Region 10
U.S. Environmental Protection Agency

DRAFT FINAL

Phase I Sediment Sampling Data Evaluation Upper Columbia River Site CERCLA RI/FS Section 2 pages 16-65

August 25, 2006

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CONTRACT NO 68-S7-04-01

SPK/062360001

SECTION 2

Field and Analytical Program Overview

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This section summarizes the Phase I sediment sampling program conducted in the spring of 2005. It summarizes the DQOs for the sampling program, describes the types of samples collected and their locations, lists the analyses conducted on each sample, and presents a usability assessment of the analytical data with respect to the procedures established within the QAPP. A more detailed description can be found in the Phase I Sediment Sampling Field Report (CH2M HILL, 2006a).

2.1 Phase I Sediment Data Quality Objectives

The Phase I sediment sampling program was designed to provide information to support refinement of the preliminary sediment CSM and to assess potential risks to human and ecological receptors in the UCR. During project planning, USEPA's DQO process (USEPA, 2000a) was used to identify specific Phase I data needs for each component of the preliminary conceptual site model for sediment and to establish decision rules for the collection and evaluation of sediment data. The Phase I sediment sampling program was then designed in consideration of the specific data needs identified in the DQO process, the unique site characteristics, and comments received from affected landowners, land managers, and regulators, including CCT, the Spokane Tribe of Indians (STI), U.S. Department of the Interior (DOI) agencies, Washington State Department of Ecology (Ecology), and tribal, state, and federal cultural resource/archeology program offices. The Phase I sediment sampling program planning process, including the DQO process, is detailed in the UCR Phase I Sediment Sampling QAPP (CH2M HILL, 2005).

The DQOs relevant to the contents of this report (i.e., contaminant source identification, nature and extent characterizations, and fate and transport evaluations) are summarized in Table 2-1.

2.2 Field Program Summary

2.2.1 Sampling Timeframe

The sediment sampling program was conducted over a 6-week period, starting in April 2005 and ending in early May 2005. The March to May timeframe was selected because the U.S. Bureau of Reclamation (USBR) had scheduled a drawdown of the reservoir to an elevation of 1250 to 1255 feet for maintenance at Grand Coulee Dam (Figure 2-1). Planning and execution of the field programs was facilitated by knowing the reservoir water level in advance. This drawdown also allowed more above-water (i.e., above the waterline) access to normally submerged bank and beach areas. Sample collection began on April 4, 2005, and ended on May 3, 2005.

2.2.2 Base of Operation, Personnel, and Sampling Teams

The sampling program was conducted from two bases of operation, referred to as sample processing stations (SPSs). The first SPS was established at the Kettle Falls Marina. All sampling activities were conducted from this SPS until the SPS was disassembled and re-established at the Two Rivers Marina on April 25, 2005. While stationed at Kettle Falls Marina, field teams collected samples in the upper and middle reaches of the UCR. After the move to the Two Rivers Marina, field teams collected samples within the lower reaches of the UCR.

Sample collection field teams were composed of personnel from CH2M HILL; Ecology & Environment, Inc.; White Shield, Inc.; E2; Elcon Construction; TEG; and Zephyr Marine in coordination with the National Park Service (NPS), CCT, and STI. Up to 30 personnel were involved in the program at any given time.

Field sampling was performed by the following six field teams:

- Four water-based sampling teams working from boats
- One land-based sampling team working from cars and pickups
- One sample processing team stationed at the SPS

The water-based sampling teams used specially configured sample vessels to facilitate travel between sampling stations and sample collection. A jet boat was used for the up-river sample locations. The ground-based sampling team used cars and pickups to access several targeted beach sampling locations that were accessible by road. The sample processing team staffed the SPSs at the marinas on a daily basis and handled the processing, documentation, packaging, and shipping associated with the samples delivered each afternoon from the water-based and land-based sampling teams.

Each water-based team was composed of a CH2M HILL field team leader, a field technician, a cultural resource observer, and the vessel operator. The land-based sampling team was made up of a CH2M HILL field team leader, a field technician, and a cultural resources observer.

2.2.3 Cultural Resources Coordination

All field work was conducted in accordance with the Cultural Resource Coordination Plan (CH2M HILL, 2005). Cultural observers from CCT, NPS, and STI were present and observed all samples as they were obtained and worked with the field team leader to adjust sampling locations if necessary.

2.2.4 Sample Collection and Processing

All sample collection and processing was conducted in accordance with the Phase I Sediment QAPP (CH2M HILL, 2005). Below-water samples were collected using van Veen grab samplers deployed over the side of each boat. Above-water samples were collected using stainless steel hand tools. The upper 10 to 15 centimeters (cm) of sediment were typically sampled, with the exception of the cores, where samples were obtained from up to 9 feet below the sediment surface (see Section 2.2.5).

The global positioning system (GPS) was used to record the horizontal position of each sample except 734A1 and 741A1(X3), whose positions were estimated based upon field observations due to difficulties with the GPS. Real-time differential GPS was used to the extent the U.S. Coast Guard signal could be received from Spokane, Washington. GPS coordinates were post-processed using Trimble® GPS Pathfinder® Office software using the U.S. Coast Guard signal. The vertical position of below-water samples was determined using a fathometer, a lead line, or survey rod to record the depth to the sample location from the water surface. For locations within the reservoir pool, the elevation of the water surface was determined twice daily from the gage at Grand Coulee Dam, and from benchmarks established at each SPS. For locations upstream from the reservoir pool, the elevation of the water surface was determined from benchmarks established on the shore at each sampling transect. The vertical position of above-water samples was measured from the surface of the reservoir pool or from the transect benchmarks, depending on location.

At the end of each day, the sample teams delivered the samples under chain of custody to the SPS, where they were processed for shipment to the analytical laboratories for testing. The FORMS II Lite™ computer program was used to assist with sample management and documentation.

2.3 Samples Collected and Locations

The approach and rationale for development of the sampling program, the types of samples collected, and the locations to be sampled are documented in the A&R Document and the QAPP. This section provides a summary of each sample type, the samples collected, and their locations.

The following five sample types were collected from locations throughout the UCR; each is described in this section:

- Transect samples
- Bioassay and reference bioassay samples
- Tributary mouth samples
- Beach samples
- Core samples

Figure 2-2 is an overview of the UCR showing the general location where sediment samples were collected. Figures 2-3 through 2-12 are more detailed maps showing sampled locations. The horizontal and vertical coordinates of each sample and the number of quality assurance/quality control (QA/QC) samples associated with each are listed in Appendix A, Table A-1). The sample identification convention incorporates the river mile (RM) where it was collected followed by a 2-character code. The first character (a letter) indicates the sample type (X = Transect, A = Bioassay, R = Reference, T = Tributary, B = Beach, and C = Core). The second character (a number) indicates the specific sample along each transect, with “1” representing the left bank (when looking downstream). For example, sample 737X1 was a transect sample collected along the left bank at RM 737.

Some samples were unattainable due to the cobbly condition of the river bottom and/or swift currents. These are described in Section 2.3.6.

2.3.1 Transect Samples and Focus Areas

Transect samples, also referred to as baseline samples in the A&R Document and the QAPP, consisted of surface sediment samples collected along regularly spaced interval lines (i.e., transects) laid out perpendicular to a line drawn upstream-to-downstream through the middle of the river. Between the U.S.-Canada border and RM 720, transect samples were generally collected along transects spaced at 1-mile intervals. Between RM 720 and Grand Coulee Dam, transect samples were generally collected along transects spaced at 3-mile intervals. Some sample locations were moved upstream or downstream from the planned transect to accommodate site-specific sediment conditions encountered at the time of sampling.

A minimum of three samples were typically collected along each transect: a sample near each opposing river bank, and a sample near the center of the original pre-dam river channel. The mid-channel samples were collected near the center of the original river channel, where historical sampling had been sparse. At selected transects (RM 605, RM 633, RM 637, RM 642, RM 661, RM 678, RM 692, RM 706, RM 715, RM 723, RM 732, and RM 742), up to six additional samples were collected in different positions across the channel to further assess transverse sediment variability.

Six 4- to 5-mile-long focus areas were identified in the QAPP to assess current and future conditions within selected reaches of the river/reservoir system (see Figure 2-2). Given the large size of the site, the focus areas were intended to serve as smaller, representative subareas within the study area that potentially could be used as a gauge of sediment conditions for the larger areas that lie between focus areas. The focus areas included an increased density of sediment samples (i.e., selected transects, described above) within a discrete area.

2.3.2 Bioassay and Reference Samples

Sediment from 50 locations along the length of the UCR and from 6 reference locations near the mouth of UCR tributaries was collected from below shallow near-shore water for bioassay testing to evaluate potential toxicity of the constituents to aquatic organisms and to allow correlation of contaminant concentrations and sediment toxicity. All except one bioassay sample were co-located with the transect samples.

Reference bioassay samples were collected from the following tributaries at elevations greater than the maximum water level in the reservoir:

- Fivemile Creek (RM 732, elevation 1,410 feet)
- Crown Creek (RM 726, elevation 1,716 feet)
- Flat Creek (RM 721, elevation 1,310 feet)
- Nancy Creek (RM 705, elevation 1,360 feet)
- Barnaby Creek (RM 686, elevation 1,302 feet)
- Cheweka Creek (RM 685, elevation 1,297 feet)

In addition to whole sediment (i.e., solids and associated liquid), sediment water samples (referred to as pore water samples) were obtained from each of the bioassay and reference area samples at USEPA's Manchester laboratory. The intent of pore water sampling was to provide additional supporting data for interpretation of biotoxicity in surface sediment.

2.3.3 Tributary Mouth Samples

Tributary sediment samples were collected within the UCR near the mouths of the following six major tributaries:

- Big Sheep Creek (RM 736)
- Onion Creek (RM 729)
- Kettle River (RM 706)
- Colville River (RM 699)
- Spokane River (RM 639)
- Sanpoil River (RM 615)

The samples were collected to better understand the role of tributaries from larger watersheds in the study area as potential sources of contaminants and to assess potential contaminant dilution or enrichment effects on main UCR river channel sediments immediately downstream from the tributary mouths.

Two samples were collected from each tributary mouth area. One sample was collected approximately mid-mouth at the tributary's confluence with the UCR. The other sample was collected along the near bank of the UCR approximately 0.1 to 0.2 mile downstream from the mouth of the tributary. At the Colville River (RM 699), only one tributary mouth sample was collected: a transect sample at RM 698 served as the downstream tributary mouth sample. At Big Sheep Creek, only one tributary sample was collected; the other was unattainable because of a cobbly bottom and swift current.

2.3.4 Beach Sediment Samples

A total of 15 beach areas were sampled in order to provide a sufficient number of representative samples to assess potential risk to human and ecological receptors. These beaches were as follows:

- Black Sand Beach—RM 742, East Side
- Northport City Boat Launch—RM 735, East Side
- Dalles Orchard—RM 730, East Side
- North Gorge Campground—RM 718, East Side
- Marcus Island Campground—RM 708, East Side
- Kettle Falls Swim Beach—RM 700, East Side
- Haag Cove—RM 697, West Side
- French Rocks Boat Launch—RM 690, West Side
- Cloverleaf Beach—RM 675, East Side
- AA Campground—RM 673, East Side
- Rogers Bar Campground—RM 658, West Side
- Columbia Campground—RM 642, East Side
- Lincoln Mill Boat Ramp—RM 633, East Side
- Keller Ferry No. 2—RM 615, East Side
- Spring Canyon Campground—RM 600, South Side

Three of the 15 beaches, referred to in the QAPP as "Selected Beaches"—Northport City Boat Launch, Kettle Falls Swim Beach, and Columbia Campground Beach—were the subject of more detailed discrete and composite sampling. The other 12 beaches, referred to in the QAPP as "Standard Beaches," were sampled by the collection of three composite samples. The locations of beach samples are shown in Figures 2-13 to 2-27. The area sampled at each beach was selected based on human use patterns and took reservoir water levels and topography into account. Where practical, depending on each beach's configuration and near-shore topography, the sample locations were laid out along three specified elevations (1,285 feet, 1,270 feet, and 1,255 feet) as described in the QAPP.

2.3.4.1 Selected Beach Samples

The sampling program for three beaches—Northport City Boat Launch, Kettle Falls Swim Beach, and Columbia Campground Beach—consisted of collecting discrete samples from nine locations at each beach. The nine samples were collected from three locations (left, right, and center) typically laid out along each of the three specified elevation contours. The planned locations at the Northport City Boat Launch were field adjusted to accommodate a higher than expected water level.

In addition to the discrete samples, three elevation-specific composite samples were also made by combining samples taken from the three locations (left, right, and center) along each of the three elevation contours. All nine locations where beach sediment was collected from the Selected Beaches are shown in Figures 2-13 to 2-15. The coordinates of the middle sample location along each elevation contour were used to represent the coordinates for that contour's composite sample for the project database. In addition, a large overall composite sample was created from the nine sample locations at these three beaches. The composite was submitted to a laboratory for particle size fractionation by sieving. Two samples were fractionated from the composite: one made up of sediment between 2 millimeters (mm) and 75 microns, and one made up of sediment less than 75 microns. This was done to provide information on contaminant concentration with respect to the particle size to be used in the human health risk assessment to gauge contaminant concentrations in the fraction of the beach sediment that may be inhaled. The coordinate of the very middle sample location of all nine samples was used to represent the coordinates for this overall composite sample for the project database (Figures 2-16 to 2-27). Standard of Practice (SOP) SEDFSP-5A within the QAPP further describes the beach sampling methodology, including a sample compositing schematic (Figure 1 of SOP SEDFSP-5A).

2.3.4.2 Standard Beach Samples

The sampling program for the other 12 beaches consisted of collecting 3 composite samples, one from each of three specified elevation contours. Each composite was made of three samples taken along each elevation contour. Similar to the Selected Beaches, the coordinates of the middle sample location along each elevation contour were used to represent the coordinates for that contour's composite sample for the project database.

2.3.5 Sediment Core Samples

Sediment cores were collected from nine locations to characterize vertical variations in contaminant concentrations within the upper sediment column and to establish the apparent thickness of the contaminated sediment layer. The cores were obtained using a vibratory corer (Vibracore). The steel core barrels were lined with 4-inch-diameter Lexan plastic tubes. The depth of water through which cores could be obtained was limited to

200 feet. Table 2-2 summarizes the collected cores. The four cores planned upriver from RM 708 were unattainable due to cobbly river bottom conditions and swift current.

The cores were divided into multiple sample intervals representing the full thickness of sediment recovered at each location, with the upper one foot of sediment divided into two 6-inch-long sample intervals, and the remainder of the core divided into 24-inch-long sample intervals.

2.3.6 Unattainable Samples

Every mid-channel transect and core sample between the U.S.-Canada border and RM 730 was unattainable due to cobbly river bottom conditions and swift current. One-half of the mid-channel transect samples between RM 729 and RM 710 were attainable. Every mid-channel transect channel downstream from RM 710 was obtained. This indicates a general lack of sampleable sediment (sand sized or smaller) in the mid-channel upstream from RM 729, pockets or discrete areas of mid-channel sampleable sediment between RM 729 and RM 710, and then continuous mid-channel sampleable sediment from RM 710 to Grand Coulee Dam.

Unattainable samples are summarized in Table 2-3 and are shown as black asterisks in Figures 2-3 through 2-12. A few of the unattainable transect samples planned for collection from mid-channel in this river stretch were relocated to a position near the banks. In addition, Transect Sample RM744X2 was collected behind a large rock located mid-river. The eddy behind the rock contained sampleable sediment, although the adjacent mid-channel areas did not.

2.4 Analytical Program

Following collection and processing at the SPSs, the samples were packaged and sent under chain of custody via FedEx overnight delivery to the analytical laboratories. The following analytical suites were conducted on various sample types:

- **Standard Analytical Suite**: Target Analyte List (TAL) metals (plus uranium), Target Compound List (TCL) semivolatile organic compounds (SVOCs), TCL pesticides/PCB Aroclors, TOC, and particle size
- **Dioxins and Furans :** Tetra- through octa-chlorinated dibenzo-p-dioxins and chlorinated dibenzofurans
- **Bioassay Analytical Suite:** TAL metals (plus uranium), TCL SVOCs, TCL pesticides/PCB Aroclors, TOC, acid volatile sulfides/simultaneously extracted metals (AVS/SEM), and toxicity tests
- **Dissolved Metals:** Dissolved TAL metals (plus uranium) in pore water isolated from sediment

The analytical suite conducted on each sample type is listed in Table 2-4. Individual analytes and parameters associated with the listed analytical suites are listed in Table 2-1 in the main body of the QAPP. Appendix A, Table A-2, lists the analyses conducted on each sample by sample type. Chemical analyses were conducted by Contract Laboratory Program (CLP) laboratories and the USEPA Region 10 Manchester Laboratory.

2.5 Phase I Sediment Chemical Data QA/QC Program

The objective of the Phase I sediment data collection and analyses was to generate data of known quality appropriate for project needs in terms of end decisions. This objective was accomplished through the following cycle:

- The DQO process identified project data needs and decision rules and was documented as an appendix to the QAPP (CH2M HILL, 2005).
- The QAPP defined organization, functional activities, procedures, and policy that were implemented to obtain project-specific data of known and appropriate quality.
- Laboratory statements of work referenced in Table 2-5 detailed laboratory analytical procedures and QA/QC procedures, including documentation.
- Laboratory and field QA/QC was performed through internal and external audits.
- Data quality and usability review outside the laboratory were documented in data validation reports.
- Individual data points were qualified by applying data validation report flags to the project database.
- An overall assessment of data quality was performed to evaluate the usability of the data within the context of the project objectives.

The following is a description of the analytical methodology, the data validation methodology, the associated sample/analyte-specific validation reports, and the overall data quality evaluation findings. Information about QA/QC samples is provided in this report as Appendix B. Summaries of the analytical results for each sample group are provided as Appendix C. Data quality evaluation reports for the individual method and sample results are too large for inclusion with this report, but are available upon request.

2.5.1 Analytical Program/Methodology

A listing of analytes and associated methods is provided in Table 2-5. In addition, for each analytical parameter and method, the standard USEPA analytical method references are provided in the QAPP (CH2M HILL, 2005) and the associated laboratory statements of work (also listed in Table 2-5). These documents identify the following method-specific quality control (QC) requirements:

- Method-specific QC procedure
- Level of effort (frequency of QC checks) for each QC procedure
- Quantitative acceptance limits for QC data
- Corrective action requirements for the laboratories for QC data that are outside the acceptance limits

- Documentation

These requirements, as detailed for each analytical method in the QAPP and the laboratory statements of work referenced in Table 2-5, were followed by the laboratory as the project analytical requirements.

The detection limit requirements also are shown in QAPP Tables 2-2 and 2-3. The analytical laboratories established method detection limits (MDLs) in accordance with Title 40, Part 136, Appendix B, of the Code of Federal Regulations (CFR) before start of the work to ensure that laboratory-specific limits complied with the specifications.

2.5.2 Data Validation and Findings

2.5.2.1 Data Validation Methodology

All data (100 percent) were evaluated independently of the laboratory by project chemists. All sample data were reviewed for the QC specifications identified in the project QAPP and USEPA CLP statements of work for each specific parameter and were flagged in accordance with the QAPP and USEPA functional validation guidelines as referenced in data validation reports that are available on request.

2.5.2.2 Reporting

Sample- and parameter-specific data validation reports are based on review of the individual laboratory sample delivery groups (SDGs). The SDG-based reports are organized by analytical groups as follows: SVOCs, organochlorine pesticides, polycyclic aromatic hydrocarbons (PAHs), PCB Aroclors, dioxins, and inorganics/metals. A separate report is presented for each SDG in increasing SDG number order. The cover of each report identifies individual samples included in the SDG.

Each report has subsections that correspond to the internal QC check requirements for that specific method as identified in the QAPP. If laboratory data were found to deviate from the specifications, the subsection provides quantitative details for the QC data deviation and the associated affected samples and provides flags according to defined conventions.

Field blank, matrix spike, and duplicate sample results are listed in the laboratory result data sheets.

The individual SDG reports provide a summary table at the end of each section where flags are applied, and the report is followed by flagged data sheets. The reports list all flags and their appropriate classifications as well as the reason for the flags.

2.5.2.3 Data Flagging Conventions, Data Validation Findings, and Overall Summaries

USEPA data validation functional guidelines and QAPP criteria were used to determine flagging conventions.

Sample- and analyte-specific data validation findings/qualifying flags for laboratory internal quality control data are at the end of each validation report. Data validation flags were entered into the project database.

The data meet and exceed project quality goals, as further described in Section 2.5.3.

Rejected Results

The number of results that were rejected for each analyte are listed in the summary tables in Appendix C. Data points that were rejected are in the following groups:

- SVOCs for continuing calibration (percent deviation values higher than criteria)
- Metals for low matrix spike recoveries

For the SVOCs, the rejected data points were very few, the project completeness goals were met for the overall data, and overall decisions based on use of the data are not affected.

For metals, including antimony, the rejected values were due to low matrix spike recoveries (below 30 percent) that indicated low bias in the measurement. This is not due to laboratory or field error, but is intrinsic to the nature of the site sediments. The nondetect values were flagged “R” because the low bias indicates elevated detection and potential for false nondetects. For the initial flags shown on laboratory data Form I's, the data reviewer crossed out the nondetect “U” flag and replaced it with R; thus, the data appear as rejected detect values. The U flag was reentered as UR in the project database to clarify that the data are nondetects. Thus for analytes that are mostly nondetected, such as antimony, more rejected values are observed than for analytes that were frequently detected. At large, this still amounts to a low percentage of rejected data for metals other than antimony, and completeness goals therefore were met for those metals. For antimony, however, the laboratory analytical results for 109 of the 236 transect samples were rejected during validation. Given the percentage of rejected results, the Phase I data for antimony do not provide equivalent coverage compared to other metals for the transect sample group to allow a full assessment of the nature and extent of the element.

Elevated Detection Limits

Detection limits in excess of the required levels identified in the QAPP were reported for a number of samples. However, the results for uranium appear to be the most affected by detection limit issues. The values listed for nondetect results are the CLP-required reporting limits. The laboratory-specific MDLs are significantly lower than the CLP reporting limits. For example, for uranium the MDLs are lower than the reporting limits by a factor of five. The MDLs are shown on laboratory data sheets. The elevated detection levels are due to sediment moisture correction because the data are reported on a dry weight basis. The initial laboratory detection limits prior to moisture correction were according to standard state of the art methods (inductively coupled plasma atomic emission as well as mass spectra); therefore, these levels are not due to laboratory deficiency.

The elevated detection limit for uranium affected use of uranium data as follows. Uranium was detected in 83 of 368 sediment samples, with concentrations ranging between 4.6 and 127 milligrams per kilogram (mg/kg) (Figure 2-28). More than 75 percent of the samples were reported as nondetects, with reporting limits ranging between 14.5 and 84 mg/kg (Figure 2-28). The corresponding range for laboratory-specific MDLs is 2.9 to 16.8 mg/kg. All of the nondetect reporting limits exceed the 5-mg/kg detection limit specified in the QAPP and also exceed the lowest risk-based screening level for the metal (8 mg/kg). However, if the laboratory-specific MDLs are taken into consideration, a significant number of these elevated nondetect data points can be considered as nondetect below the project criteria.

Given the ranges of detected and nondetected results relative to the screening level, the Phase I data for uranium are not usable for a quantitative assessment of the nature and extent of the chemical because of the elevated reporting levels. However, if the MDLs are considered, nondetects at reporting levels below 25 mg/kg (corresponding to the 5-mg/kg criterion) or below 40 mg/kg (corresponding to 8-mg/kg criterion) can be considered to have values below the project criteria. The distribution of samples with such results and the effect on the usability of uranium data has not been examined.

2.5.2.4 Data Storage and Documentation

Backup information for the data evaluation and validation findings includes the following:

- Laboratory hard copy packages, assembled in SDG units, which include all QC data. These packages are stored at USEPA offices as well as at the laboratories.
- An electronic database, which includes all sample concentration data with validation flags and a subset of laboratory QC data.
- Chain-of-custody forms and tracking records.
- Laboratory bench records and sample custody logs maintained by the laboratory.

2.5.3 Data Quality Assessment and Quality Control Data

DQOs are prescribed in the QAPP in terms of precision, accuracy, representativeness, comparability, and completeness (PARCC) parameters. The following is a description of the assessment for each parameter. PARCC objectives for the project are shown in Table 2-5. Associated data for the PARCC parameters are provided in the laboratory data package.

2.5.3.1 Accuracy

Accuracy measurement data include laboratory control sample and matrix spike recovery data for both organic and inorganic analytical parameters, as well as surrogate recovery data for organic parameters. The accuracy data were provided to the project team (data users) for consideration during data evaluation because these data need to be applied to whole sites. Over 90 percent of the data are within the criteria, thus meeting project goals.

2.5.3.2 Precision

Precision measurement data include laboratory and field duplicate data expressed as relative percent deviation. The validation reports also detail duplicates outside control limits, if any. The duplicate data were provided to the project team (data users) for consideration during data evaluation because these data need to be applied to whole sites. Over 90 percent of the data are within the criteria, thus meeting project goals.

2.5.3.3 Representativeness

Representativeness is a measure of how closely the measured results reflect the actual concentration or distribution of the chemical compounds in the sampled media. Representativeness is assessed in both qualitative and quantitative terms. The project report discusses the qualitative aspects of representativeness in terms of design of the field sampling plan, sampling techniques, sample handling protocols, and associated documentation. Quantitative measures of representativeness include field and laboratory blank measurements to identify whether contamination was introduced through field or laboratory operations. Field duplicate measurements are used to establish variability.

Laboratory and trip blank measurements were detailed on a sample- and parameter-specific basis in the validation reports. All qualifications as a result of laboratory and trip blank effects were incorporated into the project sample/analyte specific data. Field blank results are summarized in the database and provided to data users on a sitewide basis.

Field duplicate results and associated relative percent deviation data are listed in Appendix B, Table B-1, and were taken into account during data evaluation.

2.5.3.4 Comparability

Comparability expresses the confidence with which one data set can be compared to another. Comparability of data has been established through use of the following:

- Standard analytical methods and QC procedures established in the project QAPP and USEPA CLP and Manchester Regional Laboratory protocols
- Consistent reporting units for a specified procedure
- MDLs for all analytical parameters that were established in accordance with 40 CFR Part 136, Appendix B, before the start of the analyses to meet the project requirements

2.5.3.5 Completeness

This QA/QC analysis assesses completeness as a measure of the amount of valid data obtained from the analytical measurements. Field activity completeness is assessed within the context of the overall sampling design. Data completeness was found to be above 90 percent at large and meets project objectives.

2.6 Sample Management and Recordkeeping

A sample is physical evidence collected from a hazardous waste site, from the immediate environment, or from another source. Because of the potential evidentiary nature of samples, the possession of samples must be traceable from the time the samples are collected until they are introduced as evidence. Field notebooks, sampling records, chain-of-custody forms, and other field documents were used to record information about each sample collected during the Phase I sediment sampling event.

2.6.1 Field Notebooks

A bound field notebook was maintained by each sampling field team leader. The field notebook provides a daily record of significant events, observations, and measurements during the field investigation. All entries were signed and dated.

2.6.2 Field Documents

Field documents including sample custody seals, chain-of-custody records, and packing lists were obtained from the Regional Sample Control Coordinator (RSCC) in USEPA's Quality Assurance Office. Chain-of-custody procedures were used to maintain and document sample collection and possession. After sample packaging, one or more of the following chain-of-custody forms was completed, as necessary, for the appropriate samples:

- Organic traffic report and chain-of-custody record; Forms II Lite forms as applicable
- Inorganic traffic report and chain-of-custody record; Forms II Lite forms as applicable
- USEPA Region 10 Chain-of-Custody Record
- Overnight shipping courier air bill

Copies of the above forms were filled out and distributed in accordance with the instructions for sample shipping and documentation. Completed field QA/QC summary forms were sent to the RSCC at USEPA's Region 10 Quality Assurance Office at the conclusion of the sampling event. The sampling records and other data from the sampling event are provided in the Phase I Sediment Sampling Field Report (CH2M HILL, 2006a).

2.7 Data Management Program

Data obtained during the Phase I sampling program were managed according to the processes described in the project-specific data management plan prepared for the UCR site (CH2M HILL, 2004c) and according to the procedures described in the QAPP (CH2M HILL, 2005).

Following receipt of validated data, the data and validation qualifiers were input into the site information management system (SIMS) database to facilitate queries and report preparation. The data are stored in SIMS with all laboratory and independent validator qualifiers included. Laboratory data from ASCII or equivalent files, provided by the USEPA Region X CLP Project Officer, were adapted to files compatible with the project database, as described in the project-specific data management plan. The SIMS database continues to be maintained in a manner that is compatible with, and provided to, USEPA or others at USEPA's request.

TABLE 2-1
Phase I Remedial Investigation Data Quality Objectives for Source Identification, Nature and Extent of Contaminants, and Fate and Transport of Contaminants in Sediment
Upper Columbia River RI/FS

Problem Statement	Identify the Decision	Inputs to Decisions	Study Boundaries	Decision Rule	Acceptable Limits on Decision Errors	Optimized Sampling Design
Source Identification						
Potential sources of sediment contaminants in the UCR have not been fully established.	Identify potential primary sources of sediment contaminants.	Release information from upstream UCR industry and operations Available process and historical information from the facilities Review of industry-related chemical literature All Phase I analytical results	Study boundaries are limited to the UCR Site; however, primary sources have been determined to be present north of the international border and may also be present in tributaries. These areas will not be sampled as part of Phase I.	If contaminants found in sediment are similar to chemicals/materials managed or discharged from an upstream UCR operation, that operation is a potential primary source; otherwise the operation is not a potential source.	Decision is to be made using quantitative and qualitative data.	Sample design described for human and ecological risk assessments detailed in QAPP.
Nature and Extent of Contaminants in River Sediments						
To adequately characterize impacts to public health and the environment, constituents that are most likely to contribute to risk need to be evaluated during the RI.	Confirm list of COIs for sediment.	Release information from upstream industry and operations Available process and historical information from the facilities Review of industry-related chemical literature Analytical results from prior investigations, including the PA and ESI All Phase I analytical results Appropriate benchmark or screening levels for sediment, including background concentrations, as developed for risk assessment COI selection process, as developed for risk assessment	UCR site; may be subdivided according to results of risk assessments and Phase I analytical results.	Decision rules for COI identification will be developed as part of risk assessment process.	Decision is to be made using quantitative and qualitative data.	Sample design described for human and ecological risk assessments detailed in QAPP.
To adequately characterize impacts on public health and the environment, the longitudinal, transverse, and vertical distributions of COIs need to be evaluated during the RI.	Identify longitudinal and transverse distribution of COIs in sediment along length of UCR. Identify vertical distribution of COIs in sediment at selected locations along length of UCR.	Analytical results of sufficient quality for historical surface and subsurface sediment samples All Phase I surface sediment analytical results Phase I subsurface sediment analytical results Sediment thickness measurements at core locations Longitudinal and transverse variability information Appropriate benchmark or screening levels for sediment, as developed for risk assessment	UCR site; may be subdivided according to results of risk assessment and Phase I analytical results.	If a COI in sediment poses potential unacceptable risk, further evaluation and delineation may be required to determine extent; otherwise, further evaluation and delineation may not be required.	Decision is to be made using quantitative and qualitative data.	Sample design described for human and ecological risk assessments detailed in QAPP Vertical distribution of COIs evaluated using sediment cores. Each sediment core divided into samples representing the 0- to 6- and 6- to 12-inch intervals, and every 2 feet below 12 inches until the core bottom is reached. An expanded analytical suite (includes dioxins/ furans) was used for samples collected to evaluate the possible relationship between dioxins/furans and the elevated total organic carbon (TOC) concentrations that occur downstream from Marcus Flats.

TABLE 2-1
Phase I Remedial Investigation Data Quality Objectives for Source Identification, Nature and Extent of Contaminants, and Fate and Transport of Contaminants in Sediment
Upper Columbia River RI/FS

Problem Statement	Identify the Decision	Inputs to Decisions	Study Boundaries	Decision Rule	Acceptable Limits on Decision Errors	Optimized Sampling Design
Describe Fate and Transport of Contaminants in River Sediment						
Contaminated sediments and slag in the UCR may be eroded and transported to different areas of the site.	Determine which portions of the study area pose potential risk and are susceptible to erosion under the range of hydraulic conditions that are present in the UCR.	Conceptual hydrologic model Historical analytical data, including suspended sediment data (TSS, TOC, particle size, and COI concentrations) Particle size, particle density, and shape analyses Slag weathering information All Phase I surface sediment analytical results Phase I subsurface sediment analytical results Sediment thickness measurements at core locations COI distribution relative to particle size and material type (slag versus mineral) and vertical trend analysis Critical erosion velocities	UCR site; may be subdivided according to results of risk assessment and Phase I analytical results.	If contaminated sediments pose potential risk and are located in areas that can be eroded, remedial action alternatives will need to consider potential for sediment movement; otherwise, remedial action alternatives for the area do not need to consider potential for sediment movement.	Decision is to be made using quantitative and qualitative data.	Sample design described for human and ecological risk assessments detailed in QAPP.
Contaminants in sediments and slag may be mobilized and/or transformed in such a way that other media, receptor populations, or downstream areas become contaminated at levels that pose risk.	Determine whether contaminated sediments may act as potential sources of COIs that may be remobilized to affect other media, receptor populations, or downstream areas at levels that pose risk.	All Phase I surface sediment analytical results Phase I subsurface sediment analytical results Slag weathering information COI fate and bioavailability characteristics derived from literature Conceptual hydrologic model Geochemical parameter measurements	UCR site; may be subdivided according to results of risk assessment and Phase I analytical results.	If COIs are potentially mobile under typical UCR conditions and are shown to pose unacceptable risk at the concentrations observed, assess the need to evaluate the presence of COIs in other media and take potential mobility into consideration during subsequent evaluations; otherwise, other media evaluations do not need to consider sediment as a potential source and remedial action alternatives for the area do not need to consider COI mobility.	Decision is to be made using quantitative and qualitative data.	Sample design described for human and ecological risk assessments detailed in QAPP and sampling design for vertical extent described above.

ESI = expanded site investigation
COI = constituent of interest
PA = preliminary assessment
TOC = total organic carbon
TSS = total suspended solids

TABLE 2-2
Summary of Collected Cores
Upper Columbia River RI/FS

River Mile of Core Location	Position in Channel	Length of Core (feet)
708	Within historic river channel	7
704	Within historic river channel	9
692	Within historic river channel	7
676	Within historic river channel	7
661	Within historic river channel	7
644	On submerged river terrace to right (looking downstream) of historic river channel	7
637	On submerged river terrace to left (looking downstream) of historic river channel	5
622	On bank slope just above terrace to left (looking downstream) of historic river channel	9
605	On submerged river terrace to left (looking downstream) of historic river channel	5

TABLE 2-3
Unattainable or Relocated Mid-Channel Samples
Upper Columbia River RI/FS

Sample/Type	Unattainable or Relocated	Comment
744X2 Transect	Relocated	Relocated to behind large rock in mid-channel and is not representative of adjacent channel sediment
743X2 Transect	Unattainable	Unattainable due to cobbly bottom and swift current
742X3 Transect	Unattainable	Unattainable due to cobbly bottom and swift current
742X2 Transect	Unattainable	Unattainable due to cobbly bottom and swift current
741X2 Transect	Unattainable	Unattainable due to cobbly bottom and swift current
740X2 Transect	Unattainable	Unattainable due to cobbly bottom and swift current
739X2 Transect	Unattainable	Unattainable due to cobbly bottom and swift current
738X2 Transect	Unattainable	Unattainable due to cobbly bottom and swift current
737X2 Transect	Relocated	Relocated from mid-channel to left bank
736X2 Transect	Unattainable	Unattainable due to cobbly bottom and swift current
736T2 Tributary	Unattainable	Unattainable due to cobbly bottom and swift current
735X2 Transect	Unattainable	Unattainable due to cobbly bottom and swift current
734X1 Transect	Unattainable	Unattainable due to cobbly bottom and swift current
734C1 Core	Unattainable	Unattainable due to cobbly bottom and swift current
734X2 Transect	Unattainable	Unattainable due to cobbly bottom and swift current
733X2 Transect	Relocated	Relocated from mid-channel to right bank due to cobbly bottom and swift current

TABLE 2-3
Unattainable or Relocated Mid-Channel Samples
Upper Columbia River RI/FS

Sample/Type	Unattainable or Relocated	Comment
732X2 Transect	Relocated	Relocated from mid-channel to bench right of mid-channel due to cobbly bottom and swift current
731X2 Transect	Unattainable	Unattainable due to cobbly bottom and swift current
730X3 Transect	Unattainable	Unattainable due to cobbly bottom and swift current
730X2 Transect	Unattainable	Unattainable due to cobbly bottom and swift current
728X2 Transect	Unattainable	Unattainable due to cobbly bottom and swift current
727X2 Transect	Unattainable	Unattainable due to cobbly bottom and swift current
725X2 Transect	Unattainable	Unattainable due to cobbly bottom and swift current
723X2 Transect	Unattainable	Unattainable due to cobbly bottom and swift current
723C1 Core	Unattainable	Unattainable due to cobbly bottom and swift current
715X2 Transect	Unattainable	Unattainable due to cobbly bottom and swift current
715C1 Core	Unattainable	Unattainable due to cobbly bottom and swift current
713X2 Transect	Unattainable	Unattainable due to cobbly bottom and swift current

TABLE 2-4
Summary of Phase I Sediment Sampling Program Analytical Suites
Upper Columbia River RI/FS

Sample Type/Group	Standard Analytical Suite: TAL Metals (plus uranium), TCL SVOCs, TCL Pesticides/PCB Aroclors, Particle Size, TOC	Bioassay Analytical Suite: Standard Analytical Suite plus AVS/SEM, and Bioassay	Dissolved TAL Metals	Dioxins and Furans
Transect Samples	X			
Bioassay and Reference Samples		X		
Pore Water Isolated from Bioassay and Reference Samples			X	
Tributary Mouth Samples	X			
Selected Beach Discrete Samples[a]	X			
Selected Beach Composite Samples[b]				X
Selected Beach Fractionated Composite Samples[c]				
As-Received, Wet Composite Samples	X			X
Air-Dried, Particle-Size-Fractionated Samples	X			X
Standard Beach Composite Samples	X			X
Core Samples	X			X

[a] Northport City Boat Launch, Kettle Falls Swim Beach, Columbia Campground Beach; nine discrete samples per beach.

[b] Northport City Boat Launch, Kettle Falls Swim Beach, Columbia Campground Beach; three composite samples per beach.

[c] Northport City Boat Launch, Kettle Falls Swim Beach, Columbia Campground Beach; one composite per beach, two particle size fractions per composite.

TABLE 2-5
Analytical Program Objectives, Procedures, and Criteria
Upper Columbia River RI/FS

Parameter	Method [b]	Reporting Limit/Target Detection Limit	Analytical Accuracy (% Recovery)	Analytical Precision (Relative % Deviation)	Overall Completeness (%)
Site Sediment					
TCL Semivolatiles[a]	CLP	CLP[c]	CLP	CLP	90
TCL Pesticides/PCBs[a]	CLP	CLP[c]	CLP	CLP	90
TAL Metals[a]	CLP	CLP[c]	CLP	CLP	90
Dioxins/Furans (tetra through octa)[a]	CLP	CLP[c]	CLP	CLP	90
Ammonia	PSEP	0.25 ppm/% Solids	65-135	35	90
Total sulfides	PSEP	0.5 ppm	65-135	35	90
TOC	PSEP	0.05 %	65-135	35	90
AVS/SEM	PSEP		65-135	35	90
Volatiles		0.5 ppm			
Antimony		0.5 ppm			
Cadmium		0.05 ppm			
Chromium		0.1 ppm			
Copper		0.1 ppm			
Lead		1 ppm			
Mercury		0.01 ppm			
Nickel		0.2 ppm			
Zinc		0.1 ppm			
Particle size	ASTM D422	NA	NA	NA	90
Bioassay analyses:					
10-day Sediment Toxicity Test with *Chironomus tentans*	ASTM Method E 1706-00 (ASTM, 2003) and USEPA Method 100.2 (USEPA, 2000b)	NA	NA	NA	90
7-Day Sediment Toxicity Test with *Ceriodaphnia dubia*	ASTM Method E 1706-00 (ASTM, 2003)	NA	NA	NA	90

TABLE 2-5
Analytical Program Objectives, Procedures, and Criteria
Upper Columbia River RI/FS

Parameter	Method [b]	Reporting Limit/Target Detection Limit	Analytical Accuracy (% Recovery)	Analytical Precision (Relative % Deviation)	Overall Completeness (%)
28-day Sediment Toxicity Test with *Hyalella azteca*	ASTM Method E 1706-00 (ASTM, 2003) and USEPA Method 100.4 (USEPA, 2000b)	NA	NA	NA	90
Investigation-Derived Waste					
TCL Semivolatiles[a]	CLP	CLP[c]	CLP	CLP	90
TCL Pesticides/PCBs[a]	CLP	CLP[c]	CLP	CLP	90
TAL Metals[a]	CLP	CLP[c]	CLP	CLP	90
Dioxins/Furans (tetra through octa)[a]	CLP	CLP[c]	CLP	CLP	90

[a] TCL and TAL analytes and dioxin/furans are listed in the CLP statements of work referenced below, Table 2-1 of the QAPP and the data tables of this document.
[b] CLP method per USEPA CLP statements of work:

- Multi-Media, Multi-Concentration, Organic Analytical Service for Superfund (OLM04.3)and the modified analysis flexibility clause MA1216.1.
- Multi-Media, Multi-Concentration, Inorganic Analytical Service for Superfund (ILM05.3).
- Multi-Media, Multi-Concentration Dioxins and Furans Analysis (DLM01.4).

Other methods per USEPA and standard methods:

- USEPA, 1979. *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, revised March 1983.
- USEPA, 1989. *Test Methods for Evaluating Solid Waste*, SW846, *Standard Methods for the Examination of Water and Wastewater*, 17th Edition.
- *Recommended Protocols for Measuring Conventional Sediment Variables in Puget Sound* (PSEP, 1986).

[c] CLP detection limits are shown in the CLP statements of work referenced above, Tables 2-2b through 2-2e of the QAPP, as well as the data tables in this report.

ASTM = American Society for Testing and Materials
CLP = Contract Laboratory Program
PSEP = Puget Sound Estuary Program