STANDARD OPERATING PROCEDURE

FOUR

MONITORING WELL SAMPLING

Modified from

U.S. Environmental Protection Agency Environmental Response Team

Response Engineering and Analytical Contract

Standard Operating Procedures

Well Sampling

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and

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Region II

Ground Water Sampling Standard Operating Procedure

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1.0 SCOPE AND APPLICATION

The objective of this standard operating procedure (SOP) is to provide general reference information on sampling of wells. This guideline is primarily concerned with the collection of water samples from the saturated zone of the earth's subsurface at sites that are thought to be contaminated. Every effort must be made to ensure that the sample is representative of the particular zone of water being sampled. The procedures described in this document are designed to be used in conjunction with analyses for the most common types of ground-water contaminants.

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

Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

2.0 METHOD SUMMARY

Monitoring wells can be sampled immediately after initial well installation and development (see SOP #3 Section 5.3.9, Well Development requirements). Prior to sampling a monitor well, the well must be purged to remove water that may have been stagnant in the well, and to introduce fresh ground water into the well for sampling. This may be achieved with one of a number of instruments. The most common of these are the bailer, submersible pump, non-contact gas bladder pump, suction pump, inertia pump, and air-lift pump. At a minimum, three well volumes should be purged if recharge to the well is sufficient; Section 8.0 of this SOP shows all calculations necessary to determine the well volume. While the well is being purged, field parameters (i.e., pH, temperature, and electrical conductivity) should be measured and recorded following removal of each well volume until the readings stabilize. This is done to assure that fresh ground water is entering the well. Field parameters are stable when there is less than 0.2 pH unit change and 10% change for conductivity and temperature for three consecutive measurements.

Once purging is completed and the laboratory-cleaned sample containers have been labeled, 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. Only the air-lift pump may not be used for sampling due to aeration of the sample. Care should be taken when choosing the sampling device as some may affect the integrity of the sample.

Sampling should occur in a progression from the least to most contaminated well, if this information is known. Even though the sampling and purging equipment are always decontaminated between wells, the possibility always exists that some contamination may remain on this equipment. By beginning the sampling at the least contaminated, it is hoped that any cross contamination of wells that may occur will be kept to a minimum.

3.0 INTERFERENCES AND POTENTIAL PROBLEMS

The primary goal in performing ground-water sampling is to obtain a representative sample of the ground water. Sample integrity and analytical results 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 and utilizing trained field personnel. Section 7.0 of this SOP discusses the appropriate procedures which should be followed in order to collect a representative ground water sample.

4.0 SAMPLE PRESERVATION, STORAGE, HANDLING AND DOCUMENTATION

The type of analysis for which a sample is being collected determines the type of sample container, preservative, holding time, and filtering requirements which are used (see the Standard Operating Procedures for Sample Preservation, Storage, Handling and Documentation). Samples should be collected directly from the sampling device into the appropriate laboratory cleaned containers. Check that a Teflon liner is present in the cap, if required. Attach a sample identification label to the container. Complete a field-data sheet, a chain of custody form, and record all pertinent data in the site logbook while at the sampling location.

Samples shall be appropriately preserved, labeled, logged, and placed in a cooler with ice to be maintained at $4^{o}C$. Samples must be shipped well before the holding time is up and ideally should be shipped within 24 hours of sample collection. It is recommended 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 analyses. The containers should be shipped with adequate packing and cooling to ensure that they arrive intact.

Certain conditions may require special handling techniques. Special requirements must be determined prior to conducting fieldwork. This can be done by consulting the Standard Operating Procedures for Sample Preservation, Storage, Handling and Documentation and by also consulting with the analytical lab(s) that will be analyzing the water sample(s).

5.0 EQUIPMENT/APPARATUS

5.1 General

- Water-level indicator (i.e., electric sounder, steel tape, transducer, or air line)
- Depth sounder
- Appropriate keys for well-cap locks
- Steel brush
- Flame-ionization detector (FID), photo-ionization detector (PID), or organic-vapor analyzer (OVA) -- whichever is most appropriate
- Logbook
- Calculator
- Field-data sheets and sample labels
- Chain of custody records and seals
- Sample containers

- Engineer's ruler
- Sharp knife (locking blade)
- Toolbox (to include at least: screwdrivers, pliers, hacksaw, hammer, flashlight, adjustable wrench)
- Leather work gloves
- Appropriate health and 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
- Several brushes
- Pails or tubs
- Aluminum foil
- Protective gloves (examples: rubber, plastic, or latex)
- Preservatives
- Distilled or deionized water
- Ice or other coolant

5.2 Purging and Sampling Equipment and Materials

Materials of construction for purging and sampling equipment (bladders, pump, bailers, tubing, etc.) should be limited to stainless steel, Teflon, and glass in areas where concentrations are expected to be at or near the detection limit. 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 (polyvinyl chloride) or polyethylene, should be avoided when analyzing for organics. However, PVC may be used for evacuation equipment as it will not come in contact with the sample, and in highly contaminated wells, disposable equipment (i.e., polypropylene bailers) may be appropriate to avoid cross contamination.

5.2.1 Bailer

- Clean, decontaminated bailers of appropriate size and construction material
- Nylon line, enough to dedicate to each well or Teflon coated bailer wire (preferably on some type of reel or spool)
- Sharp knife
- Wire cutters
- Five-gallon pail

5.2.2 Submersible pump

- Pump(s)
- Generator (110/120 or 240 volt) or 12-volt battery if necessary
- PVC pipe (solid or coil type) - enough to dedicate to each well
- Hose clamps
- Safety cable
- Toolbox supplements (to include at least: pipe wrenches, wire strippers, electrical tape, heat shrink wrap, hose connectors, Teflon tape)
- Winch, pulley or hoist
- Gasoline for generator/gas can
- Flow meter with gate valve
- Nipples and various plumbing fittings (i.e., pipe connectors)

5.2.3 Non-contact gas bladder pump

- Non-contact gas bladder pump
- Compressor or nitrogen gas tank
- Generator (110/120 or 240 volt) or 12-volt battery if necessary

- Gasoline for generator/gas can
- Teflon tubing - enough to dedicate to each well
- Toolbox supplements (to include at least: pipe wrenches, wire strippers, electrical tape, heat shrink wrap, hose connectors, Teflon tape)
- Control box (if necessary)
- Spare batteries for control box if necessary

5.2.4 Suction pump

- Pump
- PVC pipe (solid or coil type) - enough to dedicate to each well
- Generator (110/120 or 240 volt) or 12-volt battery if necessary
- Gasoline for generator/gas can
- Toolbox supplements (to include at least: pipe wrenches, wire strippers, electrical tape, heat shrink wrap, hose connectors, Teflon tape)
- Plumbing fittings
- Flow meter with gate valve

5.2.5 Inertia pump

- Pump assembly
- Five-gallon pail

5.2.6 Air-Lift pump

- Air compressor and motor
- Air-storage tank
- Toolbox supplements (to include at least: pipe wrenches, wire strippers, electrical tape, heat shrink wrap, hose connectors, Teflon tape)
- Hose or tubing with perforated lower end
- Filter for the air entering the well

5.3 Advantages/Disadvantages of Certain Purging and Sampling Equipment

5.3.1 Bailer

Some advantages of a bailer are:

- Bailers are available in many different size ranges and many different compositions.
- No electrical power source is needed.
- Bailers are portable.
- Relatively inexpensive, so it can be dedicated and left in a well, thereby reducing the chances of cross contamination between wells.
- Minimal out-gassing of volatile organics while sample is in bailer.
- Readily available.
- Stagnant water can be removed first.
- Rapid, simple method for removing small volumes of purge water.

Some disadvantages of a bailer are:

- Time consuming to purge large volumes of stagnant water.
- Transfer of the sample to a container may cause aeration.
- The potential for the concentration of trace organics to be affected exists.

5.3.2 Submersible pump

Some advantages of a submersible pump are:

- Submersible pumps are portable.
- Depending upon the size of the pump and the pumping depths, relatively high pumping rates are possible.
- These pumps are generally very reliable and do not require priming.

Some disadvantages of a submersible pump are:

- The potential for the concentrations of trace organics to be affected exists.
- Some of these pumps are somewhat cumbersome to deal with in deep wells.
- Submersible pumps are often quite expensive.
- An electrical power source is needed.
- Sediment in the water may cause problems with the pumps.

- Submersible pumps are impractical in low yielding wells.

5.3.3 Non-contact gas bladder pump

An advantage of a non-contact gas bladder pump is:

- Bladder pumps maintain the integrity of the sample because they do not subject the sample to excessive pressures.

- Some disadvantages of a non-contact gas bladder pump are:

- Difficult to clean, though dedicated tubing and bladder may be used.

- Maximum, useful depth is about 100 feet.

- Supply of inert gas for operation, gas bottles and/or compressors may be difficult to obtain and are cumbersome.

- Pumping rates are relatively low.

5.3.4 Suction pump

An advantage of a suction pump is:

- Suction pumps are portable, relatively inexpensive, and readily available.

Some disadvantages of a suction pump are:

- Water levels must be within approximately 20 feet of the ground surface (or discharge height of the well) for this pump to be useful.

- Vacuum can cause loss of dissolved gasses and volatile organics.

- This type of pump commonly must be primed, and vacuum is often difficult to maintain during initial stages of pumping.

5.3.5 Inertia pump

An advantage of an inertia pump is:

- Inertia pumps are portable, inexpensive, and readily available.

Some disadvantages of an inertia pump are:

- Water levels must be within approximately 70 feet of the ground surface for this pump to be useful.

- It is often very time consuming to purge wells with manual versions of these pumps.

- Manual versions of these pumps are very labor intensive.

5.3.6 Air-Lift pump

Some advantages of an air-lift pump are:

- Air-lift pumps use simple, readily available equipment.
- These pumps are well suited for use in all types of well construction.

Some disadvantages of an air-lift pump are:

- Requires fairly heavy, bulky equipment that must often be towed on a separate trailer.
- Foreign fluid (air) is introduced into the well.
- Effectiveness is dependent on the height of the water column in the well. For this method to work properly, at least half of the well casing usually needs to have water in it.

6.0 REAGENTS

Reagents may be utilized for preservation of samples and for decontamination of sampling equipment. Consult the Standard Operating Procedures for Sample Preservation, Storage, and Handling and check with the analytical laboratory in order to determine which preservative(s) to use, if any, and the quantities required.

7.0 PROCEDURES

7.1 Initial Office and Field 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.
2. Obtain necessary sampling and monitoring equipment, appropriate to type of contaminant being investigated.
3. Decontaminate or pre-clean equipment and ensure that it is in working order.
4. Prepare scheduling and coordinate with staff, clients, land owners, and regulatory agencies.
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, or other suitable material, around the well to minimize the 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 site logbook.

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 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 (at least twice to confirm measurement) and record in site logbook.

9. Calculate the volume of water in the well and the volume to be purged using the calculation in Section 8.0 of this SOP.

10. Select the appropriate purging and sampling equipment.

7.3 Purging

The amount of purging that a well receives prior to sample collection depends on the intent of the monitoring program as well as the hydrogeologic conditions. Programs where general quality determination of water resources are involved may require long pumping periods to obtain a sample, or several samples over time, that is representative of a large volume of that aquifer. The pumped volume can be determined prior to sampling so that the sample is collected after a known volume of the water is evacuated from the aquifer, or the well can be pumped until the stabilization of parameters such as temperature, electrical conductance, or pH has occurred. Field parameters are considered to be stabilized when there is less than 0.2 pH unit change and 10% change in conductivity and temperature for at least three consecutive well volumes.

However, monitoring for 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 based on the aquifer parameters and well dimensions can be made to determine the appropriate volume to remove prior to sampling.

During purging, water-level measurements may be taken at regular intervals. These data may be used to compute aquifer transmissivity and other hydraulic characteristics.

In a non-pumping well, there will be little or no vertical mixing of the water, and stratification of the water will occur. The well water in the screened section will mix with the ground water due to normal ground water flow patterns, but the well water above the screened section will remain isolated, become stagnant, and may lack the contaminants which are representative of the ground water. Persons sampling should realize that stagnant water may contain foreign material inadvertently or deliberately introduced from the surface, which may also result in an unrepresentative sample.

To safeguard against collecting non-representative stagnant water, the following guidelines and techniques should be adhered to during purging and sampling:

- As a general rule, all monitoring wells should be pumped or bailed prior to sampling.

- Evacuation of a minimum of three well volumes of water in the casing is recommended for a representative sample.

- Analytical parameters typically dictate whether the sample should be collected through the purging device, or through a separate sampling instrument.

- When purging with a pump (not a bailer), the pump should be set at the screened interval, or if the well is an open-rock well, it should be set at the same depth at which the sample will be collected.

- The well should be sampled as soon as possible after purging. When sampling a screened well, the sample should be collected from the screened interval.

- For wells that can be pumped or bailed to dryness with the equipment being used, the well should be evacuated and allowed to recover prior to sample withdrawal. If the recovery rate is fairly rapid and time allows, evacuation of more than 1 well volume of water is preferred. If recovery is slow, on the order of several hours to several days, sample the well upon recovery after one evacuation.

- A non-representative sample can also result from excessive purging of the monitoring well. Excessive pumping can dilute or increase the contaminant concentrations from what is representative of the sampling point of interest.

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.

7.3.1 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 materials used in making bailers are PVC, Teflon, and stainless steel.

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

7.3.1.1 Operation

Equipment needed will include a clean decontaminated bailer, Teflon-coated wire or nylon line, a sharp knife or wire cutters, and plastic sheeting or other suitable material.

1. Determine the volume of water to be purged as described in Section 7.2, Field Preparation.

2. Lay plastic sheeting, or other suitable material, around the well to prevent contamination of the bailer line with foreign materials.

3. Attach the line to the bailer and slowly lower until the bailer is completely submerged, being careful not to drop the bailer to the water, causing turbulence and the possible loss of volatile-organic contaminants.

4. Pull bailer out ensuring that the line either falls onto a clean area of plastic sheeting, or is wound onto a clean reel or spool, and never touches the ground.

5. Empty the bailer into a graduated vessel or container of known volume in order to determine the number of bails necessary to achieve the required purge volume.

6. Samples may be periodically collected to determine if field parameters such as pH, temperature, and electrical conductivity have stabilized.

7. Thereafter, pour the water into a container and dispose of purge water as specified in the site specific sampling plan.

7.3.2 Submersible pump

Submersible pumps are generally constructed of plastics, 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 some investigations requiring analyses of samples for trace contaminants. However, they are still useful for presample purging in most instances. 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 or air. Electric-powered pumps may run off a 12 volt DC rechargeable battery or a 110/120 volt AC power supply. Those units powered by compressed air normally use a small electric or gas-powered air compressor. They may also utilize compressed gas (i.e., nitrogen) from bottles. Different size pumps are available for different depth or diameter monitoring wells.

<u>7.3.2.1 Operation</u>

1. Determine the volume of water to be purged as described in Section 7.2, Field Preparation.

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

3. Assemble pump, hoses, and any safety cables, and lower the pump into the well. Make sure the pump is deep enough so that it stays submerged during pumping. Running the pump without water around it may cause damage.

4. Attach flow meter to the outlet hose to measure the volume of water purged or use a graduated vessel to determine the flow rate.

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

6. 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 farther into the well or decrease the pumping rate and continue pumping.

7. Collect and dispose of purge waters as specified in the site specific sampling plan.

7.3.3 Noncontact gas bladder pump

For this procedure, an all stainless steel and Teflon bladder pump is used to provide the least amount of material interference to the sample (Barcelona and others, 1984). Water comes into contact with the inside of the Teflon bladder and the Teflon sample tubing that may be dedicated to each well. Some wells may have permanently installed bladder pumps that will be used to sample for all parameters.

7.3.3.1 Operation

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

2. The procedure for purging with a bladder pump is the same as for a submersible pump as described in Section 7.3.2.1.

3. Be sure to adjust flow rate to prevent violent jolting of the hose as sample is drawn in.

7.3.4 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 rollers 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.

7.3.4.1 Operation

1. Assembly of the pump, tubing, and power source if necessary.

2. Procedure for purging with a suction pump is the same as for a submersible pump as described in Section 7.3.2.1.

7.3.5 Inertia Pump

Inertia pumps are generally manually operated, although some are motorized. They are most appropriate to use when wells are too deep to bail by hand or too narrow (or inaccessible) to warrant an automatic (i.e., submersible) pump. Inertia pumps are generally made of plastic and may be either decontaminated or discarded.

7.3.5.1 Operation

1. Determine the volume of water to be purged as described in Section 7.2, Field Preparation.

2. Lay plastic sheeting, or other suitable material, 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, discharging water into a 5-gallon pail (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.

7.3.6 Air-Lift pump

An air lift purging device uses compressed air that mixes with the water in the well. This air/water mixture is lighter than the water in the well; therefore, this air/water mixture is driven out of the top of the well.

This method of purging requires a gas or electric-driven compressor and an air- storage tank. Flexible tubing (preferably Teflon) with an in-line air filter is also required.

7.3.6.1 Operation

1. Determine the volume of water to be purged as described in Section 7.2, Field Preparation.

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

3. Assemble all hoses and safety cables and lower the perforated end of the hose into the well. Make sure that the hose remains a minimum of 10 feet above the well screen to prevent aeration of the well screen.

4. Open the valve on the compressor tank and begin purging water.

5. Adjust the pressure in the compressor tank to achieve the desired flow rate.

6. Periodically collect samples to determine if field parameters have stabilized.

7. Collect and dispose of purge waters as specified in the site specific sampling 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 manufacture, 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. A 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 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.

7.4.1.1 Operation

1. Surround the monitoring well with clean plastic sheeting or other suitable material.

2. Assemble and label appropriate sample containers.

3. Attach a line to a clean decontaminated bailer.

4. Lower the bailer slowly and gently into the well, taking care not to shake the casing side or to splash the bailer into the water. Stop lowering at a point adjacent to the screen.

5. 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.

6. Remove the cap from the sample container and place it in a location where it won't become contaminated. See Section 7.7 for Special Considerations on Volatile Organic Compound Sampling.

7. Begin slowly pouring from the bailer into the pre-labeled sample container or filtering device.

8. Filter and preserve samples if required by sampling plan.

9. Cap the sample container tightly and place pre-labeled sample container in a carrier.

10. Replace the well cap.

11. Log all samples in the site logbook.

12. Package samples and complete necessary paperwork.

13. Transport sample to decontamination zone and prepare for transport to analytical laboratory.

7.4.2 Submersible pump

Although it is recommended that some water samples not be collected with a submersible pump due to the reasons stated in Section 5.3.2 of this SOP, there are many situations where they may be used.

7.4.2.1 Operation

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

2. Attach gate valve (or other flow control device) to hose (if not already fitted), and reduce flow of water to a manageable sampling rate (several hundred milliliters per minute is preferred).

3. Assemble and label the appropriate sample containers.

4. If no gate valve or other flow-control device is available, run the water down the side of a clean jar and fill the sample containers from the jar.

5. Fill the pre-labeled sample container, cap it tightly, and place it 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 and prepare for transport to the analytical laboratory.

10. Upon completion, remove pump and assembly and fully decontaminate prior to setting into the next sample well. Dedicate the tubing to the hole.

7.4.3 Non-contact gas bladder pump

The use of a non-contact gas positive displacement bladder pump is often mandated by the use of dedicated pumps installed in wells. They are somewhat difficult to clean, but may be used with dedicated sample tubing to avoid cleaning. They may be operated at variable flow and pressure rates making them ideal for both purging and sampling.

Barcelona and others (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.

7.4.3.1 Operation

1. Allow well to recharge after purging.

2. If the bladder pump is not dedicated to the well to be sampled, a clean bladder pump must be lowered into the appropriate interval of the well.

3. Assemble and label the appropriate sample containers.

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

5. Fill the pre-labeled sample container, cap it tightly, and place it in a carrier.

6. Replace the well cap.

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

8. Package samples and complete necessary paperwork.

9. Transport sample to decontamination zone and prepare for transport to analytical laboratory.

10. 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.

11. Unfiltered samples shall be collected directly from the outlet tubing into the sample container.

12. For filtered samples, connect the pump outlet tubing directly to the filter unit. The pump pressure should remain decreased so that the pressure does not build up on the filter and blow out the pump bladder or displace the filter.

7.4.4 Suction pump

In view of the limitations of these pumps, as stated in Section 5.3.4 of this SOP, they are not recommended for sampling purposes.

<u>7.4.4.1 Operation</u>

Sampling with a suction pump is generally not recommended.

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 as described in Section 7.4.1 of this SOP.

<u>7.4.5.1 Operation</u>

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

2. Assemble and label the appropriate sample containers.

3. Since these pumps are generally 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. Fill the pre-labeled sample container, cap it tightly, and place it 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 decontamination zone and prepare for transport to the analytical laboratory.

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

7.4.6 Air-Lift Pump

Due to aeration of the sample caused by this method, it is not recommended for sampling purposes.

7.4.6.1Operation

Sampling with an air lift pump is not recommended.

7.5 Filtering

For samples requiring filtering, such as dissolved metals analysis, the filtering device must be decontaminated prior to and between uses. Filters work by two methods. A barrel filter is commonly used in conjunction with a bicycle pump that creates positive pressure in the chamber containing the sample which is then forced through the filter paper (minimum size 0.45 um; this filter paper is often overlain by a pre-filter to prevent premature clogging of the filter paper) 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 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 um) divides the chambers. Using a hand pump or a Gilian-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 all the sample into the lower chamber. If preservation of the sample is necessary, this should be done after filtering.

Filtering is not allowed for samples which are to be analyzed for organic compounds.

7.6 Post Operation

After all samples from a well are collected and preserved, the sampling equipment should be decontaminated prior to sampling another well to prevent cross contamination of equipment and monitor wells between locations.

1. Decontaminate all equipment in the field, if appropriate, following Standard Operating Procedure Eight for Sampling Equipment Decontamination.

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 Sampling

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

Sample-retrieval systems suitable for the valid collection of samples for volatile-organic analysis are: positive displacement bladder pumps, gear driven submersible pumps, syringe samplers and bailers (Barcelona and others, 1984; Nielsen and Yeates, 1985). 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. When collecting duplicates, collect both samples at the same time.

2. Fill the vial to just overflowing. Do not rinse the vial or excessively overflow it. 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 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.

6. Samples should be shipped or delivered to the laboratory daily so as not to exceed the holding time or recommended storage temperature.

8.0 OTHER PURGING & SAMPLING PROCEDURES

8.1 Low Flow Purging & Sampling Overview

Low flow (or low stress) purging and sampling results in collection of ground water samples from monitoring wells that are representative of ground water conditions in the geological formation. This is accomplished by minimizing the stress on the geological formation and minimizing disturbance of sediment that has collected in the well. The procedure applies to monitoring wells that have an inner casing diameter of 2.0 inches or greater and maximum screened interval of ten feet unless multiple intervals are sampled. The procedure is appropriate for collection of ground water samples that will be analyzed for volatile and semi-volatile organic compounds (VOCs and SVOCs), pesticides, polychlorinated biphenyls (PCBs), metals, and microbiological contaminants.

The purpose of the low stress purging and sampling procedure is to collect water samples from monitoring wells that are representative of ground water conditions in the geological formation. This is accomplished by setting the intake velocity of the sampling pump to a flow rate that limits drawdown inside the well casing.

Sampling at the prescribed (low) flow rate has three primary benefits:

1. It minimizes disturbance of sediment in the bottom of the well, thereby producing a sample with low turbidity (i.e., low concentration of suspended particles).

2. The procedure minimizes aeration of the ground water sample during collection, which improves the sample quality for VOC analysis.

3. In most cases the procedure significantly reduces the volume of ground water purged from a well and the costs associated with its proper treatment and disposal.

Problems that may be encountered using this technique include, difficulty in sampling wells with insufficient yield, failure of one or more key indicator parameters to stabilize, cascading of water and or the formation of air bubbles in the tubing, and cross contamination between wells.

Wells with insufficient yield (low recharge rate of the well) may dewater during purging. Care should be taken to avoid loss of pressure in the tubing due to dewatering of the well below the level of the pump's intake. Purging should be interrupted before the water level in the well drops below the top of the pump, as this may induce cascading. Pumping the well dry should be avoided to the extent possible. Sampling should commence as soon as the water in the well has recovered sufficiently to allow for collection of a sample.

If one or more key indicator parameters fails to stabilize after 4 hours, one of four options should be considered: continue purging in an attempt to achieve stabilization; discontinue purging, do not collect samples, and document attempts to reach stabilization; discontinue purging, collect samples and document attempts to reach stabilization; or secure the well, then purge and collect samples the next day. The key indicator for samples to be analyzed for VOCs is dissolved oxygen. The key indicator parameter for all other samples is turbidity.

To prevent cascading and/or air bubble formation in the tubing, care should be taken to ensure that the flow rate is sufficient to maintain pump suction. Minimize the length and diameter of tubing (i.e., 1/4 or 3/8 inch ID) to ensure that the tubing remains filled with ground water during sampling.

To prevent cross-contamination between wells, it is strongly recommended that dedicated, in-place pumps be used. As an alternative, the potential for cross-contamination can be reduced by performing the more thorough "daily" decontamination procedures outlined in SOP 8.

8.1.1 Low Flow Sampling Procedure

1. ***Install pump:*** Slowly lower the pump, safety cable, tubing, and electrical lines into the well. The pump intake must be kept at least two (2) feet above the bottom of the well to prevent disturbance and re-suspension of any sediment in the well bottom. Record the depth to which the pump is lowered. (**Note:** A variety of sampling devices are available for low-flow purging and sampling and include peristaltic pumps, bladder pumps, electrical submersible pumps, and gas driven pumps.)

2. ***Measure water level:*** Before starting the pump, measure the water level again with the pump in the well. Leave the water level measuring device in the well.

3. ***Purge well:*** Start pumping the well at 200 to 300 milliliters per minute (ml/min). The water

level should be monitored at five minute. Ideally, a steady flow rate should be maintained that results in a stabilized water level (drawdown of 0.3 feet or less). Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. As noted above, care should be taken to maintain pump suction and to avoid entrainment of air in the tubing. Record each adjustment made to the pumping rate and the water level measured immediately after each adjustment.

4. ***Monitor indicator parameters:*** During purging of the well, monitor and record the field indicator parameters (turbidity, temperature, specific conductance, pH, Eh, and dissolved oxygen) approximately every five minutes. The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings as follows (Puls and Barcelona, 1996):

   $\pm$ 0.1 pH
   $\pm$ 3% for specific conductance (conductivity)
   $\pm$ 10 millivolts for redox potential
   $\pm$10% for dissolved oxygen and turbidity

   (**Note:** The pump must not be removed from the well between purging and sampling.)

5. ***Collect samples:*** Collect samples at a flow rate between 100 and 250 ml/min and such that the drawdown of the water level within the well does not exceed the maximum drawdown of 0.3 feet. VOC samples must be collected first and directly into sample containers. All sample containers should be filled with minimal turbulence by allowing the ground water to flow from the tubing gently down the inside of the container.

8.2 Non-Purge Well Sampling *(Modified from Indiana Department of Environmental Management – Interoffice Memorandum December 1, 1999)*

A review of the available data comparing standard purge type sampling to non-purge sampling shows that the non-purge sampling methodology provides comparable results to purged sampling. The non-purge method can be used as an option at hydrocarbon contaminated sites, if the following conditions are met:

(Note: The procedure must be approved by the department before non-purge sampling is implemented at a site.)

1. The method can be utilized only for wells used to monitor hydrocarbons, benzene, toluene, xylenes, and MTBE. It cannot be used for metals, DNAPLs or other contaminants.

2. It can only be utilized in unconsolidated unconfined aquifers.

3. The monitoring well must be properly constructed, at least two-inches in diameter, and properly developed. In addition, the water table must be below the top of the well screen.

4. The monitoring well cannot contain free-product or a visible sheen.

5. If dedicated bailers are used they cannot be stored within the well. The Department recommends that disposable bailers be used with this sampling methodology.

6. If closure or no further action is requested on a site that has only been monitored using non-purge sampling, the final monitoring event must include both purged and non-purged samples from each well.

7. The sampling methodology and procedures must be detailed in each monitoring report. A separate table must be provided in each monitoring report, listing top of screen elevation and current water level of each monitoring well, to show that the water table has not fluctuated above the top of the screen. If the water table is above the screened interval, purged samples are required for that well.

9.0 CALCULATIONS

To calculate the water volume of a well (in gallons of water per foot of casing), utilize the following equation:

Water volume = pr^2h (cf) [Equation 1]

where:
- p = pi (approximately 3.14)
- 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 factor (gal/ft^3) = 7.48 gal/ft^3 [In this equation, 7.48 gal/ft^3 is the necessary conversion factor.]

If the diameter of the monitor well is known, 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 monitor well diameters can be calculated as follows:

volume (in gal/ft) = pr^2 (cf) [Equation 2]

where:
- p = pi (approximately 3.14)
- r = radius of monitoring well (feet)
- cf = conversion factor (7.48 gal/ft^3)

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

volume (in gal/ft) = pr^2 (cf) [Equation 2]
= 3.14 (1/12 ft)^2 7.48 gal/ft^3
= 0.1632 gal/ft

Remember that the well diameter in inches must be converted to a radius in feet in order to use the equation. Some examples of volumes in gallons per linear foot for some different well diameters (Schedule 40 PVC) are listed below.

Well Diameter	2 inches	3 inches	4 inches	6 inches
Approximate Volume (gal./ft.)	0.1632	0.3672	0.6528	1.4688

If volumes in gallons per foot, such as those listed above, are utilized, then Equation 1 should be modified as follows:

Water volume = (h) volume (in gal/ft) [Equation 3]

where: h = height of water column (feet)

The water volume of a well is typically tripled to determine the volume to be purged.

10.0 QUALITY ASSURANCE/QUALITY CONTROL

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

- All data must be documented 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.
- The collection of rinsate blanks is recommended to evaluate potential for cross contamination from or between the purging and/or sampling equipment.
- Trip blanks are required if analytical parameters include volatile-organic compounds.

For additional information refer to the Standard Operating Procedures for Quality Assurance/Quality Control Samples (SOP 7).

11.0 DATA VALIDATION

Results of quality-control samples will be evaluated by lab personnel and the project leader. This information will be utilized to qualify the sample results in accordance with the project's data-quality objectives.

12.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. Environmental Protection Agency (U.S. EPA), Occupational Safety and Health Administration (OSHA), or corporate 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:

- Avoid breathing constituents venting from the well.
- Survey the well headspace with a flame-ionization detector (FID) or photo-ionization detector (PID) prior to sampling.
- If monitoring results indicate organic constituents, sampling activities may be conducted in protective clothing. At a minimum, skin protection will be afforded by disposable protective clothing.

Physical hazards associated with well sampling:

- Lifting injuries associated with pump and bailers retrieval; moving equipment.
- Cuts associated with the use of pocket knives for cutting discharge hose, etc.
- Heat/cold stress as a result of exposure to extreme temperatures and because of protective clothing.
- Situations conducive to slipping, tripping, or falling as a result of wet or icy conditions.
- Electrical shock associated with use of submersible pumps is possible. Use a ground fault circuit interrupter or a copper grounding stake to avoid this problem.
- Acid burns may occur if acid preservatives are mishandled.
- Long-term exposure to hazardous chemicals found at many sites of investigation may pose a health hazard, especially if proper protective clothing is not worn.

13.0 REFERENCES

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