APPENDIX 3A

PSC Standard Operations Procedures (SOPs)

Collection and Handling of Sediment Samples

Written By:	Approved By:	Date:	QA Concurrence:	Date:
Carolyn Mayer	Carolyn Mayer	6/1/98	Laurel Muselwhite	7/1/98

This SOP Contains 8 Sections:

1.0 Purpose

The purpose of this SOP is provide a set of guidelines to filed sampling personnel responsible for the collection and handling of sediment samples.

2.0 Application

This SOP provides step by step guidelines to be followed by field personnel responsible for the collection and handling of sediment samples from rivers, streams and standing bodies of water.

3.0 References

A Compendium of Superfund Field Operations Methods, Office of Emergency and Remedial Response, Office of Waste Programs Enforcement, U.S. Environmental Protection Agency, EPA/540/P-87/001, December 1987.

Refer to specific Survey Plans or Quality Assurance/Work Plans for the scope of work associated with individual sediment sampling programs.

4.0 Associated SOPs

PSC-102
PSC-103
PSC-200
PSC-300
PSC-400
PSC-106

5.0 Equipment

The following equipment is required to perform the collection of sediment samples:

- stainless steel bowl and spoon
- stainless steel dredge
- stainless steel hand auger
- modified Van-Veen grab sampler
- a supply of disposable rope or line;
- chemical resistant gloves;
- water proof boots, hip waders, or chest waders;
- stainless steel knife
- position locationing equipment including, Brunton compass, stainless steel rods, wooden stakes, flagging, location bouys, a weighted measuring tape and a camera;
- decontamination equipment and supplies;

- coolers and duct tape to ship samples;
- bubble wrap, ziploc bags, and garbage bags to ship samples;
- all required documentation includine a sufficient supply of the appropriate field forms, field log books, a field sampling notebook, and chain of custody forms;
- a copy of the Field Operations Plan, including, at a minimum, the Field Sampling Plan, the Health and Safety Plan, and the Quality Assurance Plan; and

When collecting samples from a boat or barge, the following support equipment is required in addition to the equipment already listed:

- life jackets for all personnel;
- sufficient lighting and flagging, as needed, for compliance with US Coast Guard requirements;
- spare oars as emergency backup in the event of engine failure;
- radio communications with shoreline personnel; and,
- an anchor.

6.0 Procedure

6.1 Sampling Criteria

Certain criteria are to be met prior to the collection of sediment samples. Locations selected for sediment sampling will be within areas of deposition, i.e., slow moving or standing areas of water. Sediment will be collected to a depth of 12 inches below the sediment-water interface. All loose organic debris will be removed from the sediment surface prior to sampling. Any organic debris which is representative of the depositional environment (i.e., has been buried within the sediment) will remain as

part of the sample, within the approximate percent of organic material recorded on the sample log. Large stones are to be removed from the samples after the relative percent of the stones has been recorded.

All locations will be approached from a downstream direction to minimize turbidity within the water column; downstream locations will be collected before upstream locations. At locations where surface water samples are also schedule for collection, the corresponding surface water sample will be collected before the sediment sample.

All sampling equipment will be decontaminated prior to use following in the procedure outlined in SOP PSC-200.

All samples intended for volatile organic analyses will be collected as grab samples. All other analytes will be composited in a stainless steel bowl to increase homogeneity. Distribution of the composited sediment sample into the various analyte bottles will not occur until a volume of sediment sufficient to fill all analyte bottles from the location has been collected for composite.

6.2 Collection of Sediment in Shallow Water (0-4 feet)

Collection of samples in areas of shallow water will be conducted by wading to the sampling location. One member of the sampling team will remain in visual contact with the sampler from the shoreline. All sediment samples will be collected using the stainless steel dredge with the following exceptions:

- a stainless steel hand auger may be used for collection of compacted sediments
- a stainless steel spoon may used for sediment collection beneath a water column of less than six inches

Following collection and distribution, each sample container will be wiped dry and placed on ice in cooler for the remainder of the days' sampling activities. Following the collection of the sample, the location will be marked by driving a labeled stake into the adjacent bank or shoreline. The position of the sample location will be noted as a range and a bearing to the marked stake. All documentation regarding the sample collection will be made in the field notebook.

6.3 Collection of Sediment in Deep Water (greater than 4 feet)

Sampling will be conducted from a boat. The boat will be positioned on the sampling location and the water depth at the sample location will be determined using a weighted measuring tape. Sediment samples will be collected using a modified Van Veen grab

sampler. Sample handling, storage and sample location documentation will be performed as in described section 6.2 and 7.0.

7.0 Chain of Custody Forms and Sample Labels

SOP PSC-400 describes in detail the procedures for filling out sample labels and the Chain of Custody documentation. Sample containers should be prelabeled if possible and the corresponding Chain of Custody Form will be completed before the samples are shipped to the analytical laboratory.

8.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing Sections 6.0 and 7.0 a minimum of twice under the direct supervision of the Corrective Actions Manager or his/her designee.

Collection and Handling of Surface Soil Samples

Written By:	Approved By:	Date:	QA Concurrence:	Date:
Carolyn Mayer	Carolyn Mayer	10/27/98	Chris Minton	11/1/98

This SOP Contains 8 Sections:

1.0 Purpose

The purpose of this SOP is provide a set of guidelines to filed sampling personnel responsible for the collection and handling of surface soil samples.

2.0 Application

This SOP provides step by step guidelines to be followed by field personnel responsible for the collection and handling of surface soil samples.

3.0 References

A Compendium of Superfund Field Operations Methods, Office of Emergency and Remedial Response, Office of Waste Programs Enforcement, U.S. Environmental Protection Agency, EPA/540/P-87/001, December 1987.

Refer to specific Survey Plans or Quality Assurance/Work Plans for the scope of work associated with individual surface soil sampling programs.

4.0 Associated SOPs

PSC-102
PSC-103
PSC-200
PSC-300
PSC-400
PSC-106

5.0 Equipment

The following equipment is required to perform the collection of sediment samples:

- stainless steel bowl and spoon
- stainless steel hand auger
- chemical resistant gloves;
- stainless steel knife
- position locationing equipment including, Brunton compass, stainless steel rods, wooden stakes, flagging, and a camera;
- decontamination equipment and supplies;

- coolers and duct tape to ship samples;
- bubble wrap, ziploc bags, and garbage bags to ship samples;
- all required documentation includine a sufficient supply of the appropriate field forms, field log books, a field sampling notebook, and chain of custody forms;
- a copy of the Field Operations Plan, including, at a minimum, the Field Sampling Plan, the Health and Safety Plan, and the Quality Assurance Plan; and

6.0 Procedure

6.1 Sampling Criteria

Surface soil samples will be collected from 0-4' below ground surface. All loose organic debris will be removed from the soil surface prior to sampling. Large stones are to be removed from the samples after the relative percent of the stones has been recorded.

All sampling equipment will be decontaminated prior to use following in the procedure outlined in SOP PSC-200.

Surface soil samples collected between 0-6" can be collected using a stainless steel spoon. Samples between 6" and 4' below ground surface should be collected using a stainless-steel hand auger.

All samples intended for volatile organic analyses will be collected as grab samples (i.e., directly from the sampling device). Soil for all other analyses will be homogenized in a stainless steel bowl. Distribution of the homogenized soil sample into the various sample bottles will not occur until a volume of soil sufficient to fill all bottles from the location has been collected.

Following collection and distribution, each sample container will be wiped dry and placed on ice in cooler for the remainder of the day's sampling activities.

The position of the sample location will be noted. All documentation regarding the sample collection will be made in the field notebook.

7.0 Chain of Custody Forms and Sample Labels

SOP PSC-400 describes in detail the procedures for filling out sample labels and the Chain of Custody documentation. Sample containers should be prelabeled if possible and the corresponding Chain of Custody Form will be completed before the samples are shipped to the analytical laboratory.

8.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing Sections 6.0 and 7.0 a minimum of twice under the direct supervision of the Corrective Actions Manager or his/her designee.

Standard Penetration Tests and Split Spoon Sampling

Written By:	Approved By:	Date:	QA Concurrence:	Date:
Carolyn Mayer	Carolyn Mayer	7/1/98	Laurel Muselwhite	7/1/98

This SOP contains ten sections:

1.0 Purpose
1.0 Application
1.0 References
1.0 Associated SOPs
1.0 Equipment
1.0 Decontamination
1.0 Standard Penetration Test Procedures
1.0 Split Spoon Sampling Procedures
1.0 Documentation
1.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to provide geotechnical field personnel with an outline of the specific information needed to conduct and document standard penetration tests and split spoon sampling. The required equipment and field forms are also outlined for each of these procedures.

1.0 Application

This SOP provides a step-by-step guideline to be followed by the site geologist when obtaining split spoon samples during drilling operations.

1.0 References

None

1.0 Associated SOPs

PSC-101	PSC-200
PSC-102	PSC-300
PSC-104	PSC-400
PSC-106	PSC-202

1.0 Equipment

The following equipment is required to properly conduct split spoon sampling and standard penetration tests from soil borings:

- a 24 inch or 60 inch split spoon sampler, including sample traps;
- sample characterization equipment such as a Geological Society of America Rock-Color Chart (Munsell System), a 10x (minimum) hand lens, a rigid two foot ruler (accurate to a hundredth of a foot), the Unified Soil Classification System, and an organic vapor analyzer (e.g. a photoionization detector, HNU PI-101, or a flume ionization detector, OVA)
- a stainless steel bowl and scoop;
- sample bottles, including labels, and;
- all personal protective and decontamination equipment required in the project sampling plan and Standard Operating Procedure PSC-200 and PSC-202

1.0 Decontamination

All equipment which will come in contact with the subsurface and/or be used to acquire a sample will be decontaminated prior to arrival on site, between samples, and site exit. Standard Operating Procedure PSC-200 shall be followed.

1.0 Standard Penetration Test

Engineering and physical properties of soil may be of interest should site construction activities be planned. Soil types, bearing strength, compressibility, permeability, plasticity, and moisture content are some of the physical characteristics that may be determined on soil samples. The ASTM Standard Penetration Test (SPT) is an important component in identifying some of these characteristics (e.g., relative density,

compactness, and cohesiveness). The following procedure must be followed in order to conducted the SPT:

- Attach a decontaminated 24 inch split spoon sampler to the appropriate length of drill rods and gently lower the sampler to the bottom of the bore hole (the spoon should only be handled while wearing a clean pair of Latex gloves in order to reduce the risk of contamination). The spoon should be resting on undisturbed soil at the upper boundary of the soil interval to be sampled;

- mark 6 inch increments on the drill rod upward from a rigid surface datum (e.g., ground surface or hollow stem auger drill casing), for a length of 24 inches;

- drive the split spoon into the soil using a certified 140 lb. Hammer dropped consistently from a height of 30 inches;

- count and record the number of blows struck by the hammer for each six inch increment of penetration;

- the test is completed when either the spoon has been driven 24 inches or when 100 blows are counted within a 6 inch increment before the complete 6 inch penetration of the increment has been obtained (refusal); and,

- if refusal occurs at anytime during the test, record the number of blows counted for each 6 inch increment penetrated prior to refusal, and then 100 blows per the amount of penetration (to the nearest hundredth of a foot) attained during the final increment.

In situations where the weight of the drill rods (w/r) or the weight of the hammer and drill rods together (w/h) is sufficient to drive the split spoon into soil without inflicting blows from the hammer, this should be recorded on the Soil Boring Logs as "w/r" or "w/h" for each applicable 6 inch increment.

1.0 Split Spoon Sampling Procedure

Subsurface soil samples are collected in order to accurately characterize local stratigraphic compositions and interfaces.

The following procedures for retrieving and logging a subsurface soil sample via split spoon sampling shall be followed:

- 24 inch split spoon soil samples will be collected at ground surface and at 5.0 foot intervals, unless otherwise indicated in the Sampling Plan;

- the SPT will be conducted for each sample and the blows recorded on the geologic sample label and on the Soil Boring Logs;

- upon completion of the SPT, the split spoon is brought to the surface and removed from the drill rods;

- the split spoon sample will be opened and immediately screened for organic vapors by the site geologist using a calibrated photo or flame ionization detector (PSC-300). Organic vapor measurements are made by placing the instrument probe approximately 1.5 inches from the sample core and slowly passing the probe over the length of the sample;

- record the highest reading obtained, and the position of that reading along the length (depth) of the spoon in both the field notebook and on the Soil Boring Logs;

Groundwater Monitoring Well Installation

Written By:	Approved By:	Date:	QA Concurrence:	Date:
Carolyn Mayer	Carolyn Mayer	7/1/98	Laurel Muselwhite	7/1/98

This SOP contains nine sections:

1.0 Purpose
1.0 Application
1.0 References
1.0 Associated SOPs
1.0 Installation Equipment and Materials
1.0 Monitoring Well Installation Procedure
1.0 Standard Surface Finishing Designs
1.0 Documentation
1.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to provide geotechnical field personnel with an outline of the specific information needed to install and construct monitoring wells in both unconsolidated and bedrock media. The required equipment and documentation are also outlined for each of these procedures. The recommended monitoring well design, as presented in this SOP, is based on the assumption that the objective of the program is to obtain representative ground water information and water quality samples from aquifers.

1.0 Application

Ground water monitoring wells are generally used as collection points for ground water samples and as measuring points for aquifer hydraulic properties.

This SOP provides a step-by-step guideline to be followed by the site geologist to design and install monitoring wells suited to these purposes.

1.0 References

ASTM Proposed Recommended Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers (February 19, 1990).

U.S. EPA, Office of Solid Waste. 1992. RCRA Ground-Water Monitoring Draft Technical Guidance. November.

Driscoll, Fletcher G. 1986. Groundwater and Wells. Second Edition. Published by Johnson Filtration Systems, Inc., St. Paul Minnesota.

1.0 Associated SOPs

PSC-103
PSC-121
PSC-400

1.0 Installation Equipment and Materials

The following equipment should be provided and maintained by the site geologist:

- a calibrated photoionization detector; isobutylene span gas, regulator, and tedlar bag;
- a weighted fiberglass tape calibrated to .001 foot and of sufficient length to reach the bottom of the deepest bore hole;
- a wooden folding ruler calibrated to a .001 foot;
- an electric water level indicator, immiscible phase probe or chalked steel tape for obtaining water level measurement to an accuracy of .001 foot;
- a field notebook and calculator.
- a camera;

- a small file or saw to permanently mark a double notch at the top of the well casing/riser;
- permanent marker or paint pen to mark the identification of the well on the steel pipe finish;
- a sufficient supply of blank daily drilling reports and monitoring well construction field forms;
- a copy of the Field Operations Plan including, at a minimum, the Field Sampling Plan, the Health and Safety Plan and the Quality Assurance Project Plan
- all required personnel protective equipment as defined in the Health and Safety Plan;
- a sufficient amount of deionized water to hydrate the bentonite.
- A brass or hardened-steel security lock.

The drilling contractor is responsible for providing the following:

- well screen and riser components with flush joints with square profile threads to obtain water tight seals;
- machine slotted well screens (0.010 size);
- bentonite pellets or chips;
- "quick-set" additive (if necessary when cold weather conditions);
- filter sand;
- a steam cleaner;
- cement grout, mixer, tremie pipe;
- the project specific required surface finishing materials; and
- all required personnel protective equipment as defined in the Health and Safety Plan.

6.0 Monitoring Well Installation Procedure

Once a stable bore hole has been advanced to the desired depth in accordance with Standard Operating Procedure PSC-103, the installation of a well screen and riser will proceed as follows:

Materials Inspection and Cleaning

- decontaminate both inside and outside of the well screen, bottom plug and riser immediately prior to assembly and installation, using a water source of known chemistry and a mild non-phosphate detergent then rinse with deionized water; store decontaminated riser and screen in an area free of contaminants and cover with plastic sheeting;

- inspect all materials prior to assembly to insure material integrity.

Bore Hole Preparation

- if viscous drilling fluids were introduced to the borehole, then the borehole should be flushed with clean water of known chemistry. This is done to remove all viscous drill fluids from the bore hole which could prevent proper setting of well construction materials;

- record the volume of water introduce into the bore hole and recovered from the bore hole during flushing. The difference in there two volumes requires recovery during well development in addition to the calculated well volume to be removed PSC-121.

- check the total depth of the bore hole using a weighted fiberglass tape and a constant datum such as the ground surface. Bore holes that are partially obstructed by caved or blow-in sediments should be cleared in accordance with Standard Operating Procedure PSC-103 prior to initiating well installation;

- a 1.0 foot thick base layer of filter san should be placed at the base of the bore hole using a decontaminated, flush threaded, one inch internal diameter (minimum) tremie pipe. Alternatively, the filter sand may be added directly between the rise pipe and the auger or casing. Verify the depth of the top of the sand base;

Monitoring Well Pre-assembly

- pre-cut the uppermost section of the well riser so that when the well is in place, the top of the well riser will be approximately 4 to 6 inches below the ground surface for flush finished wells, or 3.0 feet above the ground surface for wells designed with a standpipe finish;

- permanently identify the survey and measuring point on the upper rim of the well riser by cutting a double notch into the rim (Figure 1);

Monitoring Well Installation

- quickly assemble the well within the bore hole by adding sections to the top of the column until the screened section is set at the desired depth. Care should be taken to prevent any materials from entering the well during down hole assembly;

- use of a geosock to prevent fines from entering the well should be discussed on an individual basis per project. If used, slip it on over the screened interval as the well is being assembled.

- cap the well riser to prevent materials from entering the well during construction;

- begin placing the chemically inert filter pack within the annular space surrounding the well screen while simultaneously removing the augers or casing;

- the filter pack should be added slowly in order to prevent bridging of the sand between the riser and the borehole or auger; when adding filter pack below the water table or to a deep well, a tremie pipe should be used;

- add the filter sand until it extends no more than 2.0 feet inside the auger or casing, then pull the casing upward allowing the filter sand to flow from the bottom, filling the resultant annular space. Frequent depth measurements should be taken using a weighted tape to verify the effectiveness of this procedure. The augers or casings should not be extracted in greater than 2.0 foot increments to minimize the potential for native sediments to cave or slump into the annular space;

- continue placing the filter pack until it extends above the screen for a distance equal to approximately 20% of the total screened interval, but not less than 2.0 feet above the top of the screen. Where there is a hydraulic connection between the zone to be monitored and the overlying strata, this upward extension of the filter pack should be minimized, subject to the construction described above, to prevent seepage from upper zones which may result in less than representative sampling;

- it is optional to place a secondary, finer filter pack directly above the first to prevent intrusion of the bentonite seal into the primary filter pack. This filter pack should be designed with a vertical thickness ranging between 0.5 and 2.0 feet. As with the primary filter pack, the secondary filter must not extend into an overlying hydrologic unit. The need for this filter pack should consider the gradation of the primary filter pack, the hydraulic heads between adjacent units, and the potential for grout intrusion into the primary filter pack;

- place an annular sealant seal directly above the filter pack(s) while continuing to remove the augers or casing in 2.0 foot increments. This seal consisting of bentonite pellets or chips, should extend a minimum of 3.0 feet above the top of the filter pack. Frequent depth measurements should be taken using a weighted tape to verify the efficiency of this procedure.

- pour water of a known chemistry over the bentonite pellets or ships if the seal is located in the vadose (unsaturated) zone (i.e., above the water table) to hydrate the bentonite. Record the amount of water added during this procedure for corrected well water removal during well development (PSC-121).

- fill the remaining annular space with a bentonite grount slurry continuing to remove the augers or casing in two foot increments. The slurry should extend to approximately 5.0 to 6.0 feet below ground surface and all augers or casing should be withdrawn. Allow 24 hours to settle and set;

- top-off the grouted column to 5.0 to 6.0 feet below the ground surface and allow to set overnight.

6.0 Standard Surface Finishing Designs

The following defined our standard "flush mount" and "stand pipe" monitoring well finishing procedures:

7.1 Standard Flush Mount Finish

This finishing design (Figure 2) is used when monitoring wells are installed in high traffic areas or other areas where a low profile design is needed. Flush mount wells are less preferable than stand pipe wells because there is a greater chance of surface water entering a flush mount well. The standard flush mount finish is constructed as follows:

- add filter sand to the annular space above the grouted column to a depth of approximately 3.5 feet below ground surface;
- center a 4.0 foot length of 4 or 5 inch diameter steel casing, with locking steel cap into the bore hole. This casing should be placed so that the locking lid rests approximately 2 inches above the top of the capped well riser, and is seated a minimum of 6 inches into the filter sand;
- place a bentonite seal using water of known chemistry;
- place filter sand in the annular space between the well riser and the steel casing to a depth of 1.0 foot below ground surface;
- center a 13 inch diameter, aluminum cast, manhole-type cover equipped with a water tight gasket and a 1.0 foot aluminum vertical extension, over the locking steel casing. The top of the aluminum cover should be approximately a ¼ inch above the ground surface;

- add grout to the excavated area, allowing the grout to flow into the annular spacing surrounding the steel casing. Fill the excavation evenly to a depth of approximately 8 inches below the ground surface and allow to settle and set (to shorten the setting time, the use of adding "quick-set" to the grout is acceptable). The bottom few inches of the aluminum cover should be seated in the cement;

- add cement to the excavated area surrounding the aluminum cover until the cement is flush with the ground surface. Gently grade and smooth the cement from the edge to the cover, so that runoff is away from the well and allow to set;

- permanently identify the well by labeling the cement pad, aluminum cover and lid to the locking steel casing; and

- secure well with an approved brass or hardened-steel lock.

7.2 Standard Stand Pipe Finish

This finishing design (Figure 3) is used when the flush finish design is not needed. The standard stand pipe finish is constructed as follows:

- add filter sand to the annular space above the grouted column to a depth of approximately 1.5 feet below ground surface;

- center a 5.0 foot length of 4 or 5 inch inside diameter steel casing, with locking steel cap into the bore hole. This casing should be placed so that the locking lid rests approximately 2 inches above the top of the capped well riser, and is seated a minimum of 6 inches into filter sand;

- place filter sand in the annular space between the well riser and the steel casing to ground surface;

- excavate a 2.5 foot square which measures approximately 6 inches deep around the edges and grades deeper with depth at a slope of approximately 45° toward the bore hole. Take care to minimize the deposition of soil into the annular space outside the steel casing;

- using 2' x 6' lumber, construct a 3.0 foot square wooden frame and insert the frame into the excavation. Situate the frame so that all edges are flush with the ground surface;

- place three 3.0 foot long steel bumper guards in the excavation to protect the stand pipe from damage resultant from vehicular traffic on the line;

- add cement to the excavated area, allowing the cement to flow into the annular spacing surrounding the steel casing, until the cement is flush with the ground surface. Gently grade and smooth the cement from the edge to the casing, so the runoff is away from the well, and allow to set (to shorten the setting tiem, the sue of adding "quick-set" to the cement is acceptable under cold weather conditions);

- permanently identify the well by labeling the cement pad, stand pipe and lid to the locking steel casing; and,

- secure well with an approved brass or hardened-steel lock and record key number in field log book.

8.0 Documentation

Documentation of all monitoring well installation activities including all geotechnical forms and the maintenance of a detailed field notebook will be recorded in accordance with Standard Operating Procedure PSC-400.

9.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing Sections 6.0, 7.0 and 8.0 a minimum of twice under the direct supervision of the Corrective Actions Manager or a designee.

Written By:	Approved By:	Date:	QA Concurrence:	Date:
Laurel Muselwhite	Carolyn Mayer	6/29/98	Carolyn Mayer	7/1/98

This SOP contains twelve sections:

1.0 Purpose

The purpose of this SOP is to provide field personnel with an outline of the specific information needed to measure and document the elevation of ground water, light non-aqueous phase liquid (LNAPL), and dense non-aqueous phase liquid (DNAPL) in monitoring wells.

2.0 Application

This SOP provides a step-by-step guideline to be followed by the field sampling crew to assure consistent and representative measurements of groundwater, LNAPL, and DNAPL.

3.0 References

"RCRA Ground-Water Monitoring: Draft Technical Guidance", USEPA, Office of Solid Waste, Nov. 1992.

4.0 Associated SOPs

PSC-122 PSC-123 PSC-124 PSC-200 PSC-201
PSC-202 PSC-300

5.0 Equipment

The following equipment is necessary to properly measure ground water levels:

- A well key, hand drill, socket set, pad lock key, or other well access equipment.
- A photo-ionization detector (PID) to monitor and record the well headspace.
- An electric water meter and oil/water interface probe calibrated to a hundredth of a foot, sufficiently long enough to reach the bottom of the well, and narrow enough to fit in the monitoring well or dedicated pump well seal.
- All required documentation materials including field books and field forms.
- Personal protective equipment as described in the Site Health and Safety Plan.
- Decontamination equipment as specified in the Work Plan.

6.0 Procedures

6.1 Measuring water-level elevations

Upon arrival at each well, the following procedures shall be followed:

- Suit up in appropriate personal protective equipment as described in the Site Health and Safety Plan.
- Brush any soil or vegetation away from the well opening.
- Open the well cap.
- Monitor the headspace at the well opening using the PID. See PSC-300 for PID calibration and operation. This is done by placing the instrument probe at the opening of the well, and recording the maximum reading in the field book and on the appropriate water level field forms.
- Measure and record the depth to water using a decontaminated water level indicator. The water level indicator should be turned on to a medium level of sensitivity and slowly lowered until it reaches the water table. When the probe reaches the interface of the water table, it will beep. If the well does not have a dedicated pump, lower the water-level indicator probe to the bottom of the well to measure total depth of the well. Gently bounce the probe on the well bottom and pull the slack on the cord to read the total depth. All measurements should be read from a notch or marking in the PVC well riser or, in the event there is no notch, record the measurement from the north side of the well. All measurements should be duplicated to ensure that the readings are accurate and represent true depths. Measurements are to be made to the nearest one hundredth of a foot and recorded in the field book and on the appropriate water level field form.
- Decontaminate the water level indicator as specified in Standard Operating Procedure PSC-200.
- Close the well appropriately and record any well integrity concerns in the field book and on the well maintenance form.

6.2 Measuring LNAPL Elevations

Some wells require measurement of Light Non Aqueous Phase Liquids (LNAPLs) during the periodic water level reading procedure. An oil/water interface probe will be used for the measurement. LNAPLs exist at the top of the water table. Therefore, the probe should be lowered very slowly in order to detect the slightest sheen of LNAPL. An intermittent beep indicates the presence of LNAPL and a constant beep indicates the probe is in water. Record "sheen" if the instrument detects LNAPL <0.01 feet. Otherwise, record the measurement to the nearest hundredth of a foot below ground surface. Decontaminate the oil/water interface probe as specified in Standard Operating Procedure PSC-200. Close the well appropriately and record any well integrity concerns in the field book and on the well maintenance form.

6.3 Measuring DNAPL Elevations

Some wells require measurement of Dense-Non-Aqueous-Phase-Liquids (DNAPLs) during the periodic water level reading procedure. An oil/water interface probe will be used for the measurement. DNAPLs exist at the bottom of the water column, usually on top of a confining layer. The probe should be lowered to the bottom of the well very slowly in order to detect the slightest sheen of DNAPL. An intermittent beep indicates the presence of DNAPL and a constant beep indicates the probe is in water. Record the measurement to the nearest hundredth of a foot below ground surface. Decontaminate the oil/water interface probe as specified in Standard Operating Procedure PSC-200. Close the well appropriately and record any well integrity concerns in the field book and on the well maintenance form.

7.0 Decontamination

All equipment that will come in contact with the well water will be decontaminated prior to arrival on site, relocation on site, and site exit. Decontamination procedures outlined in Standard Operating Procedure PSC-200 shall be followed.

8.0 Documentation

All monitoring well water level, LNAPL, or DNAPL measurements will be documented on field forms and in a detailed field notebook. Standard Operating Procedure PSC-400 describes documentation procedures and provides examples of approved field forms.

9.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing sections 6.0, 7.0, and 8.0 a minimum of twice under the direct supervision of the Corrective Actions Manager or her/his designee.

Monitoring Well Development

Written By:	Edited by:	Approved By:	QA Concurrence:
Carolyn Mayer	Tasya Gray	Carolyn Mayer	Kevin McNeil
11/23/97	7/24/01	7/24/01	7/24/01

This SOP contains nine sections:

1.0 Purpose

The purpose of this SOP is to provide field personnel with a set of guidelines to assure proper monitoring well development. According to EPA all monitoring wells should be developed to create an effective filter pack around the well screen, to rectify damage to the formation caused by drilling, to remove fine particulates from the formation near the borehole, and to assist in restoring the natural water quality of the aquifer in the vicinity of the well.

2.0 Application

This SOP provides a step-by-step guideline to be followed by the field sampling crew for performing or overseeing monitoring well development.

3.0 References

RCRA Groundwater Monitoring Draft Technical Guidance (Nov. 1992) EPA/530-R-93-001

4.0 Associated SOPs

PSC-200 – Equipment Decontamination Procedure
PSC-300 – Photo-ionization Detector Calibration and Operation
PSC-400 – Documentation Procedures

5.0 Equipment

The following equipment is necessary to properly develop a ground water monitoring well:

- A well key, hand drill, socket set, pad lock key, or other well access equipment.
- A calibrated photo-ionization detector (PID) to monitor and record the well headspace.
- An electric water meter and oil/water interface probe calibrated to a hundredth of a foot, and sufficiently long to reach the bottom of the well.
- Well purging equipment (e.g. bailer, silicone line, PVC pipe, plug, pump, tubing, power supply, and extension cord), as needed.
- A solid PVC surge block.
- A sufficient number of 55-gallon drums (including lids, gaskets, and fasteners) to contain all purge water, unless other water handling arrangements have been made.
- A calibrated water quality meter that measures temperature, pH, specific conductivity, dissolved oxygen, redox potential, and turbidity.
- All required documentation including sample labels, field books, sampling forms, and chains-of-custody.
- Personal protective equipment as described in the Site Health and Safety Plan.

- Decontamination equipment as specified in the Work Plan.

6.0 Decontamination

All equipment that will come in contact with the well water will be decontaminated prior to arrival on site, relocation on site, and site exit. Standard Operating Procedure PSC-200 shall be followed.

7.0 Well Development Procedures

Upon arrival at each well, the following procedures shall be followed:

- Suit up in appropriate personal protective equipment as described in the Site Health and Safety Plan.

- Brush any soil or vegetation and pump any standing water away from the well opening.

- Lay plastic sheeting around well to place equipment on and keep cords, tubing and pumps from touching the ground.

- Open the well cap.

- Monitor the headspace within the well using the PID (PSC-300 for PID operation). This is done by placing the instrument probe at the opening of the well, and recording the reading in the field book and on the appropriate field forms.

- Measure and record the depth to LNAPL, water, DNAPL, and total depth of the well using a decontaminated oil/water interface probe or water level indicator (depending on the historical presence of NAPLs in the well). All LNAPL and DNAPL measurements are to be made in accordance with PSC-120. Measurements are to be made to the nearest one hundredth of a foot and recorded in the field book and on the appropriate field form.

- Compute the unit purge volume using the following formula and the input values on the attached Well Volumes Sheet.

  1 well volume (including annular space) = [x(total well depth – water level)] + [y(total well depth – bottom of seal)]

where "x" is the Casing/Riser Volume per Unit Length, Internal (gal/ft) and "y" is the Annular Volume per Unit Length (gal/ft)

7.1 New Well Development Procedure

- If a submersible pump is to be used for well development, gently lower the pump to the well bottom. If a non-submersible pump is used, lower the tubing to the bottom of the well.

- Begin to purge the well at a rate sufficient to remove fines, slowly run the pump up and down the well over the length of the screen, and initiate physical water quality testing at least every 20% water removed for temperature, pH, conductivity, dissolved oxygen, and turbidity.

- A minimum of three and maximum of five well volumes (including annular space) will be removed. If this is the first time the well has been developed and water was used in the drilling process, the volume of water introduced into the formation during well formation must also be removed during development. *Purging is completed once the following has occurred:*
  - *the minimum purge volume has been removed and the water quality parameters have stabilized by the following screening requirements for three consecutive readings: Turbidity <5 NTU, specific conductivity within 10% of each other, and pH within 0.5 units; OR*
  - *the well runs dry; OR*
  - *five purge volumes and drilling process water volumes have been removed.*

- Measure total depth of well after development.

- Containerize all purge water in 55-gallon drums, unless other handling arrangements have been made.

- Record additional information such as unique odors or water color, and a description of the suspended particle content in the field notes and on appropriate field forms.

- Upon completion of development, both the well and the purge drums are to be properly sealed and secured.

- All drums are to be permanently labeled as follows:

Well ID
Facility Name
Drum Contents
Date
Drum Number

- Close the well appropriately and record any well integrity concerns in the field book and on the sampling form.

7.2 Existing Well Development Procedure

- Remove pump from well.
- Attach one length of twine to the surge block or use a drill rig or tripod and lower it to the bottom of the well.
- Vigorously begin moving the surge block up and down in the well creating a surging action across the screened interval. This action will bring the finer grained materials into suspension.
- Remove the surge block.
- Begin to purge the well at a sufficient rate to remove fines and initiate physical water quality testing at a minimum of every 20% water removed for turbidity.
- Repeat surging and purging to reduce silt presence in water and keep checking total depth measurements.
- A minimum of three and maximum of five well volumes (including annual space) will be removed. *Purging is completed once the following has occurred:*
  - *the minimum purge volume has been removed and the water quality parameters have stabilized by the following screening requirements for three consecutive readings: Turbidity <5 NTU, specific conductivity within 10% of each other, and pH within 0.5 units; OR*
  - *the well runs dry; OR*
  - *five purge volumes and drilling process water volumes have been removed.*
- Measure total depth of well after development.

- Containerize all purge water in 55-gallon drums, unless other handling arrangements have been made.

- Record additional information such as unique odors or water color, and a description of the suspended particle content in the field notes and on appropriate field forms.

- Upon completion of development, both the well and the purge drums are to be properly sealed and secured.

- All drums are to be permanently labeled as follows:
  Well ID
  Facility Name
  Drum Contents
  Date
  Drum Number

- Close the well appropriately and record any well integrity concerns in the field book and on the sampling form.

8.0 Documentation

Documentation of all monitoring well development activities including all field forms and the maintenance of a detailed field notebook are described in PSC-400.

9.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing sections 6.0, 7.0, and 8.0 a minimum of twice under the direct supervision of the Corrective Actions Manager or her/his designee.

Monitoring Well Development

Written By:	Edited by:	Approved By:	Date:	QA Concurrence:	Date:
Carolyn Mayer	Tasya Gray	Carolyn Mayer	3/27/01	Kevin McNeil	3/27/01

This SOP contains nine sections:

1.0 Purpose

The purpose of this SOP is to provide field personnel responsible for the development of monitoring wells with a set of guidelines to assure proper monitoring well development. According to EPA all monitoring wells should be developed to create an effective filter pack around the well screen, to rectify damage to the formation caused by drilling, to remove fine particulates from the formation near the borehole, and to assist in restoring the natural water quality of the aquifer in the vicinity of the well.

2.0 Application

This SOP provides a step-by-step guideline to be followed by the field sampling crew for performing or overseeing monitoring well development.

3.0 References

RCRA Groundwater Monitoring Draft Technical Guidance (Nov. 1992) EPA/530-R-93-001

4.0 Associated SOPs

PSC-122	PSC-123	PSC-200	PSC-201
PSC-300	PSC-400		

5.0 Equipment

The following equipment is necessary to properly sample a ground water monitoring well:

- A well key, hand drill, socket set, pad lock key, or other well access equipment.
- A calibrated photo-ionization detector to monitor and record the well headspace.
- An electric water meter and oil/water interface probe calibrated to a hundredth of a foot, and sufficiently long to reach the bottom of the well.
- Well purging equipment (e.g. bailer, silicone line, PVC pipe, plug, pump, tubing (silicone and Teflon), power supply, and extension cord).
- A solid PVC surge block.
- A sufficient number of 55-gallon drums (including lids, gaskets, and fasteners) to contain all purge water, unless other water handling arrangements have been made.
- A calibrated water quality meter that measures temperature, pH, specific conductivity, dissolved oxygen, redox potential, and turbidity.
- All required documentation including sample labels, field books, sampling forms, and chains-of-custody.
- Personal protective equipment as described in the Site Health and Safety Plan.
- Decontamination equipment as specified in the Work Plan.

6.0 Decontamination

All equipment that will come in contact with the well water will be decontaminated prior to arrival on site, relocation on site, and site exit. Standard Operating Procedures PSC 200 shall be followed.

7.0 Well Development Procedures

Upon arrival at each well, the following procedures shall be followed:

- Suit up in appropriate personal protective equipment as described in the Site Health and Safety Plan.
- Brush any soil or vegetation and pump any standing water away from the well opening.
- Lay plastic sheeting around well to place equipment on and keep cords, tubing and pumps from touching the ground.
- Open the well cap.
- Monitor the headspace within the well using the PID (PSC-300 for PID operation). This is done by placing the instrument probe at the opening of the well, and recording the reading in the field book and on the appropriate field forms.
- Measure and record the depth to (LNAPL), water, (DNAPL), and total depth of the well using a decontaminated oil/water interface probe or water level indicator (depending on the historical presence of NAPLs in the well). All LNAPL and DNAPL measurements are to be made in accordance with PSC-122 and PSC-123. Measurements are to be made to the nearest one hundredth of a foot and recorded in the field book and on the appropriate field form.
- Compute the unit purge volume using the Monitoring Well Development Data Sheet (PSC-400).

7.1 New Well Development Procedure

- If a submersible pump is to be used for well development, gently lower the pump to the well bottom. If a non-submersible pump is used, lower the tubing to the bottom of the well.

- Begin to purge the well at a rate sufficient to remove fines, slowly run the pump up and down the well over the length of the screen, and initiate physical water quality testing at least every 20% water removed for temperature, pH, conductivity, dissolved oxygen, and turbidity.

- A minimum of three and maximum of five well volumes (including annual space) will be removed. If this is the first time the well has been developed and water was used in the drilling process, the volume of water introduced into the formation during well formation must also be removed during development. *Purging is completed once the following has occurred:*
  - *the minimum purge volume has been removed and the water quality parameters have stabilized by the following screening requirements for three consecutive readings: Turbidity <5 NTU, specific conductivity within 10% of each other, and pH within 0.5 units; OR*
  - *the well runs dry; OR*
  - *five purge volumes have been removed.*

- Containerize all purge water in 55-gallon drums, unless other handling arrangements have been made.

- Record additional information such as unique odors or water color, and a description of the suspended particle content in the field notes and on appropriate field forms.

- Upon completion of development, both the well and the purge drums are to be properly sealed and secured.

- All drums are to be permanently labeled as follows:
  Well ID
  Facility Name
  Drum Contents
  Date
  Drum Number

- Close the well appropriately and record any well integrity concerns in the field book and on the sampling form.

7.2 Existing Well Development Procedure

- Remove pump from well.
- Attach one length of twine to the surge block or use a drill rig and lower it to the bottom of the well.
- Vigorously begin moving the surge block up and down in the well creating a surging action across the screened interval. This action will bring the finer grained materials into suspension.
- Remove the surge block.
- Begin to purge the well at a sufficient rate to remove fines and initiate physical water quality testing at a minimum of every 20% water removed for turbidity.
- Repeat surging and purging to reduce silt presence in water and keep checking total depth measurements.
- A minimum of three and maximum of five well volumes (including annual space) will be removed. *Purging is completed once the following has occurred:*
  - *the minimum purge volume has been removed and the water quality parameters have stabilized by the following screening requirements for three consecutive readings: Turbidity <5 NTU, specific conductivity within 10% of each other, and pH within 0.5 units; OR*
  - *the well runs dry; OR*
  - *five purge volumes have been removed.*
- Containerize all purge water in 55-gallon drums, unless other handling arrangements have been made.
- Record additional information such as unique odors or water color, and a description of the suspended particle content in the field notes and on appropriate field forms.
- Upon completion of development, both the well and the purge drums are to be properly sealed and secured.

- All drums are to be permanently labeled as follows:
  Well ID
  Facility Name
  Drum Contents
  Date
  Drum Number

- Close the well appropriately and record any well integrity concerns in the field book and on the sampling form.

8.0 Documentation

Documentation of all monitoring well development activities including all field forms and the maintenance of a detailed field notebook are described in PSC-400.

9.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing sections 6.0, 7.0, and 8.0 a minimum of twice under the direct supervision of the Corrective Actions Manager or her/his designee.

Monitoring Well Development

Written By:	Approved By:	Date:	QA Concurrence:	Date:
Carolyn Mayer	Carolyn Mayer	11/23/97	Laurel Muselwhite	11/23/97

This SOP contains nine sections:

1.0 Purpose
2.0 Application
3.0 References
4.0 Associated SOPs
5.0 Equipment
6.0 Decontamination
7.0 Well Development Procedure
8.0 Documentation
9.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to provide field personnel responsible for the development of monitoring wells with a set of guidelines to assure proper monitoring well development.

2.0 Application

This SOP provides a step-by-step guideline to be followed by the field sampling crew for performing or overseeing monitoring well development procedures.

3.0 References

None

4.0 Associated SOPs

PSC-122 PSC-123 PSC-200 PSC-201 PSC-300
PSC-400

5.0 Equipment

The following equipment is necessary to properly sample a ground water monitoring well:

- A well key, hand drill, socket set, pad lock key, or other well access equipment.
- A photo-ionization detector to monitor and record the well headspace.

- An electric water meter and oil/water interface probe calibrated to a hundredth of a foot, and sufficiently long to reach the bottom of the well.
- Well purging equipment (e.g. bailer, twine, PVC pipe, plug, pump, tubing (silicone and Teflon), power supply, and extension cord).
- A solid PVC surge block.
- A sufficient amount of strong disposable twine equal to twice the well depth of each well to be developed if a bailer is to be used or a single well depth if a submersible pump is to be used.
- A sufficient number of 55-gallon drums (including lids, gaskets, and fasteners) to contain all purge water, unless other water handling arrangements have been made.
- A water quality meter that measures temperature, pH, specific conductivity, dissolved oxygen, redox potential, and turbidity.
- All required documentation including sample labels, field books, sampling forms, and chains-of-custody.
- Personal protective equipment as described in the Site Health and Safety Plan.
- Decontamination equipment as specified in the Work Plan.

6.0 Decontamination

All equipment that will come in contact with the well water will be decontaminated prior to arrival on site, relocation on site, and site exit. Standard Operating Procedures PSC-201 (for Teflon and glass) and PSC-200 (for metal) shall be followed.

7.0 Well Development Procedure

Upon arrival at each well, the following procedures shall be followed:

- Suit up in appropriate personal protective equipment as described in the Site Health and Safety Plan.
- Brush any soil or vegetation away from the well opening.
- Lay plastic sheeting around well to place equipment on and keep cords, tubing and pumps from touching the ground.
- Open the well cap.
- Monitor the headspace within the well using the PID (PSC-300 for PID operation). This is done by placing the instrument probe at the opening of the well, and recording the reading in the field book and on the appropriate field forms.
- Measure and record the depth to (LNAPL), water, (DNAPL), and total depth of the well using a decontaminated oil/water interface probe or water level indicator (depending on the historical presence of NAPLs in the well). All LNAPL and DNAPL measurements are to be

made in accordance with PSC-122 and PSC-123. Measurements are to be made to the nearest one hundredth of a foot and recorded in the field book and on the appropriate field form.

- Compute the unit purge volume using the Monitoring Well Development Data Sheet (PSC-400):

  Unit Purge Volume (Vp) – [Well Volume (Vw) + Annulus Volume (Va)]

- If a submersible pump is to be used for well development, gently lower the pump to the well bottom.

- Attach one length of twine to the surge block and lower it to the bottom of the well or just above the top of the pump.

- Vigorously begin moving the surge block up and down in the well creating a surging action across the screened interval. This action will bring the finer grained materials into suspension. *NOTE: It is very important to avoid contact between the surge block and the pump while performing this procedure.*

- Remove the surge block.

- Begin to purge the well and initiate physical water quality testing for temperature, pH, conductivity, dissolved oxygen, and turbidity.

- A minimum of three and maximum of five well volumes (including annual space) will be removed. If this is the first time the well has been developed and water was used in the drilling process, the volume of water introduced into the formation during well formation must also be removed during development. *Purging is completed once the minimum purge volume has been removed and the physical water quality parameters have stabilized or the well runs dry or five purge volumes have been removed. The physical water quality parameters are considered stabilized when temperature +/- 0.5 deg C, pH +/- 0.5 pH units, conductivity +/- 10%, and dissolved oxygen +/- 1 ppm over three consecutive readings.*

- Containerize all purge water in 55-gallon drums, unless other handling arrangements have been made.

- Record additional information such as unique odors or water color, and a description of the suspended particle content in the field notes and on appropriate field forms.

- Upon completion of development, both the well and the purge drums are to be properly sealed and secured.

- All drums are to be permanently labeled as follows:
  Well ID
  Facility Name
  Drum Contents
  % Full
  Date
  Drum _ of _

- Close the well appropriately and record any well integrity concerns in the field book and on the sampling form.

8.0 Documentation

Documentation of all monitoring well development activities including all field forms and the maintenance of a detailed field notebook are described in PSC-400.

9.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing sections 6.0, 7.0, and 8.0 a minimum of twice under the direct supervision of the Corrective Actions Manager or her/his designee.

Low-Flow Groundwater Sampling Procedure
SOP No. PSC – 124
Origination Date: 11/23/97
Revision Date: 2/22/02
Revision No.4

Written By:	Edited by:	Approved By:	QA Concurrence:	Date:
Carolyn Mayer	Joe Depner	Tasya Gray	Tasya Gray	2/22/02

This SOP contains nine sections:

1 Purpose
2 Application
3 References
4 Associated SOPs
5 Equipment
6 Decontamination
7 Well Sampling Procedures
8 Documentation
9 Measure of Proficiency

1 Purpose

The purpose of this SOP is to provide personnel with the specific information needed to consistently collect and document representative groundwater samples for laboratory analyses from monitoring wells using a low-flow groundwater sampling technique.

The purpose of low-flow groundwater sampling is to collect a groundwater sample that is representative of actual site conditions. Therefore, the purge rate is designed to be low enough to simulate actual groundwater flow and to pull water from a discrete zone near the pump intake into the pump rather than pulling groundwater from a large area around the well or outside of the screened area of the well. A low purge rate is also intended to reduce the possibility of stripping volatile organic compounds from groundwater and to reduce the likelihood of mobilizing colloids in the subsurface that are immobile under natural flow conditions.

2 Application

This SOP applies to groundwater sampling of permanent monitoring wells at PSC facilities that are undergoing RCRA Corrective Action in Washington State.

The basis for choosing low-flow sampling methodology for these sites is that all of the sites have defined groundwater plumes and wells that are accurately screened in the known plume areas.

3 References

U.S. EPA. 1992. RCRA Groundwater Draft Technical Guidance.

U.S. EPA, Region I. 30 July 1996. SOP GW-0001, Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells.

Puls, R. and M. Barcelona. April 1996. Ground Water Issue: Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures. U.S. EPA. EPA/540/S-95/504.

Wilde, F.D., D.B. Radtke, J.Gibs and R.T. Iwatsubo, eds. 1998. *National Field Manual for the Collection of Water-Quality Data*; U.S. Geological Survey Techniques of Water-Resources Investigations, Book 9, Handbooks for Water-Resources Investigations, variously paginated.

Wilkin, R.T., M.S. McNeil, C.J. Adair and J.T. Wilson. 2001. Field Measurement of Dissolved Oxygen: A Comparison of Methods. *Ground Water Monitoring and Remediation*, Vol. 21, No. 4, pp. 124-132.

Phoenix Health and Safety, Inc. January 2001. Site Health and Safety Plan – Corrective Actions Group.

PSC, 2002. Groundwater Sampling Field Manual. (Updated Annually)

4 Associated SOPs

PSC-120 – Measuring Water, LNAPL, and DNAPL Elevations
PSC-200 – Equipment Decontamination Procedure

PSC-300 – Photoionization Detector Calibration and Operation
PSC-301 – YSI Calibration and Operation
PSC-302 - Hach Digital Titrator and Colorimeter Procedures
PSC-303 – Turbidimeter DRT-15CE Calibration and Operation
PSC-304 – HORIBA Calibration and Operation
PSC-400 – Documentation Procedures

5 Equipment

The following equipment is recommended for properly sampling a groundwater monitoring well:

- A Groundwater Sampling Field Manual that includes a map of well locations, sampling plan, appropriate SOPs and well construction information.
- A well key, hand drill, socket set, padlock key, or other well access equipment.
- A calibrated photoionization detector (PID) or similar device (and calibration gases), to monitor volatile constituents in the well headspace and breathing zone.
- An electric water-level indicator and/or oil/water interface detector calibrated to 0.01 foot, and sufficiently long to reach the bottom of the well.
- A weighted tape measure for determining total depths of wells, when this is required.
- Well purging equipment (e.g.; pump, converter, tubing, power supply and extension cord).
- A sufficient number of containers (e.g., 55-gallon drums with lids, labels, gaskets, and fasteners) to store all purge water, unless other water handling arrangements have been made.
- A calibrated flow-through water-quality meter(s) and calibration solutions to measure temperature, pH, specific conductivity, dissolved oxygen (DO) and oxidation-reduction potential (ORP).
- An instrument and calibration solutions to measure turbidity.

- In-line disposable filters, if necessary, for metals analyses.
- A sufficient number of sampling containers, including containers for regular samples and quality control samples (e.g., field blanks, equipment blanks, duplicates, trip blanks, and matrix spike/matrix spike duplicates).
- All required documentation including sample labels, field books, sampling forms, chain-of-custody (COC) forms, pens and paper for sampling forms, and COC seals.
- Personal protective equipment (PPE) described in the site health and safety plan.
- Decontamination equipment as specified in SOP PSC-200.
- Water flow-rate measurement equipment (e.g., flow meter, or graduated container and stopwatch).
- Sampling support equipment and supplies (e.g., sample coolers, ice/blue ice, bubble wrap and VOC bottle holders, tape, plastic locking bags, razor knives, garbage bags, paper towels, deionized water, nitrile gloves, five-gallon buckets, and protective plastic sheeting) as needed.

6 Decontamination

All reusable equipment that will contact the well and/or water samples will be decontaminated prior to its use, according to the procedures described in SOP PSC-200.

7 Well Sampling Procedures

7.1 Set Up

On arrival at each well, the following procedures shall be followed:

- Don appropriate PPE as described in the site health and safety plan.
- Remove any soil or vegetation, and standing water from the well monument casing. Check the well condition, making sure the flexible gasket seals are clean

and intact. If applicable, also check the condition of the dedicated pump cap. Record any problems in the field book and the appropriate field forms.

- Lay plastic sheeting on the ground around the well, and place the sampling equipment and bottles on the sheeting to keep them from touching the ground.

- Remove the well cap.

- Monitor the headspace within the well using a PID or similar instrument (see SOP PSC-300 for PID operation). Record the reading in the field book and on the appropriate field form(s).

- Set up the pump, converter, and flow-through cell and turbidity meter in preparation for purging. Connect the discharge line from the pump to a flow-through cell. A "T" connection is needed in the tubing between the pump discharge line and the flow-through cell to allow for the collection of water for the turbidity measurements, using a turbidimeter or similar instrument. The discharge line from the flow-through cell must be directed to a container to contain the purge water during the purging and sampling of the well.

- Record the depth of the pump intake on the sampling form and/or in the sampling field book. The Groundwater Sampling Field Manual should specify the pre-determined depths for the pump intakes. The pump intake is set at the interval within the screen where the contamination is known to exist. Check with the project manager if there is uncertainty regarding this issue. The pump should be lowered into the well alongside of a weighted measuring tape or water-level indicator to ensure that the intake of the pump is set at the appropriate depth.

- Measure and record the depth to water using a decontaminated water-level indicator or oil/water interface detector to the nearest 0.01 foot, in accordance with SOP PSC-120. Record the reading in the field book and on the appropriate field form(s). Calculate the volume of water in the casing and the screened interval. The following equation is used to calculate the well volume:

$$V = V_{casing} \text{ (well depth - static water depth)}$$

where:
V_{casing} = casing volume per unit length
(e.g., ~ 0.17 gal/ft for two-inch casing)

(The Groundwater Sampling Field Manual includes all well specifications necessary for this calculation.)

- Before purging, adjust the pumping rate to its lowest setting, and set the data logger in the flow-through cell to record readings every three minutes.

7.2 Purging Monitoring Wells

7.2.1 Purging Procedure

Measure the initial (static) water level in the well and record the reading on the field form(s). All wells have dedicated tubing that will be used for both purging and sampling.

Start the pump at a flow rate of 200 to 500 mL/min. Maintain a steady flow rate while maintaining a drawdown of less than 0.33 foot. The flow rate can be measured using a graduated cup and a stop watch.

To determine water-level stability, subtract the second water-level reading (not the static water-level reading) from the current water-level reading to determine the current drawdown.

After the flow rate is stable, record the water level and the flow rate every three to five minutes. Record water levels more frequently if the rate is being adjusted. A drawdown less than 0.33 foot is preferred but may not always be possible. If the drawdown exceeds 0.33 foot at low flow rates (≤ 500 mL/min), lower the flow rate as practical (not to drop below 100 mL/min) to reduce the drawdown.[1]

Begin recording water-quality parameters after all water has been purged from the sample tubing, pump, and flow-through cell. Initiate water-quality testing for temperature, pH, specific conductivity, DO, ORP and turbidity. Record water-quality parameters every three to five minutes.

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[1] *The 0.33-foot drawdown goal may be difficult to achieve under some circumstances due to geologic heterogeneities within the screened interval, and may require adjustment based on site-specific conditions and personal experience. The water levels in water-table wells should not be allowed to drop below the pump intake. In all other cases, the water level should not be allowed to drop below the top of the well screen. If the water table drops below one of these minimum values, the pump should be turned off and the water level should be allowed to recover. See section 7.2.2, fifth bullet for more information.*

7.2.2 Purging Requirements

Sampling cannot begin until the drawdown is no greater than 0.33 foot, and all water-quality parameters are stable. Each water-quality parameter is considered stable when it satisfies the corresponding stability criterion specified in the table below.

Water-Quality Parameter	Stability Criterion
Turbidity	{X} < 5 NTU or RPD < 10 % for values {X} > 5 NTU
Dissolved Oxygen	$\Delta \leq 0.3$ mg/L
Specific Conductivity	RPD ≤ 3 %
ORP	$\Delta < 10$ mV
pH	$\Delta < 0.1$ unit

Where: {X} = the last three water-quality readings

$$m = \text{mean} = \frac{\text{Max } \{X\} + \text{Min}\{X\}}{2}$$

$$\Delta = \text{Max } \{X\} - \text{Min } \{X\}$$

$$\text{RPD} = \frac{\Delta}{m} \times 100\%$$

In some circumstances, the well may not stabilize according to the above criteria, but the well can be sampled if one of the following conditions occurs:

- Wells are unable to meet stability criteria due to equipment accuracy. The accuracy of the instruments will often limit the ability to achieve stabilization on a percentage basis. For example, if the ORP is consistently fluctuating between 1 and 15 mV, then Δ = 14 mV, which is not within the requirements for stability. However, the accuracy of the instrument currently used is +/- 20 mV. Therefore, in this case the stability criterion would be considered satisfied within the range of accuracy of the equipment. This is particularly important when the water-quality parameter values are low. Examples of accuracy limits for the equipment that is currently used (e.g.; YSI and Horiba flow-through cells, and the HF Scientific Turbidimeter) are provided here for reference. However, if another instrument is used, field personnel must consult the instrument's manual to determine its accuracy.

Water-Quality Parameter	Equipment Accuracy
Turbidity	+/- 0.02 NTU
Dissolved Oxygen[2]	+/- 0.2 mg/L
Specific Conductivity	+/- 0.001 mS/cm
ORP[2]	+/- 20 mV
pH	+/- 0.2 unit

- Wells for which all water-quality parameters have stabilized may be sampled if it is clear that the drawdown will not stabilize before the water level drops below the minimum allowable value (i.e., pump intake, or top of screen if aquifer is confined).

- If collecting metals samples and all water-quality parameters except turbidity stabilize, it is acceptable to collect filtered and unfiltered metals samples without waiting for turbidity to stabilize or for one well volume to be purged. A filtered sample should be collected using a disposable in-line filter. If there are no directions on the filter for rinsing, then a minimum of 0.5 liter of groundwater from the well should be run through the filter prior to collecting the sample.

- Water-quality parameters are not stable, but at least one well volume of water has been removed from the well. See the equation in Section 7.1.

- The water level drops below the minimum value (i.e., the pump intake, or the top of the screen if the aquifer is confined) during purging. In this case, the pump should be turned off and the well should be allowed to recover. As long as a minimum of two tubing volumes (including the tubing and pump) has been removed from the well, then the well should be sampled as soon as the water level has recovered sufficiently to collect volume of groundwater necessary for all samples. Use the following equations to determine the minimum volume of groundwater to be removed prior to sampling when this problem occurs:

  Minimum purge volume = 2 [500 mL + M (length of tubing in feet)]
  where M is the volume (in mL) contained in a one-foot length of tubing

[2] If the final dissolved oxygen measurement is less than 1 mg/L, a sample should be collected and analyzed by the spectrometric, colorimetric or Winkler titration methods.
[3] ORP may not always be an appropriate stabilization parameter, depending on site conditions. The project manager may designate wells in the Groundwater Sampling Field Manual that will not require ORP measurements.

For tubing of various inner diameters, M is equal to:

Inner Diameter	M
1/8"	2.4
¼"	9.7
½"	39

This is acceptable even though the water-quality parameters have not stabilized and one well volume has not been removed.

Record in the field book and field form if any monitoring wells did not meet the stabilization and drawdown criteria and describe the rationale for sampling the well at the time it was sampled.

7.3 Sampling Procedure

Do not stop pumping after the purging requirements have been met. Don clean nitrile gloves. Disconnect the sampling tube from the T-fitting. All wells have dedicated tubing that will be used for both purging and sampling. Collect each sample directly from the dedicated tubing. Minimize the turbulence by allowing the groundwater to flow from the tubing gently down the inside of the container.

The sampling flow rate may remain at the established purge rate or may be adjusted slightly to minimize aeration, bubble formation, turbulent filling of sample bottles, or loss of volatiles due to extended residence time in tubing. Typically, flow rates less than 500 mL/min are appropriate.

When collecting the dissolved gas samples (e.g. volatile organic compounds, total petroleum hydrocarbons – gasoline range, or methane/ethane/ethane) the following procedures should be followed:

- The tubing should be completely filled with water to prevent the groundwater from being aerated as it flows through the tubing.

- A meniscus must be formed over the mouth of the vial to eliminate the formation of air bubbles and headspace prior to capping.

Samples do not have to be collected in a particular order unless unfiltered metals samples

are collected, in which case they should be collected last.

7.4 Post-Sampling Procedures

After all of the samples have been collected in containers that are labeled and appropriately treated with preservatives, the following tasks should be completed:

- Measure and record the depth to water to determine total drawdown. Record the estimated total volume of water purged from the well.
- If dedicated equipment is in place at the well, disconnect aboveground tubing and properly seal the well.
- If non-dedicated equipment is used, then remove the equipment. Discard disposable items and decontaminate reusable items according to PSC SOP-200.
- Close and secure the well, and record any well integrity concerns (bolt tightness, etc) in the field book and on the sampling form.
- Rinse the water-quality meters with deionized water between wells.
- Report if any monitoring wells did not meet the stabilization and drawdown criteria with recommendation on how to conduct the sampling for the next sampling event.

8 Documentation

SOP PSC-400 describes the documentation of all monitoring well sampling activities, including all field forms, and the maintenance of a detailed field notebook.

9 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by properly completing sections 6, 7 and 8 at least twice under the direct supervision of the project manager or her/his designee.

MicroPurge Ground Water Sampling Procedure
SOP No. PSC - 124
Origination Date: 11/23/97
Revision Date: 8/14/99
Revision No. 3

Written By:	Approved By:	Date:	QA Concurrence:	Date:
Carolyn Mayer	Carolyn Mayer	8/14/99	Natasya Gray	8/14/99

This SOP contains nine sections:

1.0 Purpose

The purpose of this SOP is to provide ground water sampling personnel with an outline of the specific information needed to collect and document representative ground water samples for chemical analyses from monitoring wells using USEPA's MicroPurge low-flow groundwater sampling technique.

2.0 Application

This SOP provides a step-by-step guideline to be followed by the field sampling crew to assure consistent and representative sampling.

3.0 References

RCRA Groundwater Draft Technical Guidance (EPA, 1992)

SOP GW-0001, Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells (USEPA, Region I, July 30, 1996)

4.0 Associated SOPs

PSC-121	PSC-122	PSC-123	PSC-200
PSC-201	PSC-300	PSC-400	

5.0 Equipment

The following equipment is necessary to properly sample a ground water monitoring well:

- A well key, hand drill, socket set, pad lock key, or other well access equipment.
- A photo-ionization detector to monitor and record the well headspace.
- An electric water meter and oil/water interface probe calibrated to a hundredth of a foot, and sufficiently long to reach the bottom of the well.
- Well purging equipment (e.g. pump, tubing, power supply, and extension cord).
- A sufficient number of 55-gallon drums (including lids, gaskets, and fasteners) to contain all purge water, unless other water handling arrangements have been made.
- Flow-through water quality meter(s) that measures temperature, pH, specific conductivity, dissolved oxygen, redox potential, and a separate turbidity meter.
- A sufficient number of sampling containers including containers for field blanks, equipment blanks, duplicates, trip blanks, and matrix spike/matrix spike duplicates.
- All required documentation including sample labels, field books, sampling forms, and chains-of-custody.
- Chemical preservatives for samples as described in the project-sampling plan or as required by the laboratory.
- Personal protective equipment as described in the Site Health and Safety Plan.

- Decontamination equipment as specified in the Work Plan.

- Sampling support equipment (e.g., sample coolers, ice/blue ice, bubble wrap, clear tape, duct tape, Ziploc bags, razor knives, garbage bags, paper towels, distilled water, pipettes, nitrile gloves).

6.0 Decontamination

All reusable equipment that will come in contact with the well and/or be used to acquire samples will be decontaminated prior to arrival on site, relocation on site, and site exit. Standard Operating Procedures PSC-201(for Teflon and glass) and PSC-200 (for metal) shall be followed.

7.0 Well Sampling Procedures

7.1 Set Up

Upon arrival at each well, the following procedures shall be followed:

- Suit up in appropriate personal protective equipment as described in the Site Health and Safety Plan.

- Brush any soil or vegetation and pump any standing water away from the well opening.

- Lay plastic sheeting around well to place equipment on and keep cords, tubing and pumps from touching the ground.

- Open the well cap.

- Monitor the headspace within the well using the PID (PSC-300 for PID operation). This is done by placing the instrument probe at the opening of the well, and recording the reading in the field book and on the appropriate field forms.

- Measure and record the depth to water using a decontaminated water level indicator or oil/water interface probe. All measurements are to be made in accordance with PSC-121-123. All measurements will be taken from the north point on the dedicated

pump or at the hatch mark on the well riser. Measurements are to be made to the nearest one hundredth of a foot and recorded in the field book and on the appropriate field form.

- Set up pump, converter, and flow-through cell in preparation for purging. Turn converter to its lowest setting, set memory in flow-through cell to record readings every three minutes, then turn the converter on. Begin purging slowly so that the water table is not drawn down.

7.2 Purging Monitoring Wells

7.2.1 Purging Procedure

General Considerations

Begin to purge and initiate water quality testing for temperature, pH, specific conductivity, dissolved oxygen, redox potential, and turbidity. Water quality parameters should be recorded every 3 minutes.

Water levels should also be recorded every 3-5 minutes. It is imperative that the water level does not drop by more than 0.3' during the purging process.

Flow rates should also be recorded every 3-5 minutes. It is also important to ensure the flow rate does not exceed 300 ml/min during the purging process.

7.2.1.1 Purging Wells with Dedicated Pumps

Wells with dedicated pumps also have dedicated tubing that will be used for both purging and sampling. A converter, powered by a generator or electrical outlet, will be hooked up to the Grundfos Redi-Flow II submersible pump and operated at a low flow rate of less than 300 ml/min. Be sure that the control box is set at low when it is turned on so that the water column is not abruptly disturbed.

7.2.1.2 Purging Wells with Non-Dedicated Pumps

Wells without dedicated pumps will be purged with a peristaltic pump and disposable Teflon and silicon tubing. The flow rate for these pumps is also expected to be less than 300 ml/min during the purging process.

If the well does not have a dedicated pump or LNAPL, then the Teflon sample tubing can be lowered to the middle of the screened interval of the well. Pumping can begin at a low rate of less than 300 ml/min. Be sure that the control box is set on low when it is turned on so that the water column is not abruptly disturbed.

If the well currently contains LNAPL, then a 1.5" diameter PVC pipe with a silicone plug will be lowered into the well in order to pass through the LNAPL layer. The Teflon tubing will be lowered through the PVC pipe and it will knock out the plug to reach the water column beneath the LNAPL layer. The bottom of the Teflon tubing should be in the middle of the well screen. (The plug will be tied to a silicone line that reaches to ground surface so that the plug can be removed from the well after sampling.) Once the Teflon tube is in the water column, the pump can be started at a low rate of less than 300 ml/min. Be sure that the control box is set at low when it is turned on so that the water column is not abruptly disturbed.

7.2.2 Purging Requirements

Sampling cannot begin until one of the following requirements has been met:

- Turbidity, redox potential, and dissolved oxygen have stabilized within 10% of each other, temperature and specific conductivity have stabilized within 3% of each other, and pH has remained within 0.1 pH unit for at least three consecutive readings;
- If stabilization of the water quality parameters is unachievable but one well volume of groundwater has been removed from the well;
- The well runs dry twice during the purging procedure.

7.3 Sampling Procedure

General Considerations

Do not stop pumping once the purging requirements have been met. Disconnect the sampling tube from the flow-through cell. Slow the pumping rate to about 100 ml/min in order and to reduce the chance of volatilization of the chemicals will collecting the samples. It is also imperative not to lower the water table or disturb the water column.

7.3.1 Sampling Wells with Dedicated Pumps

Wells with dedicated pumps will be sampled directly from the dedicated tubing.

7.3.2 Sampling Wells with Non-dedicated Pumps

Wells without dedicated pumps will be sampled with the peristaltic pump using the disposable Teflon tubing that was used for purging.

7.4 Post-Sampling Procedures

After all the samples have been collected in their appropriate bottles, at least one more water quality reading should be recorded in order to see if there was any change during sampling.

The depth to water should be recorded to determine whether the water level changed from the original reading.

Close the well appropriately and record any well integrity concerns in the field book and on the sampling form.

8.0 Documentation

Documentation of all monitoring well development activities including all field forms and the maintenance of a detailed field notebook are described in PSC-400.

9.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing sections 6.0, 7.0, and 8.0 a minimum of twice under the direct supervision of the Corrective Actions Manager or her/his designee.

MicroPurge Ground Water Sampling Procedure
SOP No. PSC - 124
Origination Date: 11/23/97
Revision Date: 5/14/99
Revision No.2

Written By:	Approved By:	Date:	QA Concurrence:	Date:
Carolyn Mayer	Carolyn Mayer	5/14/99	Chris Minton	5/14/99

This SOP contains nine sections:

1.0 Purpose
2.0 Application
3.0 References
4.0 Associated SOPs
5.0 Equipment
6.0 Decontamination
7.0 Well Sampling Procedures
8.0 Documentation
9.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to provide ground water sampling personnel with an outline of the specific information needed to collect and document representative ground water samples for chemical analyses from monitoring wells using USEPA's MicroPurge low-flow groundwater sampling technique.

2.0 Application

This SOP provides a step-by-step guideline to be followed by the field sampling crew to assure consistent and representative sampling.

3.0 References

RCRA Groundwater Draft Technical Guidance (EPA, 1992)

SOP GW-0001, Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells (USEPA, Region I, July 30, 1996)

4.0 Associated SOPs

PSC-121	PSC-122	PSC-123	PSC-200
PSC-201	PSC-300	PSC-400	

5.0 Equipment

The following equipment is necessary to properly sample a ground water monitoring well:

- A well key, hand drill, socket set, pad lock key, or other well access equipment.
- A photo-ionization detector to monitor and record the well headspace.
- An electric water meter and oil/water interface probe calibrated to a hundredth of a foot, and sufficiently long to reach the bottom of the well.
- Well purging equipment (e.g. bailer, silicone line, PVC pipe, plug, pump, tubing (silicone and Teflon), power supply, and extension cord).
- A sufficient number of 55-gallon drums (including lids, gaskets, and fasteners) to contain all purge water, unless other water handling arrangements have been made.
- Flow-through water quality meter(s) that measures temperature, pH, specific conductivity, dissolved oxygen, redox potential, and a separate turbidity meter.
- A sufficient number of sampling containers including containers for field blanks, equipment blanks, duplicates, trip blanks, and matrix spike/matrix spike duplicates.
- All required documentation including sample labels, field books, sampling forms, and chains-of-custody.
- Chemical preservatives for samples as described in the project-sampling plan or as required by the laboratory.
- Personal protective equipment as described in the Site Health and Safety Plan.
- Decontamination equipment as specified in the Work Plan.

- Sampling support equipment (e.g., sample coolers, ice/blue ice, bubble wrap, clear tape, duct tape, Ziploc bags, razor knives, garbage bags, paper towels, distilled water, pipettes, nitrile gloves).

6.0 Decontamination

All reusable equipment that will come in contact with the well and/or be used to acquire samples will be decontaminated prior to arrival on site, relocation on site, and site exit. Standard Operating Procedures PSC-201(for Teflon and glass) and PSC-200 (for metal) shall be followed.

7.0 Well Sampling Procedures

7.1 Set Up

Upon arrival at each well, the following procedures shall be followed:

- Suit up in appropriate personal protective equipment as described in the Site Health and Safety Plan.
- Brush any soil or vegetation and pump any standing water away from the well opening.
- Lay plastic sheeting around well to place equipment on and keep cords, tubing and pumps from touching the ground.
- Open the well cap.
- Monitor the headspace within the well using the PID (PSC-300 for PID operation). This is done by placing the instrument probe at the opening of the well, and recording the reading in the field book and on the appropriate field forms.
- Measure and record the depth to water using a decontaminated water level indicator or oil/water interface probe. All measurements are to be made in accordance with PSC-121-123. All measurements will be taken from the north point on the dedicated pump or at the hatch mark on the well riser. Measurements are to be made to the

nearest one hundredth of a foot and recorded in the field book and on the appropriate field form.

- Set up pump, converter, and flow-through cell in preparation for purging. Turn converter to its lowest setting, set memory in flow-through cell to record readings every three minutes, then turn the converter on. Begin purging slowly so that the water table is not drawn down.

7.2 Purging Monitoring Wells

7.2.1 Purging Procedure

General Considerations

Begin to purge and initiate water quality testing for temperature, pH, specific conductivity, dissolved oxygen, redox potential, and turbidity. Water quality parameters should be recorded every 3 minutes.

Water levels should also be recorded every 3-5 minutes. It is imperative that the water level does not drop by more than 0.3' during the purging process.

Flow rates should also be recorded every 3-5 minutes. It is also important to ensure the flow rate does not exceed 300 ml/min during the purging process.

7.2.1.1 Purging Wells with Dedicated Pumps

Wells with dedicated pumps also have dedicated tubing that will be used for both purging and sampling. A converter, powered by a generator or electrical outlet, will be hooked up to the Grundfos Redi-Flow II submersible pump and operated at a low flow rate of less than 300 ml/min. Be sure that the control box is set at low when it is turned on so that the water column is not abruptly disturbed.

7.2.1.2 Purging Wells with Non-Dedicated Pumps

Wells without dedicated pumps will be purged with a peristaltic pump and disposable Teflon and silicon tubing. The flow rate for these pumps is also expected to be less than 300 ml/min during the purging process.

If the well does not have a dedicated pump or LNAPL, then the Teflon sample tubing can be lowered to the middle of the screened interval of the well. Pumping can begin at a low rate of less than 300 ml/min. Be sure that the control box is set on low when it is turned on so that the water column is not abruptly disturbed.

If the well currently contains LNAPL, then a 1.5" diameter PVC pipe with a silicone plug will be lowered into the well in order to pass through the LNAPL layer. The Teflon tubing will be lowered through the PVC pipe and it will knock out the plug to reach the water column beneath the LNAPL layer. The bottom of the Teflon tubing should be in the middle of the well screen. (The plug will be tied to a silicone line that reaches to ground surface so that the plug can be removed from the well after sampling.) Once the Teflon tube is in the water column, the pump can be started at a low rate of less than 300 ml/min. Be sure that the control box is set at low when it is turned on so that the water column is not abruptly disturbed.

7.2.2 Purging Requirements

Sampling cannot begin until one of the following requirements has been met:

- Turbidity, redox potential, and dissolved oxygen have stabilized within 10% of each other, temperature and specific conductivity have stabilized within 3% of each other, and pH has remained within 0.1 pH unit for at least three consecutive readings;
- If stabilization of the water quality parameters is unachievable but one well volume of groundwater has been removed from the well;
- The well runs dry twice during the purging procedure.

7.3 Sampling Procedure

General Considerations

Do not stop pumping once the purging requirements have been met. Disconnect the sampling tube from the flow-through cell. Slow the pumping rate to about 100 ml/min in order and to reduce the chance of volatilization of the chemicals will collecting the samples. It is also imperative not to lower the water table or disturb the water column.

7.3.1 Sampling Wells with Dedicated Pumps

Wells with dedicated pumps will be sampled directly from the dedicated tubing.

7.3.2 Sampling Wells with Non-dedicated Pumps

Wells without dedicated pumps will be sampled with the peristaltic pump using the disposable Teflon tubing that was used for purging.

7.4 Post-Sampling Procedures

After all the samples have been collected in their appropriate bottles, at least one more water quality reading should be recorded in order to see if there was any change during sampling.

Then a depth to water and total depth of the well should be recorded to determine whether the water level changed from the original reading and to determine whether any silt in the well screen was removed during purging.

Close the well appropriately and record any well integrity concerns in the field book and on the sampling form.

8.0 Documentation

Documentation of all monitoring well development activities including all field forms and the maintenance of a detailed field notebook are described in PSC-400.

9.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing sections 6.0, 7.0, and 8.0 a minimum of twice under the direct supervision of the Corrective Actions Manager or her/his designee.

Low-Flow Ground Water Sampling Procedure
SOP No. PSC - 124
Origination Date: 11/23/97
Revision Date: 4/12/99
Revision No.1

Written By:	Approved By:	Date:	QA Concurrence:	Date:
Carolyn Mayer	Carolyn Mayer	4/12/99	Chris Minton	4/12/99

This SOP contains nine sections:

1.0 Purpose

The purpose of this SOP is to provide ground water sampling personnel with an outline of the specific information needed to collect and document representative ground water samples for chemical analyses from monitoring wells using USEPA's MicroPurge low-flow groundwater sampling technique.

2.0 Application

This SOP provides a step-by-step guideline to be followed by the field sampling crew to assure consistent and representative sampling.

3.0 References

RCRA Groundwater Draft Technical Guidance (EPA, 1992)

4.0 Associated SOPs

PSC-121	PSC-122	PSC-123	PSC-200
PSC-201	PSC-300	PSC-400	

5.0 Equipment

The following equipment is necessary to properly sample a ground water monitoring well:

- A well key, hand drill, socket set, pad lock key, or other well access equipment.
- A photo-ionization detector to monitor and record the well headspace.
- An electric water meter and oil/water interface probe calibrated to a hundredth of a foot, and sufficiently long to reach the bottom of the well.
- Well purging equipment (e.g. bailer, twine, PVC pipe, plug, pump, tubing (silicone and Teflon), power supply, and extension cord).
- A sufficient number of 55-gallon drums (including lids, gaskets, and fasteners) to contain all purge water, unless other water handling arrangements have been made.
- Flow-through water quality meter(s) that measures temperature, pH, specific conductivity, dissolved oxygen, redox potential, and turbidity.
- A sufficient number of sampling containers including containers for field blanks, equipment blanks, duplicates, trip blanks, and matrix spike/matrix spike duplicates.
- All required documentation including sample labels, field books, sampling forms, and chains-of-custody.
- Chemical preservatives for samples as described in the project-sampling plan or as required by the laboratory.
- Personal protective equipment as described in the Site Health and Safety Plan.
- Decontamination equipment as specified in the Work Plan.
- Sampling support equipment (e.g., sample coolers, ice/blue ice, bubble wrap, clear tape, duct tape, Ziploc bags, razor knives, garbage bags, paper towels, distilled water, pipettes, nitrile gloves).

6.0 Decontamination

All reusable equipment that will come in contact with the well and/or be used to acquire samples will be decontaminated prior to arrival on site, relocation on site, and site exit. Standard Operating Procedures PSC-201(for Teflon and glass) and PSC-200 (for metal) shall be followed.

7.0 Well Sampling Procedures

7.1 Set Up

Upon arrival at each well, the following procedures shall be followed:

- Suit up in appropriate personal protective equipment as described in the Site Health and Safety Plan.
- Brush any soil or vegetation and pump any standing water away from the well opening.
- Lay plastic sheeting around well to place equipment on and keep cords, tubing and pumps from touching the ground.
- Open the well cap.
- Monitor the headspace within the well using the PID (PSC-300 for PID operation). This is done by placing the instrument probe at the opening of the well, and recording the reading in the field book and on the appropriate field forms.
- Measure and record the depth to water and total depth of the well using a decontaminated water level indicator or oil/water interface probe. All measurements are to be made in accordance with PSC-121-123. All measurements will be taken from the north point on the dedicated pump or at the hatch mark on the well riser. Measurements are to be made to the nearest one hundredth of a foot and recorded in the field book and on the appropriate field form.

7.2 Purging Requirements

Sampling cannot begin until the following requirements have been met:

- Turbidity, redox potential, and dissolved oxygen must stabilize within 10% of each other, temperature and specific conductivity stabilize within 3% of each other, and pH remains within 0.1 pH unit for at least three consecutive readings.

7.2.1 Purging Procedure

General Considerations

Begin to purge and initiate water quality testing for temperature, pH, conductivity, dissolved oxygen, redox potential, and turbidity. Water quality parameters should be recorded every 3 minutes.

Water levels should also be recorded every 3-5 minutes. It is imperative that the water level does not drop during the purging process.

Flow rates should also be recorded every 3-5 minutes. It is also important to ensure the flow rate does not exceed 300 ml/min during the purging process.

7.2.1.1 Purging Wells with Dedicated Pumps

Wells with dedicated pumps also have dedicated tubing that will be used for both purging and sampling. A converter, powered by a generator or electrical outlet, will be hooked up to the Grundfos Redi-Flow II submersible pump and operated at a low flow rate of less than 300 ml/min. Be sure that the control box is set at low when it is turned on so that the water column is not abruptly disturbed.

7.2.1.2 Purging Wells with Non-Dedicated Pumps

Wells without dedicated pumps will be purged with a peristaltic pump and disposable Teflon and silicon tubing. The flow rate for these pumps is also expected to be less than 300 ml/min during the purging process.

If the well does not have a dedicated pump or LNAPL, then the Teflon sample tubing can be lowered to the middle of the screened interval of the well. Pumping can begin at a low rate of less than 300 ml/min. Be sure that the control box is set on low when it is turned on so that the water column is not abruptly disturbed.

If the well currently contains LNAPL, then a 1.5" diameter PVC pipe with a silicone plug will be lowered into the well in order to pass through the LNAPL layer. The Teflon tubing will be lowered through the PVC pipe and it will knock out the plug to reach the water column beneath the LNAPL layer. The bottom of the Teflon tubing should be in the middle of the well screen. (The plug will be tied to a silicone line that reaches to ground surface so that the plug can be removed from the well after sampling.) Once the Teflon tube is in the water column, the pump can be started at a low rate of less than 300 ml/min. Be sure that the control box is set at low when it is turned on so that the water column is not abruptly disturbed.

7.3 Sampling Procedure

General Considerations

Do not stop pumping once the purging requirements have been met.

Slow the pumping rate to about 100 ml/min in order to collect the samples, in order to reduce the chance of volatilization of the chemicals. It is also imperative not to lower the water table or disturb the water column.

7.3.1 Sampling Wells with Dedicated Pumps

Wells with dedicated pumps will be sampled directly from the dedicated tubing.

7.3.2 Sampling Wells with Non-dedicated Pumps

Wells without dedicated pumps will be sampled with the peristaltic pump using the disposable Teflon tubing that was used for purging.

7.4 Post-Sampling Procedures

After all the samples have been collected in their appropriate bottles, at least one more water quality reading should be recorded in order to see if there was any change during sampling.

Then a depth to water and total depth of the well should be recorded to determine whether the water level changed from the original reading and to determine whether any silt in the well screen was removed during purging.

Close the well appropriately and record any well integrity concerns in the field book and on the sampling form.

8.0 Documentation

Documentation of all monitoring well development activities including all field forms and the maintenance of a detailed field notebook are described in PSC-400.

9.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing sections 6.0, 7.0, and 8.0 a minimum of twice under the direct supervision of the Corrective Actions Manager or her/his designee.

Low-Flow Ground Water Sampling Procedure

Written By:	Approved By:	Date:	QA Concurrence:	Date:
Carolyn Mayer	Carolyn Mayer	11/23/97	Laurel Muselwhite	11/23/97

This SOP contains nine sections:

1.0 Purpose
2.0 Application
3.0 References
4.0 Associated SOPs
5.0 Equipment
6.0 Decontamination
7.0 Well Sampling Procedure
8.0 Documentation
9.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to provide ground water sampling personnel with an outline of the specific information needed to collect and document representative ground water samples for chemical analyses from monitoring wells.

2.0 Application

This SOP provides a step-by-step guideline to be followed by the field sampling crew to assure consistent and representative sampling.

3.0 References

RCRA Groundwater Draft Technical Guidance (EPA, 1992)

4.0 Associated SOPs

PSC-121	PSC-122	PSC-123	PSC-200
PSC-201	PSC-300	PSC-400	

5.0 Equipment

The following equipment is necessary to properly sample a ground water monitoring well:

- A well key, hand drill, socket set, pad lock key, or other well access equipment.
- A photo-ionization detector to monitor and record the well headspace.

- An electric water meter and oil/water interface probe calibrated to a hundredth of a foot, and sufficiently long to reach the bottom of the well.
- Well purging equipment (e.g. bailer, twine, PVC pipe, plug, pump, tubing (silicone and Teflon), power supply, and extension cord).
- A sufficient number of 55-gallon drums (including lids, gaskets, and fasteners) to contain all purge water, unless other water handling arrangements have been made.
- Decontaminated or disposable sampling bailers or tubing that are constructed of materials, which are chemically compatible with the sampling media and potential contaminants.
- A flow-through water quality meter that measures temperature, pH, specific conductivity, dissolved oxygen, redox potential, and turbidity (or a separate turbidity meter).
- A sufficient number of sampling containers including containers for field blanks, equipment blanks, duplicates, trip blanks, and matrix spike/matrix spike duplicates.
- All required documentation including sample labels, field books, sampling forms, and chains-of-custody.
- Chemical preservatives for samples as described in the project-sampling plan, unless the lab will analyze the samples immediately.
- Personal protective equipment as described in the Site Health and Safety Plan.
- Decontamination equipment as specified in the Work Plan.
- Sampling support equipment (e.g., sample coolers, ice/blue ice, bubble wrap, clear tape, duct tape, ziplock bags, razor knives, garbage bags, paper towels, distilled water, pipettes, nitrile gloves).

6.0 Decontamination

All reusable equipment that will come in contact with the well and/or be used to acquire samples will be decontaminated prior to arrival on site, relocation on site, and site exit. Standard Operating Procedures PSC-201(for Teflon and glass) and PSC-200 (for metal) shall be followed.

7.0 Well Sampling Procedure

7.1 Set Up

Upon arrival at each well, the following procedures shall be followed:

- Suit up in appropriate personal protective equipment as described in the Site Health and Safety Plan.
- Brush any soil or vegetation away from the well opening.
- Lay plastic sheeting around well to place equipment on and keep cords, tubing and pumps from touching the ground.
- Open the well cap.

- Monitor the headspace within the well using the PID (PSC-300 for PID operation). This is done by placing the instrument probe at the opening of the well, and recording the reading in the field book and on the appropriate field forms.

- Measure and record the depth to (LNAPL), water, (DNAPL), and total depth of the well using a decontaminated oil/water interface probe or water level indicator (depending on the historical presence of NAPLs in the well). All measurements are to be made in accordance with PSC-121-123. Measurements are to be made to the nearest one hundredth of a foot and recorded in the field book and on the appropriate field form.

- Compute the unit purge volume using the Monitoring Well Sampling Data Sheet (PSC-400):

  Unit Purge Volume (Vp) – [Well Volume (Vw) + Annulus Volume (Va)]

7.2 Purging Requirements

Sampling cannot begin until the following requirements have been met:

- At least one volume of water is removed, AND

- Turbidity, redox potential, and dissolved oxygen must stabilize within 10% of each other for at least two consecutive readings.

7.3 Purging Procedure

7.3.1 General Considerations

- Begin to purge and initiate water quality testing for temperature, pH, conductivity, dissolved oxygen, redox potential, and turbidity. Water quality parameters should be recorded every 3-5 minutes.

- Water levels should also be recorded every 3-5 minutes. It is imperative that the water level does not drop more than 1 foot during the purging process.

- Flow rates should also be recorded every 3-5 minutes. It is also important to ensure the flow rate does not exceed 1000 ml/min during the purging process.

7.3.2 Purging Wells with Dedicated Pumps

Wells with dedicated pumps also have dedicated tubing that will be used for both purging and sampling. A converter, powered by a generator or electrical outlet, will be hooked up to the Grundfos Redi-Flow II submersible pump and operated at a low flow rate of less than 1000 ml/min. Be sure that the control box is set at low when it is turned on so that the water column is not abruptly disturbed.

7.3.3 Purging Wells with Non-Dedicated Pumps

Wells without dedicated pumps will be purged with a peristaltic pump and disposable Teflon and silicon tubing.

7.3.3.1 Wells without LNAPLs

- If the well does not have LNAPLs, then the Teflon tubing can be lowered to the middle of the screened interval of the well.

- Pumping can begin at a low rate of less than 1000 ml/min. Be sure that the control box is set on low when it is turned on so that the water column is not abruptly disturbed.

7.3.3.2 Wells with LNAPLs

- If the well has LNAPLs, then a 1.5" diameter PVC pipe with a silicone plug will be lowered into the well in order to pass through the LNAPL layer.

- The Teflon tubing will be lowered through the PVC pipe and it will knock out the plug to reach the water column beneath the LNAPL layer. The bottom of the Teflon tubing should be in the middle of the well screen. (The plug will be tied to a silicone line that reaches to ground surface so that the plug can be removed from the well after sampling.)

- Once the Teflon tube is in the water column, the pump can be started at a low rate of less than 1,000 ml/min. Be sure that the control box is set at low when it is turned on so that the water column is not abruptly disturbed.

7.4 Sampling Procedure

7.4.1 General Considerations

- Do not stop pumping once the purging requirements have been met.

- Slow the pumping rate to about 100 ml/min in order to collect volatile organic compound samples, in order to reduce the chance of volatilization of the chemicals.

- Once the volatile samples have been collected, the pumping rate can be increased, but no more than 1,000 ml/min. It is imperative not to lower the water table or disturb the water column.

7.4.2 Sampling Wells with Dedicated Pumps

Wells with dedicated pumps will be sampled directly from the dedicated tubing.

7.4.3 Sampling Wells with Non-dedicated Pumps

7.4.3.1 Wells without LNAPLs

- Wells without dedicated pumps will be sampled with a dedicated bailer and disposable Teflon tubing.

- The volatile organic compounds must be sampled with a dedicated Teflon bailer.

- In a non-NAPL well, the Teflon tubing from the peristaltic pump can remain in the well while the bailer is used to collect the volatile sample, then the peristaltic pump can be used to collect the rest of the samples.

7.4.3.2 Wells with LNAPLs

- In a NAPL well, the Teflon tubing must be removed and placed on clean plastic sheeting while the bailer is used to collect the volatile sample.

- Once the volatile sample has been collected, the Teflon tubing can be placed back in the well and used to collect the rest of the samples.

7.5 Post-Sampling Procedures

- After all the samples have been collected in their appropriate bottles, then two more water quality readings should be recorded in order to see if there was any change during sampling.

- Then a depth to (LNAPL), water, (DNAPL), and total depth of the well should be recorded to determine whether the water level fell below one foot of the original reading and to determine whether any LNAPL or DNAPL or silt was removed during purging.

- Close the well appropriately and record any well integrity concerns in the field book and on the sampling form.

8.0 Documentation

Documentation of all sampling including all field forms and the maintenance of a detailed field notebook are described in PSC-400.

9.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing sections 6.0, 7.0, and 8.0 a minimum of twice under the direct supervision of the Corrective Actions Manager or her/his designee.

Ground Water Sampling Procedure
SOP No. PSC - 125
Origination Date: 11/16/98
Revision Date: 11/16/98
Revision No.0

Written By:	Approved By:	Date:	QA Concurrence:	Date:
Carolyn Mayer	Carolyn Mayer	11/16/98	Chris Minton	11/16/98

This SOP contains nine sections:

1.0 Purpose
2.0 Application
3.0 References
4.0 Associated SOPs
5.0 Equipment
6.0 Decontamination
7.0 Procedure
8.0 Documentation
9.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to provide ground water sampling personnel with an outline of the specific information needed to collect and document representative ground water samples for chemical analyses from monitoring wells.

2.0 Application

This SOP provides a step-by-step guideline to be followed by the field sampling crew to assure consistent and representative sampling.

3.0 References

RCRA Groundwater Draft Technical Guidance (EPA, 1992)

4.0 Associated SOPs

PSC-121	PSC-122	PSC-123	PSC-200
PSC-201	PSC-300	PSC-400	

5.0 Equipment

The following equipment is necessary to properly sample a ground water monitoring well:

- A well key, hand drill, socket set, pad lock key, or other well access equipment.
- A photo-ionization detector to monitor and record the well headspace.
- An electric water meter and oil/water interface probe calibrated to a hundredth of a foot, and sufficiently long to reach the bottom of the well.
- Well purging equipment (e.g. bailer, twine, PVC pipe, plug, pump, tubing (silicone and Teflon), power supply, and extension cord).
- A sufficient number of 55-gallon drums (including lids, gaskets, and fasteners) to contain all purge water, unless other water handling arrangements have been made.
- Decontaminated or disposable sampling bailers or tubing that are constructed of materials, which are chemically compatible with the sampling media and potential contaminants.
- A water quality meter that measures temperature, pH, specific conductivity, dissolved oxygen, and turbidity.
- A sufficient number of sampling containers including containers for field blanks, equipment blanks, duplicates, trip blanks, and matrix spike/matrix spike duplicates. One field blank, duplicate, and MS/MSD per 20 samples and one trip blank per cooler containing aqueous volatile organic compound samples.

- All required documentation including sample labels, field books, sampling forms, and chains-of-custody.

- Chemical preservatives for samples as described in the project-sampling plan, unless the lab will analyze the samples immediately.

- Personal protective equipment as described in the Site Health and Safety Plan.

- Decontamination equipment as specified in the Work Plan.

- Sampling support equipment (e.g., sample coolers, ice/blue ice, bubble wrap, clear tape, duct tape, ziploc bags, razor knives, garbage bags, paper towels, distilled water, pipettes, nitrile gloves).

6.0 Decontamination

All reusable equipment that will come in contact with the well and/or be used to acquire samples will be decontaminated prior to arrival on site, relocation on site, and site exit. Standard Operating Procedures PSC-201 (for Teflon and glass) and PSC-200 (for metal) shall be followed.

7.0 Well Sampling Procedure

7.1 Set Up

Upon arrival at each well, the following procedures shall be followed:

- Suit up in appropriate personal protective equipment as described in the Site Health and Safety Plan.

- Brush any soil or vegetation away from the well opening.

- Lay plastic sheeting around well to place equipment on and keep cords, tubing and pumps from touching the ground.

- Open the well cap.

- Monitor the headspace within the well using the PID (PSC-300 for PID operation). This is done by placing the instrument probe at the opening of the well and recording the reading in the field book and on the appropriate field forms.

- Measure and record the depth to (LNAPL), water, (DNAPL), and total depth of the well using a decontaminated oil/water interface probe or water level indicator (depending on the historical presence of NAPLs in the well). All measurements are to be made in accordance with PSC-121-123. Measurements are to be made to the nearest one hundredth of a foot and recorded in the field book and on the appropriate field form.

- Compute the unit purge volume using the Monitoring Well Sampling Data Sheet (PSC-400):

  Unit Purge Volume (Vp) – [Well Volume (Vw) + Annulus Volume (Va)] x 3

7.2 Purging Requirements

Sampling cannot begin until the following requirements have been met:

- At least three volume of water is removed, AND

- Turbidity, specific conductivity, and dissolved oxygen must stabilize within 10% of each other for at least three consecutive readings, OR

- The well is purged dry twice.

7.3 Purging Procedure for Bailers

- Tie the silicone (chemical resistant) twine onto the bailer. Make sure the knot will not slip.

- Tie the other end of the twine to a secure permanent fixture (e.g., stand pipe monitoring well cover or your own wrist) to prevent the bailer from slipping into the well.

- Purge the well by lowering a bailer to the middle of the screened interval of the well, then removing the bailer and emptying it into a drum or bucket for proper disposal.

- Once enough water has been removed to run through the water quality instrument, initiate water quality testing for temperature, pH, conductivity, dissolved oxygen, and turbidity.

- Water quality parameters should be recorded incrementally during purging (every 10% of the total volume to be removed).

- Once the purge requirements have been met, prepare to sample the well.

7.4 Purging Procedure for Peristaltic Pumps

- Hook up the tubing to the peristaltic pump.
- Lower the Teflon lined tubing to the middle of the screen in the well.
- Place the discharge tubing into a bucket or drum.
- Turn the pump on.
- Once enough water has been removed to run through the water quality instrument, initiate water quality testing for temperature, pH, conductivity, dissolved oxygen, and turbidity. Water quality parameters should be recorded incrementally during purging (every 10% of the total volume to be removed).
- Once the purge requirements have been met, prepare to sample the well.

7.5 Purging Wells with LNAPLs

- If the well has LNAPLs, then a 1.5" diameter PVC pipe with a silicone plug will be lowered into the well in order to pass through the LNAPL layer.

- The Teflon tubing will be lowered through the PVC pipe and it will knock out the plug to reach the water column beneath the LNAPL layer. The bottom of the Teflon tubing should be in the middle of the well screen. (The plug will be tied to a silicone line that reaches to ground surface so that the plug can be removed from the well after sampling.)

- Once the Teflon tube is in the water column, the pump can be started at a low rate of less than 1,000 ml/min. Be sure that the control box is set at low when it is turned on so that the water column is not abruptly disturbed.

- Once enough water has been removed to run through the water quality instrument, initiate water quality testing for temperature, pH, conductivity, dissolved oxygen, and turbidity. Water quality parameters should be recorded incrementally during purging (every 10% of the total volume to be removed).

- Once the purge requirements have been met, prepare to sample the well.

7.6 Sampling Procedure

- Do not stop bailing/pumping once the purging requirements have been met.

- Collect volatile organic compund (VOC) samples first. If pumping, slow the pumping rate to about 100 ml/min in order to collect volatile organic compound samples, in order to reduce the chance of volatilization of the chemicals. If bailing, slowly lower the bailer into the well, fill the bailer, attach the VOC sampling piece to the end of the bailer, and fill the VOC vial from the end of the bailer.

- Fill the rest of the sampling bottles.

- Label and preserve the samples, then add the sample information to the chain-of-custody.

7.7 Post-Sampling Procedures

After all the samples have been collected in their appropriate bottles, then two more water quality readings should be recorded in order to see if there was any change during sampling.

Then the depth to LNAPL, DNAPL, total depth, and depth to water in the well should be recorded to determine whether any LNAPL or DNAPL or silt was removed during purging and to estimate the recharge rate of the well.

Close the well appropriately and record any well integrity concerns in the field book and on the sampling form.

8.0 Documentation

Documentation of all monitoring well development activities including all field forms and the maintenance of a detailed field notebook are described in PSC-400.

9.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing sections 6.0, 7.0, and 8.0 a minimum of once under the direct supervision of the Corrective Actions Manager or her/his designee.

Equipment Decontamination Procedure
SOP No. PSC - 200
Origination Date: 10/28/99
Revision Date: 3/19/01
Revision No.1

Written By:	Edited by:	Approved By:	Date:	QA Concurrence:	Date:
Tasya Gray	Tasya Gray	Carolyn Mayer	3/27/01	Kevin McNeil	3/27/01

This SOP contains eight sections:

1.0 Purpose

The purpose of this SOP is to provide field personnel with an outline of the procedure and frequency of decontaminating equipment that has come into contact with monitoring well water.

2.0 Application

This SOP provides a step-by-step guideline to be followed by the field sampling crew to prevent cross-contamination between monitoring wells and preserve well integrity.

3.0 References

RCRA Groundwater Draft Technical Guidance (EPA, 1992)

4.0 Associated SOPs

PSC-120 PSC-121 PSC-124 PSC-125 PSC-400

5.0 Equipment

The following equipment is necessary to properly decontaminate equipment used with monitoring wells:

- Di-ionized water and spray bottle.
- Alconox and spray bottle, hexane and spray bottle, and 10% Nitric acid and spray bottle, paper towels/rags.
- PVC pipe, capped on one end, 5 feet long.
- A clean hose and tap water source.
- A labeled 55-gallon drum for wastewater and a bucket to use for smaller volume prior to containing in drum.
- Personal protective equipment as described in the Site Health and Safety Plan.

6.0 General Decontamination Procedures

All reusable equipment that will come in contact with the well and/or be used to acquire samples will be decontaminated prior to arrival on site, relocation on site, and site exit.

6.1 Decontamination When Organic Constituents Are of Interest

- Wash the equipment with a solution of nonphosphate detergent (Alconox or equivalent) and water.

- Rinse the equipment with tap water.
- Rinse the equipment with Hexane.
- Rinse the equipment with DI water.

6.2 Decontamination When Inorganic Constituents Are of Interest

- Wash the equipment with a solution of nonphosphate detergent (Alconox or equivalent) and water.
- Rinse the equipment with tap water.
- Rinse the equipment with 10% Nitric Acid solution.
- Rinse the equipment with DI water.

6.3 Decontamination When Inorganic and Organic Constituents Are of Interest

- Wash the equipment with a solution of nonphosphate detergent (Alconox or equivalent) and water.
- Rinse the equipment with tap water.
- Rinse the equipment with Hexane.
- Rinse the equipment with DI water.
- Rinse the equipment with 10% Nitric Acid solution.
- Rinse the equipment with DI water.

7.0 Specific Decontamination Procedures

7.1 Non-Dedicated Submersible Pump Decontamination Procedure

After sampling or developing a well using a non-dedicated submersible pump, decontaminate the pump as follows:

- Use hose to spray off pump with tap water.
- Place pump into a capped approximately 5' long, 3" diameter PVC pipe.
- Fill the PVC pipe with tap water and detergent.
- Run the pump until the pipe is empty, refilling it with tap water 3 times. The discharge decontamination water will be pumped into a 55-gallon drum.
- Remove the pump and wash out the pipe using tap water from the hose.
- Place the pump in the pipe again and fill with tap water.

- Repeat the process, running the pump until the pipe empties 3 times, when there is half a pipe of water left, add 2L of Hexane and continue pumping until pipe is empty.
- Remove the pump and rinse out the pipe with tap water.
- Place the pump back in the pipe and fill with tap water.
- Run the pump until the pipe empties 3 times, when there is half a pipe of water left add 2L of 10% Nitric Acid.
- Run the pump until it empties, then rinse it with water and refill the pipe with di-ionized water.
- Run the pump until the pipe empties three times with the deionized water.

8.0 Documentation

Documentation of all decontamination procedures associated with monitoring well activities including all field forms and the maintenance of a detailed field notebook as described in PSC-400.

9.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing sections 6.0, 7.0, and 8.0 a minimum of twice under the direct supervision of the Corrective Actions Manager or her/his designee.

Equipment Decontamination Procedure
SOP No. PSC - 200
Origination Date: 8/31/99
Revision Date: 8/31/99
Revision No.1

Written By:	Approved By:	Date:	QA Concurrence:	Date:
Tasya Gray	Carolyn Mayer	8/31/99	Chris Minton	8/31/99

This SOP contains eight sections:

1.0 Purpose

The purpose of this SOP is to provide field personnel with an outline of the procedure and frequency of decontaminating equipment that has come into contact with monitoring well water.

2.0 Application

This SOP provides a step-by-step guideline to be followed by the field sampling crew to prevent cross-contamination between monitoring wells and preserve well integrity.

3.0 References

RCRA Groundwater Draft Technical Guidance (EPA, 1992)

4.0 Associated SOPs

PSC-120 PSC-121 PSC-124 PSC-125 PSC-400

5.0 Equipment

The following equipment is necessary to properly decontaminate equipment used with monitoring wells:

- Di-ionized water and spray bottle.
- Alconox and spray bottle, hexane and spray bottle, and 10% Nitric acid and spray bottle.
- PVC pipe, capped on one end, 5 feet long.
- A clean hose and tap water source.
- A 55-gallon drum for waste water.
- Personal protective equipment as described in the Site Health and Safety Plan.

6.0 Decontamination

All reusable equipment that will come in contact with the well and/or be used to acquire samples will be decontaminated prior to arrival on site, relocation on site, and site exit.

6.1 Water Level Indicator Decontamination Procedure

Spray the Water Level Indicator with Alconox. Then rinse it thoroughly with di-ionized water after sampling at each well has been completed.

6.2 Oil/Water Interface Probe Decontamination Procedure

The oil water interface probe will be decontaminated after sampling at a well has been completed. The exposed tape should be wiped down with a hexane-wetted rag, followed by wiping it down with a DI water-wetted rag. The probe shall be cleaned using hexane or hexane soaked rag followed by a thorough rinsing with DI water.

6.3 Grundfos EZ-Reel Portable Pump Decontamination Procedure

After sampling or developing a well using the Grundfos EZ-Reel Portable Pump, decontaminate the pump as follows:

- Use hose to spray off EZ-Reel with tap water.
- Place pump into the PVC pipe.
- Fill the PVC pipe with tap water and Alconox.
- Run the pump until the pipe is empty, refilling it with tap water 3 times, running the discharge decontamination water into a 55-gallon drum.
- Remove the pump and wash out the pipe using tap water from the hose.
- Place the pump in the pipe again and fill with tap water.
- Repeat the process, running the pump until the pipe empties 3 times, then fill the pipe with 1L of Hexane.
- Repeat the process, running the pump until the pipe empties, then remove the pump and rinse out the pipe with tap water.
- Place the pump back in the pipe and fill with tap water.
- Run the pump until the pipe empties 3 times, then fill the pipe with 1L of 10% Nitric Acid.
- Run the pump until it empties, then rinse it with di-ionized water and refill the pipe with di-ionized water.
- Run the pump until the pipe empties three times with the di-ionized water.

7.0 Documentation

Documentation of all decontamination procedures associated with monitoring well activities including all field forms and the maintenance of a detailed field notebook as described in PSC-400.

8.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing sections 6.0 and 7.0 a minimum of twice under the direct supervision of the Corrective Actions Manager or her/his designee.

Equipment Decontamination Procedure
SOP No. PSC - 200
Origination Date: 10/28/99
Revision Date:
Revision No.0

Written By:	Approved By:	Date:	QA Concurrence:	Date:
Tasya Gray	Carolyn Mayer	10/28/99	Carolyn Mayer	10/28/99

This SOP contains eight sections:

1.0 Purpose

The purpose of this SOP is to provide field personnel with an outline of the procedure and frequency of decontaminating equipment that has come into contact with monitoring well water.

2.0 Application

This SOP provides a step-by-step guideline to be followed by the field sampling crew to prevent cross-contamination between monitoring wells and preserve well integrity.

3.0 References

RCRA Groundwater Draft Technical Guidance (EPA, 1992)

4.0 Associated SOPs

PSC-120 PSC-121 PSC-124 PSC-125 PSC-400

5.0 Equipment

The following equipment is necessary to properly decontaminate equipment used with monitoring wells:

- Di-ionized water and spray bottle.
- Alconox and spray bottle, hexane and spray bottle, and 10% Nitric acid and spray bottle.
- PVC pipe, capped on one end, 5 feet long.
- A clean hose and tap water source.
- A 55-gallon drum for waste water.
- Personal protective equipment as described in the Site Health and Safety Plan.

6.0 General Decontamination Procedures

All reusable equipment that will come in contact with the well and/or be used to acquire samples will be decontaminated prior to arrival on site, relocation on site, and site exit.

6.1 Decontamination When Organic Constituents Are of Interest

- Wash the equipment with a solution of nonphosphate detergent (Alconox) and water.
- Rinse the equipment with tap water.
- Rinse the equipment with Hexane.
- Rinse the equipment with DI water.

6.2 Decontamination When Inorganic Constituents Are of Interest

- Wash the equipment with a solution of nonphosphate detergent (Alconox) and water.
- Rinse the equipment with tap water.
- Rinse the equipment with 10% Nitric Acid solution.
- Rinse the equipment with DI water.

7.0 Specific Decontamination Procedures

7.1 Non-Dedicated Submersible Pump Decontamination Procedure

After sampling or developing a well using a non-dedicated submersible pump, decontaminate the pump as follows:

- Use hose to spray off EZ-Reel with tap water.
- Place pump into the PVC pipe.
- Fill the PVC pipe with tap water and Alconox.
- Run the pump until the pipe is empty, refilling it with tap water 3 times, running the discharge decontamination water into a 55-gallon drum.
- Remove the pump and wash out the pipe using tap water from the hose.
- Place the pump in the pipe again and fill with tap water.
- Repeat the process, running the pump until the pipe empties 3 times, then fill the pipe with 1L of Hexane.
- Repeat the process, running the pump until the pipe empties, then remove the pump and rinse out the pipe with tap water.
- Place the pump back in the pipe and fill with tap water.
- Run the pump until the pipe empties 3 times, then fill the pipe with 1L of 10% Nitric Acid.
- Run the pump until it empties, then rinse it with di-ionized water and refill the pipe with di-ionized water.
- Run the pump until the pipe empties three times with the di-ionized water.

8.0 Documentation

Documentation of all decontamination procedures associated with monitoring well activities including all field forms and the maintenance of a detailed field notebook as described in PSC-400.

9.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing sections 6.0, 7.0, and 8.0 a minimum of twice under the direct supervision of the Corrective Actions Manager or her/his designee.

Photo-ionization Detector Calibration and Operation
SOP No. PSC - 300
Origination Date: 5/14/98
Revision Date: 6/29/98
Revision No. 1

Written By:	Approved By:	Date:	QA Concurrence:	Date:
Laurel Muselwhite	Carolyn Mayer	5/14/98	Carolyn Mayer	7/1/98

This SOP contains nine sections:

1.0 Purpose
2.0 Application
3.0 References
4.0 Associated SOPs
5.0 Equipment
6.0 PID Calibration
7.0 PID Operation
8.0 Documentation
9.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to provide field personnel with step-by-step instructions on the proper use, operation, and handling of the PE Photovac MicroTIP Hand Held Air Monitor/Photoionization Detector, Model 2020 and Model IS-3000.

2.0 Application

This Photovac MicroTIP is used as a field screening instrument for detection of total volatile organic (TVO) concentrations in air. Typical uses include air monitoring of the breathing zone for Health and Safety purposes, and ground water and soil screening for TVO emissions.

The Photovac MicroTIP is a highly sensitive instrument with an operating range of 0.1 to 2000 ppm isobutylene equivalent. Its detection limit is 0.1 ppm isobutylene and its response time is less than 3 seconds.

3.0 References

PE Photovac, 2020 Photo-ionization Air Monitor Instruction Manual (Sept. 1997)

4.0 Associated SOPs

PSC-120 PSC-124 PSC-200 PSC-201 PSC-202

5.0 Equipment

The following equipment is necessary to calibrate the PID:

- A calibration gas regulator
- Calibration gas containing approximately 100 ppm Hexane, or an equivalent calibration gas
- A charged Nickel Cadmium battery pack

6.0 PID Calibration

Before operating the PID, the following calibration procedures must be followed:

- Turn the PID on and allow it to warm up according to manufacturer's instruction.
- Connect the regulator to the calibration gas cylinder.
- Select "Set", "Cal", and then "Mem".
- Select the desired Cal Memory. The PID has 15 Cal Memories and can be calibrated with 15 different span gases or response factors if required. Only one Cal memory can be used at a time.
- Select "Chng" and then "User".
- Press the ENTER key and enter a response factor (RF). Refer to the PID Users Manual for a list of response factors. If the compound you are using is not listed, or you are measuring gas mixtures, then enter a value of 1.0.
- Press the ENTER key and enter an alarm level for STEL, TWA, and PEAK.
- Press ENTER and expose the PID to a supply of zero air.
- Select "Set", "Cal", and "Zero".
- Select "Set", "Cal", and "Span". Enter the known span gas concentration, without pressing enter to confirm it.
- Insert the PID sample probe into the regulator tubing. Open the regulator and press the ENTER key.
- When the display reverts to the default display, the PID is calibrated and ready for use.

7.0 PID Operation

The following procedures should be followed when monitoring for detectable emissions or leaks:

- Place the probe inlet at an interface point where leakage could occur.
- Slowly move the probe along the interface periphery while observing the instrument readout.

- If an increased meter reading is indicated, slowly sample the interface where leakage is indicated until the maximum meter reading is obtained and leave the probe inlet in that position for approximately six seconds.

- If the maximum reading is $\geq$ 10,000 ppm, a "leak" has been identified. A maximum reading of less than 10,000 ppm does not indicate a "leak".

8.0 Documentation

All PID measurements for all monitoring events will be documented on field forms and in a detailed field notebook . Observations of varying weather conditions such as temperature and humidity fluctuations will also be recorded. Standard Operating Procedure PSC-400 describes documentation procedures and provides examples of approved field forms.

9.0 Measure of Proficiency

Field staff will demonstrate proficiency of this SOP by successfully completing sections 6.0, 7.0, and 8.0 a minimum of twice under the direct supervision of the Corrective Actions Manager or her/his designee.

Written By:	Approved By:	Date:	QA Concurrence:	Date:
Tasya Gray	Carolyn Mayer	9/1/99	Carolyn Mayer	9/1/99

This SOP contains nine sections:

1.0 Purpose

The purpose of this SOP is to provide field personnel with step-by-step instructions on the proper use, operation, and handling of the YSI 600XL in correlation with the YSI 610-DM for multi-parameter water quality monitoring.

2.0 Application

The YSI 600XL is used as a field screening instrument for monitoring temperature, dissolved oxygen, redox, pH, and conductivity in water. The YSI 610-DM is used to view and store this information to help determine parameter stability for groundwater sampling.

3.0 References

YSI 6-Series Environmental Monitoring Systems Operations Manual

4.0 Associated SOPs

PSC-124 PSC-125 PSC-200 PSC-400

5.0 Equipment

The following equipment is necessary to calibrate and use the YSI 600XL in correlation with the YSI 610-DM:

- pH buffer standard calibration solutions for pH of 4, 7, and 10, Conductivity calibration standard 718 uS solution, and ORP calibration solution.
- 3 clean, dry or pre-rinsed calibration cups.
- Di-ionized water with spray bottle and paper towels.
- Two 5 gallon buckets, a stand to hold YSI 600XL and flow through cell stationary, and rubber tubing to attach to the YSI flow through cell.

6.0 YSI Calibration

The YSI must be calibrated for Dissolved Oxygen daily. Weekly calibration is required for pH, Conductivity, and ORP (redox potential). Temperature is factory calibrated and does not require field calibration.
To operate the YSI start by doing the following:

- Connect the YSI 610-DM to the YSI 600XL (sonde) using the field cable.
- Remove probe from storage cup.
- Turn the YSI 610-DM on by pressing **Power**.

6.1 Calibration for Dissolved Oxygen

Before operating the YSI to monitor for dissolved oxygen the following calibration procedures must be followed:

- Press **Esc** to get to the Main Menu.
- Scroll down, using the arrow keys, to "Calibration Mode" and press **Enter**.
- Scroll down to "Dissolved Oxy" and press **Enter**.
- Select "DO %" and press **Enter**.
- Enter "760" for the Barometric Pressure and press **Enter**.
- Observe the readings under "DO" and when they show no significant change for approximately 30 seconds press **Enter**. Record the observed reading in the calibration log.
- Press **Esc** 4 times to return to the Main Menu. At this point the YSI is calibrated for dissolved oxygen.

6.2 Calibration for pH

Before operating the YSI to monitor for pH, the following calibration procedures must be followed:

- From the Main Menu on the YSI 610-DM select "Calibration Mode" and press **Enter**.
- Select "ISE1 pH" and press **Enter**.
- Select "3 point" and press **Enter**.
- Fill 3 calibration cups with pH 4,7, and 10 buffer standard solution.
- Carefully immerse the probe in the pH 4 solution.
- Enter "4.0" on the YSI 610-DM and press **Enter**.
- Observe the readings under "pH" and when they show no significant change for approximately 30 seconds press **Enter**. Record the observed reading in the calibration log.
- Remove the probe from the cup and rinse it with di-ionized water.
- Carefully immerse the probe in the pH 7 solution.
- Enter "7.0" on the YSI 610-DM and press **Enter**.
- Observe the readings under "pH" and when they show no significant change for approximately 30 seconds press **Enter**. Record the observed reading in the calibration log.
- Remove the probe from the cup and rinse it with di-ionized water.
- Carefully immerse the probe in the pH 10 solution.
- Enter "10.0" on the YSI 610-DM and press **Enter**.

- Observe the readings under "pH" and when they show no significant change for approximately 30 seconds press **Enter**. Record the observed reading in the calibration log.
- Remove the probe from the cup and rinse it with di-ionized water.
- Press **Esc** 3 times to return to the Main Menu. At this point the YSI is calibrated for pH and is now ready for use.

6.3 Calibration for Conductivity

Before operating the YSI to monitor for pH, the following calibration procedures must be followed:

- From the Main Menu on the YSI 610-DM select "Calibration Mode" and press **Enter**.
- Select "Conductivity" and press **Enter**.
- Select "Cond" and press **Enter**.
- Fill one calibration cup with Conductivity Standard 718 uS solution.
- Carefully immerse the probe in the solution.
- Enter the calibration solution concentration in mS/cm (.718) and press **Enter**.
- Observe the readings under conductivity and when they show no significant change for 30 seconds press **Enter**. Record the observed reading in the calibration log.
- Remove the probe from the cup and rinse it with di-ionized water.
- Press **Esc** 3 times to return to the Main Menu. At this point the YSI is calibrated for Conductivity and is now ready for use.

6.4 Calibration for ORP (Redox Potential)

Before operating the YSI to monitor for ORP, the following calibration procedures must be followed:

- From the Main Menu on the YSI 610-DM select "Calibration Mode" and press **Enter**.
- Select "ISE2 Orp" and press **Enter**.
- Fill one calibration cup with Zobel 231 mV calibration solution.
- Carefully immerse the probe in the solution.
- Enter the concentration of calibration solution in mV and press **Enter**.
- Observe the readings under ORP and when they show no significant change for 30 seconds press **Enter**. Record the observed reading in the calibration log.
- Remove the probe from the cup and rinse it with di-ionized water.

- Press **Esc** 3 times to return to the Main Menu. At this point the YSI is calibrated for ORP and is now ready for use.

7.0 YSI Operation

7.1 YSI Operation for Logging Data

The following procedures should be used, after calibrating the YSI for dissolved oxygen and pH, when using the YSI to monitor and log groundwater parameters to be download later:

- Connect the YSI 610-DM to the YSI 600XL (sonde) using the field cable.
- Remove probe from storage cup and screw on protective shield.
- Place the YSI 600XL in the flow through cell and secure it using the stand.
- Place the stand on top of an overturned 5-gallon bucket, placing the other 5-gallon bucket in front of it between the YSI and the monitoring well.
- Attach a 1' length of rigid 3/16" ID tubing to the top nozzle of the flow through cell and a 3' length of rigid 1/4" ID tubing to the bottom nozzle of the flow through cell. Point the upper tube into the bucket to collect wastewater.
- Attach the sample tubing to the 3' length of 1/4" ID tubing.
- Turn the YSI 610-DM on by pressing **Power**.
- From the Main Menu on the YSI 610-DM scroll down to "610 Logging Mode" and press **Enter**.
- Select "Setup Header" and press **Enter**.
- Next to "File:" type in the name of the well currently being sampled and press **Enter.**
- Press **Esc** once and then select "Start 610 Logging" and press **Enter.**
- Press **Y** for a new file.
- Start pumping the well.
- When the flow through cell is full of water, press **N** for weather data, then data will begin recording.
- Values will be displayed and recorded every 3 minutes. Press **Power** to turn off the YSI and end logging when sampling commences.

7.2 YSI Operation for Viewing Data That Does Not Need To Be Logged

The following procedures should be used when using the YSI to monitor groundwater parameters that do not need to be logged for later downloading:

- Connect the YSI 610-DM to the YSI 600XL (sonde) using the field cable.
- Remove probe from storage cup and screw on protective shield.
- Place the YSI 600XL in the flow through cell and secure it using the stand.
- Place the stand on top of an overturned 5-gallon bucket, placing the other 5-gallon bucket in front of it between the YSI and the monitoring well.
- Attach a 1' length of rigid 3/16" ID tubing to the top nozzle of the flow through cell and a 3' length of rigid 1/4" ID tubing to the bottom nozzle of the flow through cell. Point the upper tube into the bucket to collect wastewater.
- Attach the sample tubing to the 3' length of 1/4" ID tubing.
- Turn the YSI 610-DM on by pressing **Power** and pressing **Esc** to get to the Main Menu.
- Select "Run" from the Main Menu and press **Enter**.
- Data will be displayed continually.
- Press **Power** to end readings and turn off YSI.

8.0 Documentation

All YSI logging can be downloaded using the YSI software after fieldwork is completed (see manual listed in References for an explanation of how to download data). Monitoring events will be documented on field forms as well and in a detailed field notebook. Standard Operating Procedure PSC-400 describes documentation procedures.

9.0 Measure of Proficiency

Field staff will demonstrate proficiency of this SOP by successfully completing sections 6.1, 6.2, 7.0, and 8.0 a minimum of twice under the direct supervision of the Corrective Actions Manager or her/his designee.

Written By:	Approved By:	Date:	QA Concurrence:	Date:
Tasya Gray	Carolyn Mayer	9/1/99	Chris Minton	9/1/99

This SOP contains ten sections:

1.0 Purpose

The purpose of this SOP is to provide field personnel with step-by-step instructions on the proper use, operation, and handling of the YSI 600XL in correlation with the YSI 610-DM for multi-parameter water quality monitoring.

2.0 Application

The YSI 600XL is used as a field screening instrument for monitoring temperature, dissolved oxygen, redox, pH, and conductivity in water. The YSI 610-DM is used to view and store this information to help determine parameter stability for groundwater sampling.

3.0 References

YSI 6-Series Environmental Monitoring Systems Operations Manual

4.0 Associated SOPs

PSC-124 PSC-125 PSC-200 PSC-400

5.0 Equipment

The following equipment is necessary to calibrate and use the YSI 600XL in correlation with the YSI 610-DM:

- pH buffer standard calibration solutions for pH of 4, 7, and 10.
- 3 clean, dry or pre-rinsed calibration cups.
- Di-ionized water with spray bottle and paper towels.
- Two 5 gallon buckets, a stand to hold YSI 600XL and flow through cell stationary, and rubber tubing to attach to the YSI flow through cell.

6.0 YSI Calibration

To operate the YSI start by doing the following:
- Connect the YSI 610-DM to the YSI 600XL (sonde) using the field cable.
- Remove probe from storage cup.
- Turn the YSI 610-DM on by pressing **Power**.

6.1 Calibration for Dissolved Oxygen

Before operating the YSI to monitor for dissolved oxygen the following calibration procedures must be followed:
- Press **Esc** to get to the Main Menu.
- Scroll down, using the arrow keys, to "Calibration Mode" and press **Enter**.
- Scroll down to "Dissolved Oxy" and press **Enter**.
- Select "DO %" and press **Enter**.
- Enter "760" for the Barometric Pressure and press **Enter**.
- Observe the readings under "DO" and when they show no significant change for approximately 30 seconds press **Enter**.

- Press **Esc** 4 times to return to the Main Menu. At this point the YSI is calibrated for dissolved oxygen.

6.2 Calibration for pH

Before operating the YSI to monitor for pH, the following calibration procedures must be followed:

- From the Main Menu on the YSI 610-DM select "Calibration Mode" and press **Enter**.
- Select "ISE1 pH" and press **Enter**.
- Select "3 point" and press **Enter**.
- Fill 3 calibration cups with pH 4,7, and 10 buffer standard solution.
- Carefully immerse the probe in the pH 4 solution.
- Enter "4.0" on the YSI 610-DM and press **Enter**.
- Observe the readings under "pH" and when they show no significant change for approximately 30 seconds press **Enter**.
- Remove the probe from the cup and rinse it with di-ionized water.
- Carefully immerse the probe in the pH 7 solution.
- Enter "7.0" on the YSI 610-DM and press **Enter**.
- Observe the readings under "pH" and when they show no significant change for approximately 30 seconds press **Enter**.
- Remove the probe from the cup and rinse it with di-ionized water.
- Carefully immerse the probe in the pH 10 solution.
- Enter "10.0" on the YSI 610-DM and press **Enter**.
- Observe the readings under "pH" and when they show no significant change for approximately 30 seconds press **Enter**.
- Remove the probe from the cup and rinse it with di-ionized water.
- Press **Esc** 3 times to return to the Main Menu. At this point the YSI is calibrated for pH and is now ready for use.

7.0 YSI Operation

7.1 YSI Operation for Logging Data

The following procedures should be used, after calibrating the YSI for dissolved oxygen and pH, when using the YSI to monitor and log groundwater parameters to be download later:

- Connect the YSI 610-DM to the YSI 600XL (sonde) using the field cable.
- Remove probe from storage cup and screw on protective shield.
- Place the YSI 600XL in the flow through cell and secure it using the stand.
- Place the stand on top of an overturned 5-gallon bucket, placing the other 5-gallon bucket in front of it between the YSI and the monitoring well.
- Attach a 1' length of rigid 3/16" ID tubing to the top nozzle of the flow through cell and a 3' length of rigid 1/4" ID tubing to the bottom nozzle of the flow through cell. Point the upper tube into the bucket to collect wastewater.
- Attach the sample tubing to the 3' length of 1/4" ID tubing.
- Turn the YSI 610-DM on by pressing **Power**.
- From the Main Menu on the YSI 610-DM scroll down to "610 Logging Mode" and press **Enter**.
- Select "Setup Header" and press **Enter**.
- Next to "File:" type in the name of the well currently being sampled and press **Enter.**
- Press **Esc** once and then select "Start 610 Logging" and press **Enter**.
- Press **Y** for a new file.
- Start pumping the well.
- When the flow through cell is full press **N** for weather data.
- Values will be displayed and recorded every 3 minutes. Press **Power** to turn off the YSI and end logging when sampling commences.

7.2 YSI Operation for Viewing Data That Does Not Need To Be Logged

The following procedures should be used, after calibrating the YSI for dissolved oxygen and pH, when using the YSI to monitor groundwater parameters that do not need to be logged for later downloading:

- Connect the YSI 610-DM to the YSI 600XL (sonde) using the field cable.
- Remove probe from storage cup and screw on protective shield.
- Place the YSI 600XL in the flow through cell and secure it using the stand.

- Place the stand on top of an overturned 5-gallon bucket, placing the other 5-gallon bucket in front of it between the YSI and the monitoring well.
- Attach a 1' length of rigid 3/16" ID tubing to the top nozzle of the flow through cell and a 3' length of rigid 1/4" ID tubing to the bottom nozzle of the flow through cell. Point the upper tube into the bucket to collect wastewater.
- Attach the sample tubing to the 3' length of 1/4" ID tubing.
- Turn the YSI 610-DM on by pressing **Power** and pressing **Esc** to get to the Main Menu.
- Select "Run" from the Main Menu and press **Enter**.
- Data will be displayed continually.
- Press **Power** to end readings and turn off YSI.

8.0 Documentation

All YSI logging can be downloaded using the YSI software after fieldwork is completed (see manual listed in References for an explanation of how to download data). Monitoring events will be documented on field forms as well and in a detailed field notebook. Standard Operating Procedure PSC-400 describes documentation procedures.

9.0 Measure of Proficiency

Field staff will demonstrate proficiency of this SOP by successfully completing sections 6.1, 6.2, 7.0, and 8.0 a minimum of twice under the direct supervision of the Corrective Actions Manager or her/his designee.

Hach Digital Titrator and Colorimeter Procedures
SOP No. PSC - 302
Original Date: 1/19/00
Revision Date:
Revision No. 0

Written By:	Approved By:	Date:	QA Concurrence:	Date:
Salamah Magnuson	Carolyn Mayer	1/19/00	Tasya Gray	1/19/00

This SOP contains ten sections:

1.0 Purpose

The purpose of this SOP is to provide sampling personnel with an outline of the specific information needed to perform chemical analyses on water samples using the Hach Digital Titrator and Colorimeter.

2.0 Application

This SOP provides a step-by-step guideline to test for Alkalinity, Carbon Dioxide, Ferrous Iron, Nitrate, and Sulfate in water samples. The field sampling crew will follow this SOP to assure consistent and representative analyses.

3.0 Precision

3.1 Alkalinity

Range: 10 to 4000 mg/L as $CaCO_3$

3.2 Carbon Dioxide

Range: 10 to 1000 mg/L as CO_2

3.3 Ferrous Iron

Range: 0 to 3.00 mg/L Fe^{+2}

Standard Deviation: +-0.017 mg/L Fe^{+2}

Estimated Detection Limit: 0.03 mg/L Fe^{+2}

3.4 Nitrate

Range: 0 to 30.0 mg/L NO_3^--N

Standard Deviation: +-1.7 mg/L NO_3^--N

Estimated Detection Limit: 0.8 mg/L NO_3^--N

3.5 Sulfate

Range: 0 to 70 mg/L SO_4^-

Standard Deviation: +-0.5mg/L SO_4^-

Estimated Detection Limit: 4.9 mg/L SO_4^-

4.0 References

Hach Company Operation Manual for Digital Titrator Model 16900

Hach Datalogging Colorimeter Handbook DR/820-DR/850-DR/890

Health and Safety Plan for General Corrective Action Activities, (PSC, 1999)

5.0 Equipment

5.1 Hach Digital Titrator Equiptment

The following equipment is necessary to properly analyze a ground water sample using the Hach Digital Titrator:

- Hach Digital Titrator Model 16900.
- Hach Permachem Reagents.
- Cartridges for the Digital Titrator.
- Equipment to conduct analysis: delivery tubes, 125-ml Erlenmeyer flask, 250-ml Erlenmeyer flask, and a stir bar.
- Deionized water to dilute the samples and to decontaminate equipment.
- A sufficient number of sampling containers to collect the sample.
- Required documentation tools including sample labels, field books, and sampling forms.
- Personal protective equipment (PPE) as described in the PSC General Health and Safety Plan.

5.2 Hach Colorimeter Equipment

The following equipment is necessary to properly analyze a groundwater sample using the Hach Colorimeter:

- Hach Colorimeter DR/820.
- Hach Permachem Reagents.
- Equipment to conduct analysis: 2 round sample cells with 10-mL, 20-mL and 25-mL marks.
- Deionized water for the blank sample and to decontaminate equipment.
- A sufficient number of sampling containers to collect the sample.
- Required documentation tools including sample labels, field books, and sampling forms.
- PPE as described in the PSC General Health and Safety Plan.

6.0 Decontamination

All reusable equipment that will come in contact with the samples will be decontaminated following each analysis.

6.1 Decontamination of the Hach Digital Titrator

To clean the delivery tube, force deionized water, then air, into the tube opening with a syringe or wash bottle. To clean the Erenmeyer flasks, rinse three times with deionized water.

6.2 Decontamination of the Hach Colorimeter

Rinse cells with deionized water three times.

7.0 Hach Digital Titrator Procedure

7.1 Set-Up

Upon collecting each sample, the following preparations shall be followed:

- Suit up in appropriate PPE.
- Place equipment and sampling bottles on plastic sheeting in the designated area to perform analysis.

7.2 Analysis

7.2.1 Alkalinity Analysis

Upon completing the preparations, the following procedures shall be followed:

- Select a sample volume and Sulfuric Acid (H_2SO_4) Titration Cartridge corresponding to the expected alkalinity concentration as mg/L calcium carbonate ($CaCO_3$) from Table 1.

  If the expected sample concentration is not known, start with one of the smaller sample volumes and determine its approximate concentration. Retest with appropriate sample size.

- Set up Digital Titrator: Slide the selected cartridge into the titrator receptacle and lock in position, remove the polyethylene cap and insert a clean delivery tube, start titrant flow into the delivery tube, use the counter reset knob to turn the digital counter back to zero, and run the tip in deionized water.

- Preparation of sample: Measure the sample volume from Table 1 with a graduated cylinder or pipet. Transfer the sample into a clean 250-ml Erlenmeyer flask and dilute to the 100-mL mark with deionized water if necessary. Add the contents of one Phenolphthalein Indicator Powder Pillow and swirl to mix.

- Titrate to a colorless end point if the solution turns pink: Place the delivery tube in the solution and swirl the flask while titrating with the sulfuric acid. Record the number of digits required in field book.

- Calculate and record in field book: Digits Required x Digit Multiplier = mg/L $CaCO_3$ P Alkalinity

- Add the contents of one Bromocresol Green-Methyl Red Indicator Powder Pillow to the flask and swirl to mix.

- Continue the titration with sulfuric acid to a light greenish blue-gray (pH 5.1), a light violet-gray (pH 4.8), or a light pink (pH 4.5) color, as required by the sample composition; see Table 2. Record the number of digits required in field book.

- Calculate and record in field book: Total Digits Required x Digit Multiplier = mg/L as $CaCO_3$ Total (T or M) Alkalinity

Table 1

Range (mg/L as CACO3)	Sample Volume (mL)	Titration Cartridge (H2SO4)	Catalog Number	Digit Multiplier
10-40	100	0.1600	14388-01	0.1
40-160	25	0.1600	14388-01	0.4
100-400	100	1.600	14389-01	1.0
200-800	50	1.600	14389-01	2.0
500-2000	20	1.600	14389-01	5.0
1000-4000	10	1.600	14389-01	10.0

Table 2

Sample Composition	End Point
Alkalinity about 30 mg/L	pH 5.1
Alkalinity about 150 mg/L	pH 4.8
Alkalinity about 500 mg/L	pH 4.5
Silicates or Phosphates present	pH 4.5
Industrial waste or complex system	pH 3.7

7.2.1.1 General Considerations

Highly colored or turbid samples may mask the color change at the end point.

Chlorine may interfere with the indicators. Add one drop of 0.1 N Sodium Thiosulfate to eliminate this interference.

7.2.2 Carbon Dioxide Analysis

Upon completing the preparations, the following procedures shall be followed:

- Select a sample size and a Sodium Hydroxide (NaOH) Titration Cartridge corresponding to the expected carbon dioxide (CO_2) concentration from Table 3.

  If the expected sample concentration is not known, start with one of the smaller sample volumes and determine its approximate concentration. Retest with appropriate sample size.

- Set up Digital Titrator: Slide the selected cartridge into the titrator receptacle and lock in position, remove the polyethylene cap and insert a clean delivery tube, start titrant flow into the delivery tube, use the counter reset knob to turn the digital counter back to zero, and run the tip in deionized water.

- Prearation of sample: Collect a sample directly into the titration flask by filling to the appropriate mark. Measure the sample volume from Table 1 with a graduated cylinder or pipet. Add the contents of one Phenolphthalein Indicator Powder Pillow and swirl to mix. Note: Minimize agitation because carbon dioxide may be lost.

- Titrate: Place the delivery tube in the solution and swirl the flask while titrating with the sodium hydroxide from colorless to a slight pink color that persists for 30 seconds. Record the number of digits required in field book.

- Calculate and record in field book: Total Digits Required x Digit Multiplier = mg/L as CO_2

Table 3

Range mg/L as CO2	Sample Volume mL	Titration Cartridge N NaOH	Catalog Number	Digit Multiplier
10-50	200	0.3636	14378-01	0.1
20-100	100	0.3636	14378-01	0.2
100-400	200	3.636	14380-01	1.0
200-1000	100	3.636	14380-01	2.0

7.2.2.1 General Considerations

Highly colored or turbid samples may mask the color change at the end point.

Other acid components in the sample will be titrated and interfere directly in this determination.

8.0 Hach Colorimeter Procedure

8.1 Set up

Upon collecting each sample, the following preparations shall be followed:

- Suit up in PPE.
- Place equipment and sampling bottles on plastic sheeting in the designated area to perform analysis.

8.2 Analysis

8.2.1 Ferrous Iron Analysis

Upon completing the preparations, the following procedures shall be followed:

- Enter the stored program number for ferrous iron (Fe^{+2}): Press **PRGM**, then **33** **ENTER**. If using a User–Entered Program, enter the Program number **101-105**, then **ENTER**.

- Prepare blank: Fill a clean sample cell with 25-mL of deionized water. Place the blank sample into the cell holder. Tightly cover the sample cell with the instrument cap.

- Run blank: Press **ZERO**. The display will show "0.00 mg/L Fe".

- Set-up sample: Fill a second sample cell with 25-mL of sample. Add the contents of one Ferrous Iron Reagent Powder Pillow to the sample cell (the prepared sample). Cap the cell and inert several times to mix.

- Begin 3 minute reaction time: Press **TIMER**, then **ENTER**.

- Prepare sample: Place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.

- Run prepared sample: Press **READ**. The display will show the result in mg/L Fe^{+2}. Record in field book.

8.2.1.1 General Considerations

Analyze samples as soon as possible to prevent oxidation of ferrous iron to ferric iron, which is not determined.

8.2.2 Nitrate (High Range) Analysis

Upon completing the preparations, the following procedures shall be followed:

- Enter the stored program number for nitrate nitrogen (NO_3^--N): Press **PRGM**, then **51 ENTER**. If using a User–Entered Program, enter the Program number **101-105**, then **ENTER.**

- Set-up sample: Fill a sample cell with 10-mL of sample. Add the contents of one Nitra Ver 5 Nitrate Reagent Powder Pillow to the sample cell (the prepared sample). Cap the cell and inert several times to mix. Note: It is important to remove all of the powder from the foil pillow.

- Begin 1 minute reaction time: Press **TIMER**, then **ENTER**. Shake the cell vigorously until the timer beeps.

- After the timer beeps, the display will show "5:00 Timer 2". Press **ENTER**.
- Prepare blank: During the 5 minutes, fill a second sample cell with 10-mL of deionized water. Wipe off any fingerprints or liquid. Place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.
- Run blank: Press **ZERO**. The display will show "0 mg/L NO^-_3-N".
- Prepare sample: Place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.
- Run prepared sample: Press **READ**. The display will show the result in mg/L NO^-_3-N. Record in field book.

8.2.2.1 General Considerations

A deposit will remain after the reagent dissolves and will not affect test results.

An amber color will develop if nitrate nitrogen (NO^-_3-N) is present.

8.2.3 Sulfate Analysis

Upon completing the preparations, the following procedures shall be followed:

- Enter the stored program number for sulfate: Press **PRGM**, then **91 ENTER**. If using a User–Entered Program, enter the Program number **101-105**, then **ENTER**.
- Set-up sample: Fill a clean sample cell with 10-mL of sample. Add the contents of one Sulfa Ver 4 Sulfate Reagent Powder Pillow to the sample cell (the prepared sample). Cap the cell and inert several times to mix. Note: Filter highly turbid or colored samples.
- Begin 5 minute reaction time: Press **TIMER**, then **ENTER**.
- Prepare blank: After the timer beeps, fill a second sample cell with 10-mL of
- deionized water. Place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.

- Run blank: Press **ZERO**. The display will show "0 mg/L SO_4^{-}".

- Prepare sample: Within 5 minutes after the timer beeps, place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.

- Run prepared sample: Press **READ**. The display will show the result in mg/L SO_4. Record in field book.

8.2.3.1 General Considerations

The following interfere at levels above those concentrations listed:

Calcium: 20,000 mg/L as $CaCO_3$	Magnesium: 10,000 mg/L as $CaCO_3$
Chloride: 40,000 mg/L as Cl-	Silica: 500 mg/L as $CaCO_3$

9.0 Documentation

Documentation of all analyses will be made in field forms and a detailed field notebook.

10.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing sections 6.0, 7.0, and 8.0 a minimum of twice under the direct supervision of the Corrective Actions Manager or her/his designee.

Hach Digital Titrator and Colorimeter Procedures
SOP No. PSC - 302
Original Date: 1/19/00
Revision Date:
Revision No. 0

Written By:	Approved By:	Date:	QA Concurrence:	Date:
Salamah Magnuson	Carolyn Mayer	1/19/00	Tasya Gray	1/19/00

This SOP contains ten sections:

1.0 Purpose

The purpose of this SOP is to provide sampling personnel with an outline of the specific information needed to perform chemical analyses on water samples using the Hach Digital Titrator and Colorimeter.

2.0 Application

This SOP provides a step-by-step guideline to test for Alkalinity, Carbon Dioxide, Ferrous Iron, Nitrate, and Sulfate in water samples. The field sampling crew will follow this SOP to assure consistent and representative analyses.

3.0 Precision

3.1 Alkalinity

Range: 10 to 4000 mg/L as $CaCO_3$

3.2 Carbon Dioxide

Range: 10 to 1000 mg/L as CO_2

3.3 Ferrous Iron

Range: 0 to 3.00 mg/L Fe^{+2}

Standard Deviation: +-0.017 mg/L Fe^{+2}

Estimated Detection Limit: 0.03 mg/L Fe^{+2}

3.4 Nitrate

Range: 0 to 30.0 mg/L NO_3^--N

Standard Deviation: +-1.7 mg/L NO_3^--N

Estimated Detection Limit: 0.8 mg/L NO_3^--N

3.5 Sulfate

Range: 0 to 70 mg/L SO_4^-

Standard Deviation: +-0.5mg/L SO_4^-

Estimated Detection Limit: 4.9 mg/L SO_4^-

4.0 References

Hach Company Operation Manual for Digital Titrator Model 16900

Hach Datalogging Colorimeter Handbook DR/820-DR/850-DR/890

Health and Safety Plan for General Corrective Action Activities, (PSC, 1999)

5.0 Equipment

5.1 Hach Digital Titrator Equiptment

The following equipment is necessary to properly analyze a ground water sample using the Hach Digital Titrator:

- Hach Digital Titrator Model 16900.
- Hach Permachem Reagents.
- Cartridges for the Digital Titrator.
- Equipment to conduct analysis: delivery tubes, 125-ml Erlenmeyer flask, 250-ml Erlenmeyer flask, and a stir bar.
- Deionized water to dilute the samples and to decontaminate equipment.
- A sufficient number of sampling containers to collect the sample.
- Required documentation tools including sample labels, field books, and sampling forms.
- Personal protective equipment (PPE) as described in the PSC General Health and Safety Plan.

5.2 Hach Colorimeter Equipment

The following equipment is necessary to properly analyze a groundwater sample using the Hach Colorimeter:

- Hach Colorimeter DR/820.
- Hach Permachem Reagents.
- Equipment to conduct analysis: 2 round sample cells with 10-mL, 20-mL and 25-mL marks.
- Deionized water for the blank sample and to decontaminate equipment.
- A sufficient number of sampling containers to collect the sample.
- Required documentation tools including sample labels, field books, and sampling forms.
- PPE as described in the PSC General Health and Safety Plan.

6.0 Decontamination

All reusable equipment that will come in contact with the samples will be decontaminated following each analysis.

6.1 Decontamination of the Hach Digital Titrator

To clean the delivery tube, force deionized water, then air, into the tube opening with a syringe or wash bottle. To clean the Erenmeyer flasks, rinse three times with deionized water.

6.2 Decontamination of the Hach Colorimeter

Rinse cells with deionized water three times.

7.0 Hach Digital Titrator Procedure

7.1 Set-Up

Upon collecting each sample, the following preparations shall be followed:

- Suit up in appropriate PPE.
- Place equipment and sampling bottles on plastic sheeting in the designated area to perform analysis.

7.2 Analysis

7.2.1 Alkalinity Analysis

Upon completing the preparations, the following procedures shall be followed:

- Select a sample volume and Sulfuric Acid (H_2SO_4) Titration Cartridge corresponding to the expected alkalinity concentration as mg/L calcium carbonate ($CaCO_3$) from Table 1.

  If the expected sample concentration is not known, start with one of the smaller sample volumes and determine its approximate concentration. Retest with appropriate sample size.

- Set up Digital Titrator: Slide the selected cartridge into the titrator receptacle and lock in position, remove the polyethylene cap and insert a clean delivery tube, start titrant flow into the delivery tube, use the counter reset knob to turn the digital counter back to zero, and run the tip in deionized water.

- Preparation of sample: Measure the sample volume from Table 1 with a graduated cylinder or pipet. Transfer the sample into a clean 250-ml Erlenmeyer flask and dilute to the 100-mL mark with deionized water if necessary. Add the contents of one Phenolphthalein Indicator Powder Pillow and swirl to mix.

- Titrate to a colorless end point if the solution turns pink: Place the delivery tube in the solution and swirl the flask while titrating with the sulfuric acid. Record the number of digits required in field book.

- Calculate and record in field book: Digits Required x Digit Multiplier = mg/L $CaCO_3$ P Alkalinity

- Add the contents of one Bromocresol Green-Methyl Red Indicator Powder Pillow to the flask and swirl to mix.

- Continue the titration with sulfuric acid to a light greenish blue-gray (pH 5.1), a light violet-gray (pH 4.8), or a light pink (pH 4.5) color, as required by the sample composition; see Table 2. Record the number of digits required in field book.

- Calculate and record in field book: Total Digits Required x Digit Multiplier = mg/L as $CaCO_3$ Total (T or M) Alkalinity

Table 1

Range (mg/L as CACO3)	Sample Volume (mL)	Titration Cartridge (H2SO4)	Catalog Number	Digit Multiplier
10-40	100	0.1600	14388-01	0.1
40-160	25	0.1600	14388-01	0.4
100-400	100	1.600	14389-01	1.0
200-800	50	1.600	14389-01	2.0
500-2000	20	1.600	14389-01	5.0
1000-4000	10	1.600	14389-01	10.0

Table 2

Sample Composition	End Point
Alkalinity about 30 mg/L	pH 5.1
Alkalinity about 150 mg/L	pH 4.8
Alkalinity about 500 mg/L	pH 4.5
Silicates or Phosphates present	pH 4.5
Industrial waste or complex system	pH 3.7

7.2.1.1 General Considerations

Highly colored or turbid samples may mask the color change at the end point.

Chlorine may interfere with the indicators. Add one drop of 0.1 N Sodium Thiosulfate to eliminate this interference.

7.2.2 Carbon Dioxide Analysis

Upon completing the preparations, the following procedures shall be followed:

- Select a sample size and a Sodium Hydroxide (NaOH) Titration Cartridge corresponding to the expected carbon dioxide (CO_2) concentration from Table 3.

  If the expected sample concentration is not known, start with one of the smaller sample volumes and determine its approximate concentration. Retest with appropriate sample size.

- Set up Digital Titrator: Slide the selected cartridge into the titrator receptacle and lock in position, remove the polyethylene cap and insert a clean delivery tube, start titrant flow into the delivery tube, use the counter reset knob to turn the digital counter back to zero, and run the tip in deionized water.

- Prearation of sample: Collect a sample directly into the titration flask by filling to the appropriate mark. Measure the sample volume from Table 1 with a graduated cylinder or pipet. Add the contents of one Phenolphthalein Indicator Powder Pillow and swirl to mix. Note: Minimize agitation because carbon dioxide may be lost.

- Titrate: Place the delivery tube in the solution and swirl the flask while titrating with the sodium hydroxide from colorless to a slight pink color that persists for 30 seconds. Record the number of digits required in field book.

- Calculate and record in field book: Total Digits Required x Digit Multiplier = mg/L as CO_2

Table 3

Range mg/L as CO2	Sample Volume mL	Titration Cartridge N NaOH	Catalog Number	Digit Multiplier
10-50	200	0.3636	14378-01	0.1
20-100	100	0.3636	14378-01	0.2
100-400	200	3.636	14380-01	1.0
200-1000	100	3.636	14380-01	2.0

7.2.2.1 General Considerations

Highly colored or turbid samples may mask the color change at the end point.

Other acid components in the sample will be titrated and interfere directly in this determination.

8.0 Hach Colorimeter Procedure

8.1 Set up

Upon collecting each sample, the following preparations shall be followed:

- Suit up in PPE.
- Place equipment and sampling bottles on plastic sheeting in the designated area to perform analysis.

8.2 Analysis

8.2.1 Ferrous Iron Analysis

Upon completing the preparations, the following procedures shall be followed:

- Enter the stored program number for ferrous iron (Fe^{+2}): Press **PRGM**, then **33** **ENTER**. If using a User–Entered Program, enter the Program number **101-105**, then **ENTER**.

- Prepare blank: Fill a clean sample cell with 25-mL of deionized water. Place the blank sample into the cell holder. Tightly cover the sample cell with the instrument cap.

- Run blank: Press **ZERO**. The display will show "0.00 mg/L Fe".

- Set-up sample: Fill a second sample cell with 25-mL of sample. Add the contents of one Ferrous Iron Reagent Powder Pillow to the sample cell (the prepared sample). Cap the cell and inert several times to mix.

- Begin 3 minute reaction time: Press **TIMER**, then **ENTER**.

- Prepare sample: Place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.

- Run prepared sample: Press **READ**. The display will show the result in mg/L Fe^{+2}. Record in field book.

8.2.1.1 General Considerations

Analyze samples as soon as possible to prevent oxidation of ferrous iron to ferric iron, which is not determined.

8.2.2 Nitrate (High Range) Analysis

Upon completing the preparations, the following procedures shall be followed:

- Enter the stored program number for nitrate nitrogen (NO^-_3-N): Press **PRGM**, then **51 ENTER**. If using a User–Entered Program, enter the Program number **101-105**, then **ENTER**.

- Set-up sample: Fill a sample cell with 10-mL of sample. Add the contents of one Nitra Ver 5 Nitrate Reagent Powder Pillow to the sample cell (the prepared sample). Cap the cell and inert several times to mix. Note: It is important to remove all of the powder from the foil pillow.

- Begin 1 minute reaction time: Press **TIMER**, then **ENTER**. Shake the cell vigorously until the timer beeps.

- After the timer beeps, the display will show "5:00 Timer 2". Press **ENTER**.

- Prepare blank: During the 5 minutes, fill a second sample cell with 10-mL of deionized water. Wipe off any fingerprints or liquid. Place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.

- Run blank: Press **ZERO**. The display will show "0 mg/L NO^-_3-N".

- Prepare sample: Place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.

- Run prepared sample: Press **READ**. The display will show the result in mg/L NO^-_3-N. Record in field book.

8.2.2.1 General Considerations

A deposit will remain after the reagent dissolves and will not affect test results.

An amber color will develop if nitrate nitrogen (NO^-_3-N) is present.

8.2.3 Sulfate Analysis

Upon completing the preparations, the following procedures shall be followed:

- Enter the stored program number for sulfate: Press **PRGM**, then **91 ENTER**. If using a User–Entered Program, enter the Program number **101-105**, then **ENTER**.

- Set-up sample: Fill a clean sample cell with 10-mL of sample. Add the contents of one Sulfa Ver 4 Sulfate Reagent Powder Pillow to the sample cell (the prepared sample). Cap the cell and inert several times to mix. Note: Filter highly turbid or colored samples.

- Begin 5 minute reaction time: Press **TIMER**, then **ENTER**.

- Prepare blank: After the timer beeps, fill a second sample cell with 10-mL of

- deionized water. Place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.

- Run blank: Press **ZERO**. The display will show "0 mg/L SO_4^{-}".

- Prepare sample: Within 5 minutes after the timer beeps, place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.

- Run prepared sample: Press **READ**. The display will show the result in mg/L SO_4. Record in field book.

8.2.3.1 General Considerations

The following interfere at levels above those concentrations listed:

Calcium: 20,000 mg/L as $CaCO_3$	Magnesium: 10,000 mg/L as $CaCO_3$
Chloride: 40,000 mg/L as Cl-	Silica: 500 mg/L as $CaCO_3$

9.0 Documentation

Documentation of all analyses will be made in field forms and a detailed field notebook.

10.0 Measure of Proficiency

Field staff will demonstrate proficiency on this SOP by successfully completing sections 6.0, 7.0, and 8.0 a minimum of twice under the direct supervision of the Corrective Actions Manager or her/his designee.

Turbidimeter DRT-15CE Calibration and Operation
SOP No. PSC - 303
Origination Date: 1/20/00
Revision Date:
Revision No.0

Written By:	Approved By:	Date:	QA Concurrence:	Date:
Salamah Magnuson	Carolyn Mayer	1/20/00	Tasya Gray	1/20/00

This SOP contains ten sections:

1.0 Purpose

The purpose of this SOP is to provide field personnel with step-by-step instructions on calibration, operation, and handling of the Turbidimeter DRT-15CE for water quality monitoring.

2.0 Application

The Turbidimeter DRT-15CE is used as a field-screening instrument for monitoring turbidity in water.

3.0 Precision

Range: A linear display throughout all ranges in Nephelometric Turbidity Units (NTU).

Turbidimeter DRT-15CE uses solid state electronic components to resist thermal variation and will not be affected by normal line voltage fluctuations.

4.0 References

DRT-15CE Portable Turbidimeter Operating & Maintenance Manual

5.0 Associated SOPs

PSC-301 PSC-302 PSC-400

6.0 Equipment

The following equipment is necessary to properly measure turbidity and maintain accuracy using the Turbidimeter DRT-15CE:

- Turbidimeter DRT-15CE, including 1 Cuvette and Battery Charger 120 V 60 Hz.
- Reference Standard 0.02 NTU (Nominal) with an indexing ring and locator pin.
- Lint-free wiper to clean the Cuvette.

7.0 Turbidimeter Calibration

The Turbidimeter must be calibrated daily.

To calibrate the Turbidimeter DRT-15CE:

- Clean the Reference Standard (0.02 NTU) with a lint-free wipe to remove all moisture and fingerprints.
- Place the Reference Standard (0.02 NTU) in the optical well. Align the indexing ring with the locator pin.
- Turn the Range knob to the right, from "Off" to the "10" range.
- Record the value displayed as the "Drift value" in the calibration field book.

- Press the Reference Adjust buttons in the appropriate direction to cause the display to read 0.02 NTU.

8.0 Turbidimeter Operation

8.1 Turbidimeter Operation

To operate the Turbidimeter DRT-15CE:

- To turn on: Switch the Range knob to the right, to the "10", "100", or "1000" range.
- To shut off: Switch the Range knob to the left, to "Off".

8.2 Turbidity Measurement

To measure turbidity for a water sample:

- Collect sample: Clean the cuvette and fill it with your sample to within approximately ½" (12mm) of the top. Place the cap on the cuvette and carefully clean the outside surface of the cuvette with a lint free wiper to remove all moisture and fingerprints.
- Prepare sample to be measured: Place the sample in the optical well. Turn on Turbidimeter. Set Range knob initially to the "10" range. If the triangle appears on the display, indicating it is "Over Range", select the appropriate range for best readability.
- Measure sample: Take NTU reading directly from display.
- Record turbidity value on sampling form.

8.2.1 General Considerations

If the instrument has been subjected to cold (below 10 degrees Celsius) and then brought indoors, it should be allowed to warm up before use, since condensation may form on the various lenses.

Turn off Turbidimeter between readings in order to obtain longer battery life between charges.

9.0 Documentation

Documentation of all measurements will be made on field forms and entered into computer spreadsheet for water quality parameters.

10.0 Measure of Proficiency

Field staff will demonstrate proficiency of this SOP by successfully completing sections 7.0 and 8.0 a minimum of twice under the direct supervision of the Corrective Actions Manager or her/his designee.

Written By:	Edited By:	Approved By:	QA Concurrence:
Salamah Magnuson		Carolyn Mayer	Kevin McNeill
7/26/01		7/26/01	7/26/01

This SOP contains eleven sections:

1.0 Purpose

The purpose of this SOP is to provide field personnel with step-by-step instructions on the proper calibration, operation and handling of the HORIBA U-22 Sensor probe and meter for the purpose of multi-parameter water quality monitoring.

2.0 Application

The HORIBA U-22 Sensor probe is a field screening instrument for measuring turbidity, temperature, dissolved oxygen, redox, pH, and conductivity in water. The HORIBA U-22 Meter (U-2000) is used to view and store this information to determine parameter stability during groundwater monitoring.

3.0 References

HORIBA U-20 Series Multi-Parameter Water Quality Monitoring System Operational Manual

4.0 Associated SOPs

PSC-124 – Micropurge Groundwater Sampling Procedure
PSC-200 – Equipment Decontamination Procedure
PSC-400 – Documentation Procedures

5.0 Equipment

The following equipment is necessary to calibrate and operate the HORIBA U-22 Sensor probe and meter:

- HORIBA U-22 Sensor probe and meter
- HORIBA flow through cell.
- An alkaline battery 6LR61 (Manganese battery 6F22 [006P]) for the U-22 meter, and three alkaline batteries LR03 [AAA] (Manganese battery [R03]) for the U-22 Sensor probe.
- Auto Calibration Solution.
- Level 2 Calibration Solution.
- A labeled bottle for waste calibration solution.
- De-ionized water with spray bottle.
- One waste water receptacle.
- A stand to hold the HORIBA Sensor probe and flow through cell stationary.
- A stable elevated surface.
- Tubing to attach to the HORIBA flow through cell.
- Field Log Calibration book to record calibration information, or Field Log book if Field Log Calibration book is unavailable.

6.0 HORIBA Calibration

The HORIBA calibration procedures outlined here have been excerpted from the HORIBA Standard Operation Manual. For more information and troubleshooting tips, refer to the manual. The HORIBA Sensor probe should be calibrated daily for

conductivity, DO, turbidity and pH. The U-22 Sensor probe does not require calibration for temperature and redox. To operate the HORIBA Sensor probe and meter, the following procedure should be followed:

- Connect the HORIBA Sensor probe to the HORIBA meter using the field cable.
- Remove the Sensor probe from the calibration cup and remove the protective shield from the Sensor probe.
- Turn the HORIBA meter on by pressing **Power**, and wait approximately 10 seconds.
- Fill calibration cup with the proper volume of AutoCal solution, as indicated by the black line on the calibration cup.
- Immerse Sensor probes in calibration cup with AutoCal solution and snap tight to seal.
- Press **Cal** on the meter. AUTO and CAL will appear on the display. Press **ENT** to start the AUTO Calibration.
- Wait until the DATA IN signal stops flashing and press **ENT**.
- Press **MEAS** to return to the Measurement mode.

7.0 HORIBA Drift

The drift from the initial daily calibration should be measured and recorded after use. This will provide an indication of how accurate the instrument remained during the day. To measure the drift on the HORIBA U-22, the following procedure should be followed:

- Insert the HORIBA Sensor probe into the calibration cup filled with the Level 2 Calibration solution to the appropriate level, as indicated by the black line.
- Wait until the reading is stabilize for approximately 30 seconds.
- Record the reading for water quality parameters: conductivity, DO, turbidity and pH.
- Rinse the Sensor probe with DI water.
- Prior to calibrating the Sensor probe for daily use, the drift from the AutoCal Solution should also be measured and recorded from the previous calibration. Insert the HORIBA Sensor probe into the AutoCal solution.
- Wait until the reading is stabilize for approximately 30 seconds.
- Record the reading for each of these parameters.
- Following the measurement of the drift with both solutions, the HORIBA can be recalibrated using the AutoCal solution.

8.0 HORIBA Operation

8.1 HORIBA Operation for Collecting Data Using the Flow Through Cell

The following procedures should be applied when using the HORIBA U-22 to monitor groundwater parameters using the flow through cell:

- Connect the HORIBA Sensor probes to the HORIBA meter using the field cable.
- Remove probes from the calibration cup, making sure the protective shield is secure on the HORIBA Sensor probe.
- Place the HORIBA Sensor probe in the flow through cell and secure it using the stand.
- Place the stand on top of an elevated stable surface, placing the waste water receptical in front of the stand between the HORIBA and the monitoring well.
- Attach a 2-3 inch piece of disposable tubing to the top nozzle of the flow through cell and another piece of disposable tubing to the bottom nozzle of the flow through cell. Direct the upper tube into the waste water receptacle.
- Attach the sample tubing to the disposable tubing on the bottom nozzle.
- Turn the HORIBA meter on by pressing **POWER.**
- Water quality parameters can be viewed by pressing **MEAS** to select each parameter. Water quality parameters should be recorded every 3 minutes using the clock on the HORIBA meter. Press **POWER** to turn off the HORIBA and end logging when sampling commences.

8.2 HORIBA Operation for Collecting Data without the Flow Through Cell

The following procedures should be applied when using the HORIBA U-22 to monitor groundwater parameters without using the flow through cell:

- Connect the HORIBA Sensor probes to the HORIBA meter using the field cable.
- Remove probes from the calibration cup, making sure the protective shield is secure on the HORIBA Sensor probe.
- Collect groundwater sample directly from the tubing into the calibration cup. Fill the calibration cup with the proper volume of sample, as indicated by a black line on the calibration cup.
- Secure the calibration cup to the HORIBA Sensor probe by gently pressing the calibration cup up onto the HORIBA Sensor probe. Typically, there will be a slight snap when the calibration cup is secured.

- Turn the HORIBA meter on by pressing **POWER.**
- Water quality parameters can be viewed by pressing **MEAS** to select each parameter. The time of measurement can be recorded using the clock on the HORIBA meter.
- Press **POWER** to turn off the HORIBA.

9.0 Decontamination and Maintenance

When use of the HORIBA U-22 is complete for the day, disassemble the HORIBA Sensor probe and meter. Rinse the HORIBA Sensor probe and flow through cell thoroughly with tap water. When the equipment has been sufficiently cleaned, return the flow through cell to the case. Before storing the HORIBA Sensor probe, fill the calibration cup to the black line with DI water. Secure the calibration cup on the HORIBA Sensor probe, and secure it in the case.

The probes need to be cleaned thoroughly on a monthly basis. The following procedures should be used for the various probes:

Temperature/Conductivity/Turbidity Sensor Units

1. Remove the lid from the cell.
2. Clean the unit in tap water. If the unit is still visibly contaminated, use an absorbent piece of cotton to remove contamination.
3. Attach the lid to the cell block before storage.

pH/Redox Sensor

1. Use a piece of gauze dampened with detergent and wipe off sensor.

In addition to cleaning the pH/Redox sensor with a dampened gauze, the internal solution needs to be replaced, as follows:

1. Remove the sensor from the sensor probe using a sensor spanner.
2. Open the internal solution replenishment rubber stopper and remove the internal solution with a syringe.
3. Pour a new internal solution (#330) to the level near the rubber stopper. Be careful to avoid air bubbles from forming in the solution.
4. Attach the sensor to the sensor probe.

DO Sensor

1. Wipe off contamination with gauze, avoiding damage to the diaphragm.

10.0 Documentation

Monitoring events will be documented on field forms and in a detailed field notebook. Standard Operating Procedure PSC-400 describes documentation procedures.

11.0 Measure of Proficiency

Field staff will demonstrate proficiency of this SOP by successfully completing sections 6.0, 7.0, 8.1 and 8.2 a minimum of twice under the direct supervision of the Corrective Actions Manager or her/his designee.

Documentation Procedures

Written By:	Approved By:	Date:	QA Concurrence:	Date:
Carolyn Mayer	Carolyn Mayer	11/23/97	Laurel Muselwhite	11/23/97

This SOP contains seven sections.

1.0 Purpose
2.0 Application
3.0 References
4.0 Associated SOPs
5.0 Field Books
6.0 Field Forms
7.0 Measure of Proficiency

1.0 Purpose

The purpose of this SOP is to outline, in detail, the required documentation needed to maintain accurate logs and files of all field procedures conducted by Philip Services Corporation (PSC).

2.0 Application

This SOP provides documentation guidelines, including examples, required for all geotechnical exploratory and sampling procedures conducted or overseen by PSC personnel (see Table 1).

3.0 References

None

4.0 Associated SOPs

PSC-100	PSC-101	PSC-102	PSC-103
PSC-104	PSC-110	PSC-111	PSC-120
PSC-121	PSC-122	PSC-123	PSC-124
PSC-125	PSC-126	PSC-127	PSC-200
PSC-201	PSC-202	PSC-300	PSC-301
PSC-302			

5.0 Field Books

All field books should be pocket size "Rite in the Rain" or equivalent and should have non-removable pages. These field books are to be dedicated to a project, and the corrective actions' project manager is responsible for maintaining a field book inventory. This inventory should include a numbering and tracking mechanism for each field book assigned to a particular case.

Each field book is to be maintained as follows:

- Label the outside front cover with the following information: Burlington Environmental dba Philip Services Corporation, Facility Name, Dates Included, and Book Number. The inside cover should include: Burlington Environmental d.b.a. Philip Services Corporation, Project Manager's Name, 955 Powell Avenue, Renton, WA 98155, (206) 227-XXXX, Dates Included, and Book Number.
- Inside the cover, list the full names and initials of each person working on the project that will be referred to in the field book.
- Maintain all field notes directly in the field books (i.e. notes are not to be taken then transferred to the field books at a later time).
- Record all field notes in permanent ink (sharpie markers).
- Initial, date, and number each page upon completion.
- Correction of mistakes are made with a single line and initialing the correction.
- Avoid blank spaces within the notes. Unavoidable blank spaces are to be struck with a single line.

Examples of information required in the field book include:

- The date of entry
- Time of entry for specific events (in military time)
- A meteorological description of daily changes
- Personnel present including arrival and departure times and affiliations
- Make, model and condition of equipment used
- The time interval and reasons for delays including a detailed description of corrective actions taken by the field crew.
- A detailed description and rationale for any deviations for the Work Plan, Sampling Plan, or Health and Safety Plan.

6.0 Field Forms

The field forms have been designed to detail all steps, actions, and readings associated with specific field procedures. These forms are to be completed in full. No sections are to be left blank, if a section is "not applicable", it is to be indicated as such. All forms, including location diagrams, are to be completed in the field with permanent ink. Refer to Table 1 to see which forms are required for specific field procedures. Examples of each form are also attached.

7.0 Measure of Proficiency

Proficiency assessment for documentation is associated with specific procedural proficiency, therefore, no separate proficiency measures for documentation are needed.