5 FIELD SAMPLING METHODS

The following sections summarize the soil collection procedures for the sampling methods anticipated to be conducted during the investigation. Detailed procedures are included in Appendix A, Standard Operating Procedures (SOPs). Field sampling will include in situ soil samples, decontamination water samples, and quality control samples (source blanks and duplicates). The sampling frequencies, locations, and designations are described in the previous sections. Tables 2-9, 2-10, 3-1, and Section 4 provide the estimated number of samples and required analysis for field sampling.

5.1 SURFACE SOIL SAMPLING

Surface soil samples on the mill site will be collected from discrete source areas as defined in Section 2.3. EPA operationally defines surface soils as samples collected in the shallowest interval as practicable. For purposes of this investigation, this interval is assumed to be from 0 to 3 inches bgs.

Discrete surface soil samples will be collected using a shovel or hand auger, stainless steel spatula or knife, and spoon. Location of samples will be by hand-held GPS, following the general sampling location point map as a guide. Exact locations will depend upon field observations and obvious nonsoil material, such as loose demolition debris, concrete waste, piping, or wood debris will be avoided unless specifically targeted by the plan. All subsurface samples should be co-located with the corresponding surface soil sample.

The following general sampling procedures are to be followed for discrete surface soil sample collection:

- Visually inspect the potential area for an appropriate soil site, relatively free of debris or foreign objects.
- Locate exact sample location with GPS.
- Label appropriate glassware in accordance with sample numbering scheme.
- Use a shovel to dig a small hole at this location and expose a soil face; use a pick or pick-axe, if necessary, to assist.
- Remove any foreign debris. Non-soil material (e.g., crushed concrete, wood chips, ash) will be excluded from the sample.
- Use a stainless steel spatula or knife to cut a clean soil face.
- Alternatively, soil can be collected from a surficial core from a hand auger, following the SOP. The core should be subsampled using a clean stainless steel spoon.

- Place soil directly from stainless steel spoon (or spatula) into sample containers. If collecting samples for VOCs, gasoline range organics (GRO), or benzene, toluene, ethylbenzene, and total xylenes (BTEX), fill these jars first. Immediately field-preserve GRO and BTEX samples with the method as described in SOPs.
- Collect duplicate samples as required.
- Take care to collect an even amount of material from the entire face; avoid bias in samples.
- Secure container lids, place completed custody seals over lids of all jars with the exception of VOC, GRO, and/or BTEX samples.
- Place samples in iced cooler.
- Record sampling location in the field logbook.
- Photograph sample location.

Collect subsurface samples, as appropriate, following procedures described below.

- Fill in excavation back to original ground surface.
- Decontaminate sampling equipment in accordance with SOP 7, and change sampling gloves between each sampling location.
- Collect any decontamination wastewater and source water quality control (QC) samples as specified.

At certain areas and locations, the presence of asphalt, crushed rock, or concrete (foundations) may preclude the direct procedure described above. Based upon initial site inspection, if it is impractical to relocate the general position, special sampling equipment will be required. This may include a powered cutting auger or concrete coring device. Use of this equipment should be directed by the Field Operations Lead (FOL). Procedures for these operations are typically equipment specific, and will be incorporated into the plan as necessary. In no case should material (such as surface asphalt residue or concrete coring cuttings) be included in a collected sample that is not obviously a part of the in situ soil matrix.

5.2 SUBSURFACE SOIL SAMPLING

Subsurface soil samples will be collected from discrete operation areas. The samples will be a composite; representing an interval from 3 inches bgs to saturated soil (groundwater), typically 6 to 8 feet bgs. Method of collection will typically be by either a hollow-stem auger or geoprobe. Any subsurface sample should be co-located with a corresponding surface soil sample.

The following general sampling procedures are to be followed for subsurface soil sample collection:

- Visually inspect the potential area for an appropriate soil site, relatively free of debris or foreign objects.
- Locate exact sample location with GPS.
- Label appropriate glassware in accordance with sample numbering scheme.
- Operate geoprobe in accordance with manufacturer's instructions.
- Care should be taken due to subsurface historic riprap and buried former facility lines. Therefore, appropriate clearance must be considered and probe refusal points acknowledged.
- If the probe is refused, up to two additional attempts should be made, slightly varying the position of the device. If it becomes obvious that a major subsurface impediment is precluding sampling, an alternate sampling location must be selected in consultation with the FOL, Project Manager, and Site Management Team (SMT), if necessary.
- Selected samples will be field screened for hydrocarbons or VOCs as outlined below, with the results of the screening marked on the boring log.
- The ends of the sleeves will immediately be capped and the sample will be marked with the boring number, depth, and time collected.
- Place samples in iced cooler for later compositing and subsampling. Alternatively, cores may be subsampled. A clean surface is cut lengthwise from the core with a spatula or knife.
- Alternatively, follow hollow-stem auger SOP to collect soil. The same general guidance for sample refusal applies, i.e., up to two additional attempts, and consult management.
- A subsample will be removed at approximately every vertical foot of core and placed into clean stainless bowls and processed following the surface soil sampling SOP. Foreign debris will be removed from the sample. Non-soil material (e.g., crushed concrete, wood chips, ash) will be excluded from the sample.
- Record sampling location in the field logbook.
- Photograph sample location.
- Fill in excavation back to original ground surface.
- Decontaminate sampling equipment in accordance with SOP 7, and change sampling gloves between each sampling location.

As noted above, selected individual cores will be screened for potential hydrocarbon and VOC contamination. The suspect soil sample will be field-screened using a photoionization detector (PID), and by visual inspection and olfactory (smell) observation to determine if hydrocarbon contamination is present in the soil. The screening process will be conducted as follows:

- The PID wand will be placed at the end of the transparent sleeve and the meter reading will be recorded on the boring log as well as in the site logbook.
- A visual inspection will be made of the soil exposed within the transparent sleeves to determine if soil discoloration or hydrocarbon type sheen is observed. A note will be made on the boring log and in the field logbook as to the observations made during the visual inspection.
- If a hydrocarbon odor is observed from the sample, make a note on the boring log and in the field notebook as to the relative intensity of the odor.

The combination of these three field screening methods will be used to determine if additional samples will be sent to the analytical laboratory for analysis.

As with surface samples at certain areas and locations, the presence of asphalt, crushed rock, or concrete (foundations) may preclude the direct procedure described above. In addition, subsurface fill materials or structures may also be encountered. Based upon initial site inspection, if it is impractical to relocate the general position, special sampling equipment will be required. This may include a concrete coring device or special drill rig. Use of this equipment should be directed by the FOL. Procedures for these operations are typically equipment specific, and will be incorporated into the plan as necessary. In no case should material (such as surface asphalt residue or concrete coring cuttings) be included in a collected sample that is not obviously a part of the in situ soil matrix.

5.3 ECOLOGICAL SOIL SAMPLING

Field sampling will begin with a site survey whose purpose is to characterize the existing earthworm and grass communities. Field documentation will follow the procedures described in Section 4.8. The objectives of the site survey are:

- Determine if earthworms and appropriate grass species are present at or proximal to the sampling locations
- Identify the dominant earthworm and grass species at the site that will be sampled
- Select the soil depth at which earthworms are more often present and the greatest mass of grass roots occur.

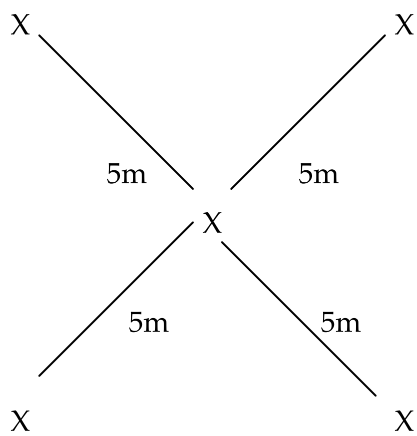
The site survey will consist of visiting each of the sample locations, making observations on the plant community, digging several holes with a shovel near sample locations, and measuring with a ruler the depth to which most earthworms and grass roots extend. The dominant earthworm and grass species for the site will be qualitatively determined and identified as the species that will be sampled. It is important to try to collect samples of the same species from all locations because this will eliminate inter-species differences in bioaccumulation of contaminants. However, the same species may not exist at all sample locations. In these cases, alternate species will have to be collected and this will be noted. Samples of earthworms and grasses will be collected for taxonomic verification. Grass samples including the flower, leaf, stem, and root will be labeled and placed in a standard plant press, and earthworm samples will be labeled and stored in glass vials containing 70 percent alcohol.

If the dominant earthworm and grass species identified during the site survey (or alternate species) are not present at the sample location, the nearest location to the location containing these species will be identified as the final sampling location. Field changes will be documented using the procedures described in Section 4.6.

The biologically active soil horizon represents the primary source by which earthworms and plants are exposed to soil-borne contaminants. Where soil moisture conditions are favorable, earthworms typically concentrate in the upper soil horizon where particulate organic matter, the primary food of earthworms, is most abundant. Roots of grasses also tend to concentrate in the upper soil horizon, but may extend to greater depths dependent upon soil and environmental characteristics. The average depth to which most earthworms and grass roots extend will be identified and recorded at each sample location in the field. A soil sample will be collected from the biologically active soil horizon from each location.

Representative samples of soil, earthworms, and plants will be obtained from the sample location using a composite sample design. The composite sample will consist of subsamples from five locations distributed approximately as shown in Figure 5-1. Equal numbers of earthworm and plants, and volumes of soil will be collected from each subsample location and pooled into a single sample. The same sample design will be used at locations where only soil samples are being collected. This sample design may need to be modified depending on site-specific limitations. Additional information on compositing samples is presented in Section 4.9.

Figure 5-1. Soil, Earthworm, and Plant Composite Sample Design



Soil sampling will be conducted using a shovel following the general sampling procedures described for a hand auger in SOP 9 and decontamination procedures described in Section 4.3. A hole will be dug with a shovel to a depth encompassing the biologically active zone. A clean soil face will be exposed along one wall of the hole using a clean stainless steel knife. A uniform slice of soil extending from the surface to the maximum depth of the biologically active zone will be excavated with the aid of the stainless steel knife and placed into a clean stainless steel mixing bowl. Sampling will be repeated at the five subsample locations, and the cuttings will be mixed thoroughly with a clean spoon prior to filling the sample container. Large roots and stones will be excluded from the sample containers. Decontamination of the stainless steel knife, mixing bowl, and spoon will be performed between sample locations and not between subsample locations. Soil samples will be processed for shipping using the procedures described in Section 4.8 and Section 5.

Ecological soil sampling will follow the methods described in Section 5.1 on the industrialized portion of the mill site where grasses and earthworms are not being sampled.

5.4 PLANT AND INVERTEBRATE SAMPLING

Results from the plant and earthworm tissue analysis will be used to evaluate exposure to wildlife via the food consumption exposure route. In addition, tissue results will be coupled with analytical results for soil samples collected from the same locations to calculate site-specific BAFs that can be used to estimate tissue concentrations from locations that only have soil data.

Earthworms will be collected by digging with a shovel and hand sorting. Earthworms from the five subsamples at a sample location will be pooled to yield a sample of 30 grams of tissue or what can be practically collected. Sampling equipment that comes into potential contact with the earthworms (e.g., stainless steel forceps) will be decontaminated between sample locations (not between subsample locations) following procedures described in Section 4.13.

The shrew and robin exposure models include a separate parameter that accounts for incidental soil ingestion. Therefore, use of whole body earthworm samples that include the tissue and gut contents that may contain up to 25 percent soil on a fresh body weight basis would give an inaccurate estimate of potential exposure for the shrew and robin. Soil will be removed from the gut of the earthworms prior to chemical analyses to eliminate this inaccuracy. The most widely used method for removing the gut contents from earthworms is to eliminate their food source (soil and its associated organic matter) and let them purge their gut contents naturally. The pooled earthworm sample from each sample location will be placed in a clean sample jar (see Section 5.1 for details) with 2 milliliters of distilled/deionized water for 24 hours and then transferred to a second clean sample jar containing 2 milliliters of distilled/deionized water for an additional 24-hour period. During purging, the jars containing the earthworms will be labeled with the appropriate sample number and stored in a cooler over the ice or coolant (e.g., blue ice). Following the 48-hour purging period, the earthworms will be rinsed in distilled/deionized water to remove any adhering soil, placed in clean sample jars (see Section 6.1 for details) and allowed to air-dry in the opened sample jar to a level where free water is not observed. At that point, the sample jar will be processed using the procedures described in Section 4.8 and Section 5.

Plant tissue samples will be collected using clean stainless steel scissors, forceps, and bowls. Leaves of the dominant grass species in the area will be collected from the five subsamples and pooled to yield 30 grams of tissue. The entire leaf will be excised from a minimum of five plants within the subsample area and placed into the sample bowl. Sampling equipment (e.g., scissors, forceps) will be decontaminated between sample locations (not subsample locations) following procedures described in Section 4.13. The exposure model for the herbivorous wildlife receptor (i.e., vole) has a separate parameter to account for incidental soil ingestion. The use of whole plant samples would give an inaccurate estimate potential exposure because it includes soil that has been deposited on the surface of the leaf as fugitive dust. Therefore, soil will be removed from the leaf surface prior to chemical analysis. Each pooled leaf sample will be rinsed in two changes of distilled/deionized water containing a surfactant and allowed to air-dry in a clean stainless steel bowl to remove visible water before being placed in the sample container. Leaf samples will be rinsed twice by shaking for 90 and 30 seconds, respectively, in a solution of EDTA ($3x10^{-2}$ moles, pH5) in a clean sample jar (Bakker, et al. 2001). At that point, the leaf sample will be placed in a sample jar (see Section 5 for details) and processed using the procedures described in Section 4.8 and Section 5.

Investigation derived waste (i.e., decontamination waste) will be managed following the procedures described in Section 4.10.

5.5 GROUNDWATER SAMPLING

Nineteen groundwater wells form the RI monitoring network (Figure 3-1), and each well will be sampled for the parameters shown on Table 3-1. The wells will be sampled using either portable or dedicated submersible pumps.

In wells where light nonaqueous phase liquid (LNAPL) layers are present, or historically have had LNAPL layers, dedicated submersible pumps will be installed. Dedicated pumps in these wells will prevent the swabbing of the LNAPL layer into the water column of the well during repeated installation of portable pumps, which may affect the results of the subsequent groundwater samples. All sampling activities will be recorded in the field logbook. Additionally, all sampling data will be recorded on a well sampling form.

During each groundwater sampling event, wells will be inspected for signs of tampering or other damage. If tampering is suspected (i.e., casing is damaged, lock or cap is missing), this will be recorded in the field logbook and on the well sampling form and reported to the FOL. Wells that are suspected to have been tampered with will not be sampled until the FOL has discussed the matter with the Project Manager.

Before the start of sampling activities, plastic sheeting will be placed on the ground surrounding the well, if necessary, to provide a clean working area around the well head and to prevent any soil contaminants from contacting sampling equipment. Remove water in the protective casing or in the vaults around the well casing prior to venting and purging. Procedures in the HASP will be followed when high concentrations of organic vapors or explosive gases are detected; however, this occurrence is deemed highly unlikely for this site.

Purge pump intakes will be equipped with a positive foot check valve to prevent purged water from flowing back into the well. Purging and sampling will be performed in a manner that minimizes aeration in the well bore and the agitation of sediments in the well and formation. Equipment will not be allowed to free-fall into a well. The following sections detail the required activities to be conducted during each groundwater sampling event.

Field parameter monitoring equipment will be calibrated in accordance with the manufacturer's specifications and the procedures presented in SOP 4, Appendix A.

5.5.1 LNAPL THICKNESS/WATER LEVEL MEASUREMENTS

A decontaminated interface probe will be used in all wells to determine if a nonconductive LNAPL layer is present in the well. The groundwater level will then be measured to the nearest 0.0l foot using the interface probe. LNAPL and water levels will be measured from the notch located at the top of the well casing.

If an LNAPL layer is encountered in a well, the thickness of the layer will be calculated by subtracting the LNAPL depth from the water level depth. The measurements and thickness will be recorded on the water sampling form and in the field logbook.

Following water level measurement, the total depth of the well from the top of the casing will be determined using a weighted tape or electric sounder and recorded on the well sampling form. The water level depth will then be subtracted from the total depth of the well to determine the height of the water column present in the well casing. All water level and total depth measuring devices will be routinely checked with a tape measure to ensure measurements are accurate.

5.5.2 PURGING PRIOR TO SAMPLING

Purging of monitoring wells is performed to evacuate water that has been stagnant in the well and may not be representative of the aquifer. Purging will be accomplished using a submersible Grundfos® (or equivalent) pump using micropurge techniques. Micropurge is a low-flow rate monitoring well purging and sampling method that induces laminar (nonturbulent) flow in the immediate vicinity of the sampling pump intake, thus drawing groundwater directly from the sampled aquifer, horizontally through the well screen, and into the sampling device. Low-flow pumping rates associated with the micropurge technique are in the approximate range of 0.2 to 2.0 liters per minute (L/min). These low-flow rates minimize disturbance in the screened aquifer, resulting in minimal production of artificial turbidity and oxidation, minimal mixing of chemically distinct zones, minimal loss of VOCs, and collection of representative samples while minimizing purge volume. Each well will be purged until the selected field parameters have stabilized as defined below.

5.5.3 GROUNDWATER SAMPLE COLLECTION

Groundwater samples at each well will be collected using the micropurge techniques described above. Using micropurge, groundwater samples may be collected after the temperature, pH, specific conductance, dissolved oxygen, redox potential (Eh), and turbidity have stabilized. Stabilization will be defined as in Table 5.1.

Table 5.1 Groundwater Sampling Stabilization Parameters and Criteria

Field Parameter	Stabilization Criteria
Temperature	± 1°C
pH	± 0.1 pH units
Specific conductance	± 5 percent
Dissolved oxygen	± 10 percent
Redox potential (Eh)	± 50 mV
Turbidity	± 10 NTUs

Groundwater samples will be collected directly from the discharge bib on the Grundfos® pump system. Samples for dissolved metals will be field filtered by attaching a 0.45 micron filter directly in-line with the discharge tubing.

Protocols and procedures for groundwater sample collection are presented in SOP 5 in Appendix A. Required sample containers, preservation methods, volumes, and holding times are given in Table 5-1. Sampling equipment will be decontaminated in accordance with SOP 7 prior to commencing sampling activities, as well as between each well.

5.5.4 WATER LEVEL MEASUREMENTS

During each groundwater sampling event, water level measurements will be taken in all monitoring wells and piezometers at least once within a single 24-hour period to determine the elevation of the water table and to provide the data necessary for preparation of water table contour maps for each event. These measurements will be taken after all monitoring wells have been installed and developed and their water levels have recovered completely. Any conditions (e.g., barometric pressure) that may affect water levels will be recorded in the field log. The field log will also include the previous water level measurement for each well (to determine if current water level is reasonable).

Water level measurements will be taken with electric sounders or interface probes. All measuring equipment will be decontaminated according to the specifications in Section 3.4.8. Groundwater level will be measured to the nearest 0.01 foot (two or more sequential measurements will be taken at each location until two measurements agree to within ±0.01 foot).

5.5.5 SLUG TESTS

In order to determine the approximate hydraulic conductivity of the unconfined fill aquifer beneath the site, rising and falling head slug tests will be conducted in most wells at the site. Slug tests will be conducted for new wells and all existing MW, PZ, and FR wells except those for which tests were completed in early 2001. The total number of wells tested could be 23, although no slug tests will be conducted in wells in which LNAPLs are identified.

Water level measurements will be recorded during the slug tests using pressure transducers and data loggers. Protocols and procedures for conducting the slug tests are presented in SOP 6 in Appendix A. Hydraulic conductivity will be calculated from the results of the slug tests using commercially available software using the Bouwer and Rice Protocol for Unconfined Aquifers.

5.5.6 TIDAL INFLUENCE ASSESSMENT

After installation of the monitoring wells, groundwater levels will be measured in all wells and piezometers at the site for a 24-hour period to determine the effects, if any, of tides on the unconfined till aquifer beneath the site. A period of high tidal fluctuations will be selected. Water level measurements will be collected from each using electronic water level sounders. Each well will be measured at least once every 4 hours to determine if tidal changes affect groundwater levels in the wells.

At the completion of the 24-hour test, the data will be reviewed and a follow-up study using pressure transducers and data loggers will be implemented in any well, up to a maximum of 12, showing tidal influence greater than 0.2 feet. If more than 12 wells indicate a fluctuation of greater than 0.2 feet, the 12 wells showing the greatest fluctuations will be selected.

The transducers will be placed in the wells shown to have tidal influence and will be monitored using electronic data loggers for a duration of at least 14 days to achieve a more detailed analysis of tidal influences on the unconfined fill aquifer. Tidal influence monitoring will be scheduled for either August or September to minimize the influence of groundwater recharge that may occur from a precipitation event. The extended monitoring will yield an accurate average hydraulic head elevation representative of conditions at the well. Water elevations of all site wells will be measured at the beginning and end of the tidal influence monitoring.

5.5.7 BOREHOLE DRILLING, LITHOLOGIC SAMPLING, AND BOREHOLE LOGGING

Well installation activities in the unconfined fill aquifer at the site will be conducted using a hollow-stem auger drill rig. All drilling activities shall conform to state and local regulations including WAC 173-160, Minimum Standards for Construction and Maintenance of Wells. All permits, applications, and other documents required by state and local authorities will be completed prior to drilling.

The drill rig shall be inspected by the project geologist prior to beginning drilling activities to ensure that the drill rig has been cleaned and decontaminated prior to entering the site to prevent cross-contamination from other sites. The drill rig shall not leak any fluids that may enter the borehole or contaminate equipment placed in the hole. The use of rags or absorbent materials to absorb leaking fluids is unacceptable. Any leaks found on the drill rig shall be repaired prior to starting or resuming drilling activities.

One well in each area (western operational and eastern shoreline) will be drilled to the depth of the Vashon Till Unit (estimated to be up to 30 feet bgs). The auger flights will then be back pulled to within 1 foot of the bottom of the well depth and the borehole below will be allowed to collapse.

A log of drilling activities will be kept in a bound field notebook. Information in the logbook will include location, time on site, personnel and equipment present, down time, materials used, samples collected, measurements taken, and any other observations or information that would be necessary to reconstruct field activities at a later date. At the end of each day of drilling, the drilling supervisor shall complete a daily drilling log.

The lithology in all boreholes shall be logged. A boring log form shall be used for recording the lithologic logging information. Information on the boring log sheet shall include the borehole location; drilling information; sampling information such as sample intervals, recovery, and blow counts; and sample description information.

Unconsolidated samples for lithologic description shall be obtained every 5 feet, at depths specified for analytical (physical and/or chemical) samples, or at each change in lithology, whichever is less. Sample locations at which no physical or chemical testing is to be conducted, lithologic samples shall be collected using a split-spoon (or equivalent) sampler. At locations where testing is required, the samples shall be collected using the appropriate sampling devices.

Lithologic descriptions of unconsolidated materials encountered in the boreholes shall generally be described in accordance with American Society for Testing and Materials (ASTM) D2488-90 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) (ASTM, 1990). In addition, identification of the Unified Soil Classification System (USCS) group symbol shall be recorded on the boring log.

Descriptive information to be recorded in the field shall include:

- identification of the predominant particle size and range of particle sizes;
- percent of gravel, sand, fines, or all three;
- description of grading and sorting of coarse particles;
- particle angularity and shape;
- maximum particle size or dimension

- color using Munsell Color System
- moisture (dry, wet, or moist)
- consistency of fine-grained soils
- structure of consolidated materials, and
- cementation (weak, moderate, or strong).

Additional information to be recorded includes depth to the water table, caving or sloughing of the borehole, presence of heaving sand, changes in drilling rate, depths of laboratory samples, and other noteworthy observations or conditions, such as the locations of geologic boundaries.

All samples will be monitored with an organic vapor monitor (e.g., PID, organic vapor analyzer) to assist in the determination of the presence of VOCs in the soil. The samples will be field screened using the headspace field screening SOP 1 presented in Appendix A. Headspace field screening results will be entered on the field boring log and also in the site logbook.

Soil cuttings will be examined for their hazardous characteristics. Materials suspected to be hazardous because of abnormal color, odor, or organic vapor monitor readings will be containerized in conformance with Resource Conservation and Recovery Act (RCRA), state, and local requirements as described in Section 4.10 and SOP 4 in Appendix A.

5.5.8 SOIL SAMPLING FOR PHYSICAL AND CHEMICAL ANALYSIS

Soil samples will be collected from each borehole drilled for well installation purposes as well as those areas previously identified. Soil samples for chemical analysis will be collected at depths and intervals presented in Section 2.

Soil samples for saturated zone physical properties shall be collected from the interval of approximately 5 to 8 feet below the water table, as determined during drilling activities. At each borehole, samples will be collected for all of the following aquifer matrix characteristics analyses:

- dry bulk density
- grain size distribution
- effective porosity
- TOC content
- cation exchange capacity

Required analytical methods, sample containers, preservation methods, volumes, and holding times are provided in Volume III.

Because of the volume of sample required at each location, multiple drives with the sampler may be required. In this case, the auger flights will be advanced to the depth reached by the sampler prior to collection of the next drive sample. No multiple sampler drives shall be conducted from the same depth interval.

5.5.9 MONITORING WELL CONSTRUCTION

All monitoring wells installed as part of this RI will be screened across the water table at the site to check for the presence of LNAPL layers which have been observed in portions of the site during previous investigations. Depending on the time of year of installation of the wells, between 1 to 3 feet of screened interval will be placed above the water table as observed during drilling.

Because of the shallow nature of the water table in the unconfined aquifer beneath the site, installation of some site wells may not meet minimum requirements for filter pack and well seal installation in accordance with WAC 173-160, while also meeting the project objective of screen placement across the water table. As such, a variance will be requested from the Washington State Department of Ecology in accordance with WAC 173-160-406 prior to commencing drilling activities.

Monitoring well construction details will be recorded on the monitoring well construction form and also in the site logbook

5.5.9.1 Borehole Requirements

Borehole diameters shall be at least 4 inches larger than the outside diameter of the casing and well screen. In the case of a hollow-stem auger, the inside diameter of the auger shall be at least 4 inches larger than the outside diameter of the casing and well screen.

5.5.9.2 Casing Requirements

The wells to be installed as part of this RI study shall be constructed using Schedule 40, threaded, polyvinyl chloride (PVC) casing which meet the following requirements: 1) all casing shall be new and decontaminated according to the specifications of Section 4.13; 2) glue shall not be used to join casing, and casings shall be joined only by tightening of threaded couplings; 3) all PVC shall conform to the ASTM Standard F480-88A or the National Sanitation Foundation Standard 14 (Plastic Pipe System); 4) casing shall be straight and plumb; and 5) the driller will cut a notch in the top of the casing to be used as a measuring point for water levels.

5.5.9.3 Well Screen Requirements

Well screens selected for use during this project will consist of 10 feet of Schedule 40, 0.010-slot, 2-inch diameter, PVC well screens. PVC end caps will be installed on the bottom of all well screens to prevent sediment from entering the well.

Wherever possible, factory pre-packed well screens will be utilized during this project. Pre-packed well screens consist of a 0.010-slot, 2-inch PVC screen encased in 5-inch diameter slotted schedule 40 PVC screen. The annular space between the two screens is factory filled with 10-20 silica sand. These well screens provide a well filter pack that is not subject to erosion over time and reduce the development time required to remove initial sedimentation introduced into the well. Because of the shallow nature of the water table in the fill aquifer, pre-packed well screens may not be feasible at all well locations.

The 0.010-slot screen was selected based on inspection of field boring logs from existing wells at the site which indicate that the unconfined fill aquifer consists primarily of silty, fine to medium sands with minor amounts of gravel. Because of the fine-grained nature of the aquifer matrix, a larger slot size may allow an unwanted amount of fine-grained material to enter the well, and result in sedimentation problems within the well.

5.5.9.4 Filter Pack Requirements

Except as noted above, the filter pack for the wells installed during this RI will consist of 20-40 silica sand and will extend from at least 1 foot below the end cap of the well to at least 3 feet above the top of the well screen. After the filter pack is installed, the well will be surged with a surge block for 10 minutes. The top of the sand pack will be sounded to verify its depth during placement. Additional filter pack will be placed as required to return the level of the pack to 3 feet above the screen. Surge the well for 5 minutes. Again, place additional filter pack as required to bring its level to 3 feet above the screen. If a variance has been obtained for the well, the filter pack will be placed to the level above the screen as allowed by the variance.

As noted above, in wells where pre-packed well screens are used, the remainder of the annular space between the outer walls of the borehole and the screen will be filled with 10-20 silica sand. Additional 10-20 sand will be placed above the pre-packed screen to bring the sand filter pack to 3 feet above the screen, or to the height required by any Ecology variances issued.

5.5.9.5 Bentonite Seal Requirements

The bentonite seal requirements are the following: 1) the bentonite seal will consist of at least 2 feet of bentonite between the filter pack and the monument cement and 2) only 100 percent sodium bentonite may be used. If a variance has been obtained for the well, the bentonite seal requirements will be those as described in the variance. In all cases, the bentonite seal will extend from the top of the filter pack to 6 inches bgs.

5.5.9.6 Surface Completion Requirements

Depending upon the location of each well, either a flush mount or above ground stand-pipe type monument will be utilized for surface completion. The following describes the requirements of each type of well monument.

For flush-mounted completions, cut the casing about 3 inches below the land surface and provide a water-tight casing cap to prevent surface water from entering the well. The valve box lid will be centered in a concrete pad that slopes away from the box at one-quarter inch per foot. The identity of the well will be permanently marked on the valve box lid and the casing cap. Where heavy traffic may pass over the well or for other reasons, the concrete pad and valve box/lid assembly will be constructed to meet the strength requirements of surrounding surfaces.

Above ground stand-pipe monuments will consist of a steel protective casing extending at least 6 inches above the top of the well casing and will be cemented at least 2 feet into the ground. A lockable monument cap will be placed on top of the protective casing. A weep hole will be drilled in the side of the protective casing, approximately 3 to 6 inches above the ground surface to allow for water drainage. Three metal posts, minimum of 3 inches in diameter, will be placed in a triangular pattern around the protective casing. The posts will be installed at least 2 feet away from the protective casing and will extend at least 3 feet above and below the ground surface. Where the water table is less than 3 feet bgs, an application for a variance will be submitted to allow for a shallower installation of the posts to avoid contact with the water table.

All wells will be secured as soon as possible after drilling. Corrosion-resistant locks will be used. Wherever possible, keyed alike locks will be used. Protocols and procedures for monitoring well installation are shown in SOP 2 in Appendix A.

5.5.9.7 Monitoring Well Development

The new monitoring wells installed as part of this RI will be developed after installation using a combination of a surge block and submersible pump. The wells will be developed no sooner than 24 hours after installation to allow for the bentonite seal to cure. In addition, at least 48 hours will be allowed to pass after well development before the first round of sampling is conducted in order for the aquifer to recover from installation and development disturbances. Protocols and procedures for monitoring well development are presented in SOP 3 in Appendix A.

5.6 ENNIS CREEK SEDIMENT SAMPLING

Sediment sampling for Ennis Creek should be accomplished using a hand held coring device if possible. The procedures for using this type of sampling equipment are provided in SOP 7. These procedures are applicable to most small hand held sampling devices and tools. If the characteristics of the sediments in the creek are not acceptable for core sampling using a hand held device (i.e., too sandy, too rocky, or too hard), alternative sampling devices may be used. These include a hand auger and small grab sampler (SOP 9).

5.7 FIELD CHANGES

Due to contingencies during field activities, modifications of the procedures outlined in this SAP may be required. Modifications of procedure will be at the discretion of the FOL after consultation with the Technical Lead, Chemical QC Manager, or Project Manager. In the event that major modifications are required or warranted, every effort will be made to consult Ecology and the Tribe prior to implementation of the changes. Significant modifications will be documented with a Field Change Request (FCR) (Figure 5-2). If a field change is later found to be unacceptable, the action taken during the period of deviation will be evaluated to determine the significance of any departure from the established program practices and appropriate action taken.

The FCR forms will be numbered as follows, consecutively starting with the number FCR-RRI-001:

FCR	Type of form
RRI	Rayonier Remedial Investigation
XXX	Consecutive Number, starting with 001

5.8 DECONTAMINATION PROCEDURES

Field equipment used during the sampling activities will be decontaminated prior to sample collection to minimize the potential for cross-contamination. Whenever possible, disposable sampling equipment will be used to minimize the need for decontaminating equipment. Prior to sample collection, all nondisposable field-sampling equipment that will come in contact with the samples will be cleaned and decontaminated following SOP 7, Appendix A. Hand-held sampling equipment may include split spoons, pumps, bailers, sounding tapes, and other devices. For large pieces of equipment (such as casings, auger flights, pipe, rods, and those portions of the drill rig that may stand directly over a boring or well location or that come into contact

Figure 5-2. Field Change Request Form

FOSTER WHEELER ENVIRONMENTAL CORPORATION

FIELD CHANGE REQUEST (FCR)

PROJECT NAME	PROJECT NO.	CHANGE REQUEST NO. **FCR-**
TO (Ecology Mgr.,Tribe Rep.,Rayonier PM):	LOCATION	DATE

RE: ________________________________ Drawing No. ______________ Title ______________________________

______________________________ ______________________________

Spec Section ______________________________ Title ______________________________

______________________________ ______________________________

Other ______________________________ ______________________________

***1. DESCRIPTION (Items involved, submit sketch, if applicable)*:**

2. REASON FOR CHANGE

3. RECOMMENDED DISPOSITION (Submit sketch, if applicable):

_____ Minor Change _____ Major Change (Impacts Cost, Schedule or Technical)

3a. Will this change result in a contract cost or time change? _____ YES _____ NO

3b. Estimate of contract cost or time charge (if any) _________________

PREPARER (Signature)	DATE	PREPARER'S TITLE	SITE SUPERINTENDENT (Signature)	DATE

4. DISPOSITION

___ Not approved (give reason).

___ Considered minor change - approved per Recommended Disposition - Documents will not formally be revised, field to maintain as-built records.

___ Considered major change – Project Manager approval required via contract modification process.

1) FOSTER WHEELER ENVIRONMENTAL DESIGN MANAGER (Signature) (IF ENGINEERING RELATED)	DATE	2) PROJECT MANAGER (Signature)	DATE
3) HEALTH AND SAFETY MANAGER (Signature) (IF HEALTH AND SAFETY RELATED) _____ Comments (attached) _____ No Comments	DATE	4) QC REVIEWER (Signature) _____ Comments (attached) _____ No Comments	DATE

Project Manager distributes to:

Foster Wheeler Design Manager Contracts Manager QA Manager Site Management Team Reps. FCR Preparer
QC Manager Site Superintendent Project Controls Supervisor Project Health and Safety Manager

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with casing, auger flights, pipe, or rods), the following procedure will be used to decontaminate the equipment. The external surfaces of equipment will be washed with high-pressure hot water and Alconox, or equivalent laboratory-grade detergent, and, if necessary, scrubbed until all visible dirt, grime, grease, oil, loose paint, rust flakes, etc., have been removed. The equipment will then be rinsed with potable water. The inside surfaces of casings, drill rods, and auger flights will also be washed as described. In addition, the contractor will take care to prevent the sample from coming into contact with potentially contaminating substances, such as tape, oil, engine exhaust, corroded surfaces, and dirt.

5.9 DOCUMENTATION

Six primary types of documentation will used for this project: site logbooks, photographs, sample summary logs, sample labels, custody seals, and chain-of-custody forms. The site logbooks are vital for documenting all on-site activities. Photo documentation will be used to provide an accurate visual account of sampled materials, sample locations, and environmental conditions. Sampling information will be recorded on sample summary logs. Sample labels are used to provide essential information and identification for all samples collected during field activities. Custody seals are used on all sample shipment containers to detect any tampering which may have occurred during transport or shipment. The chain-of-custody forms are used to track sample custody, and document the proper handling and integrity of the samples. A description of each of these documentation methods is provided in the following sections.

5.9.1 SITE LOGBOOKS

Site logbooks will be used to document all field and sampling activities performed at the site. Entries to the logbooks will include the date, time, description of field activities performed, names of personnel, weather conditions, areas where photographs were taken (if applicable), and any other data pertinent to the project. The site logbooks will also contain all sample collection and identification information and (if appropriate) a drawing of each area sampled, along with the exact location (coordinates) of where the sample was taken. When samples are collected, the logbooks will include the date, time, sample location, sample identification number, sample matrix, sample collection method, analyses to be performed, any comments, and the sampler's name.

Each page of the site logbooks will be pre-numbered, dated, and signed by the author at the end of each day's activities. The logbooks should be sturdy, weatherproof, and bound to prevent the removal of pages. All writing will be done in waterproof, black permanent ink. No pages may be removed from the site logbooks for any reason. Blank pages must be marked "page intentionally left blank." Mistakes must be crossed out with a single line, initialed, and dated. If multiple logbooks are used, they will be numbered sequentially. Requirements for the site logbooks are detailed further in SOP 10, Appendix A.

5.9.2 PHOTOGRAPHS

Photographs will be utilized during the project to document field activities and to provide an accurate visual record of the material sampled. All photographs taken will be identified in the site logbooks (preferably in a separate section of the book that is set aside for that purpose). Photographic logs will contain the film roll number, photograph number, date, time, initials of the photographer, and a description of the image in the photograph. Developed photographic prints will be sequentially numbered and dated corresponding to the logbook descriptions.

5.9.3 SAMPLE SUMMARY LOGS

Sample summary logs will be maintained by the FOL and used to keep track of all phases of the sampling and analysis process for all individual samples (Figure 5-3). The summary logs will include the sample identification number, date of collection, sample delivery date, date analytical results are received, and laboratory identification number.

5.9.4 SAMPLE LABELS

Sample containers will be clearly labeled with waterproof black ink at the time of sampling. Sample labels (Figure 5-4) will include the following information:

- project name
- sampling date
- sampling time
- sample location
- sample identification number
- analysis to be performed
- preservation used, if any
- initials of sampler

The sample label will be attached to the sample container prior to, or just after, the container is filled and the lid secured. As an added measure of security, the finished label should be covered with clear packaging tape to protect the ink from moisture and to tightly secure the label to the sample container. Information on the sample label must match the information on the chain-of-custody form and in the site logbook.

5.9.5 CUSTODY SEALS

Custody seals (Figure 5-4) will be used on sample shipping containers (coolers) that will either be shipped or sent by messenger to the laboratory. Custody seals will be attached to the lid and body of the coolers to detect any tampering during shipment. The custody seals will be signed and dated. Custody seals are not required for samples hand-delivered directly to the laboratory, unless the coolers are left unattended at any time.

5.9.6 CHAIN-OF-CUSTODY FORMS

The chain-of-custody form (Figure 5-5) is necessary to document sample collection and the analysis required for each sample. The history of each sample and its handling will be documented from its collection through all transfers of custody until it is transferred to the analytical laboratory. The custody record will be completed using waterproof ink. Any corrections will be made by drawing a line through and initialing and dating the change, then entering the correct information. Erasures or whiteouts are not permitted.

When transferring possession of samples, the individuals relinquishing and receiving them will sign, date, and note the time on the form. This will document sample custody transfer from the sampler to the laboratory. Containers shipped by common carrier will have the chain-of-custody form enclosed in a watertight container (e.g., Ziploc® bag) and placed in the container prior to sealing.

Internal laboratory records will document custody of the sample from the time it is received through its final disposition. The chain-of-custody form will be filled out as each sample is taken and double-checked before the samples are delivered to the laboratory. At a minimum, the chain-of-custody form will have the following information:

- name of project
- name and signature of sampler
- sample identification numbers
- sampling date
- sampling time
- number and type of containers per sample
- sample matrix
- sample preservation, if any
- analyses requested

Copies of each chain-of-custody form will be given to the FOL for tracking the sampling and analysis process for all samples. The copies will be maintained by the FOL and kept in a binder on site.

Figure 5-3. Sample Summary Log

Sample ID #	Sampling Location	Sampling Date	Time	Analysis Requested	Date Shipped	Date Fax Results	Due Date Prelim.	Due Date Final	Date Received	Laboratory ID No.	Notes

Figure 5-4. Sample Container Label and Custody Seal

Client ____________________

Collection Date ____________ Time ____________

Sample Location ____________________

Sample I.D. ____________________

Sampler ____________________

Analysis	Lab No.

Preserved with: None Cool HNO_3 HCL
H_2SO_4 NaOH Other ________

CUSTODY SEAL

Date ____________________

Signature ____________________

Sample Container Label and Custody Seal

Figure 5-5. Chain of Custody Record

Request for Analysis

Page ______ of ______ Lab. Ref. No. ____________________

Project Name: ____________ Project Address: ____________ ____________ ____________ FW Project No.: ____________	Sampling Shipping Shipping Ref.:	Analysis Laboratory: Laboratory Contact: P.O. No.: Reports to be Sent to: Address/Phone No.:
Sampler(s): *(printed name)* Sampler(s): *(signature)*	Sample Disposal Instructions: ☐ Lab disposal ☐ Return to FWENC ☐ Hold for pickup (will call)	
Special Instructions:		

SAMPLE IDENTIFICATION	TIME COL-LECTED	NO. OF CONTAINERS, SIZE & TYPE	PRES-ERV-ATIVE	MATRIX	SAMPLE TYPE Com-posite	SAMPLE TYPE Grab	Sample prep. Method Standard (EPA # ____)	Sample prep. TCLP (1311) ____ Other ____	ANALYSES REQUEST (circle appropriate method number) CLP Data Pkg.; Other ____	Halogenated Volatiles 8010B, 8121, 601, 502.1, CLP	Aromatic Volatiles 8020A,8021B, 602, 502.2, 503.1, CLP	BETX Only 8020A, 602, CLP	GC/MS VOAs 8260B, 624, 524.1, 524.2, CLP	GC/MS SVOAs 8270C, 625, 525, CLP	Pesticides (Organochlorine) 8081A, 608, 505, CLP	PCBs 8082 (Arodors, Full Congeners)	HPLC PNA/PAHs 8310,610	Organophosphorus Comps. (Pest. & Herbs) 8141A	Chlorinated Herbicides 8151A	Dioxins 8290, CLP, 1613	Nitroaromatics and Nitramines(Ordnance) 8330	TPH-HCID AK NWHCID	TPH-Gx AK101, NWTPHGx	TPH-Dx AK102,103, NWTPHDx	TPH frac. NWVPH NWEPH AK101AA AK102AA	Lead 6010, 7420, 7421	Priority Poll. Metals (13) 6010B & 7000 Series, 6020 CLP	TCL Metals (23) 6010B & 7000 Series, 6020, CLP	TCLP 1311 (metals, VOAs, SVOAs, Pest., Herb.)	Inorganic Anions (Cl, F, NO_3, NO_2, PO_4, SO_4) 300 ____	Total Organic Carbon (TOC) 9060 ____				REMARKS

Turnaround Time:	Sample Receipt:	Relinquished by: *(signature)*	Relinquished by: *(signature)*	Relinquished by: *(signature)*	Relinquished by: *(signature)*
☐ Standard	Total # Containers Recvd.: ________				
☐ 1 Week	COC Seals Present? ________	Date: Time:	Date: Time:	Date: Time:	Date: Time:
☐ 4 Work Day	COC Seals Intact? ________	Received by: *(signature)*	Received by: *(signature)*	Received by: *(signature)*	Received by: *(signature)*
☐ 3 Work Day	Received Cold? ________				
☐ 2 Work Day	Received Intact? ________				
☐ 24 Hour	Received Via: ________	Date: Time:	Date: Time:	Date: Time:	Date: Time:

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5.10 SAMPLE COMPOSITING AND OTHER SUBSAMPLING

For water sampling, discrete samples will be collected. For soil sampling, composite samples will be collected. Because soil samples will not be analyzed for VOCs, all soil samples will be composited.

Soil samples will be composited by placing equal volumes of sampling material in a decontaminated bowl and mixing with decontaminated spoons. The sampling materials will be mixed until homogenous and will continue to be stirred while individual aliquots are taken of the homogenate and placed in containers. This will ensure that the mixture remains homogenous. After placement of the sample in the appropriate sample container, each container will be firmly sealed and stored at approximately $4^{o}C$ until sent to the laboratory for analysis. Upon receipt, the laboratory will store the samples at method-specified temperatures.

5.11 INVESTIGATION DERIVED WASTE

All soil and water remaining after sampling will be disposed of in drums near the vicinity of the collection site or by the analytical laboratory. All disposable sampling materials and personal protective equipment used in sample processing, such as disposable coveralls, gloves, and paper towels, will be placed in heavy-weight garbage bags, 5-gallon buckets, or other appropriate containers. These containers will be removed from sampling areas daily and placed in a central storage location at the project site. At the end of the field program, disposable waste will be removed from the storage area and disposed according to regulations and standard practice. Additional guidelines for managing investigation derived waste are provided in SOP 15 in Appendix A.

5.12 UNDERGROUND UTILITIES CLEARANCE

Prior to the start of any intrusive activities (i.e., drilling/well installation) associated with the RI, all boring locations will be field marked using either wooden lath or white spray paint. A commercial utility locating service will then be used to perform a survey of the boring locations. In addition, a call will be placed to the Washington Utilities, Underground Cable, Pipe, and Wire Locating Service (1-800-424-5555) a minimum of 48 hours prior to intrusive activities for location of commercial utility lines which may be present at the site.

5.13 SURVEYING

All surveying locations of field activities will be measured by a certified land surveyor as the distance in feet from a reference location that is tied to the state plane system, and the elevation in feet relative to mean sea level. Measurements by the surveyors will be provided for the horizontal well location to a precision of 0.1 foot, top of well casing elevation to a precision of 0.01 foot, and ground surface elevation adjacent to the well to a precision of 0.1 foot. An XY-coordinate system will be used to identify locations. The X-coordinate will be the east-west axis, and the Y-coordinate will be the north-south axis, with the reference location as the origin. The surveyed control information for all data collection points will be recorded and displayed in a table. The table will give the X and Y coordinates in state plane coordinate values, the ground elevation, and the measuring point elevation. The elevation of all newly installed wells will be surveyed at the water level measuring point (notch) on the riser pipe.