



July 27, 2009

File No.: 1-773180-000

Ms. Monica Tonel
Project Coordinator, Office of Environmental Cleanup
U.S. Environmental Protection Agency, Region 10
1200 6th Avenue, Suite 900 (ECL-111)
Seattle, WA 98101-3140

Subject: Upper Columbia River Remedial Investigation and Feasibility Study (UCR
RI/FS) –2009 Beach Sediment Study Plan
Response and Resolution to Quality Assurance Comments
Signature Page for the Beach Sediment Sampling Program

Dear Ms. Tonel:

On behalf of Teck American Incorporated (Teck), please find enclosed for your records and review the above referenced material as prepared by Integral Consulting Inc. As you know, the enclosed information has been prepared based on technical communications with the U.S. Environmental Protection Agency (EPA) and Syracuse Research Corporation. In addition to the above-mentioned, I have also attached for your signature and internal circulation, the signature page of the approved Quality Assurance Project Plan (QAPP) to conduct beach sediment sampling.

It would be greatly appreciated that upon obtaining the required EPA signatures, if the signature page could be returned to my attention for additional circulation. I wish to confirm that once all the required signatures have been obtained, I will provide you with a copy for inclusion into the QAPP.

We would like to take this opportunity to thank you in advance for your assistance on this matter and a productive field sampling season. Should you have any questions or require any additional information at this time, please do not hesitate to contact me at (509) 892-2585.

Sincerely,
Teck American Incorporated



Marko E. Adzic, P.E.
Manager, Environmental Engineering

Attachments (7)

- Attachment 1 – Response summary letter as prepared by Integral Consulting Inc.
- Attachment 2 – Standard Operating Procedure as prepared by Columbia Analytical Service, Inc.
- Attachment 3 – Table A-7
- Attachment 4 – Site-Specific Standard Operating Procedure as prepared by Integral Consulting Inc.
- Attachment 5 – Table B-1
- Attachment 6 – Table 2-2
- Attachment 7 – QAPP signature page

cc: Kris McCaig - Teck, Spokane, WA (w/o attachments)
Helen Bottcher - U.S. Environmental Protection Agency – Seattle, WA (w/o attachments)
Marc Stifelman - U.S. Environmental Protection Agency – Seattle, WA (attachments)
Dina Johnson – Integral Consulting Inc., Seattle, WA (attachments)



ATTACHMENT 1

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July 10, 2009

Project No. C534-0101

Marko E. Adzic
Manager, Environmental Engineering
Teck American Incorporated
501 North Riverpoint Boulevard, Suite 300
Spokane, WA 99202

Subject: **Responses to EPA Quality Assurance Review of the Quality Assurance Project Plan and Field Sampling Plan for the Upper Columbia River 2009 Beach Sediment Study Revision March 2009**

Dear Mr. Adzic:

Integral has reviewed the enclosed EPA memorandum dated March 13, 2009, from Ginna Grepo-Grove, RQAM, to Monica Tonel, RPM, and Kevin Rochlin, RPM, regarding "QA Review of the Quality Assurance Project Plan and Field Sampling Plan for the Upper Columbia River 2009 Beach Sediment Study Revision March 2009." The referenced plan was approved by EPA on March 5, 2009. Clarification and discussion of each of these comments occurred during a conference call on March 26, 2009, in which I participated along with other Integral staff (Jane Sexton and Craig Hutchings), EPA staff (Monica Tonel, Marc Stifelman, and Ginna Grepo-Grove), and SRC (Lynn Woodbury). Action items identified during this call were subsequently followed up by participants and a consensus approach for resolving all of the comments was developed. A summary of the consensus approach, as well as clarification of specific comments and responses, is provided below and in the enclosed materials.

1. **Resolution of "General Comments," 1st Bulleted Comment:** Based on initial clarification of this comment and follow-up actions taken by EPA, SRC, and Integral, it was agreed that response to this comment could be achieved by detailing the sieving protocols to be conducted by the contract laboratory for this study, Columbia Analytical Services, Inc. (CAS), on Upper Columbia River (UCR) Beach Sediment Study field samples. These details are provided in the enclosed standard operating procedure (SOP) for "Particle Size Determination" which CAS prepared, as directed by Integral, in

response to the clarified comment. Additionally, this procedure describes wet sieving protocols used when trace metals analysis are to be performed on the sieved fractions.

2. **Resolution of "General Comments," 2nd Bulleted Comment:** During the March 26, 2009, conference call, it was clarified that the requested project analytical concentration goals and reporting limits were included in Table A-7 of the UCR Beach Sediment Study Quality Assurance Project Plan (QAPP). Based on consensus reached during that call, no further action in response to this comment was necessary.
3. **Resolution of "General Comments," 3rd Bulleted Comment:** Based on initial clarification of this comment, it was agreed that response to this comment could be achieved by detailing the site-specific operating procedure (SSOP) to be conducted by field program staff during execution of the UCR Beach Sediment Study sampling program. These details are provided in the enclosed SSOP for "Beach Sediment Sampling at Upper Columbia River," which Integral prepared in response to the clarified comment. This SSOP details the systematic processes that will be instituted by the field sampling team(s) to ensure that project schedule and sample integrity will be maintained during collection of surface and subsurface beach sediment samples from the UCR.

In addition, replacement pages for Table B-1 of the QAPP and Table 2-2 of the Field Sampling Plan (FSP) are also enclosed to address the portion of this comment that pertains to sampling containers designated in the March 2009 Beach Sediment Study QAPP and FSP.

Finally, during the March 26, 2009, conference call, it was clarified that the recommendation for EPA team evaluation of the Beach Sediment Study field team(s) sample collection and processing production line could best be accomplished on the first week of sampling, after the first sample collection day.

4. **Resolution of "Specific Comments" – "Page B-1, section B1, Sampling Design – surface sediment collection":** Based on initial clarification of this comment, it was agreed that response to this comment could also be achieved via the SSOP developed in response to the prior comment (General Comments, 3rd Bullet). This SSOP address the details requested in this specific comment as well as additional details discussed and clarified during the March 26, 2009, conference call.
5. **Resolution of "Specific Comments" – "Page B-6, section B4.1.4, SVOCS and PAHs":** Sample extractions for SVOC and PAHs will be completed using Soxhlet or automated Soxhlet extraction procedures and 40 g of sample (wet weight). The extract will be

processed through gel permeation chromatography (GPC) and the final extract volume will be 1 mL.

6. **Resolution of "Specific Comments" – "Page B-7 section B4.1.5, Pesticides":** Aroclor standards will be analyzed with each pesticide analytical sequence to assess potential PCB interferences to pesticide identification and quantitation as described in "EPA Region 10 Clarification of SW-846 Method 8081 and Supplemental Guidance for Data Review" (May 3, 2006).
7. **Resolution of "Specific Comments" – "Table A7":** During the March 26, 2009, conference call, consensus was reached that Mirex did not need to be added to the target analytes for pesticides. No further action in response to this comment was necessary.
8. **Resolution of "Specific Comments" – "Table A-5 – PCB Congener Analyses":** Based on initial clarification of this comment and follow-up actions taken by EPA and SRC, it was agreed that existing methods specified for PCB congener analyses would achieve the Beach Sediment Study analytical concentration goals and that the addition of carbon cleanup was not necessary.

However, a replacement Table A-7 for the March 2009 Beach Sediment QAPP is enclosed that includes the PCB congener-specific values that were not previously incorporated. Table A-7 has also been updated to include MDLs and MRLs from the laboratories selected following finalization of the March 2009 Beach Sediment QAPP.

9. **Resolution of "Specific Comments" – "Corrections Needed in Table B-1 and Table 2-2 in FSP":** Based on additional information obtained from the laboratories contracted following finalization of the March 2009 Beach Sediment Study QAPP, CAS will extract 20 g dry weight to a final volume of 4 mL for the pesticide and Aroclor analyses. SGS will extract 10 g dry weight for the dioxin and PBDE analyses. Replacement pages for QAPP Table B-1 and FSP Table 2-2 are enclosed to address the information requested in this comment regarding the amount of samples needed for extraction.

In addition, during the March 26, 2009 conference call, it was agreed:

- that further action regarding the comment on grain size containers was not necessary;

- that omitting the preservative for sulfides would be acceptable, but that method deviations would be noted in final reporting for the study;
- that correction of the preservation/holding times for mercury was not necessary;
- that correction of the holding time for TOC was not necessary;
- that increasing the sample amount extracted for PCB congeners was not necessary based on resolution of the prior comment (Specific Comments, Table A-5 – PCB Congener Analyses).

10. **Resolution of "Specific Comments" – "Page C-1, section C1 Assessments and response Actions"**: Based on initial clarification of this comment and follow up actions taken by EPA and SRC, it was agreed that addressing item (1) of this comment (i.e., analysis of EPA Performance Evaluation Soil Samples or Standard reference) would not be required. Agreement to items (2), (3), and (4) was acknowledged during the March 26, 2009, conference call and no further action is required.

11. **Resolution of "Specific Comments" – "Page D-2, Verification and Validation Methods" and "QA oversight"**: Agreement to these comments was acknowledged during the March 26, 2009, conference call and no further action is required.

12. **Resolution of "FSP Comments" – "Page 2-6, section 2.2.3.1, surface sediment sample collection"**: The information requested is provided in Table 2-4 of the FSP.

13. **Resolution of "FSP Comments" – "Page 2-8, section 2.2.4, Equipment decontamination"**: Agreement was reached during the March 26, 2009 conference call that, due to concern regarding transport and handling of methanol in field, replacement equipment would be used when visible sheen is present. Decontamination would then occur at end of each day at central location employing a less toxic agent than methanol.

The additional detail requested in this last comment for sample processing procedures for both surface and subsurface sediment is addressed by the enclosed SSOP.

It is my understanding that the information provided above and in the enclosed materials will appropriately address all of the EPA QA review comments on the UCR Beach Sediment Study QAPP and FSP, as clarified during and subsequent to the March 26, 2009, conference call.

Integral appreciates the opportunity to assist Teck on this matter. Please do not hesitate to contact me directly should you have any questions about this summary.

Mr. Marko Adzic
July 10, 2009
Page 5

Sincerely,

Dina Johnson
Managing Scientist

Enclosures

ATTACHMENT 2

SOP NO. GEN-PSP

Revision 6

Date: July 23, 2009

Page 1 of 12

STANDARD OPERATING PROCEDURE

PARTICLE SIZE DETERMINATION

GEN-PSP

Revision 6


July 23, 2009

Approved By:



Supervisor

7/24/09
Date



QA Manager

7/24/09
Date



Laboratory Manager

7/24/09
Date

COLUMBIA ANALYTICAL SERVICES, INC.

1317 South 13th Avenue

Kelso, Washington 98626

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Annual review of this SOP has been performed
and the SOP still reflects current practice.

Initials: _____ Date: _____

Initials: _____ Date: _____

Initials: _____ Date: _____

DOCUMENT CONTROL

NUMBER: _____

Initials: _____ Date: _____

PARTICLE SIZE DETERMINATION

1. SCOPE AND APPLICATION

- 1.1. This procedure is used to determine the fraction of pre-determined sizes of particles in sediments. The procedures are based on Puget Sound Protocols, Plumb (1981) and ASTM D422 methodology. Particle size can be characterized in a wide range of detail. The grossest divisions that generally are considered useful for characterizing particle size distributions are percentages of gravel, sand, silt, and clay. However, each of these size fractions can be subdivided further so that additional characteristics of the size distribution (e.g., mean diameter, skewness, kurtosis) can be determined. Additionally, this procedure describes wet sieving protocols used when trace metals analysis are to be performed on the sieved fractions.
- 1.2. Detection limits are determined from accuracy of analytical balances. Samples are weighed to the nearest 0.01g and results are reported to the nearest 0.01 percent.

2. METHOD SUMMARY

- 2.1. Particle size is used to characterize the physical characteristics of sediments. Because particle size influences both chemical and biological variables, it can be used to normalize chemical concentrations according to sediment characteristics and to account for some of the variability found in biological assemblages. Particle size is also an important variable for marine engineering purposes. In addition to Plumb (1981), other references discuss the uses and measurement of particle size (e.g., Krumbein and Pettijohn 1938; Folk 1968; Buchanan 1984).
- 2.2. Particle size determinations can either include or exclude organic material. If organic material is removed prior to analysis, the "true" (i.e., primarily inorganic) particle size distribution is determined. If organic material is included in the analysis, the "apparent" (i.e., organic plus inorganic) particle size distribution is determined. Because true and apparent distributions may differ, detailed comparisons between samples analyzed by these different methods are questionable. It is therefore desirable that all samples within each study (at a minimum) and among different studies (if possible) be analyzed using only one of these two methods.

3. DEFINITIONS

- 3.1. Particle size – The size of various solid components making up a sediment, as named in the applicable method reference (gravel, sand, silt, clay, etc.).

- 3.2. True particle size – The particle size determined when organic material is removed prior to analysis.
- 3.3. Apparent particle size – The particle size determined when organic material is not removed prior to analysis.

4. INTERFERENCES

Depending on the required particle size distribution, organic material can be an interference.

5. SAFETY

- 5.1. All appropriate safety precautions for handling solvents, reagents and samples must be taken when performing this procedure. This includes the use of personnel protective equipment, such as, safety glasses, lab coat and the correct gloves.
- 5.2. Chemicals, reagents and standards must be handled as described in the CAS safety policies, approved methods and in MSDSs where available. Refer to the CAS Environmental, Health and Safety Manual and the appropriate MSDS prior to beginning this method.

6. SAMPLE COLLECTION, CONTAINERS, PRESERVATION, AND STORAGE

- 6.1. Samples can be collected in glass or plastic containers. A minimum sample size of 100-150g is recommended. If unrepresentative material is to be removed from the sample, it should be removed in the field under the supervision of the chief scientist and noted on the field log sheet.
- 6.2. Samples should be stored at 4 ± 2 °C, and can be held for up to 6 months before analysis. Samples must not be frozen or dried prior to analysis, as either process may change the particle size distribution.

7. APPARATUS AND EQUIPMENT

- 7.1. Sieve shaker - Ro-Tap or equivalent
- 7.2. Drying oven
- 7.3. Constant temperature bath
- 7.4. Analytical balance - 0.1mg accuracy
- 7.5. Desiccator

- 7.6. Clock - with second hand
- 7.7. Standard sieves - Appropriate mesh sizes, sieve pan and top, sieve brush.
- 7.8. Funnel
- 7.9. Graduated cylinders
- 7.10. 250-mL beakers
- 7.11. 20-mL pipettes
- 7.12. Water pique or squirt bottle
- 7.13. Glossy paper
- 7.14. 1000 mL Polycarbonate Centrifuge Bottles
- 7.15. Centrifuge - With buckets appropriate for 1000 mL bottles

8. STANDARDS, REAGENTS, AND CONSUMABLE MATERIALS

- 8.1. Dispersant - 1 percent sodium hexamethaphosphate = 1 percent commercially available Calgon. To prepare, weigh 10.0g sodium hexamethaphosphate and dilute to 1.0L in DIW.
- 8.2. Distilled water

9. PREVENTIVE MAINTENANCE

- 9.1. No specific maintenance steps are needed for sieves other than normal cleaning and inspection.
- 9.2. Balance calibration checks are performed daily.
- 9.3. Color-indicating desiccant is recommended so that spent desiccant can be detected easily. Also, the seal on the desiccator should be checked periodically, and, if necessary, the ground glass rims should be greased or the "O" rings should be replaced.

10. RESPONSIBILITIES

- 10.1. It is the responsibility of the analyst to perform the analysis according to this SOP and to complete all documentation required for data review. Analysis and interpretation of the results are performed by personnel in the laboratory who have demonstrated the ability to generate acceptable results utilizing this SOP. This demonstration is in accordance with the training program of the laboratory. Final review and sign-off of the data is performed by the department supervisor/manager or designee.
- 10.2. It is the responsibility of the department supervisor/manager to document analyst training. Training and proficiency is documented in accordance with the SOP for Documentation of Training (ADM-TRANDOC).

11. PROCEDURE (Particle Size Fractionation)

11.1. Sample Preparation

- 11.1.1. Unless specifically asked for, organic oxidation is not performed and the apparent particle size distribution is determined.
- 11.1.2. It is critical that each sample be homogenized thoroughly in the laboratory before a subsample is taken for analysis. Laboratory homogenization should be conducted even if samples were homogenized in the field.
- 11.1.3. The total amount of sample used for analysis should be 25-100g. Refer to section 12.1 for a discussion of use of alternate sample sizes.

11.2. Analysis

- 11.2.1. Particle size determination is determined by four similar methods using this SOP. They include Puget Sound Estuary Protocols; condensed version and expanded version, and ASTM D422 Modified; condensed version and expanded version. The differences between these methods are explained below:
 - 11.2.1.1. Puget Sound Estuary Protocol (Condensed Version): Course particle size fractions are determined by using the following standard sieves: 10, 18, 35, 60, 120, and 230. The silt/clay portion of the sample is determined by pipette extraction using the withdrawal times given in Table 1.

11.2.1.2. Puget Sound Estuary Protocol (Expanded Version): Course particle size fractions are determined by using the following standard sieves: 10, 18, 35, 60, 120, and 230. The silt/clay portions of the sample are broken down into subdivisions and are determined by pipette extraction using the withdrawal times given in Table 2.

11.2.1.3. ASTM D422 Modified (Condensed Version): Course particle size fractions are determined by using the following standard sieves: 4, 10, 20, 40, 60, 140, and 200. The silt/clay portion of the sample is determined by pipette extraction using the withdrawal times given in Table 1.

11.2.1.4. ASTM D422 Modified (Expanded Version): Course particle size fractions are determined by using the following standard sieves: 4, 10, 20, 40, 60, 140, and 200. The silt/clay portions of the sample are broken down into subdivisions and are determined by pipette extraction using the withdrawal times given in Table 2.

11.2.2. Weigh sample as received and perform total solids at the same time.

11.2.3. Wet sieve through the appropriate (200 or 230) sieve, washing what goes through into a 1000mL graduated cylinder.

11.2.4. Add 10mL of a 1% sodium hexametaphosphate solution to cylinder.

11.2.5. Retain what was left on the 200 (or 230) sieve (gravel/sand fraction). Wash into a preweighed 250-ml beaker, and dry in 105°C oven to dryness. Dry sieve through the applicable sieves (see 11.2.1). After dry-sieving a sample, all material must be removed from the sieve. This can be accomplished by tapping the rim of the sieve evenly on a hard surface and by brushing the screen.

11.2.6. Silt-clay fraction:

Note: Before pipette extractions can be made, the sample must be homogenized thoroughly within the settling cylinder. Once the pipette analysis begins, the settling cylinders must not be disturbed, as this will alter particle settling velocities. Care must be taken to disturb the sample as little as possible when pipette extractions are made.

11.2.6.1. After sample is brought to 1L and mixed, it is left on the counter and the temperature is tracked with a thermometer in a graduated cylinder with DI water. The temperature does not usually vary by more than $\pm 2^{\circ}\text{C}$.

11.2.6.2. Withdrawal times for pipette analysis as a function of particle size and water temperature are given in Tables 1 and 2. Shake for 1 minute and take a 20mL aliquot at 20cm deep at 20 seconds.

11.2.6.3. Take 20mL aliquots at 10cm at differing times according to temperature of the suspension (see the attached sheets for specific times).

11.2.6.4. If the condensed analysis is wanted (silt & clay) only use 4 and 8 phi/times (Table 1). If the expanded analysis is wanted, refer to Table 2 for phi sizes and times.

11.2.6.5. After a pipette extract has been transferred to a drying beaker, any sample adhering to the inside of the pipette must be removed. This can be accomplished by drawing 20mL of distilled water into the pipette and adding this rinse water to the drying beaker.

11.2.7. Dried samples should be cooled in a desiccator and held there until they are weighed. If a desiccator is not used, the sediment will accumulate ambient moisture and the sample weight will be overestimated. A color-indicating desiccant is recommended so that spent desiccant can be detected easily.

12. PROCEDURE (Preparation for trace metals analysis)

12.1. Special Considerations

12.1.1. Metal sieves must not be used when preparing samples for trace metals analysis. Polymer mesh and pans are to be utilized.

12.1.2. Site water related to the samples being prepared is recommended for the wet sieving procedure. However, if site water is not available laboratory dionized water can be used.

12.1.3. Decontamination of all equipment that comes in contact with the sample must be performed prior to initiating the sieving. Rinse with 25% hydrochloric acid, followed by a minimum DIW rinses.

12.2. Analysis (Dry Sieve for Fractions >63 um)

12.2.1. Follow protocol described in Section 11, but include considerations listed in Section 12.1.

12.3. Analysis (Wet Sieve for ≤ 63 μ m Fraction)

- 12.3.1. Place an aliquot of sample onto the appropriate size sieve (sieve sized to be determined on a project specific basis).
- 12.3.2. Using a squirt bottle filled with the specified rinse solution (i.e. site or DI water) wash the sample through the sieve. Use a plastic funnel to capture the target sample fraction in a 1000 mL polycarbonate centrifuge bottle.
- 12.3.3. When sufficient sample has been captured, centrifuge the polycarbonate bottle then pour off and discard the supernatant. Transfer the remaining sample to an appropriate sized glass jar (i.e. 8 oz., 16 oz., etc.) clearly labeled with the sample I.D. and particle size fraction information. Store at $4 \pm 2^\circ\text{C}$.
- 12.3.4. The remaining sample is now ready for trace metals determination. (Note: The variety and combinations of trace metals analyses that can be performed vary widely, so subsequent analytical procedures will be defined on a project specific basis.) If further particle size reduction is needed an aliquot is retained for analysis. The remaining sample is then processed once more as described above using the next smaller sieve size as designated in the project plan.
- 12.3.5. So the final results can be reported on a dry weight basis perform a total solids determination on each fraction being analyzed for trace metals.

13. QA/QC REQUIREMENTS

- 13.1. The total amount of fine-grained material used for pipette analysis should be 5-25g. If more material is used, particles may interfere with each other during settling and the possibility of flocculation may be enhanced. If less material is used, the experimental error in weighing becomes large relative to the sample size.
- 13.2. It is recommended for Puget Sound Protocols that triplicate analyses be conducted on one of every 20 samples, or one sample per batch if less than 20 samples are analyzed. For ASTM Modified, it is recommended that duplicate analyses be conducted on one of every 20 samples, or one sample per batch if less than 20 samples are analyzed.

14. DATA REDUCTION, REVIEW, AND REPORTING

14.1. Calculations

- 14.1.1. The total weight of a phi-size interval in the 1-L graduated cylinder is determined as follows:

$$\text{Phi weight (g dry weight)} = 50[(A-C)-(B-C)]$$

Where: A = weight (g) of residue in a 20-mL aliquot for a given
 phi-size boundary
 B = weight (g) residue in a 20-mL aliquot for the next
 larger phi-size boundary
 C = mean weight (g) of dispersant in a 20-mL aliquot.

14.2. The data is entered into a spreadsheet and results determined using the appropriate equations. Refer to Appendix A.

14.3. Reporting and review

14.3.1. The weight of each sediment fraction should be reported to the nearest 0.0001g dry weight. The laboratory should report the results of all samples analyzed (including QA replicates) and should note any problems that may have influenced data quality.

14.3.2. It is the analyst's responsibility to review analytical data to ensure that all quality control requirements have been met for each analytical run. Results for QC analyses are calculated and recorded as specified for samples (above). These results are then used to calculate QC determinations

14.3.3. The results are entered directly onto the appropriate EDD forms located in the CAS network directory R:\WET\WIP. Refer to Appendix A. Once the results are transferred, the data and report are reviewed.

14.3.4. Refer to the SOP for Laboratory Data Review Process for general instructions for data review.

15. TRAINING

15.1. Training outline

15.1.1. Review literature (see references section). Read and understand the SOP. Also review the applicable MSDS for all reagents and standards used. Following these reviews, observe the procedure as performed by an experienced analyst at least three times.

15.1.2. The next training step is to assist in the procedure under the guidance of an experienced analyst. During this period, the analyst is expected to transition from a

role of assisting, to performing the procedure with minimal oversight from an experienced analyst.

- 15.1.3. Independently perform the analyses. For Initial Demonstration of Capability the data must be reviewed by a supervisor and the supervisor must document that the analyst is trained.

15.2. Training is documented following the *SOP for Documentation of Training*.

NOTE: When the analyst training is documented by the supervisor on internal training documentation forms, the supervisor is acknowledging that the analyst has read and understands this SOP and that adequate training has been given to the analyst to competently perform the analysis independently.

16. CHANGES SINCE THE LAST REVISION

- 16.1. Sec 1.1 removed the word Estuary.
- 16.2. Sec. 1.1 added Plumb 1981 reference
- Sec 12.2 Added dry sieve fraction size.
- Sec 12.3 Added wet sieve fraction size
- Sec 12.3.3 Added storage and container transfer instructions.
- Sec 12.3.4 Added note for trace metal analysis.

17. REFERENCES

- 17.1. Conventional Sediment Variables - Particle Size, March 1986, *Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound*, January, 1996.
- 17.2. *Procedures for Handling and Chemical Analysis of Sediment and Water Samples*, R.H. Plumb, prepared for USEPA and Army Corps of Engineers, May, 1981.
- 17.3. ASTM Procedure D422.

Table 1

**Withdrawal Times for Pipette Analysis as a Function of Particle Size and Water Temperature
Silt & Clay Fraction – Condensed Analysis**

Micron μm	Diameter finer than (phi)	Diameter finer than (μm)	Withdrawal depth (cm)	Elapsed time for withdrawal of sample in hours (h), minutes (m), and seconds(s).						
				18°C	19°C	20°C	21°C	22°C	23°C	24°C
62.5	4.0	62.5 - 3.9	20	20s	20s	20s	20s	20s	20s	20s
3.9	8.0 ^a	3.9	10	2h8m	2h5m	2h2m	1h59m	1h56m	1h53m	1h51m

a) Breakpoint between silt and clay.

Table 2

**Withdrawal Times for Pipette Analysis as a Function of Particle Size and Water Temperature
Silt & Clay Fraction – Expanded Analysis**

Micron μm	Diameter finer than (phi)	Diameter finer than (μm)	Withdrawal depth (cm)	Elapsed time for withdrawal of sample in hours (h), minutes (m), and seconds(s).						
				18°C	19°C	20°C	21°C	22°C	23°C	24°C
62.5	4.0	62.5	20	20s	20s	20s	20s	20s	20s	20s
31.2	5.0	31.2	10	2m0s	1m57s	1m54s	1m51s	1m49s	1m46s	1m44s
15.6	6.0	15.6	10	8m0s	7m48s	7m36s	7m25s	7m15s	7m5s	6m55s
7.8	7.0	7.8	10	31m59s	31m11s	30m26s	29m41s	28m59s	28m18s	27m39s
3.9	8.0 ^a	3.9	10	2h8m	2h5m	2h2m	1h59m	1h56m	1h53m	1h51m
1.95	9.0	1.95	10	8h32m	8h18m	8h6m	7h56m	7h44m	7h32m	7h22m
0.98	10.0	0.98	10	34h6m	33h16m	32h28m	31h40m	30h56m	30h12m	29h30m

a) Breakpoint between silt and clay.

Appendix A

Benchsheets and Spreadsheets

COLUMBIA ANALYTICAL SERVICES, INC.

1317 South 13th Avenue

Kelso, Wa 98626

Method: PSEP Particle Size
Puget Sound Protocol

Service Request #: 0
Sample #: 0

Client: 0
Project: 0
Sample Matrix: 0

Sample Name: 0
Date Collected: 1/0/1900
Date Received: 1/0/1900
Date Analyzed: 1/0/1900

I. Sieving Operation	Sieve #
Gravel 2.00 mm (g)	10
V.C. Sand, 1.00 mm (g)	18
C. Sand, 0.500 mm (g)	35
M. Sand, 0.250 mm (g)	60
F. Sand, 0.125 mm (g)	120
V.F. Sand, 0.0625 mm (g)	230
S/C <0.0625 mm (g)	Pan

Weight (g)

As Rec'd (g)
#DIV/0!
#DIV/0!
#DIV/0!
#DIV/0!
#DIV/0!
#DIV/0!
#DIV/0!

Total (g) Recov'd	0.0000
Total (%) Recov'd	#DIV/0!

II. Dry Sieving of Gravel/Sand

Grams Gravel/Sand & Beaker	
Grams Beaker (Tare)	
Grams Gravel/Sand	0.0000

I. Sample Preparation

Grams As Received Sample	
Percent (%) Solids	
Grams Oven Dried Sample	0.0000

III. Determination of Silt/Clay Fraction

Temperature: 0 Time Start: 12:00 AM Time Finish: 12:00 AM

	Silt/Clay Fraction	Clay Fraction
Total Volume of Sample (mls)	1000	1000
Amount of Dispersant	10	10
Volume of Aliquot (mls)	20	20
Grams Sample, Dispersant & Tare		
Grams of Tare		
Grams of Dispersant Correction	0.0000	0.0000
Grams of Sample	0.0000	0.0000
Total Grams Sample X 50	0.0000	0.0000

Analyst: 0
Reviewed by:

Date: 1/0/1900
Date:

COLUMBIA ANALYTICAL SERVICES, INC.

1317 South 13th Avenue

Kelso, Wa 98626

Method: PSEP Particle Size
Puget Sound Protocol

Service Request #: 0
Sample #: 0

Client: 0
Project: 0
Sample Matrix: 0

Sample Name: 0
Date Collected: 1/0/1900
Date Received: 1/0/1900
Date Analyzed: 1/0/1900

I. Sieving Operation	Sieve #
Gravel 2.00 mm (g)	10
V.C. Sand, 1.00 mm (g)	18
C. Sand, 0.500 mm (g)	35
M. Sand, 0.250 mm (g)	60
F. Sand, 0.125 mm (g)	120
V.F. Sand, 0.0625 mm (g)	230
S/C <0.0625 mm (g)	Pan

Weight (g)	As Rec'd (g)
	N/A
	N/A
	N/A
	N/A
	N/A
	N/A
	N/A

Total (g) Recov'd	0.0000
Total (%) Recov'd	#DIV/0!

II. Dry Sieving of Gravel/Sand

Grams Gravel/Sand & Beaker	
Grams Beaker (Tare)	
Grams Gravel/Sand	0.0000

I. Sample Preparation

Grams As Received Sample	
Percent (%) Solids	
Grams Oven Dried Sample	0.0000

III. Determination of Silt/Clay Fraction

Temperature: _____

	4	5	6	7	8	9	10
Total Volume of Sample (mls)	1000	1000	1000	1000	1000	1000	1000
Amount of Dispersant	10	10	10	10	10	10	10
Volume of Aliquot (mls)	20	20	20	20	20	20	20
Grams Sample, Dispersant & Tare							
Grams of Tare							
Grams of Dispersant Correction		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Grams of Sample	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total Grams Sample X 50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Analyst: _____
Reviewed by: _____

Date: _____
Date: _____

Table A-7. Analytes, Method Reporting Limits, and Human Health Screening Values for Beach Sediment Samples.

Human Health Screening Values						
Analyte	CAS number	MDL ^a	MRL ^{a,b,c}	Rochlin		
				(2008, pers. comm.; 2009, pers. comm.)	USEPA (2008b)	USEPA (2006c)
				Traditional		
				Subsistence Scenario RBC	2005 Mean Sediment Detection Limit	Recreational PRGs
Chemical Analyses						
Conventional and Geotechnical Analyses						
Grain size (percent)	--	NA	0.1	--	--	--
pH (pH units)	--	NA	0.1	--	--	--
Total organic carbon (percent)	--	0.04	0.05	--	--	--
Total solids (percent of whole weight)	--	NA	0.1	--	--	--
Total sulfides (mg/kg)	--	0.05	0.5	--	--	--
TAL Metals/Metalloids and Uranium (mg/kg)						
Aluminum	7429-90-5	9	10	5,733	--	--
Antimony	7440-36-0	0.05	0.05	2.3	1.6	521
Arsenic	7440-38-2	0.2 / 0.03*	0.5 / 0.1*	0.11	--	16
Barium	7440-39-3	0.3	2	1,147	--	--
Beryllium	7440-41-7	0.04	1	11	--	--
Cadmium	7440-43-9	0.009	0.02	5.7	0.13	--
Calcium	7440-70-2	4	10	--	--	--
Chromium	7440-47-3	0.2	0.2	8,600	--	--
Cobalt	7440-48-4	0.7	2	115	--	--
Copper	7440-50-8	0.9	2	229	--	52,143
Iron	7439-89-6	2	4	4,013	--	782,143
Lead	7439-92-1	0.05	0.05	400	--	400
Magnesium	7439-95-4	0.8	4	--	--	--
Manganese	7439-96-5	0.002	0.02	268	--	60,833
Mercury	7439-97-6	0.002	0.02	1.7	0.057	--
Nickel	7440-02-0	2	4	115	--	--
Potassium	7440-09-7	200	200	--	--	--
Selenium	7782-49-2	0.4	1	29	2.5	--
Silver	7440-22-4	0.02	0.02	29	1.0	--
Sodium	7440-23-5	20	20	--	--	--
Thallium	7440-28-0	0.005	0.02	0.40	2.3	--
Uranium	7440-61-1	0.004	0.02	17	20	--
Vanadium	7440-62-2	0.04	0.2	5.7	--	261
Zinc	7440-66-6	0.4	2	1,720	--	--
Pesticides (µg/kg-dry weight)						
2,4'-DDD	53-19-0	0.032	0.2	0.85	0.73	--
4,4'-DDD	72-54-8	0.047	0.2	0.85	0.73	--
Total DDD	--	--	--	--	--	--
2,4'-DDE	3424-82-6	0.03	0.2	0.6	0.73	--
4,4'-DDE	72-55-9	0.034	0.2	0.6	0.73	--
Total DDE	--	--	--	--	--	--
2,4'-DDT	789-02-6	0.03	0.2	0.6	0.73	--
4,4'-DDT	50-29-3	0.13	0.2	0.6	0.75	--
Total DDT	--	--	--	--	--	--
Total DDx	--	--	--	--	--	--
Aldrin	309-00-2	0.055	0.2	0.012	0.36	--
alpha-BHC	319-84-6	0.047	0.2	0.032	0.36	--
beta-BHC	319-85-7	0.054	0.2	0.11	0.36	--
delta-BHC	319-86-8	0.037	0.2	--	0.36	--
alpha-Chlordane (cis-)	5103-71-9	0.032	0.2	0.58	0.36	--
gamma-BHC (Lindane)	58-89-9	0.043	0.2	0.58	0.36	--
gamma-Chlordane (trans-)	5103-74-2	0.035	0.2	--	0.36	--
cis-Nonachlor	5103-73-1	0.053	0.2	--	0.36	--
trans-Nonachlor	39765-80-5	0.036	0.2	--	0.36	--
Oxychlordane	27304-13-8	0.054	0.2	--	0.36	--
Total Chlordane	--	--	--	--	--	--
Dieldrin	60-57-1	0.036	0.2	0.013	0.73	--
Endosulfan I	959-98-8	0.025	0.2	34	0.36	--
Endosulfan II	33213-65-9	0.051	0.2	34	0.73	--
Endosulfan sulfate	1031-07-8	0.053	0.2	34	0.73	--
Endrin	72-20-8	0.046	0.2	1.7	0.73	--
Endrin aldehyde	7421-93-4	0.047	0.2	--	0.73	--
Endrin ketone	53494-70-5	0.042	0.2	--	0.73	--
Heptachlor	76-44-8	0.07	0.2	0.045	0.36	--
Heptachlor epoxide	1024-57-3	0.057	0.2	0.022	0.36	--
Hexachlorobenzene	118-74-1	0.12	0.2	0.13	0.36	--
Hexachlorobutadiene	87-68-3	0.065	0.2	2.6	0.36	--
Methoxychlor	72-43-5	0.054	0.2	29	3.6	--
Toxaphene	8001-35-2	4.3	10	0.18	36	--
Semivolatile Organic Compounds (µg/kg-dry weight)						
1,1'-Biphenyl	92-52-4	1.9	20	287	90	--
1,2,4-Trichlorobenzene	120-82-1	2.6	10	57	90	--
1,2-Dichlorobenzene	95-50-1	2.9	10	516	90	--
1,3-Dichlorobenzene	541-73-1	3	10	--	90	--
1,4-Dichlorobenzene	106-46-7	2.9	10	37.7	90	--
2,2'-oxybis(1-Chloropropane)	108-60-1	2.6	10	2.9	90	--
2,4,5-Trichlorophenol	95-95-4	1.5	10	573	229	--
2,4,6-Trichlorophenol	88-06-2	1.4	10	5.7	90	--
2,4-Dichlorophenol	120-83-2	1	10	17	90	--
2,4-Dimethylphenol	105-67-9	5.5	50	115	90	--
2,4-Dinitrophenol	51-28-5	17	200	11	232	--
2,4-Dinitrotoluene	121-14-2	1.5	10	11	90	--

Table A-7. Analytes, Method Reporting Limits, and Human Health Screening Values for Beach Sediment Samples.

Analyte	CAS number	MDL ^a	MRL ^{a,b,c}	Human Health Screening Values		
				Rochlin (2008, pers. comm.; 2009, pers. comm.)	USEPA (2008b)	USEPA (2006c)
				Traditional Subsistence Scenario RBC	2005 Mean Sediment Detection Limit	Recreational PRGs
2,6-Dinitrotoluene	606-20-2	2	10	5.7	90	--
2-Chloronaphthalene	91-58-7	1.6	10	459	90	--
2-Chlorophenol	95-57-8	2	10	29	90	--
2-Methylphenol (o-cresol)	95-48-7	1.5	10	287	90	--
2-Nitroaniline	88-74-4	3.2	20	--	229	--
2-Nitrophenol	88-75-5	1.5	10	--	90	--
3,3'-Dichlorobenzidine	91-94-1	3.7	100	0.45	90	--
3-Nitroaniline	99-09-2	2.5	20	1.72	229	--
4,6-Dinitro-2-methylphenol	534-52-1	1.4	100	0.57	229	--
4-Bromophenyl-phenylether	101-55-3	1.6	10	--	90	--
4-Chloro-3-methylphenol	59-50-7	1.4	10	--	90	--
4-Chloroaniline	106-47-8	1.9	10	4	90	--
4-Chlorophenyl-phenyl ether	7005-72-3	1.4	10	--	90	--
4-Methylphenol (p-cresol)	106-44-5	1.5	10	29	90	--
4-Nitroaniline	100-01-6	1.8	20	9.69	229	--
4-Nitrophenol	100-02-7	18	100	--	229	--
Acetophenone	98-86-2	12	50	573	90	--
Benzaldehyde	100-52-7	7.7	20	573	90	--
Benzoic acid	65-85-0	96	200	22933	99	--
Benzyl alcohol	100-51-6	2.1	10	2867	90	--
Bis(2-Chloroethoxy)methane	111-91-1	1.5	10	17.2	90	--
Bis(2-chloroethyl)ether	111-44-4	1.9	10	0.18	90	--
Bis(2-Ethylhexyl)phthalate	117-81-7	7	100	15	90	--
Butyl benzyl phthalate	85-68-7	3.2	10	107	90	--
Caprolactam	105-60-2	19	50	2867	90	--
Carbazole	86-74-8	1.2	10	--	90	--
Dibenzofuran	132-64-9	1.2	10	--	4.4	--
Diethyl phthalate	84-66-2	1.3	10	4587	90	--
Dimethyl phthalate	131-11-3	1	10	--	90	--
Di-n-butyl phthalate	84-74-2	7.9	20	573	90	--
Di-n-octylphthalate	117-84-0	1.7	10	--	90	--
Hexachlorocyclopentadiene	77-47-4	29	50	--	90	--
Hexachloroethane	67-72-1	3.1	10	5.7	90	--
Isophorone	78-59-1	1	10	214	90	--
Nitrobenzene	98-95-3	2.2	10	2.9	90	--
N-Nitrosodi-n-propylamine	621-64-7	2.4	10	0.029	90	--
N-Nitrosodiphenylamine	86-30-6	1.6	10	42	90	--
Pentachlorophenol	87-86-5	20	100	1.7	229	--
Phenol	108-95-2	2	30	1720	90	--
Polycyclic Aromatic Hydrocarbons (µg/kg-dry weight)						
2-Methylnaphthalene	91-57-6	0.39	5	23	4	--
Acenaphthene	83-32-9	0.23	5	344	4.4	--
Acenaphthylene	208-96-8	0.24	5	--	4.4	--
Anthracene	120-12-7	0.47	5	1720	4.4	--
Benzo(a)anthracene	56-55-3	0.48	5	0.131	4.4	--
Benzo(a)pyrene	50-32-8	0.14	5	0.0131	4.4	--
Benzo(b)fluoranthene	205-99-2	0.25	5	0.13	4.4	--
Benzo(ghi)perylene	191-24-2	0.64	5	--	4.4	--
Benzo(k)fluoranthene	207-08-9	0.15	5	1.31	4.4	--
Chrysene	218-01-9	0.25	5	13.1	4.4	--
Dibenzo(a,h)anthracene	53-70-3	0.28	5	0.01	4.4	--
Fluoranthene	208-44-0	0.61	5	229	4.4	--
Fluorene	86-73-7	0.5	5	229	4.4	--
Indeno[1,2,3-cd]pyrene	193-39-5	0.16	5	0.13	4.4	--
Naphthalene	91-20-3	0.37	5	115	3.2	--
Phenanthrene	85-01-8	0.75	5	--	4.3	--
Pyrene	129-00-0	0.37	5	172	4.4	--
Dioxins/Furans (ng/kg-dry weight)						
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	35822-46-9	0.429	5	1.6E-04	--	--
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	0.573	5	1.6E-04	--	--
1,2,3,4,7,8,9-Heptachlorodibenzofuran	55673-89-7	0.593	5	1.6E-04	--	--
1,2,3,4,7,8-Hexachlorodibenzodioxin	39227-28-6	0.407	5	1.6E-05	--	--
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	0.573	5	1.6E-05	--	--
1,2,3,6,7,8-Hexachlorodibenzodioxin	57653-85-7	0.429	5	1.6E-05	--	--
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	0.138	5	1.6E-05	--	--
1,2,3,7,8,9-Hexachlorodibenzodioxin	19408-74-3	0.235	5	1.6E-05	--	--
1,2,3,7,8,9-Hexachlorodibenzofuran	72918-21-9	0.265	5	1.6E-05	--	--
1,2,3,7,8-Pentachlorodibenzofuran	40321-76-4	0.319	5	1.6E-06	--	--
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	57117-41-6	0.277	5	5.2E-05	--	--
2,3,4,6,7,8-Hexachlorodibenzofuran	60851-34-5	0.313	5	1.6E-05	--	--
2,3,4,7,8-Pentachlorodibenzofuran	57117-31-4	0.261	5	5.2E-06	--	--
2,3,7,8-Tetrachlorodibenzodioxin	17460-16	0.119	1	1.6E-06	--	--
2,3,7,8-Tetrachlorodibenzofuran	51207-31-9	0.113	1	1.6E-05	--	--
Octachlorodibenzodioxin	32688-79	0.831	10	5.2E-03	--	--
Octachlorodibenzofuran	39001-02-0	0.738	10	5.2E-03	--	--
TCDD TEQ	--	--	--	--	--	--
Polychlorinated Biphenyls (µg/kg-dry weight)						
Aroclor 1016	12674-11-2	1	2.5	--	--	--
Aroclor 1221	11104-28-2	1	5	--	--	--
Aroclor 1232	11141-16-5	1	2.5	--	--	--

Table A-7. Analytes, Method Reporting Limits, and Human Health Screening Values for Beach Sediment Samples.

Analyte	CAS number	MDL ^a	MRL ^{a,b,c}	Human Health Screening Values		
				Traditional Subsistence Scenario RBC	2005 Mean Sediment Detection Limit	Recreational PRGs
				Rochlin (2008, pers. comm.; 2009, pers. comm.)	USEPA (2008b)	USEPA (2006c)
Aroclor 1242	53469-21-9	1	2.5	--	--	--
Aroclor 1248	12672-29-6	1	2.5	--	--	--
Aroclor 1254	11097-69-1	1	2.5	--	--	--
Aroclor 1260	11096-82-5	1	2.5	--	0.94	--
Aroclor 1262	37324-23-5	1	2.5	--	--	--
Aroclor 1268	11100-14-4	1	2.5	--	--	--
PCB congeners:						
PCB-77	32598-13-3	0.000537	0.001	15.7	--	--
PCB-81	70362-50-4	0.000610	0.001	5.2	--	--
PCB-105	32598-14-4	0.000911	0.001	52.2	--	--
PCB-114	74472-37-0	0.000688	0.001	52.2	--	--
PCB-118	31508-00-6	0.001220	0.001	52.2	--	--
PCB-123	65510-44-3	0.001410	0.001	52.2	--	--
PCB-126	57465-28-8	0.001000	0.001	0.0157	--	--
PCB-156 ^g	38380-08-4	0.000823	0.002	52.2	--	--
PCB-157 ^g	69782-90-7	--	--	52.2	--	--
PCB-167	52663-72-6	0.000695	0.001	52.2	--	--
PCB-169	327741-6-6	0.000441	0.001	0.0522	--	--
PCB-189	39635-31-9	0.000488	0.001	52.2	--	--
Total PCBs	--	--	--	--	--	--
Polybrominated Diphenylethers (µg/kg-dry weight)						
2,2',4-TriBDE (BDE-17)	147217-75-2	TBD	20	--	--	--
2,4,4'-TriBDE (BDE-28)	41318-75-6	TBD	5	--	--	--
2,2',4,4'-TetraBDE (BDE-47)	5436-43-1	TBD	10	0.57	--	--
2,2',4,5'-TetraBDE (BDE-49)	40088-47-9	TBD	TBD	--	--	--
2,3',4,4'-TetraBDE (BDE-66)	189084-61-5	TBD	5	--	--	--
2,3',4',6'-TetraBDE (BDE-71)	189084-62-6	TBD	TBD	--	--	--
2,2',3,4,4'-PentaBDE (BDE-85)	182346-21-0	TBD	10	--	--	--
2,2',4,4',5'-PentaBDE (BDE-99)	60348-60-9	TBD	10	0.57	--	--
2,2',4,4',6'-PentaBDE (BDE-100)	189084-64-8	TBD	5	--	--	--
2,2',3,3',4,4'-HexaBDE (BDE-128)	82865-89-2	TBD	TBD	--	--	--
2,2',3,4,4',5'-HexaBDE (BDE-138)	182677-30-1	TBD	10	--	--	--
2,2',4,4',5,5'-HexaBDE (BDE-153)	68631-49-2	TBD	5	1.1	--	--
2,2',4,4',5,6'-HexaBDE (BDE-154)	207122-15-4	TBD	5	--	--	--
2,2',3,4,4',5',6'-HeptaBDE (BDE-183)	207122-16-5	TBD	10	--	--	--
2,2',3,4,4',6,6'-HeptaBDE (BDE-184)	119264-56-1	TBD	TBD	--	--	--
2,3,3',4,4',5,6'-OctaBDE (BDE-190)	79682-25-0	TBD	5	--	--	--
2,3,3',4,4',5',6'-HeptaBDE (BDE-191)	--	TBD	TBD	--	--	--
2,2',3,4,4',5,5',6'-OctaBDE (BDE-203)	CASID30339	TBD	TBD	--	--	--
2,2',3,3',4,4',5,5',6'-NonaBDE (BDE-206)	63936-56-1	TBD	TBD	--	--	--
Decabromodiphenyl ether (BDE-209)	1163-19-5	TBD	200	40	--	--
IVBA Assay for Lead, Arsenic, and Other Metals ^f						
	NA	NA	NA	NA	NA	NA
Radionuclide Testing (pCi/g)						
Radium-226	--	NA	0.1	0.011	--	--
Uranium-238	--	NA	0.1	0.37	--	--

Notes:

"--" = no data

CAS = Chemical Abstracts Service

MDL = method detection limit

MRL = method reporting limit

NA = not applicable

PRG = preliminary remediation goal

RBC = risk-based concentration

TBD = to be determined

^a MDLs are updated periodically by the laboratories. MDLs that are in effect at the laboratory at the time of analysis will be used. These may differ slightly from the MDL shown in this table.

^b The MRL is provided on a dry-weight basis and assumes 50% moisture in the samples. The MRL for project samples will vary with moisture content in the samples.

^c The MRL represents the level of lowest calibration standard (i.e., the practical quantitation limit).

^d The lowest screening value (i.e., the minimum concentration for each metal) is shown in bold.

^e Limit for EPA Method 6020 / limit for EPA Method 7062. Arsenic will be analyzed by EPA Method 7062 if it is not detected at the MRL by EPA Method 6020.

^f See USEPA (2005).

^g PCBs 156 and 157 are reported as a co-eluting pair, 156/157.

SITE-SPECIFIC OPERATING PROCEDURE

BEACH SEDIMENT SAMPLING AT UPPER COLUMBIA RIVER

Scope and Application

The following procedures are designed to include the systematic processes that will be instituted by the field sampling team(s) to ensure that project schedule and sample integrity will be maintained during collection of surface and subsurface beach sediment samples from the upper Columbia River between the Coulee Dam and the U.S.-Canadian border.

As specified in the project-specific field sampling plan (FSP), surface and subsurface beach sediment samples will be collected at discrete locations randomly distributed throughout the beach between the water's edge and the maximum elevation for a specific beach. The beaches will be accessed by either boat or van.

The sediment compositing scheme will follow the descriptions of the project-specific FSP. All subsample locations will be randomly selected from a uniform grid. In addition to the required number of randomly selected sampling locations for surface and subsurface sediment, an additional number of alternate locations (also randomly selected) have been identified on the uniform grid as secondary sampling locations if the primary locations cannot be accessed due to physical limitations (e.g., under water). This compositing scheme using randomly generated sampling locations is to ensure that the composite samples will be representative of the entire site.

Team Organization

A beach sampling team will generally be made up of a field team leader, navigator, sediment samplers (surface and subsurface), a boat pilot (if necessary), and support personnel. A separate supply trailer with support personnel will be assigned to each team. In addition, when multiple teams are deployed, a field coordinator will also be assigned to the project. If the field coordinator is also part of a sampling team, then they will also take on the role of field team leader for one of the sampling teams.

The *field coordinator* will be in charge of communications between all field team leaders to ensure that:

- All sampling personnel are safe
- All samples are being collected in an efficient manner
- All sample collection is completed according to the project-specific quality assurance project plan (QAPP) and FSP instructions
- Samples are shipped to the respective analytical laboratories on time
- If problems arise during sample collection or sample shipping, the field coordinator will be responsible for communicating the issues with the project manager and obtaining authorization for implementing an alternative solution.

Each *field team leader* will be responsible for daily communications to ensure that:

- Any situation that could create a deviation from the project-specific QAPP or FSP is immediately communicated to the field coordinator
- The immediate health and safety needs of all field sampling personnel are met; including selection of a safe working area at each beach for the team's command post and for sample processing
- The field coordinator knows the exact location of each command post and sample processing area at each beach whether or not the beach has been accessed by boat or by van
- The field coordinator knows that all samples have been collected safely and completely and that the samples were shipped to the analytical laboratories on time
- Support personnel know when and where samples will be ready for further processing and shipping.

The *navigator* is responsible for navigating to each sampling point on the beach and inserting a numbered and color-coded flag into the sediment to identify each sampling site. Each composite sample will be assigned a different colored flag. After all of the sampling sites have been identified, the navigator will assist with processing samples, logging chain of custody forms, and storing samples in coolers.

The *surface sediment samplers* are responsible for transporting sampling equipment to each sampling point (as marked by the navigator) and collecting and compositing all surface sediment samples needed at each beach. It is estimated that two field samplers will be needed for this task.

The *subsurface sediment samplers* are responsible for handling the coring device, collecting a sediment core, carrying the core to a processing area at the site, and processing all sediment cores needed at each beach. It is estimated that two field samplers will be needed for this task.

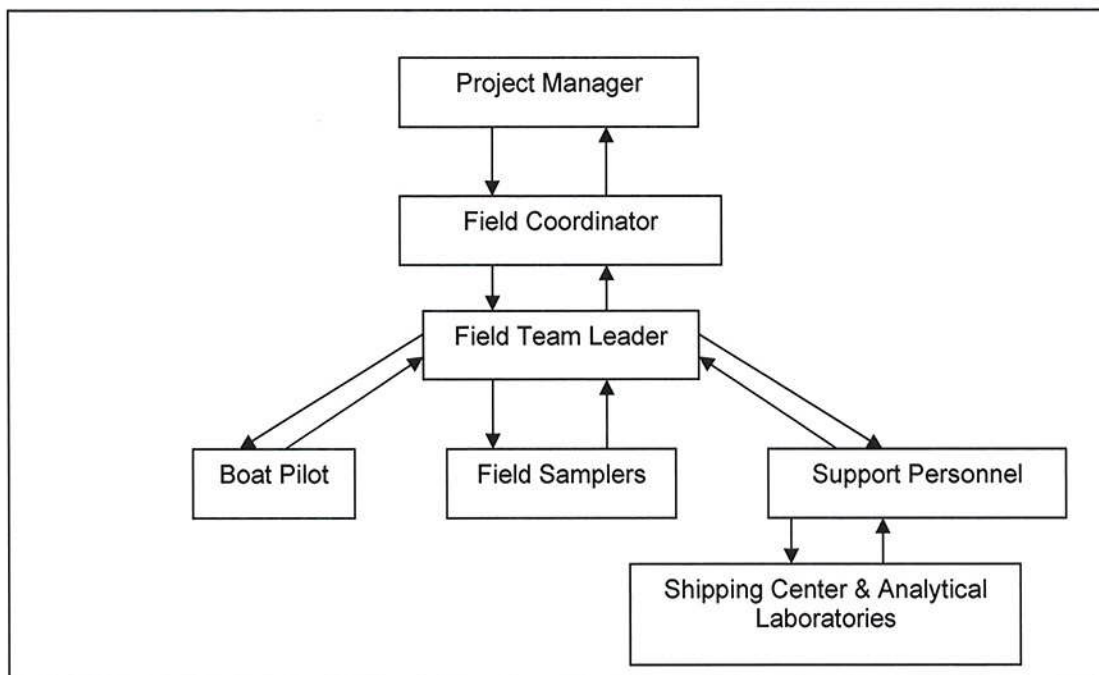
The *boat pilot* (if needed) will be in charge of navigating the boat to each beach where van access is not available or where beach access can be more efficiently achieved via boat (e.g., access from the road is too difficult or travel time is greater by van than by boat). The pilot will have limited availability to assist the field crew; the pilot's primary responsibility is to ensure the safety of the vessel and the sampling crew while on board.

Support personnel will be responsible for daily communications with a field team leader to ensure that they:

- Know when and where samples will be ready for further processing and shipping (i.e., the support personnel will perform a quality assurance check of sample labeling against the prepared chain of custody form and properly complete sample packaging and shipping)
- Communicate to the field team leader that samples were safely delivered to the shipping center (e.g., nearest FedEx drop off location) for delivery to the analytical laboratories
- Communicate with the analytical laboratories relaying the information about when samples will arrive and the number of coolers and number of samples
- Communicate with the field team leader to determine if any additional field supplies are needed.

Communications Protocol

During the beach sampling event, there may be multiple teams each sampling a different beaches on any given day. The field coordinator will be in responsible for keeping track of all teams' activities and for the safety of all field sampling personnel. The following diagram shows the flow of communications.



Lines of Communication

Each team will be equipped with a satellite phone, cell phone, and laptop computer with Wi-Fi and air-card (i.e., cell phone connection).

All team members will be trained in the proper use of the satellite phone and when satellite coverage is available. A daily Optimum Satellite Availability Report (as provided at http://www.globalstarusa.com/en/optimum_tool/) will be downloaded prior to each sampling event and distributed to each field team leader prior to the sampling event. Real time satellite tracking for Globalstar can also be found at <http://www.n2yo.com/?k=17>.

The Globalstar Optimum Satellite Availability Report will be used by the field coordinator to establish a contact time with each field team leader via satellite phone (if cell phone coverage is not available) for the daily tailgate health and safety meeting and daily end-of-the-day status update.

Field Procedures

1. Locate each beach as directed in the project-specific FSP and determine where to safely set up the team's command post and sample processing area. When boats are used to access the beach, the sampling processing area will be located on the aft boat deck if sufficient space is available.

Note: Before allowing any sampling personnel to disembark from the boat, the boat pilot and the field team leader will determine that the beach area is safe for walking.

- 1.1. The sample processing area will include a covered canopy to protect samplers from inclement weather. The canopy must be secured to the ground with weights (e.g., recyclable water jugs or sand bags) or attached to a structure (e.g., a tree or boat gunnel). Collapsible processing tables will be covered with aluminum foil or plastic sheeting. Separate tables will be used to label sampling jars and to collect and process samples (e.g., sectioning cores or filling jars from composited surface sediment sampling bowls). In addition, at least two folding chairs, garbage bags, aluminum foil, plastic sheeting, paper towels, sample jars, labels, coolers with ice, plastic buckets, and potable water will be available.
- 1.2. The entire sample processing area where sediment will be exposed is considered part of the exclusion zone (see site health and safety plan [HSP] for further details, Attachment A1 of Appendix A in the project-specific QAPP) and will be marked with warning tape to prevent any unauthorized personnel from accidentally walking into the exclusion zone. In the case of using the boat deck, the aft deck will be considered the exclusion zone and no unauthorized personnel will be allowed on board of the sampling boat.
- 1.3. A sampling equipment decontamination area will be set up as a reduction zone. The reduction zone will be set up away from the sample processing area and marked with tape in similar fashion as the exclusion zone. This area will contain distilled water spray container, aluminum foil, garbage bags, and three large plastic totes or large pressurized spray bottles placed side by side on the ground for sampling equipment decontamination. The first tote (or large pressurized spray bottle) will contain site or tap water to remove any remaining sediment from sampling equipment. The second tote will contain clean tap water (or large pressurized spray bottle) and soap (e.g., Liqui-Nox™) to thoroughly brush all sampling equipment parts. The third tote (or large pressurized spray bottle) will contain clean distilled/deionized water (provided by the testing laboratory) for rinsing the cleaned equipment. This final rinse of distilled/deionized water will be done before the sampling equipment is drained and wrapped in clean foil ready for the next sampling location (i.e., beach).
- 1.4. The support zone will be the boat cabin or pilot house, the van interior or any area away from the exclusion and decontamination zones. Personnel wearing protective clothing who are leaving the exclusion or decontamination zone will be required to rinse off their protective clothing with potable or river water before entering this area (as necessary).

2. The *navigator* will be equipped with a handheld global positioning system (GPS) unit, a digital camera, a site map with all target locations, and a set number of flags for each of the color groups related to each beach sediment composite. An additional set of flags will be marked with a double black line on the edge for each of the coring locations.
 - 2.1. The *navigator* will locate the target sampling sites utilizing the same GPS procedures as outlined in SOP AP-06.
 - 2.2. The *navigator* will start at one end of the beach by marking each sampling site with a flag. If multiple composite samples are required, each sampling site will be marked with a flag containing the site-specific number location and a color matching the site-specific composite ID. For example, five composites are needed at each beach and each composite needs 12 randomly spaced sediment samples. Each composite is assigned a color-coded flag (e.g., composites 1, 2, and 3 will be assigned the colored flags red, white, and blue respectively). Each sample for a particular composite will be numbered 1 through 12. The navigator will carry 5 different color coded sets of 12 flags each and mark each colored flag with the assigned number of the sampling site that he/she encounters with the GPS (i.e., a total of 60 flags).
 - 2.3. Prior to sample collection, a photograph of each proposed sample collection location will be taken following the procedures provided in SOP AP-08. The purpose of these photographs will be to provide additional information on field conditions, such as the proportion of the sample location represented by gravel versus more fine sediment material.
 - 2.4. If the *navigator* determines that the target location is not suitable for sampling (i.e., too many cobbles or too much vegetation), an alternate station, already loaded in the GPS, will be randomly selected. The navigator will make an entry in the field logbook noting the target location and a brief explanation for why that site was rejected. For surface sediment sampling locations only, if subsequent alternate stations continue to be unsuitable for sampling and a non-random alternate is apparent to the *navigator*, then this non-random station will be marked with a unique flag and the *field team leader* will inspect the proposed, non-random alternate sampling location and determine if it is suitable for sample collection. For both surface and subsurface sediment sampling, a photograph will be taken only of the location where the final sample was collected, and if the entire beach is unacceptable for sample collection (i.e., entirely covered by cobble, water, or vegetation), then an overview photograph will be taken of the length of the beach.
 - 2.5. While the *navigator* is staking each sampling site with a flag, the surface and subsurface sediment samplers will be setting up the staging area for sample

processing, field sampling equipment setup and equipment decontamination after sampling.

3. The *surface sediment samplers* will set up a push/pull utility cart with all the necessary sampling equipment and begin sampling along the same beach where the navigator has placed the target location flags. It is estimated that two field samplers will be needed for this task.
 - 3.1. Sampling will begin from one end of the beach to the other at a depth of between 0 and 6-in. (15 cm) below ground surface (bgs) from each flagged site until all samples are collected.
 - 3.2. The utility cart will contain the same number of decontaminated stainless steel bowls and spoons as the number of composites assigned to that beach. Using the same example above, five sediment composites will be needed at a single beach. The sampling crew will need five bowls and spoons on the cart. Because all 60 sampling sites are randomly assigned for all composite samples, samplers will encounter many different colored flags near each other. As soon as a different colored flag is encountered, the respectively marked stainless steel bowl and spoon for that composite will be used to collect sediment from that site. Each bowl will be covered with an aluminum foil cover marked with the composite color code and composite number.
 - 3.3. At each site, the sampler will examine the area and avoid sampling from areas where foot traffic has been observed. Sediment characterization will be done according to SOP SD-13.
 - 3.4. All sediment samples will be dried at the analytical laboratory and then sieved to <2 mm to generate at least 111 g of dry surface sediment for all analyses. Therefore, a factor of 2 has been added to the original sample volume estimate and a larger volume of sediment will be collected at these stations to fulfill all analytical dry weight requirements. For each beach sediment composite, the following sediment volume will be collected based on the analytical requirements provided in the project-specific QAPP.

- Surface wet sediment: 104 oz (3.25 quarts)

Each large stainless steel spoon contains approximately 2 oz of sediment by volume. Because each composite sample requires equal volumes of sediment from each of the 12 sampling sites, the following is the approximate volume requirement per sampling site.

- Surface sediment: 104 oz/12 sites = 9 oz/site or equivalent to 5 large spoonfuls/site

- 3.5. The sampler will collect sediment so that the final volume from all individual sampling sites per composite will fulfill the analytical laboratory requirements as described above. Surface sediment sampling will follow the procedures in SOP SL-05. After sediment has been placed in the bowl from each subsampling location, the sampler will homogenize it and then cover it with aluminum foil. If samples for volatile organic analyses are required, sediment will be scooped from the sample collection bowl before homogenization.
- 3.6. Once all individual sampling sites are collected and thoroughly homogenized at the staging area, the final sediment composite is placed inside a large Teflon bag, sealed with a plastic clip, labeled on the outside, placed inside a larger polyethylene resealable plastic bag and stored in a cooler with ice.
- 3.7. This method of sampling will prevent contamination of surface sediments by foot traffic if multiple trips along the beach were to take place. Once the sampling team reaches the end of the beach transect, the utility cart will contain five completed composite samples.
4. The *subsurface sediment samplers* will set up a push/pull utility cart with all the necessary sampling equipment for sediment coring at each of the randomly assigned sampling sites with care not to step on areas around the marked flags for surface sediment stations. It is anticipated that two field samplers will be needed for this task.
 - 4.1. Sampling of subsurface sediments with a portable electric vibracorer will follow procedures in SOP SD-08 and SOP SL-06. A portable generator will be placed as far away as possible and downwind from the sampling site with care not to rest the generator over an area where the surface sediment sampling team may collect samples.
 - 4.2. Each depth stratum (A = 0–6 in. [0–15 cm], B = 6–18 in. [15–45 cm], and C = 18–30 in. [45–75 cm]) at each location (5 sites) (i.e., 15 discrete samples) will be submitted to the laboratory for sieving to < 2 mm and the analysis of target analyte list metals/metalloids prior to sample homogenization.
 - 4.3. To address sample mass requirements, a single composite sample of each depth stratum from each of the five locations will be collected from each beach (i.e., three composite samples; one per depth interval). The composite sample will be divided into two components:
 1. The whole sediment that will be analyzed for grain size distribution
 2. A sieved < 2 mm size fraction of the sample that will be analyzed for the remaining chemical analyses as described in the project-specific QAPP.

All subsurface sediment samples will be dried at the analytical laboratory and then sieved to < 2 mm to generate at least 226 g of dry sediment per depth interval for all analyses. Therefore, a factor of 2 has been added to the original estimate to collect a larger volume of sediment samples to fulfill all analytical dry weight requirements. For each depth profile composite, the following sediment volumes will be collected based on the project-specific QAPP analytical requirements.

Three depth intervals from each core will be analyzed: A = 0–6 in. (0–15 cm), B = 6–18 in. (15–45 cm), and C = 18–30 in. (45–75 cm). Segment A contains approximately 1.0 quart of sediment by volume (a 15 cm length by 10 cm diameter core yielding 1,177 cm³, or 39.8 oz, of sediment). Segments B and C have the same volume of approximately 2.0 quarts provided the core is able to penetrate down to a depth of 30 in., or 75 cm, bgs (a 30 cm length by 10 cm diameter core yielding 2,355 cm³, or 79.6 oz, of sediment). Because each composite sample requires equal volumes of sediment from the same sediment depth interval, the following is the approximate volume requirement per depth interval.

- Subsurface sediments: 200 oz (6.25 quarts) per sediment depth interval.

The larger volume requirements for the subsurface samples reflect the additional analyses for organic compounds.

Segment A will require six or seven cores to collect sufficient sediment for all analyses required; Segments B and C will require only three or four cores to collect sufficient sediment for all analyses required and can be sampled from the complete cores required for Segment A collection.

Once the cores described above are collected for each depth interval at each location, the team will carry the cores back to the staging area for sample processing. The Lexan™ cores will be placed on a table and the materials will be extruded onto clean aluminum foil. Logging of sediment cores will be done following the procedures outlined in SOP SD-12. This routine will be repeated at five sites for each beach. After the core is described and depth sections measured and marked, sediment from each section will be sampled into stainless steel bowls, homogenized and sample jars will be filled. If samples for volatile organic analyses are required, sediment will be scooped from the core sections before homogenization.

5. The *sediment samplers* will decontaminate the sampling equipment according to Integral's SOP on decontaminating equipment for soil sampling (SOP SL-01) and in accordance with the project-specific FSP.

6. *Support personnel* will contact the field team leader and determine the time to meet at the beach or boat ramp to receive the samples from the field sampling team. It is anticipated that two field technicians may be needed for this task.
 - 6.1. Support personnel will carefully check that all sampling jars were labeled correctly with sample ID, date, time, and sampler initials against the chain of custody forms that have been previously completed in the field and are accompanying the samples.
 - 6.2. After checking for accuracy and ensuring that the correct number of vials was collected, support personnel will wrap jars individually in bubble wrap and place them in coolers according to shipping specifications in SOP AP-01.
 - 6.3. The coolers will be filled with wet ice and placed inside the van for transport to the shipping center (e.g., FedEx drop off site). Depending on the time of the year, a refrigerated van or truck may be needed to maintain coolers in cold storage until shipped to the analytical laboratories.

Equipment and Supplies Required

- Decontaminated sampling tool (stainless-steel shovel, scoop, trowel, or spoon)
- Large stainless steel mixing bowls and spoons
- 12 in. by 25 in. Teflon bags
- 5 gal plastic buckets with lids
- Heavy duty elastic rubber bands
- Four-wheel push/pull utility cart with enough space to accommodate sampling equipment (i.e. stainless steel bowls, spoons and aluminum foil)
- Handheld GPS unit
- Plastic flags on wire stems
- Marking pens (thick tip Sharpie® markers)
- Auger or coring device (e.g., stainless-steel bucket auger with special teeth, coring device with liner and core catcher, stainless-steel hand auger, or equivalent type of equipment)
- Power generator (2000 Watt) if auger or coring device requires electric power

- Collapsible canopy for sample processing
- Folding tables and folding chairs
- Plastic tarp
- Garbage bags
- Paper towels
- Heavy duty aluminum foil roll
- Roll of plastic sheeting
- Stainless steel ruler
- First aid kit with eye washer
- Laboratory-supplied sample containers, insulated coolers, and ice
- Chain-of-custody forms, custody seals, sample labels
- Ziploc® bags
- Camera
- Tape measure
- Field logbook, surface soil field collection form, and pens
- Project-specific FSP and HSP
- Personal protective equipment (safety glasses, hip waders, nitrile gloves, and any other items required by the project-specific HSP)
- Decontamination supplies (e.g., Liqui-Nox™, laboratory-grade distilled/deionized water).

Table B-1. Sample Containers, Preservation, and Holding Time Requirements for Sediment.

Container		Analysis	Preservation	Holding Time	Sample Size
Type	Size				
Surface Sediment					
G/P	8 oz ^{a,b}	Grain size (sediment)	4±2°C	6 months	100 g ^{b,c}
Teflon Bag	104 oz (3.5 quart) ^{a,b}	pH	4±2°C	7 days	20 g ^b
		Total organic carbon		14 days	1 g
		Mercury		28 days	5 g
		Metals/metalloids, uranium and percent moisture		6 months	10 g
		Metals/metalloids, and uranium - fine fraction		6 months	10 g
		Total sulfides	4±2°C	7 days	5 g
		Radionuclide	No headspace; 4±2°C (do not freeze)	6 months	150 g
		IVBA for lead, arsenic, and other metals	None. Store at room temperature	NA	30 g
		Archival	4±2°C	NA	NA
		Radionuclide archival	Deep frozen (-20°C) Deep frozen (-20°C)	6 months	150 g
Subsurface Sediment					
G/P	8 oz ^{a,b}	Grain size (sediment)	4±2°C	6 months	100 g ^{b,c}
Teflon Bag	200 oz (6.5 quart) ^{a,b}	pH	4±2°C	7 days	20 g ^b
		Total organic carbon		14 days	1 g
		Mercury		28 days	5 g
		Metals/metalloids, uranium and percent moisture		6 months	10 g
		Metals/metalloids, and uranium - fine fraction		6 months	10 g
		Total sulfides	4±2°C	7 days	5 g
		PCBs (Aroclors)	No headspace; 4±2°C (do not freeze)	14 days	20 g
		PCB congeners	4±2°C	1 year	10 g
		Dioxins/furans	Deep frozen (-20°C)	1 year	10 g
		PBDEs	Deep frozen (-20°C)	1 year	10 g
Pesticides	4±2°C	14 days	20 g		
PAHs			40 g		

Table B-1. Sample Containers, Preservation, and Holding Time Requirements for Sediment.

Container		Analysis	Preservation	Holding Time	Sample Size
Type	Size				
		SVOCs			
		Archival	Deep frozen (-20°C)	NA	NA
		Radionuclide archival	Deep frozen (-20°C)	NA	150 g

Notes:

G/P = glass or plastic

IVBA = *in vitro* bioaccessibility assay

NA = not applicable

^aCollection of 2 times the indicated sample size will be necessary for 5 percent of samples to allow for laboratory QA procedures.

^bA larger sample size will be needed for coarse-grained sediment.

Table 2-2. Sample Containers, Preservation, and Holding Time Requirements for Sediment.

Container		Analysis	Preservation	Holding Time	Sample Size
Type	Size				
Surface Sediment					
G/P	8 oz ^{a,b}	Grain size (sediment)	4±2°C	6 months	100 g ^{b,c}
Teflon Bag	104 oz (3.5 quart) ^{a,b}	pH	4±2°C	7 days	20 g ^b
		Total organic carbon		14 days	1 g
		Mercury		28 days	5 g
		Metals/metalloids, uranium and percent moisture		6 months	10 g
		Metals/metalloids, and uranium - fine fraction		6 months	10 g
		Total sulfides	4±2°C	7 days	5 g
		IVBA for lead, arsenic, and other metals	No headspace; 4±2°C (do not freeze)	NA	30 g
		Radionuclide	4±2°C	6 months	150 g
		Archival	None. Store at room temperature	NA	NA
		Radionuclide archival	Deep frozen (-20°C)	6 months	150 g
			Deep frozen (-20°C)		
Subsurface Sediment					
G/P	8 oz ^{a,b}	Grain size (sediment)	4±2°C	6 months	100 g ^{b,c}
Teflon Bag	200 oz (6.5 quart) ^{a,b}	pH	4±2°C	7 days	20 g ^b
		Total organic carbon		14 days	1 g
		Mercury		28 days	5 g
		Metals/metalloids, uranium and percent moisture		6 months	10 g
		Metals/metalloids, and uranium - fine fraction		6 months	10 g
		Total sulfides	4±2°C	7 days	5 g
		PCBs (Aroclors)	No headspace; 4±2°C (do not freeze)	14 days	20 g
		PCB congeners	4±2°C	1 year	10 g
		Dioxins/furans	Deep frozen (-20°C)	1 year	10 g
		PBDEs	Deep frozen (-20°C)	1 year	10 g
		Pesticides	4±2°C	14 days	20 g
PAHs			40 g		

Table 2-2. Sample Containers, Preservation, and Holding Time Requirements for Sediment.

Container		Analysis	Preservation	Holding Time	Sample Size
Type	Size				
		SVOCs			
		Archival	Deep frozen (-20°C)	NA	NA
		Radionuclide archival	Deep frozen (-20°C)	NA	150 g

Notes:

G/P = glass or plastic

IVBA = *in vitro* bioaccessibility assay

NA = not applicable

^aCollection of 2 times the indicated sample size will be necessary for 5 percent of samples to allow for laboratory QA procedures.

^bA larger sample size will be needed for coarse-grained sediment.