benchmark publications on these topics, including: Puls and Barcelona, 1989, Puls et al., 1990, Puls et al., 1991; Puls et al., 1992, Puls and Powell, 1992, Gibbons and Sara, 1993, McLean and Bledsoe, 1992; Pohlmann et al., 1994, and Puls and Barcelona, 1995.

Variations from the procedures outlined in this appendix may be justified based on a project's technical objectives and field conditions, and should be documented in both the project work plan and final project report. Projects that require analysis of metals at ultra-low concentrations (e.g. below standard Manchester Environmental Laboratory reporting limits) may require specialized field techniques and ultra-clean equipment; these methods are not discussed here.

Sampling Groundwater Metals Concentrations in Water Supply Wells with Permanently Installed Pumps – Considerations

There are a variety of special considerations related to the collection of groundwater metals samples from water supply wells. These considerations should be evaluated during the project planning process, prior to starting your field work.

Project Objectives

The technical objective of your project is a key consideration when deciding if water supply wells are appropriate for the collection of groundwater samples for characterization of metals, particularly at lower concentrations when even small biases can have a significant influence on the reported result.

Many of the features of wells that are designed and constructed to deliver water for supply have the potential to introduce unwanted bias into samples collected for metals analysis (e.g. carbon steel well casing, larger-diameter screen perforations or open-hole open intervals, higher-flow-rate dedicated pumps, metal-based delivery lines from the well to the sampling point, holding tanks and water treatment systems). As a result, water supply wells are often not well-suited for the collection of samples that are representative of in-situ groundwater metal concentrations.

Dedicated PVC-cased monitoring wells are the preferred well type if accurate characterization of in-situ groundwater metals concentrations is the primary technical objective of the sampling project. See SOP EAP100 for sampling procedures related to collecting metals samples from dedicated monitoring wells.

If monitoring wells are not available in your study area, you may have to rely on water supply wells as sampling locations. In this situation, however, additional considerations are necessary to minimize bias in the metals sample results, and the analytical results should be evaluated and interpreted with regard to the potential for such bias.

The most appropriate use of water supply wells for metals sampling is for projects where the primary objective is to characterize a groundwater user's direct chemical exposure, through either

consumption of drinking water or by dermal contact. Water supply wells may also be acceptable for studies focused on preliminary or reconnaissance detection of metals contamination in an aquifer system, where precise characterization of in situ groundwater metals concentrations or geochemistry is not a high priority.

Well construction considerations

The construction details and open-interval position of the wells you are considering monitoring should be determined prior to sampling (usually by review of the well logs). When selecting water supply wells for metals sampling, it is important to carefully evaluate these construction details in the context of your project objectives.

Pay close attention to the length and position of the open interval of the wells you plan to sample. Unless your project goal is focused on reconnaissance detection of metals in groundwater, you should generally avoid sampling supply wells with open intervals that are longer than those typically used for monitoring wells (> 10 feet).

Longer screens may draw and mix water from different water bearing zones within an aquifer, depending on the hydrogeologic setting and vertical water chemistry stratification. This mixing process can composite water of significantly different metals concentrations or geochemical characters, leading to a potential underreporting of the actual maximum concentrations in the subsurface, or even a misrepresentation of the in situ metals condition. For example, mixing groundwater from an oxic zone with water from an anoxic zone screened by the same well could alter metal partitioning, significantly biasing the resulting concentration of the sample (McIlvride and Rector, 1988; Cleary and Miller, 1993).

If your project objective requires accurate characterization of in situ metals concentrations and geochemistry, favor selection of supply wells that have shorter screen lengths, if possible. If your project goal requires characterization of groundwater metals concentrations across multiple water bearing zones or in an aquifer with significant potential for vertical geochemical stratification, consider adopting alternative monitoring approaches (e.g. sampling multiple short-screened wells constructed at different vertical positions in the aquifer).

Supply wells constructed with a screened or perforated casing across the open interval are generally favored for metals sampling over wells with open boreholes. Cased wells are more likely to allow the development of a filter pack adjacent to the casing, which can help to reduce turbidity in the pump discharge in some cases.

If possible, try to avoid sampling newly constructed wells. New wells may produce excessively turbid water, and significant bias may be introduced into metals (and major ion) concentration results if sampling too soon after well construction (due to the fact that the groundwater and aquifer substrate may not have had the opportunity to chemically re-equilibrate from the drilling process)(Puls and Barcelona, 1989).

Well pump considerations

Supply wells selected for sampling should be fitted with a dedicated submersible pump. Wells equipped with surface-based suction lift or jet pumps should be avoided when sampling for metals.

Control of material or water system bias

Samples should be collected as close to the well pump/wellhead as possible. Metals samples should always be collected before the water passes through any physical or chemical treatment systems that can significantly alter the quality of the groundwater sample (e.g. water softeners, iron removal equipment, or reverse osmosis treatment systems).

Make sure to record in your field notes any special condition in the well system that might represent a source of bias in the metals sampling results (e.g. copper or galvanized piping upstream of the sampling point; lead-based soldering on delivery line joints). Identify and note the well casing and delivery line material type. Avoid collecting samples for metals analysis from metal-cased wells or metal delivery lines that show signs of significant corrosion.

Any equipment that comes in direct contact with the water downstream of the sampled faucet should be made of material that will not bias the sample concentration. High density polyethylene or PTFE (Teflon) components are the preferred material types for metals sample collection⁴; metal-based components (including stainless steel) should be avoided. Expendable components of the sampling apparatus such as filters and tubing should always be factory new for each well. Metals samples (and turbidity measurements) should never be collected through garden hoses attached to the sampling faucet.

Control of sample turbidity

Controlling the turbidity of the sample stream is the primary data-bias consideration when sampling groundwater monitoring wells for metals, and the turbidity condition of the pump discharge from the well can directly influence sampling procedures and filtration decisions.

Many metals tend to 1) strongly adsorb to solid mineral or organic particulate surfaces by ion exchange or 2) be directly incorporated into the chemical structure of particulates by precipitation/complexation reactions. These sorption reactions can significantly limit metals occurrence and mobility in the aqueous phase by binding metals to aquifer matrix solids that are physically immobile under normal groundwater pore-velocity conditions (McLean and Bledsoe, 1992; NGWA, 2011; Puls and Powell, 1992).

Due to their large surface areas and negative electrostatic surface charge (pH dependent), sorption of cationic metals often occurs in association with fine-particles (e.g. colloids, clay, and organic material) or with amorphous oxide and (oxy)hydroxide particle coatings of iron and manganese. These types of materials are ubiquitous in groundwater aquifers (Langmuir et al., 2004; NGWA, 2011).

⁴ Short sections of flexible sample tubing can be used if necessary. Such tubing should be composed of a material with a low affinity for metals sorption and low gas permeability (e.g. PharMed™ tubing). Keep such sections as short as possible.

Sampling procedures that mobilize and then capture metal-bearing particles that would normally remain immobile in groundwater can introduce significant positive bias into reported sample concentrations (Puls and Powell, 1992; Puls et al., 1992). If such particles are entrained in the sample sent to the laboratory, and then digested during analysis, the reported metals concentration will be higher than the in situ groundwater condition.

Research has shown that colloidal-scale particles (up to 10 microns in diameter) can be mobile in the groundwater environment under normal fluid velocities (Puls et al., 1991; Puls and Powell, 1992). It is important to use sampling procedures that account for colloidal transport of metals, particularly if attempting to characterize contaminant mobility at a project site. Filtering such particles out prior to analysis can introduce a significant negative bias into the reported concentrations (i.e. the lab will report metal concentrations that are lower than the in situ groundwater condition). As a result, standard industry practice is to leave most groundwater metals samples unfiltered, and focus on controlling artificial or 'induced' turbidity effects caused by poor well design or excessive pumping rates.

The use of the low flow (< 0.3 L/min) purge and sample procedures employed to help control the artificial mobilization of particles into a monitoring well is normally not possible when sampling water supply wells equipped with standard dedicated pumps⁵. However, the frequent pumping cycles and high pumping rates experienced by water supply wells that are in regular use often reduce the turbidity of the pump discharge to negligible levels.

Re-development of water supply wells to mitigate problems with excess turbidity (for example for wells that are not in frequent use) will, in most cases, not be practical for EAP projects. In limited cases, it may be appropriate to filter groundwater samples collected from water supply wells that produce water with elevated levels of turbidity. Filtration, however, should never be used as an easy substitute for careful well selection and proper sampling techniques. If you must filter samples due to problems with the turbidity condition of the water, you should always collect an additional, unfiltered sample for comparison.

A decision tree outlining conditions, decision points, and methods required for monitoring turbidity conditions is presented in Figure 2. Figure 4 provides related guidance on how the turbidity condition of the water influences the decision to filter or not, in light of the project objectives.

Control of pressure changes and atmospheric exposure of a groundwater metals sample

The concentration, phase, and mobility of metals can be highly sensitive to changes in the pressure condition or oxidation state of groundwater that can occur during the sampling process. Bringing a groundwater sample to the surface and exposing it to the atmosphere can alter both the pH (due to a change in the partial pressure of CO₂) and the redox potential (Eh) of the water. This is particularly true if the sample is agitated or aerated in any way during collection.

⁵ The goal of low-flow groundwater sampling for metals is to withdraw groundwater from a well at a rate that is no greater than the natural flow that would occur from the formation to a well under an ambient hydraulic gradient. Standard water supply well pumps are not capable of producing in-well pumping rates this low.

Changes in pH and Eh condition can result in a change in solubility for many metals (e.g. As, Cd, Co, Cr, Cu, Fe, Mn, Pb, Zn), and can lead to unwanted precipitation or sorption reactions that can alter dissolved phase concentrations and misrepresent (often negatively bias) the in-situ condition of the water. For example, exposing a groundwater sample to the atmosphere can result in a change from a reduced state to an oxidized state, causing many metals to precipitate out of solution and rapidly sorb onto solid particle surfaces. The precipitation of iron, widely prevalent in most geologic settings, is of particular concern since ferric (oxy)hydroxide acts as an important sorption site for many other metals (NGWA, 2011; McLean and Bledsoe, 1992; Puls and Powell, 1992). These reactions can rapidly scavenge metals out of solution. If the particles bearing sorbed metals are filtered from the sample before analysis, the resulting groundwater concentrations reported by the lab could be biased low.

It is important to recognize that the reactions that influence metals phase distribution in the water/solid environment can potentially occur over very short time frames (Langmuir, 1997; NGWA, 2011; Puls et al., 1990; Puls and Powell, 1992); as a result it is critical to recognize the importance of closely following the sequence of the steps outlined in this SOP.

Although some degree of change in pressure or exposure of the sample to the atmosphere is unavoidable, it is important to always take steps to minimize the effect of these changes on a sample. When sampling water supply wells, the primary techniques for controlling these concerns include:

- Whenever possible, try to collect the sample prior to any holding or pressure tanks present in the supply system.
- Always minimize the degree to which the sample is agitated or mixed during collection. This can include, for example, removing screens or aerators from the faucet used for sample collection.
- Never collect a metals sample from a portion of the water delivery system that has experienced extended exposure to the atmosphere (for example from a vented cistern).
- Always use a closed-atmosphere flow cell to measure the standard field parameters used to judge purge equilibration [temperature, pH, specific conductance (SC), dissolved oxygen (DO), and oxidation/reduction potential (ORP)].
- Depending on the redox and pH condition of the in-situ groundwater, turbidity measurements may also have to be taken in a closed-atmosphere environment (since transitioning a sample from a reduced condition to an oxidized condition can change the turbidity of the sample due to precipitation reactions or colloidal flocculation). See Section 6.3 and Figure 2 for more detail regarding field measurement of turbidity.
- Always collect samples into containers using a low-flow sampling rate (≤ 0.3 L/min) to minimize aeration of the sample. When sampling from a faucet or household tap, an additional flow valve can be used to control the sample discharge rate if necessary.
- If a metals sample needs to be filtered, always filter the water prior to contact with the atmosphere.⁶ See Section 6.3 and Figure 4 for more detail regarding sample filtration procedures.

⁶ Please note, this requirement is contrary to, and takes precedence over, instructions provided in the current version of the Manchester Environmental Laboratory Lab Users Manual.

- Preserve samples immediately upon collection to prevent ongoing sorption and precipitation reactions.

Control of sample temperature changes

In some cases, redox-driven precipitation reactions that can change dissolved metals concentrations are kinetically favored at higher temperatures. Therefore it is important to try to always keep groundwater samples at a temperature that is at or below the in situ condition.

Metals samples should always be collected from a cold water faucet/tap.

While in the field try to keep unfilled sample bottles in a cool place (e.g. shade, ice-filled cooler). Samples should be placed in an ice-filled cooler immediately upon collection.

Equipment Decontamination Procedures

In most cases unfiltered samples collected from water supply wells can be collected directly from a water system faucet or tap to the sample container, without the need for additional sample collection equipment that requires decontamination.

If any intermediary sampling apparatus is required (e.g. filters, couplers, tubing), the sample contact portions of that equipment must be either factory new or decontaminated prior to use. An equipment blank sample (using trace-metal-free DI water) should be collected through such equipment at the beginning of your project in order to quantify any positive material bias on the sample results.

Standard procedures for decontamination of sample-contact equipment for collection of metals samples includes the following steps:

1. tap/phosphate-free detergent brush wash
2. tap rinse
3. triple rinse with metals-free DI water
4. Foil wrap until use

If site-specific conditions indicate a high potential for cross contamination between sampling locations, a 10% nitric acid rinse should be inserted between steps 2 and 3.

Equipment rinsate blanks (using laboratory supplied, trace-metal free DI water) should be collected after cleaning to determine the adequacy of the decon procedures for preventing cross-contamination or material bias. Do not use DI water from the EAP Operations Center to prepare blank samples.

Field Measurements Associated with Groundwater Metals Samples

Measurement of Turbidity

- Careful monitoring of the groundwater turbidity condition is critical for obtaining representative metals samples from an aquifer (see Section 6.3). A decision tree outlining conditions, decision points, and methods for monitoring the groundwater turbidity condition is presented in Figure 2.
- Field staff should recognize that turbidity can be the final field parameter to equilibrate during well purging, following DO and ORP stabilization (Puls et al., 1990; Puls et al.,

1991; Puls et al., 1992). For the purpose of metals characterization, reaching a turbidity value of less than 10 NTU (Yeskis and Zavala, 2002) is the key decision point to proceed to sampling (assuming all other parameters have stabilized). Elevated turbidity is rarely expected to be a problem when collecting water samples from water supply wells.

- Turbidity can be measured once all other purge parameters have equilibrated. The flow rate discharging from the tap chosen for sampling should be lowered to ≤ 0.3 L/min for the turbidity measurement.
- If the equilibrated DO of the purge water from the well indicates a potentially anoxic groundwater condition (<1 mg/L), and the pH is >6 S.U., turbidity should be measured within a closed atmosphere to prevent bias introduced by precipitation reactions that may occur on contact of the water with air. If using separate flow cells for measurement of turbidity and other standard field parameters, place the turbidity flow cell upstream of other instruments (see for example Puls et al., 1991).

Measurement of dissolved oxygen (DO)

- In addition to serving as a standard field parameter for determining the adequacy of well purging prior to sample collection, dissolved oxygen measurements are used to support the geochemical interpretation of groundwater metals data. Accurate field measurements of DO condition should always be part of metals sample collection.
- Whenever end-of-purge measurements collected using a standard calibrated DO probe (e.g. the EAP groundwater team Hach Hydrolab Surveyor LDO probe) indicate an equilibrated DO concentration of ≤ 1.0 mg/L, standard EAP procedure is to collect a field spectrophotometer confirmation measurement using a Rhodazine D-based test kit prior to sample collection (CHEMtrics Kit K-7553; ASTM, 2014; Rounds et al., 2013). The sample should be collected from a flowing sample stream prior to contact with the atmosphere using a sample cone and self-filling vacuum sample vial, per manufacturer's instructions (Figure 3).

Measurement of Redox Potential

- The redox potential of the sample should also always be measured when collecting samples for metals analysis (this provides information useful for evaluating the expected oxidation state of dissolved metals, particularly if collected in tandem with pH condition).
- Due to its sensitivity to rapid change upon exposure of the sample to the atmosphere, redox potential must be measured in the field at the time of sample collection, prior to contact of the sample with air. Standard procedure for quantifying groundwater redox potential during EAP groundwater studies relies on the measurement of the oxidation/reduction potential (ORP) in a closed-atmosphere flow cell, using a calibrated ORP probe.

- Geochemical interpretation of groundwater metals data normally requires an estimate of the Eh (or pe) condition. ORP field measurements can be converted to Eh using:

$$Eh = ORP + E' \quad \text{Eq. 1}$$

where:

Eh = the oxidation-reduction potential of a solution relative to a standard hydrogen electrode (SHE)(mV)

ORP = Oxidation-reduction potential relative to a reference electrode (mV)

E' is the half cell potential of the specific metal electrode and reference solution your ORP probe is comprised of (mV):

- E' for ORP probes using a calomel (mercury chloride) reference electrode = 244 mV (at 25°C)
- E' for ORP probes using an Ag/AgCl reference electrode = 199 mV (at 25°C)

Eh can alternatively be reported as pe. At 25°C:

$$Eh (mV) = 59 pe \quad \text{Eq. 2}$$

where:

pe = measure of the electron activity of a solution ($-\log\{e^-\}$).

Field analysis of Rapidly Oxidized Metals

Due to their tendency to rapidly oxidize upon exposure to the atmosphere, analysis for ferrous iron (Fe^{2+}) and manganese should be conducted in the field, particularly in cases when the equilibrated pH of the groundwater sample stream is > 6.0 and the DO is < 1.0 mg/L.

Field spectrophotometer analysis is the standard EAP procedure for measuring groundwater ferrous iron (phenanthroline method; CHEMetrics Kit K-6203; APHA, 2005) and manganese (periodate method; CHEMetrics Kit K-6503; APHA, 1975) concentrations. These measurements should be conducted on a sample captured prior to contact with the atmosphere (the process of filtration may introduce oxygen into the sample, causing a conversion to ferric hydroxide precipitate).

Samples for analysis with a spectrophotometer should be collected directly from a flowing sample stream using a sampling cone and self-filling vacuum vial, per manufacturer's instructions (Figure 3). When conducting field analysis for Fe^{2+} or Mn, do not filter the water prior to analysis. The process of filtration can introduce oxygen into the sample, potentially leading to unwanted precipitation reactions.

Sample filtration

The technical objective of the project and the turbidity condition of the sample stream both play an important role in a) determining if metals samples require field filtration prior to laboratory analysis, and b) determining what filter size is appropriate if filtration is necessary. Figure 4 presents a decision tree outlining standard EAP guidance for groundwater metals-sample filtration procedures for monitoring wells.

The process of sample filtration has a variety of potential disadvantages (e.g. aeration of the sample leading to precipitation reactions, filter clogging, filter media bias), so samples should only be filtered if your project objectives require it, and/or all other efforts to control excess water turbidity (≥ 10 NTU) have been exhausted. For some projects, it may be best to collect both unfiltered and filtered samples, or to collect samples using different filter pore sizes, to determine the impact of filtration on the reported metals concentrations.

To minimize bias introduced by redox-driven precipitation reactions that can occur after contact of the sample with the atmosphere, groundwater samples collected for metals analysis should never be filtered in the laboratory. This process must be conducted at the time of sample collection, prior to contact of the sample with the atmosphere, and prior to contact of the sample with an acid preservative.

In some cases (e.g. silty/clayey aquifer matrix, low ionic strength waters), the natural turbidity of the groundwater produced by the well may necessitate filtration (see Figure 4). In such cases you should always collect both a filtered and unfiltered sample to allow evaluation of the impact of the filtration process on the reported concentration.

Studies focused on assessing metals (and other inorganic species) concentrations in groundwater for geochemical speciation modeling or charge balance analysis purposes normally require the collection of filtered samples. EAP standard procedure of using a 0.45 micron high capacity in-line filter for this purpose is based on recommendations provided by the National Ground Water Association (NGWA, 2011).

Samples intended to characterize truly dissolved concentrations of metals should be filtered with a 0.1 micron high capacity in-line filter (Puls et al., 1991; Puls and Powell, 1992).

Unfiltered samples are strongly preferred for studies focused on assessing metal contaminant mobility in an aquifer. However, in cases where the turbidity cannot be brought below 10 NTU during purging, filtration of the sample may be required as a method of last resort (see Figure 4). EAP standard procedure under this scenario is to filter the sample using a 10 micron filter (as well as collecting an unfiltered sample for comparison purposes). The use of a larger filter size in this case is intended to allow the collection of metals associated with colloidal-sized particles that may be mobile under ambient groundwater velocities and gradients (i.e. particulates suspended and transported in solution)(Puls and Powell, 1992; Yeskis and Zavala, 2002).

EAP staff are encouraged to consider the ultimate use of the data, and the characteristics of the aquifer of interest, to determine the need for a non-standard filter size. This may include initial testing using sequential filter sizes to determine the influence of filter size on the reported concentration.

Whenever filtering samples for metals analysis always collect a filter blank to determine if any positive bias is introduced into the sample results by the sample-contact filter media. Blanks should be collected through a new filter using trace-metal-grade deionized (DI) water supplied by the Manchester Environmental Laboratory (do not use the EAP Operations Center DI water).

Filtration of anoxic samples can result in oxidation and colloidal formation within the filter media, resulting in clogging. Standard EAP procedure to minimize this problem is to use high capacity filter cartridges whenever filtering metals samples.

Preferred filter media types for metals include polyethersulfone or polypropylene.

Never use vacuum filtration for metals samples.

Sample preservation

Groundwater metals samples should always be preserved immediately upon collection into the sample container.⁷ Standard procedure is to collect all groundwater metals samples directly into pre-preserved containers supplied by MEL.

⁷ Please note, this requirement is contrary to, and takes precedence over, instructions provided in the current version of the Manchester Environmental Laboratory Lab Users Manual (10th Edition; June 2016).

12.0 Appendix B: Example Field Forms

EAP has developed several spreadsheet templates and field forms to speed and where possible automate the tasks required to evaluate, install, and process groundwater sampling data. Examples of commonly used forms are included here. See EAP's Groundwater Assessment SharePoint site for up-to-date versions. These tools and forms can easily be modified to accommodate the needs of particular instruments or projects.

Well Reconnaissance Field Sheet

Date: _____ Time: _____

Field Crew: _____

Well ID: _____

Well Tag ID: _____

Well Owner Name: _____

Facility Name: _____

Current Phone Number: _____

Current Mailing Address: _____

Renter? Name: _____

Permission granted to locate well?

Permission granted to collect Water Level?

Permission granted to sample well for Water Quality?

Permission granted to tag well? Tagged?

Call ahead required before site visit?

Recon GPS Well Coordinates:

Recording Datum: NAD83HARN NAD83 NAD27

DDLAT : _____ DDLONG _____

Wellhead Photo #: _____

Comments: _____

Add sketch map of well location and sample faucet location on back

Water Level Data Field Sheet

Well Tag #: _____ Well Study Name: _____

DDLAT: _____ DDLONG _____ T: _____ R: _____ SEC: _____

Recording Datum: _____ NAD83HARN: _____ NAD83: _____

Well Owner: _____ Well Address _____

MP Height: _____ (ft) MP Date ____ / ____ / ____ Photo _____

MP Description: _____

Date	Time	Hold (ft)	Cut (ft)	Status	Mthd.	Accu.	Remark
/ /							
/ /							
/ /							
/ /							
/ /							
/ /							
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Date	Time	Hold (ft)	Cut (ft)	Status	Mthd.	Accu.	Remark
/ /							
/ /							
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/ /							

Status Codes																
D	E	F	G	H	I	J	N	O	P	R	S	T	V	W	X	Z
Dry	Recently Flowing	Flowing	Nearby Flowing	Nearby Recently Flowing	Injector	Site Monitor	Discontinued measuring	Obstruction	Pumping	Recently Pumped	Nearby Pumping	Nearby Recently Pumping	Foreign Matter on Water	Well Destroyed	Affected by Surface Water Site	Other

Method of Measurement Codes													
A	B	C	E	G	H	L	M	N	R	S	T	V	Z
Airline	Analog	Cal. Airline	Estimate	Pressure Gage	Cal. Pressure Gage	Geophys Log	Manometer	Non-Recording Gage	Reported	Steel Tape	Electric Tape	Calibrated E-tape	Other

Measurement Accuracy Codes		
0	1	2
±1 FT	±0.1 FT	±0.01 FT

Well Name: _____

Well Tag ID: _____

Groundwater Quality Sampling Field Sheet

Well Tag ID: _____ Well Name: _____

Well Owner: _____

Well Address: _____

Date: _____ / ____ / ____ Sample Time: _____

Lab Sample #: _____ Crew: _____

Pumping Rate: _____ Meter: _____

Duplicate: Equipment Blank: Reference:

Duplicate Lab Sample #: _____ Equipment Blank Lab #: _____

Purge Parameters:

Time	pH	Temp. (°C)	Cond. (µS/cm)	DO (mg/L)	Water level (feet)

Groundwater Quality Sampling Field Sheet (cont.)

Well Tag ID: _____ Well Name: _____

Purge Parameters (cont.):

Time	pH	Temp (°C)	Cond (µS/cm)	DO (mg/L)

Photometric O₂ : **Kit:** _____ **Conc.** _____

Photometric O₂ : **Kit:** _____ **Conc.** _____

Colormetric O₂ : _____

Field Alkalinity : **Kit:** _____ **Conc.** _____

ORP: _____

Other: _____

Comments :



Sample Container Request Form

Please FAX to: (360) 871-8850 Contact: Leon Weiks

Phone: (360) 871-8825 Email: lwei461@ecy.wa.gov and cc: nros461@ecy.wa.gov

Please allow about 2 weeks for typical requests; longer for special requests

Requestor: _____

Project Name: _____

Phone: _____

Today's Date: _____

Location for Delivery: _____

Date Needed by: _____

Index #	Description	Qty.
1	1 gallon jar WM, CLR	
2	1/2 gallon jar WM, CLR	
3	1 liter jar WM, CLR (Organics) for HClD only, no preservative	
4	1 liter jar NM, CLR w/ 1:1 HCl 15mL dropper bottle included (Oil & Grease)	
7	16 oz short jar WM, CLR	
5	8 oz short jar WM, CLR	
8	4 oz short jar WM, CLR	
34	2 oz short jar WM, CLR	
13	2 oz short jar WM, CLR, w/septum	
11	40mL vial AMB w/septum <input type="checkbox"/> pre-preserved with HCl <input type="checkbox"/> ascorbic acid for chlorinated VOA samples <input type="checkbox"/> dropper bottle of HCl	
14	20mL vial w/ acetic acid (Carbamates)	
39	1 liter glass NM, AMB w/ 1:1 HCl (TPH-D)	
15	1 liter glass NM, AMB (All other Organics)	
16	500mL HDPE bottle w/ 1:1 nitric acid (Metals including standard level mercury)	
17	1 gallon cubitainer (BOD)	
19	125mL Nalgene WM, CLR w/1:1 sulfuric acid (Nutrients or COD)	
20	125mL Nalgene WM, AMB (filters and syringe also required for orthophosphate)	

Index #	Description	Qty.
22	500mL poly WM, CLR (General Chem.)	
23	1000mL poly WM, CLR (TSS)	
24	1000mL poly WM, AMB (Chlorophyll)	
25	250mL poly NM, AMB (Cyanide, Fluoride)	
26	125mL poly WM, CLR w/ 1:1 hydrochloric acid (TOC/DOC or TP) <input type="checkbox"/> Filters and syringe for DOC	
27	250mL poly WM, CLR (Fecal Coli)	
28	500mL poly WM, CLR (Multiple Micro Tests)	
29	250mL poly WM, CLR w/thiosulfate (Fecal Coliform - Chlorinated)	
30	500mL poly WM, CLR w/thiosulfate (Multiple Micro Tests - Chlorinated)	
31	8oz plastic jar (Grain size only)	
32	1 liter jar WM, CLR w/sulfuric acid (Phenolics)	
33	4oz sterile specimen cup (Micro - sediment)	
35	Soil VOA/BTEX Airtight Sampling Capsules (3 per sample)	
36	Soil VOA/BTEX Sampling Handle (1 per sampling event - please return with samples)	
37	500mL Teflon NM, CLR (low level mercury ONLY) <i>Preserved at the laboratory. Field blank and Gloves will also be provided, per EPA Method 1669.</i>	
38	Nalgene Metals Filters 0.45um	

Manchester Lab Users Manual, Tenth Edition Page 22 of 127 EFFECTIVE DATE:

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Pre-Sampling Notification Form

Fax to Manchester Laboratory: (360) 871-8850
 Or email to Nancy Rosenbower: nros461@ecy.wa.gov and cc: Leon Weiks: lwei461@ecy.wa.gov

Project Name: _____ SIC: _____ Enforcement
 Requested by: _____ Sampling Date(s): _____ Monitoring
 Program: _____ Date to Lab: _____ Emergency
 Phone No.: _____ Sample Pickup Location: _____ Class II
 Date results needed by: _____ EIM Study ID (if available) _____ Preliminary Invest
 QAPP: Yes No Special turnaround

General Chemistry	W	S	O	Microbiology	W	S	O	Organic Chemistry	W	S	O
Alkalinity				Fecal Coliforms <input type="checkbox"/> MF <input type="checkbox"/> MPN				Base/Neutral/Acids (BNA)			
Conductivity				E. Coli MF				Polynuclear Aromatics (PAH)			
Hardness				E. Coli MPN							
pH								Volatile Organic Analysis (VOA)			
Turbidity								BTEX			
<input type="checkbox"/> Fluoride <input type="checkbox"/> Chloride <input type="checkbox"/> Sulfate								Pest/PCBs (Organochlorine)			
Cyanide <input type="checkbox"/> Total <input type="checkbox"/> Dissociable				Metals	W _T	W _D	S	O	Pesticides only (Organochlorine)		
Total Solids				Priority Pollutant Metals (13 elements)					PCBs only		
Total Nonvolatile Solids (TNVS)				TCLP metals					OP - Pests (Organophosphorous)		
Total Suspended Solids (TSS)				Hardness					Herbicides (Chlorophenoxy)		
Total Nonvolatile Suspended Solids (TNVSS)									Nitrogen Pesticides		
Total Dissolved Solids (TDS)				Mercury (Hg) <input type="checkbox"/> Regular <input type="checkbox"/> Low Level					Organochlorine Pesticides by GCMS 8270		
Chlorophyll <input type="checkbox"/> Filtered in field <input type="checkbox"/> Filtered at lab				Other: List individual elements below:					PBDEs		
% Solids									Hydrocarbon ID (match to source)		
% Volatile Solids (TVS)									TPH-ID (gas/diesel/oil)		
Total Organic Carbon									TPH-D _x		
Dissolved Organic Carbon									TPH-G _x		
Biochemical Oxygen Demand (BOD) 5 day											
BOD - Inhibited											
BOD - Ultimate											
Ammonia											
Nitrate-Nitrite											
Orthophosphate											
Total Phosphorous											
<input type="checkbox"/> TPN <input type="checkbox"/> TKN											

Comments: _____ Enter the number of samples in the appropriate box(es) above W = water S = soil/sediment O = other (please specify)
 W_T = water total W_D = water dissolved

Matrix Codes	Source Codes	Code Description
Code Description	Code Description	50 Bore Hole Material
10 Water	00 Unspecified Source	60 Air (General)
11 Field Filtered Water	01 Unknown Liquid Media (Drum/Tank)	61 Ambient Air
12 Filter from Water	02 Unknown Liquid Media (Spill Area)	62 Source or Effluent Air
13 Water to be filtered upon receipt at lab	03 Unknown Liquid Media (Waste Pond)	63 Industrial or Workroom Air
40 Soil/Sediment	10 Water (General)	70 Tissue (General)
41 Frozen Soil/Sediment (PSEP)	12 Ambient Stream/River	71 Fish Tissue
45 Semi-Solid/Sludge	13 Lake Reservoir	72 Shellfish Tissue
70 Tissue	14 Estuary/Ocean	73 Bird Tissue
80 Oil/Solvent	15 Spring/Seepage	74 Mammal Tissue
90 Waste	16 Rain	75 Macroinvertebrate
00 Other (Use only if no other apply)	17 Surface Runoff/Pond (general)	76 Algae
	18 Irrigation Canal/Return Flow	77 Periphyton
	20 Well (General)	78 Plant/Vegetation
	21 Well (Industrial/Agricultural)	80 Oil/Solvent (General)
	22 Well (Drinking Water Supply)	81 Oil (Transformer/Capacitor)
	23 Well (Test/Observation)	82 Oil/Solvent (Drum Tank)
	24 Drinking Water Intake	83 Oil/Solvent (Spill Area)
	25 Drinking Water (At Tap)	84 Oil/Solvent (Waste/Pond)
	30 Effluent Wastewater (General)	90 Commercial Product Formulation
	31 Municipal Effluent	95 Well Drill Water
	32 Municipal Inplant Waters	96 Well Drill Mud
	33 Industrial Surface Runoff/Leachate	97 Well Sealing Material
	34 Industrial Effluent	98 Gravel Pack Material
	35 Industrial Inplant Waters	
	36 Industrial Surface Runoff/Pond	
	37 Industrial Waste Pond	
	38 Landfill Runoff/Pond/Leachate	
	40 Sediment (General)	
	42 Bottom Sediment or Deposit	
	44 Sludge (General)	
	45 Sludge (WastePond)	
	46 Sludge (Drum/Tank)	
	48 Soil (General)	
	49 Soil (Spill/Contaminated Area)	