

STANDARD OPERATING PROCEDURES

SOP APPROVAL FORM

TETRA TECH EM INC.
ENVIRONMENTAL STANDARD OPERATING PROCEDURE

GENERAL EQUIPMENT DECONTAMINATION

SOP NO. 002

REVISION NO. 3

Last Reviewed: June 2009

K. Riesing

Quality Assurance Approved

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Date

1.0 BACKGROUND

All nondisposable field equipment must be decontaminated before and after each use at each sampling location to obtain representative samples and to reduce the possibility of cross-contamination.

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for decontaminating equipment in the field.

1.2 SCOPE

This SOP applies to decontaminating general nondisposable field equipment. To prevent contamination of samples, all sampling equipment must be thoroughly cleaned prior to each use.

1.3 DEFINITIONS

Alconox: Nonphosphate soap, obtained in powder detergent form and dissolved in water

Liquinox: Nonphosphate soap, obtained in liquid form for mixing with water

1.4 REFERENCES

U.S. Environmental Protection Agency (EPA). 1992a. "Guide to Management of Investigation-Derived Wastes." Office of Solid Waste and Emergency Response. Washington D.C. EPA 9345.3-03FS. January.

EPA. 1992b. "RCRA Ground-Water Monitoring: Draft Technical Guidance." Office of Solid Waste. Washington, DC. EPA/530-R-93-001. November.

EPA. 1994. "Sampling Equipment Decontamination." Environmental Response Team SOP #2006 (Rev. #0.0, 08/11/94). <http://www.ert.org/mainContent.asp?section=Products&subsection=List>

1.5 REQUIREMENTS AND RESOURCES

The equipment required to conduct decontamination is as follows:

- Scrub brushes
- Large wash tubs or buckets
- Squirt bottles
- Alconox or Liquinox
- Tap water
- Distilled water
- Plastic sheeting
- Aluminum foil
- Methanol or hexane
- Isopropanol (pesticide grade)
- Dilute (0.1 N) nitric acid

2.0 PROCEDURE

The procedures below discuss decontamination of personal protective equipment (PPE), drilling and monitoring well installation equipment, borehole soil sampling equipment, water level measurement equipment, general sampling equipment, and groundwater sampling equipment.

2.1 PERSONAL PROTECTIVE EQUIPMENT DECONTAMINATION

Personnel working in the field are required to follow specific procedures for decontamination prior to leaving the work area so that contamination is not spread off site or to clean areas. All used disposable protective clothing, such as Tyvek coveralls, gloves, and booties, will be containerized for later disposal. Decontamination water will be containerized in 55-gallon drums (refer to Section 3.0).

Personnel decontamination procedures will be as follows:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of personal protection as was used for sampling.

3. Wash neoprene boots (or neoprene boots with disposable booties) with Liquinox or Alconox solution and rinse with clean water. Remove booties and retain boots for subsequent reuse.
4. Wash outer gloves in Liquinox or Alconox solution and rinse in clean water. Remove outer gloves and place into plastic bag for disposal.
5. Remove Tyvek or coveralls. Containerize Tyvek for disposal and place coveralls in plastic bag for reuse.
6. Remove air purifying respirator (APR), if used, and place the spent filters into a plastic bag for disposal. Filters should be changed daily or sooner depending on use and application. Place respirator into a separate plastic bag after cleaning and disinfecting.
7. Remove disposable gloves and place them in plastic bag for disposal.
8. Thoroughly wash hands and face in clean water and soap.

2.2 DRILLING AND MONITORING WELL INSTALLATION EQUIPMENT DECONTAMINATION

All drilling equipment should be decontaminated at a designated location on site before drilling operations begin, between borings, and at completion of the project. Decontamination may be conducted on a temporary decontamination pad constructed at satellite locations within the site area in support of temporary work areas. The purpose of the decontamination pad is to contain wash waters and potentially contaminated soil generated during decontamination procedures. Decontamination pads may be constructed of concrete, wood, or plastic sheeting, depending on the site-specific needs and plans. Wash waters and contaminated soil generated during decontamination activities should be considered contaminated and thus, should be collected and containerized for proper disposal.

Monitoring well casing, screens, and fittings are assumed to be delivered to the site in a clean condition. However, they should be steam cleaned and placed on polyethylene sheeting on-site prior to placement downhole. The drilling subcontractor will typically furnish the steam cleaner and water.

The drilling auger, bits, drill pipe, any portion of drill rig that is over the borehole, temporary casing, surface casing, and other equipment used in or near the borehole should be decontaminated by the drilling subcontractor as follows:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of personal protection as was used for sampling.
3. Remove loose soil using shovels, scrapers, wire brush, etc.
4. Steam clean or pressure wash to remove all visible dirt.
5. If equipment has directly or indirectly contacted contaminated media and is known or suspected of being contaminated with oil, grease, polynuclear aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), or other hard to remove organic materials, rinse equipment with pesticide-grade isopropanol.
6. To the extent possible, allow components to air dry.
7. Wrap or cover equipment in clear plastic until it is time to be used.
8. All wastewater from decontamination procedures should be containerized.

2.3 BOREHOLE SOIL SAMPLING DOWNHOLE EQUIPMENT DECONTAMINATION

All soil sampling downhole equipment should be decontaminated before use and after each sample as follows:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of personal protection as was used for sampling.
3. Prior to sampling, scrub the split-barrel sampler and sampling tools in a wash bucket or tub using a stiff, long bristle brush and Liquinox or Alconox solution.
4. After sampling, steam clean the sampling equipment over the rinsate tub and allow to air dry.
5. Place cleaned equipment in a clean area on plastic sheeting and wrap with aluminum foil.
6. Containerize all water and rinsate; disposable single-use sampling equipment should also be containerized.
7. Decontaminate all equipment placed down the hole as described for drilling equipment.

2.4 WATER LEVEL MEASUREMENT EQUIPMENT DECONTAMINATION

Field personnel should decontaminate the well sounder and interface probe before inserting and after removing them from each well. The following decontamination procedures should be used:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of personal protection as was used for sampling.
3. Wipe the tape and probe with a disposable Alconox- or Liquinox-impregnated cloth or paper towel.
4. If immiscible layers are encountered, the interface probe may require steam cleaning or washing with pesticide-grade isopropanol.
5. Rinse with deionized water.

2.5 GENERAL SAMPLING EQUIPMENT DECONTAMINATION

All nondisposable sampling equipment should be decontaminated using the following procedures:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of personal protection as was used for sampling.
3. To decontaminate a piece of equipment, use an Alconox wash; a tap water wash; a solvent (isopropanol, methanol, or hexane) rinse, if applicable, or dilute (0.1 N) nitric acid rinse, if applicable; a distilled water rinse; and air drying. Use a solvent (isopropanol, methanol, or hexane) rinse for grossly contaminated equipment (for example, equipment that is not readily cleaned by the Alconox wash). The dilute nitric acid rinse may be used if metals are the analyte of concern.
4. Place cleaned equipment in a clean area on plastic sheeting and wrap with aluminum foil.
5. Containerize all water and rinsate.

2.6 GROUNDWATER SAMPLING EQUIPMENT

The following procedures are to be employed for the decontamination of equipment used for groundwater sampling. Decontamination is not necessary when using disposable (single-use) pump tubing or bailers. Bailer and downhole pumps and tubing decontamination procedures are described in the following sections.

2.6.1 Bailers

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of personal protection as was used for sampling.
3. Evacuate any purge water in the bailer.
4. Scrub using soap and water and/or steam clean the outside of the bailer.
5. Insert the bailer into a clean container of soapy water. Thoroughly rinse the interior of the bailer with the soapy water. If possible, scrub the inside of the bailer with a scrub brush.
6. Remove the bailer from the container of soapy water.
7. Rinse the interior and exterior of the bailer using tap water.
8. If groundwater contains or is suspected to contain oil, grease, PAH, PCB, or other hard to remove organic materials, rinse equipment with pesticide-grade isopropanol.
9. Rinse the bailer interior and exterior with deionized water to rinse off the tap water and solvent residue, as applicable.
10. Drain residual deionized water to the extent possible.
11. Allow components to air dry.
12. Wrap the bailer in aluminum foil or a clean plastic bag for storage.
13. Containerize the decontamination wash waters for proper disposal.

2.6.2 Downhole Pumps and Tubing

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of personal protection as was used for sampling.
3. Evacuate any purge water in the pump and tubing.
4. Scrub using soap and water and/or steam clean the outside of the pump and, if applicable, the pump tubing.
5. Insert the pump and tubing into a clean container of soapy water. Pump/run a sufficient amount of soapy water to flush out any residual well water. After the pump and tubing are flushed, circulate soapy water through the pump and tubing to ensure that the internal components are thoroughly flushed.
6. Remove the pump and tubing from the container.
7. Rinse external pump components using tap water.
8. Insert the pump and tubing into a clean container of tap water. Pump/run a sufficient amount of tap water through the pump to evacuate all of the soapy water (until clear).
9. If groundwater contains or is suspected to contain oil, grease, PAH, PCB, or other hard to remove organic materials, rinse the pump and tubing with pesticide-grade isopropanol.
10. Rinse the pump and tubing with deionized water to flush out the tap water and solvent residue, as applicable.
11. Drain residual deionized water to the extent possible.
12. Allow components to air dry.
13. For submersible bladder pumps, disassemble the pump and wash the internal components with soap and water, rinse with tap water, isopropanol (if necessary), and deionized water, and allow to air dry.
14. Wrap pump and tubing in aluminum foil or a clean plastic bag for storage.
15. Containerize the decontamination wash waters for proper disposal.

3.0 INVESTIGATION-DERIVED WASTE

Investigation-derived waste (IDW) can include disposable single-use PPE and sampling equipment, soil cuttings, and decontamination wash waters and sediments. Requirements for waste storage may differ from one facility to the next. Facility-specific directions for waste storage will be provided in project-specific documents, or separate direction will be provided by the project manager. The following guidelines are provided for general use:

1. Assume that all IDW generated from decontamination activities contains the hazardous chemicals associated with the site unless there are analytical or other data to the contrary. Waste solution volumes could vary from a few gallons to several hundred gallons in cases where large equipment required cleaning.
2. Containerized waste rinse solutions are best stored in 55-gallon drums (or equivalent containers) that can be sealed until ultimate disposal at an approved facility.
3. Label IDW storage containers with the facility name and address, date, contents, company generating the waste, and an emergency contact name and phone number.
4. Temporarily store the IDW in a protected area that provides access to the containers and allows for spill/leak monitoring, sampling of containers, and removal following determination of the disposal method.

SOP APPROVAL FORM

TETRA TECH EM INC.
ENVIRONMENTAL STANDARD OPERATING PROCEDURE

SURFACE WATER SAMPLING

SOP NO. 009

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Quality Assurance Approved

6-19-09

Date

1.0 BACKGROUND

Surface water sampling is conducted to determine the quality of surface water entering, leaving, or affected by a site. Surface water bodies that can be sampled include streams, rivers, lakes, ponds, lagoons, and surface impoundments. This standard operating procedure (SOP) discusses common methods of collecting grab samples that represent water quality in a water body at a particular point in time.

A series of grab samples also can be composited to represent water quality over a longer period of time. Composite samples can be flow proportional or time proportional. The details of compositing water samples are not included in this SOP.

1.1 PURPOSE

This SOP establishes the requirements and procedures for surface water sampling.

1.2 SCOPE

This SOP applies to surface water sampling and the instruments and methods used to collect the samples.

1.3 DEFINITIONS

Kemmerer Sampler: A messenger-activated water sampling device. Water flows through the device until the release mechanism is triggered to close the container.

Peristaltic Pump: A rotary, positive-displacement pumping device characterized by its low suction and rhythmic operation, and by the fact that the pump does not come into direct contact with the water being sampled.

Pond Sampler: A sampling device fabricated by using an adjustable beaker clamp to attach a beaker to a telescoping, heavy-duty aluminum pole.

1.4 REFERENCES

- U.S. Environmental Protection Agency (EPA). 1977. “Procedures Manual for Ground Water Monitoring at Solid Waste Disposal Facilities.” EPA-530/SW-611. August.
- EPA. 1980. “Samplers and Sampling Procedures for Hazardous Waste Streams.” EPA-600/2-80-018. January.
- EPA. 1984. “Characterization of Hazardous Waste Sites — A Methods Manual, Volume II. Available Sampling Methods.” Second Edition. EPA-600/4-84-076. December.
- EPA. 2002. “Surface Water Sampling.” Environmental Response Team SOP #2013 (Rev. #1.0, 12/17/02). On-Line Address:
<http://loostrom.com/kosov/separatasidor/usepasurfacewatersampling.pdf>
- EPA. 2007. “Operating Procedure – Surface Water Sampling.” Science and Ecosystem Support Division. SCSDPROC-201-R1. November.

1.5 REQUIREMENTS AND RESOURCES

Surface water sampling requires a variety of procedures and instruments. The choice of procedure should be determined by site-specific conditions, such as the type of surface water body, the sampling depth, and the sample location’s distance from shore.

Samples can be collected from shallow depths by submerging the sample container. An intermediary disposable collection container or one constructed of a nonreactive material also may be used. A pond sampler, a peristaltic pump, or a Kemmerer sampler may be used to provide extended reach. The following equipment may be required to sample surface water:

- Decontamination materials
- Sample containers and labels
- Point-source bailer
- Dipper
- Boat
- Pond sampler
- Peristaltic pump with batteries or power source
- Silicone tubing
- Heavy-wall Teflon[®] tubing

- Kemmerer sampler
- Bucket
- Logbook or field data sheets
- Chain-of-custody documentation
- Shipping materials

2.0 PROCEDURES

Safe access, handling, and other physical limitations should be influential factors during surface water sampling. A site-specific sampling plan should delineate which of the procedures described below will be used. Any deviations from the sampling plan should be recorded in the site-specific field logbook.

The following subsections provide detailed procedures for surface water sampling using specific instruments and methods. In all cases, select a sampling location where the water quality will best represent the water chemistry of the water body. Avoid stagnant or fast-moving areas. Do not sample immediately downstream of incoming tributaries, because of the likelihood of incomplete mixing.

2.1 SURFACE WATER SAMPLING BY SUBMERGING SAMPLE CONTAINER

Samples from shallow depths should be collected by submerging the sample container. This method is advantageous when the sample might be significantly altered during transfer from a collection vessel into another container. This method should not be used for sampling lagoons or surface impoundments where contact with contaminants is a potential concern.

The following procedure can be used for sampling surface water by submerging the sample container:

1. Place all equipment on plastic sheeting next to the sampling location. Sample containers should be selected in accordance with the requirements specified in the project-specific field work plan, field sampling plan, or quality assurance project plan (QAPP).
2. If required by the project, collect field parameter measurements using procedures in relevant specific Tetra Tech SOPs and project-specific field sampling plan. Record this information on the field sheet or in the logbook.
3. A visual check for visible surface material (pond scum or ice) should be performed before sampling. If present, surface water samples should be collected by directly

submerging the sample container (with lid still on) into the surface water at the specified sampling location. Avoid contacting the bottom of the water body with the sample container because this will disturb sediment that may interfere with the surface water sample. Once submerged, the lid should be removed to allow the container to fill with water below any visible material on the surface of the water. A visual check should be conducted during and after sample collection to ensure sample integrity. If no surface materials are present, sample as instructed below.

4. For stream sampling, sample the location farthest downstream first. In general, work from zones suspected of low contamination to zones of high contamination. Orient the mouth of the sample container facing upstream while standing downstream so as not to stir up any sediment that would contaminate the sample. Avoid contacting the bottom of the water body with the sample container because this will disturb sediment that may interfere with the surface water sample.
5. For a larger body of surface water, such as a lake, collect samples near the shore, unless boats are feasible and permitted. Collect samples from shallow depths by submerging the sample container. Avoid contacting the bottom of the water body with the sample container because this will disturb sediment that may interfere with the surface water sample. If sampling from a boat, collect the sample as far away as possible from the outboard engine to avoid possible fuel contamination.
6. If sediment samples are to be collected (using procedures in SOP No. 006 [Sludge and Sediment Sampling]) with surface water samples, collect surface water samples at each location before collecting sediment samples to avoid contaminating the water samples with excess suspended particles generated during sediment sampling.
7. Continue delivery of the sample until the container is almost full. If sampling for volatile organic compounds (VOC) or other analytical parameters requiring pre-preserved sample containers, the use of a transfer device is recommended so that the preservative is not displaced.
8. Preserve the sample in accordance with requirements specified in the project-specific field work plan, field sampling plan, or QAPP. Ensure that a Teflon[®] liner is present in the cap of the sample container if required. Secure the cap tightly and affix a completed sample label to the container.
9. Complete all chain-of-custody documentation, field logbook entries, and sample packaging requirements.

2.2 SURFACE WATER SAMPLING WITH TRANSFER DEVICE

A dipper, bailer, or other device made of inert material, such as stainless steel or Teflon[®], can be used to transfer liquid samples from their source to a sample container. This prevents contamination of the outside of the sample container as a result of direct immersion in surface water. Depending on the sampling application, the transfer device may be either disposed of or reused. If reused, the device should be thoroughly rinsed and decontaminated in accordance with SOP 002 (General Equipment Decontamination), prior to sampling a different source.

A transfer device can be used in most sampling situations, and is preferred when (1) direct contact or physical access limitations pose a health and safety concern and (2) sample containers are pre-preserved. However, direct collection by submerging the sample container is the preferred method when possible.

The following procedure can be used for sampling surface water with a dipper, bailer, or other transfer device:

1. Place all equipment on plastic sheeting next to the sampling location. Sample containers should be selected in accordance with the requirements specified in the project-specific field work plan, field sampling plan, or QAPP.
2. If required by the project, collect field parameter measurements using procedures in relevant specific Tetra Tech SOPs. Record this information on the field sheet or in the logbook.
3. With minimal surface water disturbance, submerge a precleaned dipper, bailer, or other transfer device.
4. Allow the device to fill slowly and continuously.
5. Retrieve the device from the surface water with minimal disturbance.
6. Remove the cap from the sample container. Slightly tilt the mouth of the container below the edge of the transfer device.
7. Empty the device slowly, allowing the sample to flow gently down the inside of the container with minimal entry turbulence. Continue delivery of the sample until the container is almost full. If sampling for VOCs, the container must be completely filled leaving no head space.
8. Preserve the sample in accordance with requirements specified in the project-specific field work plan, field sampling plan, or QAPP. Ensure that a Teflon[®] liner is present in

the cap of the sample container if required. Secure the cap tightly and affix a completed sample label to the container.

9. Complete all chain-of-custody documentation, field logbook entries, and sample packaging requirements.
10. Decontaminate the transfer device prior to reuse or storage using the procedures in SOP No. 002 (General Equipment Decontamination).

2.3 SURFACE WATER SAMPLING WITH POND SAMPLER

A pond sampler may be used to collect liquid samples from ponds, pits, and lagoons (see Figure 1). A pond sampler is easily and inexpensively fabricated. To construct a pond sampler, use an adjustable clamp to attach a sampling beaker to the end of a two- or three-piece telescoping aluminum tube. The telescoping tube serves as the handle. All nondisposable equipment should be cleaned before and after each use.

The following procedure can be used for sampling surface water with a pond sampler:

1. Place all equipment on plastic sheeting next to the sampling location. Sample containers should be selected in accordance with the requirements specified in the project-specific field work plan, field sampling plan, or QAPP.
2. If required by the project, collect field parameter measurements using procedures in relevant specific Tetra Tech SOPs. Record this information on the field sheet or in the logbook.
3. Assemble the pond sampler. Ensure that the sampling beaker, bolts, and nuts securing the clamp to the pole are tightened properly.
4. Collect the sample by slowly submerging the precleaned beaker with minimal surface water disturbance.
5. Retrieve the pond sampler from the surface water with minimal disturbance.
6. Remove the cap from the sample container. Slightly tilt the mouth of the container below the edge of the beaker.
7. Empty the beaker slowly, allowing the sample to flow gently down the inside of the container with minimal entry turbulence. Continue delivery until the container is almost full. If sampling for VOCs, the container must be completely filled leaving no head space.

8. Preserve the sample in accordance with requirements specified in the project-specific field work plan, field sampling plan, or QAPP. Ensure that a Teflon[®] liner is present in the cap of the sample container if required. Secure the cap tightly and affix a completed sample label to the container.
9. Complete all chain-of-custody documentation, field logbook entries, and sample packaging requirements.
10. Decontaminate the pond sampler prior to reuse or storage using the procedures in SOP No. 002 (General Equipment Decontamination).

2.4 SURFACE WATER SAMPLING WITH PERISTALTIC PUMP

To extend reach in sampling efforts, a small peristaltic pump can be used (see Figure 2). A peristaltic pump draws the sample through heavy-wall Teflon[®] tubing and pumps it directly into the sample container. Use of a peristaltic pump allows the operator to reach out into a liquid body, to sample from a depth or to sweep the width of a narrow stream. A battery-powered pump is preferable because it eliminates the need for a direct current generator or an alternating current inverter.

If medical-grade silicone tubing is used in the peristaltic pump, it is suitable for sampling almost any parameter, including most organics. However, some VOC stripping may occur and some sample material may adhere to the tubing. Teflon[®] tubing may be used in place of silicone tubing on the intake side of the pump to minimize the amount of sample adherence to the tubing. If tubing is to be reused, it should be cleaned before and after each use following the procedures specified in SOP No. 002 (General Equipment Decontamination). Depending on project requirements, it may be necessary to replace the Teflon[®] intake tubing and the pump silicone tubing between sampling locations to prevent cross contamination.

Procedures for sampling surface water with a peristaltic pump are as follows:

1. Place all equipment on plastic sheeting next to the sampling location. Sample containers should be selected in accordance with the requirements specified in the project-specific field work plan, field sampling plan, or QAPP.
2. If required by the project, collect field parameter measurements using procedures in relevant specific Tetra Tech SOPs. Record this information on the field sheet or in the logbook.
3. Install clean, medical-grade silicone tubing in the pump head according to the manufacturer's instructions. Allow enough tubing on the discharge side to facilitate

delivery of liquid into the sample container. Allow only enough tubing on the suction end for attachment to the intake line. This will minimize sample contact with the tubing.

4. Select the length of intake tubing needed to reach the required sample location. Attach it to the intake side of the pump tubing. Heavy-wall Teflon[®] tubing of a diameter equal to that of the required pump tubing suits most applications. A heavier tubing wall will allow slightly greater lateral reach.
5. If possible, allow several liters of surface water to pass through the pump before collecting the sample. Collect this purge volume. Return it to the source after the samples have been withdrawn.
6. Fill the sample container by allowing the pump discharge to flow gently down the inside of the bottle with minimal entry turbulence. Continue delivery of the sample until the container is almost full.
7. If sampling for VOCs, the VOC sample must be collected using one of the “soda straw” variations. Ideally, the tubing intake will be placed at the depth from which the sample is to be collected and the pump will be run for several minutes to fill the tubing with water representative of that interval. After several minutes, the pump is turned off and the tubing string is retrieved. The pump speed is then reduced to a slow pumping rate and the pump direction is reversed. After the pump is turned back on, the sample stream is collected into the VOC vials as it is pushed from the tubing by the pump. Care must be taken to prevent any water that was in contact with the peristaltic pump head tubing from being incorporated into the sample.
8. Preserve the sample in accordance with requirements specified in the project-specific field work plan, field sampling plan, or QAPP. Ensure that a Teflon[®] liner is present in the cap of the sample container if required. Secure the cap tightly and affix a completed sample label to the container.
9. Complete all chain-of-custody documentation, field logbook entries, and sample packaging requirements.
10. Allow the pump to drain, and then disassemble it. Decontaminate the tubing before reuse using the procedures in SOP No. 002 (General Equipment Decontamination), or dispose of it.

2.5 SURFACE WATER SAMPLING WITH KEMMERER SAMPLER

The Kemmerer sampler (see Figure 3) is used to collect surface water samples when the required sample depth is greater than that which can be sampled with a pump. A Kemmerer sampler may be constructed of various materials to be compatible with the required analytical technique. The sampler should be cleaned before and after each use.

Procedures for sampling surface water with a Kemmerer sampler are as follows:

1. Place all equipment on plastic sheeting next to the sampling location. Sample containers should be selected in accordance with the requirements in specified in the project-specific field work plan, field sampling plan, or QAPP.
2. If required by the project, collect field parameter measurements using procedures in relevant specific Tetra Tech SOPs. Record this information on the field sheet or in the logbook.
3. Inspect the body of the Kemmerer sampler to ensure that the drain line valve is closed, as appropriate. Measure and mark the sample line (cable) at the desired sampling depth.
4. Open the sampler by lifting the upper stopper-trip head assembly.
5. Gradually lower the sampler into the surface water until the sample liquid reaches the sample line.
6. Place a messenger on the sample line and release it, closing the sampler.
7. Retrieve the sampler. Prevent accidental opening of the lower stopper by holding the center rod of the sampler.
8. Rinse or wipe off the exterior of the sampler. Recover the sample by grasping the lower stopper and sampler body with one hand. Transfer the sample by lifting the upper stopper with the other hand and carefully pouring the contents into the sample container. If a drain line valve is present, hold the valve over the sample container, and open the valve slowly to release the sample.
9. Transfer the sample slowly, allowing it to flow gently down the inside of the container with minimal entry turbulence. Continue delivery until the container is almost full. If sampling for VOCs, the container must be completely filled leaving no head space.
10. Preserve the sample in accordance with requirements specified in the project-specific field work plan, field sampling plan, or QAPP. Ensure that a Teflon[®] liner is present in the cap of the sample container if required. Secure the cap tightly and affix a completed sample label to the container.
11. Complete all chain-of-custody documentation, field logbook entries, and sample packaging requirements.
12. Decontaminate the Kemmerer sampler prior to reuse or storage using the procedures in SOP No. 002 (General Equipment Decontamination).

2.6 SURFACE WATER SAMPLING WITH BUCKET

A plastic bucket is used to collect surface water samples for measurement of water quality parameters (such as pH, temperature, and conductivity) or classical water quality parameters (ammonia, nitrate-nitrite, phosphorus, and total organic carbon). This method is not recommended for collecting samples for chemical analysis. A bucket is commonly used to collect a sample when the water depth is too great for wading, it is not possible to deploy a boat, or access is restricted (excessive vegetation or steep embankments) and the water column is well mixed. The water body is usually accessed from a bridge. The bucket is lowered by rope over the side of the bridge and, upon retrieval, the water is poured into the appropriate sample containers.

FIGURE 1
POND SAMPLER

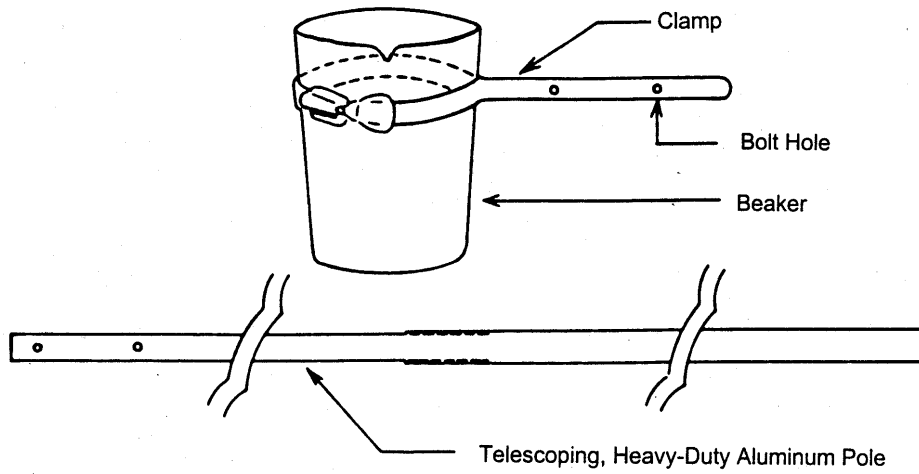


FIGURE 2
PERISTALTIC PUMP FOR LIQUID SAMPLING

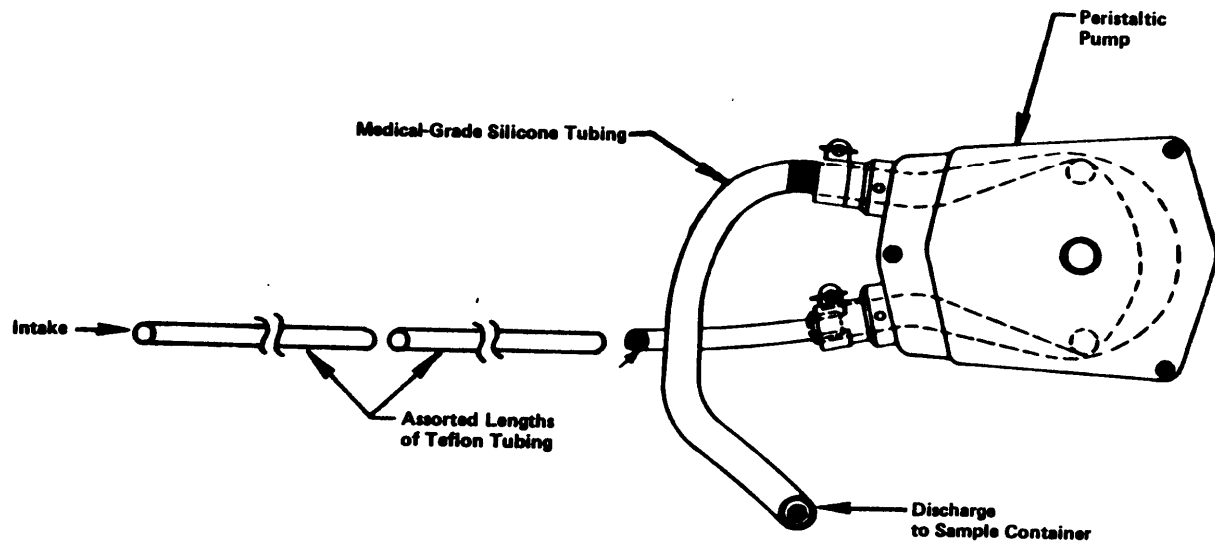
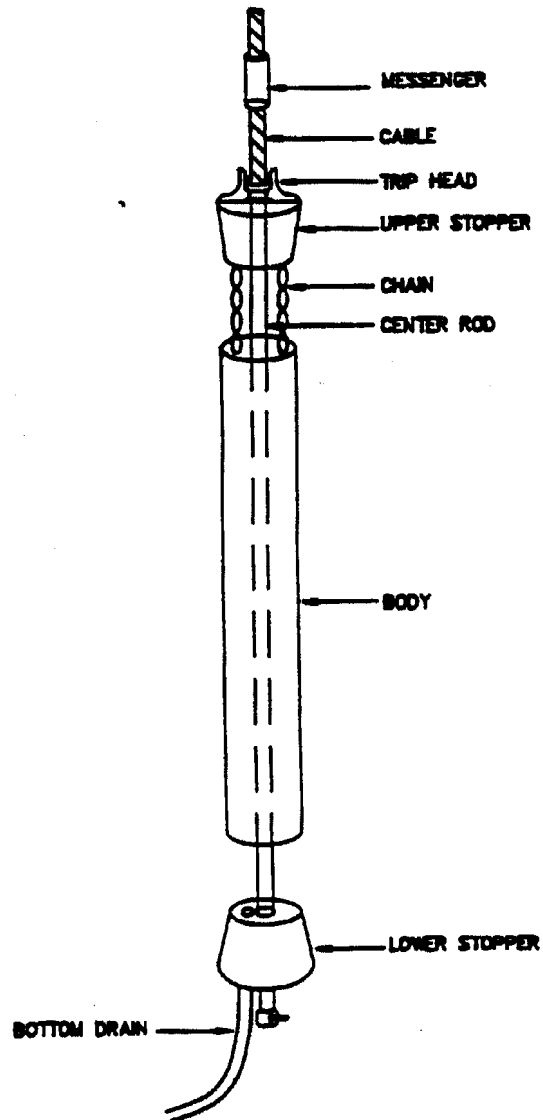


FIGURE 3
KEMMERER SAMPLER



SOP APPROVAL FORM

TETRA TECH EM INC.
ENVIRONMENTAL STANDARD OPERATING PROCEDURE

PACKAGING AND SHIPPING SAMPLES

SOP NO. 019

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Date

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Title: Packaging and Shipping Samples	Revision No. 6, December 18, 2008 Last Reviewed: December 2008

1.0 BACKGROUND

In any sampling program, the integrity of a sample must be ensured from its point of collection to its final disposition. Procedures for classifying, packaging, and shipping samples are described below. Steps in the procedures should be followed to ensure sample integrity and to protect the welfare of persons involved in shipping and receiving samples. When hazardous substances and dangerous goods are sent by common carrier, their packaging, labeling, and shipping are regulated by four primary agencies that have regulatory or advisory guidelines: (1) the U.S. Department of Transportation (DOT) Hazardous Materials Regulations (HMR, *Code of Federal Regulations*, Title 49 [49 CFR] Parts 106 through 180); (2) the International Air Transportation Association (IATA) Dangerous Goods Regulations (DGR); (3) International Civil Aviation Organization (ICAO), which provides technical instructions for safe transportation of hazardous materials (dangerous goods) by air; and (4) United Nations (UN) “Recommendations of the Committee of Experts on Transport of Dangerous Goods.”

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for packaging and shipping samples. It has been prepared in accordance with the U.S. Environmental Protection Agency (EPA) “Sampler’s Guide to the Contract Laboratory Program (CLP),” the DGR, the HMR, ICAO, and UN. Sample packaging and shipping procedures described in this SOP should be followed for all sample packaging and shipping. Deviations from the procedures in this SOP must be documented in a field logbook. This SOP assumes that samples are already collected in the appropriate sample jars and that the sample jars are labeled and tagged appropriately.

1.2 SCOPE

This SOP applies to sample classification, packaging, and shipping.

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1.3 DEFINITIONS

Custody seal: A custody seal is a tape-like seal. Placement of the custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been packaged for shipping.

Dangerous goods: Dangerous goods are articles or substances that can pose a significant risk to health, safety, or property when transported by air; they are classified as defined in Section 3 of the DGR (IATA 2008).

Environmental samples: Environmental samples include drinking water, most groundwater and ambient surface water, soil, sediment, treated municipal and industrial wastewater effluent, and biological specimens. Environmental samples typically contain low concentrations of contaminants and when handled require only limited precautionary procedures.

Hazardous Materials Regulations: The HMR are DOT regulations for the shipment of hazardous materials by air, water, and land; they are located in 49 CFR 106 through 180.

Hazardous samples: Hazardous samples include dangerous goods and hazardous substances. Hazardous samples shipped by air should be packaged and labeled in accordance with procedures specified by the DGR; ground shipments should be packaged and labeled in accordance with the HMR.

Hazardous substance: A hazardous substance is any material, including its mixtures and solutions, that is listed in Appendix A of 49 CFR 172.101 and its quantity, in one package, equals or exceeds the reportable quantity (RQ) listed in the appendix.

IATA Dangerous Goods Regulations: The DGR are regulations that govern the international transport of dangerous goods by air. The DGR are based on the International Civil Aviation Organization (ICAO) Technical Instructions. The DGR contain all of the requirements of the ICAO Technical Instructions and are more restrictive in some instances.

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Nonhazardous samples: Nonhazardous samples are those samples that do not meet the definition of a hazardous sample and **do not** need to be packaged and shipped in accordance with the DGR or HMR.

Overpack: An enclosure used by a single shipper to contain one or more packages and to form one handling unit (IATA 2008). For example, a cardboard box may be used to contain three fiberboard boxes to make handling easier and to save on shipping costs.

1.4 REFERENCES

U.S. Department of Transportation (DOT). 2007. Code of Federal Regulations, Title 49, Parts 171 through 180, especially Parts 171 (general), 172 (table, emergency response, and so on), and 173 (for shippers). Available from <http://www.access.gpo.gov/nara/cfr/cfr-table-search.html#page1>. Updated annually, late in the year or early in the following year.

DOT. 2008. "Hazardous Materials Table". (49 CFR 172.101 Table) Available on-line from <http://phmsa.dot.gov/hazmat/library>. Updated irregularly.

DOT. 2008. "Emergency Response Guidebook". Available on-line at <http://phmsa.dot.gov/hazmat/library/erg>. Updated annually.

Federal Express. 2008. "Dangerous Goods Shipping". Available on-line from <http://www.fedex.com/us/services/options/dangerousgoods/index.html>. Note especially "Declaration Forms", which can be filled out on-line or downloaded for future use, and "Resources", which includes the "Dangerous Goods Job Aid" on how to fill out the form, mark the package, and so on, the "Shipping Checklists" and the 1-800 numbers for assistance.

International Air Transport Association (IATA). 2008. "Dangerous Goods Regulations. 2009". For sale at <http://www.iata.org/ps/publications/dgr.htm>. Updated annually, with new edition available late in year.

U.S. Environmental Protection Agency. 2007. "Contract Laboratory Program Guidance for Field Samplers". EPA 540-R-07-06. Available on-line at http://www.epa.gov/superfund/programs/clp/download/sampler/clp_sampler_guidance.pdf. July.

The following additional in-house resources are also available:

Email: Contact either the TtEMI Health & Safety Director and the Regional Safety Officers at EMI.HASPAprovers or your Office Health and Safety Representative (all are included at EMI.HealthSafety).

On-line: TtEMI Intranet Page "Dangerous Goods Shipping" at <http://home.ttemi.com/C14/Dangerous%20Goods%20Shipping/default.aspx>. Includes the "Dangerous Goods Shipping Manual", various "Emergency Response Guide" excerpts, and other information, updated regularly.

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1.5 REQUIREMENTS AND RESOURCES

The procedures for packaging and shipping **nonhazardous** samples require the following:

- Coolers
- Ice
- Vermiculite, bubble wrap, or similar cushioning material
- Chain-of-custody forms and seals
- Airbills
- Resealable plastic bags for sample jars and ice
- Tape (strapping and clear)

The procedures for packaging and shipping **hazardous** samples require the following:

- Ice
- Vermiculite or other non-combustible, absorbent packing material
- Chain-of-custody forms and seals
- Appropriate dangerous goods airbills and emergency response information to attach to the airbill
- Resealable plastic bags for sample jars and ice
- Tape (strapping and clear)
- Appropriate shipping containers as specified in the DGR
- Labels that apply to the shipment such as hazard labels, address labels, “Cargo Aircraft Only” labels, and package orientation labels (up arrows)

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2.0 PROCEDURES

The following procedures apply to packaging and shipping nonhazardous and hazardous samples.

2.1 SAMPLE CLASSIFICATION

Prior to sample shipment, it must be determined whether the sample is subject to the DGR. Samples subject to these regulations shall be referred to as hazardous samples. If the hazardous sample is to be shipped by air, then the DGR should be followed. Any airline, including FedEx, belonging to IATA must follow the DGR. As a result, FedEx **may not** accept a shipment that is packaged and labeled in accordance with the HMR (although in most cases, the packaging and labeling would be the same for either set of regulations). The HMR states that a hazardous material may be transported by aircraft in accordance with the ICAO Technical Instruction (49 CFR 171.11) upon which the DGR is based. Therefore, the use of the DGR for samples to be shipped by air complies with the HMR, but not vice versa.

Most environmental samples are not hazardous samples and do not need to be packaged in accordance with any regulations. Hazardous samples are those samples that can be classified as specified in Section 3 of the DGR, can be found in the List of Dangerous Goods in the DGR in bold type, are considered a hazardous substance (see definition), or are mentioned in "Section 2 - Limitations" of the DGR for countries of transport or airlines (such as FedEx). The hazard classifications specified in the DGR (and the HMR) are as follows:

Class 1 - Explosives

- Division 1.1 - Articles and substances having a mass explosion hazard
- Division 1.2 - Articles and substances having a projection hazard but not a mass explosion hazard
- Division 1.3 - Articles and substances having a fire hazard, a minor blast hazard and/or a minor projection hazard but not a mass explosion hazard
- Division 1.4 - Articles and substances presenting no significant hazard
- Division 1.5 - Very sensitive substances mass explosion hazard
- Division 1.6 - Extremely insensitive articles which do not have a mass explosion hazard

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Class 2 - Gases

- Division 2.1 - Flammable gas
- Division 2.2 - Non-flammable, non-toxic gas
- Division 2.3 - Toxic gas

Class 3 - Flammable Liquids

Class 4 - Flammable Solids; Substances Liable to Spontaneous Combustion; Substances, which, in Contact with Water, Emit Flammable Gases

- Division 4.1 - Flammable solids
- Division 4.2 - Substances liable to spontaneous combustion
- Division 4.3 - Substances, which, in contact with water, emit flammable gases

Class 5 - Oxidizing Substances and Organic Peroxides

- Division 5.1 - Oxidizers
- Division 5.2 - Organic peroxides

Class 6 - Toxic and Infectious Substances

- Division 6.1 - Toxic substances
- Division 6.2 - Infectious substances

Class 7 - Radioactive Materials

Class 8 - Corrosives

Class 9 - Miscellaneous Dangerous Goods

The criteria for each of the first eight classes are very specific and are outlined in Section 3 of the DGR and 49 CFR 173 of the HMR. Some classes and divisions are further divided into packing groups based on their level of danger. Packing group I indicates a great danger, packing group II indicates a medium danger, and packing group III indicates a minor danger.

Class 1, explosives, includes any chemical compound, mixture, or device that by itself is capable of chemical chain reaction sufficient to produce a substantial, instantaneous release of gas, heat, and/or pressure. Tetra Tech does not ship substances that fall under this class.

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Class 2, gases, includes any compressed gas being shipped and any noncompressed gas that is either flammable or toxic. A compressed gas is defined as having a pressure over 40 pounds per square inch (psi) absolute (25 psi gauge). Most air samples and empty cylinders that did not contain a flammable or toxic gas are exempt from the regulations. An empty hydrogen cylinder, as in a flame ionization detector (FID), is considered a dangerous good unless it is properly purged with nitrogen in accordance with the HMR. A landfill gas sample is usually considered a flammable gas because it may contain a high percentage of methane.

Class 3, flammable liquids, are based on the boiling point and flash point of a substance. DOT defines flammable liquids as substances with a flash point less than 140 °F. Most class 3 samples include solvents, oil, gas, or paint-related material collected from drums, tanks, or pits.

Class 4 are flammable solids; substances liable to spontaneous combustion; and substances which, in contact with water, emit flammable gasses. Tetra Tech does not ship substances that fall under this class.

Class 5, oxidizers and organic peroxides, include substances that readily yields oxygen, which may result in the ignition of combustible materials. Organic peroxide is combustible and reacts as an oxidizer in contact with other combustible materials. By itself, an organic peroxide can be flammable or explosive. Tetra Tech does not ship substances that fall under this class.

Division 6, toxic and infectious substances, is based on oral toxicity (LD₅₀ [lethal dose that kills 50 percent of the test animals]), dermal toxicity (LD₅₀ values), and inhalation toxicity (LC₅₀ [lethal concentration that kills 50 percent of the test animals] values). Division 6.1 substances include pesticides and cyanide. Tetra Tech does not ship substances that fall under this class.

Class 7, radioactive material, is defined as any article or substance with a specific activity greater than 70 kiloBecquerels (kBq/kg) (0.002 [microCuries per gram [: Ci/g]). If the specific activity exceeds this level, the sample should be shipped in accordance with Section 10 of the DGR.

Class 8, corrosives, are based on the rate at which a substance destroys skin tissue or corrodes steel; they are not based on pH. Class 8 materials include the concentrated acids used to preserve water samples. Preserved water samples are not considered Class 8 substances and should be packaged as nonhazardous samples.

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Class 9, miscellaneous dangerous goods, are substances that present a danger but are not covered by any other hazard class. Examples of Class 9 substances include asbestos, polychlorinated biphenyls (PCB), and dry ice.

Unlike the DGR, the HMR includes combustible liquids in hazard class 3. The definition of a combustible liquid is specified in 49 CFR 173.120 of the HMR. The HMR has an additional class, ORM-D, that is not specified in the DGR. "ORM-D material" refers to a material such as a consumer commodity that, although otherwise subject to the HMR, presents a limited hazard during transport due to its form, quantity, and packaging. It must be a material for which exceptions are provided in the table of 49 CFR 172.101. The DGR lists consumer commodities as a Class 9 material.

In most instances, the hazard of a material sampled is unknown because no laboratory testing has been conducted. A determination as to the suspected hazard of the sample must be made using knowledge of the site, field observations, field tests, and other available information.

According to 40 CFR 261.4(d) and (e), samples transported to a laboratory for testing or treatability studies, including samples of hazardous wastes, are **not** hazardous wastes. FedEx will not accept a shipment of hazardous waste.

2.2 PACKAGING NONHAZARDOUS SAMPLES

Nonhazardous samples, after being appropriately containerized, labeled, and tagged, should be packaged in the following manner. Note that these are general instructions; samplers should be aware of any client-specific requirements concerning the placement of custody seals or other packaging provisions.

1. Place the sample in a resealable plastic bag.
2. Place the bagged sample in a cooler and pack it to prevent breakage.
3. Prevent breakage of bottles during shipment by either wrapping the sample container in bubble wrap, or lining the cooler (bottom and sides) with a noncombustible material such as vermiculite. Vermiculite is especially recommended because it will absorb any free liquids inside the cooler. It is recommended that the cooler be lined with a large plastic garbage bag before samples, ice, and absorbent packing material are placed in the cooler.

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4. Add a sufficient quantity of ice to the cooler to cool samples to 4 °C. Ice should be double bagged in resealable plastic bags to prevent the melted ice from leaking out. As an option, a temperature blank (a sample bottle filled with distilled water) can be included with the cooler.
5. Seal the completed chain-of-custody forms in a plastic bag and tape the plastic bag to the inside of the cooler lid.
6. Tape any instructions for returning the cooler to the inside of the lid.
7. Close the lid of the cooler and tape it shut by wrapping strapping tape around both ends and hinges of the cooler at least once. Tape shut any drain plugs on the cooler.
8. Place two signed custody seals on the cooler, ensuring that each one covers the cooler lid and side of the cooler. Place clear plastic tape over the custody seals.
9. Place address labels on the outside top of the cooler.
10. Ship samples overnight by a commercial carrier such as FedEx.

2.3 PACKAGING HAZARDOUS SAMPLES

The procedures for packaging hazardous samples are summarized below. Note that according to the DGR, all spellings must be exactly as they appear in the List of Dangerous Goods, and only approved abbreviations are acceptable. The corresponding HMR regulations are provided in parentheses following any DGR referrals. The HMR must be followed only if shipping hazardous samples by ground transport.

1. Determine the proper shipping name for the material to be shipped. All proper shipping names are listed in column B of the List of Dangerous Goods table in Section 4 of the DGR (or column 2 of the Hazardous Materials Table in 49 CFR 172.101). In most instances, a generic name based on the hazard class of the material is appropriate. For example, a sample of an oily liquid collected from a drum with a high photoionization detector (PID) reading should be packaged as a flammable liquid. The proper shipping name chosen for this sample would be “flammable liquid, n.o.s.” The abbreviation “n.o.s.” stands for “not otherwise specified” and is used for generic shipping names. Typically, a specific name, such as acetone, should be inserted in parentheses after most n.o.s. descriptions. However, a technical name is not required when shipping a sample for testing purposes and the components are not known. If shipping a hazardous substance (see definition), then the letters “RQ” must appear in front of the proper shipping name.
2. Determine the United Nations (UN) identification number, class or division, subsidiary risk if any, required hazard labels, packing group, and either passenger aircraft or cargo aircraft packing instructions based on the quantity of material being shipped in one

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package. This information is provided in the List of Dangerous Goods (or Hazardous Materials Table in 49 CFR 172.101) under the appropriate proper shipping name. A “Y” in front of a packing instruction indicates a limited quantity packing instruction. If shipping dry ice or a limited quantity of a material, then UN specification shipping containers do not need to be used.

3. Determine the proper packaging required for shipping the samples. Except for limited quantity shipments and dry ice, these are UN specification packages that have been tested to meet the packing group of the material being shipped. Specific testing requirements of the packages is listed in Section 6 of the DGR (or 49 CFR 178 of the HMR). All UN packages are stamped with the appropriate UN specification marking. Prior planning is required to have the appropriate packages on hand during a sampling event where hazardous samples are anticipated. Most samples can be shipped in either a 4G fiberboard box, a 1A2 steel drum, or a 1H2 plastic drum. Drums can be purchased in 5- and 20-gallon sizes and are ideal for shipping multiple hazardous samples. When FedEx is used to ship samples containing PCBs, the samples must be shipped in an inner metal packaging (paint can) inside a 1A2 outer steel drum. This method of packaging PCB samples is in accordance with FedEx variation FX-06, listed in Section 2 of the DGR.
4. Place each sample jar in a separate resealable plastic bag. Some UN specification packagings contain the sample jar and plastic bag to be used when shipping the sample.
5. Place each sealed bag inside the approved UN specification container (or other appropriate container if a limited quantity or dry ice) and pack with enough noncombustible, absorbent, cushioning material (such as vermiculite) to prevent breakage and to absorb liquid.
6. Place chain-of-custody forms in a resealable plastic bag and either attach it to the inside lid of the container or place it on top inside the container. Place instructions for returning the container to the shipper on the inside lid of the container as appropriate. Close and seal the shipping container in the manner appropriate for the type of container being used.
7. Label and mark each package appropriately. All irrelevant markings and labels need to be removed or obliterated. All outer packagings must be marked with proper shipping name; identification number; and name, address, and phone numbers of the shipper and the recipient. For carbon dioxide, solid (dry ice), the net weight of the dry ice within the package needs to be marked on the outer package. For limited quantity shipments, the words “limited quantity” or “LTD. QTY.” must be marked on the outer package. Affix the appropriate hazard label to the outer package. If the material being shipped contains a subsidiary hazard, then a subsidiary hazard label must also be affixed to the outer package. The subsidiary hazard label is identical to the primary hazard label except that the class or division number is not present. It is acceptable to obliterate the class or division marking on a primary hazard label and use it as the subsidiary hazard label. If using cargo aircraft only packing instructions, then the “Cargo Aircraft Only” label must be used. Package orientation labels (up arrows) must be placed on opposite sides of the outer package. Figure 1 depicts a properly marked and labeled package.

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8. If using an overpack (see definition), mark and label the overpack and each outer packaging within the overpack as described in step 7. In addition, the statement “INNER PACKAGES COMPLY WITH PRESCRIBED SPECIFICATIONS” must be marked on the overpack.
9. Attach custody seals, and fill out the appropriate shipping papers as described in Section 2.4.

2.4 SHIPPING PAPERS FOR HAZARDOUS SAMPLES

A “Shippers Declaration for Dangerous Goods” and “Air Waybill” must be completed for each shipment of hazardous samples. Four copies of the Shipper’s Declaration are required and it must be typed. FedEx supplies a Dangerous Goods Airbill to its customers; the airbill combines both the declaration and the waybill. An example of a completed Dangerous Goods Airbill is depicted in Figure 2. A shipper’s declaration must contain the following:

- Name and address of shipper and recipient
- Air waybill number (not applicable to the HMR)
- Page ___ of ___
- Shipper’s reference number (project number)
- Deletion of either “Passenger and Cargo Aircraft” or “Cargo Aircraft Only,” whichever does not apply
- Airport or city of departure
- Airport or city of destination
- Deletion of either “Non-Radioactive” or “Radioactive,” which ever does not apply
- The nature and quantity of dangerous goods. This includes the following information in the following order (obtained from the List of Dangerous Goods in the DGR): proper shipping name, class or division number, UN identification number, packing group number, subsidiary risk, quantity in liters or kilograms (kg), type of packaging used, packing instructions, authorizations, and additional handling information. Authorizations include the words “limited quantity” or “LTD. QTY.” if shipping a limited quantity, any special provision numbers listed in the List of Dangerous Goods in the DGR, and the variation “USG-14” when a technical name is required after the proper shipping name but not entered because it is unknown.

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- Signature for the certification statement
- Name and title of signatory
- Place and date of signing certification
- A 24-hour emergency response telephone number for use in the event of an incident involving the dangerous good
- Emergency response information attached to the shipper's declaration. This information can be in the form of a material safety data sheet or the applicable North American Emergency Response Guidebook (NAERG; DOT 1996) pages. Figure 3 depicts the appropriate NAERG emergency response information for "Flammable liquids, n.o.s." as an example.

Note that dry ice does not require an attached shipper's declaration. However, the air waybill must include the following on it: "Dry ice, 9, UN1845, ____ x ____ kg." The blanks must include the number of packages and the quantity in kg in each package. If using FedEx to ship dry ice, the air waybill includes a box specifically for dry ice. Simply check the appropriate box and enter in the number of packages and quantity in each package.

The HMR requirements for shipping papers are located in 49 CFR 172 Subpart C.

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3.0 POTENTIAL PROBLEMS

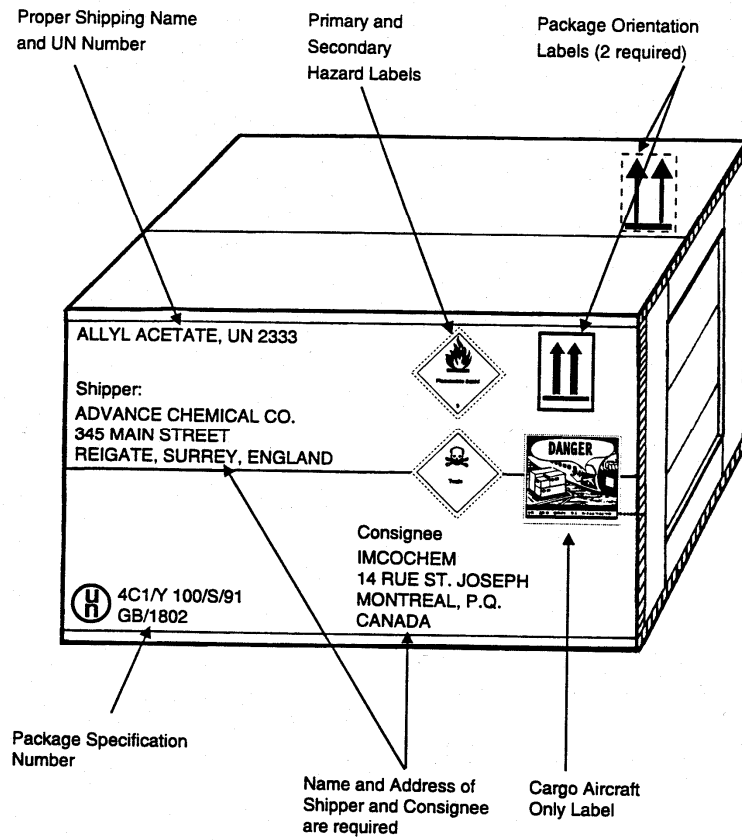
The following potential problems may occur during sample shipment:

- Leaking package. If a package leaks, the carrier may open the package, return the package, and if a dangerous good, inform the Federal Aviation Administration (FAA), which can result in fines.
- Improper labeling and marking of package. If mistakes are made in labeling and marking the package, the carrier will most likely notice the mistakes and return the package to the shipper, thus delaying sample shipment.
- Improper, misspelled, or missing information on the shipper's declaration. The carrier will most likely notice this as well and return the package to the shipper.

Contact FedEx with questions about dangerous goods shipments by calling 1-800-463-3339 and asking for a dangerous goods expert.

Also contact Tetra Tech health and safety representatives using the website identified on Page 3 of this SOP.

FIGURE 1
EXAMPLE OF A CORRECTLY MARKED AND LABELED DANGEROUS GOODS PACKAGE



Source: International Air Transport Association (IATA). 1997.

FIGURE 2

EXAMPLE OF A DANGEROUS GOODS AIRBILL

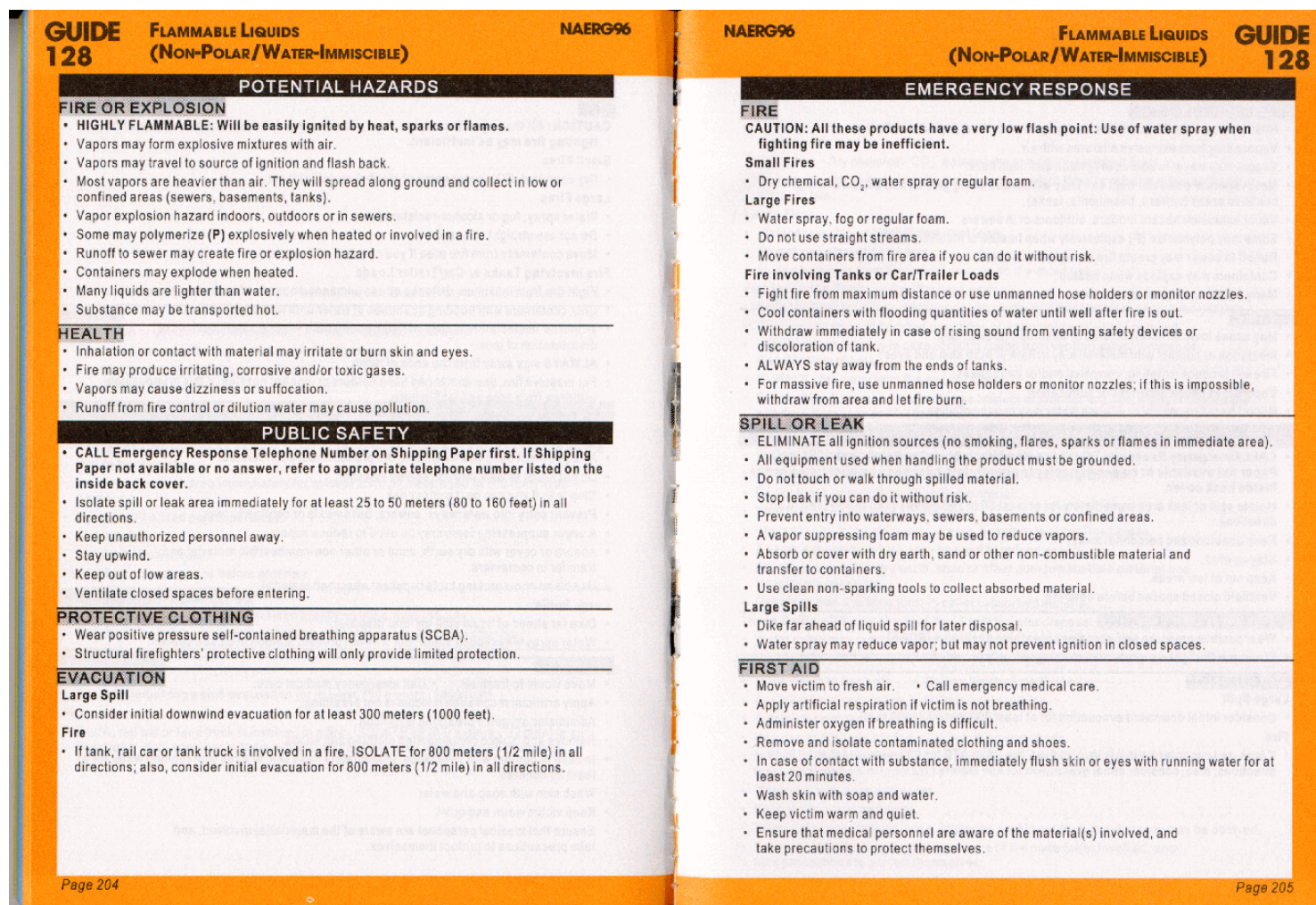
Filling Out the FedEx Dangerous Goods Airbill

- The Dangerous Goods Airbill has two sections
 - The top section of the page is the airbill portion.
 - The bottom section is the Shipper's Declaration for Dangerous Goods.
- The sender *must complete* the following fields on the pre-printed airbill:
 - Section 1: Date
 - Section 1: Sender's Name
 - Section 7: Total Packages
 - Section 7: Total Weight
- Declaration for Dangerous Goods:
 - Under the section labeled "Proper Shipping Name" fill in the infectious substance (i.e., HIV, HCV, etc.) in the parentheses.
 - Under the "Quantity and Type of Packing" section, fill in the amount of specimen in the box (in mls).
 - List an emergency telephone number in the space provided at the bottom of the airbill.
 - Sign and date the airbill in the bottom right corner.



IMPORTANT: You must follow explicitly all packaging and labeling instructions for shipping infectious substances. Correct spelling and legibility are important. Otherwise, your package will be delayed or may be rejected by FedEx.

**FIGURE 3
NAERG EMERGENCY RESPONSE INFORMATION
FOR FLAMMABLE LIQUIDS, N.O.S.**



Source: DOT and others. 1996.

SOP APPROVAL FORM

TETRA TECH EM INC.
ENVIRONMENTAL STANDARD OPERATING PROCEDURE

RECORDING OF NOTES IN FIELD LOGBOOK

SOP NO. 024

REVISION NO. 1
May 18, 1993

Last Reviewed: December 2008



Quality Assurance Approved

December 5, 2008

Date

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Title: Recording of Notes in Field Logbook	Revision No. 1, May 18, 1993 Last Reviewed: December 2008

1.0 BACKGROUND

The field logbook should contain detailed records of all the field activities, interviews of people, and observations of conditions at a site. Entries should be described in as much detail as possible so that personnel can accurately reconstruct, after the fact, activities and events during their performance of field assignments. Field logbooks are considered accountable documents in enforcement proceedings and may be subject to review. Therefore, the entries in the logbook must be accurate and detailed; and they must reflect the importance of the field events.

1.1 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide guidance to ensure that logbook documentation for any field activity is correct, complete, and adequate. Logbooks are used for identifying, locating, labeling, and tracking samples. A logbook should document any deviations from the project approach, work plans, quality assurance project plans, health and safety plans, sampling plans, and any changes in project personnel. They also serve as documentation of any photographs taken during the course of the project. In addition, the data recorded in the logbook may assist in the interpretation of analytical results. A complete and accurate logbook also aids in maintaining good quality control. Quality control is enhanced by proper documentation of all observations, activities, and decisions.

1.2 SCOPE

This SOP establishes the general requirements and procedures for recording notes in the field logbook.

1.3 DEFINITIONS

None

1.4 REFERENCES

Compton, R.R. 1985. *Geology in the Field*. John Wiley and Sons. New York, N.Y.

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1.5 REQUIREMENTS AND RESOURCES

The following items are required for field notation:

- Field logbooks
- Ballpoint pens with permanent ink
- 6-inch ruler (optional)

Field logbooks should be bound (sewn) with water-resistant and acid-proof covers; they should have preprinted lines and wide columns. They should be approximately 7 1/2 by 4 1/2 inches or 8 1/2 by 11 inches in size. Loose-leaf sheets are not acceptable for field notes. If notes are written on loose paper, they must be transcribed as soon as possible into a regular field logbook by the same person who recorded the notes.

Logbooks can be obtained from an individual's office supply room or directly from outside suppliers. Logbooks must meet the requirements specified in this SOP and should include preprinted pages that are consecutively numbered. If the numbers must be written by hand, the numbers should be circled so that they are not confused with data.

2.0 PROCEDURES

The following subsections provide general guidelines and formatting requirements for field logbooks, and detailed procedures for completing field logbooks.

2.1 GENERAL GUIDELINES

- A separate field logbook must be maintained for each project. If a site consists of multiple subsites, designate a separate logbook for each subsite. For special tasks, such as periodic well water-level measurements, data from multiple subsites may be entered into one logbook that contains only one type of information.
- All logbooks must be bound and contain consecutively numbered pages.
- No pages can be removed from the logbook for any purpose.

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- All field activities, meetings, photographs, and names of personnel must be recorded in the site logbook.
- Each logbook pertaining to a site or subsite should be assigned a serial number based on the date the logbook is issued to the project manager. The first issued logbook should be assigned number 1, the next issued logbook assigned number 2, and so on. The project manager is to maintain a record of all logbooks issued under the project.
- All information must be entered with a ballpoint pen with waterproof ink. Do not use pens with “wet ink,” because the ink may wash out if the paper gets wet. Pencils are not permissible for field notes because information can be erased. The entries should be written dark enough so that the logbook can be easily photocopied.
- Do not enter information in the logbook that is not related to the project. The language used in the logbook should be factual and objective.
- Begin a new page for each day’s notes.
- Write notes on every line of the logbook. If a subject changes and an additional blank space is necessary to make the new subject title stand out, skip one line before beginning the new subject. Do not skip any pages or parts of pages unless a day’s activity ends in the middle of a page.
- Draw a diagonal line on any blank spaces of four lines or more to prevent unauthorized entries.

2.2 LOGBOOK FORMAT

The layout and organization of each field logbook should be consistent with other field logbooks.

Guidelines for the cover, spine, and internal pagination are discussed below.

2.2.1 FORMAT OF FIELD LOGBOOK COVER AND SPINE

Write the following information in clear capital letters on the front cover of each logbook using a Sharpie® or similar type permanent ink marker:

- Logbook identification number
- The serial number of the logbook (assigned by the project manager)
- Name of the site, city, and state
- Name of subsite if applicable
- Type of activity

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- Beginning and ending dates of activities entered into the logbook
- “Tetra Tech EM Inc.” City and State
- “REWARD IF FOUND”

Some of the information listed above, such as the list of activities and ending dates, should be entered after the entire logbook has been filled or after decision that the remaining blank pages in the logbook will not be filled.

The spine of the logbook should contain an abbreviated version of the information on the cover: for example, “1, Col. Ave., Hastings, 5/88 - 8/88.”

2.2.2 First Page of the Field Logbook

Spaces are usually provided on the inside front cover (or the opening page in some logbooks), for the company name (“Tetra Tech EM Inc.”), address, contact name, and telephone number. If preprinted spaces for this information are not provided in the logbook, write the information on the first available page.

2.3 ENTERING INFORMATION IN THE LOGBOOK

Enter the following information at the beginning of each day or whenever warranted during the course of a day:

- Date
- Starting time
- Specific location
- General weather conditions and approximate temperature
- Names of personnel present at the site. Note the affiliation(s) and designation(s) of all personnel
- Equipment calibration and equipment models used.
- Changes in instructions or activities at the site
- Levels of personal protective clothing and equipment

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- A general title of the first task undertaken (for example, well installation at MW-11, decon at borehole BH-11, groundwater sampling at MW-11)
- Approximate scale for all diagrams. If this can't be done, write "not to scale" on the diagram. Indicate the north direction on all maps and cross-sections. Label features on each diagram.
- Corrections, if necessary, necessarily including a single line through the entry being corrected. Initial and date any corrections made in the logbook.
- After last entry on each page, initials of the person recording notes. No information is to be entered in the area following these initials.
- At the end of the day, signature of the person recording notes and date at the bottom of the last page. Indicate the end of the work day by writing "Left site at (time)." A diagonal line must be drawn across any remaining blank space at the bottom of this last page.

The following information should be recorded in the logbook after taking a photograph:

- Time, date, location, direction, and, if appropriate, weather conditions
- Description of the subject photographed and the reason for taking the picture
- Sequential number of the photograph and the film roll number or disposable camera used (if applicable)
- Name of the photographer.

The following information should be entered into the logbook when collecting samples:

- Location description
- Name(s) of sampler(s)
- Collection time
- Designation of sample as a grab or composite sample
- Type of sample (water, sediment, soil gas, etc.)
- On-site measurement data (pH, temperature, specific conductivity)
- Field observations (odors, colors, weather, etc.)
- Preliminary sample description
- Type of preservative used
- Instrument readings.

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If pre-printed field data forms are available (forms such as the micropurge field data collection form), data should be entered on these pre-printed forms rather than into field logbooks. Note in the logbook that the field data are recorded on separate forms.

2.4 PRECAUTIONS

Custody of field logbooks must be maintained at all times. Field personnel must keep the logbooks in a secure place (locked car, trailer, or field office) when the logbook is not in personal possession.

Logbooks are official project documents and must be treated as such.

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

**FIELD MEASUREMENT OF GROUNDWATER
INDICATOR PARAMETERS**

SOP NO. 061

REVISION NO. 2

Last Reviewed: July 2009



Quality Assurance Approved

July 2009

Date

Title: **Field Measurement of Groundwater
Indicator Parameters**

Revision No. 2, July 2009
Last Reviewed: July 2009

1.0 BACKGROUND

Various water quality monitoring systems can be used for determining groundwater indicator parameters in the field. Commonly measured field indicator parameters include pH, specific conductance, temperature, oxidation-reduction potential (ORP), dissolved oxygen (DO) and turbidity. Groundwater field measurements are typically collected in conjunction with groundwater sampling or monitoring well development (see SOPs 010, 015, and 021).

Various types of water quality systems exist including down-hole systems and flow through cells. Tetra Tech used several common water quality meters including various types of In-Situ, YSI, Hydac, and Horiba meters (see Figure 1 at the end of this SOP). The sampling team should select the type of meter or monitoring system based on site-specific conditions including data collection needs, the types of wells being sampled, and the sampling procedures used. Multiple parameter systems should be used when multiple field parameters are to be measured.

1.1 PURPOSE

This standard operating procedure (SOP) establishes the general requirements and procedures for using various water quality monitoring systems for determining groundwater pH, specific conductance, temperature, ORP, DO and turbidity in the field.

1.2 SCOPE

This SOP applies to general procedures for calibrating and operating water quality monitoring systems in the field. The project work plan or field sampling plan should identify the types of systems to be used and the actual project-specific field parameters to be measured. For each type of water quality system, the manufacturer's manual should be consulted for specific operating instructions.

1.3 DEFINITIONS

Single Parameter System: A meter or monitoring system consisting of a single probe designed to measure a single indicator parameter.

Multiple Parameter System: A meter or monitoring system consisting of multiple probes capable of measuring multiple indicator parameters.

Open Container Measurements: Field measurements performed in an open container such as a cup, a jar, or a bucket where an air/water interface exists.

Flow-Through Chamber or Cell: A plastic cell or chamber connected to the sample pump discharge tubing so that a continuous flow of water passes across the probes. Additional tubing is used to route water from the flow-through cell to a waste container or final discharge point.

Down-Hole Monitoring System: A meter or monitoring system where probes are submerged by inserting them into the well. The probes are attached to the meter (located at the well head or ground surface) by one or more cables.

pH: A measure of the acidity or alkalinity of a solution. The pH scale ranges from 0 to 14 with strongly acidic solutions at the low end, strongly basic solutions at the high end, and “pure” or neutral water at 7. Field measurements of pH are recorded in standard units.

Specific Conductance: The ability of a solution to conduct electricity; a measure of the solution’s ionic activity and content. The higher the concentration of ionic (dissolved) constituents, the higher the conductivity. Conductivity of the same water changes substantially with temperature. Specific conductivity is generally found to be a good measure of the concentration of total dissolved solids (TDS) and salinity. Conductivity is measured by placing two electrodes (with opposite electrical charge) in the water. For a known electrical current, the voltage drop across the electrodes reveals the solution’s resistance. Since the resistance of aqueous solution changes with temperature (resistance drops with increasing temperature), the resistance is corrected to the resistance of the solution at 25 °C. Field measurements are recorded in units of microsiemens per centimeters ($\mu\text{S}/\text{cm}$).

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Temperature: The degree of hotness or coldness of the solution being measured. Field measurements are typically recorded in degrees Celsius (°C).

ORP: ORP, or redox potential, is the tendency of a chemical species to acquire electrons and be reduced. In aqueous solutions, the reduction potential is the tendency of the solution to either gain or lose electrons when new chemical species are introduced. A solution with a higher (more positive) reduction potential than the new species will have a tendency to gain electrons from the new species (to be reduced by oxidizing the new species) and a solution with a lower (more negative) reduction potential will have a tendency to lose electrons to the new species (to be oxidized by reducing the new species). Just as the transfer of hydrogen ions between chemical species determines the pH of an aqueous solution, the transfer of electrons between chemical species determines the reduction potential of an aqueous solution. Like pH, the reduction potential represents an intensity factor. It does not characterize the capacity of the system for oxidation or reduction, in much the same way that pH does not characterize the buffering capacity. Field measurements are typically recorded in millivolts (mV).

DO: Dissolved oxygen (or oxygen saturation) is a relative measure of the amount of oxygen dissolved or carried in a given medium. In aquatic environments, dissolved oxygen is a relative measure of the amount of oxygen (O₂) dissolved in the water. Field measurements are typically recorded in milligrams per liter (mg/L).

Turbidity: Turbidity is the cloudiness or haziness of a fluid caused by individual particles (suspended solids). Fluids can contain suspended solid matter consisting of particles of many different sizes. While some suspended material will be large enough and heavy enough to settle rapidly to the bottom of the container if a liquid sample is left to stand, very small particles will settle only very slowly or not at all if the sample is regularly agitated or the particles are colloidal. These small solid particles cause the liquid to appear turbid. Field measurements are typically recorded in Nephelometric Turbidity Units (NTU).

1.4 REFERENCE

Essential Handbook of Ground-Water Sampling by Gillian Nielsen, 2007.

Tetra Tech EM Inc. July 2009. SOPs 010, 015, and 021

1.5 REQUIREMENTS AND RESOURCES

The following items are typically required to measure groundwater pH, specific conductance, temperature, ORP, DO, and turbidity using this SOP:

- Single or multiple parameter water quality measuring system
- Specific conductance calibration solutions
- Buffer solutions of pH 4, 7, and 10 for pH calibration
- Distilled or deionized water
- Rinse bottle
- 50-milliliter (mL) sample cups or beakers
- Sample tubing and connectors (specific to each type of system)
- Waste container to collect purge water
- Logbook or field data sheets

2.0 PROCEDURES

The procedures outlined in this SOP are general and may apply to various types of water quality monitoring systems to measure groundwater pH, specific conductance, temperature, ORP, DO and turbidity in the field. General procedures for testing and calibrating the monitoring systems are presented first, followed by procedures for using the instruments and making field measurements. Each particular monitoring system should be identified in the project work plan or field sampling plan and should be operated in accordance with the manufacturer's instruction manual.

2.1 TESTING AND CALIBRATION PROCEDURES

Each field meter or monitoring system should be calibrated according to manufacturer's specifications. In general, equipment should be thoroughly cleaned then calibrated and tested before the start-up of sampling at each site. Equipment should be calibrated and tested using manufacturer provided solutions and standards. Care should be taken to rinse the probes between testing and calibration to prevent cross contaminating solutions. Solutions should be poured from the manufacturer's container into another container to prevent compromising the entire solution provided by the manufacturer. Calibration and testing of field equipment should be documented each time it is performed in field logbooks (or field data sheets, if applicable). If testing and calibration measurements are out of tolerance, the instrument must be serviced or repaired.

2.2 FIELD MEASUREMENT PROCEDURES

Each field meter or monitoring system should be operated according to manufacturer's specifications. The actual field procedures will vary depending on the type of monitoring system being used (open container systems, flow-through cell systems, or down-hole systems) and the types of field parameters being measured. In addition, most systems include a data logging option. A description of open container, flow-through cell, and down-hole measurement processes are discussed below, followed by a general procedural summary and a summary of common errors associated with field measurements of indicator parameters.

2.2.1 Open Container Measurements

Open container measurements consist of collecting groundwater and placing it in a cup or container for field measurements using a hand held system. This method of field measurements is commonly used when bailing wells, but can also be used when pumping wells. Prior to field measurements, the equipment must be cleaned and calibrated following manufacturer's specifications. Field measurements should then be made at the frequency and for the indicator parameters specified in the project work plan or field sampling plan. To make open container field measurements, samplers collect groundwater from the well and place in a cup or container large enough to adequately submerge the probe or probes, as specified in the manufacturer's operations manual. For open containers, measurements should be taken in the following order: temperature, specific conductance, pH, and turbidity. Open container systems are not recommended for low-flow sampling as flow-through systems are more appropriate. The probes and

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cup or container should be thoroughly rinsed after each field measurement and between sampling locations.

2.2.2 Flow-Through Cell Measurements

Flow-through cell systems consist of measuring groundwater parameters as a continuous flow of water passes across the probes through a cell or chamber, and is primarily used when pumping wells and using low-flow sampling procedures. Prior to field measurements, the equipment must be cleaned and calibrated following manufacturer's specifications. Field measurements should then be made at the frequency and for the indicator parameters specified in the project work plan or field sampling plan.

The flow-through cell or chamber is placed "in line" between the discharge tubing of the pump and the container used to collect purged water. The outlet from the pump must be connected to the sample chamber input. The sample chamber outlet must then be connected or routed to a waste container (or to another designated discharge point). Tubing, fittings, and adaptors are generally required and may be provided by the manufacturer. Pump discharge tubing and chamber inlets and outlets are typically 1/2 or 3/8 inch diameter.

After the cell or chamber is connected to the pump discharge tubing and waste collection container, the sensors should be inserted into the sensor mounting plate in their respective ports. Any unused sensor ports must have plugs installed to close off the sample chamber. The probe cables are then connected to the meter following manufacturer's specifications.

With the system connected, the sampler should turn on the pump according to the manufacturer's instructions and then turn on the water quality monitor. Before recording any values, the sample chamber should be full, all air should be voided, and all of the displayed values should be stable. The probes and sample chamber should be thoroughly rinsed between sampling locations.

2.2.3 Down-Hole Measurements

Down-hole measurement systems consist of inserting the probes (or a multi-parameter sensor housing) inside a well to obtain field measurements, and is primarily used when pumping wells. Prior to field measurements, the equipment must be cleaned and calibrated following manufacturer's specifications.

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Field measurements should then be made at the frequency and for the indicator parameters specified in the project work plan or field sampling plan.

The probes or sensor are attached to a hand held meter or control unit by a cable and lowered inside the well to be sampled. Limiting factors when using down-hole systems include probe or sensor diameters and available cable lengths. The probes should be thoroughly decontaminated between sampling locations...

2.2.4 General Procedures for Field Measurements of Indicator Parameters

The following section discusses general procedures that typically apply to making field measurements of indicator parameters using various types of field instruments. Each particular type of meter or monitoring system should be identified in the project work plan or field sampling plan and should be operated in accordance with the manufacturer's instruction manual.

1. Inspect the instrument and batteries prior to the field effort.
2. Check the integrity of the buffer solutions used for field calibration since frequent replacement is necessary as a result of degradation upon exposure to the atmosphere.
3. If applicable, make sure all electrolyte solutions within the electrode(s) are at proper levels and no air bubbles are present within the electrode(s).
4. Calibrate the meter and electrode(s) on a daily use basis (or as recommended) following manufacturer's instructions and record data in field logbook or on field data sheets.
5. Immerse the electrode(s) in the sample. Stabilization may take several seconds to several minutes. If the parameter values continues to drift, the sample temperature may not be stable, a physical reaction (e.g., degassing) may be occurring in the sample, or the meter or electrode may be malfunctioning. The failure of the measurements to stabilize should be clearly noted in the logbook or field data sheet. For DO, provide for sufficient flow past the membrane by gently stirring the sample. Probes without stirrers placed in wells (down-hole measurements) may be gently moved up and down to achieve the required mixing.
6. Read and record the value of each parameter being measured making sure units of measure are clearly recorded.
7. Rinse the electrode(s) with deionized water.
8. Store the electrode(s) in accordance with manufacturer's instructions

2.2.5 Common Errors or Problems Associated With Field Measurements

The project work plan or field sampling plan should clearly identify the types of parameters to be measured, the measurement frequency, and “stabilization” requirements. It is essential to ensure that the type of monitoring system selected is compatible with the monitoring well sampling or development methods to be utilized. Some common errors to avoid are identified below:

- No, or incorrect equipment calibration
- Incorrect or expired calibration standards
- Poor equipment maintenance
- Inadequate training or unfamiliarity with equipment
- No record of units of measure and “+” or “-“ values for ORP
- Too much time taken to measure temperature sensitive parameters
- DO and ORP measured in closed systems (flow-through cell or down-hole) instead of closed cell systems

FIGURE 1

**THE HORIBA U-10 WATER QUALITY MONITORING SYSTEM
THE IN-SITU TROLL 9500 LOW-FLOW SYSTEM
THE YSI HAND HELD 556 METER**



Horiba U-10



In-Situ Troll



YSI 556

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

SOIL GAS SAMPLING METHODS

SOP NO. 074

REVISION NO. 2

Last Reviewed: July 2009

K. Klesing

July 28, 2009

Quality Assurance Approved

Date

Title: **Soil Gas Sampling Methods**Revision No. 2, July 2009
Last Reviewed: July 2009

1.0 BACKGROUND

Soil gas samples can be collected using several methods. This standard operating procedure (SOP) presents sample collection procedures for collecting soil gas samples in plastic Tedlar[®] bags, syringes, stainless-steel Summa canisters, and sorbent tubes. Procedures for collection with glass bulbs are not included in this SOP. Tedlar[®] bags are best suited for on-site or near-site chemical analysis, syringes are best suited for on-site chemical analysis, and Summa canisters and sorbent tubes are best suited for shipping samples to a full-service laboratory.

1.1 PURPOSE

The purpose of this SOP is to provide guidance for the use of Tedlar[®] bags, syringes, Summa canisters, and sorbent tubes for soil gas sample collection.

1.2 SCOPE

This SOP applies to all personnel collecting soil gas samples in Tedlar[®] bags, syringes, Summa canisters, or sorbent tubes. The site-specific work plan and sampling plan should be followed during soil gas sampling activities.

1.3 DEFINITIONS

Soil gas: The gases or atmosphere filling the void spaces in soils and unconsolidated sediments. These gases may all be of natural origin, but manmade contaminants or byproducts may be present in detectable quantities.

1.4 REFERENCES

- Department of Toxic Substances Control (DTSC). 2003. “Advisory – Active Soil Gas Investigations.” January 28. Available Online at:
<http://www.dtsc.ca.gov/LawsRegsPolicies/Policies/SiteCleanup/upload/SMBR_ADV_activesoilgasinvst.pdf>
- U.S. Environmental Protection Agency (EPA). 1990. “General Precautions in the Use of Canister Sampling for Measuring VOCs in Ambient Air.” Office of Solid Waste Emergency Response (OSWER). Bulletin Board.

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EPA. 1999. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air – Second Edition*. Atmospheric Research and Exposure Assessment Laboratory, Research Triangle Park, NC. 625/R-96/010b. January.

1.5 REQUIREMENTS AND RESOURCES

When using the Tedlar[®] bag collection method, the following items are needed:

- A sampling port and attached sampling line, ready for sampling.
- A pump (SKC universal flow pump or equivalent), capable of pumping at least 3 liters per minute (L/min) to allow purging of the sample point prior to collecting a soil gas sample.
- Sampling lines (dedicated, 0.375-inch outer diameter Tygon[®] tubing or equivalent such as Teflon[®]) to connect all field equipment.
- Y-branched plastic (Teflon[®]-lined if available) sampling hose for duplicate collection.
- 500-cubic-centimeter (cc) Tedlar[®] bags, with metal fittings.
- Vacuum chamber.
- Leak check compound.

When using syringes to collect soil gas, the following items are needed:

- A supply of clean graduated syringes.
- Plastic 3-way valve.
- Aluminum foil.
- Leak check compound.

When using Summa canisters to collect soil gas, the following items are needed:

- A supply of clean, evacuated Summa canisters with a pressure gauge to verify internal pressure and flow controller (integrated flow controller pressure gauge may be used).
- A vacuum pump (SKC universal flow pump or equivalent) to allow purging of the sample point prior to collection of soil gas samples.

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- Tygon[®] or equivalent tubing of appropriate size for connecting the sampling port to pump (during gas point purging) and the sampling port to stainless steel canister (during sample collection).
- Swagelok “T” for duplicate collection.
- Leak check compound.

When using sorbent tubes to collect soil gas, the following items are needed:

- A supply of sorbent tubes with the appropriate media.
- A pump (SKC universal flow pump or equivalent), capable of pumping at least 3 L/min to allow purging of the sample point prior to collection of samples, with a low-flow adapter for sample collection (10 to 200 milliliters per minute [mL/min]), or two separate pumps.
- Tygon[®] or equivalent tubing of appropriate size for connecting the sorbent tube and pump and union fittings.
- Cooler with ice.
- Leak check compound.

2.0 PROCEDURES

This section describes selection of soil gas sampling locations and general preparation of the sampling system to be used. This section also provides detailed procedures for collecting samples using Tedlar[®] bags, syringes, Summa canisters, and sorbent tubes. Finally, this section discusses additional considerations that affect soil gas sampling—including duplicate and equipment blank sample collection, decontamination, and sample transfer—and summarizes the advantages and disadvantages of each sampling method.

2.1 SAMPLING LOCATION SELECTION

Sampling locations should be selected and prepared for sampling as described in a site-specific quality assurance project plan and field sampling plan. Soil gas samples may be collected from depths as shallow as 3 feet or as great as 50 feet below ground surface (bgs), depending on the objectives of the project, soil type encountered, and the type of drilling equipment used. The horizontal spacing of soil gas sampling points (grid size) may be only a few feet or more than 500 feet. Again, this is a function of project-specific objectives and site conditions.

2.2 SAMPLING SYSTEM PREPARATION

Sample probe assemblies generally consist of three types:

- A hand-driven (hand auger) probe, typically good for shallow, temporary applications.
- A hydraulic-driven (direct-push) probe, good for shallow to moderately deep temporary and permanent applications.
- A drill rig-driven (hollow-stem auger) probe, typically good for deep, permanent applications including nested, multi-depth probe constructions.

The probes may be assembled in series to reach the desired sampling depth. The probes will be driven to or emplaced at the desired sample collection depth, and then fitted with the Tygon[®] or equivalent sampling tube. During probe emplacement, subsurface conditions are disturbed. To allow for subsurface conditions to equilibrate, the following equilibration times are recommended:

- 30 minutes for probes installed by hand auger method.
- 20 minutes for probes installed by direct-push method where the drive rod remains in the ground.
- 30 minutes for probes installed by direct-push method where the drive rod does not remain in the ground.
- 48 hours for probes installed by hollow-stem auger drilling method.

Once fitted with the sampling tube, the ambient air within the sampling system is purged. Usually, three to five system volumes are purged prior to sample collection. If the sampling system purge volume cannot be measured, then a standard purge time of 3 to 5 minutes should be used. A flame ionization detector (FID) or photoionization detector (PID) may be used to purge ambient air while also providing a qualitative means to indicate when purging is complete, i.e., when volatile organic compounds (VOC) are detected.

After the system is purged of ambient air but before the pump is turned off, approximately 2 inches of the sampling line closest to the entrance port of the pump should be folded over itself, and the tubing should be clamped to keep ambient air from reentering the system. After the purged system is sealed to ambient air, the pump should be turned off. Sample collection can now proceed using a Tedlar[®] bag, a syringe, a Summa canister, or a sorbent tube.

2.3 SAMPLE COLLECTION USING TEDLAR[®] BAGS

Soil gas can be collected for chemical analysis in a 500-cc Tedlar[®] sampling bag. This is accomplished by using a pump to induce a vacuum on the exterior of the bag. This will cause the Tedlar[®] bag to be inflated with soil gas. The following procedures should be used:

1. Connect the free end of the Tygon[®] or equivalent tubing (previously inserted through the top of the vacuum chamber) to the Tedlar[®] sampling bag. Open the valve on the sampling bag and place the bag into the body of the vacuum chamber.
2. Place the top on the vacuum chamber.
3. Connect the free end of the evacuation tube to the pump.
4. Turn on the pump. This will create a vacuum in the chamber, and the Tedlar[®] bag should fill at a rate of approximately 2 liters per minute. The rate at which the Tedlar[®] sampling bag fills will depend on the porosity and permeability of the soil.
5. The minimum amount of soil gas needed for analysis is approximately 0.25 liters.
6. If less than 0.25 liters is collected after 4 minutes of sampling, raise the soil gas probe 0.5 feet (if possible, i.e., when using a temporary probe). Continue to evacuate the vacuum chamber for another minute. If the minimum required soil gas is not collected, repeat the procedure again. If the minimum required volume of soil gas is still not collected, abandon the collection process. All steps conducted should be accurately recorded in a field logbook.
7. Remove the top of the vacuum chamber after the soil gas sample is collected in the Tedlar[®] bag.
8. Close the valve on the Tedlar[®] sampling bag, clamp the Tygon[®] tubing, and remove the Tedlar[®] sampling bag.
9. Turn off the pump.
10. Follow the leak check procedures described in Section 2.8.
11. Label the Tedlar[®] bag and its corresponding field data sheet (Figure 1) with the sample number.
12. Fill out the rest of the field data sheet. An alternative documentation procedure is to enter the requisite information in the field logbook.
13. Ship samples to the laboratory for analysis. Tedlar[®] samples do not need to be chilled after collection or during transportation.

2.4 SAMPLE COLLECTION USING SYRINGES

Soil gas also can be collected for chemical analysis in a syringe for on-site analysis. The system is purged and the sample is collected using the following procedures:

1. Connect the syringe to the probe tubing using a 3-way valve.
2. If the syringe is connected directly to the probe implant or tip (shallow applications only), no purging is required.
3. Open the valve and collect the sample by pulling on the syringe piston to extract the desired volume. Close the valve, then remove and cap the syringe.
4. Follow the leak check procedures described in Section 2.8.
5. Document the sample collection in a field logbook.
6. Analyze samples immediately (maximum holding time is 30 minutes); samples do not need to be chilled prior to analysis.

2.5 SAMPLE COLLECTION USING SUMMA CANISTERS

Soil gas also can be collected for chemical analysis in a stainless steel, evacuated canister, or Summa canister. Often, these expensive canisters are used to collect duplicate samples for off-site analysis from locations where field screening analysis using Tedlar[®] bags or syringes is in use.

When this method is used, the canister sampling train is connected directly to the purged Tygon[®] or equivalent sampling tube. To prevent ambient air from entering the canister during sample collection, all connections must be airtight. To collect soil gas samples using this method, the following procedures are used:

1. Confirm the valve is closed and remove the brass cap. Attach the pressure gauge and flow controller (integrated system) to the canister. Attach the soil probe to the sample train with Tygon[®] or equivalent tubing.
2. Open the canister valve, which will allow the evacuated canister to draw in soil gas, and immediately record the canister pressure reading and time.
3. Monitor sampling progress periodically. When target sample collection time has been reached, close the canister valve.

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4. Record the time and post-sampling pressure reading on the canister pressure valve. Do not let the vacuum be reduced to zero pressure as this will compromise the analytic results.
5. Remove the canister from the sample train and replace the brass cap.
6. Follow the leak check procedures described in Section 2.8.
7. Label the canister and its corresponding field data sheet with the sample number.
8. Fill out the rest of the field data sheet and chain of custody. An alternative documentation procedure is to enter the requisite information in a field logbook.
9. Ship samples to the laboratory for analysis. Summa samples do not need to be chilled after collection or during transportation.

2.6 SAMPLE COLLECTION USING SORBENT TUBES

Sorbent tubes are provided by the laboratory, and selection of the sorbent tube media is dependent on the compounds to be reported. The pump should be calibrated before sample collection begins, and flow rates should be recorded. To collect soil gas samples using this method, the following procedure is used:

1. Connect the sampling inlet end of the sorbent tube to the soil gas probe with a union fitting.
2. Connect the other end of the sorbent tube to the pump using Tygon[®] or equivalent tubing.
3. Start the pump and record the start time. After the desired duration, stop the pump and record the end time.
4. Remove the sorbent tube from the probe and pump, and replace the end plugs on both ends of the tube.
5. Follow the leak check procedures described in Section 2.8.
6. Record the sample number, tube number, sample flow rate, collection date and time on the field data sheet and chain of custody. An alternative documentation procedure is to enter the requisite information in a field logbook.
7. Due to the sampling medium, samples must be stored and transported in a cooler with ice packs to the laboratory.

2.7 DUPLICATE AND EQUIPMENT BLANK COLLECTION

Duplicate soil gas samples will be collected at each site as required in the site-specific quality assurance project plan and field sampling plan. Generally, one duplicate sample will be collected for every ten

samples collected. Each duplicate is collected in conjunction with a corresponding environmental sample.

To collect duplicate samples in Tedlar[®] bags, a Y-branched sampling hose will be connected to the vacuum chamber or pump. Two Tedlar[®] bags are then attached, one to each end of the Y-branched hose. Syringe duplicate sampling is performed by collecting and analyzing a subsequent sample. To collect duplicate samples in canisters, a Swagelok “T” will be connected to two canisters. Purging and sample collection will proceed as described above. After collection, one sample will be labeled as the environmental sample and one as the duplicate.

Equipment blanks also will be collected at each site as required in the site-specific quality assurance project plan and field sampling plan. Generally, one blank will be collected for every ten samples collected. Blanks will be collected by running ambient air through the sampling system immediately after it has been decontaminated, and by collecting the ambient air in a Tedlar[®] bag, Summa canister, or sorbent tube using the same procedures used to collect environmental samples. Blank sample collection is conducted upwind of any observed interference, and the location of the sampling should be recorded in a field logbook. Equipment blanks are collected to ensure that field equipment decontamination procedures are adequate.

2.8 LEAK CHECK PROCEDURES

Leakage during soil gas sampling may dilute samples with ambient air and produce results that underestimate the actual site concentrations, or may contaminate the sample with external contaminants. Leak tests should be conducted to determine whether leakage is occurring. Leak detection is performed using the following procedures:

1. Leak tests should be conducted at every soil gas probe.
2. Tracer compounds such as isopropanol, butane, helium, or 1,1-difluoroethane may be used as leak check compounds. These compounds may be contained in common products such as Dust-Off and rubbing alcohol. Be sure the tracer compound used does not contain chemicals or impurities that may be present as a site contaminant.

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3. Place tracer compounds around the soil gas well at the ground surface and at all connections in the aboveground sampling system train. Tracer compound is emplaced by wetting or spraying a paper towel or rag and wrapping around the area of the connection where leaks could occur.
4. Collect samples as describe in previous sections and use analytical results to determine if the tracer compound has leaked into the sample.

2.9 DECONTAMINATION

Sampling probes should be decontaminated before the first sample is collected and between sampling points. Probes that are grossly contaminated should be decontaminated using a high-pressure steam cleaner. Probes that are not grossly contaminated can be decontaminated by brushing off loose soil particles, then heating the probes until they are warm to the touch to drive off any volatile contaminants. Heating times of 7 to 10 minutes are generally sufficient for this purpose. This brushing and heating method greatly reduces the generation of decontamination fluids.

Syringes must be decontaminated between each use. Sampling syringes must be disassembled and baked at 240 °C for a minimum of 15 minutes or at 120 °C for a minimum of 30 minutes, or must be replaced. All canisters must be properly decontaminated by the laboratory as specified by appropriate EPA methods.

If Y-branched tubing or any other sampling equipment is to be reused, it must also be decontaminated between sampling locations.

2.10 SAMPLE TRANSFER

After collection, each sample container will be transported to the designated laboratory for analysis. In many cases, samples will be analyzed on site in a mobile laboratory.

2.11 ADVANTAGES AND DISADVANTAGES OF EACH SAMPLING METHOD

Tedlar® bags are relatively inexpensive to use but can only be used once and then must be disposed of. If the soil formation being sampled has a low porosity and permeability, such as clay or silty clay, it may not be possible to inflate the Tedlar® bag with soil gas. Some regulatory agencies do not recommend use of Tedlar® bags to collect soil gas for VOCs analysis. Due to short holding times, Tedlar® bags should typically only be used for on-site or near-site analysis.

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Syringes must be decontaminated between each use, and periodic equipment blanks must be analyzed to verify that the decontamination procedures used are effective. Syringes can only be used for on-site analysis.

Summa canisters are expensive and, therefore, are not cost effective when conducting on-site analysis. Samples collected in canisters and sorbent tubes are shipped off site for analysis, with the advantage of excellent assurance of sample integrity. Sorbent tubes should be kept cold.

3.0 CAUTIONS

Both Tedlar[®] bags and syringes are transparent to light, and many volatile compounds are subject to degradation in sunlight. Because of this, samples in Tedlar[®] bags should be stored in a dark place, such as a cooler, and analyzed as quickly as possible. Syringes should be covered and wrapped in aluminum foil after collection to minimize exposure to sunlight. In general, samples collected in Tedlar[®] bags should be analyzed within 24 hours after collection, at a maximum. Syringe samples should be analyzed immediately. This will ensure sample integrity and minimize contaminant loss by degradation processes or absorption onto surfaces. Soil gas samples should not be subjected to changes in ambient pressure. Samples to be analyzed off site should not be shipped by air. If condensation is observed in the sample container, the sample should be discarded and a new sample collected.

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FIGURE 1
EXAMPLE
FIELD DATA SHEET
FOR SOIL GAS SAMPLING METHODS

Date: _____ Site/Facility Name: _____

Time: _____ Project No.: _____

Sample Container:

Tedlar[®] Bag: _____ Syringe: _____ Summa canister: _____ Sorbent Tube: _____

Sampling location and depth: _____

Description of location: _____

Sample location purged: Yes _____ FID or PID (circle one) Reading: _____

Sample relinquished by: _____ Date/Time: _____

Sample received by: _____ Date/Time: _____

Attach field copy of sample label or write in sample number:

Notes: _____
