URS

October 8, 2014

Ms. Maura S. O'Brien
Washington Department of Ecology
Northwest Region Office
3190 – 160th Avenue SE
Bellevue, Washington 98008

Re: TX-03A Area Groundwater Assessment Work Plan
Shell Harbor Island Terminal
Seattle, Washington

Dear Ms. O'Brien:

INTRODUCTION

URS Corporation (URS) is pleased to submit this work plan on behalf of Shell Oil Products US (Shell) to install additional groundwater monitoring wells and perform a supplemental groundwater investigation near well TX-03A at the Shell Harbor Island Terminal (Site) in Seattle, Washington (Figure 1). Shell is performing work at this Site under Consent Decree No. 99 2-07 176 0 SEA with the Washington State Department of Ecology (Ecology).

PURPOSE AND SCOPE OF INVESTIGATION

During the Environmental Protection Agency (EPA) 5-year review, the northern boundary of the Shell Main Terminal was identified for further evaluation. Gasoline range hydrocarbons and benzene exceedances above their respective cleanup levels were identified in well TX-03A. This well is located north of the Shell Main Terminal and down gradient of a BP pipeline (Figure 1). Groundwater flows northwest across the TX-03A area at an approximate gradient of 0.006 (Figure 1).

In 2013, benzene exceeded the cleanup level of 0.071 milligrams per liter (mg/L), in all sampling events in monitoring wells MW-301 through MW-304, MW-307, MW-308, MW-310, and TX-03A at concentrations ranging from 0.160 mg/L (MW-301) to 2.81 mg/L (TX-03A).

During recent discussions with Ecology, further delineation of the impacted soil and groundwater in the vicinity of the TX-03A area is necessary to evaluate and monitor the extent of petroleum hydrocarbons down gradient and up gradient from the TX-03A area. The purpose of the offsite groundwater monitoring well installation is to assess and delineate petroleum hydrocarbons in soil and groundwater down gradient from TX-03A. In addition to the down gradient wells proposed to be installed, a temporary well will be installed in the Main Tank Farm to assess the groundwater up gradient of the TX-03A plume.

TASK 1: PRE-INVESTIGATION ACTIVITIES

Prior to commencement of field activities, soil boring locations will be clearly marked in white paint and cleared of underground utilities by a private underground utility locating service. The Utility Notification Center will also be contacted to locate where public utilities enter and travel through the property. A Site specific Health and Safety Plan (HASP) will be prepared in accordance with URS' health and safety program.

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TASK 2: WELL INSTALLATION AND SAMPLE COLLECTION

URS proposes to drill and install wells MW-311 and MW-312 down gradient of the Shell Terminal at the City of Seattle parking lot located between SW Florida Street and 16th Avenue SW near the pedestrian walk bridge. Additionally, URS proposes to advance a temporary well boring (MTF-1) up gradient of the TX-03A area inside the Shell Terminal tank farm near Tank 80001. The locations of the proposed monitoring wells and upgradient boring are shown on Figure 1.

This section describes the overall approach for conducting the soil boring and well installation activities, including a description of the wells to be installed and installation procedures. Detailed well installation and sampling procedures are also provided in the Standard Operating Procedures (SOPs) in Appendix A. The field forms are included in Appendix B.

SOIL BORING AND WELL INSTALLATION

Prior to drilling, soil borings will be advanced using air-knife equipment to a depth of approximately 5 feet below the ground surface (bgs). If indications of a utility (i.e. pea gravel or flagging) or refusal is encountered, borings will be abandoned immediately and the URS project manager will be contacted to discuss a new location. Once borings have been air-knifed, a direct-push drill rig will advance borings MW-311 and MW-312 to approximately 15 feet bgs and a groundwater monitoring well will be installed. Temporary well boring MTF-1 will be advanced to approximately 10 to 12 feet bgs. Groundwater is anticipated to be encountered at approximately 5 to 8 feet bgs.

Monitoring wells will be completed by installing a two-inch diameter PVC well casing fitted with 10 feet of pre-packed well screen within the boring. The wells will be installed and constructed in accordance with the specifications and procedures outlined in SOP 009, and in accordance with all applicable Federal, State, and local regulations and guidance. Detailed descriptions of well construction (including, but not limited to, materials used, depth of well, screened interval, water level in well, and date and type of well development) for each location, as described in SOP 009, shall be included in the report.

The temporary monitoring well MTF-1 will be constructed using a 3/4-inch diameter, schedule 40 polyvinyl chloride (PVC) well casing lowered into the open annulus of the boring, with 10-foot length of 0.010-inch slotted PVC well screen placed at the bottom of the boring, and10/20 silica sand filter pack from the bottom of the boring to three feet above the screen. Once the groundwater sample is collected the temporary well will be removed.

Soil borings will be logged and sampled in accordance with SOP 007 and SOP 008, to the extent practicable or feasible by a URS geologist. Not all included sections in SOP 008 are relevant for this work plan. Soil cores will be collected continuously using 5-foot long, 2-inch nominal outside diameter macro-core sampler lined with new acrylic sleeves. Each soil core will be field screened for volatile organic compounds (VOCs) using a photoionization detector (PID) and examined for staining, sheen, and odor as outlined in SOPs 008 and 009.

Two soil samples will be collected from each boring. One sample will be collected from 3 feet bgs. A second sample will be collected at the groundwater interface within each boring. Samples will be screened based on visual observations, organic vapor monitoring (OVM) and pan water sheen testing. Field logs will record field observations, OVM readings, and sheen test results. OVM will be performed with a PID calibrated against isobutylene (or equivalent) reference gas. OVM will be performed as a head space analysis; where soil is placed in a plastic sample bag and shaken. The PID probe is inserted in the bag and the concentration of volatile organic vapors present within the headspace is measured in parts per million (ppm). Water pan sheen testing consists of placing a small amount of soil in a black pan half filled with deionized water and observing for a silvery, metallic, colored or iridescent sheen. The following sheen descriptions will be used:

- None (N);
- Slight (S): Light, colorless, dissipating film, spotty to globular;
- Moderate (M): Light to heavy irregular film with some color or iridescence; and
- Heavy (H): Heavy, colorful, iridescence film which spreads rapidly; sheen flows off the sample.

Based on field screening, an additional soil sample may be collected from the most contaminated interval(s) above the groundwater zone or water table. One sample will be collected from each borehole from the most contaminated interval, as measured by PID readings.

Well Development

Monitoring wells will be developed and purged a minimum of three casing volumes, or until the turbidity is low. Upon completion of the development a groundwater sample will be collected for laboratory analysis.

Saturated casing purge volumes will be determined using depth to water measurement data (SOP 002). Following the calculation of the purge volume, each monitoring well will be purged using a down-hole electrical pump. The pump will be decontaminated between each well in a manner consistent with the procedures described in SOP 001. Field notes, including observations, deviations from the work plan and SOPs, and health and safety information will be kept on Daily Quality Control Report (DQCR) forms (Form 1). Purge volume measurements, field parameter measurements, and other observations will be entered on the Monitoring Well Development Field Log (Form 2).

Purging should continue until one of the following three criteria is met:

1. When turbidity is ≤ 10 nephelometric turbidity units (NTUs) and pH, temperature, and conductivity have stabilized over at least three successive well volumes. Stability criteria of water quality parameters can be used to determine when development objectives have been met. The duration and measurements should be recorded on the Monitoring Well Development Field Log (Form 2). The stabilization criteria for each specific water quality parameter are listed on the Monitoring Well Development Field Log.

2. In some instances, development to achieve a turbidity of ≤ 10 NTU is difficult or unattainable. In this case, development can stop when all of the following conditions are met.

    a. Turbidity has stabilized within ± 10% over three successive well volumes, and

    b. Conductivity and pH have stabilized over at least three successive well volumes.

3. If Criteria 1 and 2 are not achieved, then redevelopment will cease when a minimum of ten casing volumes have been removed.

Decontamination Procedures

Potential sources of contamination in the field include sampling equipment, vehicles, and dust. Sample handling will be minimized and sources of contamination will be carefully avoided. Samplers will wear disposable powder-free nitrile gloves during sample handling procedures.

Any other non-disposable sampling equipment will be decontaminated prior to initiation of sampling and between sampling locations, following the procedures outlined in SOP 001. In the field, 5-gallon buckets will be used to collect the decontamination water from sampling equipment, which will then be transferred to 55-gallon drums.

Investigation Derived Waste

Investigation derived waste (IDW) generated during the investigation will include soil cuttings. The IDW will be containerized in 55-gallon drums. The drums will be staged on site pending characterization and disposal. Prior to leaving the Site, URS will complete the Investigation Derived Waste Form (Form 5, Appendix B), which lists each drum and its contents.

Miscellaneous non-hazardous wastes may include gloves, rope, paper towels, plastic sheeting, garbage bags, and similar materials used as part of the investigation. These wastes will be disposed of at a licensed solid waste facility.

URS will collect one soil sample and submit the sample for IDW characterization.

SOIL SAMPLE COLLECTION

All soil samples obtained in the field will be collected in laboratory-approved containers as specified by standard sample handling procedures. Chain of custody procedures will be utilized to ensure the integrity of the samples. All samples collected will be submitted for laboratory analysis on a standard turnaround time (ten business days).

Before collecting soil samples, sampling personnel will don clean, nitrile or equivalent protective gloves. During collection the soil will be transferred from the acetate sleeves to the appropriate glass containers using a zero headspace extraction (ZHE) sampling device (e.g., EnCore sampler) following the EPA 5035 method.

The SOPs to be used for sample documentation, handling, custody, and packaging are specified in SOPs 004 through 006 in Appendix A.

Sample Naming

All samples will be labeled; the sample label shall contain, at a minimum, sample identification number, matrix, analysis requested, sampling date and time, and the initials of the field sampler. The sample IDs will be labeled in the following manner:

- For the soil sampling, the sample identification will be the new boring identification (e.g., MW-311) and include the soil sampling depth. For example, the first soil sample collected at MW-311 will be identified as MW-311 (2-3), indicating a soil sample collected from 2 to 3 feet bgs at new well location MW-311.

GROUNDWATER SAMPLE COLLECTION

New wells installed under this work plan will be sampled during the annual groundwater monitoring event scheduled for November 2014. Field parameters including dissolved oxygen, oxidation reduction potential, conductivity, temperature, pH, and ferrous iron, will be collected from each well. Following the initial water sampling, the new monitoring wells will be sampled on a quarterly basis. Data from these wells will be evaluated in the subsequent annual monitoring report and conclusions and recommendations will be provided regarding monitoring frequency for future events.

All groundwater samples will be collected in laboratory-approved containers as specified by standard sample handling procedures. Chain of custody procedures will be utilized to ensure the integrity of the samples. All samples collected will be submitted for laboratory analysis on a standard turnaround time (ten business days).

The SOPs to be used for sample documentation, handling, custody, and packaging are specified in SOPs 004 through 006 in Appendix A.

Sample Naming

All samples will be labeled; the sample label shall contain, at a minimum, sample identification number, matrix, analysis requested, sampling date and time, and the initials of the field sampler. The sample IDs will be labeled in the following manner:

- For groundwater sampling, the sample identification will be the new well identification (e.g., MW-311).

TASK 3: LABORATORY ANALYSIS AND DATA MANAGEMENT

All soil and groundwater samples will be analyzed for selected VOCs (benzene, toluene, ethylbenzene, and total xylenes) by EPA method 8260B, gasoline range petroleum hydrocarbons by NWTPH-Gx, diesel range hydrocarbons by NWTPH-Dx, and polycyclic aromatic hydrocarbons (PAHs) by EPA method 8270 SIM. All method-required quality control will be completed by the laboratory conducting the analyses and reported along with the analytical results. URS will collect the soil sample for BTEX analysis using a zero headspace extraction sampling device (e.g., EnCore sampler) following the EPA 5035 method.

TASK 4: REPORT PREPARATION AND DELIVERY

URS will document the results of the investigation in a report to be submitted to Shell for review and comment. The report will include a description of the field work, boring logs, and a tabulation of analytical results with a comparison to site cleanup levels. The final report will be submitted once comments have been addressed. The semi-annual sampling results will be reported in the Annual Compliance Monitoring Reports and quarterly progress reports.

SCHEDULE

URS anticipates that the well installation activities will be completed on October 21, 2014. The monitoring wells will be sampled during the site annual monitoring event in November. Following completion of the sampling, URS will prepare a results report. This installation and assessment report will be submitted to Ecology in early December 2014.

Respectfully submitted,

URS CORPORATION

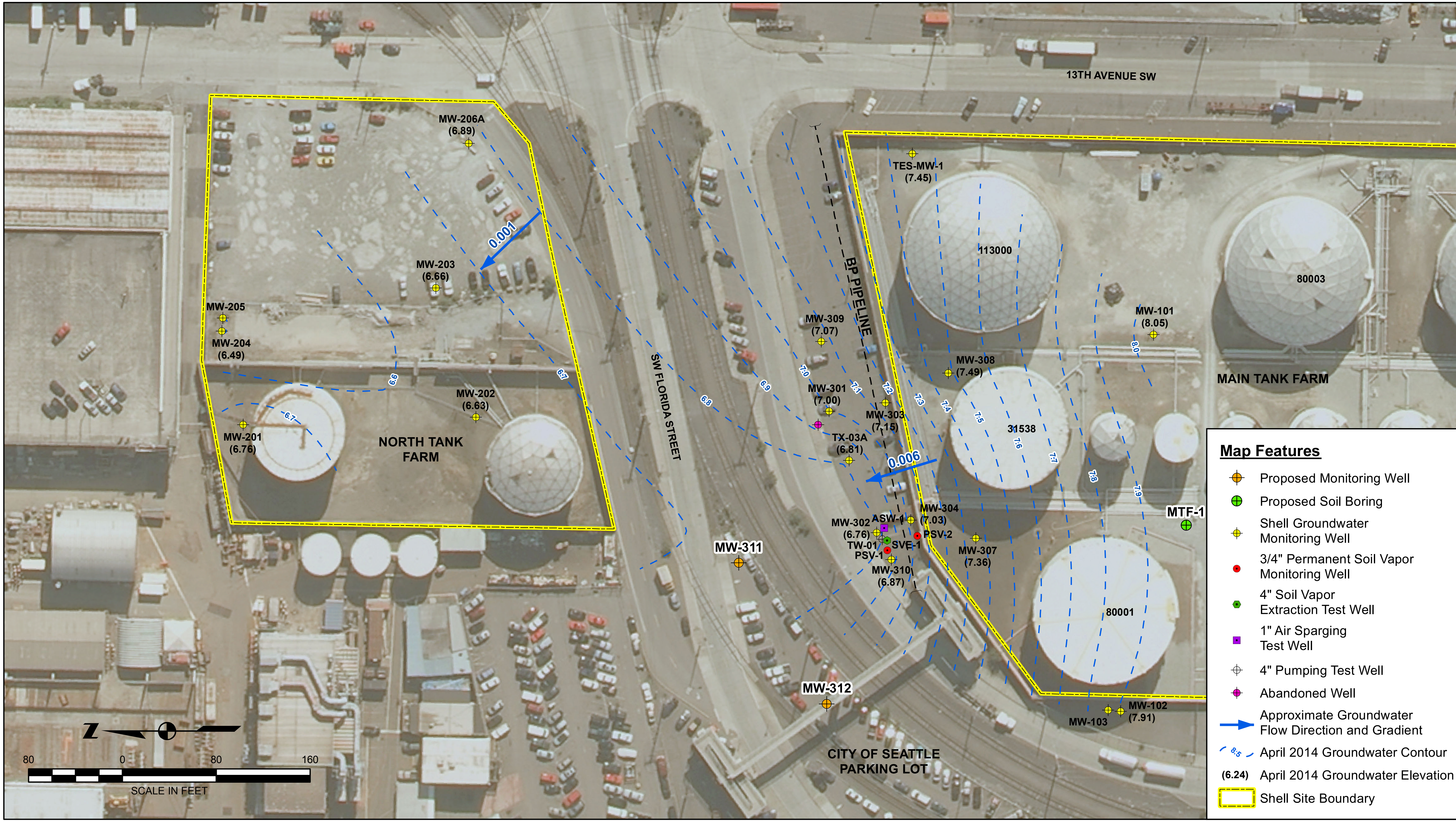
Brian Pletcher
Senior Project Manager

cc: Mr. Perry Pineda, Shell Oil Products US (electronic copy)
Paul Katz, Seattle Terminal Manager –Shell Oil Products US

Attachments:

Figure 1 – Proposed well locations
Appendix A – SOPs
Appendix B – Field Forms

FIGURE



Source: USGS, 2009.

TX-03A AREA PROPOSED WELL LOCATIONS

SEPTEMBER 2014
49241036

SHELL
HARBOR ISLAND TERMINAL
SEATTLE, WASHINGTON

URS

FIGURE 1

K:\46194268_Seattle_Terminal\MXD\2014\Fig 1 TX-03A Proposed MW Locations.mxd

APPENDIX A – SOPs

STANDARD OPERATING PROCEDURE

FOR EQUIPMENT DECONTAMINATION (SOP 001)

URS Corporation

SOP 001
EQUIPMENT DECONTAMINATION

This procedure describes the techniques used to decontaminate reusable equipment prior to collecting samples or taking measurements. Proper decontamination ensures that cross-contamination (of both equipment and samples) and off-site contaminant migration do not occur.

> ***Decontamination of equipment using a steam cleaner is also permitted in place of the following procedure.***

EQUIPMENT REQUIRED

- Clean 5-gallon plastic buckets and/or spray bottles
- 5-gallon plastic container of potable tap water
- 5-gallon carboy of laboratory-grade deionized (DI) water (organic/analyte-free)
- Spray bottle containing a 10% solution of methanol with DI water
- Alconox® detergent (or equivalent)
- Nitrile gloves
- Hard-bristle brushes
- Plastic sheeting or garbage bags
- Personal protective equipment as specified in the Health and Safety Plan (HASP)
- 55-gallon drum(s)
- Drum labels

PROCEDURES

The lead sampler will set up the area used to decontaminate sampling equipment consisting of **four stations**, as described below. This area will be located upwind from the specific sampling area. The personnel performing the decontamination procedures will wear protective clothing as specified in the site-specific Site Health and Safety Plan. This SOP describes procedures for decontaminating sampling equipment contaminated by organic materials. The specific procedures for decontaminating sampling equipment include the following:

1. Immediately after sampling, brush each piece of sampling equipment with either a bristle brush or steel wire brush to remove particulate contamination.

2. Soap wash (dilute solution of a detergent such as Alconox® in potable water solution).
3. Potable water rinse (**Station No. 2**).
4. Rinse with 10% methanol (**Station No. 3**).
5. Rinse with DI water (**Station No.4**).
6. Remove the equipment from the decontamination area and cover with plastic.

After decontaminating all the sampling equipment, the disposable gloves, and used plastic will be placed in garbage bags and disposed of. The wash and rinse water will be containerized for proper disposal. At the end of each day, all sampling equipment will be stored in large plastic bags.

STANDARD OPERATING PROCEDURE

FOR MEASUREMENT OF DEPTH TO GROUNDWATER IN WELLS (SOP 002)

URS Corporation

SOP 002
MEASUREMENT OF DEPTH TO GROUNDWATER IN WELLS

Depth to groundwater surface is measured using an electric water level meter. A light on the water level meter illuminates when the weighted probe tip contacts the water surface in the well and completes an electronic circuit. The measured depth to water is determined to within 0.01 ft by noting the point on the probe cable that corresponds to the measuring point (MP) at the top of the well casing at the initial point of contact. The MP should be notched at the lip of the casing, either on the high side or on the north side. This SOP describes the required equipment and the procedures used for the collection of water level data. Alternate equipment may be used if necessary, as long as the general procedures described below are followed.

EQUIPMENT REQUIRED

The following equipment is required for the collection of water level data:

- Electronic water-level indicator, or the equivalent
- Weighted steel measuring tape with decimal foot increments (if depth to the bottom of the well is to be determined)
- Distilled water in properly labeled spray bottle; other decontamination equipment as specified in SOP 001 (if necessary)
- Groundwater Level Form (Form 3) and Well Location Map (Figure 2)

PROCEDURES

The following steps are necessary to collect water level measurements:

1. Check the operation of the meter by turning on the indicator switch and pressing the test button.
2. Decontaminate the probe and graduated cable with distilled water. In the event that the probe is dirty, decontaminate the probe and cable with an Alconox® and water wash, followed by a distilled-water rinse.
3. Inspect condition of well (e.g., well locked, loose-fitting cap, measuring point well marked, surface casing disturbed, well casing straight, condition of concrete pad). Indicate condition of well on the Groundwater Level Form.
4. Holding the water level indicator above the well casing, lower the cable gradually into the well until the indicator contacts the water surface. The contact with water surface is indicated by the buzzer sounding and illumination of the indicator light. At this point, stop lowering the cable.
5. Note the point on the graduated cable that corresponds to the MP at the top of the casing when the electronic circuit is first completed. If necessary, grasp tape with thumb and index finger exactly at the measuring point marked at the top of the well casing. Pull tape out of well slowly and read measurement. If

the cable is not graduated to hundredths of feet, use the measuring tape and measure from the point on the cable that corresponds to the MP down to the first incremental marker. Add this measurement to the marker measurement for the depth to water reading.

6. Record the depth to the water surface to the nearest 0.01 ft.
7. Draw the cable about 1 ft above the surface of the water, then lower it and repeat Steps 3 through 5. If these two readings differ by more than 0.02 ft, repeat until the measured readings stabilize. Measurements should always be taken as the indicator is lowered into the well, not as it is raised.
8. Remove the cable from the well.
9. Record the measurement on Form 3 and Form 4 (when sampling the well).
10. Decontaminate the probe and graduated cable with Alconox® and tap-water wash and distilled water, as appropriate.
11. If the bottom of the well must be located (i.e., sounded), lower a weighted steel measuring tape slowly from center of borehole. Sounding the bottom of the well prior to sampling of the well is **NOT** recommended due to the potential for resuspension of settled solids in the formation.
12. When weight is felt to hit the bottom or tape slackens noticeably, draw tape up very slowly until it is taut again.
13. Note tape reading at level of casing top. Record this as well depth, to the nearest 0.01 ft.

REFERENCES AND OTHER SOURCES

ASTM. 1987. Standard test method for determining subsurface liquid levels in a borehole or monitoring well (observation well). ASTM D4758-87. American Society for Testing and Materials, Philadelphia, PA.

SOP 003

LOW FLOW MONITORING WELL PURGING AND SAMPLING

This SOP details the purging and sampling procedures to be used while sampling water from a groundwater monitoring well following the low-flow protocol.

Low-flow purging (also known as micro-purging) procedures are designed to minimize turbidity and suspended solids in samples allowing for collection of representative samples, as well as to minimize the volume of purge water. Low-flow sampling is most applicable at sites where the pump intake can be located within the screened/open interval, and a low rate of flow can be maintained without compromising sample integrity for the target analytes (usually unfiltered metals, polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and other chemicals that tend to be present as suspended solids).

EQUIPMENT REQUIRED

This SOP outlines low-flow sampling using an electric peristaltic pump (p-pump). Other types of pumps can be used for low-flow sampling, such as bladder pumps or submersibles, which would deviate from this SOP.

1. Peristaltic pump
2. Twelve-volt battery or cigarette lighter plug
3. Multi-parameter meter (calibrated) which includes measurements for:
    a) pH
    b) Specific conductivity in uS/cm, or S/m, or other as indicated.
    c) Temperature in degrees Celsius
    d) Oxygen reduction potential (ORP) in mV
    e) Dissolved oxygen (DO) in mg/L
    f) Turbidity (NTU)
4. Flow-through cell
5. Water level meter (decontaminated)
6. Disposable polyethylene tubing and silicone tubing
7. Graduated cylinder / container for determining purge flow rate and volume
8. Calibration solutions and deionized distilled water.
9. 0.45-μm in-line filter or other appropriate filtering approaches (for dissolved constituents only), if applicable
10. Sample containers, cooler(s), and ice

FORMS REQUIRED

Field forms to be used during low-flow sampling include (Appendix B):

1. Daily Quality Control Report (DQCR)
2. Groundwater Sampling Data Sheet
3. Chain of Custody Form

PROCEDURE

Water Level Measurements

1. Conduct water level measurement as per SOP 002.
   a) Do not tag bottom of well with water level meter probe, as this will tend to re-suspend solids that have accumulated in the end cap. If well depth must be measured, do so after sampling is complete.
   b) Do not conduct low-flow groundwater monitoring if free product is present unless specifically approved by Project Manager (PM) and dedicated equipment is available.
2. Record static water level on Groundwater Sampling Data Sheet.

Pump Setup

1. Make sure area around well head is clean and free of debris. If necessary, place a plastic drop cloth around well head to prevent sampling equipment from coming into contact with the ground surface.
2. Protective latex or nitrile gloves should be worn during possible water-contact or equipment-contact activities. At a minimum, gloves should be changed between each well or when introduction of potential contaminants to the sample tubing or containers is possible.
3. Determine depth of tubing intake. Ideal location of the intake should be at the middle of the screened interval. However, site specific / well specific conditions may require placement at a different interval (i.e. specific water-bearing zones, low water table, large screen intervals, etc.). For monitoring wells screened across the water table, the tubing intake should be placed at midlevel of the water column portion of the screened interval.
4. Measure and cut an appropriate length of clean polyethylene tubing and secure to the silicone tubing in the peristaltic pump head. Attach clean polyethylene tubing to the outlet side of the silicone tubing, to be connected to the flow-through cell.
5. Lower the tubing into the water column to the desired depth and secure the tubing using a clamp or other device.
6. Following tubing installation and pump setup, slowly lower water level probe until contact with the water table is achieved and secure the probe at this depth.

7. Insert the multi-parameter meter into the appropriate port of the flow-through cell.
8. Connect the pump's discharge tubing to the flow-through cell, and connect a length of tubing from the effluent end of the flow-through cell to the graduated cylinder / container.
    - An optional board-mounted flow meter may be selected to monitor water flow. However, this is not currently required under this SOP.

Purging the Well

1. Ensure the pump rate is at the lowest setting, and turn on the pump.
2. Once started, significant variations in flow rate should be avoided as these actions can result in surging.
3. Adjust the flow rate to ensure no more than 0.3 feet of drawdown occurs within the well. EPA (1996) suggests typical flow rates of less than 0.5 L/min, but can be as high as 1 L/min depending on hydrogeological characteristics. The highest flow rate (up to 0.5 L/min) without causing unacceptable drawdown should be maintained. If the water table level cannot be maintained, an alternative low-flow sampling method or grab sampling may be recommended by the PM.
4. Collect stabilization parameter measurements and document on the Groundwater Sampling Data Sheet at an appropriate time interval (every 3 to 5 minutes). Parameter measurements include: time, purge volume, water level, temperature, specific conductivity, DO, pH, ORP, and turbidity. Note that parameter units must be entered as well.
5. Stabilization has occurred at the point when the minimum stability criteria have been met for three consecutive measurements. The stability criteria for each parameter are included on the Groundwater Sampling Data Sheet. Once stabilization has occurred in the selected parameters, sampling may begin. Should individual parameters not stabilize after a reasonable amount of purging (two to three well volumes), contact the PM to determine an appropriate solution. DO NOT STOP PURGING THE WELL UNTIL A SAMPLE HAS BEEN COLLECTED.
6. The multi-parameter meter should be calibrated daily in accordance with the manufacture's instruction.

Collecting the Groundwater Sample

1. Disconnect the flow-through cell before sample collection.
2. Collect samples at the same flow rate as the purge rate. Do not stop purging the well until the entire sample has been collected. If necessary, flow rate can be slowed at the end of sampling to ease volatile sample collection.
3. Label and handle samples as per the work plan and this SOP. If a filtered sample is required, collect after all other sampling is completed. In general, groundwater

samples collected for multiple compounds should be collected in the following order (U.S. EPA 1992):

- VOCs
- SVOCs
- Other Organics
- Metals and cyanide
- Major water quality cations and anions

4. When collecting samples for VOCs, direct flow from the pump discharge or bailer down the side of the sample container to minimize aeration. Hold caps in hand to minimize contamination of sample. Fill all VOC sample containers to the top. A positive meniscus at the top of the container will help ensure that no air is trapped inside when cap is screwed down on the container. No air bubbles should be trapped in the sample when the container is sealed.

5. Filtered and unfiltered groundwater samples containing inorganic analytes will be submitted for laboratory analysis. If applicable, attach a new, disposable filter cartridge (typically 0.45 µ) to the discharge line. Filtered water should be introduced directly into the appropriate sample container. Although not recommended, the laboratory can filter the samples if the samples are NOT preserved and are filtered within 24–48 hours of collection.

6. Collect quality assurance and quality control (QA/QC) samples (i.e., duplicate, equipment rinsate, trip blank, laboratory matrix spike, and laboratory matrix spike duplicate, as applicable) at the same time by filling all bottles from the same flow. The number and types of QA/QC samples are specified in the work plan.

7. Sample bottles must be labeled with date, sample number, time, sampler's name, and type of preservative, as described in the work plan. Sample bottles must be placed in a cooler or on ice to keep the sample cool (4°C). Samples must be cooled continuously from time of collection to time of receipt at the laboratory, as described in the work plan and this SOP.

8. Remove pump or tubing from the well. Close and lock the well. Decontaminate all reusable equipment as per SOP 001. Purge, decontamination water should be managed as specified in the work plan.

9. Collect a final water level reading after sample collection.

10. Complete chain-of-custody form, package samples for shipment, and ship samples or arrange for courier to laboratory.

11. All field observations made and data generated in conjunction with the sample collection will be documented on the Groundwater Sampling Data Sheet.

SPECIAL CONSIDERATIONS

Keep in mind the primary purpose of the low-flow sampling method is to collect more representative samples in environments where artificially suspended solids can have a significant adverse effect on sample quality. Thus efforts should be made in all cases to minimize actions that could suspend or mobilize particles in the well and aquifer. Actions to avoid include dropping or lowering equipment into the water column too quickly, lowering any equipment to the bottom of the well, surging the well, excessive drawdown, irregular or high pumping rates (i.e. greater than 2 liters/minute), or shutdown of the pump during purging or sampling.

REFERENCES

ASTM Designation: D 6771-02. Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations. March 2002

US EPA (1996). Low Flow (Minimal Drawdown) Ground-Water Sampling Procedures. EPA/540/S-95/504. April 1996

STANDARD OPERATING PROCEDURE

FOR FIELD DOCUMENTATION (SOP 004)

URS Corporation

SOP 004
FIELD DOCUMENTATION

All information relevant to field operations must be properly documented to ensure that activities are accounted for and can be reconstructed from written records. Field documentation should include only a factual description of site-related activities. Field personnel should not include superfluous comments or speculation regarding the field activities. The Daily Quality Control Reports (DQCR) may be used for this purpose and should be consistently used by field crews.

The information recorded in each DQCR should be written in indelible ink. All corrections should consist of a single line-out deletion, followed by the author's initials and the date. DQCRs will be photocopied after each period in the field, and photocopies will be stored in the project files. After field activities are completed, DQCRs will be stored in the permanent project file.

DAILY QUALITY CONTROL REPORTS

The purpose of the DQCRs are to document events that occur and record data measured in the field to the extent that someone not present at the site can reconstruct the activity without relying on the memory of the field crew. Each page of the reports will be initialed and dated by all persons making entries. The author will sign and date the last page at the end of each day, and a line will be drawn through the remainder of the page. The DQCRs, at a minimum, must contain the following information:

1. Project name, location, and number.
2. Rationale for collecting the sample.
3. Date and time of sampling.
4. Sample numbers.
5. Cross-references of numbers for duplicate samples, if applicable.
6. Media sampled.
7. Geographical location of the sampling point in reference to site facilities.
8. Physical location of the sampling point, such as depth below ground surface (bgs).
9. Method of sampling, including procedures, equipment, and any departure from the procedures specified in this Sampling and Analysis Plan or SOPs.
10. Results of field measurements (e.g., PID readings), unless provided in other logs/forms.
11. Sample preservation.

12. Photographic information, if applicable. Briefly describe what was photographed and why, the date and time, the compass direction of the picture, number of the frame on the roll, and roll number.
13. Sketches, when appropriate, with reference points tied to existing structures in the area (i.e., trees, roads).
14. Analyses requested.
15. Other pertinent observations, such as the presence of other persons on the site (those associated with the job or members of the press, special interest groups, or passersby), and actions by others that may affect performance of site tasks.
16. Name(s) of sampling personnel.
17. A purpose and description of the field task.
18. The time and date the field work began.
19. The location and description of the work area, including sketches, map references, and photograph log, if appropriate.
20. The names and titles of field personnel and anyone present during the field work, including the times they are present.
21. The name, agency, and telephone number of any field contacts.
22. The meteorological conditions at the beginning of the field work and any changes that occur throughout the day, including the approximate time of the change.
23. Details of the field work performed, with a description of any deviations from the work plan, sampling and analysis plan, or SOPs.
24. All field measurements made (unless a specific sampling form [i.e., groundwater sampling form] is available for this purpose), including the time of measurement.
25. DQCRs should include only a factual description of site-related activities. Field personnel should not include superfluous comments, speculation, or other non-factual observations regarding the field activities.

SAMPLE COLLECTION FIELD FORMS

Appropriate sample collection field forms will be used to record the relevant sample information during a sampling event. During excavation activities, soil samples will be recorded on the Soil Sample Log Form. During groundwater sampling, data will be recorded on the Groundwater Level Form and Groundwater Sampling Data Sheet. These field forms are included in Appendix B.

SAMPLE LABELS

To provide a sample tracking mechanism, each sample collected will be given a sample identification number using the numbering system described in the work plan.

Sample labels (tags) are designed to uniquely identify each sample, and must be affixed to each sample container used. The labels should be filled out at the time the samples are collected and should consist of the following information:

1. Sample number
2. Site name
3. Date and time sample is collected
4. Initials of the samplers
5. Preservatives used, if any
6. Type of analysis (e.g., EPA Method 8260B).

PHOTOGRAPHS

In certain instances, photographs of sampling stations may be taken using a camera-lens system with a perspective similar to the naked eye. Photographs should include a measured scale in the picture, when practical. The following items should be recorded in the field logbook for each photograph taken:

1. The photographer's name, the date, the time of the photograph, and the general direction faced (orientation)
2. A brief description of the subject and the field work portrayed in the picture
3. The sequential number of the photograph and the roll number on which it is contained
4. If digital photographs are collected for internal use or presentation purposes, the file name, date, file location, description, orientation, and photograph should be recorded.

The slides, prints, or disks (as appropriate) and associated negatives will be placed in the project files after the film is developed, or files uploaded. (Any supporting documentation from the field logbooks will be photocopied and placed in the task files to accompany the slides, prints, or disks.

EQUIPMENT CALIBRATION RECORDS

Equipment calibration records, including instrument type and serial number, calibration supplies used, calibration methods and calibration results, date, time, and personnel performing the calibration, should be recorded in the DQCR. At a minimum, equipment used during the investigation should be calibrated daily in accordance with the manufacturers' recommendations.

STANDARD OPERATING PROCEDURE

FOR SAMPLE CUSTODY (SOP 005)

URS Corporation

SOP 005

SAMPLE CUSTODY

A stringent, established program of sample chain-of-custody will be followed during sample storage and shipping activities to account for each sample. The procedure outlined herein will be used in conjunction with SOP 004, which covers the use of Daily Quality Control Reports, and SOP 006, which covers sample packaging and shipping. Chain-of-custody record/sample analysis request forms (Appendix B) ensure that samples are traceable from the time of collection through processing and analysis until final disposition. A sample is considered to be in a person's custody if any of the following criteria are met:

1. The sample is in the person's possession
2. The sample is in the person's view after being in possession
3. The sample is in the person's possession and is being transferred to a designated secure area
4. The sample has been locked up to prevent tampering after it was in the person's possession.

PROCEDURE

The chain-of-custody record portion of the form is the most critical because it documents sample possession from the time of collection through the final disposition of the sample. The sample analysis request portion of the form provides information to the laboratory regarding what analyses are to be performed on the samples that are shipped.

The chain-of-custody record/sample analysis request form will be completed after each field collection activity and before the samples are shipped to the laboratory. Sampling personnel are responsible for the care and custody of the samples until they are shipped. When transferring possession of the samples, the individuals relinquishing and receiving the samples must sign the chain-of-custody record/sample analysis request form(s), indicating the time and date that the transfer occurs. Copies of the forms will be made and kept by the sampler, and the originals will be included with the samples in the transfer container. The following guidelines will be followed to ensure consistent shipping procedures and to maintain the integrity of the samples:

1. Each chain-of-custody record/sample analysis request form must be appropriately signed and dated by the sampling personnel. The person who relinquishes custody of the samples must also sign this form.
2. The chain-of-custody record/sample analysis request form should not be signed until the information has been checked for inaccuracies by the lead sampler. All changes should be made by drawing a single line through the incorrect entry and initialing and dating it. Revised entries should be made in the space below the entries. On the handwritten chain-of-custody record/sample analysis request forms, spaces remaining at the bottom of the

page after corrections are made should be marked out with single lines. This procedure will preclude any unauthorized additions.

3. At the bottom of each chain-of-custody record/sample analysis request form is a space for the signatures of the persons relinquishing and receiving the samples and the time and date that the transfer occurred. The time that the samples were relinquished should match exactly the time they were received by another party. Under no circumstances should there be any time when custody of the samples is undocumented.

4. If samples are sent by a commercial carrier not affiliated with the laboratory, such as Federal Express or UPS, the name of the carrier and airbill should be recorded on the chain-of-custody record/sample analysis request form. The time of transfer should be as close to the actual drop-off time as possible. After the chain-of-custody record/sample analysis request forms are signed and copied, they should be sealed inside the transfer container.

5. If errors are found after the shipment has left the custody of sampling personnel, a corrected version of the forms must be prepared and sent to all relevant parties. Minor errors can be rectified by making the change on a copy of the original with a brief explanation and signature. Errors in the signature block may require a letter of explanation.

6. Samples that are archived internally should be accompanied by a chain-of-custody record/sample analysis request form. While samples remain in the sampler’s custody before being shipped, all containers will be kept in sight of sampling personnel or in a secured area to preclude tampering with the samples.

STANDARD OPERATING PROCEDURE

FOR SAMPLE PACKAGING AND SHIPPING (SOP 006)

URS Corporation

SOP 006
SAMPLE PACKAGING AND SHIPPING

Specific requirements for sample packaging and shipping must be followed to ensure the proper transfer and documentation of environmental samples collected during field operations. Procedures for the careful and consistent transfer of samples from the field to the laboratory are outlined herein.

EQUIPMENT REQUIRED

Specific equipment or supplies necessary to properly pack and ship environmental samples include the following:

- Ice in sealed bags or Blue Ice®
- Sealable airtight bags
- Plastic garbage bags
- Coolers
- Bubble wrap
- Fiber reinforced packing tape
- Scissors
- Chain-of-custody seals
- Airbills for overnight shipment
- Chain-of-custody record/sample analysis request forms.

PROCEDURE

The following steps should be followed to ensure the proper transfer of samples from the field to the laboratories:

1. Appropriately document all samples on the chain-of-custody (COC) (SOP 005).
2. Make sure all applicable laboratory quality control sample designations have been made on the chain-of-custody. Samples that will be archived for future possible analysis should be clearly identified on the chain-of-custody record/sample analysis request form and should also be labeled as “Do Not Analyze: Hold and archive for possible future analysis” as some laboratories interpret “archive” to mean continue holding the residual sample after analysis.
3. Notify the laboratory contact and the project QA/QC coordinator that samples will be shipped and the estimated arrival time. Send copies of all chain-of-

custody record/sample analysis request forms to the QA/QC coordinator or project manager, as appropriate.

4. Samples will be placed in secure onsite storage or remain in the possession of the sampling personnel prior to shipment. Any temporary sample storage areas will be locked and secured to maintain sample integrity and chain-of-custody requirements.

5. Clean the outside of all dirty sample containers to remove any residual material that may lead to cross-contamination.

6. Retain the back copy of the COC for the project records prior to sealing the cooler. Store the signed chain-of-custody record/sample analysis request forms in a sealable bag and tape them to the inside of the cooler lid. For a shipment containing multiple coolers, indicate on the outside of this cooler "Chain-of-Custody Inside."

7. Check sample containers against the chain-of-custody record/sample analysis request form to ensure all samples intended for shipment are accounted for.

8. Store each sample container in a sealable bag that allows the sample label to be read. Volatile organic analyte (VOA) vials for a single sample must be encased in bubble wrap before being sealed in bags.

9. Choose the appropriate size cooler (or coolers) and line with bubble wrap.

10. Fill the cooler with the samples, separating glass containers with bubble wrap and allowing room for ice to keep the samples cold. Ice should be enclosed in sealable plastic bags to prevent leakage. Avoid separating the samples from the ice with excess bubble wrap because it will insulate the containers from the ice. After all samples and ice have been added to the cooler, use bubble wrap to fill any empty space to keep the samples from shifting during transport.

11. If possible, consolidate all VOA samples in a single cooler, and ship them with (a) trip blank(s) in accordance with the QA/QC plan.

12. After the cooler is sufficiently packed to prevent shifting of the containers, close the lid and seal it shut with fiber-reinforced packing tape. If the cooler has a drain at the bottom, it should be taped shut in the same manner.

13. As security against unauthorized handling of the samples, apply one or two chain-of-custody seals across the opening of the cooler lid. Be sure the seals are properly affixed to the cooler so they are not removed during shipment.

14. Label the cooler with destination and return addresses, and add other appropriate stickers, such as "This End Up," "Fragile," and "Handle With Care."

15. If an overnight courier is used, fill out the airbill as required and fasten it to the top of the cooler. The identification number sticker should be taped to the lid, because tracking problems can occur if a sticker is removed during shipment.

STANDARD OPERATING PROCEDURE 007
BOREHOLE LOGGING AND SAMPLING

1.0 SUMMARY

This procedure describes the methods for geological borehole logging. The boring log is the basic record for subsurface drilling activities. It is important that a detailed record of all aspects of subsurface exploration be maintained.

2.0 PROCEDURE

2.1 Introduction

A major portion of the work produced at an environmental site is concerned with characterizing the physical subsurface and the geologic and hydrologic processes operating at the site. A properly prepared borehole log serves as an essential tool in making these assessments and correlations. This standard operating procedure (SOP) defines the methodology of collecting pertinent data so that all borehole logs made at a site can create a consistent, uniform database from which interpretive conclusions can be made with confidence. Large-scale inferences such as vertical and horizontal extent of strata, facies changes, attitude of bedding or layering, structural features (faults, folds, fractures, dikes, etc.), location of the water table, lithologic characterizations, and the extent of subsurface contamination are made from small-scale observations recorded on the borehole log. These observations include bedding, grain size, degree of sorting, shape of grains, color, hardness, organic vapor levels, and other observable physical characteristics including visible evidence of contamination.

Logging should document both general and specific lithologic information about the borehole. In all cases, the lithologic log should be identified by the specific site number, well/boring number, drilling method, location, date of drilling, individual logger (geologist), drilling contractor, significant organic vapor reading, visible evidence of contamination, depth to water first encountered, final depth of water level, well/boring elevation (if data are available), total depth in feet, graphic log, and lithologic description. An example of a completed borehole log is provided as Exhibit 1.

Lithologic descriptions will be made using the Unified Soil Classification System (USCS), according to ASTM Methods D2487 and D4288.

Lithologic descriptions of unconsolidated material should contain the following characteristics when possible:

- Soil or formation name
- Gradation (degree of sorting)
- Principal constituent

- Specific descriptors for principal constituents (e.g., plasticity, grain size, and shape)
- Firmness/hardness
- Minor constituents
- Moisture content
- Color
- Particle morphology
- Other descriptors (e.g., visible evidence of contamination, specific on-site monitoring equipment readings)
- Particle size distribution

2.2 Classification System

The following sections describe in detail the parameters and descriptive terminology that should be used to classify each sample for the borehole log.

2.2.1 Soil or Formation Name

The soil or formation name will include the major constituent(s) and may be preceded by a single-word modifier indicating the subordinate constituent. Percentages of each constituent should be used to classify the material without actually recording constituent percentage.

2.2.2 Gradation (Degree of Sorting)

Size sorting describes the extent to which grain size is uniform. The comparison chart listed in Exhibit 1, Comparison Chart for Estimating Degree of Sorting, should be used to describe soils being logged from a borehole.

2.2.3 Principal Constituent

Principal constituents recorded during borehole logging include an identification of the following unconsolidated material types:

- Clay
- Sand
- Cobbles
- Silt
- Gravel
- Boulders

If known, an identification of the potential source of the material should be made (e.g., alluvium, colluvium, artificial fill, or residual material).

2.2.4 Principal Constituent Descriptors

Additional descriptors for the principal material constituents may be added to the log to further delineate or accurately record subtle changes in the lithologic structure. Modifiers such as grain size, shape, and plasticity of materials (e.g., high, medium, and low plasticity) may also be added.

2.2.5 Consistency/Density/Rock Hardness

The characteristics of unconsolidated material may be determined by the Standard Penetration Test (SPT) in accordance will ASTM Method D1586-99. The SPT involves driving a split-spoon sampler into the material by dropping a 140–pound weight from a height of 30 inches. The resistance of the material is reported in the number of blows of the weight required to drive the spoon 1 foot and translates into the descriptors listed in Table 1. The results of such SPT tests should be recorded in the field notes and/or boring log.

Table 1

Determination of Characteristics of Unconsolidated Material

Number of Blows/Foot	Description of Cohesive Consistency or Hardness
Clay	
0-2	Very soft
2-4	Soft
4-8	Medium
8-15	Stiff
15-30	Very stiff
30+	Hard

Number of Blows/Foot	Description of Cohesive Consistency or Hardness
Gravel	
0-4	Very loose
4-10	Loose
10-30	Medium dense
30-50	Dense
50+	Very dense
Rock	
<20	Weathered
20-30	Firm
30-50	Medium hard
50-80	Hard
80+	Very hard

Source: ASTM D1586-99

2.2.6 Minor Constituents

Constituents not previously described in the principal constituent description may be described as a percentage or by weight. Typically, modifiers for minor constituents conform to the following standards:

- Use no modifier when the constituent is less than 5 percent.
- Use *slightly* when the constituent is 5 to 12 percent.
- Use *moderately* (and add *y* or *ey* [e.g., *moderately* silt*y* clay]) when the constituent is 13 to 40 percent.
- Use *very* when the constituent is 41 to 50 percent.

2.2.7 Moisture Content

A wide range of terms (from *dry* to *saturated)* are used to describe the relative moisture content of a field soil sample. These terms are described as follows:

- Dry – The sample is completely without moisture. Dry, silty sands, for example, will produce suspended particles when dropped by hand.

- Damp – The sample contains a very slight amount of water.

- Moist – Soils in this range are near the maximum water content for their maximum compactibility or density. Moist soils will form a ball when compressed in the hand.

- Wet – Soil samples are wet enough to produce free water upon shaking but still contain unoccupied air voids. Fine-grained soils close to the liquid limit would be termed wet.

- Saturated – Soils have zero air voids. Samples placed in sample jars or bags will probably have standing water after a short period of time.

2.2.8 Color

The color of soil and associated materials should be recorded on the borehole log. Color descriptors should include but are not limited to the following: black, gray-black, brown, olive, mottled, streaked, etc. Color charts should be used to provide general logging guidance but specific use is not necessary for adequately described lithology.

2.2.9 Particle Morphology

The key elements of particle morphology are roundness and sphericity. Roundness is a measure of the curvature of grain corners. Sphericity is a measure of how equal the three axial lengths (x, y, z) of an object are. Determination of both properties is facilitated by the use of a hand lens. Grain roundness and sphericity should be estimated by using the Comparison Chart for Estimating Roundness and Sphericity, Exhibit 2.

2.2.10 Other Descriptors

Field-screening data collected during the drilling process may help further characterize site conditions during subsurface investigations. Readings from on-site monitoring equipment such as photoionization detectors, organic vapor analyzers, and oxygen/explosimeters should be recorded at each sample interval. Other useful information includes the organic content and the presence or absence of waste material in samples.

2.2.11 Particle Size Distribution

An estimate of particle sorting by grain size is often useful for borehole logging purposes. Precise estimates of percent composition of the sample are not necessary. Exhibit 3,Comparison Chart for Estimating Percentage Composition, can be used to estimate the percentage of various grain sizes present in a sample. However, visual estimates usually provide sufficient information for characterizing site lithology.

2.3 Borehole Logs

Field staff should record data collected during exploratory soil boring and subsurface sampling operations in the field logbook and/or on a borehole log form.

Geological correlation and aquifer properties prediction are dependent on good descriptions of exploratory boring samples. Rotary drilling with fluids is generally unacceptable since the drilling fluids may potentially contaminate the aquifer under investigation. High-quality borehole data are generally acquired with a split-spoon or pitcher core barrel. This method of sampling provides detailed logging. The lithofacies interpreted from cuttings logs may lack the accuracy necessary for detailed correlation. Where possible, techniques such as geophysical borehole logging can be used to supplement cuttings descriptions. Field staff should note on the log any geologic description determined from borehole cuttings.

In bedrock formations, cuttings may be acquired from a reverse circulation, air rotary boring or from a dual-wall rotary boring. These cuttings do not provide information on the *in situ* properties of the materials, but do provide adequate sample description information.

In summary, close sample spacing or continuous sampling in a boring provides the best material for descriptive geology. Field staff should use traditional geological terminology and supplement with the USCS descriptive system when appropriate. Staff should provide sufficient data on layering and other sedimentary structures and undisturbed textures. Sample numbers, depths, and analytes should be included in each description.

2.4 Review

Field staff conducting borehole logging of soil should record field data on a borehole log, and record a chronological summary in the field logbook or daily report. The applicable methods outlined in this procedure shall be used to record the data on this log. The personnel conducting these operations will sign and date the “logged by” and “date” blanks on the borehole log form.

The Site Manager or designee should check all field-generated data and the borehole log for completeness and accuracy. Any discrepancies should be noted and the logs returned to the originator for correction. The reviewer should acknowledge that corrections have been incorporated by signing and dating the “reviewed by” and “date” blanks on the borehole log.

3.0 REFERENCES

American Geological Institute (AGI). 1982. *AGI Data Sheets.* Falls Church, Virginia.

American Society for Testing and Materials (ASTM). 1999. *D1586-99 Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.*

ASTM Method D2487. *Standard Recommended Practice for Classification of Soils for Engineering Purposes.*

ASTM Method D2488. *Standard Recommended Practice for Description of Soils (Visual-Manual Procedure).*

Compton, R.R. 1962. *Manual of Field Geology.* John Wiley and Sons, Inc., New York, New York.

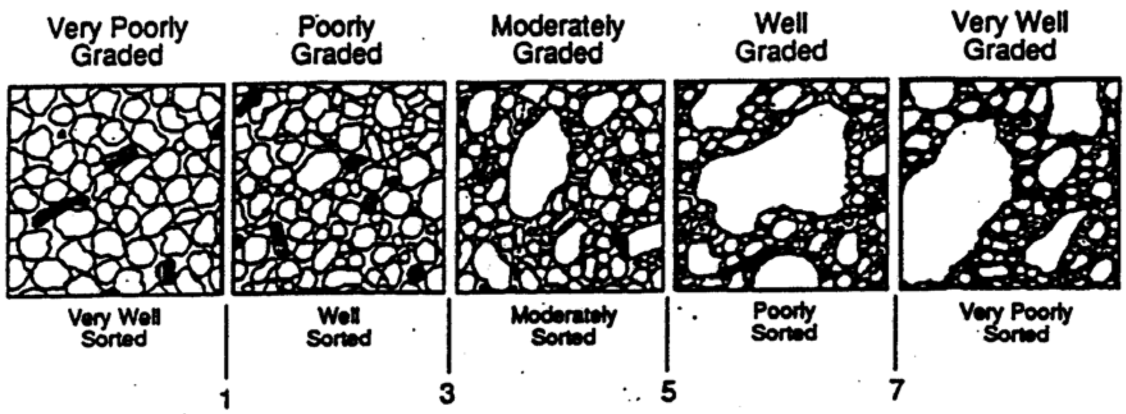
4.0 ATTACHMENTS

Exhibit 1 Comparison Chart for Estimating Degree of Sorting

Exhibit 2 Comparison Chart for Estimating Roundness and Sphericity

Exhibit 3 Comparison Chart for Estimating Percentage Composition

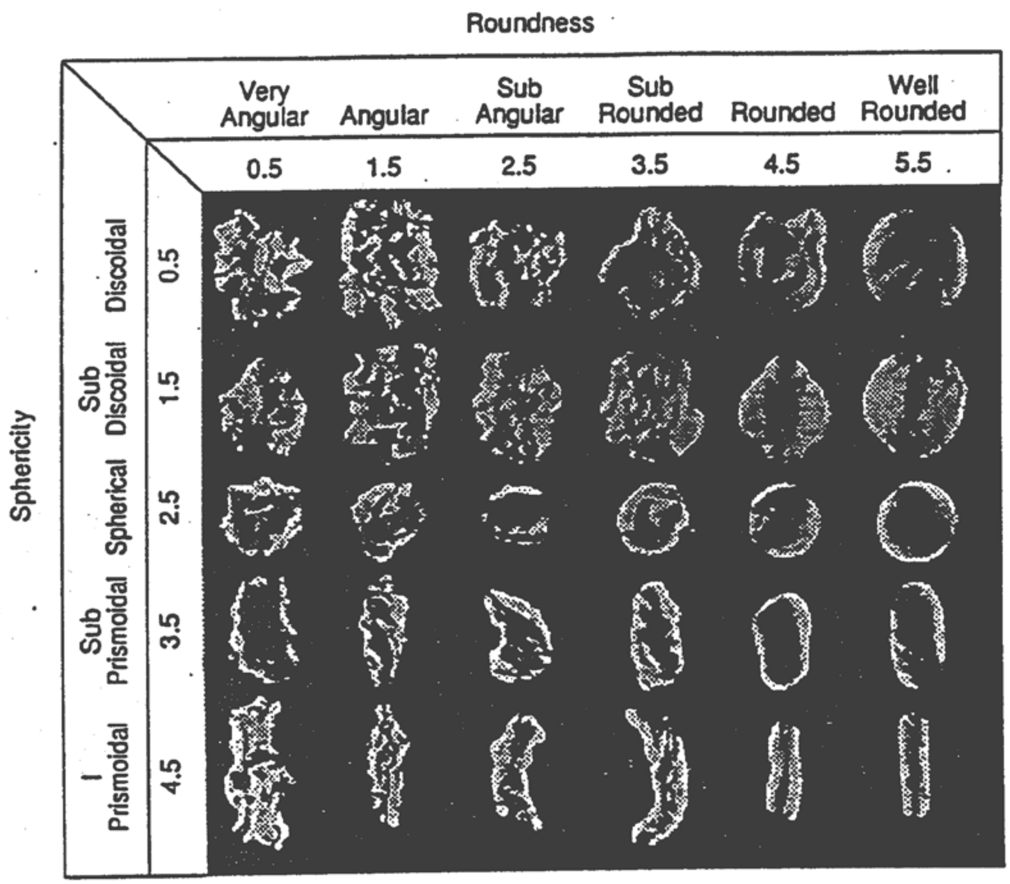
Exhibit 1
Comparison Chart for Estimating Degree of Sorting



Terms for degrees of sorting. The numbers indicate the number of size-classes included by the bulk (80 percent) of the material. The drawings represent sandstones as seen with a hand lens. Silt and clay-size materials are shown diagrammatically by the fine stipple.

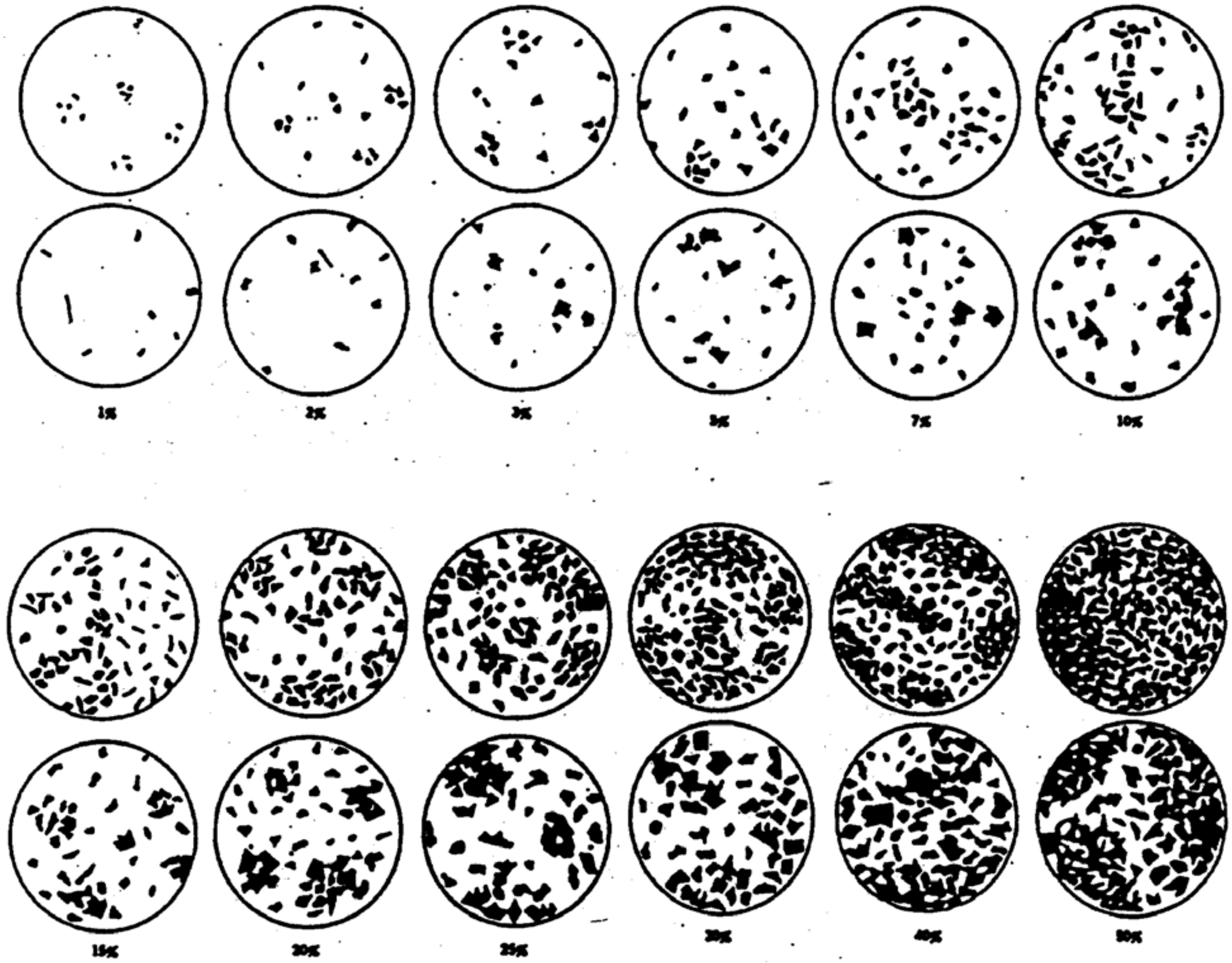
Reference: Compton, R.R. 1962. *Manual of Geology.* John Wiley & Sons, Inc. New York, N p. 214

Exhibit 2
Comparison Chart for Estimating Roundness and Sphericity



Reference:American Geological Institute. 1982. "AGI Data Sheet 18.1" in *AGI Data Sheets*. Fall Church, VA

Exhibit 3
Comparison Chart for Estimating Percentage Composition



Reference: Compton, R.R. 1962. *Manual of Geology*. John Wiley & Sons, Inc. New York, NY p. 332-333

STANDARD OPERATING PROCEDURE 008
SURFACE AND SUBSURFACE SOIL SAMPLING

1.0 SUMMARY

This procedure describes the protocols for collecting a surface or subsurface soil sample. The procedure will provide descriptions of equipment, field procedures, and documentation necessary to collect representative surface and subsurface soil samples.

2.0 SURFACE SOIL SAMPLING EQUIPMENT

Equipment and materials that may be used to collect surface soil samples include:

- Stainless steel spoon, trowel, knife, spatula
- Stainless steel bowl
- Personal protective equipment (PPE) as required by the site safety and health plan (SSHP)
- Decontamination equipment as required
- Aluminum foil
- Paper towels
- Laboratory supplied sample jars
- Packing tape
- Cooler and blue ice or ice
- Zipper-locking plastic bags (if ice is used)
- Stakes for marking sampling location
- Field forms such as chain of custody, sample collection log, air monitoring log, other necessary health and safety documentation
- Field logbook
- Appropriate health and safety equipment as required by the SSHP

3.0 SUBSURFACE SOIL SAMPLING EQUIPMENT

Equipment and materials used during the collection of subsurface soil samples include:

- Drill rig, hollow-stem auger, mud rotary, sonic, or direct-push sampling device
- Sampling device (split-barrel sampler, split-spoon sampler, modified California sampler, thin-wall tub sampler, Shelby tube continuous core sampler)
- Stainless steel spoons, trowels, putty knife

- Stainless steel bowl(s)
- Measuring tape
- Sample jars, plastic bags with labels, and marking pens
- Laboratory sample jars
- Plastic sheeting
- Decontamination equipment
- Health and safety equipment and personal protective equipment (PPE)
- Field logbook or daily report and writing instruments
- Boring log forms

4.0 GENERAL

Homogenizing is the mixing of a sample to provide a uniform distribution of the contaminants. Proper homogenization ensures that the containerized samples are representative of the total soil sample collected. All samples to be composited or split should be homogenized after all aliquots have been combined. DO NOT HOMOGENIZE (MIX OR STIR) SAMPLES FOR VOLATILE COMPOUND ANALYSIS.

Compositing is the process of physically combining and homogenizing several individual soil aliquot of the same volume or weight. Compositing samples provides an average concentration of contaminants over a certain number of sampling points.

Splitting samples (after preparation) is performed when multiple portions of the same samples are required to be analyzed separately. Fill the sample containers for the same analyses one after another in a consistent manner (i.e., fill the first lab's container, then fill the second lab's container; then go on to the next analysis and fill the first lab's container and then the second lab's container).

4.1 VOC Sample Collection using EPA Method 5035A

1. VOC samples should be collected immediately after the soil is brought to the surface using a syringe-type collection device as stipulated by EPA Method 5035A.

2. Push the syringe sampler into the freshly exposed soil until the sample chamber is filled. The sample chamber when filled should deliver approximately 5g of soil.

3. Wipe all soil or debris from outside of sampler, making sure the soil plug is flush with the mouth of the sampler. Remove any excess soil that extends beyond the mouth of the sampler.

4. Place the mouth of the sampler into the laboratory provided sampling container, extrude the sample and quickly place the lid on the vial. When capping the vial be sure to remove any soil or debris from the vial threads.

5. Repeat steps 2 through 4 to fill each of the sample containers (one preserved with methanol and the other two with sodium bicarbonate).

4.2 Soil Sample Compositing

If a representative sample is desired over a depth interval or several samples are to be taken to represent an area, composite the samples as follows:

1. As each sample is collected, place the soil in a decontaminated stainless steel bowl.
2. After all samples from each hole or area are collected in the bowl, stir the sample thoroughly with a decontaminated stainless steel trowel or spatula.
3. For organics analyses, a sheet of aluminum foil may be used instead of a stainless steel bowl.

5.0 SURFACE SOIL

5.1 Surface Soil Sample Collection

The soil samples will be collected from the top six inches (or other interval as indicated) of native soil (below any leaf litter, twigs, or other detritus) using a decontaminated stainless steel scoop. The following steps describe the procedures used to collect surface soil samples:

1. Decontaminate sampling equipment.

2. Clear and remove vegetation and any surface debris such as rocks using a decontaminated trowel.
3. Don a clean pair of powderless nitrile gloves and the appropriate level of protection as specified in the SSHP.
4. Collect the sample from the top interval (as specified) of native soil using a decontaminated stainless steel scoop/trowel.
5. Homogenize the sample in a decontaminated stainless steel bowl (Section 4.2) and fill the remainder of the prelabeled lab jars for sample analysis.
6. Replace the vegetative mat over the disturbed area.
7. Pack and preserve samples.

8. Record observations in the field logbook. Describe the homogenized soil following the Unified Soil Classification System (USCS) in accordance with SOP 2.1 Record applicable information on the sampling and chain-of-custody forms.
9. Record the sampling location on a site map.
10. Discard any unused soil (see the SOP on Investigation-Derived Waste Containerization for proper storage and disposal procedures).
11. Decontaminate sampling device for collection of next sample.

5.2 Surface Soil Sampling Documentation

Documentation of observations and data acquired in the field will provide information on the proper acquisition of samples and also provide a permanent record. These observations and data will be recorded with indelible ink in a bound weatherproof field logbook with consecutively numbered pages, and/or on the surface soil sampling form. Notes will be recorded daily when in the field. At a minimum, the surface soil sampling information in the field logbook will include the following:

- Project number/name
- Date
- Weather
- Personnel on site (samplers' names)
- Sample location
- Sample number and depth
- Time sample is collected
- Laboratory sample number and analytical parameters
- Air monitoring readings taken during sample collection
- Decontamination procedures
- PPE level
- Presence of free product or unusual observations
- Sample description the Unified Soil Classification System (USCS) in accordance with SOP 2.1.

6.0 SUBSURFACE SOIL

Please note: You may need a permit or other form of approval from regulatory agencies overseeing your site before you begin any drilling operations, especially if you are working in a wetland or other sensitive area or are installing wells. Always check with utility companies to verify the locations of underground materials before beginning drilling operations.

Subsurface soil samples can be collected using one of several different sampling methods described in this section.

6.1 Collection of Subsurface Soil Samples during Drilling Operations

The following procedures should be followed when collecting a subsurface soil sample during drilling operations:

1. Decontaminate all equipment including drill rig and all associated equipment, sampling devices, and stainless steel spoons/trowels. Place equipment on clean, plastic sheeting until it is needed.
2. Clear sampling location of all objects and utilities. Stake out sampling location.
3. Inspect, clean, and put on appropriate PPE.
4. Advance boring using selected drilling method.
5. Retrieve sample using selected sampling device.
6. Upon opening sampler or extruding sample, immediately screen soil for VOCs using either a photoionization detector or a flame ionization detector.
7. Observe the soil, measure and record the following: (1) the amount of soil recovered in the sampler, (2) the presence of any free product, (3) any unusual odors, and (4) any stratigraphic changes. Begin to form a description before disturbing the soil.
8. All sample jars should be prelabeled with appropriate information including project number, date, boring and sample number, and depth.
9. Collect a sample using a decontaminated stainless steel spoon or trowel. If sampling for VOCs, use a syringe-type collection device as stipulated by EPA Method 5035A (see Section 4.1 above) to place soil directly into the labeled laboratory provided sample containers. Next, place the remaining soil in a stainless steel bowl and collect a homogeneous sample to be analyzed for other parameters. After the laboratory samples are collected, fill a separate sample jar or plastic bag to be used for soil classification. If there is a change in the stratigraphy, set aside some soil from each and place into jars to be used for the soil classification. If the amount of soil is not sufficient, collect another sample immediately below the prior sample interval and homogenize the two samples prior to filling laboratory sample jars.
10. Place sample jars for laboratory analysis into a cooler, being careful that they remain upright, and preserve with ice.
11. If collecting samples using Shelby Tubes (ASTM D1587), seal the ends, being careful not to disturb the sample.
12. Fill in a detailed description of the soil(s) on a boring log form as described in the SOP for borehole logging and sampling.

13. Take notes in field logbook or daily report. Record applicable information on the chain-of-custody forms.
14. Discard any unused soil. See the SOP on Investigation-Derived Waste Containerization for proper storage and disposal procedures.
15. Decontaminate sampling device for collection of next sample.

6.2 Procedure for Subsurface Soil Sample Collection by Hand Auger

1. Decontaminate all equipment including sampling devices, and stainless steel spoons/trowels. Place equipment on clean, plastic sheeting until it is needed.
2. Clear vegetation and surface debris from a predetermined sample location.
3. Advance auger in 6 or 12 inch intervals.
4. Retrieve and extrude on plastic sheeting.
5. Log the description of the soil sample and fill out a boring log form.
6. Compositing based on sample depth can be performed if required. Compositing is previously described in Section 5.2.
7. Record observations in the field logbook, following the guidelines provided in the SOP for borehole logging and sampling. Record applicable information on the applicable sampling and chain-of-custody forms.
8. Place soil back in hole and replace the vegetative mat over the disturbed area.
9. Decontaminate the sampling device between each sampling location.

6.3 Procedure for Subsurface Soil Sample Collection by Excavator

Due to the rocky nature of the soils, hand augering may not be possible; an alternative is to collect samples using a small track-mounted excavator.

The following procedures should be followed when collecting a subsurface soil sample using an excavator:

1. Clear vegetation and surface debris from a predetermined sample location.
2. The excavator will then be carefully positioned to collect a sample at each of the four corners of the cleared area (approaching the area from the perimeter). An intact scoop of soil extending from 0 to 3 ft bgs will be collected in the excavator bucket and the bucket will be placed on the ground.
3. If applicable, VOC samples will be collected immediately after the subsurface soil

is brought to the surface using a syringe-type collection device as stipulated by EPA Method 5035A (see Section 4.1 above).

4. After VOC collection (if applicable) the field geologist can then collect the remaining samples from the intact soil volume within the excavator, taking care to avoid any soils in contact with the excavator bucket.

5. Compositing based on sample depth can be performed if required. Compositing is previously described in Section 5.2.

6. Observe the soil and measure and record (1) the amount of soil recovered in the sampler, (2) the presence of any free product, (3) any unusual odors, and (4) any stratigraphic changes. Describe the soil following the Unified Soil Clasification System (USCS) in accordance with SOP 2.1.

7. Label all sample containers with appropriate information including project number, date and sample number.

8. Replace excess soil back into original hole using excavator.

9. Decontaminate sampling device for collection of next sample.

6.4 Procedures for Subsurface Soil Sample Collection Using Direct-Push (Geoprobe®) Technology

There are several different types of direct-push technology. Some direct-push sampling devices may not be able to collect a soil sample from greater than 20 feet below ground surface.

The following procedures should be followed when collecting a subsurface soil using direct-push technology.

1. Decontaminate all equipment including sampling devices, and stainless steel spoons and trowels. Place equipment on clean plastic sheeting until it is needed.
2. Clear sampling location of all objects and utilities. Stake out sampling location.
3. Inspect, clean, and put on appropriate PPE.
4. Instruct subcontractor to set up truck-mounted equipment at a sampling location.
5. Remove any pavement and gravel bed using a cement-coring device mounted on the truck.
6. Inform subcontractor of the depth of sample collection.
7. Subcontractor will advance a four or five-foot long/two-inch diameter stainless steel sampling device (macro-sampler) attached to the bottom of temporary stainless steel rods to the desired depth. The predetermined depth will be reached by connecting rods together. The rod will be pushed below ground surface with a hydraulic level attached to the truck.

8. The sample core will be collected within the macro-samplers lined with new

acrylic sleeves.

9. The macro-sampler is opened in half to displace the sample core.

10. If applicable, VOC samples will be collected immediately after the subsurface soil is brought to the surface using a syringe-type collection device as stipulated by EPA Method 5035A (see Section 4.1 above).

11. Next, place remaining soil in a stainless steel bowl and collect a homogenous sample to be analyzed for other parameters. Transfer the sample to laboratory sample containers using a decontaminated stainless steel spoon or trowel and place in cooler for shipment to the laboratory. After the laboratory samples are collected, fill a separate sample jar or plastic bag to be used for soil classification (if applicable). If there is a change in the stratigraphy, set aside some soil from each and place into jars to be used for the soil classification. If recovery is not sufficient, collect another sample immediately below the prior sample interval and homogenize the two samples prior to filling laboratory sample jars.

12. Log the description of the soil sample and fill out a boring log form as described in the SOP for borehole logging and sampling.

13. Record observations in the field logbook. Record applicable information on the applicable sampling and chain-of-custody forms.

14. Decontaminate the stainless steel sample rods and sampling device between each sampling location.

7.0 QA/QC

Quality assurance/quality control (QA/QC) samples are designed to help identify potential sources of sample contamination. Different types of QA/QC samples include field blanks, rinse blanks, trip blanks, and duplicate samples. The frequency of collection and types of QA/QC samples required are indicated in the site-specific sampling plan. All QA/QC samples are labeled with QA/QC identification numbers and sent to the laboratory with the other samples for analysis.

8.0 REFERENCES

ASTM Method D1587-83, Standard Practice for Thin Walled Sampling of Soils

EPA Method 5035A Closed-system Purge and Trap and Extraction for Volatile Organics in Soil and Waste Samples

9.0 ATTACHMENTS

None

STANDARD OPERATING PROCEDURE 009
MONITORING WELL AND PIEZOMETER INSTALLATION

1.0 SUMMARY

This procedure establishes the protocols and necessary equipment for installation of groundwater monitoring wells and piezometers. A piezometer is simply a small-diameter monitoring well. Therefore, the equipment and procedures for building a piezometer are the same as those used to install any monitoring well. The step-by-step procedures described herein are sufficiently detailed to allow field personnel to properly install any size monitoring well.

2.0 EQUIPMENT

This section details the required equipment for the drilling and installation of groundwater monitoring wells.

The following is an equipment list for well drilling and installation:

- Drill rig capable of installing wells to the desired depth in the expected formation materials and conditions
- Well casing and well screen
- Bentonite pellets
- Filter pack sand
- Portland Type I or II cement and powdered bentonite for grouting (or bentonite chips)
- Protective well casing with locking cap
- High-pressure steamer/cleaner
- Long-handled bristle brushes
- Wash/rinse tubs
- Appropriate decontamination supplies as specified in the SOP for decontamination procedures
- Location map
- Plastic bags (resealable)
- Self-adhesive labels
- Weighted tape measure
- Water level probe
- Deionized water

- Appropriate health and safety equipment as specified in the site health and safety plan (HASP)
- Logbook and/or daily reports
- Boring log sheets
- Well construction form
- Plastic sheeting
- Drums for containment of cuttings and decontamination and/or development water (if necessary)

3.0 PROCEDURES

3.1 Decontamination

Before drilling or well installation begins, all drilling and well installation material should be decontaminated according to the protocols in the SOP for decontamination procedures. Drilling equipment should be decontaminated between well locations.

3.2 Instrument Calibration

Before going into the field, the sampler should verify that field instruments are operating properly. Calibration times and readings should be recorded in a notebook to be kept by the field sampler. Specific instructions for calibrating the instruments are provided in the respective SOPs.

3.3 Drilling and Well Installation Procedures

3.3.1 Drilling Technique

If soil sampling is required, all soil samples should be collected according to the subsurface soil sampling procedures. The hole should be logged according to the methods specified in the SOP for borehole logging and sampling.

Boreholes should be advanced via conventional continuous-flight hollow-stem auger, water rotary, mud rotary, or sonic drilling methods and a drill rig capable of completing the monitoring well(s) to the depth(s) specified in the project plans. Before drilling begins, well locations should be numbered and staked. The necessary permits and utility clearances should be obtained in accordance with permits and utility clearance procedures. Appropriate health and safety measures should be followed during drilling and well installation activities as specified in the HASP.

During the drilling operation, the cuttings from the boring should be placed on the ground, on plastic sheeting, or into 55-gallon drums as specified in the project plans. Disposal of cuttings should be in accordance with the project plans and the SOP for investigation-derived waste (IDW) management procedures.

3.3.2 Monitoring Well Drilling Operations

The procedure for drilling is as follows:

- Set up drilling rig at staked and cleared borehole location.
- Record location, date, time, and other pertinent information in the field logbook or daily report and boring log/well construction form.
- Drill hole of appropriate size diameter.
- Collect split-spoon samples at the predetermined intervals, if appropriate, for sample description and/or chemical analysis as specified in the project plans. See borehole logging SOP for instruction.
- Complete the borehole to the depth specified in the project plans.

3.3.3 Well Design Specifications

The general specifications for wells are as follows:

Boring Diameter. The boring should be of sufficient diameter to permit at least 2 inches of annular space between the boring wall and all sides of the centered riser and screen. The boring diameter should be of sufficient size to allow for the accurate placement of the screen, riser, filter pack, seal, and grout.

Well Casing. The well riser should consist of new flush-threaded, PVC or stainless steel. The well diameter and thickness should be specified in the project plans. The risers should extend approximately 2 feet above the ground surface, except in the case of flush-mount surface casings. The tops of all well casings should be fitted with undersized PVC plugs, oversized PVC caps, or locking caps.

Well Screens. The screen length for each well should be specified in the project plans. Well screens should consist of new threaded pipe with factory-machine slots or wrapped screen with an inside diameter equal to or greater than that of the well casing. The slot size should be indicated in the project plans and designed to be compatible with aquifer and sand pack material. The schedule thickness of PVC screen should be the same as that of the well casing. All screen bottoms should be fitted with a cap or plug of the same composition as the screen and should be within 0.5 foot of the open part of the screen. Traps may be used.

3.3.4 Well Installation Procedure

The following procedure should be initiated within 12 hours of boring completion for uncased holes or partially cased holes and within 48 hours for fully cased holes. Once installation has begun, if no unusual conditions are encountered, there should be no breaks in the installation procedure until the well has been grouted and the drill casing has been removed.

The procedure for monitoring well installation is as follows:

1. Decontaminate all well materials according to the SOP for decontamination procedures. After decontamination, all personnel who handle the casing should put on a clean pair of rubber or surgical gloves.
2. Measure each section of casing and screen to nearest 0.10 foot.
3. Assemble screen and casing as it is lowered into the open boring or boring inside the hollow-stem augers.
4. Lower screen and casing to about 6 inches above the bottom of the boring.
5. Record the level of top of casing and calculate the screened interval. Adjust screen interval by raising assembly to desired interval, if necessary, and add sand to raise the bottom of the boring.
6. Calculate and record the volume of the filter pack, filter pack seal, and annular seal required for existing boring conditions.
7. Filter Pack: Begin adding filter pack sand (10-20 size quartz sand preferable) around the annulus of the casing a few feet at a time. Repeated depth soundings should be taken to monitor the level of the sand. The filter pack should consist of a clean, washed silica sand sized to perform as a filter between the formation material and the well screen. The final depth to the top of the filter pack should be measured directly with the use of a weighted tape measure or rod and not by volumetric calculation methods. The grain size of the filter pack should be shown on the well construction log.
8. Allow sufficient time for the filter sand to settle through the water column outside the casing before measuring the sand level.
9. Filter Pack Seal: Extend the filter pack sand to at least 2 to 5 feet above the top of the well screen. After placing the sand filter pack in the shallow wells, fill the annulus successive lifts of bentonite pellets (either ¼- or 3/8-inch). The bentonite will be installed in 1-foot lifts, adding approximately 2 gallons of water per lift to hydrate the bentonite pellets.
10. After the seal sets for 24 hours the concrete pad and bollards, should be installed according to the specifications in this SOP. The protective casing and posts should be painted a highly visible color.
11. Optional: Personnel should affix to the outer steel protective casing of each well a permanent, noncorrosive tag that clearly identifies the well number, the client's name, and/or the adjusted top of casing elevation.

3.3.5 Well Installation Specifications

Personnel should take precautions to prevent tampering with the wells or the entry of foreign material into them. Upon completion of a well, a suitable cap should be installed to prevent foreign material from entering the well. The wells should be enclosed in a protective steel casing. Steel casings should be a minimum of 6 inches in diameter and should be provided with locking caps and locks. All locks should be keyed alike. If the well is specified in project plans as a stickup, a 1/4-inch drainage hole should be drilled in the protective steel casing, centered approximately 1/8-inch above the internal mortar collar. The well designation should be painted on the protective casing prior to well development. If specified in the project plans, a concrete pad should be constructed around the protective casing at the final ground level elevation and sloping away from the well. The concrete pad should measure at least 3 by 3 feet, with a thickness of 6 to 8 inches. Three 2-inch diameter or larger steel posts should be equally spaced around the well and embedded in separate concrete-filled holes just outside the concrete pad. The protective steel posts should extend approximately 1 foot above the well riser. Any well that is to be temporarily removed from service or left incomplete due to a delay in construction should be capped with a watertight cap and equipped with a "vandal-proof" cover that satisfies applicable state or local regulations or recommendations.

4.0 DOCUMENTATION

Observations and data acquired in the field during the drilling and installation of wells should be recorded to establish a permanent record. A boring log should be completed for each boring, according to the procedures outlined in the SOP for sedimentological logging procedures.

Additional documentation of well construction will include the following:

- Date
- Time
- Personnel
- Weather
- Subcontractors
- Health and safety monitoring equipment and readings
- Grout, sand, and bentonite volume calculations prior to well installation
- Quantity and composition of grout, seals, and filter pack actually used during construction
- Screen slot size (in inches), slot configuration, outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer
- Coupling/joint design and composition
- Protective casing composition and nominal inside diameter
- Start and completion dates
- Discussion of all procedures and any problems encountered during drilling and well construction

In addition, the well installation details should be shown in a diagram drawn in the field logbook and/or borehole log. Each well diagram should consist of the following (denoted in order of decreasing depth from the ground surface):

- Reference elevation for all depth measurements
- Project and site names
- Well number
- Date(s) of installation
- Depth at which the hole diameter changes (if appropriate)
- Depth of the static water level and date of measurement(s)
- Total depth of completed well
- Depth of any grouting or sealing
- Nominal hole diameter(s)
- Amount of cement used for grouting or sealing
- Depth and type of well casing
- Description of screened interval (to include length, internal diameter, slot size, and well screen material)
- Any sealing off of water-bearing strata
- Static water level upon completion of the well and after development
- Drilling date(s)
- Other construction details of monitoring well including grain size of well filter pack material and location of all seals and casing joints

All entries in the field logbook, daily report, or boring log/well construction form should be legibly printed in indelible ink.

5.0 ATTACHMENTS

None

APPENDIX B – Field Forms

Contents

URS

Daily Quality Control Report

DATE ______________________

DAY

S	M	T	W	TH	F	S

WEATHER	SNOW	RAIN	OVERCAST	CLEAR	BRIGHT SUN
TEMP	To 32	32-50	50-70	70-85	85 up
WIND	Still	Moder	High	Report No.	
HUMIDITY	Dry	Moder	Humid		

PROJECT MANAGER: Brian Pletcher

PROJECT: Shell Seattle Terminal

JOB NO.:

URS FIELD REP:

SUB-CONTRACTORS ON SITE:
EQUIPMENT ON SITE:
WORK PERFORMED:

SHEET _____ OF _____

Daily Quality Control Report

PROJECT: ____________________ REPORT NO. ____________

JOB NO.: ____________________ DATE ____________

PROBLEMS ENCOUNTERED/CORRECTION ACTION TAKEN:

SPECIAL NOTES:

TOMORROW'S EXPECTATIONS:

BY ____________________ TITLE ____________________

SHEET _____ OF _____

Monitoring Well Development Field Log

Well Number:	
Date:	

Project Information	
Project Name:	Shell Seattle Terminal
URS Project Number:	

Sampling Information		
Field Team:		
Development Method:		
Water Quality Meter:	Model:	
	Serial Number:	
Purge Water Disposition:	Drums on-site	

Well Construction Information

Stick-up or Flush	Well Diameter (in)	Screen Interval (ft bgs or btoc)

Monitoring Information

Well Depth (ft btoc)	Initial DTW (ft btoc)	Water Column (ft)	Convert Factor (gal/ft)	One Well Volume (gal)	Three Well Volumes (gal)
			0.17 (2-inch well)		

Development Comments

Well Purge Data

Time	Volume Purged (gallons)	Purge Rate (L/min) (<0.5 L/min)	DTW (ft btoc)	Temp. (^{0}C)	Conductivity (uS/cm)	D.O. (mg/L)	pH	ORP (mV)	Turbidity (NTUs)	Clarity/Color/ Remarks
	Pump On		Initial	-	±3%	±10%	±0.1	±10mv	±10%	**<= Stabilization Criteria**
			Final							

	Start Sampling	Sample ID:	Sample Time:
	End Sampling	QA/QC Sample ID:	QA/QC Sample Time:

Note: bgs= below ground surface btoc=below top of casing DTW=depth to water
Clarity: VC=very cloudy Cl=cloudy SC=slightly cloudy AC=almost clear C=clear CC=crystal clear

Monitoring Well Gauging Field Log

Date:

Job No.: 49241036

SAP: 3547032

Incident No 300036

Location: 2555 13th Ave SW Seattle (Harbor Island Terminal)

Personnel:

Well ID	Time Gauged	Depth to Water	Depth to Product	Comments
MW-16				
MW-05				
MW-111				
MW-112A				
MW-203				
MW-206A				
TES-MW-1				
MW-101				
MW-102				
MW-305				
MW-306				
MW-307				
MW-308				
MW-309				
MW-301				
MW-302				
MW-303				
MW-304				
MW-311				
MW-312				
MW-104				
MW-202				
SH-04				
TX-03A				
MW-203				
MW-213				
MW-214				

Monitoring Well Sampling Field Log

Well Number:

Date:

Project Information
Project Name:
URS Project Number:
Sampling Information
Field Team:
Purge Method:
Flow-Through Cell:
Sampling Method:
Decontamination Method:
N/A - all supplies disposable
Purge Water Disposal: drummed on site
Field Conditions:
Comments:

Sample Containers

Number	Type	Preservative	Analytical Parameters	Filtered?

Purge Volume Information

Well Diameter:	
Depth to Bottom:	
Depth to Water:	
Depth to Product:	
Water Column Height:	
Conversion Factor:	
One Well Volume:	

Conversion Factor:	3/4" = 0.023 gal/ft	2" = 0.165 gal/ft
	4" = 0.65 gal/ft	6" = 1.5 gal/ft

Well Purge Data

Time	Volume Purged (L)	Temp. (^{0}C)	Conductivity (uS/cm)	D.O. (mg/L)	pH	ORP (mV)	Turbidity (NTUs)	Clarity / Color / Remarks
		Sample Number:					**Sample Time:**	

Notes: AC = almost clear; btc = below top of casing; DTW = depth to water; VC = very cloudy
bgs = below ground surface; Cl = cloudy; C = clear; SC = slightly cloudy

Investigative Derived Waste Form

Project Description: ______________________

Project Location: ______________________

URS Project Number: ______________________

URS Field Personnel: ______________________

To Be Completed in the Field <-- | --> To Be Completed in the Office

Drum Number	Date Generated	Contents		Labeled As	Charaterized for Disposal (Yes/No)	Date Disposed	Transported By	Disposal Facility and Location
		Water/Soil	Description					

Project: ______	**Log of Boring / Well ______**
Project Location: ______	Sheet 1 of ____
Project Number: ______	

Date(s) Drilled and Installed	Logged By	Reviewed By
Drilling Method	Drilling Contractor	Total Depth of Borehole
Sampling Method	Groundwater Level(s)	Top of Casing Elevation
Size and Type of Well Casing	Screen Perforation	Ground Surface Elevation
Seal or Backfill	Location	

Depth, feet	SAMPLES: Type and Number	SAMPLES: Recovery, %	SAMPLES: Headspace PID, ppm	USCS Code	MATERIAL DESCRIPTION	Well Completion Schematic	FIELD NOTES AND WELL DETAILS
0							
5							
10							
15							
20							
25							
30							

URS