GROUNDWATER WELL SAMPLING

CONTENTS

CONTENTS (cont)

* These sections affected by Revision 0.0.

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1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) provides general information on sampling groundwater wells and ensures that the sample is representative of the particular groundwater zone being sampled. The growing concern over the past several years with respect to low levels of volatile organic compounds (VOCs) in water supplies has led to the development of highly sophisticated analytical methods that can provide detection limits at part per trillion levels. While the laboratory methods are extremely sensitive, well controlled and quality assured, they cannot compensate for a poorly collected sample. The collection of a sample should be as sensitive, highly developed and quality assured as the analytical procedures.

The procedures are designed for sampling the most common types of groundwater contaminants (e.g., volatile and semivolatile organic compounds, pesticides, herbicides, polychlorinated biphenyls (PCBs), metals, and biological parameters).

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, or equipment limitations and limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute United States Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

In order to obtain a representative groundwater sample for chemical analysis (es), it is important to remove stagnant water from the well casing and the water immediately adjacent to the well before collection of the sample. This may be achieved with one of a number of sampling devices. The most common of these devices are the bailer, submersible pump, non-contact gas bladder pump, inertia pump and suction pump. At a minimum, three well volumes should be purged, if possible. Equipment must be decontaminated prior to use and between wells. Once purging is completed and the proper sample containers have been prepared, sampling may proceed. Samples should be collected from the depth interval where contaminants are expected but need not be collected with the same device used for well purging. However, some sampling methods will affect sample integrity and care should be taken when choosing the sampling device. If possible, sampling should occur progressively from the least to the most contaminated well.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The sample analysis determines the type of bottle, preservative, holding time, and filtering requirements. Samples should be collected directly from the sampling device into appropriate sample containers. Check that a Teflon liner is present in the cap of the sample container, if required. Attach a sample identification label. Complete a field data sheet, a chain of custody form, and record all pertinent data in the site logbook.

Samples should be placed in a cooler and maintained at 4°C and ideally should be shipped within 24 hours of sample collection. If large numbers of samples are being collected, shipments may occur on a regular basis after consultation with the analytical laboratory. In all cases, samples should be shipped well before the holding time expires.

Due to the trace levels at which volatile organics are detectable, cross contamination and introduction of contaminants must be avoided. Treatment of the sample with sodium thiosulfate preservative is required only if there is residual chlorine in the water that could cause free radical chlorination and change the identity of the original contaminants. This preservative should not be used if there is no chlorine in the water. Quality assurance/quality control (QA/QC) samples are incorporated into the shipment package to provide a check against cross contamination. Samples for the analysis of volatiles, semivolatiles, pesticides, herbicides and PCBs do not normally require preservation. Groundwater samples for metal analyses should be adjusted with nitric acid to a pH of less than 2. Refer to SERAS SOP# 2003, *Sample Storage, Preservation and Handling*.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

The primary goal of well sampling is to obtain a representative sample of the groundwater. Analysis can be compromised by: (1) taking an unrepresentative sample, or (2) by incorrect handling of the sample. To avoid introducing foreign contaminants into a sample, strict sampling procedures should be followed.

4.1 Well Purging

In a non-pumping well, there will be little or no vertical mixing of the water and stratification will occur. The well water above the screened section will remain isolated and may lack the contaminants representative of the ground water. To avoid collecting unrepresentative water, all monitor wells should be purged of three to five volumes of water prior to sampling. When purging with a submersible pump, the pump intake may be set within the screened interval if evaluation of the well construction, pumping rate, and aquifer characteristics ensures that formation material will not be drawn into the well. Otherwise, the pump should be set just above the top of the screen. Bailers, peristaltic pumps, and miniature submersible pumps can also be used for purging, depending on well depth, groundwater level, and well yield. During purging, the temperature, pH, turbidity, and specific conductivity of the groundwater should be monitored at regular intervals and recorded in the site field logbook. The frequency of monitoring will depend on the purge rate but measurements are generally collected every 5 to 15 minutes. Purging is generally considered complete when these parameters stabilize. Depending on the formation characteristics and the degree of previous development, turbidity may also be a problem. Purging may have to be continued until the turbidity reaches an acceptable level, generally less than 50 nephelometric turbidity units (NTUs).

4.2 Sampling Equipment

The tendency of organics to adsorb or desorb onto or out of many materials makes the selection of sampling materials critical for trace organics analyses. Construction materials for samplers and purging equipment (bladders, pump, bailers, and tubing) should be limited to stainless steel, polytetrafluoroethylene (Teflon), and glass in areas where concentrations are expected to be at or near the detection limit. The use of plastics, such as polyvinyl chloride (PVC) or polyethylene, should be avoided when analyzing for organics. However, PVC may be used for evacuation equipment as it will not normally come into contact with the sample. Rinsate blanks may be required to check the effectiveness of decontamination procedures when using non-dedicated equipment. In highly contaminated wells, disposable equipment (i.e., polypropylene bailers) may be appropriate to avoid cross-contamination.

4.3 Light Non-Aqueous Phase Liquids (LNAPL)

The presence of floating organic layers in a well may require reevaluation of the sampling plan. There is generally little point in sampling the groundwater directly beneath an organic layer and the presence of both phases complicates the sampling procedure. The organic phase is usually sampled by skimming the top of the liquid column in the well with a bailer or small pump, depending on the viscosity of the liquid.

5.0 EQUIPMENT/APPARATUS

5.1 Bailers

Advantages

- No power source needed
- Portable
- Inexpensive, so it can be dedicated and hung in a well, thereby reducing the chances of cross contamination
- Minimal outgassing of volatile organics while sample is in bailer
- Readily available
- Removes stagnant water first
- Rapid, simple method for removing small volumes of purge water

Disadvantages

- Time-consuming to flush a large well
- Transfer of sample may cause aeration
- The valve at the bottom of the bailer often leaks thus losing some of the sample

5.2 Submersible Pumps

Advantages

- Smaller diameter pumps are usually portable and can be transported from well to well
- Relatively high pumping rates are possible
- Generally very reliable and does not require priming

Disadvantages

- Potential for effects on analysis of trace organics

- Deep wells may require pumps that are heavy and cumbersome to use
- Expensive
- Power source needed
- Sediment in water may clog intake screen or impellers
- Must be decontaminated between wells

5.3 Non-Contact Gas Bladder Pumps

Advantages

- Maintains integrity of sample
- Easy to use
- Can sample from discrete locations within the monitor well

Disadvantages

- Difficulty in cleaning, although dedicated tubing and bladder may be used
- Only useful to a depth of about 100 feet
- Requires a supply of gas or an air compressor for operation, gas bottles or compressors are often difficult to obtain and are cumbersome
- Relatively low pumping rates

5.4 Suction Pumps (including peristaltic pumps)

Advantages

- Portable, inexpensive, and readily available
- Operates from either 110 VAC or 12 VDC
- Variable flow rate, easily controlled

Disadvantages

- Restricted to wells where water levels are within 20 to 25 feet of the ground surface
- Vacuum can cause loss of dissolved gasses and volatile organics
- Some types must be primed and vacuum is often difficult to maintain during initial stages of pumping
- Generally suitable for only small diameter shallow wells; maximum flow rate of some types (e.g. peristaltic pumps) limited to approximately one gallon per minute (gpm)

5.5 Inertia Pumps

Advantages

- Portable, inexpensive, and readily available
- Offers a rapid method for purging relatively shallow wells

Disadvantages

- Restricted to areas with water levels within 70 feet of the ground surface
- May be time consuming to purge wells with these manual pumps
- Labor intensive
- WaTerra pumps (for example) are only effective in 2-inch diameter wells

5.6 Field Equipment Checklist

5.6.1 General

- Water level indicator
- electric sounder
- steel tape
- transducer
- reflection sounder
- airline
- Depth sounder
- Appropriate keys for well cap locks
- Steel brush
- HNU or OVA (whichever is most appropriate)
- Logbook (bound)
- Calculator
- Field data sheets and samples labels
- Chain of custody records and seals
- Sample containers
- Engineer's rule
- Sharp knife (locking blade)
- Tool box (to include at least: screwdrivers, pliers, hacksaw, hammer, flashlight
- Leather work gloves
- Surgical gloves (for sampling)
- Appropriate Health & Safety gear
- Five-gallon pail
- Plastic sheeting
- Shipping containers
- Packing materials
- Bolt cutters
- Ziploc plastic bags
- Containers for evacuation liquids
- Decontamination solutions
- Tap water
- Non phosphate soap
- Pails or tubs

- Aluminum foil
- Garden sprayer
- Preservatives
- Distilled or deionized water
- Fire extinguisher (if using a generator as a power source)
- In-line filters, 0.45 microns (µm)
- pH meter, temperature meter specific conductivity meter, turbidity meter
- Indelible markers
- Duct tape
- Paper towel
- First aid kit

5.6.2 Bailers

- Clean, decontaminated bailers of appropriate size and construction material
- Unused nylon line, enough to dedicate to each well
- Teflon coated bailer wire
- Sharp knife
- Aluminum foil (to wrap clean bailers)
- Five gallon bucket

5.6.3 Submersible Pumps

- Pump(s)
- Generator (120, or 240 volts) or 12 volt power source, depending on pump
- Extension cords
- PVC coil tubing, diameter suitable for flow requirements
- Hose clamps
- Safety cable
- Tool box
- pipe wrenches
- wire strippers
- electrical tape
- heat shrink wrap or tubing
- hose connectors
- Teflon tape
- Winch, pulley or hoist for large submersible pumps (4-inch diameter or greater)
- Gasoline container, gasoline
- Flow meter and gate valve
- Plumbing components (nipples, reducers, plastic pipe connectors)
- Control box (if necessary)

5.6.4 Non-Contact Gas Bladder Pumps

- Non-contact gas bladder pump
- Compressor or nitrogen gas tank
- Batteries and charger
- Teflon tubing - enough to dedicate to each well
- Swagelock fitting
- Toolbox supplements - same as submersible pump
- Control box (if necessary)

5.6.5 Suction Pumps

- Pump
- Black PVC coil tubing - enough to dedicate to each well
- Gasoline - if required
- Toolbox
- Plumbing fittings
- Flow meter with gate valve

5.6.6 Inertia Pumps

- Pump assembly (WaTerra pump, piston pump)
- Five gallon bucket

5.6.7 Peristaltic Pumps

- Small diameter "Geotubing"
- Roll of Masterflex tubing
- 110 VAC generator or 12 VDC power source
- Knife, screwdriver

6.0 REAGENTS

Reagents may be used for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed and are summarized in Environmental Response Team/Scientific, Engineering, Response and Analytical Services (ERT/SERAS) SOP #2003, *Sample Storage, Preservation, and Handling*. Decontamination solutions are specified in ERT/SERAS SOP #2006, *Sampling Equipment Decontamination*.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed (i.e., diameter and depth of wells to be sampled).

2. Obtain necessary sampling and monitoring equipment, appropriate to the type of contaminant being investigated. For collection of volatile organic samples, refer to the work plan to ensure that sufficient 40 milliliter (mL) glass sample vials with Teflon lined septa are available. Check availability of preservatives, packing material, sample labels, and coolers. Trip blanks are incorporated into the shipment package to provide a check against cross contamination.

3. Decontaminate or pre-clean equipment and ensure that it is in working order.

4. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.

5. Identify all sampling locations.

7.2 Field Preparation

1. Start at the least contaminated well, if known.

2. Lay plastic sheeting around the well to minimize likelihood of equipment contamination from the soil adjacent to the well.

3. Remove locking well cap, note location, time of day, and date in field notebook or appropriate log form.

4. Remove well casing cap.

5. Immediately screen headspace of well with an appropriate air monitoring instrument to determine the presence of volatile organic compounds and record flame ionization detector (FID) or photoionization detector (PID) readings in site logbook.

6. Measure distance from water surface to a reference measuring point and record in site logbook. A reference point may be the top of outer protective casing, the top of riser pipe, the ground surface, or the top of a concrete pad. If floating organics are present, the water level and depth to floating product can be measured with an oil/water interface probe. However, the presence of floating organics will indicate the need to reevaluate the validity of groundwater sampling.

7. Measure total depth of well and record in site logbook or on field data sheet.

8. Calculate the volume of water in the well and the volume to be purged using the calculations in Section 8.0.

9. Select the appropriate purging and sampling equipment.

7.3 Purging

The amount of purging required before sampling depends on the intent of the monitoring program as well as the hydrogeologic conditions. General assessment of groundwater quality may require long pumping periods to obtain a sample representative of a large volume of the aquifer. The purge volume is determined prior to sampling and the sample is collected after a known volume of the water is pumped from the well, or the well can be pumped until parameters such as temperature, specific conductivity, pH, or turbidity have stabilized. Groundwater quality in the well is considered stabilized after three sets of consecutive readings indicate no change. The time between readings is based on the purge rate and cumulative volume but generally is between 5 to 15 minutes.

Sampling to define a contaminant plume requires a representative sample from a small volume of the aquifer. This requires that the well be purged enough to remove the stagnant water but not enough to induce flow from other areas. Generally, three well volumes are considered sufficient. The total volume purged, purge method, purge rate, and the start and end times of purging are recorded in the field log book.

The following purging devices are most commonly used. Other evacuation devices are available, but have been omitted in this discussion due to their limited use.

7.3.1 Bailers

Bailers are the simplest purging device and generally consist of a rigid length of tube, usually with a ball check-valve at the bottom. A nylon line is used to tie and lower the bailer into the well and retrieve a volume of water. The three most common types of bailers are made of PVC, Teflon, and stainless steel. Purging with bailers is best suited to shallow or small diameter wells. For deep, larger diameter wells that require removal of large volumes of water, pumps may be more appropriate.

Equipment needed will, include a clean decontaminated bailer, Teflon or nylon line, a sharp knife, and plastic sheeting.

1. Determine the volume of water to be purged as described in Section 8.0, *Calculations*.

2. Lay plastic sheeting around the well to prevent contamination of the bailer line with soil or other foreign materials. Do not let the bailer line touch the ground.

3. Attach the line to the bailer and lower into the well until the bailer is completely submerged.

4. Pull bailer out ensuring that the line either falls onto a clean area of plastic sheeting or never touches the ground.

5. Empty the bailer into a container of known volume to determine when the purge volume is reached.

6. Dispose of purge waters as specified in the work plan.

7.3.2 Submersible Pumps

The use of submersible pumps for purging is permissible provided they are constructed of no contaminating materials. The chief drawback, however, is the difficulty in avoiding cross-contamination between wells. Some pumps can be easily disassembled for cleaning, but field decontamination may be difficult and require solvents that can affect sample analysis. The use of submersible pumps in multiple well-sampling programs, therefore, should be carefully considered against other sampling mechanisms (bailers, bladder pumps). In most cases, a sample can be collected by bailer after purging with a submersible pump; however, submersible pumps may be the only practical sampling device for extremely deep wells (greater than 300 feet of hydraulic head). Under those conditions, dedicated pump systems should be considered to eliminate the potential for cross-contamination of well samples.

Submersible pumps generally use either electric or compressed gas for power. Electric powered pumps can run off a 12 volt direct current (DC) rechargeable battery, or a 110 or 220 volt alternating current (AC) power supply. Gasoline used to power electrical generators is a potential source of contamination and should be kept well away from purging and sampling equipment. Those units powered by compressed air normally use a small electric or gas-powered air compressor. They may also use compressed gas (i.e., nitrogen) from bottles. Pumps are available for monitor wells of various depths and diameters.

The following steps describe the use of submersible pumps in purging a well:

1. Determine the volume of water to be purged as described in Section 8.0, *Calculations* .

2. Lay plastic sheeting around the well to prevent contamination of pumps, hoses or lines with soil or other foreign materials.

3. Assemble pump, hoses and safety cable, and lower the pump into the well. Make sure the pump is deep enough so as not to dewater the pump.

4. Attach flow meter to the outlet hose to measure the volume of water purged or measure with a container of known volume.

5. Use a ground fault circuit interrupter (GFCI) or ground the generator to avoid possible electric shock.

6. Attach power supply, and purge the well until the specified volume of water has been removed (or until field parameters, such as temperature, pH, conductivity, etc, have stabilized). Do not allow the pump to run dry. If the pumping rate exceeds the well recharge rate, reduce the pumping rate.

7. Collect and dispose of purge waters as specified in the work plan.

7.3.3 Non-Contact Gas Bladder Pumps

Pumps in this category may be dedicated to a well and include stainless steel and Teflon Middleburg-squeeze bladder pumps such as IEA, TIMCO, Well Wizard or Geolog.

1. Assemble Teflon tubing, pump and charged control box.

2. Procedure for purging with a bladder pump is the same as for a submersible pump (Section 7.3.2).

3. Adjust flow rate to prevent violent movement of the hose as water is drawn in.

7.3.4 Suction Pumps

Suction pumps include centrifugal, peristaltic and diaphragm. Diaphragm pumps can be used for relatively rapid purging and can be adjusted to a slower rate for sampling. The peristaltic pump is a low volume pump that uses rollers to squeeze the flexible tubing thereby creating suction. The tubing can be dedicated to a well to prevent cross-contamination. Peristaltic pumps, however, require a power source.

1. Assemble the pump, tubing, and power source if necessary.

2. Procedure for purging with a suction pump is exactly the same as for a submersible pump (Section 7.3.2).

7.3.5 Inertia Pumps

Inertia pumps such as the WaTerra pump and piston pump, are manually operated. These pumps are most appropriate to use when wells are too deep to bail by hand, too shallow or too small in diameter to warrant the use of a submersible pump. The pumps are made of plastic and may either be decontaminated or discarded after use.

1. Determine the volume of water to be purged as described in Section 8.0, *Calculations.*

2. Assemble pump and lower to the appropriate depth in the well.

3. Begin pumping manually, discharging water into a five-gallon bucket (or other graduated vessel). Purge until a specified volume of water has been evacuated (or until field parameters such as temperature, pH, and conductivity, have stabilized).

4. Collect and dispose of purge waters as specified in the work plan.

7.4 Sampling

Before choosing a sampling device, the advantages or disadvantages of any one device, as outlined in Section 5, should be reviewed. It may be appropriate to use a different device to sample than that which was used to purge. The most common example of this is the use of a submersible pump to purge and a bailer to sample. Samples for volatile organics are collected first when sampling for more than one set of parameters, followed in order by samples for semivolatile organic and inorganic analyses.

7.4.1 Bailers

The positive-displacement sampling bailer is perhaps the most appropriate for collection of water samples for volatile analysis. Other bailer types (messenger, bottom fill, etc.) are less desirable, but may be mandated by well conditions and desired sample depth. A sample is obtained with a bailer using the following steps:

1. Surround the monitor well with clean plastic sheeting.
2. Attach a line to a clean decontaminated bailer. Do not let the line touch the ground.
3. Lower the bailer slowly into the well. Stop lowering when adjacent to the screen or at the desired sample depth
4. Allow bailer to fill and then slowly retrieve the bailer from the well.
5. Remove the cap from the sample container and place it on the plastic sheet or in a location where it will not become contaminated. For VOC sampling precautions, see Section 7.6.
6. Slowly pour the sample from the bailer into the sample container. Any necessary preservative should be added to the sample container before sampling.
7. Repeat steps 3, 4, and 6 as necessary to fill the sample container(s).
8. Cap the sample container tightly and place the prelabeled sample container in a carrier.
9. Replace the well cap.
10. Log the collection time, sampling method, and analyses required for all samples in the site logbook and on field data sheets.
11. Package samples and complete necessary paperwork.

7.4.2 Submersible Pumps

Submersible pumps are not recommended for sampling but may be used in some situations. The generator and fuel (if needed) used to operate a submersible pump can be a source of contamination and should be kept separate from the sampling containers during transport and downwind during sampling.

1. Allow the monitor well to recharge after purging, keeping the pump just above the screened section.

2. Attach a clean gate valve to the discharge hose (if not already fitted), and reduce the flow of water to a manageable rate.

3. Assemble the appropriate bottles.

4. If a gate valve is not available, run the water down the side of a clean jar and fill the sample bottles from the jar.

5. Cap the sample container tightly and place the prelabeled sample container in a carrier.

6. Replace the well cap.

7. Log all samples in the site logbook and on the field data sheets and label all of the samples.

8. Package samples and complete the necessary paperwork.

9. Transport sample(s) to the decontamination zone for preparation for transport to the analytical laboratory.

10. Upon sampling completion, remove pump and assembly and fully decontaminate the equipment prior to setting it into the next sample well. When possible, dedicate the pump tubing to the well.

7.4.3 Non-Contact Gas Bladder Pumps

Non-contact gas positive displacement bladder pumps are often used when dedicated pumps are required. These pumps are also suitable for shallow (less than 100 feet) wells. They are somewhat difficult to clean, but may be used with dedicated sample tubing to avoid cleaning. These pumps require a power supply and a compressed gas supply (or compressor). They may be operated at variable flow and pressure rates making them ideal for both purging and sampling. Barcelona et al. (1984) and Nielsen and Yeates (1985) report that the non-contact gas positive displacement pumps cause the least amount of alteration in sample integrity as compared to other sample retrieval methods.

1. Allow the well to recharge after purging.

2. Assemble the appropriate bottles.

3. Turn the pump on, increase the cycle time and reduce the pressure to the minimum that will allow the sample to come to the surface.

4. Non-filtered samples shall be collected directly from the outlet tubing into the sample bottle.

5. For filtered samples, connect the pump outlet tubing directly to the filter unit. The pump pressure should be minimized so that the pressure build up on the filter does not blow out the pump bladder or displace the filter. For the Geotech barrel filter, no actual connections are necessary.

6. Cap the sample container tightly and place the prelabeled sample container in a carrier.

7. Replace the well cap.

8. Log all samples in the site logbook and on the field data sheets, and label all samples.

9. Package samples and complete the necessary paperwork.

10. Transport sample(s) to the decontamination zone for preparation for transport to the analytical laboratory.

11. On completion, remove the tubing from the well and either replace the Teflon tubing and bladder with new dedicated tubing and bladder or rigorously decontaminate the existing materials.

7.4.4 Suction Pumps

Suction pumps are not recommended for sampling because it is operated by a vacuum and could remove volatile organics from the sample.

7.4.5 Inertia Pumps

Inertia pumps may be used to collect samples. It is more common, however, to purge with these pumps and sample with a bailer (Section 7.4.1).

1. Following well evacuation, allow the well to recharge.

2. Assemble the appropriate bottles.

3. Because these pumps are manually operated, the flow rate may be regulated by

the sampler. The sample may be discharged from the pump outlet directly into the sample container.

4. Cap the sample container tightly and place the prelabeled sample container in a carrier.

5. Replace the well cap.

6. Log all samples in the site logbook and on the field data sheets and label all samples.

7. Package samples and complete necessary paperwork.

8. Upon completion, remove pump and decontaminate or discard, as appropriate.

7.5 Filtering

Samples collected for dissolved metals analysis may require filtration. The filter must be changed or decontaminated between uses. Several types of filters are available. A barrel filter such as the "Geotech" works with a pneumatic (e.g. bicycle) pump, used to build up positive pressure in the chamber containing the sample, which is then forced through the filter paper (minimum size 0.45 µm) into a jar placed underneath. The barrel itself is filled manually from the bailer or directly via the hose of the sampling pump. The pressure must be maintained up to 30 pounds/square inch (lbs/in^2) by periodic pumping.

A vacuum type filter involves two chambers; the upper chamber contains the sample and a filter (minimum size 0.45 µm) divides the chambers. Using a hand pump or a Gillian type pump, air is withdrawn from the lower chamber, creating a vacuum and thus causing the sample to move through the filter into the lower chamber where it is drained into a sample jar. Repeated pumping may be required to drain the entire sample into the lower chamber. If preservation of the sample is necessary, this should be done after filtering.

An in-line filter may be used with a peristaltic pump to transfer the sample from the original sample jar, through the filter, and into a new sample jar. In-line filters are used specifically for the preparation of groundwater samples for dissolved metals analysis, and for filtering large volumes of turbid groundwater. Groundwater samples collected for VOCs are generally not filtered. The filtering of groundwater is performed primarily to allow for the collection of silty or particulate-laden samples that would otherwise interfere with the laboratory analysis. The filters used in groundwater sampling are either cartridge type filters inserted into a reusable housing, or are self-contained and disposable. Disposable filters are preferred and often used to reduce cross-contamination of groundwater samples. Disposable filter chambers are usually constructed of polypropylene material, with an inert filtering material within the housing. Both reusable and disposable filters have barb or national pipe thread (NPT) fittings on the inlet and outlet sides of the housing to connect to ⅜" or ⅝" tubing.

7.6 Special Considerations for VOC Sampling

The proper collection of a sample for VOC analysis requires minimal disturbance of the sample to limit volatilization. Sample retrieval systems suitable for collection of volatile organic samples are: positive displacement bladder pumps, gear driven submersible pumps, syringe samplers and bailers (Barcelona et al, 1984; Nielsen and Yeates, 1985). Field conditions and other constraints will limit the choice of appropriate systems. The concern must be to collect a valid sample that has been subjected to the least amount of turbulence possible.

The following procedures should be used:

1. Open the vial, set cap in a clean place, and collect the sample. When collecting duplicates, collect both samples at the same time.

2. Fill the vial to just overflowing. Do not rinse the vial, or let it excessively overflow. There should be a convex meniscus on the top of the vial.

3. Check that the cap has not been contaminated (splashed) and carefully cap the vial. Place the cap directly over the top and screw down firmly. Do not overtighten and break the cap.

4. Invert the vial and tap gently. Observe vial for at least ten (10) seconds. If an air bubble appears, discard the sample and resample. It is imperative that no air is trapped in the sample vial.

5. The holding time for samples to be analyzed for VOCs is seven days. Samples should be shipped or delivered to the laboratory in as short a time as practical in order to arrive before the holding time has expired. Ensure that the samples are stored at 4°C during transport but do not allow them to freeze. The most readily available method of cooling is to use ice packed in double-sealed plastic bags (Ziploc® baggies).

8.0 CALCULATIONS

If it is necessary to calculate the volume of the well, use the following equation:

Well Volume (gallons) = $\pi r^2 hk$

where:

π = 3.14
r = radius of monitor well (feet)
h = height of the water column (feet). This may be determined by subtracting the depth to water from the total depth of the well as measured from the same reference point.
k = conversion factor, 7.48 gallons per cubic foot (gal/ft^3)

Monitor well diameters typically have a diameter of 2 to 4 inches. If the diameter of the monitor well is known, standard conversion factors can be used to simplify the equation above.

The volume, in gallons per linear foot, for various standard monitor well diameters can be calculated as follows:

$$V(gal/ft) = \pi r^2 k \quad \text{or } V = 23.5r^2$$

where:

π = 3.14
r = radius of monitoring well (feet)
k = conversion factor (7.48 gal/ft^3)

For a 2-inch diameter well, the volume, in gallons per linear foot, can be calculated as follows:

$$\begin{aligned} V/\text{linear ft} &= \pi r^2 k \\ &= 3.14\,(1/12)^2\,(7.48\ gal/ft^3) \\ &= 0.163\ gal/ft \end{aligned}$$

The well radius must be in feet to be able to use the equation.

The conversion factors (**f**) for the most common diameter monitor wells are as follows:

Well diameter-inches	2	3	4	6
Volume (gal/ft.)	0.1631	0.3670	0.6528	1.4680

If you use the conversation factors above, Equation 1 should be modified as follows:

Well V = he

where:

h = height of water column (feet)
f = conversion factor

9.0 QUALITY ASSURANCE/QUALITY CONTROL

There are no specific quality assurance (QA) activities that apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All sample collection data, including purge methods and time, sample collection methods, times of collection, analyses required, and decontamination procedures (if any) must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration

must occur prior to purging or sampling and should be done according to the instruction manuals supplied by the manufacturer. All calibration procedures should be documented in the site logbook.

3. The collection of rinsate blanks is recommended to evaluate potential for cross contamination from the purging and/or sampling equipment.

4. Trip blanks are required if analytical parameters include VOCs.

10.0 DATA VALIDATION

This section does not apply to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, Occupational Safety and Health Administration (OSHA) or SERAS health and safety guidelines. More specifically, depending upon the site specific contaminants, various protective programs must be implemented prior to sampling the first well. The site health and safety plan should be reviewed with specific emphasis placed on the protection program planned for the well sampling tasks. Standard safe operating practices should be followed such as minimizing contact with potential contaminants in both the vapor phase and liquid matrix through the use of respirators and disposable clothing.

When working around volatile organic contaminants:

1. Avoid breathing volatile constituents venting from the well.

2. Check the well head-space with a FID/PID prior to sampling.

3. If monitoring results indicate organic constituents, it may be necessary to conduct sampling activities in Level C protection. At a minimum, skin protection will be afforded by disposable protective clothing.

Physical hazards associated with well sampling:

1. Lifting injuries associated with pump and bailers retrieval; moving equipment.

2. Use of pocket knives for cutting discharge hose.

3. Heat/cold stress as a result of exposure to extreme temperatures in protective clothing.

4. Slip, trip, fall conditions as a result of pump discharge.

5. Restricted mobility due to the wearing of protective clothing.

6. Electrical shock associated with use of submersible pumps is possible. Use a GFCI or a copper

grounding stake to avoid this problem.

12.0 REFERENCES

Barcelona, M.J., J.A. Helfrich, E.E. Garske, J.P. Gibb. 1984. "A Laboratory Evaluation of Groundwater Sampling Mechanisms." *Groundwater Monitoring Review.* p. 32-41.

Barcelona, M.J., J.A. Helfrich, E.E. Garske. 1985. "Sampling Tubing Effects on Groundwater Samples." *Analytical Chemistry.* Vol. 57. p. 460-463.

Nielsen, David M. and Gillian L. Yeates. 1985. "A Comparison of Sampling Mechanisms Available for Small-Diameter Groundwater Monitoring Wells." *Groundwater Monitoring Review*. p. 83-99.

13.0 APPENDICES

This section does not apply to this SOP.