U.S.EPA REGION 9 LABORATORY

RICHMOND, CALIFORNIA

FIELD SAMPLING GUIDANCE DOCUMENT #1220

GROUNDWATER WELL SAMPLING

TABLE OF CONTENTS

1.0 SCOPE AND APPLICATION

The objective of this Standard Operating Procedure (SOP) is to provide general reference information on sampling of groundwater wells. This guideline is primarily concerned with the collection of water samples from the saturated zone of the subsurface. Every effort must be made to ensure that the sample is representative of the particular zone of water being sampled. These procedures are designed to be used in conjunction with analyses for the most common types of groundwater contaminants (e.g., volatile and semi-volatile compounds, pesticides, metals, biological parameters).

2.0 METHOD SUMMARY

Prior to sampling a monitoring well, the well must be purged. This may be done with a number of instruments. The most common of these are (in order of importance): submersible pump, non-gas contact bladder pump, inertia pump and bailer. Traditionally, it was required that a minimum of three well volumes should be purged; however, research has shown that by monitoring parameters, such as pH, conductivity, dissolved oxygen, oxidation-reduction potential, temperature, and turbidity, during the purging process, it is possible to determine when the static water has been purged. Often, stability is reached before three well volumes have been purged, thereby reducing the volume of waste to be disposed. If, on the other hand, after three well volumes have been removed, the chemical parameters have not stabilized according to the above criteria, additional well volumes must be removed. If the parameters have not stabilized within five volumes, it is at the discretion of the project leader whether or not to collect a sample or to continue purging. A field log record must be kept of the actual volume of water purged from the well along with the criteria used for determining when an adequate purge volume has been achieved.

All equipment must be decontaminated prior to use and between wells. Once purging is completed and the correct laboratory-cleaned sample containers have been prepared, sampling may proceed. Sampling may be conducted with any of the above instruments, and need not be the same as the device used for purging. Bailers may be used to collect samples after purging has been completed with pumps. However bailers are discouraged at purging devices since this equipment is most likely to disturb the groundwater system. Care should be taken when choosing the sampling device, as some (materials and pressure) will affect the integrity of the sample. Sampling equipment must also be decontaminated. Sampling should occur in a progression from the least to most contaminated well, if this information is known.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The type of analysis for each sample collected determines the type of bottle, preservative, holding time, and filtering requirements. Samples should be collected directly from the sampling device into appropriate laboratory-cleaned containers. Check that a Teflon liner is present in the cap, 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 shall be appropriately preserved, labeled, logged, and placed in a cooler to be maintained at 4ºC. Samples must be shipped well before the holding time is over and ideally should be shipped with 24 hours of sample collection. It is imperative that these samples be shipped or delivered daily to the analytical laboratory in order to maximize the time available for the laboratory to perform the analysis. The bottles should be shipped with adequate packing and cooling (EPA prefers double-bagged wet ice) to ensure that they arrive intact.

Certain conditions may require special handling techniques. For example, treatment of a sample for volatile organic compounds (VOCs) with ascorbic acid preservative is required if there is residual chlorine in the water (such as public water supply) that could cause free radical formation and change the identity of the original contaminants. However, ascorbic acid should not be used if chlorine is not present in the water. Special requirements must be determined prior to conducting fieldwork.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

The primary goal of groundwater sampling is to obtain a representative sample of the ground water body. Analysis can be compromised by field personnel in two primary ways: (1) taking an unrepresentative sample, or (2) by incorrect handling of the sample. There are numerous ways of introducing foreign contaminants into a sample, and these must be avoided by following strict sampling procedures performed by trained field personnel or in consultation with such personnel.

Filtration of groundwater (Section 7.5), which is typically performed in the field, it may be an addition source of contamination.

5.0 EQUIPMENT/APPARATUS

5.1 General Equipment

Monitoring equipment and supplies used during sampling includes the following:

- water level indicator
  - electric sounder
  - steel tape
  - transducer
  - reflection sounder
  - air line
- depth sounder
- appropriate keys for well cap locks
- steel brush
- HNU or OVA (whichever is most appropriate)
- logbook
- calculator
- field data sheets
- chain of custody forms
- forms and seals
- sample containers
- engineer's rule
- sharp knife (locking blade)
- tool box (include at least: screwdrivers, pliers, hacksaw, hammer, flashlight, adjustable wrench)
- leather work gloves
- appropriate health and safety gear
- 5-gallon pail
- plastic sheeting
- shipping containers
- packing materials
- bolt cutters
- zip-type plastic bags
- containers for evacuation of liquids
- decontamination solutions
- tap water
- non-phosphate soap
- several brushes
- pails or tubs
- aluminum foil
- garden sprayer
- preservatives
- distilled or deionized water

5.2 Submersible Pump

- pump(s)
- generator (110, 120, or 240 volt) or 12-volt batter if inaccessible to field vehicle
- 1-inch black PVC coil pipe -- enough to dedicate to each well
- hose clamps
- safety cable
- toolbox supplement
  - pipe wrenches, 2
  - wire strippers
  - electrical tape
  - heat shrink
  - hose connectors
  - Teflon tape
- winch or pulley
- gasoline for generator
- flow meter with gate valve
- 1-inch nipples and various plumbing (i.e., pipe connectors)

5.3 Non-Gas Contact Bladder Pump

- non-gas contact 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

5.4 Inertia Pump

- pump assembly (WaTerra pump, piston pump)
- 5-gallon bucket

5.5 Suction Pump

- pump
- black coil tubing -- enough to dedicate to each well
- gasoline -- if required
- toolbox
- plumbing fittings
- flow meter with gate valve

5.6 Bailer

- clean decontaminated bailer(s) of appropriate size (to fill the well casing) and material
- nylon line, enough to dedicate to each well
- Teflon-coated bailer wire
- sharp knife
- aluminum foil (to wrap clean bailers)
- 5-gallon bucket

5.7 Filtration equipment

- 0.45 µm filters
- filtration appartus, vacuum or pressure

5.8 Additional Comments and Precautions

Samplers and evacuation equipment (bladders, pumps, bailers, tubing, etc.) should be limited to those made with stainless steel, Teflon, and glass in areas where concentrations are expected to be at or near the detection limit. Many pumps are made of materials, such as brass, plastic, rubber, or other elastomer products which may cause chemical interferences with the sample. The tendency of organics to leach into and out of many materials make the selection of materials critical for trace analyses. The use of plastics, such as PVC or polyethylene, should be avoided when analyzing for organics; Teflon® is preferred. However, PVC may be used for evacuation equipment, as it will not come in contact with the sample. Ideally, pumps "dedicated" for each well are used for sample collection; however, practical issues often provide few alternatives so samplers resort to using one or two pumps and decontaminating them between wells.

Because of the problems associated with most pumps (see Table 2 below), only three devices are recommended to be used to collect ground water samples from most wells. These are the peristaltic pump/vacuum jug assembly, a stainless steel and Teflon® bladder pump, and a closed-top, Teflon® bailer. It is recognized that there are situations, such as industrial or municipal supply wells or private residential wells, where a well may be equipped with a dedicated pump from which a sample would not normally be collected. Discretion should always be used in obtaining a sample.

Table 2: Advantages and Disadvantages of Various Groundwater Sampling Devices

Device	Advantages	Disadvantages
Submersible Pump	- Portable; can be used on an unlimited number of wells - Relatively high pumping rate (dependent on depth and size of pump) - Generally very reliable: does not require priming	- Potential for effects on analysis of trace organics - Heavy and cumbersome, particularly in deeper wells - Expensive - Power source needed - Susceptible to damage from silt or sediment - Impractical in low yielding or shallow wells
Non-Gas Contact Bladder Pump	- Maintains integrity of sample - Easy to use	- Difficult to clean although dedicated tubing and bladder may be used - Only useful to approximately 100 feet in depth - Supply of gas for operation (bottled gas and/or compressor) is difficult to obtain and is cumbersome
Inertia Pump	- Portable, inexpensive and readily available - Rapid method for purging shallow wells	- Only useful to approx. 70 ft. Or less - May be time consuming to use - Labor intensive - Wa Terra pump is only effective in 2 inch diameter wells
Suction Pump	- Portable, inexpensive, and readily available	- Only useful to approximately 25 feet or less in depth - Vacuum can cause loss of dissolved gases and volatile organics - Pump must be primed and vacuum is often difficult to maintain - May cause pH modification
Bailer	- Minimal out gassing of volatile organics while sample is in bailer- The only practical limitations are size and materials - No power source needed - Portable - Inexpensive: it can be dedicated and hung in a well reducing the chances of cross-contamination - Readily available - Rapid, simple method for removing small volumes of purge water	- Time consuming, especially for large wells - Transfer of sample may cause aeration

6.0 REAGENTS

Reagents will be utilized for preservation of samples and for decontamination of sampling equipment. The preservation required is specified by the analysis to be performed. Decontamination solutions are specified in SOP #02, Sampling Equipment Decontamination.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and which equipment and supplies are needed.
2. Obtain necessary sampling and monitoring equipment.
3. Decontaminate or preclean equipment, and ensure that it is in working order.
4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.
5. Perform a general site survey prior to site entry in accordance with the site-specific health and safety plan.
6. Identify and mark 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 contamination of equipment from soil adjacent to the well.
3. Remove locking well cap, note location time of day, and date in the field notebook or an appropriate log form.
4. Remove well casing cap.
5. Screen headspace of well with an appropriate monitoring instrument to determine the presence of volatile organic compounds and record in site logbook.
6. Lower water level measuring device or equivalent (i.e., permanently installed transducers or air line) into well until water surface is encountered.
7. Measure distance from water surface to reference measuring point on well casing or protective barrier post and record in site logbook. Alternatively, if there is no reference point, note that water level measurement is from top of steel casing, top of PVC riser pipe, from ground surface, or some other position on the well head.
8. Measure total depth of well (do this at least twice to confirm measurement) and record in site logbook or on log form.
9. Calculate the volume of water in the well and the volume to be purged using the calculations in Section 7.3.1.

10. Select the appropriate purging and sampling equipment.

7.3 Evacuation of Static Water (Purging)

7.3.1 Purging and Purge Adequacy

Monitoring for defining a contaminant plume requires a representative sample of a small volume of the aquifer. These circumstances require that the well be pumped enough to remove the stagnant water but not enough to induce flow from other areas. Generally, three well volumes are considered effective, or calculations can be made to determine, on the basis of the aquifer parameters and well dimensions, the appropriate volume to remove prior to sampling.

Purging is the process of removing stagnant water from a monitoring well, prior to sampling, causing its replacement by ground water from the adjacent formation, which is representative of actual aquifer conditions. Most often purging is completed immediately prior to sample collection although it is acceptable to purge and then collect samples within 24 hours.

During purging, water level measurements may be taken regularly at 15- to 30-second intervals. This data may be used to compute aquifer transmissivity and other hydraulic characteristics.

In order to determine when a well has been adequately purged, field investigators should:

1. monitor the pH, specific conductance, dissolved oxygen, oxidation-reduction potential, temperature, and turbidity of the ground water removed during purging;
2. observe and record the volume of water removed.

The amount of water standing in the water column (water inside the well riser and screen) needs be estimated prior to initiating the purge. To do this, three measurements are measured and recorded: the diameter of the well, the water level and total depth of the well. Specific methodology for obtaining these measurements is found below. Once this information is obtained, the volume of water to be purged can be determined using one of several methods.

To determine well volume, use the equations below or refer to Table 1.

Well volume = nr^2h (cf) [Equation 1]

where:

n	=	pi
r	=	radius of monitoring 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.]
cf	=	conversion (gal/ft^3) = 7.48 gal/ft^3 [In this equation, 7.48 gal/ft^3 is the necessary conversion factor]

Monitoring wells are typically 2, 3, 4, or 6 inches in diameter. If you know the diameter of the monitoring well, there are a number of standard conversion factors which can be used to simplify the equation above.

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

$v = nr^2 \quad (cf)$ [Equation 2]

where:

v	=	volume in gallons per linear foot
n	=	pi
r	=	radius of monitoring well (feet)
cf	=	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:

$v = nr2\ (cf)$ [Equation 2]

$= 3.14\ (1/12\ ft)^2\ 7.48\ gal/ft^2$

$= 0.1632\ gal/ft$

Remember that if you have a 2-inch diameter well, you must convert this to the radius in feet to be able to use the equation. See Table 1 to confirm your calculated answer.

Alternatively, the volume may be determined using a casing volume per foot factor for the appropriate diameter well, similar to that in the following table (Table 1) The water level is subtracted from the total depth, providing the length of the water column. This length is multiplied by the factor in the Table 1 which corresponds to the appropriate well diameter, providing the amount of water, in gallons, contained in the well. Other acceptable methods include the use of nomographs or other equations or formulae.

With respect to the ground water chemistry, an adequate purge is achieved when the pH, specific conductance, and temperature of the ground water have stabilized and the turbidity has either stabilized or is below 10 Nephelometric Turbidity Units (NTU). Ten NTU is the (maximum) goal for most ground water sampling objectives. This is twice the Primary Drinking Water standard of 5 NTU. Stabilization occurs when: pH measurements remain constant within 0.1 Standard Unit (SU); conductivity, dissolved oxygen and redox potential vary no more that 10 percent; and the temperature is constant for at least three consecutive readings. There are no criteria establishing how many sets of measurements are adequate for the determination of stability. If the calculated purge volume is small, the measurements should be taken frequently to provide a sufficient number of measurements to evaluate stability. If the purge volume is large, measurements taken every 15 minutes may be sufficient.

With respect to volume, an adequate purge is normally achieved when three to five times the volume of standing water in the well has been removed. The field notes should reflect the single well volume calculations or determinations, according to one of the above methods, and a reference to the appropriate multiplication of that volume, i.e., a minimum three well volumes, clearly identified as a purge volume goal.

If, after three well volumes have been removed, the chemical parameters have not stabilized according to the above criteria, additional well volumes may be removed. If the parameters have not stabilized within five volumes, it is at the discretion of the project leader whether or not to collect a sample or to continue purging. The total purge volume and conditions of sampling should be noted in the field log.

The amount of flushing a well receives prior to sample collection depends on the intent of the monitoring program as well as the hydrogeologic conditions. Programs where overall quality determination of water resources are involved may require long pumping periods to obtain a sample that is representative of a large volume of that aquifer. The pumped volume can be determined prior to sampling so that the sample is a composite of known volume of the aquifer, or the well can be pumped until the stabilization of parameters such as temperature, electrical conductance, or pH has occurred.

TABLE 1
WELL CASING DIAMETER vs. VOLUME

WELL CASING DIAMETER (inches) vs. VOLUME (gals.)/FEET of WATER	
CASING	GALLONS/FT
1	0.041
2	0.163
3	0.367
4	0.653
5	1.02
6	1.469
7	1.999
8	2.611
9	3.305
10	4.08
11	4.934
12	5.875

7.3.2 Excessive Pumping

Attempts should be made to avoid purging wells to dryness. This can be accomplished, for example, by slowing the purge rate. If a well is pumped dry, it may result in the sample being comprised partially of water contained in the sand pack, which may be reflective, at least in part, of initial, stagnant conditions. In addition, as water re-enters an evacuated well, it may cascade down the sand pack or the well screen, stripping volatile organic constituents that may be present and/or introducing soil fines into the water column. It is particularly important that wells be sampled as soon as possible after purging. If adequate volume is available, the well must be sampled immediately. If not, sampling should occur as soon as adequate volume has recovered (or within 24 hours).

A nonrepresentative sample can also result from excessive pre-pumping of the monitoring well. Stratification of the leachate concentration in the groundwater formation may occur, or heavier-than-water compounds may sink to the lower portions of the aquifer. Excessive pumping can dilute or increase the contaminant concentrations from what is representative of the sampling point of interest.

7.3.3 Purging When Well Becomes Dry

In some situations, even with slow purge rates, a well may be pumped or bailed dry (evacuated). In these situations, this generally constitutes an adequate purge and the well can be sampled following sufficient recovery (enough volume to allow filling of all sample containers). It is not necessary that the well be evacuated three times before it is sampled; rather the groundwater chemistry must be consistent. That is, a minimum of four measurements (from pH, specific conductance, dissolved oxygen, redox potential, temperature, and turbidity) must be monitored during collection of the sample from the recovered volume, as the measurements of record for the sampling event.

7.3.4 Purging Devices

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

7.3.4.1 Submersible Pump

Submersible pumps are generally constructed of plastic, rubber, and metal parts which may affect the analysis of samples for certain trace organics and inorganics. As a consequence, submersible pumps may not be appropriate for investigations requiring analyses of samples for trace contaminants. However, they are still useful for pre-sample purging. However, the pump must have a check valve to prevent water in the pump and the pipe from rushing back into the well.

Submersible pumps generally use one of two types of power supplies, either electric or compressed gas. Electric pumps can be powered by a 12-volt DC rechargeable battery, or a 110- or 220-volt AC power supply. Those units powered by compressed gas normally use a small electric compressor which also needs a 12-volt DC or 110-volt AC power. They may also utilize compressed gas from bottles. Pumps differ according to the depth and diameter of the monitoring wells.

1. Determine the volume of water to be purged as described in Section 7.3.1.
2. Lay plastic sheeting around the well to prevent contamination of pumps, hoses or lines with foreign materials.
3. Assemble pump, hoses and safety cable, and lower the pump into the well. Make sure the pump is deep enough so that purging does not evacuate all the water. (Running the pump without water may cause damage.)
5. Attach power supply, and purge well until specified volume of water has been evacuated (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, lower the pump further into the well, and continue pumping.
6. Collect and dispose of purge waters as specified in the site-specific project plan.

7.3.4.2 Non-Contact Gas Bladder Pump

For this procedure, an all stainless-steel and Teflon Middleburg-squeeze bladder pump (e.g., IEA, TIMCO, Well Wizard, Geoguard, and others) is used to provide the least amount of material interference to the sample. Water comes into contact with the inside of the bladder (Teflon) and the sample tubing, also Teflon, that may be dedicated to each well. Some wells may have permanently installed bladder pumps (i.e., Well Wizard, Geoguard), that may be used to sample for all parameters.

1. Assemble Teflon tubing, pump and charged control box.
2. Determine the volume of water to be purged as described in Section 7.3.1.
3. Lay plastic sheeting around the well to prevent contamination of pumps, hoses or lines with foreign materials.
4. Assemble pump, hoses and safety cable, and loer the pump into the well. Make sure the pump is deep enough so that purging does not evacuate all the water. (Running the pump without water may cause damage.)

5. Attach power supply, and purge well until specified volume of water has been evacuated (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, lower the pump further into the well, and continue pumping.
6. Collect and dispose of purge waters as specified in the site-specific project plan.
7. Be sure to adjust flow rate to prevent violent jolting of the hose as sample is drawn in.

7.3.4.3 Inertia Pump

Inertia pumps, such as the WaTerra pump and piston pump, are manually operated. They are appropriate to use when wells are too deep to bail by hand, but are not inaccessible enough to warrant an automatic (submersible, etc.) pump. These pumps are made of plastic and may be either decontaminated or discarded, after use.

1. Determine the volume of water to be purged as described in Section 7.3.1
2. Lay plastic sheeting around the well to prevent contamination of pumps or hoses with foreign materials.
3. Assemble pump, and lower to the appropriate depth in the well.
4. Begin pumping manually, discharging water into a 5-gallon bucket (or other graduated vessel). Purge until specified volume of water has been evacuated (or until field parameters such as temperature, pH, conductivity, etc. have stabilized).
5. Collect and dispose of purge waters as specified in the site-specific project plan.

7.3.4.4 Suction Pump

There are many different types of suction pumps. They include: centrifugal, peristaltic and diaphragm. Diaphragm pumps can be used for well evacuation at a fast pumping rate and sampling at a low pumping rate. The peristaltic pump is a low-volume pump that uses roller to squeeze the flexible tubing, thereby creating suction. This 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. Determine the volume of water to be purged as described in Section 7.3.1.
3. Lay plastic sheeting around the well to prevent contamination of pumps, hoses or lines with foreign materials.

4. Assemble pump, hoses and safety cable, and loer the pump into the well. Make sure the pump is deep enough so that purging does not evacuate all the water. (Running the pump without water may cause damage.)
5. Attach power supply, and purge well until specified volume of water has been evacuated (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, lower the pump further into the well, and continue pumping.
6. Collect and dispose of purge waters as specified in the site-specific project plan.

7.3.4.5 Bailer

Bailers are the simplest purging device used and have many advantages. They generally consist of a rigid length of tube, usually with a ball check-valve at the bottom. A line is used to lower the bailer into the well and retrieve a volume of water. The three most common types of bailer are PVC, Teflon, and stainless steel.

This manual method of purging is best suited to shallow or narrow diameter wells. For deep, larger diameter wells which require evacuation of large volumes of water, other mechanical devices may be more appropriate.

Bailing equipment includes 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 Section7.3.1.
2. Lay plastic sheeting around the well to prevent contamination of the bailer line with foreign materials.
3. Attach the line to the bailer and lower 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 pail until full to determine the number of bails necessary to achieve the required purge volume.
6. Thereafter, pour the water into a container and dispose of purge waters as specified in the site-specific project plan.

7.4 Sampling

Sample withdrawal methods require the use of pumps, compressed air, bailers, and samplers. Ideally, purging and sample withdrawal equipment should be completely inert, economical to use, easily cleaned, sterilized, reusable, able to operate at remote sites in the absence of power resources, and capable of delivering variable rates for sample collection.

There are several factors to take into consideration when choosing a sampling device. Care should be taken when reviewing the advantages or disadvantages of any one device. 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.

7.4.1 Bailer

The positive-displacement volatile sampling bailer (by GPI) 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 cost and site conditions. Generally, bailers can provide an acceptable sample, providing that sampling personnel use extra care in the collection process.

1. Surround the monitoring ell with clean plastic sheeting.
2. Attach a line to the bailer. If a bailer was used for urging, the same bailer and line may be used for sampling.
3. Lower the bailer slowly and gently into the well, taking care not to shake the casing sides or to splash the bailer into the water. Stop lowering at a point adjacent to the screen.
4. Allow bailer to fill and then slowly and gently retrieve the bailer from the well, avoiding contact with the casing, so as not to knock flakes of rust or other foreign materials into the bailer.
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. See Section 7.7 for special considerations on VOC samples.
6 Begin pouring slowly from the bailer.
7. Filter and preserve samples as required by sampling plan.
8. Cap the sample container tightly and place pre-labeled sample container in a carrier.
9. Replace the well cap.
10. Log all samples in the site logbook and on field data sheets and label all samples.
11. Package samples and complete necessary paperwork.
12. Transport sample to decontamination zone (if necessary) to prepare it for transport to analytical laboratory.

7.4.2 Submersible Pump

Although it is recommended that samples not be collected with a submersible pump due to the reasons stated in Section 4.0, there are some situations where they may be used.

1. Allow the monitoring well to recharge after purging, keeping the pump just above the screened area.
2. Attach gate valve to hose (if not already fitted), and reduce flow of water to a manageable sampling rate.
3. Assemble the appropriate bottles.
4. If no gate valve is 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 pre-labeled 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 samples.
8. Package samples and complete necessary paperwork.
9. Transport sample to decontamination zone (if necessary) for preparation for transport to analytical laboratory.
10. Upon completion, remove pump and assembly and full decontaminate prior to setting into the next sample well. Dedicate the tubing to the hole.

7.4.3 Non-Gas Contact Bladder Pump

The use of a non-gas contact positive displacement bladder pump is often mandated by the use of dedicated pumps installed in wells. 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.

Non-gas contact positive displacement pumps cause the least amount of alteration in sample integrity as compared to other sample retrieval methods.

1. Allow well to recharge after purging.
2. Assemble the appropriate bottles.
3. Turn pump on, increase the cycle time and reduce the pressure to the minimum that will allow the sample to come to the surface.
4. Cap the sample container tightly and place relabeled sample container in a carrier.

5. Replace the well cap.
6. Log all samples in the site logbook and on field data sheets and label all samples.
7. Package samples and complete necessary paperwork.
8. Transport sample to staging area for preparation for transport to analytical laboratory.
9. 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.
10. Collect non-filtered samples directly from the outlet tubing into the sample bottle.
11. For filtered samples, connect the pump outlet tubing directly to the filter unit. The pump pressure should remain decreased 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, so this is not a concern.

7.4.4 Suction Pump

In view of the limitations of suction pumps, they are not recommended for sampling purposes.

7.4.5 Inertia Pump

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

1. Following well evacuation, allow the well to recharge.
2. Assemble the appropriate bottles.
3. Since 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 appropriate sample container.
4. Cap the sample container tightly and place pre-labeled sample container in a carrier.
5. Replace the well cap.
6. Log all samples in the site logbook and on field data sheets and label all samples.
7. Package samples and complete necessary paperwork.
8. Transport sample to staging area for preparation for transport to analytical laboratory.
9. Upon completion, remove pump and decontaminate or discard, as appropriate.

7.5 Filtering

Groundwater samples to be analyzed for metals require filtering. The definition of total metals is an unfiltered sample and dissolved metals is a 0.45 um filtered smple. For samples that require filtering, such as samples which will be analyzed for total and dissolved metals, the filter must be decontaminated prior to use and between uses. Filters work by two methods. A barrel filter such as the “Geotech” filter works with a bicycle ump, which is used to build up positive pressure in the chamber containing the sample. The sample is then forced through the filter paper (minimum size 0.45 um) 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 psi by periodic pumping.

A vacuum type filter involves two chambers, the upper chamber contains the sample and a filter (minimum size 0.45 um) 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 train all the sample into the lower chamber. If preservation of the sample is necessary, this should be done after filtering.

7.6 Post Operation

After all samples are collected and preserved, the sampling equipment should be decontaminated prior to sampling another well. This will prevent cross-contamination of equipment and monitoring wells between locations.

1. Decontaminate all equipment.
2. Replace sampling equipment in storage containers.
3. Prepare and transport water samples to the laboratory. Check sample documentation and make sure samples are properly packed for shipment.

7.7 Special Considerations for Volatile Organic Compound (VOC) Sampling

The proper collection of a sample for volatile organics requires minimal disturbance of the sample to limit volatilization and therefore a loss of volatiles from the sample.

Sample retrieval systems suitable for the valid collection of volatile organic samples are: positive displacement bladder pumps, gear driven submersible pumps, syringe samplers and bailers. Field conditions and other constraints will limit the choice of appropriate systems. The focus of concern must be to provide a valid sample for analysis, one which has been subjected to the least amount of turbulence possible.

The following procedures should be followed:

1. Open the vial, set cap in a clean place, and collect the sample during the middle of the cycle. When collecting duplicates, collect both samples at the same time.
2. Fill the vial to just overflowing. Do not rinse the vial, nor excessively overfill it. There should be a convex meniscus on the top of the vial.
3. Check that the cap has not been contaminated from splashing and carefully cap the vial. Place the cap directly over the top and screw down firmly. Do not over tighten and break the cap.
4. Invert the vial and tap gently. Observe vial for at least 10 seconds. If an air bubble appears, discard the sample and begin again. It is imperative that no entrapped air is in the sample vial.
5. Immediately place the vial in the protective foam sleeve and place into the cooler, oriented so that it is lying on its side, not straight up.
6. The holding time for VOCs is 7 days. If preserved with HCl to a $pH < 2$, the holding time is 14 days. Samples should be shipped or delivered to the laboratory daily so as not to exceed the holding time. Ensure that the samples remain at 4^0C, but do not allow them to freeze.

8.0 QUALITY ASSURANCE/QUALITY CONTROL

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

- All data must be documented on field data sheets or within site logbooks.

- 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 activities must occur prior to sampling/operation and they must be documented.

- Field duplicates and equipment or field blanks should be collected along with the samples at a frequency of one for every ten samples.

9.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA and specific health and safety procedures. 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.

For volatile organic contaminants:

- Avoid breathing constituents venting from the well.
- Pre-survey the well head-space with an FID/PID prior to sampling.
- If monitoring results indicate organic constituents, sampling activities may be conducted in Level C protection. At a minimum, skin protection will be afforded by disposable protective clothing.

Physical hazards associated with well sampling are:

- Lifting injuries associated with pump and bailer retrieval; moving equipment.
- Use of pocket knives for cutting discharge hose.
- Heat/cold stress as a result of exposure to extreme temperatures (may be heightened by protective clothing).
- Slip, trip, fall conditions as a result of pump discharge.
- Restricted mobility due to the wearing of protective clothing.