Appendix D

Confined Disposal Facility Monitoring Operations Manual

D.1 INTRODUCTION

The purpose of the Confined Disposal Facility (CDF) monitoring program is to assess possible changes in groundwater quality as a result of the construction of the St. Paul CDF. The objectives of this program are described in further detail in Section 5.0 of the OMMP. Construction of the CDF is part of the Thea Foss and Wheeler-Osgood Waterways Remediation Project. This field manual provides guidance to field personnel involved in the CDF monitoring program. Any future changes to the CDF monitoring program (such as changes in wells to be sampled, sampling frequency, and/or chemical analyses) will be described in addenda to this manual.

This manual is organized in five general sections:

- Preparation for Sampling;
- Well Installation and Development;
- Tidal Study/Slug Test and Sampling Protocols;
- Post-Sampling Procedures; and
- Visual Observations of CDF Berms and Cap.

Attachment D-1 presents the Quality Assurance Project Plan (QAPP) for the CDF monitoring program. Attachment D-2 provides the field forms for Groundwater and Surface Water Sample Collection. Attachment D-3 provides the Well Installation Log. Attachment D-4 provides the field form for CDF Berms and Cap Observation. Appendix F presents a project-specific Health and Safety Plan that includes CDF monitoring activities. A copy of the CDF Monitoring Operations Manual should be carried in the field when completing groundwater and surface water sampling.

D.2 PREPARATION FOR SAMPLING

Before going to the field, the following steps should be completed.

D.2.1 Review this Manual

In preparation for well installation, the tidal study and slug tests, groundwater and surface water sampling, and before conducting field work, all personnel must read and become familiar with this manual, the Health and Safety Plan requirements, and Section 5.0 of the OMMP. If questions arise, contact the City's Project Manager.

D.2.2 Contact Appropriate People for Site Access

The existing and new groundwater monitoring wells are located on Simpson property. Therefore, well inspection, installation, and testing must be coordinated with Simpson personnel. The Simpson contact person is the following:

- Dave McEntee, Director – Environment, Health and Safety, Simpson Investment Company, 253-779-6405

If the Simpson contact person changes, the new contact person will be provided in an addendum to this manual.

Coordination with Simpson will occur prior to accessing Simpson property for CDF monitoring activities. Simpson will be notified of monitoring activities, site access needs, schedule, and the personnel to perform the work. EPA will also be contacted and notified of monitoring activities and schedule prior to performing monitoring activities. Additionally, any request to move equipment or other objects obstructing access to work areas will be made to Simpson.

Personnel accessing Simpson property must have Simpson's site-specific health and safety training. If personnel performing field activities do not have Simpson's site-specific training, the training will be arranged through Simpson.

D.2.3 Contact Analytical Laboratory

The analytical laboratory will be contacted prior to initiation of CDF monitoring activities that include sampling and chemical analysis. Coordination with the analytical laboratory will occur to ensure appropriate sample storage and handling as well as to ensure that the appropriate analytical methods and procedures are performed for surface water and/or groundwater samples. A copy of the QAPP (Attachment D-1) should be provided to the laboratory prior to collection and transfer of samples to the laboratory. Any deviations from the requirements specified in the QAPP by the laboratory need to be approved by the City and EPA prior to use.

At least one week before sample collection and analysis, the analytical laboratory will be contacted to provide the laboratory with the following information:

- Date of sampling, number of samples to be collected, and date of sample delivery to the laboratory;
- Analyses to be performed, including required detection limits and laboratory Quality Assurance/Quality Control (QA/QC) requirements. Also notify the laboratory that sample filtering for dissolved copper, lead, mercury, nickel, and zinc analyses will be performed in the field. Analyses to be performed on baseline groundwater samples are dissolved copper, lead, mercury, nickel, zinc, total mercury, polycyclic aromatic hydrocarbons (PAHs), total organic carbon, total suspended solids, and salinity (analytical methods are listed in the QAPP; Attachment D-1). The analyses to be performed on performance monitoring groundwater samples will be selected based on the results of baseline sampling and analysis and groundwater flow conditions. Analyses to be performed on baseline surface water samples are dissolved copper,

lead, mercury, nickel, zinc, total mercury, and salinity. Table D-1 summarizes the analyses to be performed for each sampling event;

- When sample bottles will be needed (with cooler, blue ice, labels, and chain of custody form);
- Date analytical results are needed (i.e., requested analytical turn-around);
- Sample disposal; and
- Any other analytical requirements.

Upon receiving sample bottles from the laboratory, verify that all necessary containers are present. Review which bottles are required for which analyses and minimum required sample volumes. Label containers and organize them into coolers. Prepare necessary ice packs and other materials, as necessary, for bottle protection and sample preservation.

D.2.4 Ensure Field Equipment is Working and Calibrated

The required field equipment for each of the field activities included in this manual are presented in Table D-2.

The field parameter meter(s) should be calibrated on the day of sampling using commercially available calibration solutions and following the instrument manufacturers' directions.

D.2.5 Know Where to Go

A map of the CDF and vicinity is provided on Figure 5-1 of the OMMP and the monitoring well locations are presented on Figure D-1 of this manual. Following the installation of new monitoring wells, the well network figure (i.e., Figure D-1) will be revised if actual locations of the newly installed wells differ from the locations currently shown. The revised figure will be provided as an addendum to this manual.

D.3 WELL INSTALLATION AND DEVELOPMENT

The monitoring wells will be installed following the "Minimum Standards for Construction and Maintenance of Wells" in WAC 173-160. Borings will be advanced and wells completed by Holt Drilling, Inc. (Puyallup, WA) beginning August 28, 2006. The boreholes for the wells will be drilled using standard Hollow Stem Auger techniques. Auger boreholes will be advanced using a 4-inch auger. Split-spoon soil samples will be collected during boring every five feet. Soil samples will be documented on the well installation log form (Attachment D-2) and will be described and classified according to the United Soil Classification System (USCS). The screen placement will be determined and adjusted in the field as work progresses based on soil samples collected and inferred groundwater elevations at each well location. The objective is to place the well screen within the permeable soils, if possible avoiding lenses of silt or confining layers. Geotechnical information will be logged by a geologist and documented on the well installation log (Attachment D-2). Once the auger has been drilled to the target elevation, the base of the auger will then be filled with bentonite and the well installation completed.

The new shallow wells will be constructed with 10-foot screens set approximately from an elevation of 10 feet Mean Lower Low Water (MLLW) to 0 feet MLLW, consistent with the

previously installed shallow wells. The intermediate wells will be constructed with 10-foot screens set approximately from an elevation of 0 feet MLLW to -10 feet MLLW. The deep wells will be constructed with two 10-foot screens set approximately from an elevation of -40 feet MLLW to -60 feet MLLW, the same elevations as the bottom of the CDF.

All wells will be constructed of 2-inch diameter, flush-threaded, Schedule 40 PVC well casing and screen. Well screen assemblies will consist of 10-foot or 20-foot (deep wells) lengths of 0.020-inch (20-slot), flush-threaded, machine-slotted, Schedule 40 PVC set in a 10/20 sand or equivalent silica sand filter pack. The well design includes a 0.5-foot long flush-threaded, Schedule 40 PVC sump with a flush-threaded end cap. A 2-inch diameter PVC slip cap will cover the casing.

The sand filter pack will be installed by pouring sand into the space between the well casing and auger as the auger is withdrawn. A weighted tape will be used to monitor filter pack placement and depth during installation. The sand filter pack will extend three feet above the top of the screened interval. A minimum 2-foot thick seal of hydrated bentonite chips will be installed in the annular space immediately above the sand filter pack and hydrated with potable water if installed above the water table. The remainder of the annular space will be sealed with bentonite grout or hydrated bentonite chips to within one foot of the ground surface.

The new monitoring wells will be secured with either above-ground or flush to ground locking steel protective monuments to minimize the potential for surface water entering the monument.

Well development will be completed by continuous pumping at a steady rate using a peristaltic pump or other non-dedicated pumping equipment as needed. Wells will be developed using the described methodologies or equivalents at least 48 hours following well installation. Well development equipment will be decontaminated by pumping clean water through the pump and washing to the satisfaction of the on-site field technician. Well development will be terminated when the variation in the turbidity NTU readings is less than 10%, or to the satisfaction of the field technician. Installed wells will be labeled with a permanent marker on the well casing if above-round completions are constructed or on the well cover if flush mount wells are constructed.

D.4 72-HOUR TIDAL STUDY AND SLUG TEST PROTOCOL

After completing the installation and purging of the new monitoring wells in the monitoring well network, the post-construction hydrogeologic conditions will be evaluated by completing a 72-hour tidal study and slug tests. Water levels in monitoring wells will be recorded using a combination of pressure transducers with internal data loggers and an electronic water level indicator. The data collection will include continuous (every 15 minutes) transducer-based water level measurements in wells MW-01 through MW-15, in the surface water swale between Simpson's clarifier tanks and the offset berm, and in the Middle Waterway. The data logger will be programmed to automatically convert pressure changes to water levels. If possible, a vented transducer will be used that internally corrects for fluctuations in atmospheric pressure.

The general procedure for conducting the 72-hour tidal study and recording water levels in monitoring wells is summarized below:

1. At each monitoring well, lower a pressure transducer into the well and securely fasten it to the top of the well casing for the duration of the monitoring period.
2. Set the transducers to record the height of the water column above the transducer at 15-minute intervals.
3. Make sure the pressure transducers are rated to a minimum 15 pounds per square inch (psi) range capable of measuring a water level change of 23 feet with a resolution of 0.01 foot.
4. Periodically perform depth-to-water level measurements to the nearest 0.01 foot with a manual electronic water level indicator at the top of the well casing. Perform the manual depth-to-water level measurements in each monitoring well four times during the monitoring period.
5. At the end of the monitoring period remove the pressure transducers and upload the water level data to a computer.

Similar procedures will be used to monitor surface water levels in the surface water swale between the Simpson clarifiers, in the offset berm, and in the Middle Waterway.

Slug tests will also be performed in all monitoring wells to identify the range of hydraulic conductivities present at and adjacent to the CDF. Slug tests will act to verify the hydraulic connection between the well and the surrounding aquifer and to estimate the aquifer's hydraulic conductivity within the constructed CDF. Slug tests can be performed prior to or following the 72-hour tidal study. The tests will be performed at a tidal stage as to minimize the interference of tidal fluctuations on the aquifer and the determination of the hydraulic conductivities.

Slug tests will be performed using a PVC slug rod, a down-hole pressure transducer as described above, and a water level indicator in general accordance with ASTM D 4044-96 (2000). The general procedure for conducting the slug tests in monitoring wells is summarized below:

1. At each monitoring well, measure the static depth of groundwater as described in Section D.6.1 before placing the pressure transducer near the bottom of the well.
2. After stabilization of the groundwater level (from the displacement of the transducer), lower the slug rod into the well until it is submerged in the water column.
3. Monitor the recovery of the perturbed water level until it has returned to within 95 percent of the initial head indicated by the transducer prior to the introduction of the slug rod.
4. Once the water level has re-equilibrated quickly remove the slug from the water column and monitor the groundwater level for recovery.
5. After the water level has recovered to within tolerance (95 percent), manually measure the depth to groundwater again, remove the transducer, and secure the well.

The slug test response data will be analyzed using the Bouwer and Rice method (Bouwer and Rice 1976, Bouwer 1989).

D.5 SURFACE WATER SAMPLING PROTOCOL

Surface water samples will be collected and submitted to the laboratory for analysis concurrently with baseline groundwater samples from the CDF monitoring. Samples will be collected at the northern end of the Middle/St. Paul Peninsula and Peninsula Habitat Area (i.e., North Beach Habitat Area) (Figure D-1) and analyzed for dissolved copper, lead, nickel, and zinc; total and dissolved mercury; and salinity (analytical methods are listed in the QAPP; Attachment D-1). The analyses to be performed for surface water sampling are summarized in Table D-1.

The seawater samples will be collected at high, slack tide using a peristaltic pump with disposable tubing or tubing that has been decontaminated. The sampler will lower the pump intake to a depth of approximately three feet below the water surface. The sample intake will also remain a minimum of three feet off the bottom. At no time will the pump intake be allowed to come into contact with sediment on the bottom or come close enough to disturb sediment and create turbidity. Seawater temperature (T), pH, electrical conductivity (EC), dissolved oxygen (DO), and turbidity will be measured at the time of sampling using a water quality instrument with a flow through cell. Caution will be taken to pump water at a rate as to avoid the development of air bubbles within the flow through cell and achieve parameter stability. If groundwater parameters do not stabilize, the pumping rate will be reduced as a corrective action.

Surface water samples collected for dissolved metals analysis will be filtered in the field using an in-line 0.45 µm filter. Flexible silicone tubing will be used to attach the filter to the peristaltic pump discharge tube. Approximately one liter of water will be flushed through the filter prior to sample collection. If the filter clogs, it will be replaced with a new filter. Surface water samples will be pumped through the filter into sample collection containers.

D.6 GROUNDWATER SAMPLING PROTOCOL

Groundwater samples will be collected from selected wells during baseline and performance monitoring. Following the completion of the tidal study and slug tests, selected wells to be sampled as part of the baseline monitoring program will be equipped with dedicated sampling pumps, with the pump intake placed at the approximate midpoint of the well screen. The use of an electronic submersible dedicated pump will allow for low flow rate sampling and the down-well equipment will be dedicated to a given well, so both samples and the well will be protected from disturbance and the danger of cross-well contamination. The pumps will be constructed and assembled by the manufacturer and installed according to manufacturer's specifications. A cycle controller will be used with the pumps for well sampling. If the installed wells are flush mount wells the pumps will be assembled with ceiling caps to prevent infiltration of surface water and the pump will be suspended in the well from the flush mount cap.

As dedicated pump systems are to be used, cross-contamination is not expected and the order of well sampling is not critical. Therefore, the order of well sampling is left to the discretion of field personnel.

At each well location, inspect the area surrounding the well. If a well monument is blocked contact Simpson for site access to move equipment or other objects obstructing access to the well location. Once the well is accessible, the following field sampling procedures will be

completed. Note: The details of this protocol may be revised to account for provisions of the specific sampling equipment (i.e., equipment brand) selected for baseline and performance monitoring.

D.6.1 Measure Depth to Water

1. Open protective casing. Observe and note on field log the condition of monument/well.
2. Decontaminate well sounder by rinsing with deionized (DI) water.
3. Drop water level indicator into well and determine water level by means of LED or beeper. Measure mark on the probe to the nearest 0.01 foot using a tape measure. Record this value, with date and time, on the field log as the static depth to water.

D.6.2 Purge Well

1. Lower the dedicated pump system into the well and tighten the compression bolts with an allen wrench.
2. Connect the electrical port on the well seal to the controller (converter) with an extension cable. Connect the controller to a power source.
3. Begin purging the well. Because groundwater contamination is not anticipated, the purge water will be directly discharged to the ground.
4. Purge the well at low flow rates not to exceed 0.5 liter per minute (determined by measuring the time to fill a known volume). The purge rate can be increased to one liter per minute if the purge water is observed to be generally non-turbid (less than 50 NTU) and the purging creates less than 0.5 foot of drawdown in the well. Because water levels may fluctuate in the monitoring wells with the tide, the drawdown will be measured and compared against this criterion in the first five minutes of purging.
5. Adjust the pump controller to achieve acceptable purge rate.
6. During purging, measure field parameters (T, pH, EC, DO, and turbidity) in the purge water at 3- to 5-minute intervals. Record the time and parameter values and purge rate on the field log for each set of readings. If the field measurements for turbidity, DO, and EC are approximately stable (± 10%) for three consecutive readings, the groundwater sample will be collected. If DO is below 5 mg/L, three consecutive readings of ±1 mg/L will be considered stable. Should the turbidity readings be negative values, the measurement will be recorded as less than 1 (< 1). If the field parameter meter also measures salinity, it should be recorded, but it will not be a stabilization parameter. Depth to water will be measured and recorded during the first five minutes of purging, to calculate drawdown, as discussed above. Because these field parameters (particularly turbidity) may not reach these stringent stabilization criteria at a particular well, collection of each groundwater sample will be based on the field personnel's best professional judgment at the time of sampling. The last set of field parameters measured during purging will represent field parameters for the groundwater sample.
7. Record all field measurements and observations legibly on the field forms, as these forms (Attachment D-2) will be included as appendices in the monitoring reports.

The analyses to be performed for groundwater well sampling are summarized in Table D-1.

D.6.3 Bottle Labeling

Before or during well purging, label the bottles provided by the lab. The sample number format will be "well number—year/month/day of collection." For example, a sample collected from well MW-01 on September 15, 2007, would be labeled MW-01-091507. A duplicate sample would be labeled MW-01-091507-B. A sample collected from the surface water sampling location SWM-01 on September 15, 2007, would be labeled SMW-01-091507. In this way, every water sample has a unique identifier, and the collection date is known from the sample number. Other information to include on bottle label is date, time, and initials of sampler.

D.6.4 Sample Collection

1. After purging the well and labeling the bottles, collect the groundwater sample by directly filling the lab-provided bottles from the pump discharge line (maintain same flow rate as purging). In this way, only dedicated materials are used in sampling, and there is no need for equipment decontamination (other than the water level indicator). The specific bottles to be filled for each chemical analysis will be communicated by the laboratory.
2. Filter the sample for dissolved metals analysis. Use flexible silicon tubing to attach filter to pump discharge tube. Let approximately one liter of water run through filter before the sample is collected. If filter clogs with sediment, replace with new filter. Dispose of filter after each well sampled.
3. Immediately place all labeled, filled bottles in coolers packed with blue ice.

D.6.5 Leaving the Well

1. Turn off controller and disconnect the power source.
2. Disconnect hose connecting the well to the controller.
3. If freezing weather is possible before the next sampling event perform antifreeze maintenance. **Warning:** Never operate cold-weather blow-out mechanism with pump controller attached to pump.
4. Return water discharge tube to its original hole for storage. Retain in a closed plastic bag within the well monument, the teflon tubing and other tubing which will not fit in the well casing. Close and secure monument.

D.7 POST SAMPLING PROCEDURES

A chain of custody form will be provided with the sample bottles supplied by the laboratory. The custody form must be filled out by the sampler, indicating chemical analyses to be performed, date of sample collection, matrix (water), number of bottles per sample, method of delivery, turnaround time, etc. as specified on the form. Reference on the chain of custody to a laboratory services work order will help ensure that project-specific requirements (e.g., analytical methods, sample quantitation limits, QA/QC requirements) are completed by the

laboratory. The chain of custody form must accompany the samples at all times, documenting each change of possession.

The samples should be delivered to the laboratory as soon as possible following collection to ensure that analytical holding times are met.

D.8 VISUAL OBSERVATION OF CDF CONTAINMENT AND OFFSET BERMS AND CAP

During each quarterly groundwater monitoring event, visual observation of the CDF containment and offset berms and the CDF cap will be completed to observe the physical condition of the berms and cap. The areas that will be observed during these inspections are shown on Figure D-1. The inspections will document changes in the berm structures, integrity of the cap, and any evidence of release or contamination using field forms and photographs.

Observations will be performed of each component of the CDF (i.e., containment berm, offset berm, and cap) and documented in the field form presented in Attachment D-4. Field personnel should complete one of the attached field forms for each component of the CDF to document observations and to maintain consistency throughout successive monitoring events.

For observations of the containment berm, offset berm, and cap, the following field notes will be recorded:

- Location (i.e., containment berm, offset berm, or cap), date, time, and weather conditions;
- Personnel performing observations;
- Description of the observed surface including materials observed at the surface (i.e., habitat mix, rip rap, quarry spalls, gravel, sand, silt, etc.) and presence of objects or debris (logs, garbage, etc.). If objects or debris are observed on the surface, information concerning the location should be recorded on the diagram section of the field form;
- Description of location of the top of the berms and elevation of adjacent surface water; and
- Berm structural or cap integrity observations relative to the as-built baseline conditions including:
    - Areas of settlement;
    - Down-slope movement of berm materials (i.e., sloughing);
    - Areas of loss of cap material or penetration into the cap;
    - Evidence of through-berm / cap seepage; and
    - Indicators of potential contamination (i.e., sheen, discoloration, staining, odor, etc.).

Berm and cap conditions will also be documented with digital photographs. Digital photographs should be obtained using the following procedures:

- For each component, take a digital photograph that includes the entire area, with a stationary object to be used for location reference;

- Where multiple photographs are taken, provide adequate overlap of coverage (using stationary objects) to ensure complete photo documentation of the berms and cap; and
- Record the location(s) where photographs were taken on the field forms.

Digital photographs will be labeled with the date and time the photograph was taken.

If visible evidence of berm structural changes or cap integrity is observed, additional notes should be recorded (within the provided space on the field forms) for further evaluation. At a minimum, additional information should identify potential causes and extent of cap disturbance and should be clearly recorded on the diagram.

REFERENCES

Bouwer, H. 1989. Slug test-an update. Ground Water 27:15-20.

Bouwer, H. and M.R. Rice. 1976. A slug test determining the hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells. Water Resources Research. 12: 423-428.

TABLES

Table D-1 – CDF Monitoring Sampling Event Analyses

Table D-2 – CDF Monitoring Field Equipment Checklist

FIGURES

Figure D-1 – Monitoring Well and Surface Water Sampling Location Plan

ATTACHMENTS

Attachment D-1 – Quality Assurance Project Plan for Groundwater and Surface Water Analysis

Attachment D-2 – Groundwater and Surface Water Sample Collection Form

Attachment D-3 – Well Installation Log

Attachment D-4 – CDF Berms and Cap Observation Form

Table D-1
CDF Monitoring Sampling Event Analyses

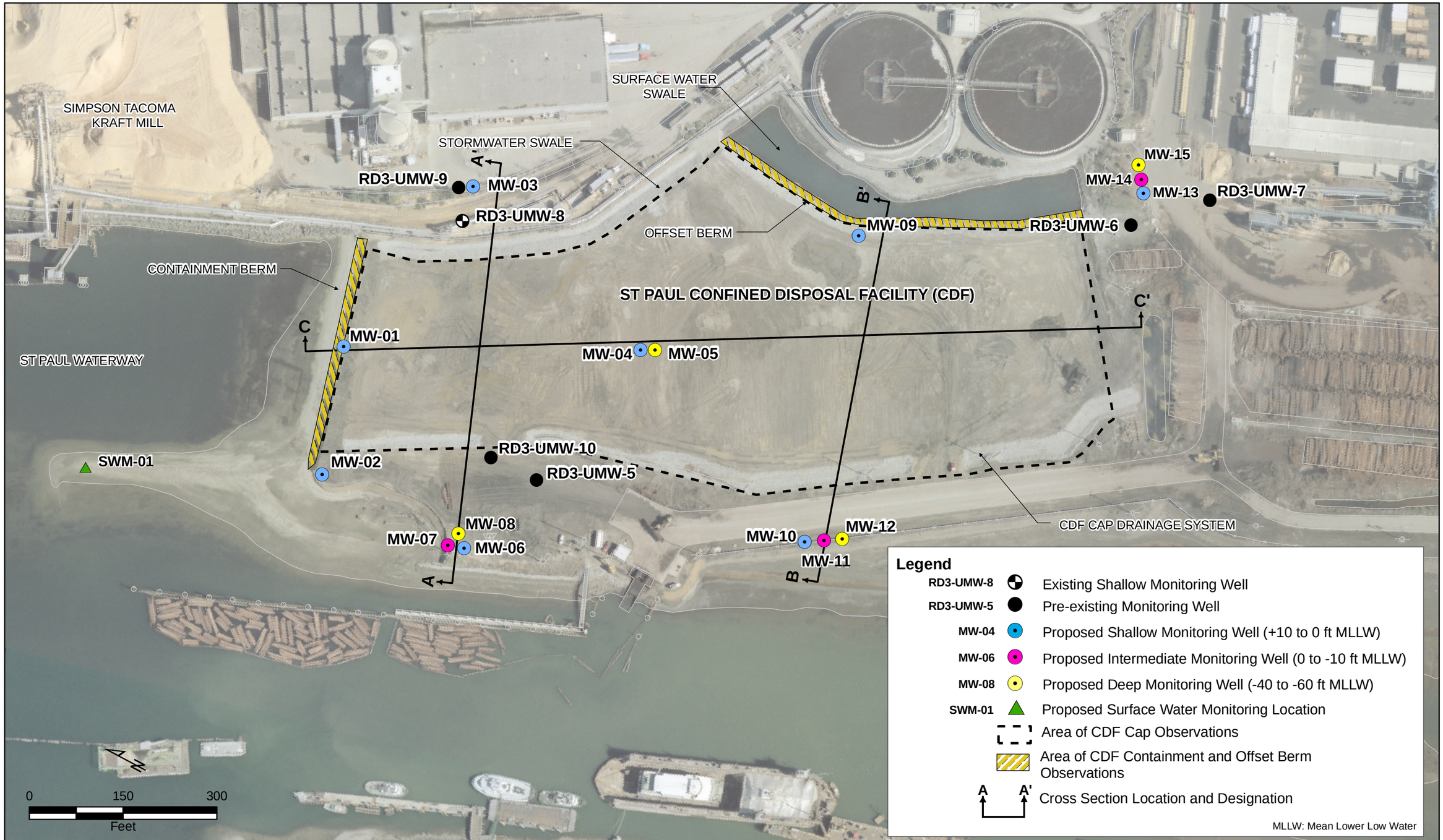
Sampling Event	Analyses					
	Metals		Organics	Conventionals		
	Dissolved Metals (Cu, Pb, Ni, Zn, Hg)	Total Metals (Hg)	PAHs	TSS	TOC	Salinity
Baseline Monitoring						
Groundwater Well Sampling						
Selected Monitoring Wells[1]	X	X	X	X	X	X
Field Duplicate	X	X	X	X	X	X
MS/MSD	X[2]	X[2]	X			
Surface Water Sampling						
Surface Water	X	X				X
Field Duplicate	X	X				X
Equipment Blank	X	X				
Compliance Monitoring						
Groundwater Well Sampling						
Selected Monitoring Wells[2]	TBD[3]	TBD[3]	TBD[3]	X	X	X
Field Duplicate	TBD[3]	TBD[3]	TBD[3]	X	X	X
MS/MSD	TBD[3]	TBD[3]	TBD[3]			

Notes:
1 Baseline sampling monitoring wells will be determined based on the results of the post-construction hydrogeologic evaluation and groundwater flow direction.
2 The laboratory will perform a laboratory duplicate and matrix spike for metals analyses.
3 Performance sampling monitoring wells and analtye list will be selected based on the results of the baseline monitoring program.

Table D-2
CDF Monitoring Field Equipment Checklist

72-Hour Tidal Study	
□	Key/tools necessary to access wells
□	Well sounder for water level measurements
□	Pressure transducer with internal data logger
□	Duck tape or materials to adhere transducer to well casing, etc.
Baseline Monitoring	
Groundwater Well Sampling	
□	Key/tools necessary to access wells
□	Air compressor with adequate gasoline
□	Controller for dedicated sampling pumps, 12-volt battery
□	Appropriate discharge tubing for each pump, with additional tubing for each well as needed, to accommodate the sampling pump tubing (likely stored inside the well monument/vault)
□	Well sounder for water level measurements
□	Field parameter probe(s) for measuring temperature (T), pH, electrical conductivity (EC), dissolved oxygen (DO), and turbidity, along with flow-through cell
□	Graduated container and stop watch for measuring well purging rate
□	Vehicle to haul equipment and supplies during sampling
□	Field forms and chain of custody forms
□	Plastic sheeting, garbage bags, and paper towels
□	0.45 micron filters (one per well, plus extras as contingency) to filter samples for dissolved metals analysis
□	Deionized (DI) water pump sprayer
□	Personal protective equipment as specified in the Health and Safety Plan (Appendix F)
□	Laboratory-supplied sample bottles
□	Blue ice and cooler
Surface Water Sampling	
□	Field parameter probe(s) for measuring temperature (T), pH, electrical conductivity (EC), dissolved oxygen (DO), and turbidity, along with flow-through cell
□	Peristalilc pump with battery
□	Appropriate discharge tubing for the pump and silicone tubing
□	0.45 micron filters (one per sample, plus extras as contingency) to filter samples for dissolved metals analysis
□	Vehicle to haul equipment and supplies during sampling
□	Field forms and chain of custody form

□	Garbage bags and paper towels
□	Personal protective equipment as specified in the Health and Safety Plan (Appendix F)
□	Laboratory-supplied sample bottles
□	Blue ice and cooler
Compliance Monitoring	
□	Key/tools necessary to access wells
□	Air compressor with adequate gasoline
□	Controller for dedicated sampling pumps, 12-volt battery
□	Appropriate discharge tubing for each pump, with additional tubing for each well as needed, to accommodate the sampling pump tubing (likely stored inside the well monument/vault)
□	Well sounder for water level measurements
□	Field parameter probe(s) for measuring temperature (T), pH, electrical conductivity (EC), dissolved oxygen (DO), and turbidity, along with flow-through cell
□	Graduated container and stop watch for measuring well purging rate
□	Vehicle to haul equipment and supplies during sampling
□	Field forms and chain of custody form
□	Plastic sheeting, garbage bags, and paper towels
□	0.45 micron filters (one per well, plus extras as contingency) to filter samples for dissolved metals analysis
□	Deionized (DI) water pump sprayer
□	Personal protective equipment as specified in the Health and Safety Plan (Appendix F)
□	Laboratory-supplied sample bottles
□	Blue ice and cooler



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Tacoma

Thea Foss and Wheeler-Osgood Waterways
OMMP

Figure D-1
Monitoring Well and
Surface Water Sampling Location Plan

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Attachment D-1

Quality Assurance Project Plan for Groundwater and Surface Water Analysis

D-1.1 INTRODUCTION

The purpose of this Quality Assurance Project Plan (QAPP) is to give the objectives, organization, and functional activities, associated with groundwater and surface water monitoring for the St. Paul Confined Disposal Facility (CDF) as a component of the Thea Foss and Wheeler-Osgood Waterways Remediation Project. The CDF monitoring program was developed to assess the potential for impacts to the surface water via transport of contaminants in groundwater flowing from the CDF. A number of EPA documents were used as aids in preparing this document including EPA 1986, 1987, and 1989.

D-1.2 QUALITY ASSURANCE OBJECTIVE

The quality assurance (QA) objective for this project is to ensure that the data collected are of known and acceptable quality so that the goal of the CDF monitoring program can be achieved. The goal of CDF monitoring is long-term protection of surface water by demonstrating that groundwater quality adjacent to the CDF is not being adversely impacted.

The quality of the laboratory data is assessed by precision, accuracy, representativeness, comparability, and completeness (the "PARCC" parameters). Definitions of these parameters and the applicable quality control (QC) procedures are given below. Applicable quantitative goals for these data quality parameters, as well as method detection limits, are listed or referenced in Table D-1-1.

D-1.3 CONTRACT LABORATORY REQUIREMENTS

In completing chemical analyses for this project, the contract laboratory is expected to meet the following minimum requirements:

1. Adhere to the methods outlined in the QAPP, including methods referenced for each analytical procedure.
2. Deliver fax, hard copy, and electronic data as specified.
3. Meet reporting requirements for deliverables.
4. Meet turnaround times for deliverables.
5. Implement QA/QC procedures, including the QAPP data quality requirements, laboratory QA requirements, and performance evaluation testing requirements.
6. Allow laboratory and data audits to be performed, if deemed necessary.

D-1.4 CHEMICAL ANALYSES

Groundwater and surface water samples will be submitted for chemical analysis that will include a combination of the following:

- Metals (EPA Method 6020 [ICP-AES] for dissolved copper, lead, mercury, nickel, and zinc; EPA Method 7470A [CVAA] for total mercury);
- Total suspended solids (TSS) (EPA Method 160.2);
- Total organic carbon (TOC) (EPA Method 415.1);
- Salinity (per manufacturers specifications); and
- Polycyclic aromatic hydrocarbons (PAHs) (EPA Method 8270C).

Table D-1-1 presents the method of analysis and data quality objectives for the groundwater analyses.

D-1.4.1 Reporting Limits

The reporting limits for each analyte of interest are presented in the data quality objectives Table D-1-1. To achieve the required detection limits, some modifications to the methods may be necessary. Any modifications from the specified analytical methods will be provided by the laboratory at the time of establishing the laboratory contract, and EPA will be notified.

D-1.5 LABORATORY QUALITY ASSURANCE OBJECTIVES

D-1.5.1 Precision

Precision measures the reproducibility of measurements under a given set of conditions. Specifically, it is a quantitative measure of the variability of a group of measurements compared to their average values. Analytical precision is measured through matrix spike/matrix spike duplicate (MS/MSD) samples for organic analysis and through laboratory duplicate samples for inorganic analyses.

Analytical precision measurements will be carried out on project-specific samples at a minimum frequency of one per sampling event or one in twenty samples, whichever is more frequent per matrix analyzed, as practical. Laboratory precision will be evaluated against quantitative relative percent difference (RPD) performance criteria provided by the laboratory.

Field precision will be evaluated by the collection of blind field duplicates at a minimum frequency of one per laboratory analysis group or one in 20 samples. Field duplicate precision will be screened against a RPD of 50 percent for water samples. However, no data will be qualified based solely on field duplicate precision.

Precision measurements can be affected by the nearness of a chemical concentration to the method detection limit, where the percent error (expressed as RPD) increases. The equations used to express precision are as follows:

$$RPD = \frac{(C_1 - C_2) \times 100\%}{(C_1 + C_2)/2}$$

Where:

RPD = relative percent difference

C_1 = larger of the two observed values

C_2 = smaller of the two observed values

D-1.5.2 Accuracy

Accuracy is an expression of the degree to which a measured or computed value represents the true value. Field accuracy is controlled by adherence to sample collection procedures as outlined.

Analytical accuracy may be assessed by analyzing "spiked" samples with known standards (surrogates, laboratory control samples, and/or matrix spike) and measuring the percent recovery. Accuracy measurements on matrix spike samples will be carried out at a minimum frequency of one in 20 samples per matrix analyzed. Because MS/MSDs measure the effects of potential matrix interferences of a specific matrix, the laboratory will perform MS/MSDs only on samples from this investigation and not from other projects. Surrogate recoveries will be determined for every sample analyzed for organics.

Laboratory accuracy will be evaluated against quantitative matrix spike and surrogate spike recovery performance criteria provided by the laboratory. Accuracy can be expressed as a percentage of the true or reference value, or as a percent recovery in those analyses where reference materials are not available and spiked samples are analyzed. The equation used to express accuracy is as follows:

$$\%R = 100\% \times (S-U)/C_{sa}$$

Where:

%R = percent recovery

S = measured concentration in the spiked aliquot

U = measured concentration in the unspiked aliquot

C_{sa} = actual concentration of spike added

D-1.5.3 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent an environmental condition. For this program, the selected analytes have been identified as constituents of concern based on previous sampling investigations.

D-1.5.4 Comparability

Comparability expresses the confidence with which one data set can be evaluated in relation to another data set. For this study, comparability of data will be established through the use of standard analytical methodologies and reporting formats and of common traceable calibration and reference materials.

D-1.5.5 Completeness

Completeness is a measure of the amount of data that is determined to be valid in proportion to the amount of data collected. Completeness will be calculated as follows:

$$C = \frac{\text{(Number of acceptable data points) x 100}}{\text{(Total number of data points)}}$$

The data quality objective for completeness for all components of this project is 95 percent. Data that have been qualified as estimated because the quality control criteria were not met will be considered valid for the purpose of assessing completeness. Data that have been qualified as rejected will not be considered valid for the purpose of assessing completeness.

D-1.6 QUALITY CONTROL PROCEDURES

Sampling procedures for this investigation are described in detail in the CDF Monitoring Operations Manual for this project. Table D-1-1 presents the field sample preservation and holding time information.

D-1.6.1 Field Quality Control Procedures

Field sampling and documentation procedures are detailed in the CDF Monitoring Operations Manual. To control the quality of field samples, field duplicates will be collected at a frequency of 1 per 20 samples collected (minimum of one per sampling event). The QA/QC samples to be collected and analyzed for each sampling event are summarized in Table D-1-2. Although validation guidelines have not been established by EPA for field quality control samples, their analysis is useful in identifying possible problems resulting from sample collection or sample processing in the field. All field quality control samples will be documented in the field logbook and verified by the QA Manager, or designee.

D-1.6.2 Laboratory Quality Control Procedures

Laboratory Quality Control Criteria. Results of the quality control samples from each sample group will be reviewed by the analyst immediately after a sample group has been analyzed. The quality control sample results will then be evaluated to determine if control limits have been exceeded. If control limits are exceeded in the sample group, the Project QA Manager will be contacted immediately, and corrective action (e.g., method modifications followed by reprocessing the affected samples) will be initiated prior to processing a subsequent group of samples.

All primary chemical standards and standard solutions used in this project will be traceable to documented, reliable, commercial sources. Standards will be validated to determine their accuracy by comparison with an independent standard. Any impurities found in the standard will be documented.

The following sections summarize the procedures that will be used to assess data quality throughout sample analysis.

Initial and Continuing Calibration. Initial and continuing calibration will be performed in accordance with each analytical method requirements. Multipoint initial calibration will be performed on each instrument at the start of the project, after each major interruption to the analytical instrument, and when any ongoing calibration does not meet control criteria. Ongoing calibration will be performed daily for metals and organic analyses and with every sample batch for conventional parameters (when applicable) to track instrument performance.

Instrument blanks or continuing calibration blanks provide information on the stability of the baseline established. Continuing calibration blanks will be analyzed immediately following continuing calibration verification at a frequency of one continuing calibration blank for every 10 samples analyzed at the instrument for inorganic analyses and every 12 hours for organic analyses. If the ongoing calibration is out of control, the analysis must come to a halt until the source of the control failure is eliminated or reduced to meet control specifications. All project samples analyzed while instrument calibration was out of control will be reanalyzed.

Laboratory Duplicates. Analytical duplicates provide information on the precision of the analysis and are useful in assessing potential sample heterogeneity and matrix effects. Analytical duplicates are subsamples of the original sample that are prepared and analyzed as a separate sample. A minimum of one duplicate will be analyzed per sample group or for every 20 samples, whichever is more frequent.

Matrix Spikes and Matrix Spike Duplicates (MS/MSD). Analysis of matrix spike samples provides information on the extraction efficiency of the method on the sample matrix. By performing duplicate matrix spike analyses, information on the precision of the method is also provided for organic analyses. A minimum of one MS/MSD will be analyzed for every sample group or for every 20 samples, whichever is more frequent, when possible. MS/MSD analyses will be performed on project specific samples; QC analyses will not be performed using samples from different projects.

Surrogate Spikes. All project samples analyzed for organic compounds will be spiked with appropriate surrogate compounds as defined in the analytical methods. Surrogate recoveries will be reported by the laboratories; however, no sample result will be corrected for recovery using these values.

Method Blanks. Method blanks are analyzed to assess possible laboratory contamination at all stages of sample preparation and analysis. A minimum of one method blank will be analyzed for every extraction batch or for every 20 samples, whichever is more frequent.

D-1.7 SAMPLING DOCUMENTATION

Sample documentation is a critical aspect of environmental investigations. Sample possession and handling must be traceable from the time of sample collection through delivery to the laboratory. A sample log form and field logbook entries will be completed for each location occupied and each sample collected. Documentation procedures for sampling are provided in the CDF Monitoring Operations Manual.

D-1.7.1 Sample Handling

Sample collection and handling procedures are detailed in the Confined Disposal Facility Monitoring Operations Manual. To control the integrity of the samples during transit to the laboratory and during holding prior to analysis, established preservation and storage measures will be taken. Table D-1-1 presents container type, preservation, and maximum holding times for various chemical analyses of groundwater. Sample containers will be labeled with the client name, sample number, sampling date and time, required analyses, and initials of the individual processing the sample. The field technician will check all container labels, custody form entries, and logbook entries for completeness and accuracy at the end of each sampling day.

D-1.7.2 Sample Chain of Custody

Sample labeling and custody documentation will be performed as described in the CDF Monitoring Operations Manual. Custody procedures will be used for all samples at all stages in the sample collection, transfer, and delivery to the laboratory.

D-1.7.3 Sample Preservation

The requirements for preserving sample aliquots destined for each type of analysis for groundwater are listed in Table D-1-1. Immediately after the sample bottles are filled with groundwater they will be placed in the appropriate coolers with a sufficient number of ice packs (or crushed ice) to keep them at approximately $4 \pm 2°C$ through the completion of that day's sampling and transport to the laboratory.

D-1.7.4 Sample Shipment

The lead field technician will be responsible for sample tracking and custody procedures in the field. The QA Coordinator will be responsible for final sample inventory and will maintain sample custody documentation. The field technician, or designee, will complete custody forms. At the end of each day, and prior to transfer, custody form entries will be made for all samples. Finally, information on the sample labels will be checked against sample logbook entries and custody forms, and samples will be recounted. All samples will be accompanied by custody forms; the forms will be signed at each point of transfer and will include sample numbers. All custody forms will be completed in indelible ink.

It is not expected that groundwater or surface water samples will require shipping, however, in the event that it is necessary the following steps will be taken. Prior to shipping, sample containers will be wrapped and securely packed inside the cooler with ice packs or crushed ice by the field technician. The original, signed custody forms will be transferred with the cooler. The cooler will be secured and appropriately sealed and labeled for shipping immediately.

Samples will be delivered to the laboratory under custody following completion of sampling activities.

D-1.7.5 Sample Receipt

The designated sample custodian at the laboratory will accept custody of the samples and verify that the chain of custody matches the samples received. A cooler receipt form will be filled out to document conditions of the cooler. The Project Manager at the laboratory will ensure that the custody forms are properly signed upon receipt of the samples and will note questions or observations concerning sample integrity on the custody forms. The laboratory will contact the Project QA Coordinator immediately if discrepancies are discovered between the custody forms and the sample shipment upon receipt. The laboratory Project Manager will specifically note any coolers that do not contain ice packs or are not sufficiently cold (4 ± 2°C) upon receipt.

D-1.8 DATA REDUCTION, VALIDATION, AND REPORTING

D-1.8.1 Data Reduction and Reporting

Initial data reduction, evaluation, and reporting at the laboratory will be carried out as described in the appropriate analytical protocols and the laboratory's QA Manual. Quality control data resulting from methods and procedures described in this document will also be reported.

The laboratory will be responsible for internal checks on data reporting and will correct errors identified during the quality assurance review. Close contact will be maintained between the Project QA Manager and the laboratory to resolve in a timely manner quality control problems that may arise. The analytical laboratory will be required, where applicable, to report the following:

- **Project Narrative.** This summary, in the form of a cover letter, will discuss problems, if any, encountered during any aspect of analysis. This summary should discuss, but not be limited to, quality control, sample shipment, sample storage, and analytical difficulties. Any problems encountered, actual or perceived, and their resolutions will be documented in as much detail as appropriate.
- **Chain of Custody Records.** Legible copies of the custody forms will be provided as part of the data package. This documentation will include the time of receipt and condition of each sample received by the laboratory.
- **Sample Results.** The data package will summarize the results for each sample analyzed. The summary will include the following information when applicable:
    - Field sample identification code and the corresponding laboratory identification code;
    - Sample matrix;
    - Date of sample extraction;
    - Date and time of analysis;
    - Reporting limits;
    - Analytical results with reporting units identified;
    - Data qualifiers and their definitions; and
    - A CD with the data.

- **Quality Assurance/Quality Control Summaries.** This section will contain the results of the laboratory QA/QC procedures. Each QA/QC sample analysis will be documented with the same information required for the sample results (see above). No recovery or blank corrections will be made by the laboratory. The required summaries are listed below; additional information may be requested.
- **Calibration Data Summary.** Report the concentrations of the initial calibration and daily calibration standards and the date and time of analysis. List the response factor, % RSD, percent difference, and retention time for each analyte as appropriate. Report results for standards to indicate instrument sensitivity.
- **Internal Standard Area Summary.** Report the stability of internal standard areas.
- **Method Blank Analysis.** Report the method blank analyses associated with each sample and the concentration of all compounds of interest identified in these blanks.
- **Surrogate Spike Recovery.** Report all surrogate spike recovery data for organic compounds. List the name and concentration of all compounds added, percent recoveries, and range of recoveries.
- **Matrix Spike Recovery.** Report all matrix spike recovery data for organic and metal compounds. List the name and concentration of all compounds added, percent recoveries, and range of recoveries. Report the RPD for all duplicate analyses.
- **Matrix Duplicate.** Report the RPD for all matrix duplicate analyses.
- **Relative Retention Time.** Report the relative retention time of each analyte detected in the samples for both primary and confirmational analyses.
- **Original Data.** Legible copies of the original data generated by the laboratory will include:
    - Weight and/or volume used for analysis;
    - Final dilution volumes or concentration factor for the sample;
    - Sample extraction, preparation, and cleanup logs;
    - Identification of the instrument used for analysis;
    - Instrument logs for all instruments used on days of calibration and analysis;
    - Reconstructed ion chromatograms for all samples, standards, blanks, calibrations, spikes, replicates, and reference materials;
    - Printouts and quantitation reports for each instrument used, including reports for all samples, standards, blanks, calibrations, spikes, replicates, and reference materials; and
    - Original data quantification reports for each sample.

D-1.8.2 Data Validation and Reporting

Once analysis is complete, a number of QC procedures will be followed to provide an accurate evaluation of the data quality. Specific procedures will be followed to assess data precision, accuracy, and completeness.

A data quality review of the analytical data will follow EPA National Functional Guidelines (EPA 1999 and 2002), in accordance with the QAPP limits. All chemical data will be reviewed with regard to the following, as appropriate to the particular analysis:

- Chain of custody/documentation;
- Holding times;
- Instrument calibration;
- Method blanks;
- Reporting limits;
- Surrogate recoveries;
- Matrix spike/matrix spike recoveries;
- Laboratory control sample recoveries; and
- Laboratory and field duplicate relative percent differences.

The results of the data quality review including text assigning qualifiers in accordance with the EPA National Functional Guidelines (EPA 1999 2002) and a tabular summary of qualifiers will be generated by the Data Validation Specialist and submitted to the Project QA Coordinator for final review and confirmation of the validity of the data. A quality assurance summary of the review will be generated by the Project QA Coordinator. This summary and copies of the complete review will be presented as an appendix to the monitoring reports.

D-1.9 LABORATORY AUDITS AND CORRECTIVE ACTIONS

Laboratory and field performance audits and corrective action procedures are described in this section.

D-1.9.1 Laboratory and Field Performance Audits

Laboratory and field performance audits consist of on-site reviews of quality assurance systems and equipment for sampling, calibration, and measurement. Laboratory audits will not be conducted as part of this study; however, all laboratory audit reports will be made available to the Project QA Coordinator upon request. The laboratory is required to have written procedures addressing internal QA/QC. The laboratory must ensure that personnel engaged in sampling and analysis tasks have appropriate training.

The laboratory will, as part of the audit process, provide for consultant's review, written details of any and all method modifications planned.

D-1.9.2 Corrective Action Procedures

Corrective Action for Field Sampling. The field technician will be responsible for correcting equipment malfunctions during the field sampling effort. The Project QA Coordinator will be responsible for resolving situations in the field that may result in noncompliance with the QAPP. All corrective measures will be immediately documented in the field logbook.

Corrective Action for Laboratory Analyses. The laboratory is required to comply with their Standard Operating Procedures (SOPs). The laboratory Project Manager will be responsible for ensuring that appropriate corrective actions are initiated as required for conformance with this

QAPP. All laboratory personnel will be responsible for reporting problems that may compromise the quality of the data.

If any quality control sample exceeds the project-specified control limits the analyst will identify and correct the anomaly before continuing with the sample analysis. The analyst will document the corrective action taken in a memorandum submitted to the Project QA Coordinator. A narrative describing the anomaly, the steps taken to identify and correct the anomaly and the treatment of the relevant sample batch (i.e., recalculation, reanalysis, and re-extraction) will be submitted with the data package.

REFERENCES

EPA. 1986. Superfund Remedial Design and Remedial Action Guidance, OSWER Directive 9355.0-4A. Office of Solid Waste and Emergency Response, Office of Emergency and Remedial Response. June 1986.

EPA. 1987. Data Quality Objectives for Remedial Response Activities. Development Processes. EPA/540/a-7/003.

EPA. 1989. Preparation Aids for the Development of RREL Quality Assurance Project Plans (Pocket Guide). Risk Reduction Engineering Laboratory, Cincinnati, Ohio. EPA/600/989087. October 1989.

EPA. 1994. USEPA Contract Laboratory Program National Functional Guidelines for Inorganic and Organic Data Review. EPA/540/R-94/012. February 1994.

EPA. 1999 and 2002. EPA National Functional Guidelines

TABLES

Table D-1-1 – Data Quality Objectives for Groundwater and Surface Water Analyses

Table D-1-2 – QA/QC Sampling Summary

Table D-1-1
Data Quality Objectives for Groundwater and Surface Water Analyses

Parameter	Units	Reporting Limit Goal	Precision	Accuracy	Completeness	Reference	Sample Container	Container Type	Holding Time (a)	Preservative
Metals	µg/L	Cu: 1.75 Pb: 1.58 Hg: 0.05 Ni: 0.5 Zn: 2.04	+/- 25%	+/- 25%	95%	EPA Method 6010B for Cu, Pb, Ni, and Zn; EPA Method 7470A for Hg	1 liter	HDPE	28 days Hg, 6 months (all other metals)	cool/4°C/dark HNO3
PAHs	µg/L	0.01[b]	+/- 25%	+/- 25%	95%	EPA Method 8270C	1 liter amber	Glass amber	7 days/40 days	cool/4°C/dark
Total organic carbon	mg/L	1	+/- 20%	+/- 20%	95%	EPA Method 9060	250 milliliter	Glass amber	28 days	cool/4°C/dark H2SO4
Total suspended solids	mg/L	1	+/- 25%	NA	95%	EPA Method 160.2	1 liter	HDPE	7 days	NA
Salinity	ppt	0.5	+/- 25%	NA	95%	SM 2520			14 days	NA

Notes:
HDPE - High Density Polyethylene
NA - Not applicable.
[a] When two holding times are listed, the first holding time is until extraction, the second is until analysis.
[b] The reporting limit listed for PAHs is achieved using Selected Ion Monitoring (SIM) methodology.
* Actual analytical reporting limits for surface water or tidally influenced groundwater samples may be affected by interferences due to salinity.
If salinity interferences become evident in the initial round of monitoring, the laboratory Project Manager will notify the OMMP Project Proponent for analytical options.

Table D-1-2
QA/QC Sampling Summary

QA/QC Sample Type	Frequency/Number of Samples	Laboratory Analyses
Duplicate (Field or Laboratory)	One for groundwater and surface water samples at a 5% frequency	Same as original sample
Equipment Blank	One for non-dedicated surface water sampling equipment	Same as original sample
MS/MSD (Laboratory Only)	One additional sample collected per 20 groundwater and surface water samples	Same as original sample, collect triplicate volume

Attachment D-2

Groundwater and Surface Water Sample Collection Form

GROUNDWATER AND SURFACE WATER SAMPLE COLLECTION FORM

Date of Collection: _____

Field Personnel: _____

Purge Data (Not required for surface water collection, however, surface water field parameters must be recorded)

Well Condition: _____ Secure: ☐ Yes ☐ No Well Damage Description: _____

Depth Sounder decontaminated Prior to Placement in Well: ☐ Yes ☐ No

Depth of water (from top of well casing): _____

After 5 minutes of purging (from top of casing): _____

Begin purge (time): _____

End purge (time): _____

Gallons purged: _____

Purge water disposal method: _____

One Casing Volume (gal): _____

Well Casing Type/Diameter: _____

Volume of Schedule 40 PVC Pipe

Diameter	O.D.	I.D.	Volume (Gal/Linear Ft.)	Weight of Water (Lbs/Lineal Ft.)
1 ¼"	1.660"	1.380"	0.08	0.64
2"	2.375"	2.067"	0.17	1.45
3"	3.500"	3.068"	0.38	3.2
4"	4.500"	4.026"	0.66	5.51
6"	6.625"	6.065"	1.5	12.5

Time	Vol. Purged	pH	DO	Conductivity	Turbidity	Temp	Comments

Sampling Data

Sample No: _____ Location and Depth: _____

Date Collected (mo/dy/yr): _____ Time Collected: _____ ☐ AM ☐ PM Weather: _____

Type: ☐ Ground Water ☐ Surface Water Other: _____ Sample: ☐ Filtered ☐ Unfiltered Other: _____

Sample Collected with: ☐ Bailer ☐ Pump Other: _____ Made of: ☐ Stainless Steel ☐ PVC ☐ Teflon Other: _____

Sample Decon Procedure: _____

Sample Description (Color, Turbidity, Odor, Other): _____

Sample Analyses

Analytes						Sample Containers		Preservatives	
TOC	☐	HG (diss/total)	☐	Filtered:	☐	Metals (filtered):	☐ (1) 1 L	Metals (filtered):	☐ HNO_3
Salinity	☐	PB (diss)	☐	Filtered:	☐	Hg (total):	☐ (1) 250mL	Hg (total):	☐ HNO_3
TSS	☐	CU (diss)	☐	Filtered:	☐	Conventionals:	☐ (1) 250mL	Conventionals:	☐ H_2SO_4
PAHs	☐	Zn (diss)	☐	Filtered:	☐	Other:	_____	Other:	_____

Additional Information

Types of Sample Containers:	Quantity:	Duplicate Sample Numbers:	Comments:

Signature: _____ **Date:** _____

Attachment D-3

Well Installation Log

Well Installation Log

Thea Foss and Wheeler-Osgood Waterways OMMP

Location Sketch

N

Coordinates

N_____ E_____ Datum_____

Obs. Well Install. Yes No If yes, see attached Sheet 2

Boring _____ Date _____ Sheet ____ of ____

Job _____ Job No. _____

Logged By _____ Weather _____

Drilled By _____

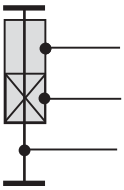
Drill Type/Method ☐ HSA, ☐ Geoprobe, other: _____

Sampling Method ☐ Splitspoon (hammer height ____, diameter ____) ☐ Shelby Tube, Other ____

Depth of Boring _____ ATD Water Level Depth(from top of PVC) _____

Ground Surface Elevation _____

SAMPLE ID	Blow Count	DEPTH From	DEPTH To	SAMPLE RECOVERY (FT)				DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	Comments
					0				
					1				
					2				
					3				
					4				
					5				
					6				
					7				
					8				
					9				
					10				
					11				
					12				
					13				
					14				
					15				
					16				
					17				
					18				
					19				
					20				



Recovery

Subsample for Analysis

Driven Interval

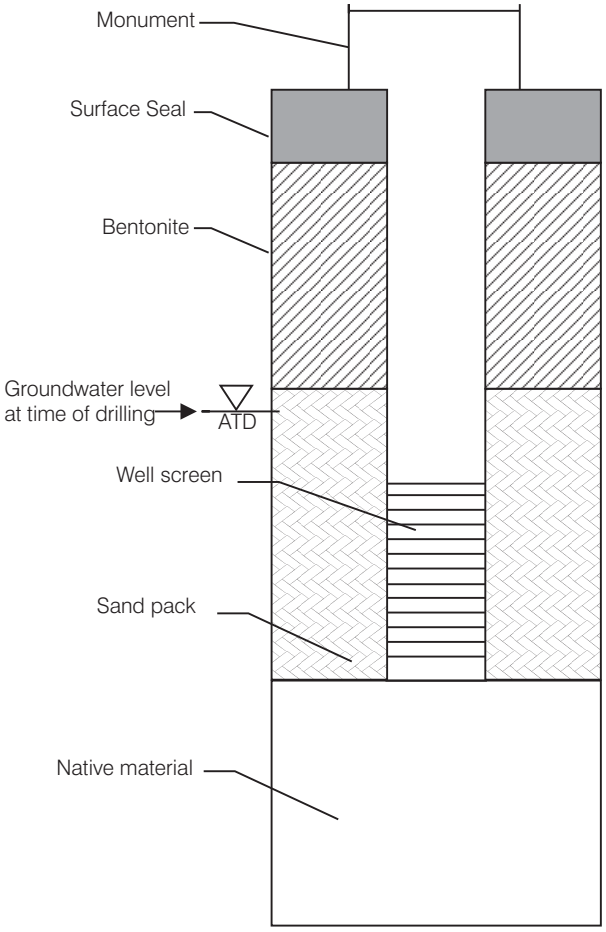
Groundwater Observed At Time of Drilling

Potentially Contaminated Soil

Well Installation Log

Boring_____ Date_____ Sheet____ of____

Logged By_____



Monument type and height_____

Depth and thickness of bentonite_____

Depth and thickness of sand pack_____

Screened interval_____

Additional Well Information

Well/Completion Type ☐ Flush mount, ☐ Above ground

If above ground - protective guard posts installed ☐ Yes ☐ No

Well material and diameter_____

Type of sand pack_____

Is screen prepacked_____

Was well developed ☐ Yes ☐ No If yes, final turbidity_____ NTU

Casing Depth_____

Soil cuttings disposal method_____

Attachment D-4

CDF Berms and Cap Observation Form

CDF BERMS AND CAP OBSERVATION FORM **Thea Foss and Wheeler-Osgood Waterways OMMP**

Location: _____

Date/Time: _____

Weather: _____

Field Personnel: _____

Observation Notes:

1) Provide general sketch of observations of berm or cap
2) Draw diagram so that observation area fills diagram box
3) Note type of material(s) at surface (i.e., habitat mix, rip rap, quarry spalls, gravel, sand, silt, etc.)
4) Note presence and location of objects or debris (i.e., logs, garbage, etc.)
5) Delineate extent of berm or cap integrity issues, if present
6) Delineate presence of seeps or possible contamination (i.e., sheen, discoloration, staining, etc.), if present
7) Note approximate location of water surface and top of bank, if appropriate (i.e., berms)
8) Label photo locations and photo direction
9) Label north arrow

Additional Notes: (For any berm structure or cap integrity issues observed, describe potential causes and extent of issue)

_____

_____

_____