

**Bonneville Forebay & Upstream Locations
Sediment Quality Evaluation
September 18, 2002
Sampling Event**

**Prepared by the US Army Corps of Engineers
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Bonneville Forebay & Upstream Locations Sediment Quality Evaluation

SEDIMENT EVALUATION REPORT-Table of Contents

SEDIMENT EVALUATION REPORT-Table of Contents	ii
1. Abstract	1
2. PROJECT DESCRIPTION	1
3. Previous Studies	2
4. CURRENT STUDY	3
5. Results – September 18,2002	5
6. Conclusion.....	8
Appendix A - DQO - Table of Contents	ii
STEP 1 - STATE THE PROBLEM	3
STEP 2 - IDENTIFY THE DECISION	6
STEP 3 - IDENTIFY INPUTS TO THE DECISION	6
STEP 4 - DEFINE THE BOUNDARIES OF THE STUDY	8
STEP 5 - DEVELOP DECISION RULES	8
STEP 6 - SPECIFY TOLERABLE LIMITS ON DECISION ERRORS	10
STEP 7 - OPTIMIZE THE DESIGN	11
REFERENCES	11
PROJECT DESCRIPTION, SITE HISTORY AND ASSESSMENT	2
PROJECT ORGANIZATION AND RESPONSIBILITIES	3
SCOPE AND OBJECTIVES	4
FIELD ACTIVITIES	4
SAMPLE CHAIN-OF-CUSTODY/DOCUMENTATION	6
Appendix C – QAPP – Table of Contents	iii
Quality Assurance Project Plan.....	iii
PROJECT MANAGEMENT	3
DATA GENERATION AND ACQUISITION	1
ASSESSMENTS OVERSIGHT	1
DATA VALIDATION AND USABILITY	1
REFERENCES	1
MEMORANDUM FOR THE RECORD	2

Bonneville Forebay & Upstream Locations Sediment Quality Evaluation

1. ABSTRACT

In December 2000 and May 2001 sediment and biological tissue samples were collected and analyzed from a former dumpsite area at the Northeast end of Bradford Island, which contained discarded electrical components discovered in the near shore area. Levels of PCB Aroclor 1254 were detected in clam tissue at 3.8 mg/kg-ppm (parts per million), in crayfish at 75.6 ppm and in sediment at 8.3 ppm. The investigation and cleanup of this former dumpsite is still in progress; the sources of the PCBs, discarded electrical components, have been removed from the in-water areas. Further sediment testing, as part of the remediation site cleanup, will take place in the near future by the contractor.

This sampling event attempted to collect, up to thirty (30) samples, to produce a statistically significant number of fine-grained sediment samples to evaluate the level of PCBs in the Bonneville Forebay and upstream areas, excluding the Bradford Island remediation site. The plan attempted to collect sufficient samples to represent the baseline conditions upstream of the eddy effects of the dam operations and reflect the conditions within the forebay. Sixteen (16) fine-grained surface grab samples were planned upstream of eddy effects area and up to fourteen (14) in the forebay below the eddy effects area. The potential fine-grained sediment locations were selected with the aid of a computer model, which reflects the various flow conditions associated with the dam's operation in near-bottom flows.

Due to the rocky nature of the river bottom and the current effect in much of the area, only eight (8) sediment samples were collected (see Table 1 for field notes associated with sample collection & Figure 1 for sample locations). Two (2) sampling stations were collected in the forebay area and six (6) stations sampled above the eddy effect area. All *Corbicula* clams present in the samples were sent to the laboratory to be archived at -20° C for potential future tissue analyses.

Polychlorinated Biphenyls (PCBs), as Aroclors, were not detected above established levels of concern^{1,2} in any of the samples collected. Aroclor 1254 was detected in one (1) sample, BF-BC-07, at 19.1 ug/kg-ppb (parts per billion).

2. PROJECT DESCRIPTION

Bonneville Dam is located between River Mile (RM) 145 and 146 of the Columbia River. The goal of this sampling event was to characterize the forebay area of both Powerhouses and upstream of the forebay, beyond the eddy currents effect associated with the dam, which reaches upstream to the area at the west (downstream) end of Goose Island. This characterization excludes the area identified as within or adjacent to the former Bradford Island Dump Site. All areas associated with the remedial action of the former dumpsite at Bradford Island will be sampled under a different SAP following CERCLA guidance. The purpose of this sampling plan is to gather additional baseline information and evaluate possible PCB migration from the dumpsite area.

- ¹ Dredge Material Evaluation Framework (DMEF) – Screening level for open water disposal = 130ug/kg-ppb total PCBs.
- ² Oregon Department of Environmental Quality (DEQ) – Level II freshwater screening level values for sediment = 34ug/kg-ppb total PCBs, derived from NOAA (TEL) SQuiRTs Tables.
- ³ See Attachment A, B & C for complete Sampling and Analysis Plan (SAP), which includes (Data Quality Objectives (DQOs), Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP).

Bonneville Forebay & Upstream Locations Sediment Quality Evaluation

Limited sediment and tissue testing performed by the US Army Corps of Engineers (Corps) in the Pool above Bonneville Dam has indicated the presence of PCBs in sediments near Bradford Island Landfill and upstream near Goose Island. In addition studies, tissues of crayfish and clams have, also, had detectable levels of PCBs. In a recent report EPA and the Columbia River Intertribal Fish Commission indicated concentrations of concern for PCBs in sturgeon, which resulted in issuance of a fish advisory against collecting and eating fish and shellfish by the state of Oregon for this reach of the river (<http://www.ohd.hr.state.or.us/news/2002/0301esc.htm>). Washington State has issued a similar advisory.

3. PREVIOUS STUDIES

3.1. Dredging Projects

In 1991 informational sampling and analysis was done on sediment downstream from the First Powerhouse Navigational Lock, on the south side of the river, with results acceptable for unconfined in-water or upland disposal. This same downstream area was dredged in 1986 and in the late 1970s.

In July 1997 seven sediment samples were collected from Bonneville Second Powerhouse forebay and water supply conduits. Divers inspecting the inside of the south Auxiliary Water Supply (AWS) took two of the samples from the downstream portion of the south AWS conduit. Three additional samples were taken from the surface of the sediment deposits at the north end of the forebay. The final two samples were collected from the sediment and woody debris removed from the north AWS intake trash rack by clamshell and stockpiled on Cascade Island, at the south end of the Elevation 90 Deck crane way extension. Physical analysis, run on four sediments, indicated the material ranges from gavel to very fine sand, with largest fractions in the coarse to medium sand range. Chemical analysis, run on five (5) sediments, included metals, pesticides/polychlorobiphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), total organic carbon (TOC), acid volatile sulfide (AVS), phenols and dioxin screen (P450). The portion of the sample submitted to the lab was representative of the material dredged, except for the woody debris. Results determined the material to be acceptable for unconfined in-water or upland disposal.

On December 18, 2001 a total of three (3) sediment samples were collected from a shoal at the adult fish ladder discharge (water intake) on the south bank of Bradford Island. All samples were submitted for physical analyses including total volatile solids and also analyzed for metals (9-inorganic), total organic carbon, pesticides and polychlorinated biphenyls, phenols, phthalates, miscellaneous extractables, polynuclear aromatic hydrocarbons and organotin.

None of the laboratory data results exceeded their respective screening levels in the DMEF¹. All sediment was determined to be suitable for unconfined, in-water placement; however, the 1577 CY of material dredged was, as a management option, barged to RABANCO's company Regional Disposal facility in Roosevelt Washington.

On January 14 & 15, 2002 thirteen (13) sediment samples (includes 1 field dup.) from four (4) stations were collected at potential log boom anchor point locations. Sediments were tested for lead, mercury, PCBs, hydrocarbons, TOC and grain size. One (1) sample analysis detected mercury slightly over the 0.41 mg/kg-ppm DMEF screening level (SL) at 0.419mg/kg-ppm. The field duplicate indicated motor oil at a 195mg/kg level, which exceeds the ODEQ Numeric Soil Cleanup standards (Soil Matrix) of 100 mg/kg. The analysis of the primary sample, associated with the field duplicate analyses above, indicated motor oil at 43.6 mg/kg, which is considerable less than the duplicate sample and well below ODEQ standard. The material represented by this sampling event is to be side-cast to construct the

Bonneville Forebay & Upstream Locations Sediment Quality Evaluation

proposed anchor structures. The volume of sediment to be side-cast for the project was estimated be less than 100 CY, which is a sufficiently small volume to be considered as having little or no environmental impact at the chemical levels reported.

3.2. Study Projects

In 1991 in a Minimum Operating Pool (MOP) study at Bonneville, which included twelve (12) sites, Cascade Locks RM 149.2, Rock Creek RM 150.0, Herman Creek RM 150.9, Wind River Boat Ramp/Mouth RM 154.8, Home Valley RM 154.8, Port of Hood River RM 169.0, SD&S Lumber, RM 170.6, Bingen Boat Basin & Marina RM 171.7, Mayer State Park RM 181.0 was conducted. All sites were analyzed for metals, PAHs, pest/PCBs, TOC and AVS, with select sites adding phenols, dioxins/furans and TBT (tributyltin). None of the test sediments exceeded current DMEF screening guidelines for open water disposal (no PCBs were detected at the method reporting limit (MRL) of 0.04 mg/kg-ppb).

In December 2000 and May 2001 sediment and biological tissue samples were collected and analyzed from an area at the Northeast end of Bradford Island, which contained discarded electrical components discovered in the nearshore area. Levels of PCB Aroclor 1254 were detected in clam tissue at 3.8 ppm, in crayfish at 75.6 ppm and in sediment at 8.3 ppm. The investigation and cleanup of this former dumpsite is still in progress; discarded electrical components from the in-water areas have been removed. Further sediment testing will take place in the near future.

In Aug 2001, as part of the Bonneville Corner Collector Juvenile Bypass System Study, one (1) surface grab sample and eight (8) in-water subsurface (borings), within the proposed plunge pool, consisted of overburden materials and bedrock. In addition to the in-water samples, 41 upland sites (borings and test pits) were also collected from the proposed upland construction site downstream of the Second Powerhouse and contain similar material. The overburden consists of fill (500 CY of riprap), alluvium, slide debris material and a poorly graded alluvial material referred to as “crystal sands” (poorly graded micaceous silty sand to sand). All the samples recovered from the drillings and surface sample is considered native material derived primarily from historical and prehistorical slides in the area. The bedrock unit consists of the sedimentary Weigle Formation.

The samples collected from the in-water area at the site of the proposed plunge pool dredging indicate the majority of the material to be disposed of consists of 80% gravel, 18% sand with fines representing <2% of total material with an estimate of <1% volatile solids.

4. CURRENT STUDY

The Data Quality Objectives (DQO) process outline is:

- Step 1. State the Problem
- Step 2. Develop a Decision Rule
- Step 3. Identify Inputs to the Decision
- Step 4. Define the Boundaries of the Study
- Step 5. Develop a Decision Rule
- Step 6. Specify Tolerable Limits on Decision Errors
- Step 7. Optimize the Design

A summary outline of project objectives is stated above and is contained in the DQO memorandum in greater detail, which is attached as Appendix A. Also attached in the appendix are the Field Sampling Plan (FSP) (Appendix B) and the Quality Assurance Project Plan (QAPP) (Appendix C). The DQO

Bonneville Forebay & Upstream Locations Sediment Quality Evaluation

memo primarily describes the questions being addressed and the rationale for sampling and decision-making. This sampling event is only one step leading toward an answer to the question of whether PCBs are specific to the dam operations and landfill, or systematic (from an upriver source), or both.

This sampling event attempted to collect, up to thirty (30) samples, to produce a statistically significant number of fine-grained sediment samples to evaluate the level of PCBs in the Bonneville Forebay and upstream areas, excluding the Bradford Island remediation site. The plan attempted to collect sufficient samples to represent the baseline conditions upstream of the eddy effects of the dam operations and reflect the conditions within the forebay. Sixteen (16) fine-grained surface grab samples were planned upstream of eddy effects area and up to fourteen (14) in the forebay below the eddy effects area. The potential fine-grained sediment locations were selected with the aid of a computer model, which reflects the various flow conditions associated with the dam's operation in near-bottom flows (see Appendix D). All sample attempts and collections were done from a contracted 29' research vessel using a 0.096 m² modified Gray O'Hare boxcore surface sampler, with 160 lbs. additional weight added to sampler. Station locations were recorded in the field using a handheld GPS unit.

Due to the rocky nature of the river bottom and the current effect in much of the area, only eight (8) sediment samples were collected out of the fifty-five (55) sampling attempts made at twenty-seven (27) sampling stations. All sampling stations were numbered to document locations even though sediment was not retrieved. Table 1 gives sampling station name, describes the location, water depth and conditions at the station. Sediment was collected at two (2) sampling stations in the forebay area and six (6) stations sampled above the eddy effect area. All *Corbicula* clams present in the samples were sent to the laboratory to be archived at -20° C for potential future tissue analyses. Figure 1 identifies sample station locations.

4.1. Contaminates of interest

Polychlorinated Biphenyls (PCBs), as Aroclors, were not detected above levels of concern^{1,2} in any of the samples collected. Aroclor 1254 was detected in one (1) sample, BF-BC-07, at 19.2 ug/kg-ppb.

4.2. Principal Study Questions (from DQO Memo Appendix A)

The overall goals for the Corps' testing (which goes beyond the current investigation) were to permit a selection (with Oregon DEQ) amongst three alternatives:

Alternative 1. Bonneville Pool and Bradford Island sediments are currently a significant contributor of PCB or metals to organisms in the Columbia River;

Alternative 2. Sediments from upstream of the Pool are as much as, or more significant contributors to exposure than Bonneville Pool and Bradford Island; or

Alternative 3. Some other source of exposure to these compounds, such as water-borne sediments in the river may be a more significant contributor to exposure at this time.

The limited effort covered by the SAP can only address alternative 1; however, the other questions are of interest and may be subject of future study.

It was the intention of this study to evaluate the data generated from this sampling event to do statistical comparisons of: 1) Sedimentary fines content and contaminants of interest, 2) Concentrations of contaminants of concern from upstream of Bonneville Pool to data from Bradford Island, 3) Comparison to regulatory risk based numbers and 4) Theoretical Bioaccumulation Potential. These statistical comparisons

Bonneville Forebay & Upstream Locations Sediment Quality Evaluation

were to be based on collection of sixteen (16) samples, with an 76% confidence level, however due to insufficient number of samples collected this will not be done.

4.3. Modifications to SAP

The sampling plan, for this sampling event, called for grain-size, TOC and PCBs analyses to be conducted on the thirty (30) samples scheduled to be collected, however, when only eight (8) samples were able to be collected, the balance of funds available, was used to analyze select samples for 23 TAL metals and Semi-volatile compounds (SW-846 method 8270).

5. RESULTS – SEPTEMBER 18,2002

5.2. Physical (ASTM method) and Total Organic Carbon (TOC) method 9060.

Eight (8) samples were submitted for physical and TOC analyses; data are presented in Table 2. Mean grain-size for all the samples is 0.91 mm, with 8.2% gravel, 65.3% sand and 26.4% fines. Volatile solids for all the samples ranged from 2210 mg/kg to 47000 mg/kg. Six (6) of the eight (8) samples collected contained >12% fine-grained (<230 sieve) material, with two (2) containing >50% fines. The PCB Aroclor 1254 was detected in one (1) sample, BF-BC-07, at 19.1 ug/kg-ppb; this sample contained 12.64% fine-grained material.

5.3. Metals (EPA method 6020/7471)

Eight (8) samples were submitted for lead (Pb) and mercury (Hg) testing, with four (4) of the eight (8) samples selected for 23 TAL metals analyses; the data are presented in Table 3. Low levels of most metals were found, but did not approach the screening levels (SL) in the DMEF. Three (3) sample analyses for nickel (Ni) and one (1) analysis for Ni slightly exceeded the DEQ Level II screening levels. These samples collected at RM 145-147 are consistent with the Minimum Operating Pool (MOP, RM 149-181) study analyses collected in 1991 for Ni and Zn.

5.4. PCBs (EPA method 8082 - Aroclor), Phenols, Phthalates and Miscellaneous Extractables (EPA method 8270).

Eight (8) samples were tested for PCB Aroclors and the data are presented in Table 4. Aroclor 1254 was found in one (1) sample, BF-BC-07, collected from the southeast side of Bradford Island at 19.2 ug/kg (ppb). Four (4) samples were selected for method 8270 analyses. Two phthalate compounds were detected in most samples, with values well below their respective SLs. Phenol was detected in the blind duplicate sample (BF-BC-A) above the SL for both DEQ and the DMEF. The level was not confirmed in the split primary sample or QA lab sample split for this sample. Benzoic Acid was, also, detected in the same sample at a level slightly under the DEQ Level II screening level, but not confirmed in the primary sample analysis.

5.5. Polynuclear Aromatic Hydrocarbons (EPA method 8270C).

Four (4) samples were tested for PAHS and the data are presented in Table 5 & 6. Low levels of some PAHs were detected in all samples, but levels were very low and did not approach levels of concern for any screening levels referenced.

Table 1

**Coordinates of Sampling Stations
Bonneville Forebay and Upstream Areas
Event of September 18, 2002**

<p>BF-BC-01 45° 38' 16.7" 121° 56' 31.5" Water depth 26.5' Two (2) attempts at this location Retrieved a trace of medium-grained sand – <u>not enough for analysis.</u></p>	<p>BF-BC-05 45° 38' 22.3" 121° 56' 21.9" Water depth 48.3' Two (2) attempts at this location Retrieved one large cobble. <u>No sample submitted.</u></p>	<p>BF-BC-09 45° 38' 26.6" 121° 56' 59.0" Water depth 4.6' Two (2) attempts at this location Retrieved cobbles and gravel. <u>No sample submitted.</u></p>	<p>BF-BC-13 45° 38' 42.0" 121° 55' 51.2" Water depth 41.2' Three (3) attempts at this location Nothing retrieved, rocky area <u>No sample submitted.</u></p>
<p>BF-BC-02 45° 38' 20.1" 121° 56' 31.4" Water depth 54.6' Two (2) attempts at this location Retrieved a trace of medium-grained sand – <u>not enough for analysis.</u></p>	<p>BF-BC-06 45° 38' 19.4" 121° 56' 14.0" Water depth 40.3' Two (2) attempts at this location Retrieved a trace of medium-grained sand – <u>no analysis.</u> <u>Submitted <i>Corbicula</i> (19 grams).</u></p>	<p>BF-BC-10 45° 38' 45.1" 121° 56' 12.4" Water depth 31.4' Two (2) attempts at this location Retrieved large cobbles. <u>No sample submitted.</u></p>	<p>BF-BC-14 45° 38' 35.9" 121° 55' 47.2" Water depth 20.5' 8" penetration Medium grained silty sand. <u>Submitted: physical, chemical & <i>Corbicula</i> (116 grams).</u></p>
<p>BF-BC-03 45° 38' 23.8" 121° 56' 27.2" Water depth 38.3' 6" penetration Silty sand <u>Submitted: physical, chemical & <i>Corbicula</i> (112 grams).</u></p>	<p>BF-BC-07 45° 38' 27.9" 121° 56' 10.0" Water depth 22.3' 2-3" penetration Four (4) attempts at this location medium-grained sand w/silt <u>Submitted: physical, chemical & <i>Corbicula</i> (280 grams).</u></p>	<p>BF-BC-11 45° 38' 53.4" 121° 56' 07.6" Water depth 36.6' One (1) attempt at this location Rocky area <u>No sample submitted.</u></p>	<p>BF-BC-15 45° 38' 39.3" 121° 55' 40.0" Water depth 21.7' 15" penetration Sandy silt <u>Submitted: physical, chemical & <i>Corbicula</i> (14grams).</u></p>
<p>BF-BC-04 45° 38' 26.2" 121° 56' 19.7" Water depth 29.3' 4-5" penetration Med. grained sand w/silt & gravel <u>Submitted: physical, chemical & <i>Corbicula</i> (177 grams).</u></p>	<p>BF-BC-08 45° 38' 25.4" 121° 56' 06.9" Water depth 65.8' One (1) attempt at this location, lots of current, rocky area Retrieved one cobble. <u>No sample submitted.</u></p>	<p>BF-BC-12 45° 38' 51.4" 121° 56' 01.8" Water depth 26.2' One (1) attempt at this location, lots of current. Rocky area <u>No sample submitted.</u></p>	<p>BF-BC-16 45° 38' 42.5" 121° 55' 32.5" Water depth 11.8' 2-3" penetration <u>Submitted: physical, chemical & <i>Corbicula</i> (5 grams).</u></p>

Table 1 (cont'd)

**Coordinates of Sampling Stations
Bonneville Forebay and Upstream Areas
Event of September 18, 2002**

<p>BF-BC-17 45° 38' 45.9" 121° 55' 28.1" Water depth 30.5' 10" penetration Medium grained silty sand. <u>Submitted: physical, chemical & Corbicula (13 grams).</u></p>	<p>BF-BC-21 45° 38' 52.6" 121° 55' 34.8" Water depth 69.0' One (1) attempt at this location Nothing retrieved. Rocky area <u>No sample submitted.</u></p>	<p>BF-BC-25 45° 38' 55.2" 121° 55' 34.1" Water depth 19.3' One (1) attempt at this location One large cobble retrieved. Rocky area <u>No sample submitted.</u></p>	
<p>BF-BC-18 45° 38' 49.1" 121° 55' 20.6" Water depth 15.8' Four (4) attempts, <1" penetration. Trace of med.-grained sand & gravel. <u>Not enough for analysis.</u> <u>Submitted: Corbicula (116 grams).</u></p>	<p>BF-BC-22 45° 38' 43.5" 121° 55' 43.3" Water depth 36.3' Four (4) attempts at this location Nothing retrieved, rocky area <u>No sample submitted.</u></p>	<p>BF-BC-26 45° 38' 58.9" 121° 55' 25.8" Water depth 28.9' <1" penetration Seven (7) attempts in this general area – combined all material retrieved Medium grained silty sand. <u>Submitted: physical, chemical & Corbicula (378 grams).</u></p>	
<p>BF-BC-19 45° 38' 55.5" 121° 55' 07.2" Water depth 39.2' Three (3) attempts at this location Nothing retrieved. Rocky area <u>No sample submitted.</u></p>	<p>BF-BC-23 45° 38' 50.8" 121° 55' 44.6" Water depth 45.7' One (1) attempt at this location Nothing retrieved. Rocky area <u>No sample submitted.</u></p>	<p>BF-BC-27 45° 39' 09.8" 121° 55' 00.9" Water depth 21.7' Four (4) attempts at this location Nothing retrieved. Rocky area <u>No sample submitted.</u></p>	
<p>BF-BC-20 45° 38' 58.9" 121° 55' 13.9" Water depth >100' Unable to sample not enough cable on sampler. <u>No sample Submitted.</u></p>	<p>BF-BC-24 45° 38' 53.4" 121° 55' 37.8" Water depth 46.5' Two (2) attempts at this location Nothing retrieved. Rocky area <u>No sample submitted.</u></p>		

Bonneville Forebay & Upstream Locations Sediment Quality Evaluation

6. CONCLUSION

Sediment and tissue testing performed by the US Army Corps of Engineers (Corps) in the Pool above Bonneville Dam has indicated the presence of PCBs in sediments near Bradford Island Landfill and upstream near Goose Island. In addition, tissues of crayfish and clams have had detectable levels of PCBs and a recent report by EPA and the Columbia River Intertribal Fish Commission indicated concentrations of concern of PCB in sturgeon and resulted in issuance of fish advisory against collecting and eating fish and shellfish by the state of Oregon for this reach of the river (<http://www.ohd.hr.state.or.us/news/2002/0301esc.htm>). Washington State has issued a similar advisory.

It was the intention of this study to evaluate the data generated from this sampling event to do statistical comparisons of: 1) Sedimentary fines content and contaminants of interest, 2) Concentrations of contaminants of concern from upstream of Bonneville Pool to data from Bradford Island, 3) Comparison to regulatory risk based numbers and 4) Theoretical Bioaccumulation Potential. These statistical comparisons were to be based on collection of sixteen (16) samples, with an 80% confidence level, however due to insufficient number of samples collected (6 samples above eddy effect and 2 in forebay), and the resulting low confidence level, these statistical analyses will not be done. The low number of samples collected was due to the rocky nature of the river bottom and the current effect in much of the area.

The main chemical of interest in this study is Polychlorinated Biphenyls (PCBs), as Aroclors. PCBs are a category, or family, of chemical compounds formed by the addition of Chlorine (Cl) to Biphenyl (C₁₂H₁₀), which is a dual-ring structure comprising two 6-carbon Benzene rings linked by a single carbon-carbon bond. Any single, unique, well-defined chemical compound in the PCB category is called a "Congener". The name of a congener specifies the total number of chlorine substituents and position of each chlorine. While PCB was manufactured and sold under many names, the most common were the "Aroclor" series, in many of which a number identifier included the percentage of Chlorine (e.g. Aroclor 1254, with 54% Chlorine).

While this study lacks the robustness planned, it would appear from the data generated from the six (6) background upstream samples, that these areas do not contain any significant levels of PCBs or PAHs. There was one unconfirmed phenol "hit" in the lab duplicate sample, but it was unconfirmed in the primary sample. Levels of nickel (Ni) and zinc (Zn) were slightly elevated in several samples, but are consistent with data generated from upstream studies (1991 MOP study) and considered at background levels. The one (1) sample BF-BC-07, in which the PCB Aroclor 1254 (19.1 ug/kg-ppb) was detected, is below the concern levels referenced^{1,2} and is adjacent to the area of concern, on the southeast end of Bradford Island; this sample contained 12.64% fine-grained material. Six (6) of the eight (8) samples collected contained >12% fine-grained (<230 sieve) material, with two (2) of the six (6) containing >50% fines.

Conclusions from this study show that little sediment is deposited on the north side of the Columbia River in the forebay area or in the upstream area where sampling was attempted. Sediment was not available downstream of the rocky island east of Bradford Island. Sediment seemed to be readily available on the South side of Bradford Island and the area around Goose Island. This sampling event did not confirm detectable PCBs in the Goose Island sediment. It would appear from the data generated, that PCB contamination is not wide spread in the Forebay area or upstream. The data would also indicate, that the PCB contamination has not migrated beyond the localized area of Bradford Island, where sample BF-BC-07 was collected.

Bonneville Forebay & Upstream Locations Sediment Quality Evaluation

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¹ Dredge Material Evaluation Framework – Screening level for open water disposal 130 ug/kg total PCBs (Aroclors).

² Oregon Department of Environmental Quality – Level II screening level 34.0ug/kg total PCBs (Aroclors).

³ See Attachment A & B for complete Sampling and Analysis Plan (Data Quality Objectives (DQOs), Field Sampling Plan and Quality

⁴ Oregon Department of Environmental Quality - Upland Soil Cleanup Table; OAR 340-122-045 for Total PCBs (Aroclors).

Physical & TOC Analysis

Sample I.D.	Grain Size (mm)		Percent			TOC
	Median	Mean	Gravel	Sand	Silt/Clay	mg/kg
BF-BC-03	0.42	1.27	17.79	76.05	6.15	6270
BF-BC-04	0.16	3.36	26.87	53.92	19.20	7120
BF-BC-07	0.31	1.28	9.81	77.54	12.64	3660
BF-BC-14	0.13	0.10	0.00	86.12	13.88	5200
BF-BC-15	0.06	0.05	0.00	47.53	52.47	16000
BF-BC-16	0.05	0.04	0.00	34.86	65.14	13600
BF-BC-17	0.08	0.07	0.00	62.26	37.74	12900
BF-BC-17 LAB DUP	0.07	0.06	0.00	56.80	43.20	NA
BF-BC-26	0.22	1.07	11.15	84.15	4.70	2210
BF-BC-A	NA	NA	NA	NA	NA	16400
BF-BC-AQA	NA	NA	NA	NA	NA	47000
BF-BC-A is the blind dup of BF-BC-03 & QA Split of BF-BC-AQA						
Mean	0.18	0.91	8.2	65.3	26.4	
Minimum	0.07	0.04	0.00	34.86	4.70	2210
Maximum	0.31	3.36	26.87	86.12	65.14	16400

Table 3, Bonneville Forebay & Upstream Sites

Sampled September 18, 2002

Inorganic Metals

Sample I.D.	Al	Sb	As	Ba	Be	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Hg	Ni	K	Se	Ag	Na	Tl	Sn	Zn
	mg/kg (ppm)																						
BF-BC-03	11400	0.41	4.57	152	0.40	0.21	7150	20.3	11.6	37.2	23800	12	5960	510	0.067	18.5	1000	<0.52	0.16	345	0.33	59.9	111
BF-BC-04	-	-	-	-	-	-	-	-	-	-	-	13.1	-	-	0.136	-	-	-	-	-	-	-	-
BF-BC-07	9870	0.4	2.42	118	0.37	0.06	5560	17	9.87	25.5	20700	8.31	5100	399	0.045	15.4	845	<0.55	0.12	263	0.19	51.3	84.4
BF-BC-14	-	-	-	-	-	-	-	-	-	-	-	13	-	-	0.074	-	-	-	-	-	-	-	-
BF-BC-15	-	-	-	-	-	-	-	-	-	-	-	17	-	-	0.197	-	-	-	-	-	-	-	-
BF-BC-16	-	-	-	-	-	-	-	-	-	-	-	14.9	-	-	0.117	-	-	-	-	-	-	-	-
BF-BC-17	11900	0.81	5.51	153	0.48	0.52	5510	21.5	12.4	28.3	26100	16.3	5170	716	0.188	19.1	1550	<0.73	0.22	366	0.27	68.9	147
BF-BC-26	9500	0.34	5.77	199	0.37	0.06	6500	15.7	14.5	33.7	25200	8.85	6980	499	0.050	18.7	878	<0.46	0.11	275	0.22	49.2	103
BF-BC-A	8970	0.47	3.14	124	0.27	0.09	5840	17	11.1	24.9	19600	8.69	4550	343	0.033	16.9	675	<0.57	0.16	224	0.19	58.8	89.8
BF-BC-AQA	20900	<3.03	3.01	158	<1.01	1.18	8250	19.7	10.6	27.3	22700	8.97	6040	404	<0.404	18.5	1060	<1.01	<1.01	438	<1.01	63.8	104
S.L. DMEF	+	150	57	+	+	5.1	+	+	+	390	+	450	+	+	0.41	140	+	+	6.1	+	+	+	410
S.L. DEQ Level II	+	3	6	+	+	0.6	+	37	+	36	+	35	+	1100	0.2	18	+	+	4.5	+	+	+	123

+ No screening level established
 * BF-BC-A is the blind dup of BF-BC-03 & Quality Assurance lab sample split for BF-BC-AQA.
 Indicates no analyses were run
 Some metal values were flagged with J, B1 & B2 by the lab (not enough room to add to this table, see lab data report for those data).
 J = Estimated value (reported values are above the MDL, but below the PQL).
 B1 = Low-level contamination was present in the method blank (reported level was < 10 times blank concentration).
 B2 = Low-level contamination was present in the method blank (reported level was > 10 times blank concentration).
 Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit).

Pesticides, PCBs, Phenols, Phthalates and Extractables

Sample I.D.	PCB as Aroclor							Phthalates		Phenol	Misc. Extractables
	ug/kg (ppb)										
	1016	1221	1232	1242	1248	1254	1260	bis(2-Ethylhexyl) phthalate	Butylbenzyl phthalate	Phenol	Benzoic Acid
BF-BC-03	<3.4	<14.4	<11.5	<6.16	<15.3	<4.78	<4.78	28	<9.83	11.9 J	<49.1
BF-BC-04	<3.43	<14.7	<11.7	<6.27	<15.6	<4.87	<4.87	-	-	-	-
BF-BC-07	<3.13	<13.4	<10.7	<5.71	<14.2	19.2	<4.43	20.2	<8.87	<8.87	<44.4
BF-BC-14	<3.04	<13.0	<10.4	<5.55	<13.8	<4.3	<4.3	-	-	-	-
BF-BC-15	<4.52	<19.3	<15.4	<8.25	<20.5	<6.41	<6.41	-	-	-	-
BF-BC-16	<4.31	<18.4	<14.7	<7.87	<19.6	<6.11	<6.11	-	-	-	-
BF-BC-17	<4.16	<17.8	<14.2	<7.6	<18.9	<5.9	<5.9	24.2	37	<12.1	<60.6
BF-BC-26	<2.72	<11.6	<9.3	<4.97	<12.4	<3.86	<3.86	8.7 J	9.9 J	<7.49	<37.5
BF-BC-A	<3.63	<15.5	<12.4	<6.63	<16.5	<5.14	<5.14	21.7	62.6	71.5	64.9 J
BF-BC-AQA	<9.79	<27.9	<22.1	<5.08	<16.2	<12.9	<6.92	<46.4	<52.5	<62.6	<222
S L DMEF	Total PCBs + 130							8300	670	28	650
S L DEQ Level II	Total PCBs + 34							750	100	28 +	65 +

+ = Screen level (SL) DEQ Level II freshwater level not established, value is marine level.
 This is considered an estimate by the lab (value falls between the PQL and the MDL); value confirmed by second column.
 BF-BC-A is the blind dup of BF-BC-03 & Quality Assurance lab sample split for BF-BC-AQA.
 J = Estimated value (reported values are above the MDL, but below the PQL).
 No other Pesticides or herbicides were detected at MDL
 Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit).
 All Total DDT values underwent second column confirmation.

Polynuclear Aromatic Hydrocarbons (PAHs)
Low Molecular Weight Analytes
ug/kg (ppb)

Sample I.D.	Acenaphthene	Acenaphthylene	Anthracene	Fluorene	2-Methyl naphthalene	Naphthalene	Phenanthrene	Total Low PAHs
BF-BC-03	<0.98	<0.98	<0.98	1.38 J	<2.46	<2.46	<0.98	1.38
BF-BC-07	0.92 J	<0.89	1.02 J	<0.89	<2.22	<2.22	4.57	5.59
BF-BC-17	<1.21	<1.21	1.23 J	1.27 J	<3.03	<3.03	5.36	6.59
BF-BC-26	<0.75	<0.75	<0.75	<0.75	<1.87	<1.87	<0.75	ND
BF-BC-A	<1.05	<1.05	<1.05	1.35 J	<2.62	<2.62	1.6 J	2.95
BF-BC-AQA	<68.6	<58.5	<68.6	<62.6	<78.7	<66.6	<66.6	ND
Screen level (SL) DMEF	500	560	960	540	670	2100	1500	5200
Screen level (SL) DEQ Level II	57	160	57	77	+	176	42	76
COUG-G-07A is the Quality Assurance lab sample splint for COUG-G-07 Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit) + = Screen level (SL) DEQ Level II freshwater level not established.								

Table 6, Bonneville Forebay & Upstream Sites

Sampled September 18, 2002

Polynuclear Aromatic Hydrocarbons (PAHs)

High Molecular Weight Analytes

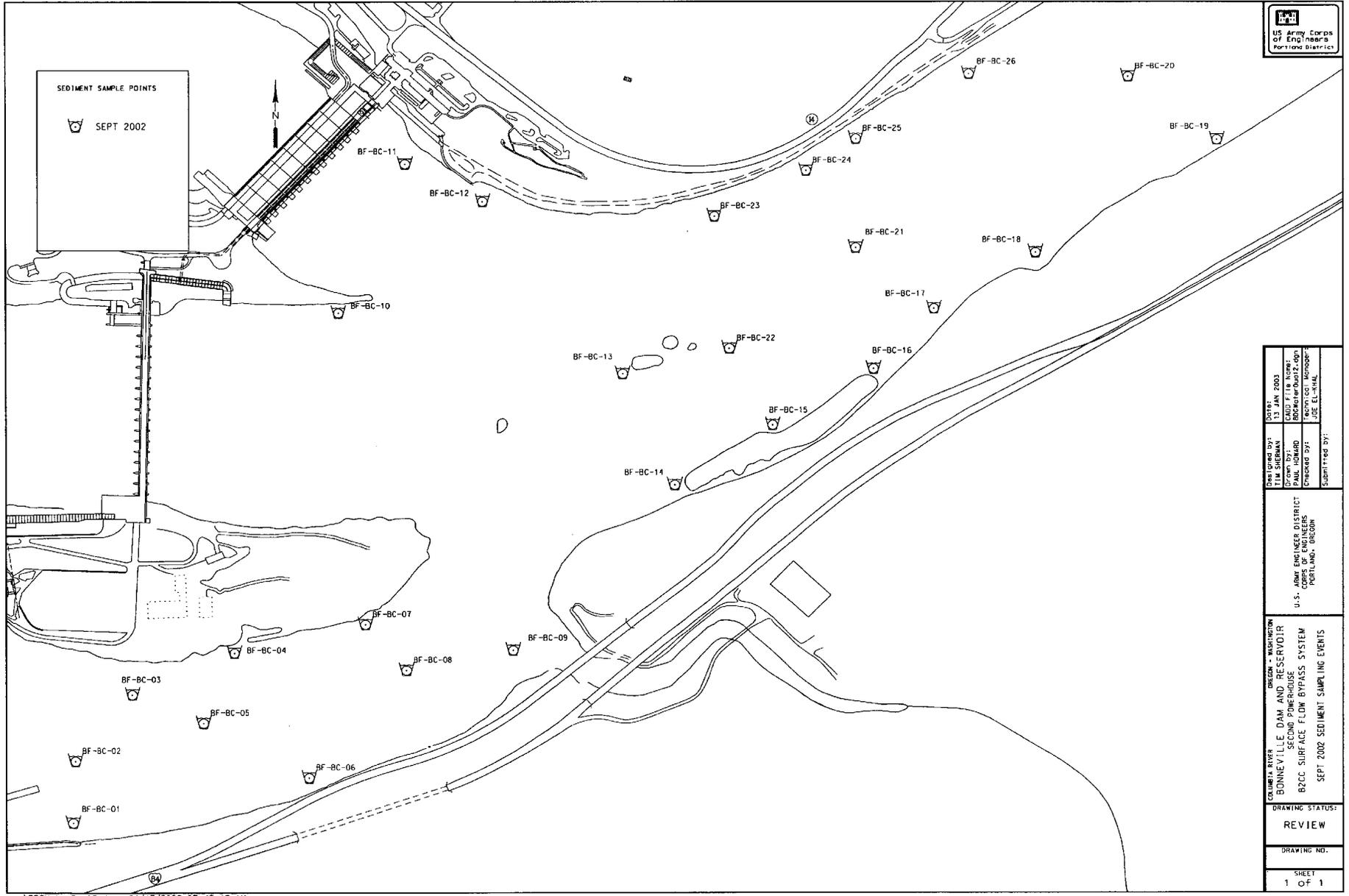
ug/kg (ppb)

Sample I.D.	Benzo(a)-anthracene	Benzo(b)-fluoranthene	Benzo(k)-fluoranthene	Benzo-(g,h,i)-perylene	Chrysene	Pyrene	Benzo(a)-pyrene	Dibenz(a,h)-anthracene	Indeno-(1,2,3-cd)-pyrene	Fluoranthene	Total High PAHs
BF-BC-03	1.12 J	3.47		<0.98	1.19 J	1.77 J	<0.98	<0.98	<0.98	2.08 J	9.63
BF-BC-07	<0.89	9.27		4.42	9.64	15.4	5.81	<0.89	4.09	13.6	68.23
BF-BC-17	6.82	14.3		6.63	8.57	9.76	7.29	<1.21	4.77	13.9	72.04
BF-BC-26	<0.75	<1.5		<0.75	<0.75	3.75	<0.75	<0.75	<0.75	1.21 J	4.96
BF-BC-A	<1.05	4.07 J		<1.05	<1.05	4.08	3.29	<1.05	<1.05	6.48	17.92
BF-BC-QA	<3.23	<7.06		<2.02	<3.23	<4.04	<2.22	<2.02	<7.87	<3.83	ND
Screen level (SL) DMEF	1300	b + k = 3200		670	1400	2600	1600	230	600	1700	12000
Screen level (SL) DEQ Level II	32	+	27	300	57	53	32	33	17	111	193
+ = Screen level (SL) DEQ Level II freshwater level not established. COUG-G-07A is the Quality Assurance lab sample splint for COUG-G-07 J = Estimated value (reported values are above the MDL, but below the PQL). Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit).											

Figure 1,

Sediment Sampling Station Site Location Map

Collected September 18, 2002



Appendix A

Data Quality Objectives Memorandum for Bonneville Pool Investigation for Polychlorinated Biphenyls

**Prepared by the US Army Corps of Engineers,
September 2002**

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Appendix A - DQO - Table of Contents

TABLE OF CONTENTS **Error! Bookmark not defined.**

1.0 STEP 1 - STATE THE PROBLEM 3

 1.1 INTRODUCTION **Error! Bookmark not defined.**

 1.2 SCOPING PROCESS **Error! Bookmark not defined.**

 1.2.1 Overview of the Facility, Site, or Study Area **Error! Bookmark not defined.**

 1.2.2 DQO Team Members **Error! Bookmark not defined.**

 1.2.3 Scoping Issues **Error! Bookmark not defined.**

 1.3 Available Resources..... **Error! Bookmark not defined.**

 1.4 Conceptual Site Model..... **Error! Bookmark not defined.**

2.0 STEP 2 - IDENTIFY THE DECISION..... **Error! Bookmark not defined.**

 2.1 Principal Study Questions..... **Error! Bookmark not defined.**

3.0 STEP 3 - IDENTIFY INPUTS TO THE DECISION **Error! Bookmark not defined.**

 3.1 Grain Size **Error! Bookmark not defined.**

 3.2 Total Organic Carbon in Sediment **Error! Bookmark not defined.**

 3.3 Polychlorinated Biphenyls in Sediment (Tissue Will Be Analyzed in Future Studies)
 **Error! Bookmark not defined.**

 3.4 Mercury and Lead in Sediment (This Study) **Error! Bookmark not defined.**

 3.5 Tissue Lipid (To Be Used In Possible Future Studies On Clam Tissue)..... **Error!**
Bookmark not defined.

4.0 STEP 4 - DEFINE THE BOUNDARIES OF THE STUDY**Error! Bookmark not**
defined.

 4.1 Scale of Decision Making for PCB in Sediment..... **Error! Bookmark not defined.**

 4.2 Scale of Decision Making for PCB Theoretical Bioaccumulation **Error! Bookmark**
not defined.

5.0 STEP 5 - DEVELOP DECISION RULES **Error! Bookmark not defined.**

 5.1 DR 1: Comparison of Sedimentary Fines Content and Contaminants of Interest **Error!**
Bookmark not defined.

 5.2 DR 2: Statistical Comparison of Concentrations of Contaminants of Concern from
 Upstream of Bonneville Pool to Data from Bradford Island ... **Error! Bookmark not defined.**

 5.5 DR 3. Comparison to Regulatory Risk Based Numbers.. **Error! Bookmark not defined.**

 5.3 DR 4: Theoretical Bioaccumulation Potential (This Study)..... **Error! Bookmark not**
defined.

 5.4 DR 5: Empirical Sediment Bioaccumulation Factor (BSAF) Derivation (Future Study)
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6.0 STEP 6 - SPECIFY TOLERABLE LIMITS ON DECISION ERRORS **Error!**
Bookmark not defined.

 6.1 Decision Errors for Comparison of Contaminant Content to (Future) Population of
 Bradford Island Area Samples. **Error! Bookmark not defined.**

7.0 STEP 7 - OPTIMIZE THE DESIGN **Error! Bookmark not defined.**

8.0 REFERENCES **Error! Bookmark not defined.**

STEP 1 - STATE THE PROBLEM

This memorandum uses the 7-step DQO process (EPA, 1994) to describe a collection program for polychlorinated biphenyls (PCB) in the pool above Bonneville Dam. This memorandum should be read with the Sampling and Analysis Plan, which it complements.

The DQO process outline is:

- Step 1. State the Problem
- Step 2. Develop a Decision Rule
- Step 3. Identify Inputs to the Decision
- Step 4. Define the Boundaries of the Study
- Step 5. Develop a Decision Rule
- Step 6. Specify Tolerable Limits on Decision Errors
- Step 7. Optimize the Design

The objective of the DQO process' first step is to define the problem so that the focus of the sampling program will be unambiguous, and so that the sampling program can be assured to meet the stated needs.

INTRODUCTION

Limited sediment and tissue testing performed by the US Army Corps of Engineers (Corps) in the Pool above Bonneville Dam (Corps, 2002) has indicated the presence of PCB in sediments near Bradford Island Landfill, and upstream near Goose Island. In addition, tissues of crayfish and clams have had detectable levels of PCB, and a recent report by EPA and the Columbia River Intertribal Fish Commission indicated concentrations of concern of PCB in sturgeon and resulted in issuance of fish advisory against collecting and eating fish and shellfish by the state of Oregon for this reach of the river (<http://www.ohd.hr.state.or.us/news/2002/0301esc.htm>). Washington State has issued a similar advisory. The Corps operates Bonneville Dam, and has prepared this DQO memo as preface to the Sampling and Analysis Plan under Corps' requirements (Corps 2001(a)). This DQO memorandum describes primarily the questions being addressed and the rationale for sampling and decision-making. It should be noted that the scope of this work is only one step leading toward an answer to the question of whether PCBs are specific to the dam operations and landfill, or systematic (from an upriver source), or both.

SCOPING PROCESS

Scoping is being conducted by meetings and by circulating this memorandum. Scoping of DQOs began by circulating an early version of a Sampling and Analysis Plan in May and June 2002. This document accompanies the Sampling and Analysis Plan (SAP), which is incorporated here by reference. This memorandum expands on the purposes of the investigation.

Overview of the Facility, Site, or Study Area

The SAP contains the pertinent history in section 1.0.

DQO Team Members

Table 1-1 identifies each of the DQO team members, the organization that each individual represents, and his or her area of technical expertise.

Table 1-1. Corps of Engineers' DQO Team Members.

Name	Organization	Area of Technical Expertise
Mark Dasso	US Army Corps of Engineers, Portland District	Project Management
Tim Sherman	US Army Corps of Engineers, Portland District	Team Leader, Planning and Implementation of FSP; negotiation of laboratory contract
John Wakeman	US Army Corps of Engineers, Seattle District	Environmental Scientist, Chief Author of DQO memo
Allison Schaub	US Army Corps of Engineers, Portland District	Sample Collection and Field Logs
Cathy Martin	US Army Corps of Engineers, Seattle District	Chemist Who, With Tim, Wrote the QAPP

Scoping Issues

Based on the results of the DQO scoping process, a number of scoping issues were identified. These issues are shown below.

There is a need to determine “systemic” (that is, upstream) river contamination from those associated with Bonneville Dam.

Insufficient data exist to characterize the Bonneville Pool.

Samples taken in coarse to medium sands that are current-swept may not be representative of contaminant regimes to which fish and shellfish are being exposed.

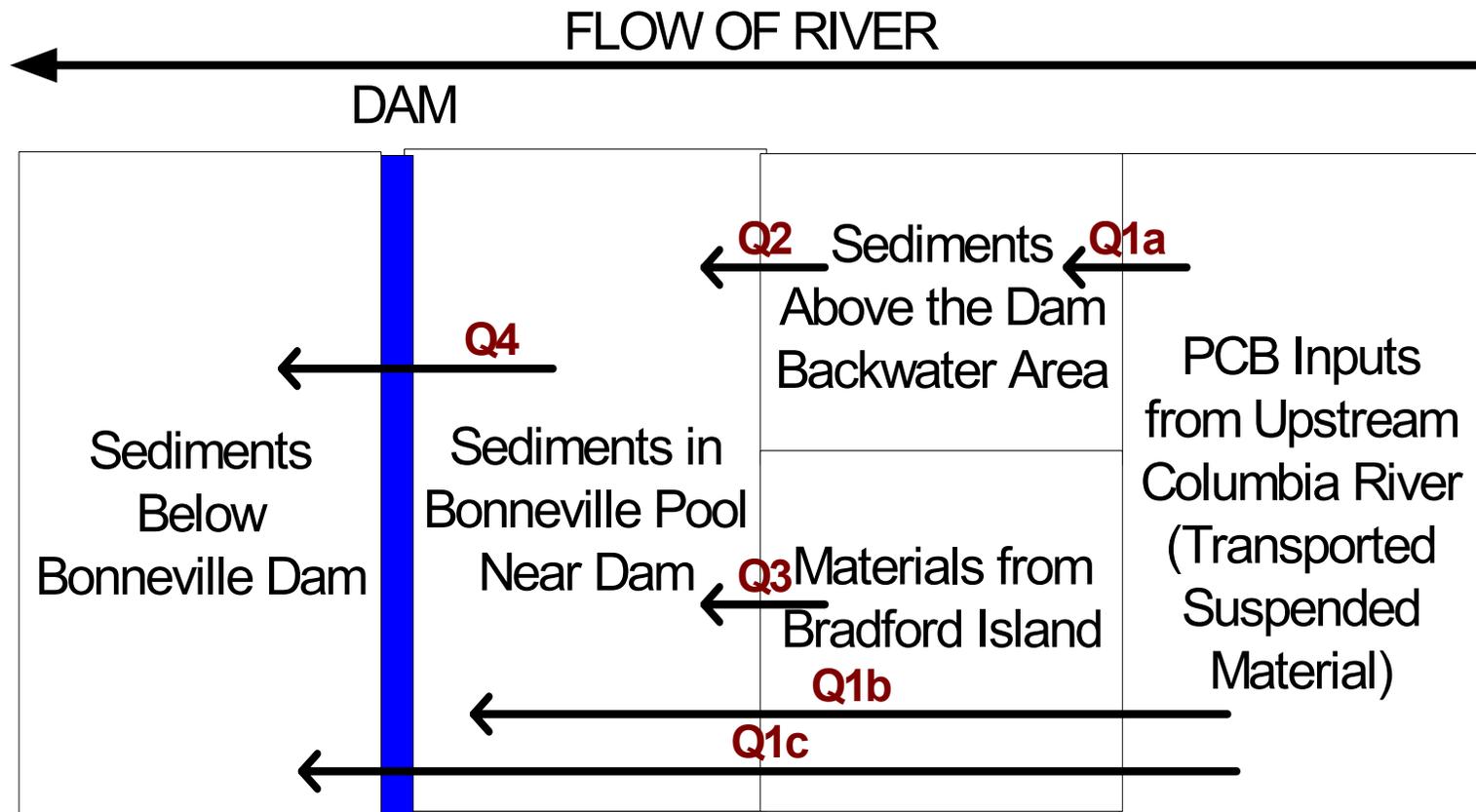
The USFWS representative requested tissue samples.

Available Resources

Major project activities include developing the DQO summary report, developing the sampling and analysis plan, performing field surveys, performing laboratory analyses, conducting the data quality assessment, and reporting the results to an interagency group.

Conceptual Site Model

Figure 1 illustrates a conceptual (or box) model of PCB in the Columbia River in the vicinity of Bonneville Dam. In the illustration, the boxes represent accumulation points from upstream components, and also sources to downstream components. The movements (Q representing flux) of contaminants from one compartment to the next are shown by arrows. Q1 has 3 components, indicating that it affects 3 downstream boxes. It affects sediments above the backwater for the dam, and near the dam, and below the dam. Q2 is flux downstream from a sediment accumulation upstream of the backwater, and it affects the Pool and below-dam sediments. This box (but not the flux) is the focus of this investigation. It will be assumed for this investigation as well as tested, that sediments in this compartment are reasonably representative of the concentration (but not the rate of deposition) of the suspended sediment in the river. Also, this investigation will provide the basis for testing (subsequent to this investigation) of the hypothesis that the sediments in the vicinity of Bonneville dam are materially enriched with PCB compared to the upstream sediment condition. While not explicitly used for the current testing, this investigation may also provide a point of comparison for sediments downstream of the dam. A Site Conceptual Exposure Model, which deals with movement of persistent, bioaccumulative compounds such as polychlorinated biphenyls, occurs in the Bradford Island Site Assessment, and is incorporated by reference here.



STEP 2 - IDENTIFY THE DECISION

The objective of DQO Step 2 is to define the decision statements to be resolved.

Principal Study Questions

The overall goals for the Corps' testing (which goes beyond the current investigation) are to permit a selection (with Oregon DEQ) amongst three alternatives:

Alternative 1. Bonneville Pool and Bradford Island sediments are currently a significant contributor of PCB or metals to organisms in the Columbia River;

Alternative 2. Sediments from upstream of the Pool are as much as, or more significant contributors to exposure than Bonneville Pool and Bradford Island; or

Alternative 3. Some other source of exposure to these compounds, such as water-borne sediments in the river may be a more significant contributor to exposure at this time.

The limited effort covered by the SAP can only address alternative 1; however, the other questions are of interest and may be subject of future study.

Figure 1 illustrates the Q or flux component; however, no flux studies are being conducted, nor are contemplated at this time. These require a time-course of change and extensive water quality sampling, which are beyond the study's resources. It is easier to measure the compartments. Also, it will not likely be possible based solely on data collected in this current investigation to select an alternative from this array. The reason for this is that sufficient data from the sediments in the Pool and vicinity of Bradford Island are not currently available; nor are tissue data for PCB. In the fall or winter of 2002, the Corps will be taking samples for that comparison, and also to complete tissue testing. This future phase of the Bradford Island investigation has not been fully scoped at this point. Also, it may include biological testing, and an additional purpose of the present study is to characterize a sediment and tissue reference area.

This investigation involves collection of sediments for bulk analysis and synoptic sample of *Corbicula spp.*, a freshwater clam that will be archived as whole, frozen samples for possible later analysis during the Bradford Island investigations. Although not part of this data collection effort, tissue hypotheses are developed herein, in order to guide the scoping of the later, Bradford Island related investigation. The analysis of the clam tissue data will be determined after review of the sediment information as described in this memorandum.

STEP 3 - IDENTIFY INPUTS TO THE DECISION

The objective of DQO Step 3 is to identify the informational inputs that will be required to address principal study questions.

Overview. Both PCB concentration and distribution in sediment will be determined during this investigation. In future, selected *Corbicula* tissue samples may be analyzed also for PCB. For the present investigation, it is desirable to adequately characterize the distribution of PCB, organic carbon, and grain size of sediments in the Pool upstream of the backwater (and thus sediment transport) influence of the dam. Patterns of concentration of PCB, lead, and mercury will be characterized by deriving concentration distributions using specified analytical techniques on a variety of samples. In addition a small number of samples will be taken in the Pool, but at a distance from Bradford Island. It is intended that comparison between upstream and Pool sediments will evaluate systemic river loading to the sediments and (eventually) to organisms.

It is useful to think of some of the compartments in the box model as comparisons, and consider possible outcomes. The outcomes are a combination between:

Sediments Upstream of Backwater area (measured in this SAP)
Sediments in Pool (some of these are measured in this SAP), and
Sediments near Bradford Island

AND

Corbicula shows low levels of bioaccumulation in Upstream for PCB, lead or mercury

Corbicula shows low levels of bioaccumulation in Pool area

Corbicula shows low levels of bioaccumulation in Bradford Island area

Corbicula shows high levels of bioaccumulation

If A is less than B and/or C, then the conclusion would be that there is a source related to Corps' activities that is enriching the vicinity of the dam with contaminants. Note: we will not answer questions about bioaccumulation in this short-term activity, as noted elsewhere in this memorandum, but it is important to sketch out the relationship of the lettered outcomes to the numbered ones. If $A < B | C$ occurs with 1 or 2, then the bioaccumulation consequence for aquatic life may be minimal from the river at large. If this occurs with 3, then it would indicate that the influence of releases from the landfill is very limited. (Some tissue samples in the close vicinity of the landfill have been shown to be high in PCB.) Co-occurrence with 4 suggests that activities are significantly contributing to the bioaccumulation of these substances. Toxicity is not measured by any of these outcomes; however, toxicity can be estimated from tables of sediment criteria and toxicity in clam tissue may be estimated from the Environmental Residue-Effects Database maintained by the Corps' Engineering Research and Development Center (<http://www.wes.army.mil/el/ered/index.html>).

If A is greater than, or more likely not distinct from, B and/or C, then the contribution of Corps' activities is minor. If this result co-occurs with 1, 2, and/or 3, then the resulting conclusion could be that activities are not biologically significant also. If $A \geq B | C$ co-occurs with 4, then some other source than local sediment enrichment may be needed to explain the situation.

Determination of significance of bioaccumulation will utilize collection of *Corbicula* and subsequent analysis for comparison to Theoretical Bioaccumulation Potential Model (TBP: Corps and EPA, 1998). Should TBP, an empirical prediction based upon sediment organic carbon content and lipid content of the organism of interest, and the tissue data both confirm a significant accumulation of PCB in the area above the dam, this will be a factor relevant both to the States of Washington's and Oregon's health advisories and to the Bradford Island waste investigation.

The following measurements are contemplated for the present investigation.

Grain Size

Gradation will include the Modified EPA sieve series: 4, 10, 18, 35, 60, 120, and 230.

Total Organic Carbon in Sediment

The Puget Sound Protocols method will be used.

http://www.wa.gov/puget_sound/Publications/protocols/protocol_pdfs/sed_conv.pdf

This method will produce data suitable for accomplishing the TBP model (for which, see below).

Polychlorinated Biphenyls in Sediment (Tissue Will Be Analyzed in Future Studies)

SW 846 M. 8082 (GC/ECD) has been selected for this comparison. This method is suitable for quantitative determinations of PCB Aroclor patterns. The prior data on the river from Bradford Island and the bulk of the information on the Columbia River is by the Aroclor method. An alternate method (M. 1668) exists for high-resolution gas chromatography/mass spectrometry. However, this method does not generate information that would be comparable to existing data, and moreover is relatively expensive and so would not permit sufficient samples to meet the statistical comparison. Five of the highest Aroclor samples will be frozen for a period not to exceed 1 year against the desire of another agency to accomplish this testing.

Mercury and Lead in Sediment (This Study)

SW 846 Methods 6020 and 7471 will be used.

Tissue Lipid (To Be Used In Possible Future Studies On Clam Tissue)

The Bligh-Dyer method as used by URS in Corps (2002) will be employed.

STEP 4 - DEFINE THE BOUNDARIES OF THE STUDY

The objective of DQO Step 4 is to define the spatial and temporal components of the representation of the sampling regime. The scale of decision-making is defined by combining the population of interest with the spatial and temporal boundaries. Implementing this step helps to ensure that the data are representative of the population.

Scale of Decision Making for PCB in Sediment

Portland District has accomplished a backwater analysis to direct the selection of suitable depositional areas. (See Figure 1 of the SAP.) In addition, the sampling will undertake to characterize lead and mercury. Both of these compounds are possibly elevated in sediments near Bradford Island. Field screening of sediment locations will be done to assure that >10% fines content will be collected. Samples that are marginal to the river will hopefully provide a range of fines to be used for correlation testing with the contaminants of interest. For placement of samples, please consult the SAP. Some samples will be taken in the compartment upstream of Bonneville Pool, and some in the Pool area well removed from likely influences of Bradford Island Landfill.

Scale of Decision Making for PCB Theoretical Bioaccumulation

Sediment samples showing a range of PCB contents and for which *Corbicula* are available, will be later analyzed and data from sediment and tissue used to compare to estimated TBP.

STEP 5 - DEVELOP DECISION RULES

The objective of DQO Step 5 is to use the key elements from DQO Steps 1 through 4 to develop decision rules (DRs).

DR 1: Comparison of Sedimentary Fines Content and Contaminants of Interest

Statistical testing will be used to regress fines content (FC) against contaminant concentration (PCB, lead and mercury) one at a time. It is expected that this will be a significant regression should fines be holding most of the contamination. This decision being made is to screen for potential significance of contribution of upstream fine sediment load to the site. The associated decision rule is:

IF the relationship of FC (as the independent variable) versus CC (as the dependent variable) is not significantly statistically at alpha = 0.9 level,

THEN the sediment concentrations are not a good representation of Q2 and/or Q1b.

ELSE the sediment concentrations may be a good representation of Q2 and/or Q1b.

DR 2: Statistical Comparison of Concentrations of Contaminants of Concern from Upstream of Bonneville Pool to Data from Bradford Island

Statistical testing (parametric or nonparametric) will be used to derive these values for the current data set. This decision requires data from other sources. When the new Bradford Island data are in hand, it will be possible to do the following test at $\alpha = 0.05$, $\beta = 0.8$.

IF the upper Bonneville Pool concentrations are significantly less than the Bradford Island sediment concentrations,

THEN Q3 is likely to be an important source to downstream locations in the river.

ELSE Q3 is not likely to be an important source to downstream locations.

HOWEVER, should DR1 show a poor relationship of fines and contamination (the *THEN* statement of DR1), this will likely result in qualifying DR2.

DR 3. Comparison to Regulatory Risk Based Numbers

It is not the explicit intention to create a risk assessment in this activity. However, the data should be comparable against suitable regulatory screening values such as the DEQ Ecological Risk Assessment Level II Values. These follow: Pb, 35 mg/kg; Hg, 0.2 mg/kg; total PCB, 34 $\mu\text{g}/\text{kg}$; Aroclor 1248, 21 $\mu\text{g}/\text{kg}$. Two comparisons are possible: simple threshold comparison for each station and statistical testing of the set of observations ($\alpha \leq 0.05$; $\beta \geq 0.8$).

IF the observed values (simple or statistical) are greater than the Level II Values,

THEN either the individual station (simple comparison) or the population of stations (statistical comparison) could have adverse ecological effects on the benthic community. (This would warrant more investigation, but it is not clear at this stage who would do it.)

ELSE either the individual station (simple comparison) or the population of stations (statistical comparison) likely does not have adverse ecological effects on the benthic community apart from bioaccumulative potential.

DR 4: Theoretical Bioaccumulation Potential (This Study)

For the current round of testing, a TBP value will be estimated using existing *Corbicula* lipid data and the sediment concentrations. The following describes the TBP procedure.

Theoretical bioaccumulation potential (TBP) is calculated relative to the biota sediment accumulation factor (BSAF) as follows:

$$\text{TBP} = \text{BSAF} (C_s / \% \text{TOC}) \% \text{L}$$

(McFarland and Clarke, 1987)

where TBP is expressed on a whole-body wet-weight basis in the same units of concentration as C_s , and C_s = concentration of nonpolar organic chemical in the river or depositional area sediment (any units of concentration may be used);
BSAF=4 (Ankley et al., 1992)

%TOC=total organic carbon content of the dredged material or reference sediment expressed as a decimal fraction (i.e., 2% = 0.02); and

%L =organism lipid content expressed as a decimal fraction (i.e., 3% = 0.03) of whole-body wet weight.

The TBP estimate will be compared to risk-based tissue concentrations of concern for sensitive populations of fisherpersons, using the most current risk assessment information available. (This value is not currently in hand, and will be developed by coordination with stakeholders and regulatory agencies during the evaluation phase.)

IF the TBP estimate is above half the risk-based level,

THEN the sediments in the upper portion of the Bonneville Pool may be contributing significantly to the tissue burden of the fish.

ELSE, the sediments are not contributing significantly to the tissue burden of the fish.

DR 5: Empirical Sediment Bioaccumulation Factor (BSAF) Derivation (Future Study)

If warranted by the TBP calculations, *Corbicula* tissue data will be analyzed to assist in determining a BSAF.

Comparison of the empirical BSAF to TBP is the decision of interest. Overprediction or an underprediction of BSAF by TBP may have occurred, as follows.

IF empirical BSAF is less than half the TBP,

THEN this is expected based on what is known of the TBP equation. Use of the factor of 4 should somewhat overestimate the bioaccumulation potential. Dr. Victor McFarland (personal communication) has stated that the factor of 4 from the Inland Water Testing Manual should be around 2, based on his research.

ELSE an under-predicted BSAF based upon sediment indicates that the suspended particulate fraction (which is not being measured in this investigation) may be a more important factor than the sediment concentration for filter-feeding organisms such as *Corbicula*. (Prior Bradford Island information from near Goose Island using bulk sediment tended to under-predict bioaccumulation.)

Should it occur that PCBs are considerably higher in the clam than suggested by the sediment concentrations, further investigation will be necessary to determine the source of the additional PCB to the clam population. In that event, a future investigation (beyond current scope) should look at the additional contribution of suspended particulates, Q1a with reference to Figure 1.

STEP 6 - SPECIFY TOLERABLE LIMITS ON DECISION ERRORS

The objective of DQO Step 6 is to specify the tolerable limits on decision errors, which are used to establish performance goals for the data collection design. This testing is a largely judgmental program based upon prior knowledge of strata and riverine processes. The testing will define population parameters for input to professional judgments. Representativeness is assured by appropriate placement of samples. The following is a somewhat judgmental approach to estimate required numbers of samples. After receiving the data, it should be possible to revisit the assumptions to determine whether they are accurate.

Decision Errors for Comparison of Contaminant Content to (Future) Population of Bradford Island Area Samples.

The tolerable uncertainty was defined in DR 2. The following shows the sampling strategy for collecting sufficient samples to make a cogent comparison.

Assumptions.

Type 1 Error Rate (false negative) is set to 5%.

Type 2 Error Rate (false positive) is set to 20%.

The Relative Standard Deviation (RSD) is assumed to be 0.4. (This is estimated for a broad area with no point sources. The RSD for a censored data set from Bradford Island in the vicinity but away from the electrical equipment was 1.19, and that was expected sediments near a source. At areas in Elliott Bay, Puget Sound, away from industry the bulk sediment RSD is around 0.4, or 40%).

The width of the "Gray Zone" was varied, and set by consensus to 0.4. (The Gray Zone is the same as Minimum Detectable Difference.)

Visual Sample Plan (Pacific Northwest Laboratory, 2002) estimated that 14 samples are required for this evaluation at the stated Minimum Detectable Difference. This is a goal for sampling in the Upstream Area. A nonstatistical approach was selected by the samplers for the Pool area, and the number will be smaller, approximately 6 samples. (Accordingly, it will not be possible to statistically compare this area.)

(Note: Decision strategies for TBP predictions versus *Corbicula* BSAF will be generated by the later investigators.)

(Note: Should the desired number of samples not be obtained due to conditions encountered during the survey, a post-sampling analysis of RSD will be used to determine the number of additional samples that are needed.)

STEP 7 - OPTIMIZE THE DESIGN

The objective of DQO Step 7 is to identify the most resource-effective data collection design for generating data that are expected to satisfy the DQOs specified in the preceding six DQO steps. See the Sampling and Analysis Plan.

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McFarland, V.A. Personal Communication, 17 May 2002.

Appendix B

FIELD SAMPLING PLAN

BONNEVILLE FOREBAY
SEDIMENT CHARACTERIZATION
AND
UPSTREAM BACKGROUND DOCUMENTATION

September 2002

Prepared by:

CENWP-EC-HR

Portland District
Corps of Engineers

TABLE OF CONTENTS

Section	Page
1.0 Project Description, Site History and Assessment	
1.1 Project Location and Description	1
1.2 Previous Sediment Sampling	1
1.2.1 Dredging Projects	1
1.2.2 Study Projects	2
2.0 Project Organization and Responsibilities	3
2.1 Key Field Personnel	3
3.0 Scoping and Objectives	3
3.1 Sampling and Analysis Requirements	3
3.2 Numbers of Samples To Be Collected	3
4.0 Field Activities	3
4.1 Sampling Locations and Numbering	3
4.2 Field Sampling Schedule	3
4.3 Field Notes	4
4.4 Photographs	4
4.5 Investigation-Derived Wastes	4
4.6 Corrective Action	5
4.7 Decontamination	6
4.8 Field Logbook	6
4.9 Field Duplications	6
4.10 Sampling Equipment	6
5.0 Sample Transport and Chain-of-Custody/Documentation	6
5.1 Sample Transport and Chain-of-Custody Procedures	6
Table 1: Key Field Personnel	3
Table 2: Sample Volume and Storage	7
Figure 1: Sample Location Maps	18

FIELD SAMPLING PLAN BONNEVILLE FOREBAY

1.0 PROJECT DESCRIPTION, SITE HISTORY AND ASSESSMENT

1.1 Project Site Location and Description. Bonneville Dam is located between River Mile (RM) 145 and 146 of the Columbia River. The area of this sediment characterization event will extend upstream of the forebay, beyond the eddy currents effect associated with the dam, which reaches upstream to the area at the west end of Goose Island (see figure 1).

This characterization will exclude the area identified as within or adjacent to the former Bradford Island Dump Site. All areas associated with the remedial action of the former dumpsite at Bradford Island will be sampled under a different SAP following CERCLA guidance. The purpose of this sampling plan is to gather additional baseline information. No samples are planned for areas where recent data has been collected (< 5 years old - see figure 1).

2.0 PREVIOUS SAMPLING EVENTS

2.1 Dredging Projects In 1991 informational sampling and analysis was done on sediment downstream from the First Powerhouse Navigational Lock, on the south side of the river, with results acceptable for unconfined in-water or upland disposal. This same downstream area was dredged in 1986 and in the late 1970s.

In July 1997 seven sediment samples were collected from Bonneville Second Powerhouse forebay and water supply conduits. Two of the samples were taken from the downstream portion of the south Auxiliary Water Supply (AWS) conduit by divers inspecting the inside of the south AWS. Three additional samples were taken from the surface of the sediment deposits at the north end of the forebay. The final two samples were collected from the sediment and woody debris removed from the north AWS intake trash rack by clamshell and stockpiled on Cascade Island, at the south end of the Elevation 90 Deck crane way extension. Physical analysis, run on four sediments, indicated the material ranges from gavel to very fine sand, with largest fractions in the coarse to medium sand range. Chemical analysis, run on five sediments, included metals, pesticides/polychlorobiphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), total organic carbon (TOC), acid volatile sulfide (AVS), phenols and dioxin screen (P450). The portion of the sample submitted to the lab was representative of the material dredged, except for the woody debris. Results determined the material to be acceptable for unconfined in-water or upland disposal.

On December 18, 2001 a total of three (3) sediment samples were collected from a shoal at the adult fish ladder discharge (water intake) on the south bank of Bradford Island. All samples were submitted for physical analyses including total volatile solids and also analyzed for metals (9-inorganic), total organic carbon, pesticides and polychlorinated biphenyls, phenols, phthalates, miscellaneous extractables, polynuclear aromatic hydrocarbons and organotin.

None of the laboratory data results exceeded their respective screening levels in the DMEF. All sediment was determined to be suitable for unconfined, in-water placement; however, the 1577 CY of material dredged was, as a management option, barged to RABANCO's company Regional Disposal facility in Roosevelt Washington.

On January 14 & 15, 2002 thirteen (13) sediment samples (includes 1 field dup.) from four (4) stations were collected at potential log boom anchor point locations. Sediments were tested for lead, mercury, PCBs, hydrocarbons, TOC and grain size. One (1) sample analysis detected mercury slightly over the

**FIELD SAMPLING PLAN
BONNEVILLE FOREBAY**

0.41 mg/kg DMEF screening level (SL) at 0.419mg/kg. The field duplicate indicated motor oil at a 195mg/kg level, which exceeds the ODEQ Numeric Soil Cleanup standards (Soil Matrix) of 100 mg/kg. The analysis of the primary sample, associated with the field duplicate analyses above, indicated motor oil at 43.6 mg/kg, which is considerable less than the duplicate sample and well below ODEQ standard. The material represented by this sampling event is to be side-cast to construct the proposed anchor structures. The volume of sediment to be side-cast for the project was estimated be less than 100 CY, which is a sufficiently small volume to be considered as having little or no environmental impact at the chemical levels reported.

2.2 Study Projects In 1991 in a Minimum Operating Pool (MOP) study at Bonneville, which included twelve (12) sites, Cascade Lock RM 149.2, Rock Creek RM 150.0, Herman Creek RM 150.9, Wind River Boat Ramp/Mouth RM 154.8, Home Valley RM 154.8, Port of Hood River RM 169.0, SD&S Lumber, RM 170.6, Bingen Boat Basin & Marina RM 171.7, Mayer State Park RM 181.0 was conducted. All sites were analyzed for metals, PAHs, pest/PCBs, TOC and AVS, with select sites adding phenols, dioxins/furans and TBT. None of the test sediments exceeded current Dredge Material Evaluation Framework (DMEF) screening guidelines for open water disposal (no PCBs were detected at the method reporting limit (MRL) of 0.04 mg/kg).

In December 2000 and May 2001 sediment and biological tissue samples were collected and analyzed from an area at the Northeast end of Bradford Island, which contained discarded electrical components discovered in the near shore area. Levels of PCB Aroclor 1254 were detected in clam tissue at 3.8 mg/kg, in crayfish at 75.6 mg/kg and in sediment at 8.3 mg/kg. The investigation and cleanup of this former dumpsite is still in progress; discarded electrical components from the in-water areas have been removed. Further sediment testing will take place in the near future.

In Aug 2001, one (1) surface grab sample and eight (8) in-water subsurface (borings), within the proposed plunge pool, consisted of overburden materials and bedrock. In addition to the in-water samples, 41 upland sites (borings and test pits) were also collected from the proposed upland construction site downstream of the Second Powerhouse and contain similar material. The overburden consists of fill (500 CY of riprap), alluvium, slide debris material and a poorly graded alluvial material referred to as “crystal sands” (poorly graded micaceous silty sand to sand). All the samples recovered from the drillings and surface sample is considered native material derived primarily from historical and prehistorical slides in the area. The bedrock unit consists of the sedimentary Weigle Formation.

The samples collected from the in-water area at the site of the proposed plunge pool dredging indicate the majority of the material to be disposed of consists of 80% gravel, 18% sand with fines representing <2% of total material with an estimate of <1% volatile solids.

3.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

Key field personnel

Table 1

Name	Organization	Responsibility
Tim Sherman	US Army Corps of Engineers Portland District	Team Leader Planning and implementation of FSP, Sample collection and handling.

**FIELD SAMPLING PLAN
BONNEVILLE FOREBAY**

Allison Schaub Donna Ebner	US Army Corps of Engineers Portland District	Sample collection and field log data recording.
John Vlastelicia	Contracted Research Vessel Owner	Operate boat and sample deployment and retrieval.

4.0 SCOPE AND OBJECTIVES

4.1 Sampling and Analysis Requirements. This sampling event will attempt to collect a statistically significant number of fine-grained sediment samples to evaluate the level of PCBs, Pb & Hg, as well as conduct grain-size and TOC analyses, in the Bonneville Forebay and upstream areas, excluding the Bradford Island remediation site and recently sampled areas. The plan will attempt to collect sufficient samples to represent the baseline conditions upstream of the eddy effects of the dam operations and reflect the conditions within the forebay. The plan will attempt to collect at least sixteen (16) fine-grained surface grab samples (see figure 1) in the upstream area and up to fourteen (14) in the forebay area below the eddy effects area. The potential fine-grained sediment locations are being selected with the aid of a computer model, which reflects the various flow conditions associated with the dam's operation in near-bottom flows. In-channel samples will be collected on an intersect grid spaced evenly throughout the selected study area where model data indicates higher flows are present under all conditions. It is likely, if sediment is present in these areas, it will contain few fine-grained (<230 sieve) sediments and will be field screened * for percent fines, and submitted for grain-size analyses only, if screening indicates <10% fines. *(Ref. 2. Wet Sieving Method)

4.2 Number of Samples To Be Collected. A total of up to thirty (30) samples will be collected as described above. Several attempts will be made at each station to retrieve fine-grained material at each location. All sample attempt coordinates will be recorded in the field log. Any *Corbicula* clams collected during this event will be separated and placed in separate zip lock bags for archiving at -20° C for potential future tissue analyses.

FIELD ACTIVITIES

4.3 Sampling Locations and Numbering. Figure 1 shows the project area and sample locations. Sampling sites are located for the best characterization of the material as possible. Proper QA/QC procedures as outlined in this section will be followed. Any deviation from these procedures shall be noted in the field log. Sample identification shall follow the following convention:

BF-XX-YY

Where, "BF" denotes samples collected from the Bonneville Forebay, "XX" denotes the type of sampling device such as "BC" = Box Core; "YY" denotes the numeric sample sequence number and will consist of two digits for all samples. The QC replicates (blind duplicate) will have a letter designation in place of the numeric designation of the primary sample; e.g. "A" added (BP-BC-A). Duplicate samples will be identified in the field notes.

4.4 Field Sampling Schedule. Sampling is scheduled for September 18, 2002.

4.5 Field Notes. Field notes will be maintained during sampling operations. Included in the field notes will be the following:

FIELD SAMPLING PLAN BONNEVILLE FOREBAY

Name and title of author, date and time of entry.

Name and address of field contact.

Propose of sample activity.

Names and responsibilities of all field crewmembers.

Sample collection method.

Number and Volume of samples taken.

Location, description and log of photographs (if taken) of the sampling sites.

Date and time of collection.

Field observations.

Weather conditions.

Depth of water at each station sampled as measured from the water surface. This will be accomplished using a leadline or corrected depth recorder.

The sample station number and individual designation numbers assigned for each individual sample.

Descriptions of sediment.

Penetration depth of the sampling device.

Any deviation from the approved sampling plan.

4.6 Photographs. Photographs will not be used to identify each sample location, but will show general areas where samples are collected. (Sample locations will be identified by GPS).

4.7 Investigation-derive wastes (IDW). Any sample material collected beyond the amount collected for analyses will be placed back in the water at the collection site. Any decontamination waste derived will be released to the Bonneville Project point of contact (Brian McCavitt) for disposal in accordance with the Bonneville Dam health and safety plan.

4.8 Corrective action. In the event it is determined that a discrepancy in sampling or sample handling is detected, all field notes will be reviewed by team leader and a determination of the appropriate action will be made. Written documentation will be made and placed in the permanent file and actions will be recorded in the final evaluation report

4.9 Decontamination. All sampling devices and utensils will be thoroughly cleaned prior to use according to the following procedure:

Wash with brush and Alconox soap

Rinse with distilled water

Rinse with 10% nitric acid solution

Rinse with distilled water

Rinse with methanol

Rinse with distilled water

Utensils used to collect physical samples only or sampling devices such as the surface grab sampler will be washed down before each sampling event. However, they will not require the cleaning procedure listed above as long as samples collected for chemical analyses are not in contact with the core walls. All utensils used to collect chemical samples will require decontamination prior to each use. All handwork for chemical analyses will be conducted with disposable latex gloves that will be rinsed with distilled water before and after handling each individual sample, as appropriate, to prevent sample contamination. Gloves will be disposed of between samples or composites to prevent cross contamination between samples.

FIELD SAMPLING PLAN BONNEVILLE FOREBAY

4.10 Field Log Book. The following information will be included in the field logbook entries:

Sample recovery

Physical soil description (includes soil type, density/consistency of soil, color)

Odor (e.g., hydrogen sulfide, petroleum products)

Visual stratification and lenses

Vegetation

Debris

Biological Activity (e.g., detritus, shells, tubes, bioturbation, live or dead organisms)

Presence of oil sheen

Any other distinguishing characteristics or features

4.11 Field Compositing. Samples will not be composited during this event.

4.12 Field Duplicates. One (1) to 2 duplicate field samples (QC) and 1 to 2 quality assurance samples will be submitted to a separate quality assurance lab for all analyses conducted on the primary project sample. Laboratory QA/QC will be used to evaluate and access data quality.

4.13 Sampling Equipment. All samples will be collected using a box-core surface grab sampler. The box-core has a capacity of approximately 2 cubic feet, with 12 square inch opening and weighs approximately 150 pounds. Up to eight (8) 50 pound weights can be added for up to 550 pounds total weight. The box-core will be deployed off the stern of the contractor's 29-foot boat, using a hydraulically operated "A-frame" lifting device.

5.0 SAMPLE CHAIN-OF-CUSTODY/DOCUMENTATION

5.1 Sample Transport and Chain-of-Custody Procedures. After sample containers have been filled, they will be packed in ice or "blue ice" in coolers. Chain-of-custody procedures will commence in the field and will track delivery of the samples. Sample holding times and storage requirements are presented in the QAPP. Specific procedures are as follows:

Samples will be packaged and shipped in accordance with U.S. Department of Transportation regulations as specified in 49 CFR 173.6 and 49 CFR 173.24 or delivered directly to the testing laboratory.

Individual sample containers will be packed to prevent breakage.

The coolers will be clearly labeled with sufficient information (name of project, time and date container was sealed, person sealing the cooler and office name and address) to enable positive identification.

Chain-of-custody forms will be enclosed in a plastic bag and placed inside cooler.

Upon transfer of sample possession to the laboratory, the persons transferring custody of the coolers will sign the chain-of-custody form. Upon receipt of samples at the laboratory, the coolers will be inspected and the receiver will record the condition of the samples.

Custody Seals will be used on cooler during shipment.

**FIELD SAMPLING PLAN
BONNEVILLE FOREBAY**

Table 2, Sample Volume and Storage

Sample Type	Holding Time	Sample Size (a)	Temperature (b)	Container
Particle Size	6 Months	200 g		1-1 Quart Plastic Bag
PCBs	14 Days	125 g	4°C	1-8 oz Glass
Total Organic Carbon	14 Days	125 g	4°C	1-8 oz Glass (combined)
Mercury (Hg)	28 Days	5g	4°C	
Lead (Pb)	6 Months	50 g	4°C	
<i>Corbicula</i>	2 years	All collected	-20°C	1-1 Quart Plastic Bag

Required sample sizes for one laboratory analysis. Actual volumes to be collected have been increased to provide a margin of error and allow for retest.

During transport to the lab, samples will be stored on ice.

FIELD SAMPLING PLAN BONNEVILLE FOREBAY

References

1. U.S. Army Corps of Engineers, Portland District and Seattle District; U.S. Environmental Protection Agency, Region 10; Oregon Department of Environmental Quality; Washington State Department of Natural Resources and Department of Ecology. 1998 Final. Dredge Material Evaluation Framework for the Lower Columbia River Management Area.

2. Subject: Wet Sieving Method for Percent Fines to Match Test Sediments and Reference Sediments

PSDDA requires running reference sediments, which are matched against dredged material by percent fines (that is, the dry weight of sediment passing a standard 63 um sieve divided by the total dry weight of the sediment). This is difficult to do because the easily obtained field measurements (wet weight, volume) are only surrogates for the dry-weight basis used in the laboratory. This memorandum describes an interim protocol for collecting field information that will allow a grain-size approximation.

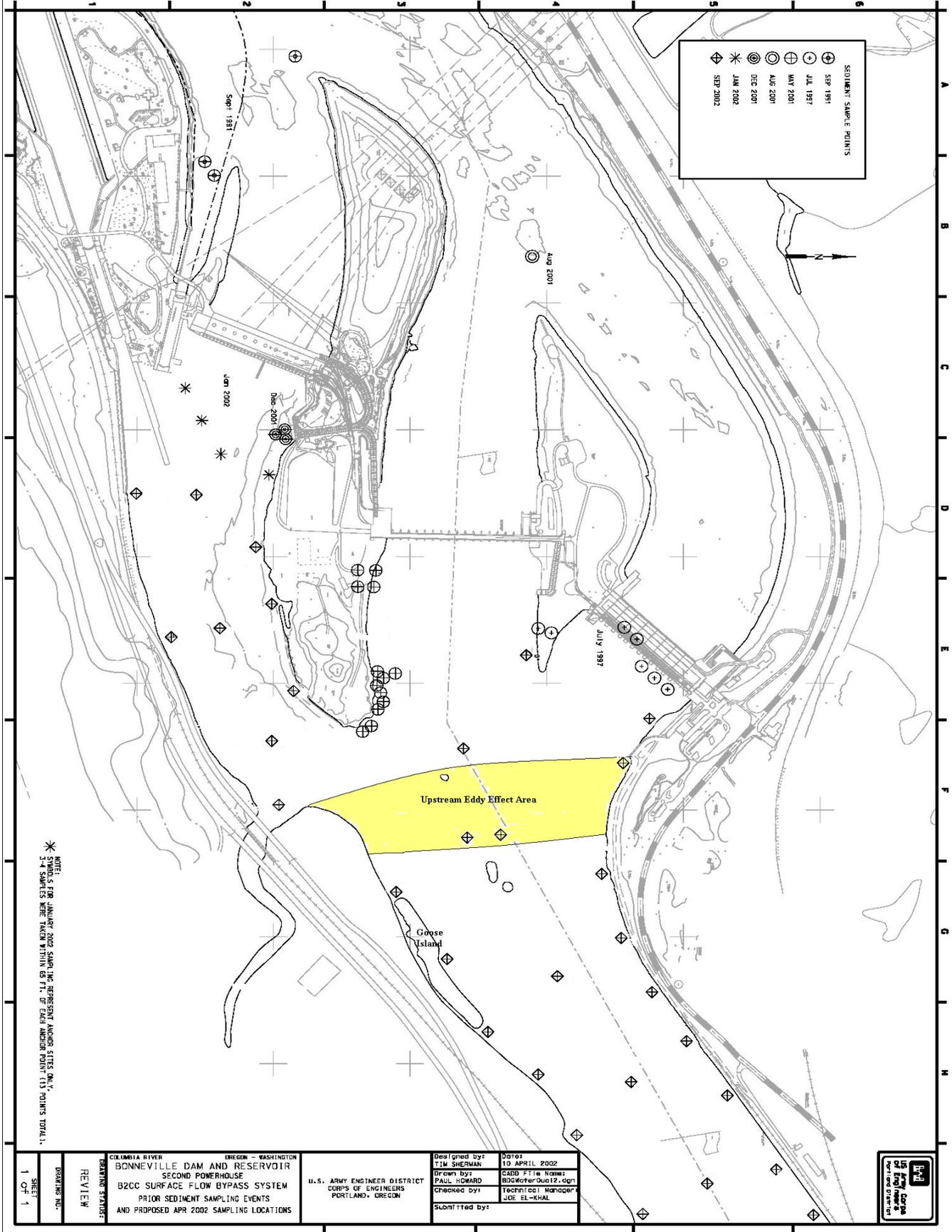
The wet sieve method was developed by Dr. Tom Ginn, Dr. Scott Becker and Mr. John Green of PTI during studies conducted for EPA's PSEP. The technique (but not the figures used here) is described in a technical memorandum from PTI to EPA's Office of Puget Sound, titled "Reconnaissance Survey of Reference Area Sediments in Shallow Waters of Carr Inlet," dated February 1990. Scott Becker verbally transmitted the following data and methods to John Wakeman of Seattle District on May 29, 1990.

The method for the Carr Inlet cruise used a starting volume of 65 ml of sediment collected in a marked beaker. The sediment was gently washed on a 63 um sieve until the water passing the sieve was clear. The retained material was then carefully rinsed into a 100 ml graduated cylinder and allowed to settle until the supernatant water was also clear. For sandy sediment this will occur quickly, within one minute; for silty sediment, it may take up to 15 minutes. (Should colloidal materials remain in suspension after 15 minutes, the sediment was not washed sufficiently on the sieve.) However, the endpoint is usually not determined by clarity, but instead the degree of compacted flocculated sediment. One should see at least a clear delineation between floc and supernatant water at endpoint.

Interpretation. Figure 1 shows the relationship that was developed by comparing field values with lab values, this relationship probably only holds for the Raft Island area. In general, the values appear to agree with the assumption that the wet density is equal to the dry weight: one would predict that 10% fines (=90% sands) would be $0.9 \times 65 \text{ mL}$ (grams), or 58.5; the realized value is 56. For 89% fines (11% sands retained) $0.11 \times 65 = 7.2$ predicted, and 9 were recovered.

3. EPA commissioned PTI to do further studies on reference areas, and they will be developing this technique further during the studies; they are now using a standard of 50 ml of material.
4. U.S. Army Corps of Engineers. February 1, 2001. Engineer Manual EM 200-1-3, Requirements for the Preparation of Sampling and Analysis Plans.

FIELD SAMPLING PLAN BONNEVILLE FOREBAY



⊕	SEP 1981
⊕	JUL 1987
⊕	MAY 2001
⊕	AUG 2001
⊕	DEC 2001
⊕	JAN 2002
⊕	SEP 2002

NOTE:
* SYMBOLS FOR JANUARY 2002 SAMPLING REPRESENT ANCHOR STIES ONLY.
3-4 SAMPLES WERE TAKEN WITHIN 60 FT. OF EACH ANCHOR POINT (13 POINTS TOTAL).

COLUMBIA RIVER
DRAINING STATUS
REVIEW
SHEET
1 OF 1

OREGON - WASHINGTON
BONNEVILLE DAM AND RESERVOIR
SECOND POWERHOUSE
B2CC SURFACE FLOW BYPASS SYSTEM
PRIOR SEDIMENT SAMPLING EVENTS
AND PROPOSED APR 2002 SAMPLING LOCATIONS

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
PORTLAND, OREGON

Designed by:	DATE:
TIM SHERMAN	10 APRIL 2002
Drawn by:	CADD FILE NAME:
PAUL HOWARD	BDCWaterQuel2.dgn
Checked by:	Technical Manager:
	JOE EL-KHAL
Submitted by:	



Appendix C

Appendix C – QAPP – Table of Contents

**Quality Assurance Project Plan
Bonneville Pool
Polychlorinated Biphenyls
Investigation**

21 June 2002

U.S. Army Corps of Engineers
Seattle District

Engineering and Technology Section

4735 East Marginal Way South

P.O. Box 3755
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Appendix C – QAPP – Table of Contents

1.0	PROJECT MANAGEMENT	3
1.1	INTRODUCTION	3
1.2	Project Organization	3
1.2.1	Portland District	3
1.2.1.1	Mark Dasso – Project Manager	3
1.2.1.2	Paul Huebschman – Technical Manager	4
1.2.1.3	Tim Sherman – Sediment Quality Specialist	4
1.2.1.4	Allison Schaub – Field Sampler	4
1.2.1.5	Chip Pierson – Site Health and Safety Officer	4
1.2.2	Seattle District	4
1.2.2.1	John Wakeman – Senior Scientist	4
1.2.2.2	Sandy Lemlich – Project Chemist	5
1.3	Problem Definition and Background	5
1.3.1	Problem Definition	5
1.3.2	Background	5
1.3.2.1	Dredging Projects	5
1.3.2.2	Study Projects	6
1.4	Project Description	7
1.5	Quality Objectives and Criteria	7
1.5.1	Data Quality Indicators	7
1.5.1.1	Precision	7
1.5.1.2	Accuracy	8
1.5.1.3	Representativeness	8
1.5.1.4	Comparability	8
1.5.1.5	Completeness	9
1.5.1.6	Sensitivity	9
1.6	Special Training and Certification	9
1.6.1	USACE Project Staff	9
1.6.2	Analytical Laboratories	10
1.6.2.1	Primary Laboratory	10
1.6.2.2	Quality Assurance Laboratory	10
1.7	Documentation and Records	10
1.7.1	Project Report	10
1.7.2	Field Logbooks	10
1.7.3	Photographic Records	11
1.7.4	Laboratory Data	11
1.7.4.1	Format for the Comprehensive Certificates of Analysis	11
1.7.4.2	Raw Data Packages	12
2.0	DATA GENERATION AND ACQUISITION	1
2.1	Sampling Process Design (Experimental Design)	1
2.1.1	Sampling Design Theory	1
2.1.1.1	Decision Rule 1 - Comparison of Sedimentary Fines Content and Contaminants of Interest	1
2.1.1.2	Decision Rule 2 - Statistical Comparison of Concentrations of Contaminants of Concern from Bonneville Pool to Data from Bradford Island	2
2.1.1.3	Decision Rule 3 - Comparison to Regulatory Risk Based Numbers	2

2.1.1.4	Decision Rule 4: Theoretical Bioaccumulation Potential (This Study)	2
2.1.1.5	Decision Rule 5 - Empirical Sediment Bioaccumulation Factor (BSAF)	
	Derivation (Future Study)	3
2.1.2	Decision Errors	4
2.1.2.1	Decision Errors for Comparison of Contaminant Content to (Future) Population of Bradford Island Area Samples	4
2.2	Sampling Methods	4
2.3	Sample Handling and Custody Requirements	5
2.4	Analytical Methods Requirements	5
2.4.1	Instrument Methods & Particle Size Determination	5
2.4.1.1	EPA SW 8082 – PCB and PCB Congeners	5
2.4.1.2	EPA SW 6020 – Inductively Coupled Plasma/Mass Spectroscopy	6
2.4.1.3	EPA SW 7470/7471 – Mercury by Cold-Vapor Atomic Absorption	6
2.4.1.4	EPA 9060 – Total Organic Carbon	6
2.4.1.5	ASTM D 2487 – Standard Practice for the Classification of Soils for Engineering Purposes (Unified Soil Classification System)	6
2.4.2	Sample Preparation and Cleanup	6
2.4.2.1	EPA SW 3554B – Soxhlet Extraction	6
2.4.2.2	EPA SW 3620 – Florisil Cleanup	7
2.4.2.3	EPA SW 3630C – Silica Gel Cleanup	7
2.4.2.4	EPA SW 3640A – Gel Permeation Cleanup (GPC)	7
2.4.2.5	EPA SW 3660B – Sulfur Cleanup	8
2.4.2.6	EPA SW 3665A – Sulfuric Acid/Permanganate Cleanup	8
2.5	Quality Control (QC) Requirements	8
2.5.1	Field Quality Control	8
2.5.1.1	Field Duplicate Samples	8
2.5.1.2	Temperature Blanks	8
2.5.2	Analytical Quality Control	9
2.5.2.1	Initial and Continuing Calibration Standards	9
2.5.2.2	Method Blanks	9
2.5.2.3	Surrogate Spikes	9
2.5.2.4	Laboratory Control Samples	9
2.5.2.5	Matrix Spike/Matrix Spike Duplicates	9
2.5.2.6	Quality Assurance Samples	10
2.6	Instrument/Equipment Testing, Inspection, and Maintenance Requirements	10
2.6.1	Standard Solutions	10
2.6.2	Balances	10
2.6.3	Refrigerators	10
2.6.4	Volumetric Measurements	11
2.6.5	Water Supply System	11
2.6.6	Laboratory Instruments	11
2.7	Instrument/Equipment Calibration and Frequency	11
2.7.1	Analytical Support Areas Calibration Verification	11
2.7.1.1	Balances	11
2.7.1.2	Refrigerators/Freezers	12
2.7.1.3	Pipets and Other Volumetric Labware	12
2.7.1.4	Water Supply System	12
2.7.1.5	Other Analytical Support Equipment	12

2.7.2	Initial Calibration Curve.....	12
2.7.2.1	Inorganic Analyses.....	13
2.7.2.2	Organic Analyses.....	14
2.7.3	Initial Calibration Verification.....	15
2.7.3.1	Method 8082.....	16
2.7.4	Continuing Calibration Verification (CCV).....	16
2.7.4.1	Inorganic Analyses.....	17
2.7.4.2	Organic Analyses.....	17
2.8	Inspection/Acceptance Requirements for Supplies and Consumables.....	17
2.9	Data Acquisition Requirements (Non-direct Measurements).....	17
2.10	Data Management.....	17
3.0	ASSESSMENTS OVERSIGHT.....	1
3.1	Assessments and Response Actions.....	1
3.1.1	Technical Reviews.....	1
3.1.2	Laboratory Validation.....	1
3.2	Reports to Management.....	1
4.0	DATA VALIDATION AND USABILITY.....	1
4.1	Data Review, Verification, and Validation Requirements.....	1
4.2	Verification Methods.....	1
4.3	Reconciliation with User Requirements.....	1
5.0	REFERENCES.....	1

LIST OF ACRONYMS

<u>Acronym</u>	<u>Definition</u>
B	Detected concentration below the contract required detection limit but above the instrument detection limit (inorganics)
CLP	Contract Laboratory Program
CRDL	Contract Required Detection Limit
Corps	see USACE
EPA	United States Environmental Protection Agency
FSP	Field Sampling Plan
GPS	Global Positioning System
ICP-AES	Inductively Coupled Plasma-Atomic Emission Spectroscopy
IDW	Investigation Derived Waste
mg/kg	milligrams per kilogram
MS/MSD	matrix spike/matrix spike duplicate
PM	Project Manager
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SOPs	Standard operating procedures
USACE	United States Army Corps of Engineers (Corps)

EXECUTIVE SUMMARY

This Quality Assurance Project Plan (QAPP) is one of two components which address technical planning of the Bonneville Pool Polychlorinated Biphenyl (PCB) Investigation. The QAPP focuses primarily on the analytical methods and QA/QC procedures that are used to analyze the samples and manage the data. The QAPP should include the organization and responsibilities of project laboratory and data assessment personnel; QA objectives; sample receipt, handling, custody, and holding time requirements; analytical procedures, equipment preventive maintenance, calibration, internal quality control procedures, and performance/system audits; data reduction, review, and reporting; and data assessment, data useability, and DQO reconciliation. The recommended requirements for the contents of QAPPs are discussed in the following documents:

- [EPA QA/R-5](#)
- [EPA QA/G-5](#)
- [EPA QA/G-4](#)

The second component is a Field Sampling Plan (FSP) written by the Portland District in accordance with [EM 200-1-3](#). The FSP describes the field activities to be performed and defines the procedures and methods that must be used to collect field measurements and samples. The FSP also addresses the sample packaging and shipping requirements, proper handling and disposal of investigation-derived wastes (IDWs), field documentation procedures, corrective action procedures, and the project schedule.

Together the QAPP and FSP form the Sampling and Analysis Plan (SAP). The SAP describes the project requirements for all field and laboratory activities designed to answer the question of whether or the Bradford Island Landfill contributes to contamination evidenced as high PCB concentrations in crayfish and sediments from the waters northeast of Bradford Island. It should be noted that the scope of this work is only one step leading toward an answer to the question of whether the PCBs source is the Bradford Island Landfill or another source upstream of the eddy effects of the Bonneville Pool.

PROJECT MANAGEMENT

INTRODUCTION

Bonneville Dam was constructed by the Corps of Engineers (Corps). It is the first dam upriver (river mile 145 or river km 232) on the main stem Columbia River and is located east of Portland, Oregon. and consists of two powerhouses, a spillway, and a navigation lock. The first powerhouse was completed in 1938 and is located between the Oregon shore and Bradford Island (Figure 1-2). The second powerhouse was built in 1982, and is located between the Washington shore and Cascades Island (Figure 1-2). The spillway, consisting of 18 gates, each 50 ft wide, is located between the Bradford Island and Cascades Island, spanning the north channel. Bonneville Dam is currently operated and maintained by the Corps.

Bradford Island is part of the Bonneville lock and Dam Project. The island is a former waste disposal site that was active from the early 1940's until the early 1980s. The Corps is conducting hazardous waste investigations on Bradford Island under the oversight of the Oregon Department of Environmental Quality (DEQ), through the Voluntary Cleanup Program. Investigations have shown that polychlorinated biphenyls (PCBs) and PCB containing materials exist in the landfills and in the sediments north of the landfill area. Limited sediment and tissue testing performed by the Corps in the Pool above Bonneville Dam (Corps, 2002) has indicated the presence of PCB in sediments near Bradford Island Landfill, and upstream near Goose Island. Detectable levels of PCB were also reported in the tissues of crayfish and clams. A recent report by EPA and the Columbia River Intertribal Fish Commission indicated PCBs in sturgeon above levels of concern. As a result, a fish advisory against collecting and eating fish and shellfish was issued by the state of Oregon for this reach of the river (Corps, 2002). Washington State has issued a similar advisory.

The Corps and the Oregon Department of Environmental Quality (ODEQ) are working cooperatively to study and correct possible environmental damage that may have occurred from the Corps' use of the landfill and other industrial areas on Bradford Island. During the next two years, the Corps and ODEQ will take steps to reverse the unintended consequences of past actions. This project is only one step leading toward an answer to the question of whether PCBs are specific to the dam operations and landfill, or systematic (from an upriver source), or both. The quality assurance and quality control measures necessary to insure that the results obtained are of the type and quality needed are described in this QAPP.

Project Organization

The Corps has established an organizational structure to provide overall technical and administrative control of this project. This organizational structure assures that project-specific objectives are defined and achieved through the utilization of quality assurance system with appropriate quality control activities. The quality assurance system provides a means of supporting the decisions necessary to resolve the principle study questions. The following individuals have been assigned responsibility for the management, design, and implementation and quality of the Bonneville Forebay Project.

Portland District

Mark Dasso – Project Manager

Responsibilities: The Project Manager reports to the Commander and is responsible for administrative and technical aspects of the project. The PM determines the technical, schedule and quality requirements of the project and assures that these requirements are met. The PM maintains the administrative and technical interface with the stakeholders in order to resolve questions regarding technical and quality performance.

Qualifications: Mark Dasso is a civil engineer with 20 years experience, 3 in project management. He has worked in various functional areas within the Corps (construction, engineering, operations and project management) as well as in the private sector and with other Government agencies (FEMA, BPA). He has performed various scheduling, bidding, billing, project management and client interface activities for the Portland District. Mark has completed various leadership, supervisory and technical training courses

Paul Huebschman – Technical Manager

Responsibilities: Technical lead for all work related to the Bradford Island Landfill

Qualifications: Engineering Geologist, with 20 years experience in hazardous and toxic waste work.

Tim Sherman – Sediment Quality Specialist

Responsibilities: The Sediment Quality Specialist coordinates planning, collection and evaluation of sediment sampling events.

Qualifications: Tim Sherman is a biologist with 5 years experience in sediment quality, evaluation of dredge material, and 25 years experience in chemistry and biology:

Allison Schaub – Field Sampler

Responsibilities: The responsibilities of the Field Sampler are to assist the Sediment Quality Specialist in collecting the samples. The Field Sampler will record the field notes describing the sample, conditions and any deviation from the approved sampling plan.

Qualifications: Allison Schaub is a Civil Engineer in an Engineer-in-Training rotational position. She has sampled at Cougar Reservoir for the Temperature Control Project and several coastal projects.

Chip Pierson – Site Health and Safety Officer

Responsibilities: The Site Health and Safety officer manages the site Health and Safety and Accident Prevention Program. The Safety Officer will be a point of contact on matters of job safety and will be responsible for ensuring the health and safety of on-site personnel. The Site Safety Officer reports to the Project Manager.

Qualifications: Mr. Pierson has over 25 years experience in General Safety and 3 years experience in the various remedial construction activities including civil, remedial, demolition, and environmental projects. He has written numerous site-specific health and safety policies and procedures and has a working knowledge of USACE's QC documentation system. Chip has completed 24 -hour Construction Safety and is certified by the American Red Cross as a first aid/CPR/AED provider.

Seattle District

John Wakeman – Senior Scientist

Responsibilities: Mr. Wakeman prepared the Data Quality Objectives Memorandum associated with this Sampling and Analysis Plan. He serves as Independent Technical Reviewer for work products that are generated by Seattle District in the furtherance of this investigation.

Qualifications: Mr. Wakeman is a senior environmental scientist in Environmental Engineering and Technology Section in Engineering/Construction Division at Seattle District, and has performed the roles of chemist, risk assessor, and sediment specialist in the District for over 20 years. Mr. Wakeman has planned and prepared numerous DQO documents and Sampling and Analysis Plans. He is also a reviewer of the Bradford Island work products generated by URSG, particularly in the risk assessment and regulatory arenas

Sandy Lemlich – Project Chemist

Responsibilities: Ms Lemlich will be reviewing plans and reports associated with this investigation with particular emphasis on sampling and chemistry.

Qualifications: Ms. Lemlich is a chemist/environmental scientist with over 20 years of experience in water quality, sediment chemistry and evaluations in both the Corps dredging program and HTRW program. She is also a reviewer of the Bradford Island work products generated by URSG, particularly in the sampling, chemistry, and regulatory areas.

Problem definition and background

Problem Definition

In March 2002, the Corps removed all known electrical components containing PCB, lead and mercury from the bottom of the Columbia River near Bradford Island. It is known that sediments and aquatic invertebrates downstream and around Bradford Island contain PCBs ([Corps, 2002](#)) The principle study question that this sampling event is designed to answer is...

“What are the concentrations of PCBs, lead and mercury in fines within the Bonneville Pool and above the upstream eddy efferct?”

Informational inputs required to address this question include:

- Sediment chemical analysis (PCBs, pesticides, mercury, lead, TOC concentration)
- Sediment conventional (grain size, total solids)

Upper confidence and upper tolerance limits on mean concentrations of contaminants will be compared to sediment and debris concentrations below Bonneville Dam and above Bonneville the Dam Pool.

The overall goals for the Corps’ testing (which goes beyond the current investigation) are to permit a selection (with Oregon DEQ) among three alternatives:

- Alternative 1 - Bonneville Pool is a currently the significant contributor of PCB to exposure of organisms in the Columbia River;
- Alternative 2 - Sediment load from upstream of the Pool is a more significant contributor to exposure compared to Bonneville Pool and Bradford Island; or
- Alternative 3 - Some other source, such as water-borne sediments in the river and sediment load may be a more significant contributor to exposure at this time.

Background

Dredging Projects

In 1991 informational sampling and analysis was done on sediment downstream from the First Powerhouse Navigational Lock, on the south side of the river, with results acceptable for unconfined in-water or upland disposal. This same downstream area was dredged in 1986 and in the late 1970s.

In July 1997 seven sediment samples were collected from Bonneville Second Powerhouse forebay and water supply conduits. Two of the samples were taken from the downstream portion of the south Auxiliary Water Supply (AWS) conduit by divers inspecting the inside of the south AWS. Three additional samples were taken from the surface of the sediment deposits at the north end of the forebay. The final two samples were collected from the sediment and woody debris removed from the north AWS intake trash rack by clamshell and stockpiled on Cascade Island, at the south end of the Elevation 90 Deck crane way extension. Physical analysis, run on four sediments, indicated the material ranges from gavel to very fine sand, with largest fractions in the coarse to medium sand range. Chemical analysis, run on five sediments, included metals,

pesticides/polychlorobiphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), total organic carbon (TOC), acid volatile sulfide (AVS), phenols and dioxin screen (SW-4425). The portion of the sample submitted to the lab was representative of the material dredged, except for the woody debris. Results determined the material to be acceptable for unconfined in-water or upland disposal.

On December 18, 2001 a total of three (3) sediment samples were collected from a shoal at the adult fish ladder discharge (water intake) on the south bank of Bradford Island. All samples were analyzed for total volatile solids, metals, total organic carbon, pesticides and polychlorinated biphenyls, phenols, phthalates, miscellaneous extractables, polynuclear aromatic hydrocarbons and organotin. None of the laboratory data results exceeded their respective screening levels in the DMEF. All sediment was determined to be suitable for unconfined, in-water placement; however, the 1577 CY of material dredged was, as a management option, barged to RABANCO's company Regional Disposal facility in Roosevelt Washington.

On January 14 & 15, 2002 thirteen (13) sediment samples (includes 1 field dup.) from four (4) stations were collected at potential log boom anchor point locations. Sediments were tested for lead, mercury, PCBs, hydrocarbons, TOC and grain size. One (1) sample analysis detected mercury slightly over the 0.41 mg/kg DMEF screening level (SL) at 0.419mg/kg. The field duplicate indicated motor oil at a 195mg/kg level, which exceeds the ODEQ Numeric Soil Cleanup standards (Soil Matrix) of 100 mg/kg. The analysis of the primary sample, associated with the field duplicate analyses above, indicated motor oil at 43.6 mg/kg, which is considerable less than the duplicate sample and well below ODEQ standard. The material represented by this sampling event is to be side-cast to construct the proposed anchor structures. The volume of sediment to be side-cast for the project was estimated be less than 100 CY, which is a sufficiently small volume to be considered as having little or no environmental impact at the chemical levels reported.

Study Projects

In 1991 in a Minimum Operating Pool (MOP) study at Bonneville, which included twelve (12) sites, Cascade Lock RM 149.2, Rock Creek RM 150.0, Herman Creek RM 150.9, Wind River Boat Ramp/Mouth RM 154.8, Home Valley RM 154.8, Port of Hood River RM 169.0, SD&S Lumber, RM 170.6, Bingen Boat Basin & Marina RM 171.7, Mayer State Park RM 181.0 was conducted. All sites were analyzed for metals, PAHs, pest/PCBs, TOC and AVS, with select sites adding phenols, dioxins/furans and TBT. None of the test sediments exceeded current Dredge Material Evaluation Framework (DMEF) screening guidelines for open water disposal (no PCBs were detected at the method reporting limit (MRL) of 0.04 mg/kg).

In December 2000 and May 2001 sediment and biological tissue samples were collected and analyzed from an area at the Northeast end of Bradford Island, which contained discarded electrical components discovered in the near shore area. Levels of PCB Aroclor 1254 were detected in clam tissue at 3.8 mg/kg, in crayfish at 75.6 mg/kg and in sediment at 8.3 mg/kg. The investigation and cleanup of this former dumpsite is still in progress; discarded electrical components from the in-water areas have been removed. Further sediment testing will take place in the near future.

In Aug 2001, one (1) surface grab sample and eight (8) in-water subsurface (borings), within the proposed plunge pool, consisted of overburden materials and bedrock. In addition to the in-water samples, 41 upland sites (borings and test pits) were also collected from the proposed upland construction site downstream of the Second Powerhouse and contain similar material. The overburden consists of fill (500 CY of riprap), alluvium, slide debris material and a poorly

graded alluvial material referred to as “crystal sands” (poorly graded micaceous silty sand to sand). All the samples recovered from the drillings and surface sample is considered native material derived primarily from historical and prehistorical slides in the area. The bedrock unit consists of the sedimentary Weigle Formation. The samples collected from the in-water area at the site of the proposed plunge pool dredging indicate the majority of the material to be disposed of consists of 80% gravel, 18% sand with fines representing <2% of total material with an estimate of <1% volatile solids.

project description

This sampling event is designed to collect a statistically significant number of fine-grained sediment samples for evaluation of the baseline concentrations of PCBs, Pb & Hg, in the Bonneville Forebay and upstream areas. This characterization will exclude the area identified as within or adjacent to the former Bradford Island Dump Site. All areas associated with the remedial action of the former dumpsite at Bradford Island will be sampled under a different SAP following CERCLA guidance. The purpose of this sampling plan is to gather additional baseline information on sediments and biota. No samples are planned for areas where recent data has been collected (< 5 years old - see figure 1).

Synoptic samples of *Corbicula* spp. (a freshwater clam) will also be collected and archived as whole, frozen samples for possible later analysis. Although not part of this data collection effort, tissue hypotheses are developed in the DQO Memorandum (Attachment 1), in order to guide the scooping of future Bradford Island related investigation. The analysis of the clam tissue data will be determined after review of the sediment information as described in this memorandum.

quality objectives and criteria

This section describes the quality of data and information necessary to answer the principle study question, resolve the problem and support the decisions among alternatives. The decision quality is based on data quality as measures by performance criteria, acceptance criteria or data quality objectives. Performance criteria apply to information that is collected for the project, new data, while acceptance criteria apply to the adequacy of existing information included in the decision process. Quantitative and qualitative evaluation of data quality assessed in terms of data quality indicators (DQIs) as discussed below.

Data Quality Indicators

The key indicators of data quality are precision, bias, accuracy, representativeness, comparability, completeness, and sensitivity. These DQIs are defined below as well as methods for their determination. Acceptance and performance criteria for DQI are listed in Method Quality Objectives Tables 1-1 to 1-3.

Precision

Precision is defined as the degree of agreement between or among independent, similar, or repeated measures. Precision is expressed in terms of analytical variability. For this investigation, analytical variability will be measured as the RPD or coefficient of variation between analytical laboratory duplicates and between the MS and MSD analyses. Monitoring variability will be measured by analysis of blind field duplicate samples.

Precision will be calculated as the RPD as follows:

$$RPD (\%) = 100 \times \frac{|S - D|}{(S + D) / 2}$$

where:

S = Analyte concentration in a sample

D = Analyte concentration in a duplicate sample

The resultant RPD will be compared to criteria established by this QAPP, and deviations from these criteria will be reported. If the QAPP criteria are not met, the laboratory will supply a justification of why the limits were exceeded and implement the appropriate corrective actions. The RPD will be evaluated during data review and validation. The data reviewer will note deviations from the specified limits and will comment on the effect of the deviations on reported data.

Accuracy

Accuracy is the amount of agreement between a measured value and the true value. It will be measured as the percent recoveries of MS and MSD, organic surrogate compounds, and the LCS. Additional potential bias will be quantitated by the analysis of calibration standards and blank samples (e.g., method and equipment rinsate blanks).

In cases where accuracy is determined from spiked samples, accuracy will be expressed as the percent recovery. The closer these values are to 100, the more accurate the data. Surrogate recovery will be calculated as follows:

$$\text{Recovery (\%)} = \frac{MC}{SC} \times 100$$

where:

SC = Spiked concentration

MC = Measured concentration

Matrix spike percent recovery will be calculated as follows:

$$\text{Recovery (\%)} = \frac{MC - USC}{SC} \times 100$$

where:

SC = Spiked concentration

MC = Measured concentration

USC = Unspiked sample concentration

The resultant percent recoveries will be compared to criteria established by this QAPP, and deviations from these criteria will be reported. If the objective criteria are not met, the laboratory will supply a justification of why the limits were exceeded and implement the appropriate corrective actions. Percent recoveries will be evaluated during data review and validation and the data reviewer will comment on the effect of the deviations on the reported data.

Representativeness

Representativeness is the degree to which sample results represent the system under study. This component is generally considered during the design phase of a program. This program will use the results of all analyses to evaluate the data in terms of its intended use. Site sampling locations for this investigation are placed using a biased approach to maximize the likelihood of locating and identifying site contamination, if present. Areas of apparent contamination have been selected to be representative of potential impacts from past activities. Representativeness will also be determined by evaluating hold time, sample preservation, and blank contamination. Samples with expired hold times, improper preservation, or contamination may not be representative.

Comparability

Comparability is the degree to which data from one study can be compared with data from historical studies at the site, other similar studies, reference values (such as background), reference materials, and screening values. This goal will be achieved through using standard techniques to collect samples, EPA-approved methods to analyze samples, and consistent units to report analytical results. Data comparability also depends on data quality. Data of unknown quality cannot be compared.

Completeness

The basis for evaluation of the analytical data will be the MRL requirements listed in Appendix A, the DQI contained in Appendix B, and guidelines established by the CLP (EPA 1994, 1998, 2001) as applied to the methods used. Quality data are data that fulfill the DQO requirements established in these documents. Completeness for quality data (percentage of quality data out of the total data set generated) for the Moorings investigation will be ³ 95 percent. Data will be rejected if these criteria are not met and no documented corrective actions have been taken. Rejected data are not usable.

The amount of sample collected will be sufficient to reanalyze the sample, should the initial results not meet QC requirements. Because the number of sample aliquots that will be collected to measure each parameter exceeds that required for the analysis, thus allowing for reanalysis, 100 percent completeness is anticipated. Less than 100 percent completeness could result if sufficient chemical contamination exists to require sample dilutions, resulting in an increase in the investigation-required detection/quantitation limits for some parameters. Highly contaminated environments can also be sufficiently heterogeneous to prevent the achievement of specified precision and accuracy criteria. If corrective actions recommended in the QAPP (Appendix B) have been utilized but QC criteria can not be met, the data are still usable and the laboratory will flag the data and provide written documentation of the corrective actions taken. Overall investigation completeness will be 98 percent for usable data (defined as the percentage of useable data compared to the total data set generated).

Completeness will be calculated as follows:

$$Completeness (\%) = \frac{V}{P} \times 100$$

where:

V = Number of valid measurements

P = Number of planned measurements

Valid and nonvalid data (i.e., data qualified as “R” rejected) will be identified during data review and validation ([Section 10.2](#)). The completeness goal for this project has been established at 90% overall. However, the completeness goal for hold times is 100%.

Sensitivity

Sensitivity will be determined by reviewing PQLs (see Table 1-2). The sensitivity of some of the analytical methods identified for this investigation is insufficient to allow comparison of all the target analytes to the anticipated screening criteria

The laboratory will be directed to report compounds detected and positively identified below the PQL and above the MDL as estimated (J flag). These estimated compound concentrations will be used, in addition to the fully quantitated concentrations, for comparison to screening criteria.

special training and certification

USACE Project Staff

No special training requirements or certifications are required for this project except for the 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) class and annual refreshers. Health and safety procedures for USACE personnel and subcontractors are addressed in the site-specific health and safety plan. Copies of this document are maintained in the Corps District Offices and at the project site.

Analytical Laboratories

Primary Laboratory

The analytical laboratory selected for this project is Severn Trent Laboratory (STL). STL is a USACE validated laboratory located in Tacoma, WA. The laboratory validation (see Attachment 2) letter indicates that the Tacoma facility is currently approved to perform all analyses specified for this work.

Quality Assurance Laboratory

Quality assurance analyses will be provided by North Creek Analytical, Inc. in Bothell Washington. North Creek is validated by the USACE for analysis of PCB (EPA Method SW 8082) and metals (EPA Methods SW 7470/7471, 6020). The laboratories validation letter can be found in [Attachment 2](#).

Documentation and Records

The documentation requirements applicable to this project are described below. All documentation relevant to this project will managed by the USACE PM pursuant to Army Regulation 25-400-2, the Modern Army Recordkeeping System. Project records are defined as follows:

"...all books, papers, maps, photographs, machine readable materials, or other documentary materials, regardless of physical form or characteristics, made or received by an agency of the United States Government under Federal law or in connection with the transaction of public business and preserved or appropriate for preservation by that agency or its legitimate successor as evidence of the organization, functions, policies, decisions, procedures, operations, or other activities of the Government or because of the informational value of data in them. Library and museum material made or acquired and preserved solely for reference or exhibition purposes, extra copies of documents preserved only for convenience of reference, and stocks of publications and of processed documents are not included."

Federal Records Act, 44 U.S.C. 3301

Project Report

Following the completion of fieldwork and the receipt of analytical data, a report summarizing project findings will be prepared. Data will be presented according to location in tabular format using MS Excel compatible software. The project report will also address data usability, variances from stated plans and objectives, any corrective action taken, and lessons learned.

Field Logbooks

Permanently bound, sequentially paginated field logbooks shall be used to document all phases of fieldwork.. All logbook entries shall be factual, detailed and objective. Recordable information may include the following items:

- General observations
- Equipment identification
- Field calculations
- Weather conditions
- Names and organizational affiliations of site visitors
- Notes from field meetings
- Details of telephone /radio conversations
- Maps or sketches, which should include compass direction and locations based on Columbia River Datum (see the Field Sampling Plan)
- Sample identification numbers, collection time, volume, sampler name, chain-of-custody numbers

- Log of photographs taken including the photographers name, subject matter, sample identification number and other pertinent information

Field logbooks will be maintained as part of the project record.

Photographic Records

Photographic records of samples shall be taken as needed to document sediment conditions. Photographic records may be acquired using 35 mm and/or digital cameras. The original printed and electronic images will be maintained in the project records.

Laboratory Data

To ensure that project chemical data assessment can be performed in a manner sufficient to meet qualitative and quantitative objectives, 90% of data deliverable shall be formatted as comprehensive certificates of analyses. The remaining 10% shall be formatted as raw data packages. Requirements for each deliverable type are described below.

Format for the Comprehensive Certificates of Analysis

A. The "Cooler Receipt Form shall be completed by the Contract Laboratory documenting sample conditions on arrival at the laboratory. Original copies of cooler receipt forms as well as original copies of chain of custody forms shall be provided with certificates of analysis.

B. For each analytical method the Contract Laboratory shall report all analytes as a detected concentration or as less than the PQL. All samples with out of control spike recoveries being attributed to matrix interference will be designated as such. All soil samples will be reported on a dry weight basis with the percent moisture reported for each sample. Dilution factors, date of extraction, date of analysis, and practical quantitation limits shall be reported for each analyte and method.

C. Reports of method blanks shall include all analytes for each analytical method. Analytical results for each sample shall be clearly associated with a particular method blank. Any detected concentration found in method blanks shall be reported. Reports of concentrations below the PQL are necessary to evaluate low level determinations of target compounds in samples.

D. Surrogate spike recoveries shall be reported for all applicable methods. The report shall also specify the control limits for surrogate recoveries. Any out-of-control recoveries shall result in the sample being rerun once. If subsequent analyses result in out of control recoveries both results shall be reported and the data flagged.

E. MS/MSD recoveries shall be reported for all analyses. All sample results shall be designated as corresponding to a particular set of MS/MSD analyses. MS/MSD analyses not meeting quality control criteria specified in the QAPP shall be rerun once. If subsequent analyses result in out of control recoveries both results shall be reported and the data flagged. Only samples from this project shall be used for MS/MSD analyses. (The Contract Laboratory shall not use samples from other projects for MS/MSD analyses.) The report shall also specify control limits for spike recoveries and RPD for each spiked analyte.

F. Results for laboratory duplicates shall be reported with RPD limits for duplicate analyses.

G. LCS results shall be reported with control limits for LCS analyses. Analytical results for each sample shall be clearly associated with a particular LCS sample.

H. Results of initial and continuing calibration analyses for all analyses shall be included in the data package. Continuing calibration results shall be organized such that sample results shall be clearly correlated with the calibration check samples that bracket the sample results. Injection records for all sample analyses shall be included with the calibration data. Summaries of calibration data should be provided as a CLP Form VI and VII or equivalent for organic analyses and Form II modified for SW-846 analyses for inorganic analyses. (Note: Copied pages of

handwritten laboratory notebooks will be unacceptable to fulfill the requirements of these specifications.)

I. The Contract Laboratory shall prepare a summary of all samples with detected concentrations of target compounds indexed by method and by sample ID.

J. The Contract Laboratory shall prepare a summary of all surrogate recoveries for organic analyses for each applicable method with the acceptable recovery range clearly indicated. This summary shall be performed for all samples for each analytical method involving surrogate spikes.

K. The Contract Laboratory shall prepare a summary of all Matrix Spike/Matrix Spike Duplicate analyses for each applicable method indicating acceptable recovery ranges and QC acceptance criteria for RPD.

L. The Contract Laboratory shall prepare a summary of all laboratory and field duplicates with QC acceptance criteria for RPD clearly indicated.

M. The comprehensive certificate of analysis shall contain a narrative section identifying samples not meeting quality control criteria and any other out of control condition. The narrative shall describe the corrective action taken. If "matrix effects" are invoked as a cause for out of control recoveries a subsection of the narrative shall present a detailed justification for this assertion to include a summary of all relevant quality control data.

N. Chromatographs for all fuels analyses (detects and non-detects) presented at an attenuation where features of the chromatography are clearly visible shall be submitted for all projects involving fuels analyses by gas chromatography. Chromatographs of standards used for identification of fuels must also be included in the data package.

O. All data for analyses during the period covered by the comprehensive certificate of analysis shall be included as an appendix to the comprehensive report. This data shall be presented on numbered pages with an index or table of contents describing the contents of the appendix.

Raw Data Packages

Raw data packages shall be submitted to USACE for 10% of all samples analyzed by the Contract Laboratory. The Portland District shall select samples for raw data packages to include all analyses and matrices, to provide temporal representation, to provide data in particular areas of interest, and to provide data at periods of maximum loading of the Contract Laboratory. The Contractor should notify the USACE CO of the samples that have been selected for submittal as raw data packages and the CO will have the option of directing the Contractor to select specific samples (other than those proposed by the Contractor) for reporting in this manner. The Contract Laboratory shall not be notified of the samples for which raw data packages will be required until after the analytical process has been initiated. Raw data packages shall be delivered in place of the Comprehensive Certificate of Analysis. Raw data packages shall be delivered to the CO within 28 days of the time of sample acquisition in the field.

A. Organic Analyses

The raw data package for organic analyses shall consist of a case narrative, chain-of-custody documentation, summary of results for environmental samples, summary of QA/QC results, and the raw data. Detailed descriptions of the requirements for each component of an organic raw data package are provided in the following sections.

1. Case Narrative. The case narrative shall be written on laboratory letterhead and the laboratory manager or his/her designee shall authorize the release of data. Items to be included in the case narrative are the field sample ID with the corresponding laboratory ID, parameters analyzed for in each sample and the methodology used (EPA method

- numbers or other citation), a statement on the status of samples analyzed with respect to holding times (met or exceeded), detailed description of all problems encountered, discussion of possible reasons for out of control QA/QC criteria, and observations regarding any occurrences which may effect sample integrity or data quality.
2. Chain-of-Custody Documentation. Legible copies of Chain-of-Custody forms for each sample shall be maintained in the data package. Cooler login sheets shall be associated with the corresponding Chain-of-Custody form. Any internal laboratory-tracking document shall be included.
 3. Summary of Environmental Results. For each environmental sample analysis this summary should include field ID and corresponding laboratory ID, sample matrix, date of sample extraction (if applicable), date and time of analysis, identification of the instrument used for analysis, GC column and detector specifications (if applicable), weight or volume of sample used for analysis/extraction, dilution or concentration factor used for the sample extract, percentage of moisture in the sample, method detection limit or sample quantitation limit, definitions of any data qualifiers used, and analytical results.
 4. Summary of QA/QC Results. The following QA/QC results shall be presented in summary form. Details specified in “Organic Analysis” shall also be included for the summary of QA/QC results. Acceptance limits for all categories of QC criteria shall be provided with the data. All summaries will be presented on standard forms. Use of CLP standard forms is not necessary, however submission of standard instrument output alone is unacceptable to satisfy the requirements for raw data packages.
 - a. *Initial Calibration:* The concentrations of the standards used for analysis and the date and time of analysis. The response factor, percent relative standard deviation (%RSD), and retention time for each compound (as applicable, GC and GC/MS analyses) shall be included in initial calibration summaries. A statement should also be made regarding the samples or dates for which a single initial calibration applies.
 - b. *Daily Calibration and Mid-level Standard:* The concentration of the calibration standard used for daily calibration and/or the mid-level calibration check shall be reported. The response factor, percent difference, and retention time for each compound shall be reported (GC and GC/MS). Daily calibration information shall be linked to sample analyses by summary or by daily injection or analysis logs. Tuning information for GC/MS shall also be included with the calibration.
 - c. *Method Blank Analyses:* The concentrations of any compounds found in method blanks shall be reported. The environmental samples and QA/QC analyses associated with each method blank shall be stated.
 - d. *Surrogate Standard Recovery:* The name and concentration of each surrogate compound added shall be detailed. The percent recovery of each surrogate compound in the samples, method blanks, matrix spike / matrix spike duplicates and other QA/QC analyses shall be summarized with sample ID's such that the information can be linked to sample and QA/QC analyses.
 - e. *Internal Standard Recovery:* The name and concentration of each internal compound added shall be detailed (retention time and area counts). The percent recovery of each internal compound in the samples, method blanks, matrix spike/matrix spike duplicates and other QA/QC analyses shall be summarized with sample ID's such that the information can be linked to sample and QA/QC analyses.

f. *Precision and Accuracy:* For matrix spike / matrix spike duplicate analyses the sample results, spiked sample results, percent recovery, and RPD with the associated control limits shall be detailed. For laboratory duplicate analyses the RPD between duplicate analyses shall be reported as applicable. For laboratory QC Check and/or LCS analyses the percent recovery and acceptable control limits for each analyte shall be reported. All batch QC information shall be linked to the corresponding sample groups.

g. *Retention Time Windows (GC, GC/MS):* The retention time window for each compound for both primary and confirmation analyses shall be reported. Retention time windows are to be updated daily per EPA SW-846.

h. *Compound Identification (GC, GC/MS):* the retention times and the concentrations of each compound detected in environmental and QA/QC samples shall be reported for both primary and confirmation analyses.

i. *Method Detection Limits:* Results of the most current detection limit study shall be provided in the raw data package.

j. *Injection Record:* Injection logs for all instruments used for analysis of project samples shall be provided indicating the date and time of analysis of project samples and the associated laboratory QA/QC samples (initial calibration, continuing calibration check, method blank, matrix spikes, etc.).

5. Raw Data. Legible copies of all raw data shall be organized systematically on numbered pages. The raw data for compound identification and quantitation must be sufficient to support all results presented in other sections of the raw data package. All raw data will be presented on standard forms and accompanied by the instrument output. Use of CLP standard forms is not necessary, however submission of standard instrument output alone is unacceptable to satisfy the requirements for raw data packages.

a. *GC Analyses:* This section of the data package shall include legible copies of the raw data for environmental samples (arranged in increasing order of field ID, primary and confirmation analyses), instrument calibrations, QA/QC analyses, sample extraction and cleanup logs, instrument analysis logs (injection record) for each instrument used, and GC/MS confirmations if applicable. The raw data for each analysis shall include chromatograms (preferably with target compound, internal standard and surrogate compounds labeled by name) with a quantitation report and/or areas print out.

b. *GC/MS Analyses:* This section of the data package shall include legible copies of the raw data for environmental samples (arranged in increasing order of field ID, spectrometer tuning and mass calibration reports, initial and continuing instrument calibrations, QC analyses, sample extraction logs, and instrument analysis logs (injection record) for each instrument used. The raw data for each analysis shall include chromatograms (preferably with target compound, internal standard, and surrogate compounds labeled by name) and enhanced spectra of target compounds and/or tentatively identified compounds with the associated best-matched spectra. Quantitation reports for all analyses shall be included in the data package.

B. Inorganic Analyses. The raw data package for inorganic analyses shall consist of a case narrative, chain-of-custody documentation, summary of results for environmental samples, summary of QA/QC results, and the raw data. Detailed descriptions of the requirements for each component of an inorganic analyses raw data package are provided in the following sections.

1. Case Narrative. The case narrative shall be written on laboratory letterhead and the laboratory manager or his/her designee shall authorize the release of data. Items to be included in the case narrative are the field sample ID with the corresponding laboratory ID, parameters analyzed for in each sample and the methodology used (EPA method numbers or other citation), a statement on the status of samples analyzed with respect to holding times (met or exceeded), detailed description of all problems encountered, discussion of possible reasons for out of control QA/QC criteria, and observations regarding any occurrences which may effect sample integrity or data quality. The case narrative shall be sufficiently detailed such that the process of analysis can be reconstructed (i.e. if samples are diluted to bring results into the linear dynamic range, or re-extracted for QC failures the course of analysis shall be detailed in the case narrative.)
2. Chain-of-Custody Documentation. Legible copies of Chain-of-Custody forms for each sample shall be maintained in the data package. The date of receipt must be described on the Cooler login sheets shall be associated with the corresponding Chain-of-Custody form. Any internal laboratory-tracking document shall be included.
3. Summary of Environmental Results. For each environmental sample analysis the raw data package should include field identification and corresponding laboratory identification number, sample matrix, date of sample digestion (as applicable), date and time of analysis, identification of the instrument used for analysis, instrument specifications, weight or volume of sample used for analysis/digestion, dilution or concentration factor used for the sample extract, percentage of moisture in the sample, method detection limit or sample quantitation limit, definitions of any data qualifiers used, and analytical results.
4. Summary of QA/QC Results. The following QA/QC results shall be presented in summary form. Details specified in Section 5.10 (Inorganic Analysis) shall also be included for the summary of QA/QC results. All summaries will be presented on standard forms. Use of CLP standard forms is not necessary, however submission of standard instrument output alone is unacceptable to satisfy the requirements for raw data packages.
 - a. *Instrument Calibration:* The order of reporting of calibrations for each analyte must follow the temporal order in which standards were analyzed.
 - b. *Initial Calibration:* The source of the calibration standards, true value concentrations, found concentrations, the percent recovery for each element analyzed, and the date and time of analysis shall be reported.
 - c. *Continuing Calibration Verification:* The source of the calibration standards, true value concentrations, found concentrations, the percent recovery for each element analyzed, and the date and time of analysis shall be reported.
 - d. *Method Blank Analyses:* The concentrations of any analytes found in initial calibration blanks, continuing calibration blank, and in the preparation blank shall be reported. The date and time of analysis shall also be reported.
 - e. *Interference Check Sample:* The source of the interference check sample, true value concentrations, found concentrations, the percent recovery for each element analyzed, and the date and time of analysis shall be reported.
 - f. *Precision and Accuracy - Matrix Spikes and Duplicates:* For matrix spike analyses the sample results, spiked sample results, percent recovery, the spiking solution used, and the control range for each element shall be detailed. For post digestion spikes the concentration of the spiked sample, the sample result, the spiking solution added, percent

recovery and control limits shall be detailed. For laboratory duplicates the original concentration, duplicate concentration, relative percent difference, and control limits shall be detailed. Date and time for all analyses shall be recorded.

g. *Precision and Accuracy - Laboratory Control Samples*: The source of the laboratory control sample, true value concentrations, found concentrations, the percent recovery for each element analyzed, and the date and time of analysis shall be reported.

h. *Method of Standard Additions (MSA)*: This summary must be included when MSA analyses are required. The absorbance values and the corresponding concentration values, the final analyte concentrations, and correlation coefficients shall be reported for all analyses. Date and time of analysis shall be recorded for all analyses.

i. *ICP Serial Dilution*: The initial and serial dilution results with percent difference shall be reported.

j. *ICP Linear Ranges*: For each instrument and wavelength used the date on which the linear range was established, the integration time, and the upper limit concentration shall be reported.

k. *ICP Inter-element Correction Factors*: For each instrument and wavelength used the date on which correction factors were determined shall be detailed. Specific correction factors for Al, Ca, Fe, Mg, and any other element and the analytes to which they are applied shall be detailed.

l. *Instrument Detection Limits*: Results of the most current detection limit study shall be provided in the raw data package.

m. *Analysis Record*: Analysis logs for all instruments used for analysis of project samples shall be provided indicating the date and time of analysis of project samples and the associated laboratory QA/QC samples (initial calibration, continuing calibration check, method blank, matrix spikes, etc.).

5. Raw Data. Legible copies of all raw data shall be organized systematically on numbered pages. The raw data for compound identification and quantitation must be sufficient to support all results presented in other sections of the raw data package. This section of the data package shall include legible copies of the raw data for environmental samples (arranged in increasing order of field ID), instrument calibrations, QA/QC analyses, sample extraction and cleanup logs, instrument analysis logs for each instrument used. Instrument analysis logs are particularly important since they provide the basic link between all sample analyses and QC information. (calibration standards, matrix spike, etc.) Instrument analysis logs for all instruments used for sample analyses for this project shall be provided for all days on which analysis was performed. The raw data for each analysis shall include measurement print outs and quantitation reports for each instrument used. Records of absorbance, titrimetric, or other measurements for wet chemical analysis shall be recorded. All raw data will be presented on standard forms and accompanied by the instrument output. Use of CLP standard forms is not necessary, however submission of standard instrument output alone is unacceptable to satisfy the requirements for raw data packages.

DATA GENERATION AND ACQUISITION

Sampling Process Design (Experimental Design)

The sampling process design for this project incorporates statistically based criteria used to determine the quantity of samples taken and velocity studies to assist in determining the boundaries of upstream eddy effects. In order to determine the usefulness of this design, decision error must be measured and controlled.

Decision errors occurs when the sample data set misleads you into making the wrong decision and, therefore, taking the wrong response action. The possibility of a decision error exists because a decision is based on sample data that are incomplete and never perfect. Sample data are subject to random and systematic errors at different stages of acquisition, from field collection to sample analysis. The combination of all these errors is called "total study error." There can be many contributors to total study error, but there are typically two main components:

- Sampling design error – This error is influenced by the inherent variability of the population over space and time, the sample collection design, and the number of samples. It is usually impractical to measure the entire decision unit, and limited sampling may miss some features of the natural variation of the measurement of interest. Sampling design error occurs when the data collection design does not capture the complete variability within the decision unit to the extent appropriate for the decision of interest. Sampling design error can lead to random error (i.e., variability or imprecision) and systematic error (bias) in estimates of population parameters.
- Measurement error – This error (variability) is influenced by imperfections in the measurement and analysis system. Random and systematic measurement errors are introduced in the measurement process during physical sample collection, sample handling, sample preparation, sample analysis, data reduction, transmission, and storage.

The information presented in the sections below addresses sampling theory and the assessment of sampling error for the Bonneville Pool Project. Measurement error is addressed in Section 2.1.

Sampling Design Theory

Under the assumption that there is no uncertainty in the decision making process, unambiguous “If...then...” statements (theoretical decision rules) have been developed. These rules describe the conditions under which possible alternative actions would be chosen.

Decision Rule 1 - Comparison of Sedimentary Fines Content and Contaminants of Interest

Statistical testing will be used to regress fines content (FC) against contaminant concentration (CC) one at a time. It is expected that this will be a significant regression should fines be holding most of the contamination. This decision being made is to screen for potential significance of contribution of upstream fine sediment load to the site. The associated decision rule is:

IF the relationship of FC (as the independent variable) versus CC (as the dependent variable) is not significantly statistically at $\alpha = 0.9$ level,

THEN the sediment concentrations are not a good representation of Q2 and/or Q1b.

ELSE the sediment concentrations may be a good representation of Q2 and/or Q1b.

Decision Rule 2 - Statistical Comparison of Concentrations of Contaminants of Concern from Bonneville Pool to Data from Bradford Island

Statistical testing (parametric or nonparametric) will be used to derive these values for the current data set. This decision requires data from other sources. When the new Bradford Island data are in hand, it will be possible to do the following test at alpha (Type I Error) = 0.95, beta (Type II Error) = 0.8.

IF the upper Bonneville Pool concentrations are significantly less than the Bradford Island sediment concentrations,

THEN Q3 is likely to be an important source to downstream locations in the river.

ELSE Q3 is not likely to be an important source to downstream locations.

HOWEVER, should Decision Rule 1 shows a poor relationship of fines and contamination (the *THEN* statement of Decision Rule 1), this will likely result in qualifying Decision Rule 2.

Decision Rule 3 - Comparison to Regulatory Risk Based Numbers

It is not the explicit intention to create a risk assessment in this activity. However, the data should be for comparable against suitable regulatory screening values such as the DEQ Ecological Risk Assessment Level II Values. These follow: Pb, 35 mg/kg; Hg, 0.2 mg/kg; total PCB, 34 µg/kg; Aroclor 1248, 21 µg/kg. Two comparisons are possible: simple and statistical (alpha ≤ 0.05; beta ≥ 0.08).

IF the observed values (simple or statistical) are greater than the Level II Values,

THEN either the individual station (simple comparison) or the population of stations (statistical comparison) could have adverse ecological effects on the benthic community. (This would warrant more investigation, but it is not clear at this stage who would do it.)

ELSE either the individual station (simple comparison) or the population of stations (statistical comparison) likely does not have adverse ecological effects on the benthic community.

Decision Rule 4: Theoretical Bioaccumulation Potential (This Study)

For this round of testing, a TBP value will be estimated using existing *Corbicula* lipid data and the sediment concentrations. The following describes the TBP procedure.

Theoretical bioaccumulation potential (TBP) is calculated relative to the biota sediment accumulation factor (BSAF) as follows:

$$\text{TBP} = \text{BSAF} (C_s / \% \text{TOC}) \% \text{L}$$

(McFarland and Clarke,

1987)

where TBP is expressed on a whole-body wet-weight basis in the same units of concentration as C_s , and...

- C_s = concentration of nonpolar organic chemical in the river or depositional area sediment (any units of concentration may be used);

- BSAF=4 (Ankley et al., 1992)
- %TOC=total organic carbon content of the dredged material or reference sediment expressed as a decimal fraction (i.e., 2% = 0.02); and
- %L =organism lipid content expressed as a decimal fraction (i.e., 3% = 0.03) of whole-body wet weight.

The TBP estimate will be compared to risk-based tissue concentrations of concern for sensitive populations of fisherpersons, using the most current risk assessment information available. (This value is not currently in hand, and will be developed by coordination with stakeholders and regulatory agencies during the evaluation phase.)

IF the TBP estimate is above half the risk-based level,

THEN the sediments in the upper portion of the Bonneville Pool may be contributing significantly to the tissue burden of the fish.

ELSE, the sediments are not contributing significantly to the tissue burden of the fish.

Decision Rule 5 - Empirical Sediment Bioaccumulation Factor (BSAF) Derivation (Future Study)

If warranted by the TBP calculations, *Corbicula* tissue data will be analyzed to assist in determining a BSAF.

Comparison of the empirical BSAF to TBP is the decision of interest. Overprediction or an underprediction of BSAF by TBP may occur, as follows.

IF empirical BSAF is less than half the TBP,

THEN this is expected based on what is known of the TBP equation. Use of the factor of 4 should somewhat overestimate the bioaccumulation potential. Dr. Victor McFarland (personal communication) has stated that the factor of 4 from the Inland Water Testing Manual should be around 2, based on his research.

ELSE an under-predicted BSAF based upon sediment indicates that the suspended particulate fraction (which is not being measured in this investigation) may be a more important factor than the sediment concentration for filter-feeding organisms such as *Corbicula*. (Prior Bradford Island information from near Goose Island using bulk sediment tended to under-predict bioaccumulation.)

Should it occur that PCBs are considerably higher in the clam than suggested by the sediment concentrations, further investigation will be necessary to determine the source of the additional PCB to the clam population. In that event, a future investigation (beyond current scope) should look at the additional contribution of suspended particulates, Q1a with reference to Figure 1.

Underpredicted BSAF based upon sediment alone will suggest that the suspended particulate fraction (which is not being measured in this investigation) may be a more important factor than the sediment concentration for filter-feeding organisms such as *Corbicula*. (Prior Bradford Island information from near Goose Island using bulk sediment tended to underpredict

bioaccumulation.) Should it occur that PCBs are considerably higher in the clam than suggested by the sediment concentrations, further investigation will be necessary to determine the source of the additional PCB to the clam population. In that event, a future investigation (well beyond the current scope) should look at the additional contribution of suspended particulates, or Q1a with reference to Figure 1.

Decision Errors

Tolerable limits on decision errors are used to establish performance goals for the data collection design. The following is a somewhat judgmental approach for estimating the required numbers of samples. After receiving the data, it should be possible to revisit the assumptions to determine whether they are accurate.

Decision Errors for Comparison of Contaminant Content to (Future) Population of Bradford Island Area Samples

The probabilities of making decision errors with sample data can be quantified through the use of a statistical decision procedure known as hypothesis testing. When hypothesis testing is applied to decision-making, the sample data are used to choose between a baseline condition of the environment and an alternative condition. The test can then be used to show either that there is insufficient evidence to indicate that the baseline condition is false (and therefore you accept the default that the baseline condition is presumed to be true), or that the baseline condition is probably false (and therefore the alternative condition is probably true). The burden of proof is placed on rejecting the baseline condition. This approach is taken because the test-of-hypothesis structure maintains the baseline condition as being true until overwhelming evidence is presented to indicate that the baseline condition is not true.

For this project, the null hypothesis for testing PCB content is...

”The critical difference of the means of the two areas (main channel and depositional area) is greater than 1.”

The following information was utilized in order to develop a strategy for collecting sufficient background samples for cogent comparison to samples taken within the theoretical influence of Bradford Island.

Assumptions.

- Type I Error Rate (false negative) is set to 5%.
- Type 2 Error Rate (false positive) is set to 20%.
- The Relative Standard Deviation (RSD) is assumed to be 0.4. (This is estimated for a broad area with no point sources. The RSD for a censored data set from Bradford Island in the vicinity but away from the electrical equipment was 1.19, and that was expected sediments near a source. At areas in Elliott Bay, Puget Sound, away from industry the bulk sediment RSD is around 0.4, or 40%).
- The width of the “Gray Zone” is set by consensus to 0.3. (The gray zone is the same as Minimum Detectable Difference.)

Visual Sample Plan (Pacific Northwest Laboratory, 2002) estimated that 16 samples are required for this evaluation at the stated Minimum Detectable Difference. Twenty-four samples have been selected to accommodate a 92% minimum completeness. (NOTE: Decision error strategies for TBP predictions versus Corbicula BSAF will be generated in future investigations.)

Sampling Methods

Sampling methodology is addressed in the Field Sampling Plan (FSP) and includes information on the following topics:

- Description of sample/data collection procedures
- List of equipment needed

- Identification of performance requirements
- Description of corrective actions
- Sampling Equipment Decontamination
- Investigation-Derived Wastes

Sample Handling and Custody Requirements

Sample handling and custody requirements are addressed in the Field Sampling Plan (FSP) and include information on the following topics:

- Sample labeling
- Sample numbering
- Preservation and Container Requirements
- Shipment
- Chain-of-custody
- Sample disposal

Analytical Methods Requirements

Analysis of sediment samples collected during the field event will be performed by Severn Trent Laboratory in Tacoma, WA. The instrument, preparatory and cleanup methods are described below and shall be performed in accordance with the USACE Shell for Analytical Chemistry Requirements found in Appendix I of EM 200-1-3 (Requirements for the Preparation of Sampling and Analysis Plans, Feb 2001). A list of target analytes can be found in Table 2-1.

Instrument Methods & Particle Size Determination

EPA SW 8082 – PCB and PCB Congeners

This method utilizes gas chromatography with an electron capture detector to identify and quantitate PCBs and PCB congeners. These target analytes produce chromatograms with single and multiple peaks in recognizable patterns. Identification is based on the comparison of resulting chromatograms with those of standards. Quantitation is performed by comparing the response of a sample peak to that of a standard in the initial calibration.

Water samples are extracted at a neutral pH with methylene chloride by EPA SW 3510C or 3520C. EPA SW 3510C is a separatory funnel method extraction technique and EPA SW 3520 is a continuous liquid-liquid extraction. Soil samples are extracted with methylene chloride and acetone using EPA SW3550, a sonication extraction procedure. Extracts are solvent exchanged into hexane and undergo cleanup procedures as deemed necessary for the sample.

PCBs will be calibrated as Aroclors for this project. The calibration procedures are described in the method. All multipoint bracketing standards must be within ± 15 percent from the expected concentration, as quantitated from the calibration factor determined in the initial calibration (ICAL). Initial calibration, ICV, and CCV criteria must be met on the column used for Quantitation and final reporting of the target analyte. Where a specific PCB Aroclor has not been identified as a target analyte from the site, PCBs will be calibrated using mixed standards containing Aroclors 1016 and 1260, unless otherwise specified. If PCBs are not detected, or if only Aroclors 1016 or 1260 are detected, no additional calibration is required. If other Aroclors are present or appear to be present, calibration will be performed with Aroclors that match sample chromatograms.

Confirmation by a second column or other qualitative technique is required for all detections. Second column confirmation may be performed simultaneously with the analysis as described in the method under dual-column option.

EPA SW 6020 – Inductively Coupled Plasma/Mass Spectroscopy

Inductively coupled plasma/mass spectroscopy determines elements in solution. All matrices including groundwater, surface water, aqueous samples, industrial wastes, solids, sludges, and sediments require digestion by EPA SW 3010A (water) or 3050B (soil). Method 6020 provides a simultaneous multi-element determination by ICP/MS. The method measures ions produced by radio frequency ICP. Analytes are nebulized from the sample and the resulting aerosol is transported by argon gas to the plasma torch. The ions are entrained in the plasma gas and introduced by means of a water-cooled interface, into a quadrupole mass spectrometer. The ions are sorted according to their mass-to-charge ratios and quantified by a channel multiplier. Interference must be assessed and valid corrections applied or the data flagged to indicate nonconformance. Interference correction must include compensation for background ions contributed by plasma gas, reagents, and constituents of the sample matrix.

EPA SW 7470/7471 – Mercury by Cold-Vapor Atomic Absorption

Mercury will be determined in selected solid samples using Method 7471A and in water samples by 7470A. These are cold-vapor atomic absorption procedures for determining the concentration of mercury in extracts, groundwater, and waste samples. Sample preparation is specified in the method. Following dissolution, mercury in the sample is reduced to the elemental state, aerated from solution, and the vapor passes through a cell positioned in the light path of an atomic absorption spectrometer. Permanganate is added to the sample during preparation to reduce interferences from sulfides and chlorides.

EPA 9060 – Total Organic Carbon

Method 9060 is used to determine the concentration of organic carbon in ground water, surface and saline waters, and domestic and industrial wastes. The ultraviolet (UV) promoted oxidation technique determines non-purgable organic carbon. An aliquot of sample is decanted into vials to minimize particulate interference when injected into a reaction vessel containing 2 percent potassium persulfate and a UV lamp to promote oxidation. The resulting carbon dioxide is measured on an infrared detector and the peak is integrated by the instrument.

ASTM D 2487 – Standard Practice for the Classification of Soils for Engineering Purposes (Unified Soil Classification System)

This practice describes a system for classifying mineral and organo-mineral soils for engineering purposes based on laboratory determination of particle-size characteristics, liquid limit, and plasticity index and shall be used when precise classification is required. This classification system identifies three major soil divisions: coarse-grained soils, fine-grained soils, and highly organic soils. These three divisions are further subdivided into a total of 15 basic soil groups. Based on the results of visual observations and prescribed laboratory tests, a soil is catalogued according to the basic soil groups, assigned a group symbol(s) and name, and thereby classified. The flow charts for fine-grained soils and coarse-grained soils can be used to assign the appropriate group symbol(s) and name.

Sample Preparation and Cleanup

EPA SW 3554B – Soxhlet Extraction

This method is utilized for extracting nonvolatile and semivolatile organic compounds from solids such as soils, wastes and sludges. It is applicable to the isolation of water insoluble and slightly water-soluble organics for further analysis by gas chromatography. The solids sample is

mixed with anhydrous sodium sulfate to form a free-flowing powder, placed in an extraction thimble, and extracted using an appropriate solvent in a Soxhlet extractor. The extract is then dried, exchanged (as necessary) into a solvent compatible with the determinative method, and concentrated to the appropriate volume.

EPA SW 3620 – Florisil Cleanup

Florisil, a registered trade name of U.S. Silica Co., is a magnesium silicate with basic properties. It is used to separate analytes from interfering compounds prior to sample analysis by a chromatographic method. Florisil has been used for the cleanup of pesticide residues and other chlorinated hydrocarbons; the separation of nitrogen compounds from hydrocarbons; the separation of aromatic compounds from aliphatic-aromatic mixtures; and similar applications for use with fats, oils, and waxes. Additionally, Florisil is considered good for separations with steroids, esters, ketones, glycerides, alkaloids, and some carbohydrates.

Florisil cleanup may be accomplished using a glass chromatographic column packed with Florisil or using solid-phase extraction cartridges containing Florisil. This method includes procedures for cleanup of sample extracts containing the following analyte groups: phthalate esters, chlorinated hydrocarbons, nitrosamines, organochlorine pesticides, nitroaromatics, organophosphates, haloethers, organophosphorus pesticides, aniline and aniline derivatives and PCBs.

EPA SW 3630C – Silica Gel Cleanup

Silica gel (silicic acid) is a regenerative adsorbent of silica with weakly acidic properties. It is produced from sodium silicate and sulfuric acid. Silica gel can be used in column chromatography for the separation of analytes from interfering compounds of a different chemical polarity. It may be used activated, after heating to 150 - 160°C, or deactivated with up to 10% water.

This method includes guidance for standard column cleanup of sample extracts containing polynuclear aromatic hydrocarbons, derivatized phenolic compounds, organochlorine pesticides, and PCBs as Aroclors. This method also provides cleanup procedures using solid-phase extraction cartridges for pentafluorobenzyl bromide-derivatized phenols, organochlorine pesticides, and PCBs. This technique also provides the best separation of PCBs from most single component organochlorine pesticides. When only PCBs are to be measured, this method can be used in conjunction with sulfuric acid/permanganate cleanup (Method 3665). Other analytes may be cleaned up using this method if the analyte recovery meets the specified criteria.

EPA SW 3640A – Gel Permeation Cleanup (GPC)

GPC is the most universal cleanup technique for a broad range of semivolatile organic compounds and pesticides. High molecular weight compounds are separated from sample analyte although extraneous peaks interfering with chromatographic interpretation may not be completely eliminated. This technique is useful for removing heavy compounds that may contaminate injection ports and decrease the life of the column.

Gel-permeation chromatography (GPC) is a size exclusion cleanup procedure using organic solvents and hydrophobic gels in the separation of synthetic macromolecules (1). The packing gel is porous and is characterized by the range or uniformity (exclusion range) of that pore size. In the choice of gels, the exclusion range must be larger than the molecular size of the molecules to be separated (2). A cross-linked divinylbenzene-styrene copolymer (SX-3 Bio Beads or equivalent) is specified for this method.

GPC is recommended for the elimination from the sample of lipids, polymers, copolymers, proteins, natural resins and polymers, cellular components, viruses, steroids, and dispersed high-

molecular weight compounds. GPC is appropriate for both polar and non-polar analytes, therefore, it can be effectively used to cleanup extracts containing a broad range of analytes.

EPA SW 3660B – Sulfur Cleanup

Elemental sulfur is encountered in many sediment samples (generally specific to different areas in the country), marine algae, and some industrial wastes. The solubility of sulfur in various solvents is very similar to the organochlorine and organophosphorus pesticides. Therefore, the sulfur interference follows along with the pesticides through the normal extraction and cleanup techniques. In general, sulfur will usually elute entirely in Fraction 1 of the Florisil cleanup (Method 3620).

Sulfur will be quite evident in gas chromatograms obtained from electron capture detectors, flame photometric detectors operated in the sulfur or phosphorous mode, and Coulson electrolytic conductivity detectors in the sulfur mode. If the gas chromatograph is operated at the normal conditions for pesticide analysis, the sulfur interference can completely mask the region from the solvent peak through Aldrin.

Two techniques for the elimination of sulfur are detailed within this method: (1) the use of copper powder; and (2) the use of tetrabutylammonium sulfite. Tetrabutylammonium sulfite causes the least amount of degradation of a broad range of pesticides and organic compounds, while copper may degrade organophosphorus and some organochlorine pesticides.

EPA SW 3665A – Sulfuric Acid/Permanganate Cleanup

This method removes compounds that elevate baselines and obscure patterns in PCB analysis. It cannot be used where analytes are degraded by sulfuric acid or permanganate such as pesticides and most organic compounds.

Quality Control (QC) Requirements

QC activities are those technical procedures routinely performed, not to eliminate or minimize errors, but to measure or estimate their effect. These activities are implemented during sampling and analytical activities and may vary depending on project needs. Requirements for the type, frequency and assessment of QC activities planned for this sampling event are described below and in Table 2-3..

Field Quality Control

Field Duplicate Samples

Field duplicate sediment samples are used to check for sampling and analysis reproducibility. One duplicate composite sediment sample and two duplicate discrete sediment samples will be collected for this investigation. Field duplicate samples will be collected in conjunction with and analyzed by the same methods as the primary samples. Field duplicate samples will be collected from areas most likely to be contaminated and will be submitted blind to the laboratory, with sample numbers that are indistinguishable from the primary sample numbers. Control limits for field duplicate precision are 50 percent relative percent difference (RPD) for sediment samples.

Temperature Blanks

Temperature blanks are used to measure cooler temperatures upon receipt of the coolers at the laboratory. One temperature blank will be prepared and submitted to the investigation laboratory with each cooler. The temperature blank (consisting of a sample jar containing water) will be packed on ice in the cooler in the same manner as the rest of the samples and labeled “temperature blank.”

Analytical Quality Control

Initial and Continuing Calibration Standards

Laboratory instrument calibration and maintenance requirements are discussed in Section 2.7.

Method Blanks

Method blanks are used to check for laboratory and reagent contamination, instrument bias, and accuracy. Laboratory method blanks will be analyzed at a minimum frequency of 5 percent or one per analytical batch for all chemical parameter groups.

QC criteria require that minimum contamination be detected in the blank(s). If a chemical is detected, the action taken will follow the criteria established by this QAPP. Blank samples will be analyzed for the same parameters as the associated field samples. The concentrations of analytes detected in the method blanks will not be subtracted from the sample concentrations.

Surrogate Spikes

The accuracy of an analytical measurement may be evaluated by using surrogate spikes. Surrogate compounds are compounds that are not expected to be found in environmental samples; however, they are chemically similar to several compounds analyzed in the methods and behave similarly in extracting solvents. Samples for organic compound analysis will be spiked with surrogate compounds consistent with the requirements described in the analytical methods.

Percent recovery of surrogates is calculated concurrently with the analytes of interest. Because sample characteristics will affect the percent recovery, the percent recovery is a measure of accuracy of the overall analytical method on each individual sample.

Laboratory Control Samples

LCSs are used to monitor the laboratory's day-to-day performance of routine analytical methods, independent of matrix effects. LCSs are prepared by spiking reagent water with standard solutions that contain the same compounds used in establishing instrument calibration. Spiking levels will be between the low and mid-level calibration standards used for the primary samples. LCSs are extracted and analyzed with each batch of samples. Results are compared on a per-batch basis and are used to evaluate the laboratory's performance for accuracy. LCSs may also be used to identify any background contamination of the analytical system that may lead to the reporting of elevated concentration levels or false-positive measurements.

Matrix Spike/Matrix Spike Duplicates

MS/MSD sample pairs are used to assess sample matrix interferences and analytical errors, as well as to measure the accuracy and precision of the analysis. For MS or MSD samples, known concentrations of analytes are added to environmental samples; the samples are then processed through the entire analytical procedure and the recovery of the analytes is calculated. Results are expressed as percent recovery of the known spiked amount (and RPD for MS/MSD).

Spiked samples will contain all the target compounds required by the designated methods. Spiking concentrations for all MS/MSD sample analyses will be at concentrations in the middle of the calibration range that is used to analyze the primary sample.

Because MS/MSD samples are used to measure the matrix interference of a specific matrix, only samples from this investigation will be analyzed as MS/MSD. The MS/MSD samples will be analyzed for the same parameters as the associated field samples in the same QC analytical batch. Poor MS/MSD recoveries may not be attributed to matrix interference until the laboratory reprepares the samples, with accompanying cleanup procedures and reanalysis, and the results indicate similarly poor recoveries.

The sample for MS/MSD analyses will be designated in the field and will be collected from a location with the estimated lowest concentrations of target analytes so that the added spike

compounds are not masked by the sample analyte concentrations. Required laboratory QC criteria and corrective actions for MS/MSD samples are presented in Appendix B.

Quality Assurance Samples

Quality Assurance Samples are collected to monitor the quality of sampling and analytical operations. This type of sample is typically a split or duplicate analyzed by the QA laboratory following the same procedures that the primary laboratory uses. QA sample collection and analysis is the main tool to determine that the data generated by primary laboratories is technically valid and of adequate quality for the intended data usage. Based on the needs of this project, two QA samples for PCBs lead and mercury collected as split, given a unique sample identification (ID) and sent to a primary contract laboratory and to a QA laboratory for analysis.

Instrument/Equipment Testing, Inspection, and Maintenance Requirements

Instrument calibration will be in compliance with the USACE Shell ([EM 200-1-3](#), Appendix I) and EPA SW-846. General requirements are discussed below.

Standard Solutions

A critical element in the generation of quality data is the purity/quality and ability to trace the standard solutions and reagents used in the analytical operations. To ensure the highest purity possible, the laboratory will obtain all primary reference standards and standard solutions from the National Institute of Standards and Technology (NIST), the EPA repository, or other reliable commercial source. The laboratory will maintain a written record of the supplier, lot number, purity/concentration, receipt/preparation date, name of the analyst, method of preparation, expiration date, and all other pertinent information for all standards, standard solutions, and individual standard preparation logs.

Standard solutions will be validated prior to use. Validation procedures can range from a check for chromatographic purity to verification of the concentration of the standard solution using another standard solution prepared at a different time or obtained from a different source. Stock and working standard solutions will be checked regularly for signs of deterioration, such as discoloration, formation of precipitates, or change of concentration. Care will be exercised in the proper storage and handling of standard solutions, and all containers will be labeled as to compound, concentration, solvent, expiration date, and preparation data (initials of preparer/date of preparation). Reagents will be examined for purity by subjecting an aliquot or subsample to the corresponding analytical method as well.

Balances

The laboratory will calibrate analytical balances annually according to manufacturer's instructions and have a calibration check before each daily use by laboratory personnel. All balance calibrations will use Class 1 or S weights and will be within a range appropriate to the sample mass. Acceptance criteria are 1 percent for top-loading balances and 0.1 percent for analytical balances. Annual calibrations and calibration checks will be documented in appropriate hardbound logbooks with prenumbered pages.

Refrigerators

The laboratory will monitor all refrigerators for proper temperature by measuring and recording internal temperatures on a daily basis using National Institute of Standards and Technology (NIST)-certified or NIST-traceable thermometers. At a minimum, thermometers used for these measurements will be calibrated annually according to manufacturer's instructions. Refrigerators will be maintained at $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and freezers at -10°C to -20°C . Refrigerator and freezer temperatures will be documented in appropriate hardbound logbooks with prenumbered pages.

Volumetric Measurements

Before use, volumetric glassware or other laboratory ware will be inspected for cracks or damages. Eppendorf-type pipettes will be verified (weekly, at a minimum) at the volume to be used or at two different volumes that bracket the range of use. Fixed volume Eppendorf-type pipettes will be verified monthly. All non-standard laboratory ware used to measure the initial sample volume or the final volume of the extracts/digestates will be verified to be accurate within 3 percent. Each calibration check will be documented in appropriate hardbound logbooks with prenumbered pages.

Water Supply System

The investigation laboratory will maintain an appropriate water supply system that is capable of furnishing American Society for Testing and Materials (ASTM) Type II polished water to the various analytical areas. ASTM Type I or equivalent water should be used for trace metal analysis.

Initial calibration blanks and continuing calibration blanks will be used to document that the laboratory water supply system produces water that is free of the analytes of interest at the level of concern for the investigation. Method blanks will be used to ensure that none of the reagents used for the requested analyses are contaminated with the analytes of interest.

Laboratory Instruments

As stated in laboratory SOPs, calibration of all analytical instrumentation is required to ensure that the analytical system is operating correctly and functioning at the sensitivity required to meet investigation-specific objectives. Each instrument will be calibrated with standard solutions appropriate to the instrument and analytical method, in accordance with the methodology specified, and at the QC frequency specified in the laboratory SOPs.

The calibration history of the fixed laboratory instrumentation is an important aspect of the investigation's overall QA/QC program. As such, all initial and continuing calibration procedures will be implemented by trained personnel following the manufacturer's instructions and in accordance with applicable EPA protocols to ensure the equipment is functioning within the tolerances established by the manufacturer and the method-specific analytical requirements.

Instrument/Equipment Calibration and Frequency

The calibration of instruments and support equipment are required to ensure that the analytical system is operating correctly and functioning at the proper precision, bias (accuracy) and sensitivity. The frequency of calibration and calibration verification are presented below, based upon by the various analytical methods, industry standards, or may be changed based upon project-specific DQOs. Tables 2-1 through 2-3 are enclosed to highlight key information on calibration procedures and acceptance limits for each SW-846 method discussed.

Analytical Support Areas Calibration Verification

Suggest referring to the Standard Specification for Minimum Requirements for Laboratories Engaged in Chemical Analysis of Soil, Rock, and Contained Fluid, ASTM D5522-94, Annual Book of ASTM Standards, for additional details on the following procedures and performance criteria.

Balances.

The calibration of analytical balances shall be verified on first daily use at a mass or masses which bracket, or are representative of the measurements routinely performed at that balance. The quality of the weights used for this calibration verification shall be documented and in accordance with the quality requirements established within the referenced ASTM standard. Balance calibration verifications shall be documented in appropriate logbooks. Acceptance

criteria shall be clearly identified. Apply a 1% performance criterion to top-loading balances, and 0.1% to analytical balances. Refer to Standard Test Method of Testing Top Loading, Direct-Reading Laboratory Scales and Balances, ASTM Methods Vol. 14.02 E 898-88, June 1990 and Standard Practice for the Evaluation of Single-Pan Mechanical Balances, ASTM E 319-85, Annual Book of ASTM Standards for additional details.

Refrigerators/Freezers

All refrigerators and freezers shall be monitored for proper temperature by measuring and recording internal temperatures on a daily basis. The calibration of all thermometers used for these measurements shall be verified at least annually against NIST-certified or NIST-traceable thermometers. Electronic thermometers shall be calibrated at least quarterly. Temperatures shall be recorded in appropriate logbooks. Acceptance ranges shall be clearly identified. Maintain refrigerators to $4 \pm 20\text{C}$, and freezers to -10 to -200C . Refer to Standard Test Method for Inspection and Verification of Liquid in Glass Thermometers. Refer to ASTM Methods Vol. 14.03 E 77-89, June 1990 for additional details on thermometers calibration.

Pipets and Other Volumetric Labware

All volumetric devices, glassware, or labware shall be initially inspected, and all cracked or damaged items pulled from use. The calibration of variable volume Eppendorf-type pipets shall be verified at the volume of use, or at two volumes which bracket the range of use on the day of use, or at a minimum of weekly. The calibration of all fixed volume Eppendorf type pipets shall be verified monthly. In addition, the accuracy of all nonstandard labware (K-D tubes, Zymark tubes, plastic cups, centrifuge tubes, etc.) used to measure the initial sample volume, or final volume of sample extracts/digestates must be verified. Accuracy must be verified to within 3%. If the check reveals greater than 3%, steps should be taken to improve the accuracy of these measurements, or use alternative procedures, which meet this requirement. It is also recommended that the calibration of all other volumetric glassware (flasks and pipets) be verified at the time of purchase for each lot of labware received. Each calibration check shall consist of at least three measurements, the average calculated, and recorded in appropriate logbooks. Refer to Standard Practice for Calibration of Volumetric Ware, ASTM Methods Vol. 14.02 E 542-94 for additional details.

Water Supply System

The laboratory shall maintain an appropriate water supply system that can furnish high purity water that can meet the needs of the various analytical areas. Method blanks' performance provides an indication of the source water suitability for the analysis. However, the water supply system should be monitored on a regular basis (i.e., daily or before use) by conductivity readouts or implementation of general chemistry parameters. Appropriate general chemistry parameters should be based upon the analysis performed at the laboratory. Refer to ASTM D 1193-91, Standard Specification for Reagent Water for additional details.

Other Analytical Support Equipment

Other support equipment used to maintain appropriate temperatures as prescribed within the analytical method (i.e., hotplates, water baths, etc.) should be monitored for compliance with the method-specified ranges. Recommend notation of any critical times or temperatures onto appropriate bench sheets or laboratory logbooks.

Initial Calibration Curve

An analytical instrument is considered calibrated when an instrumental response can be related to the concentration of an analyte. This relationship may be depicted graphically, and referred to as a 'calibration curve'. Initial calibration curves must be established based upon the requisite

number of standards identified within the method for each target analyte (and surrogate for organic analyses). The practical quantitation limit(s) shall be established by the laboratory at the low standard for each target analyte. All reported concentrations for target analytes shall be within the high and low initial calibration standards. Data generated below the low standard shall be reported as estimated (J-flag) values. Data generated above the high standard shall be diluted into the calibration range and reanalyzed. The frequency requirements for the initial calibration vary amongst the individual methods and are presented below. Tables 2-1 through 2-3 highlight key information on initial calibrations by method also.

Inorganic Analyses

For metals analyses, an initial calibration must be performed at the beginning of each analytical shift, and when a CCV fails or significant instrument maintenance is performed. Linearity is acceptable only if the linear regression coefficient $r > 0.995$. If $r > 0.995$, take corrective action and recalibrate.

As previously noted, classical (wet chemistry) techniques are not addressed directly. But while calibration and standardization procedures vary depending on the type of system and analytical methodology, the general principles outlined in these calibration sections apply universally. Analytical systems for wet chemistry techniques shall be calibrated prior to analyses being conducted. The calibration consists of defining the working range by use of a series of standard solutions. A minimum of five to seven standards is typically used. The calibration shall be verified on an ongoing basis (every ten to twenty samples at a minimum and at the end of the analysis sequence) to ensure that the system remains within specifications.

Method 6010. The term “standard” may refer to a “mixed” standard solution containing all the metals of interest (when the metals are compatible) or to a set of standard solutions where each standard contains a subset of the (compatible) metals of interest. The initial calibration must be established following one of the options presented below.

Calibration Option 1. Perform the initial calibration with a high-level standard and a calibration blank. The concentration of the single standard establishes the linear calibration range, and must fall below the upper linear dynamic range of the instrument. To ensure accuracy of concentrations at the PQL, verification at a low-level standard is prepared from the primary source standard and results must be within $\pm 20\%$ of its expected value. If the 20% criterion cannot be consistently met, then the concentration of the daily low-level CCV standard (and associated quantitation limits) should be increased until compliance is attained.

Calibration Option 2. The ICP-AES may be alternatively calibrated with three standards and a calibration blank. The concentration of the low-level calibration standard must be set no lower than the PQL for each analyte. The concentration of the high-level standard establishes the linear calibration range, and must fall below the upper linear dynamic range of the instrument. All standards and samples analyzed shall have a minimum of three exposures and the mean of each set of exposures used for quantitation. The exposure times should be optimized for instrumental response and analysis time. Evaluate the RSD for high-level and mid-level standards and calibration verification standards to $< 5\%$. Take corrective action (e.g., recheck the appropriateness of the exposure time) and recalibrate if the QC criteria are not met.

Method 7000. An initial calibration for GFAA must be established from at least three standards and a calibration blank. CVAA calibration requirements are similar to the standard AA procedures but with a minimum of 5-points. For GFAA a minimum of duplicate injections shall be performed for all standards and samples to improve precision and help reduce furnace

pipetting uncertainty. The RPD between duplicate injections for all standards shall be < 10%. If unacceptable, reanalyze the standard. If still unacceptable, perform instrument maintenance as needed to correct the problem and recalibrate.

Organic Analyses

The initial calibration curve is established as specified in the individual methods, using (a minimum of) five standards for all single-component target compounds and surrogates, and at least three standards for multiple component target compounds (e.g., toxaphene, chlordane, and PCBs). Once verified, an initial calibration is valid until a CCV fails or significant instrument maintenance is performed. The shapes of calibration 'curves' are typically a linear function between the concentration of each target compound to the instrument response. However, many method target compounds listings have been expanded to include compounds, which cannot be optimized without application of models for quadratic or higher order mathematical functions. When these models are employed, additional standards must be analyzed to accurately delineate the relationship as outlined in Method 8000B.

Linearity may be determined using linear regression analysis for each target compounds by calculating the "correlation coefficient" (r). The resulting line would normally not be forced through the origin, or use the origin as a calibration point, unless it is demonstrated that the intercept of the regression line is not statistically different from zero at the 95% level of confidence. Another term used to describe the goodness of fit of the line is 'Coefficient of Determination' (r²), the squared correlation coefficient). Alternatively for chromatographic methods, the average calibration factor (CF) or response factors (RF) may be calculated for each target compound. Linearity may be evaluated by calculating the percent relative standard deviation (%RSD) of the CFs/RFs from the initial calibration standards for each target compound. Linearity is presumed if the "correlation coefficient (r) is equal to or greater than 0.995 or the coefficient of determination (r²)" is equal to or greater than 0.99, or if the %RSD is less than or equal to 15% or 20% (depending on the method specifications). A visual inspection of the calibration curve should also be used as a diagnostic tool when nonlinear behavior is observed to verify if there is a large percentage error in any particular portion of the calibration curve. If the visual inspection indicates problems, or if one of the above criteria is not met, then the laboratory shall evaluate the following items for implementation based on an understanding of the detector response/contaminant concentration relationship:

- Check the instrument operating conditions or the initial calibration standards used and make adjustments to achieve a linear calibration curve.
- Narrow the calibration range using the same number of standards as required by the individual method. In general, the highest standard would be lowered first. The consequences of all actions taken must also be addressed, i.e., reduction of the calibration range, raising of the PQL, etc.
- Evaluate the use of a nonlinear calibration curve, when applicable. When nonlinear calibration models are used, the resultant line should not be forced through the origin and the origin should not be used as a calibration point. No higher than a third order (cubic) calibration model shall be used. Note that when a nonlinear calibration model is employed, more data points are needed to maintain at least three degrees of freedom. For example, use of a quadratic function requires a six-point initial calibration curve. The resulting 'coefficient of determination' (r²) should be greater than or equal to 0.99 for this to be considered acceptable.

- Use of alternative techniques (e.g., relative standard error (RSE)) outlined in the EPA Memorandum titled, Clarification Regarding Use of SW-846 Methods, dated 7 August 1998.
- Despite implementation of the above alternatives, method limitations may exist which make the acceptance criteria unattainable for all target compounds. Therefore, SW-846 has incorporated an allowance to evaluate the mean of the RSD values for all target compounds in the calibration is less than the method acceptance criterion. To avoid the inclusion of target compounds showing gross method failure, this approach may be utilized as long as the target compounds do not exceed the criteria established for poor performers in the enclosed method-specific tables. If the averaging option is employed, the laboratory must communicate the following information within the case narrative to the client: summary of all of the target compounds exceeding method acceptance criteria, the individual RSD results for those compounds, and the mean RSD calculated.

Method 8082. When PCBs are to be determined as Aroclors, external standard calibration techniques should be used. The approach taken for an initial calibration will differ depending on the project DQOs. For instance, projects, which have defined a few specific Aroclors associated with the site, recommend the following procedures. Perform the initial calibration using five standards for each Aroclor identified by the project. When samples contain a known mixture of different Aroclors, the analyst may perform a five-point calibration using that Aroclor mixture. When a multi-point calibration is performed for individual Aroclors, calculate and use the calibration factors from a minimum of 3 to 5 peaks for those standards and evaluate. If the PCBs are unknown or the types of PCBs have not been determined, recommend the following procedures. Perform the initial calibration using five standards for a mixture of Aroclor 1016 and Aroclor 1260 standards in order to determine linearity of the detector response. For the remaining five Aroclors, a mid-level standard is analyzed to aid in pattern recognition. Based upon the positive identification of any PCBs in samples corresponding to the Aroclors with only the mid-level standard analyzed, calibrate the instrument for that PCB with a minimum of three standards and reanalyze the extract to enable accurate quantitation. Again, using a minimum of 3 to 5 peaks, calculate appropriate CFs for the 1016/1260 and any positively identified PCB standards and evaluate linearity.

Initial Calibration Verification

The initial calibration curve shall be verified as accurate with a standard purchased or prepared from an independent source. This initial calibration verification (ICV) involves the analysis of a standard containing all of the target analytes, typically in the middle of the calibration range, each time the initial calibration is performed. The % recovery of each target analyte in the ICV is determined from the initial calibration and compared with the specifications for the CCV in each method (except for mercury by CVAA).

Note for methods which report several (>5) target analytes, a small percentage of sporadic marginal failures may be tolerated (i.e., will not trigger re-extraction and analysis of the entire batch). This is subject to approval by the district chemist and based on the data quality objectives. The number of target analytes reported for the method will dictate the number of allowable QC failures as given below. Refer to the individual method tables for details on the implementation of this concept.

N ¹	X ²
5 - 15	1
16 - 30	2
31 - 45	3
46 - 60	4
61 - 75	5
76 - 90	6
91 - 105	7

The marginal failure allowance entails the application of an expanded acceptance criterion. If these QC criteria are not met, a new initial calibration must be performed.

Method 8082

The ICV standards may be limited to contain a mixture of Aroclors 1016 and 1260 or the project-specified Aroclors.

ICBs and CCBs are required for inorganic metals analyses to verify the system is free of contamination. The frequency of ICB/CCB analyses is presented in Tables 4-7 and 4-8 as outlined within Methods 6010 and 7000. The concentrations of each target analyte in the ICB/CCB must be less than or equal to the MDL check sample (~ 2 times the MDL. Samples must not be analyzed until the ICB is acceptable, and all results must be bracketed by passing CCBs in order to be considered valid.

Continuing Calibration Verification (CCV)

CCVs are analyzed to determine whether the analytical system is working properly, and if a new initial calibration (and the reanalysis of sample extracts) is required. Calibration “verification” differs in concept and practice from “continuing calibration”. In this latter technique, a standard is analyzed and new response factors are calculated, or a new calibration curve is drawn from the analysis of the continuing calibration standard. The former verifies compliance with the initial calibration curve, but does not overwrite the response factors used for the quantitation, nor allows re-sloping of the calibration curve. Calibration verification shall be used for all analytical methods, calculating a % Drift when the initial calibration is based on regression analysis, and a % Difference when the initial calibration is determined based upon % RSD values. Continuing calibration verification (CCV) typically involves the analysis of a single primary source standard in the middle of the calibration range, between the concentrations of low-level and mid-level calibration standards. The frequencies of the CCV vary between methods, but are related to the type of detector used, and sample matrices analyzed. The analysis of more frequent CCVs is recommended for very sensitive detectors and when analyzing difficult matrices. This frequency is typically presented within SW-846 methods as (1) At the beginning of the analytical shift/sequence; (2) every 12 hours of analyses or every 10 to 20 samples; and may include (3) at the end of the analytical sequence. Refer to Section Tables 4-7 through 4-14 for details on requirements for CCV implementation and acceptance limits for the individual methods. If these QC criteria are not met, take corrective action to inspect the analytical system to determine the cause and perform instrument maintenance to correct the problem before analyzing a second CCV. If the second CCV is acceptable after system maintenance is performed, re-calibration is not required but all sample extracts analyzed after the last acceptable CCV must be reanalyzed. If however, the second CCV fails, a new initial calibration must be performed and all associated sample extracts reanalyzed.

Inorganic Analyses

A calibration verification pair of a CCB and CCV must be analyzed after every 10 samples (including batch QC samples) and at the end of the analytical. Refer to Tables 2-1 and 2-for a summary of CCV implementation and QC requirements.

Organic Analyses

Calibration verification must be analyzed as summarized in Table 2-3, in addition to the following:

- For certain organic analyses, additional CCVs at low- and high-level concentrations are recommended, due to the instability of their detectors (e.g., HECD, ECD). Method quality objectives (acceptance limits) for the high-level CCV should be in accordance with the mid-level CCV criteria. **This criterion however, may not be achievable for the low-level CCV. Therefore, no method quality objectives for low-level CCV are included at this time, and should be identified within project documents based upon the data's use. For instance, if low-level detection is critical based on project action levels or decision levels, appropriate method quality objectives should be determined based on an acceptable level of error to support the data's use.**
- For methods that contain multi-component target compounds (e.g., PCBs), typically only a subset of these analytes would be used in the CCV.

Method 8082. When quantitating for PCBs as Aroclors, a mid-level CCV standard containing a mixture of Aroclors 1016 and 1260 (or Aroclors of interest) must be analyzed. Due to the instability and potential drift of the electron capture (ECD) detector, it is suggested that the mid-level CCV be alternated with high- and low-level CCVs

Inspection/Acceptance Requirements for Supplies and Consumables

All purchased supplies and consumables that support field and laboratory activities or that have a direct relationship to sample quality (e.g., sample containers, decontamination supplies, distilled/deionized water) will be inspected upon receipt. Inspection will ensure that: 1) the material corresponds to the part number and physical description on the purchase order or purchasing instructions; 2) the material is received intact and undamaged; and 3) all requested certifications or manuals are delivered with the equipment or item. Any non-conformance will be documented and returned to the vendor for replacement, rework or other action as appropriate.

Data Acquisition Requirements (Non-direct Measurements)

No data will be used from sources other than previous investigations. The quality of previous results has been determined and documented in quality assurance reviews associated with the individual events.

Data Management

Hardcopy and electronic data results from the subcontracted commercial laboratory will be delivered to the Portland District upon completion of each sample delivery group. Data review and validation will be performed as listed in Section 4.3.

GIS data will be are collected as samples are acquired. When GIS data are collected, the following fields are captured as appropriate:

- Station Identifier
- Station Alternate or Previous IDs
- Station Type Description

- Station Coordinates
- Station Horizontal Datum (if applicable)
- Method for determining Station Location
- Station Coordinate Units
- Station Elevation
- Station Vertical Datum (if applicable)
- Method for determining Station Elevation

and appropriate Station Attributes such as:

- Sample Depth
- Water Elevation
- Sediment Sampling Interval

The major data items captured to create a complete chemical analytical data set are as follows:

- Station Identifier
- Sample Identifier
- Sample Description (Primary, Field, Duplicate, Replicate...)
- Sample Date
- Full name of analytical parameter, observation or compound analyzed
- CAS number when available or appropriate
- Analytical result concentration value
- Data validation qualifier
- Units
- Analytical method reference
- Sample Media
- Sample Media modified

Bonneville Pool QAPP

ASSESSMENTS OVERSIGHT

Assessments and Response Actions

The elements in this section address the activities for assessing the effectiveness of project implementation and associated QA and QC activities. The purpose of assessment is to ensure that the QAPP is implemented as prescribed.

Technical Reviews

All draft and final technical memorandums and reports will be subject to technical review. Comments generated in the review process will be documented, resolved and incorporated as appropriate. A record of this process will be maintained in the project files by the PM.

Laboratory Validation

The primary objectives of the USACE laboratory validation program are to communicate to analytical service providers the USACE QC/QA requirements, verify the laboratories are performing specified analytical methods, and to ensure these laboratories meet the USACE requirements prior to sample analysis. Laboratory validations are performed under the administration of the HTRW-CX applying guidance outlined in EM 200-1-1. Laboratories utilized by this project are currently validated for the applicable methods (EPA SW 9060, 8082, 7470, 7471, and 6020).

Reports to Management

At the conclusion of this project, a letter report will be prepared for inclusion into the project files and possible future use in related projects. This report will describe the activities performed in the field and laboratory as well as any associated nonconformances. All project data including field documentation will be attached to the report.

DATA VALIDATION AND USABILITY

Data Review, Verification, and Validation Requirements

Analytical data generated through the subcontract laboratory will be verified and reviewed prior to utilization for project decisions.

Verification Methods

All of the data validations will be performed in accordance with the QA/QC requirements specified in the QAPP, the technical specifications of the analytical methods and the following EPA Guidance documents:

- EPA CLP National Functional Guidelines for Inorganic Data Review (1994a)

1. EPA CLP National Functional Guidelines for Organic Data Review (1999)

Validation deliverables will include a QA memo discussing QA conformance and deviations issues that may have affected the quality of the data. Data usability and the bases of application of qualifiers will also be discussed in the QA memo. Forms I (Analysis Data Sheet) with the applied validation qualifiers for estimated-qualified values also will be a part of the validation deliverables. The following qualifiers shall be used in the data validation:

- U — The compound was analyzed for, but not detected.
- UJ — The compound was analyzed for, but was not detected; the associated quantitation limit is an estimate because quality control criteria were not met.
- J — The analyte was positively identified, but the associated numerical values is an estimate quantity because quality control criteria were not met or because concentrations reported are less than the quantitation limit or lowest calibration standard.
- NJ — The analysis indicates the presence of an analyte that has been “tentatively identified” and the associated numerical value represents its approximate concentration.
- R — Quality control indicates that data are unusable (compound may or may not be present). Resampling and reanalysis are necessary for verification.
- B — Detected concentration is below the method reporting limit/Contract Required Detection Limit (CRDL) but is above the instrument detection limit (inorganics only).

Reconciliation with User Requirements

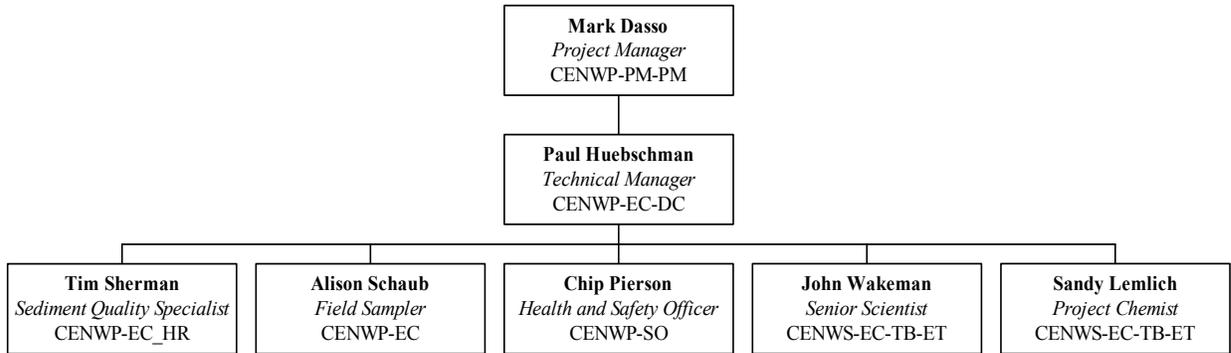
The user requirements for the data generated in this project are not known at this time. Therefore, the variability and soundness of the data and the data gaps required to meet the objectives of future projects will be reconciled at a later date.

REFERENCES

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Figure 1

Bonneville Pool Project Team



**Table 1-1
Project Organization**

Name Function	Organization	Phone Fax e-mail
US ARMY CORPS OF ENGINEERS, PORTLAND DISTRICT Robert Duncan Plaza 333 S.W. First Avenue P.O. Box 2946 Portland, OR 97208-2946 Portland, OR 97204 https://www.nwp.usace.army.mil/		
Mark Dasso <i>Project Manager</i>	CENWP-PM-PM	503-808-4728 503-808-4699 Joseph.M.Dasso@nwp01.usace.army.mil
Paul Huebschman <i>Technical Manager</i>	CENWP-EC-DC	503-808-4914 503-808-4905 Paul.A.Huebschman@nwp01.usace.army.mil
Tim Sherman <i>Sediment Quality Specialist</i>	CENWP-EC-HR	503-808-4884 503-808-4875 Timothy.J.Sherman@nwp01.usace.army.mil
Allison Schaub <i>Field Sampler</i>	CENWP-EC	503-808-4420 503-808-4875 Allison.A.Schaub@nwp01.usace.army.mil
Chip Pierson <i>Site Safety and Health Officer</i>	CENWP-SO	503-808-4540 503-808-4542 Winthrop.C.Pierson@nwp01.usace.army.mil
US ARMY CORPS OF ENGINEERS, SEATTLE DISTRICT Engineering and Technology Section 4735 East Marginal Way South P.O. Box 3755 Seattle, WA 98124-3755 http://www.nws.usace.army.mil/		
John Wakeman <i>Environmental Scientist</i>	CENWS-EC-TB-ET	Phone: 206-764-3430 Fax: 206-764-3706 John.S.Wakeman@nws02.usace.army.mil
Sandy Lemlich <i>Chemist</i>	CENWS-EC-TB-ET	206-764-6930 Fax: 206-764-3706 Sandra.K.Lemlich@nws02.usace.army.mil

PRIMARY LABORATORY SERVICES

Severn Trent Laboratory

5755 8th Street East
Tacoma, WA 98424
Phone 253-922-2310
Fax 253-922 -5047

<http://www.stl-inc.com/Labs/Seattle/Contacts.htm>

Lila Transue
QA/QC Director

ltransue@stl-inc.com

Dawn Werner
Project Manager

dwerner@stl-inc.com

QUALITY ASSURANCE LABORATORY

North Creek Analytical

11720 North Creek Parkway N., Suite 400
Bothell, WA 98011-8223
Phone: 425-420-9200
Fax: 425-420-9210

<http://www.ncalabs.com/>

Suzanne LeMay
*QA/QC Director,
Beaverton*
David Wunderlich
*QA/QC Director,
Bothell*

s.lemay@nclabs.com

d.wunderlich@nclabs.com

Lisa Domenighini
*Project Manager,
Beaverton*

l.domenighini@nclabs.com

Note: The laboratory contract is with North Creek Laboratories Beaverton, Oregon facility. However, samples were analyzed at North Creek in Bothell, WA.

TABLE 1-2

TARGET COMPOUND LIST FOR METHOD 8082 PCBs AS AROCLORS

Analyte	MDL (mg/kg)	PQL (mg/kg)
PCBs by 8082 (3550)		
Aroclor 1016	0.0012	0.01
Aroclor	0.00176	0.01
Aroclor	0.00156	0.01
Aroclor	0.0031	0.01
Aroclor	0.00101	0.01
Aroclor	0.0015	0.01
Aroclor	0.00305	0.01
Mercury by 7471		
Lead	?	?
Lead by 6010B		
Mercury	?	?

**TABLE 1-3
QUALITY CONTROL AND QUALITY ASSURANCE SAMPLE SUMMARY**

Sample Type	Temperature Blank	QA Duplicate	Laboratory Duplicates	Field Duplicate	Matrix Spikes
Lead	N/A	1/project	1/project	1/project	1/20 samples
Mercury	N/A	1/project	1/project	1/project	1/20 samples
PCBs	1/cooler	1/project	1/project	1/project	1/20 samples
TOC	1/cooler	1/project	1/project	1/project	None
% Solids	N/A	1/projecte	1/project	1/projecte	N/A
Particle Size	N/A				N/A

TABLE 2-1
SUMMARY OF METHOD QUALITY OBJECTIVES FOR METHOD 6010
ICP METALS (Pb)

Quality Control Element	Description of Element	Frequency of Implementation	Acceptance Criteria
Initial Calibration (4.9.2.1.1)	<u>Option 1</u> - 1 std and blank, and a low-level check standard at <u>PQL</u> <u>Option 2</u> - 3 stds and blank	Daily	<u>Option 1</u> - Low-level check standard \pm 20% <u>Option 2</u> - $r > 0.995$
Instrumental Precision (4.9.2.1.1)	%RSD 3 integrations (exposures)	Each calibration and calibration verification standards (ICV/CCV)	%RSD < 5%
Initial Calibration Verification (ICV) (4.9.3)	Mid-level (2nd source) verification	After initial calibration	%Recovery \pm 10%
Initial Calibration Blank (ICB) (4.9.4)	Interference-free matrix to assess analysis contamination	After initial calibration	Analytes < MDL Check Sample (~2X MDL)
Interelement Check Standards (ICS) (4.8.1)	ICS-A - interferents only ICS-B - interferents and target analytes	Beginning of analytical sequence	%Recovery \pm 20% for target analytes
Continuing Calibration Blank (CCB) (4.9.4)	Interference-free matrix to assess analysis contamination	Every 10 samples and at end of analytical sequence	Analytes < MDL Check Sample (~2X MDL)
Continuing Calibration Verification (CCV) (4.9.5 / 4.9.5.1)	Mid-level verification	Every 10 samples and at end of analytical sequence	%Recovery \pm 10%
Method Blank (MB) (5.2.1.7.4.1)	Interference-free matrix to assess overall method contamination	1 per sample batch	Analytes < MDL Check Sample (~2X MDL)
Laboratory Control Sample (LCS) (5.2.1.7.4.2)	Interference-free matrix containing all target analytes	1 per sample batch	%Rec = 80% - 120%

Quality Control Element	Description of Element	Frequency of Implementation	Acceptance Criteria
Matrix Spike (MS) (5.2.1.7.4.3)	Sample matrix spiked with all/subset of target analytes prior to digestion	1 per sample batch	%Rec = 75% - 125%
Matrix Duplicate (MD) or Matrix Spike Duplicate (MSD) (5.2.1.7.4.4)	Refer to text for MD or MS.	1 per sample batch	RPD < 25%
Post Digestion Spike (PDS) (5.2.1.7.4.7.1)	Sample digestate spiked with all/subset of target analytes	As needed to confirm matrix effects	%Rec = 75% - 125%
Serial Dilution (SD) (5.2.1.7.4.7.2)	1:4 dilution analyzed to assess matrix effects	As needed to assess new and unusual matrices	Agreement between undiluted and diluted results ± 10%
Method of Standard Addition (MSA) (5.2.4.1.6.4.2.1)	Method of quantitation	As needed for samples with suspected or confirmed matrix effects	$r > 0.995$

Note: Sections numbers are referenced to EM 200-1-3 Appendix I.

TABLE 2-2
SUMMARY OF METHOD QUALITY OBJECTIVES FOR METHOD 7000 SERIES
GFAA/CVAA METALS (Hg)

Quality Control Element	Description of Element	Frequency of Implementation	Acceptance Criteria
Initial Calibration (4.9.2.1.2)	3 stds and blank	Daily	$r > 0.995$
Instrumental Precision (4.9.2.1.2)	RPD of 2 injections	All standards, and ICV/CCV	$RPD \pm 10\%$
Initial Calibration Verification (ICV) (4.9.3)	Mid-level (2nd source) verification	After initial calibration	$\%Rec \pm 10\%$
Initial Calibration Blank (ICB) (4.9.4)	Interference-free matrix to assess analysis contamination	After initial calibration	Analytes < MDL Check Sample (~2X MDL)
Continuing Calibration Blank (CCB) (4.9.4)	Interference-free matrix to assess analysis contamination	Every 10 samples and at end of analytical sequence	Analytes < MDL Check Sample (~2X MDL)
Continuing Calibration Verification (CCV) (4.9.5 / 4.9.5.1)	Mid-level verification	Every 10 samples and at end of analytical sequence	$\%Rec \pm 20\%$
Method Blank (MB) (5.2.1.7.4.1)	Interference-free matrix to assess overall method contamination	1 per sample batch	Analytes < MDL Check Sample (~2X MDL)
Laboratory Control Sample (LCS) (5.2.1.7.4.2)	Interference-free matrix containing target analytes	1 per sample batch	$\%Rec = 80\% - 120\%$
Matrix Spike (MS) (5.2.1.7.4.3)	Sample matrix spiked with target analytes prior to digestion	1 per sample batch	$\%Rec = 80\% - 120\%$
Matrix Duplicate (MD) or Matrix Spike Duplicate (MSD) (5.2.1.7.4.4)	Refer to text for MD or MS.	1 per sample batch	$RPD < 20\%$
Post Digestion Spike	Sample digestate	As needed to confirm	$\%Rec = 85\% - 115\%$

Quality Control Element	Description of Element	Frequency of Implementation	Acceptance Criteria
(PDS) (5.2.1.7.4.7.1)	spiked with target analytes	matrix effects	
Serial Dilution (SD) (5.2.1.7.4.7.2)	1:4 dilution analyzed to assess matrix effects	As needed to assess new and unusual matrices	Agreement between undiluted and diluted results $\pm 10\%$
Method of Standard Addition (MSA) (5.2.4.1.6.4.2.1)	Method of quantitation	As needed for samples with suspected or confirmed matrix effects	$r > 0.995$

Note: Sections numbers are referenced to EM 200-1-3 Appendix I.

**TABLE 2-3
SUMMARY OF METHOD QUALITY OBJECTIVES FOR METHOD 8082 (PCBs)**

QC Element	Target Compound/Surrogate
Initial Calibration (4.9.2.2.3)	$r > 0.995$, %RSD < 20%, $r^2 > 0.990$
ICV (4.9.3 / 9.3.2)	%Rec = 85% - 115%
CCV (9.5 / 9.5.2)	%Drift < 15%, %D < 15%
MB (5.2.1.7.4.1)	Analytes < MDL Check Sample (~2X MDL) or ½ PQL
LCS (5.2.1.7.4.2)	<u>Water</u> : %Rec = 50% - 130% <u>Solids</u> : %Rec = 50% - 130%
MS (5.2.1.7.4.3)	%Rec = 40% - 140%
MSD/MD (5.2.1.7.4.4)	RPD = 35%
Surrogates (5.2.1.7.4.5)	<u>LCS</u> : <u>Water</u> : %Rec = 50% - 130% <u>Solids</u> : %Rec = 50% - 130% <u>Project Sample Matrix</u> : %Rec = 40% - 140%
Target Analyte Confirmation (5.2.3.4)	RPD < 40%

Note: Sections numbers are referenced to EM 200-1-3 Appendix I.

APPENDIX A
DQO Memorandum

APPENDIX B

STL Validation

December 13, 2001

Hazardous, Toxic and Radioactive Waste
Center of Expertise

STL Seattle
ATTN: Lila Transue
5755 8th Street East
Tacoma, WA 98424

Gentlemen:

This correspondence addresses the recent evaluation of STL Seattle (formerly Sound Analytical, Inc.) of Tacoma, WA by the U.S. Army Corps of Engineers (USACE) for chemical analysis in support of the USACE Hazardous, Toxic and Radioactive Waste Program.

Your laboratory is now validated for the parameters listed below:

<u>METHOD</u>	<u>PARAMETERS</u>	<u>MATRIX⁽¹⁾</u>
300.0	Anions ⁽⁴⁾	Water ⁽²⁾
8021B	BTEX	Water ⁽²⁾
8021B	BTEX	Solids
9010B/9012A	Cyanide	Water ⁽²⁾
9013/9012A	Cyanide	Solids
8330	Explosives	Water ⁽²⁾
8330	Explosives	Solids ⁽²⁾
8151A	Herbicides	Water ⁽²⁾
8151A	Herbicides	Solids
8081A	Organochlorine Pesticides	Water ⁽²⁾
8081A	Organochlorine Pesticides	Solids
8082	Polychlorinated Biphenyls	Water ⁽²⁾
8082	Polychlorinated Biphenyls	Solids ⁽²⁾
8270C-SIM	Polynuclear Aromatic Hydrocarbons	Water ⁽²⁾
8270C-SIM	Polynuclear Aromatic Hydrocarbons	Solids
8270C	Semivolatile Organics	Water ⁽²⁾
8270C	Semivolatile Organics	Solids ⁽²⁾
6010B/7000A	TAL Metals ⁽³⁾	Water ⁽²⁾
6010B/7000A	TAL Metals ⁽³⁾	Solids ⁽²⁾
6020	TAL Metals ⁽⁶⁾	Water ⁽²⁾
6020	TAL Metals ⁽⁶⁾	Solids ⁽²⁾
9060	Total Organic Carbon	Water ⁽²⁾
Mod 8015	TPH - DRO/GRO/RRO ⁽⁵⁾	Water
Mod 8015	TPH - DRO/GRO/RRO ⁽⁵⁾	Solids
8260B	Volatile Organics	Water ⁽²⁾
8260B	Volatile Organics	Solids

- Remarks:
- 1) 'Solids' includes soils, sediments, and solid waste.
 - 2) The laboratory has successfully analyzed a performance evaluation sample for this method/matrix.

- 3) TAL Metals: Aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc.
- 4) Anions: Chloride, fluoride, sulfate, nitrate, nitrite, and ortho-phosphate.
- 5) Approval for this parameter is based on review of SOPs only.
- 6) TAL Metals except for calcium, iron, mercury, potassium, magnesium and sodium.

Enclosed for your information is a copy of the Laboratory Inspection and Evaluation Report. Your laboratory has responded to the deficiencies as noted in the report. No further responses are necessary.

Based on the successful analysis of the performance evaluation samples, the results of the laboratory inspection, and your Corrective Action Report, your laboratory will be validated for sample analysis by the methods listed above. The period of validation is 24 months and expires on December 13, 2003.

The USACE reserves the right to conduct additional laboratory inspections or to suspend validation status for any or all of the listed parameters if deemed necessary. It should be noted that your laboratory may not subcontract USACE analytical work to any other laboratory location without the approval of this office. This laboratory validation does not guarantee the delivery of any analytical samples from a USACE Contracting Officer Representative.

Any questions or comments can be directed to Richard Kissinger at (402) 697-2569. General questions regarding laboratory validation may be directed to the Laboratory Validation Coordinator at (402) 697-2574.

Sincerely,

Marcia C. Davies, Ph.D.
Director, USACE Hazardous,
Toxic and Radioactive Waste
Center of Expertise

Enclosure

KISSINGER/cak/2569

COATS/CENWO-HX-C

DAVIES/CENWO-HX

Q:\LABS\WA\STL SEATTLE\01APR.VAL\LAB-L01.DOC

APPENDIX C

North Creek Validation Letter

July 3, 2002

Hazardous, Toxic and Radioactive Waste
Center of Expertise

North Creek Analytical, Inc.
ATTN: Dave Wunderlich
11720 North Creek Parkway North, Suite 400
Bothell, WA 98011-8244

Gentlemen:

This correspondence addresses the recent evaluation of North Creek Analytical, Inc. of Bothell, WA by the U.S. Army Corps of Engineers (USACE) for chemical analysis in support of the USACE Hazardous, Toxic and Radioactive Waste Program.

Your laboratory is now validated for the parameters listed below:

<u>METHOD</u>	<u>PARAMETERS</u>	<u>MATRIX⁽¹⁾</u>
300 series	Anions ⁽⁴⁾	Water ⁽²⁾
9010B/9012A	Cyanide	Water ⁽²⁾
9013/9012A	Cyanide	Solids ⁽²⁾
8151A	Herbicides	Water ⁽²⁾
8151A	Herbicides	Solids ⁽²⁾
8081A	Organochlorine Pesticides	Water ⁽²⁾
8081A	Organochlorine Pesticides	Solids ⁽²⁾
9065/9066	Phenolics	Water ⁽²⁾
8082	Polychlorinated Biphenyls	Water ⁽²⁾
8082	Polychlorinated Biphenyls	Solids ⁽²⁾
8270C	Semivolatile Organics	Water ⁽²⁾
8270C	Semivolatile Organics	Solids ⁽²⁾
8270C/SIM	Semivolatile Organics	Water ⁽⁵⁾
8270C/SIM	Semivolatile Organics	Solids ⁽⁵⁾
6010B/7000A	TAL Metals ⁽³⁾	Water ⁽²⁾
6010B/7000A	TAL Metals ⁽³⁾	Solids ⁽²⁾
9060	Total Organic Carbon	Water ⁽²⁾
Mod 8015	TPH - DRO/GRO	Water ⁽²⁾
Mod 8015	TPH - DRO/GRO	Solids ⁽²⁾
8021B	Volatile Organics (BTEX)	Water ⁽²⁾
8021B	Volatile Organics (BTEX)	Solids ⁽²⁾
8260B	Volatile Organics	Water ⁽²⁾
8260B	Volatile Organics	Solids ⁽²⁾

- Remarks:
- 1) 'Solids' includes soils, sediments, and solid waste.
 - 2) The laboratory has successfully analyzed a performance evaluation sample for this method/matrix.
 - 3) TAL Metals: Aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc.

- 4) Anions: Chloride, fluoride, sulfate, nitrate, nitrite, and ortho-phosphate.
- 5) Validation for this parameter is based upon review of the laboratory's SOP only. No performance evaluation samples were analyzed for this parameter.

Enclosed for your information is a copy of the Laboratory Inspection and Evaluation Report. Your laboratory has responded to the deficiencies as noted in the report. No further responses are necessary.

Based on the successful analysis of the National Environmental Laboratory Accreditation Program Performance Testing samples for the appropriate fields of testing, the results of the laboratory inspection, and your Corrective Action Report, your laboratory will be validated for sample analysis by the methods listed above. The evaluation which was conducted for your facility is based substantially on ISO Guide 25 (General Requirements for the Competence of Testing Laboratories) and USACE Engineering Manual (EM) 200-1-3, Appendix I (Shell for analytical Chemistry Requirements). The period of validation is 24 months and expires on July 3, 2004.

The USACE reserves the right to conduct additional laboratory inspections or to suspend validation status for any or all of the listed parameters if deemed necessary. It should be noted that your laboratory may not subcontract USACE analytical work to any other laboratory location without the approval of this office. This laboratory validation does not guarantee the delivery of any analytical samples from a USACE Contracting Officer Representative.

Any questions or comments can be directed to Joseph Solsky at (402) 697-2573. General questions regarding laboratory validation may be directed to the Laboratory Validation Coordinator at (402) 697-2574.

Sincerely,

Marcia C. Davies, Ph.D.
Director, USACE Hazardous,
Toxic and Radioactive Waste
Center of Expertise

Enclosure

SOLSKY/cak/2569

COATS/CENWO-HX-C

DAVIES/CENWO-HX

Appendix D

Computer Model

Figure 1

MEMORANDUM FOR THE RECORD

SUBJECT: Near Bottom Velocities in the Bonneville Forebay around Bradford Island

1. The Portland District will be taking sediment samples from the Bonneville Forebay this year and near bottom velocities would provide valuable insight into sediment sample locations. CENWP-EC-HD has several numerical model runs of different flow conditions at Bonneville that will be used to provide estimates of the bottom velocities. The following information is summarized in this MFR:
 - Catalog of flow conditions already ran
 - CFD – 3D numerical model
 - MASS2 – 2D depth average numerical model
 - Identify if additional flow conditions are necessary
 - Develop an estimate of the upstream extent of flow conditions that would transport material upstream (excluding flow conditions initiated by wind)
 - Provide plots of bottom velocities
2. CENWP-EC-HD has conducted several studies over the past few years that involved 3-D and 2-D numerical models. Each model has been ran for several flow conditions but the majority of the flow conditions involved significant spill events. Attachments 1-3 are summary tables of the flow conditions. Attachment 1 – Table 2.4 are MASS2 (2-D) flow conditions associated with the Bonneville Adult Fallback Study. Attachment 2 – Table 2.5 are CFD (3-D) flow conditions associated with the Bonneville Adult Fallback Study. Attachment 3 is a listing of CFD runs that have been made for various Bonneville Studies. The spill flow for the various runs ranges from 0 Kcfs to 179 Kcfs, with the majority of the runs at 75 Kcfs, 120 Kcfs or 125 Kcfs.
3. Flow conditions of interest for identify sediment sample locations are for no spill conditions. There are a couple of CFD runs that meet the requirements and are identified as AWS-1, AWS-3 and Case5. AWS-1 and AWS-3 have minimal spill and Case5 has 143.9 Kcfs spill. Ideally two additional runs would be made:
 - Total river 100 Kcfs all through B1
 - Total river 240 Kcfs with B1 at 100 Kcfs and B2 at 140 KcfsResults should be similar to AWS-1 and AWS-3 but would provide slightly different circulation patterns in and around the tip of Bradford Island.
4. Concerns have been raised about how far upstream material deposited at the tip of Bradford Island could be transported. Three plots, Figures 1-3 have been developed

Figure 1

of the velocity directions for AWS-1, AWS-3 and Case5. The first two plots use a velocity scale 0 to 4 fps; Figure 3 uses a velocity scale of 0 to 6 fps. The river flows vary from 115 Kcfs to 373 Kcfs and in all cases the flow heads downstream until of the rock outcropping in the middle of river (white spot, middle of the river upstream of the powerhouses and spillway channels). These results do not incorporate the impacts of surface winds but generally surface winds would only have impact on the surface and near shore area.

5. The CFD model has been develop to evaluate flow fields as they approach the powerhouse or spillway. The number of cells has been minimized (and thus cells are as large as possible) to the number that provides the necessary detail near the powerhouse. The focus of the models has not been providing bottom velocities in the forebay. The models do provide insight into the velocities but additional grid refinement would be recommended if additional accuracy or refinement is needed. Bottom velocities have been estimated by using the post processing capability of the CFD model. The cells adjacent to the riverbed are identified. The velocities of that cell are then contoured and on average provide the velocity at 18 to 30 inches above the riverbed.
6. Figures 4-9 are bottom velocities plot for AWS-1, AWS-3 and Case5. Figures 4-9 display velocity in m/s and are the velocities at the center of the cells located at the mudline. The figures have been annotated to provide some insight into the relationship between m/s and fps.
7. Figure 10 identifies locations where sediment sampling might be warranted. The locations are based on areas where velocities are minimal under certain operations and containments could settle out. The point furthest upstream should be background based on the velocity information shown in Figures 1-3.
8. If you have questions or want additional plots please contact Laurie Ebner at 503-808-4880.

Figure 1

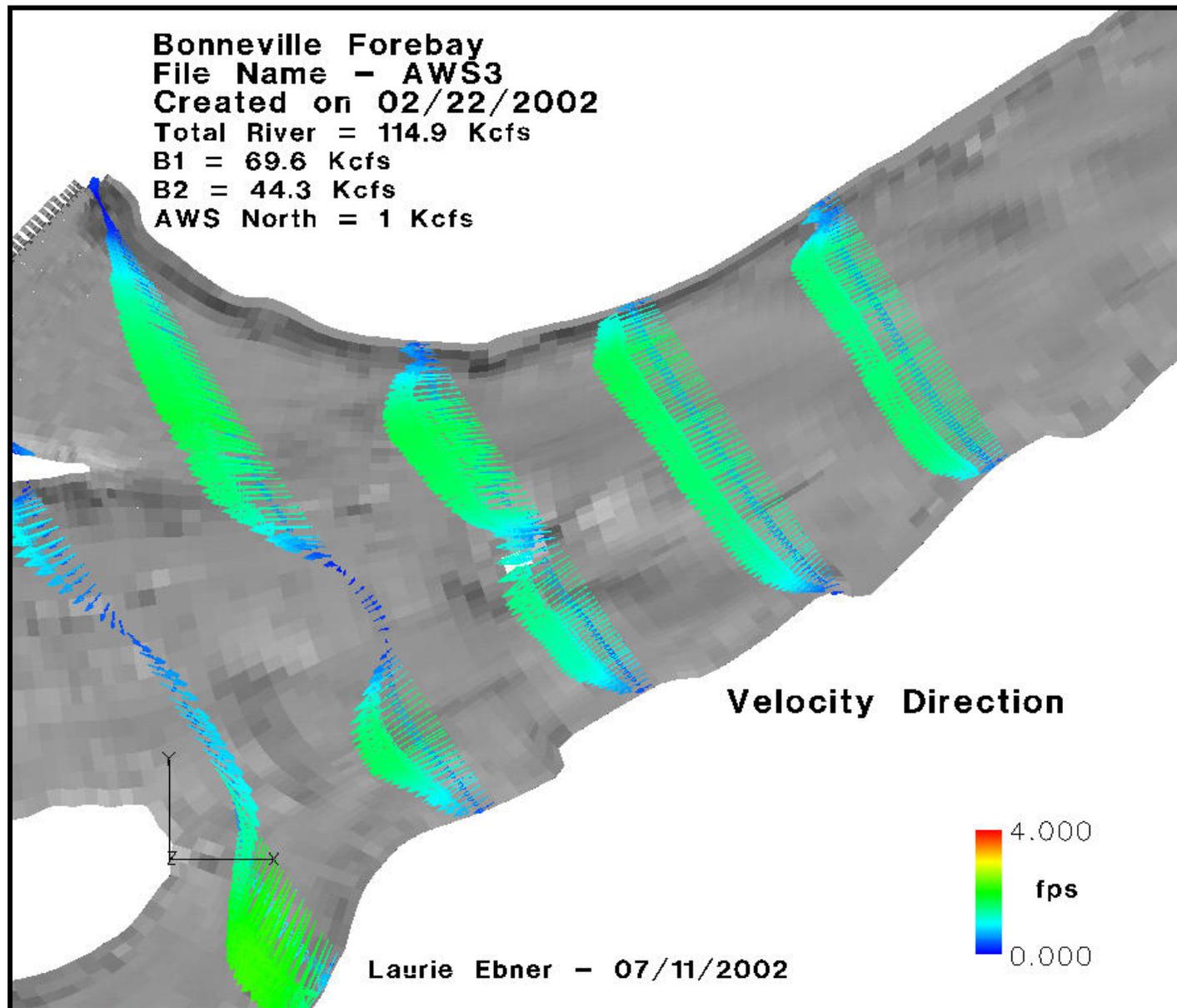


Figure 2

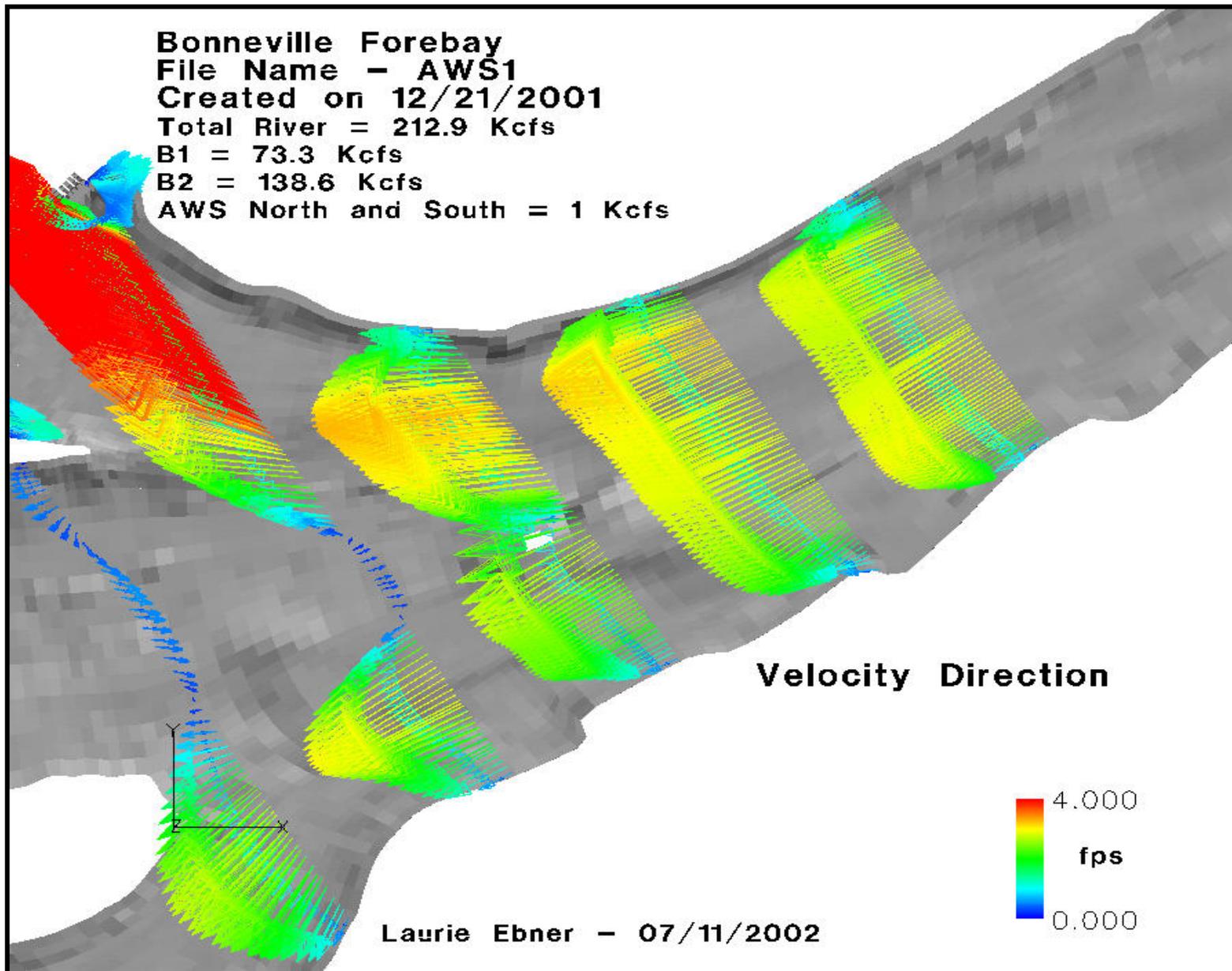


Figure 3

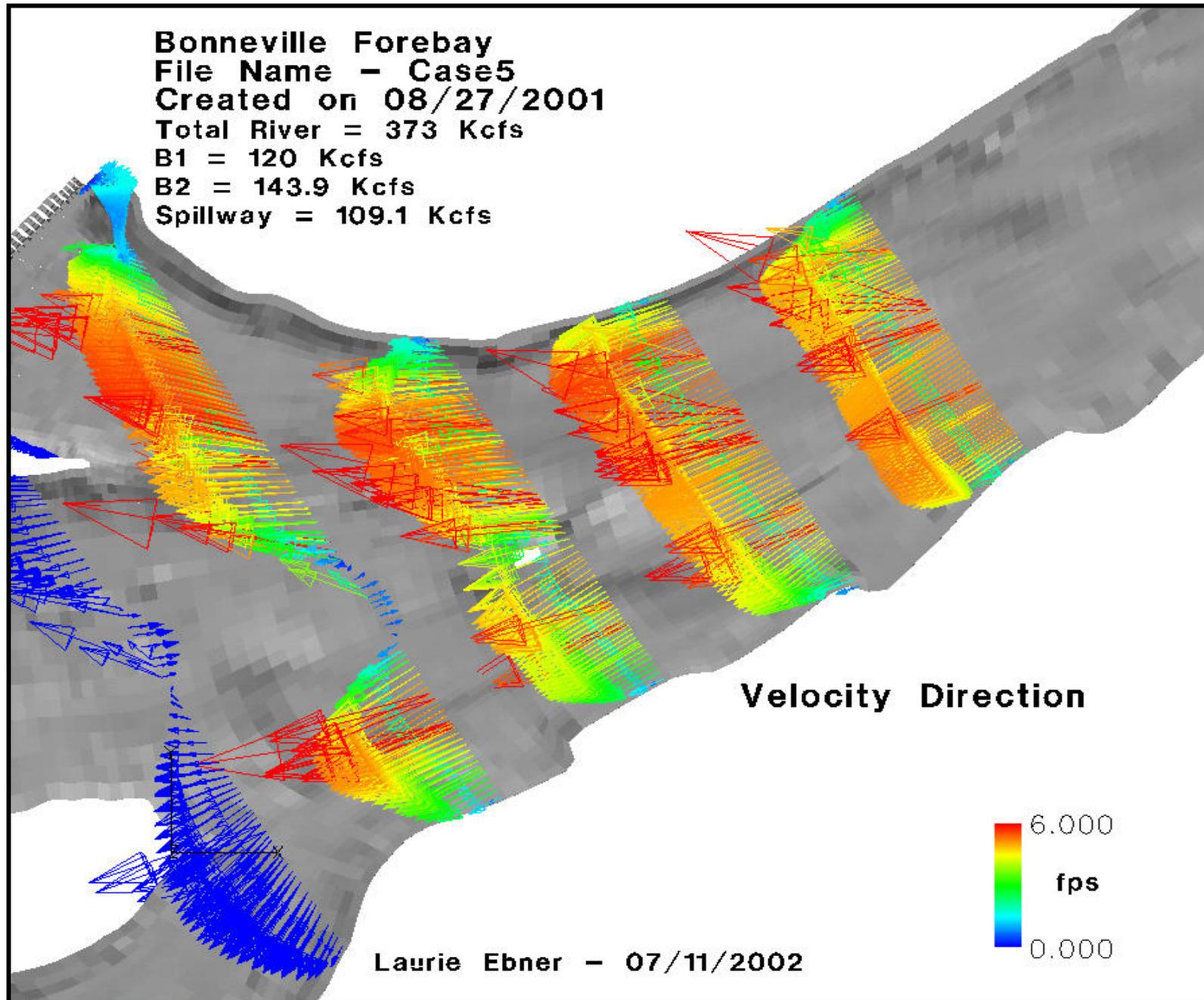


Figure 4

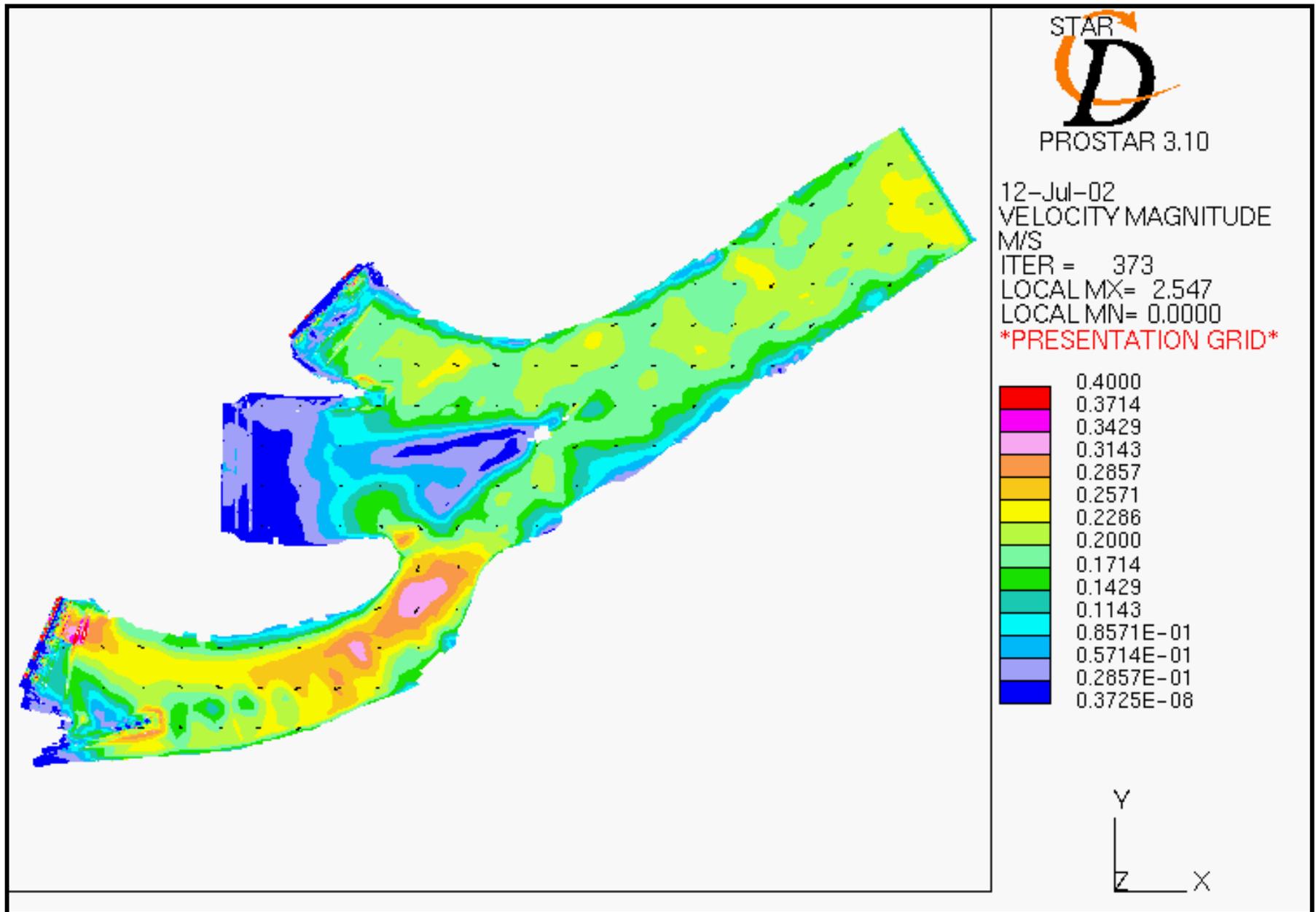


Figure 5

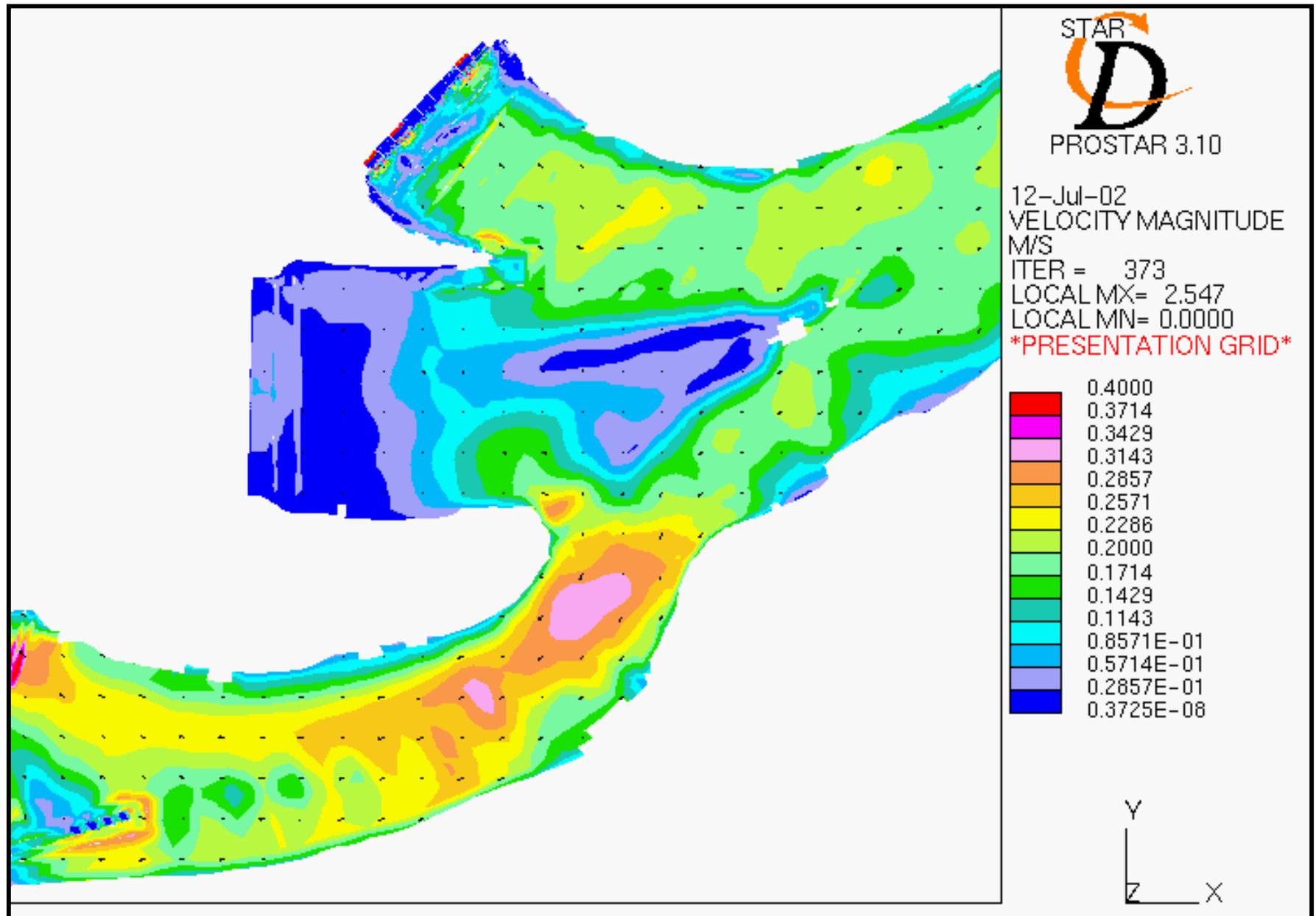


Figure 6

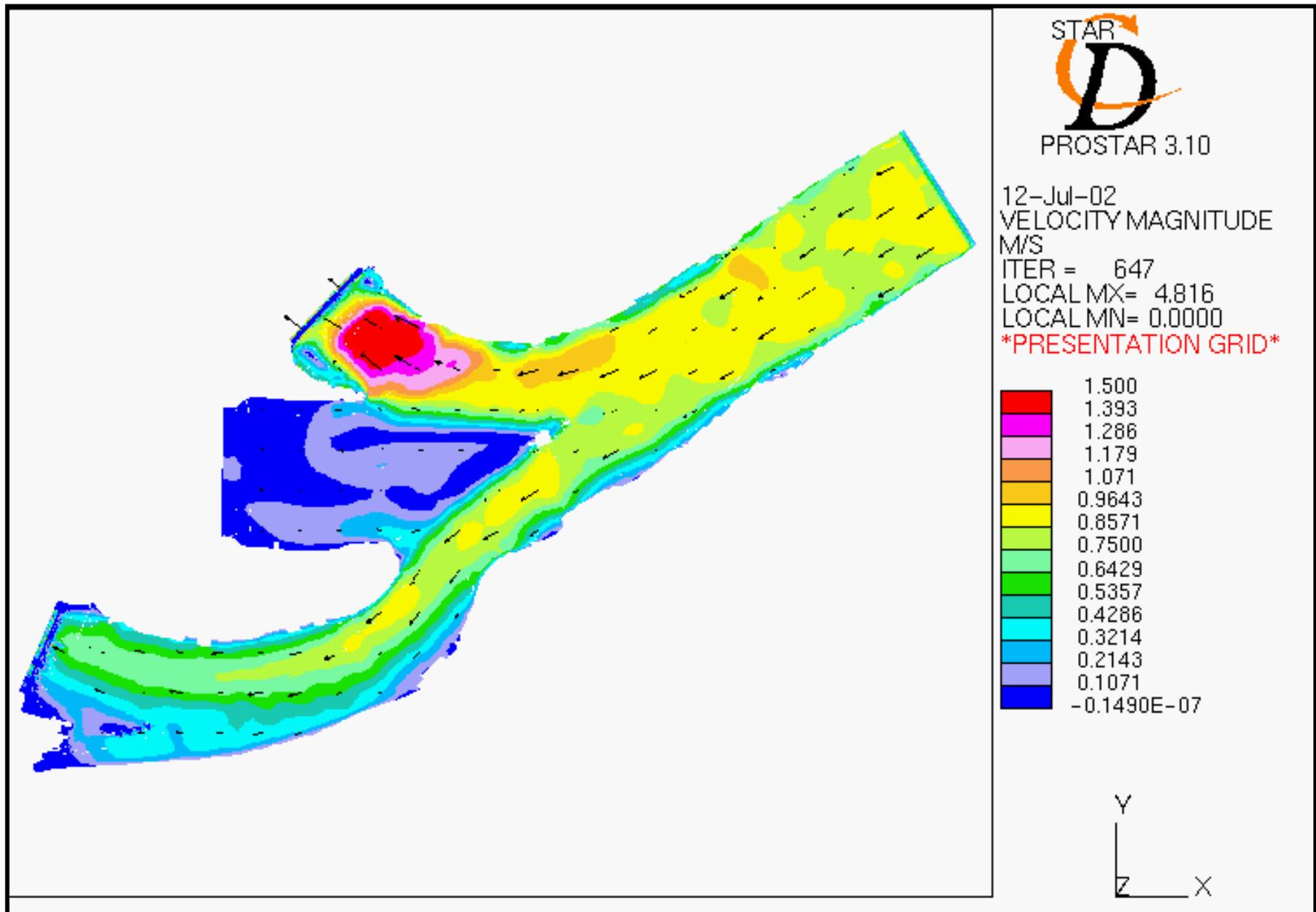


Figure 7

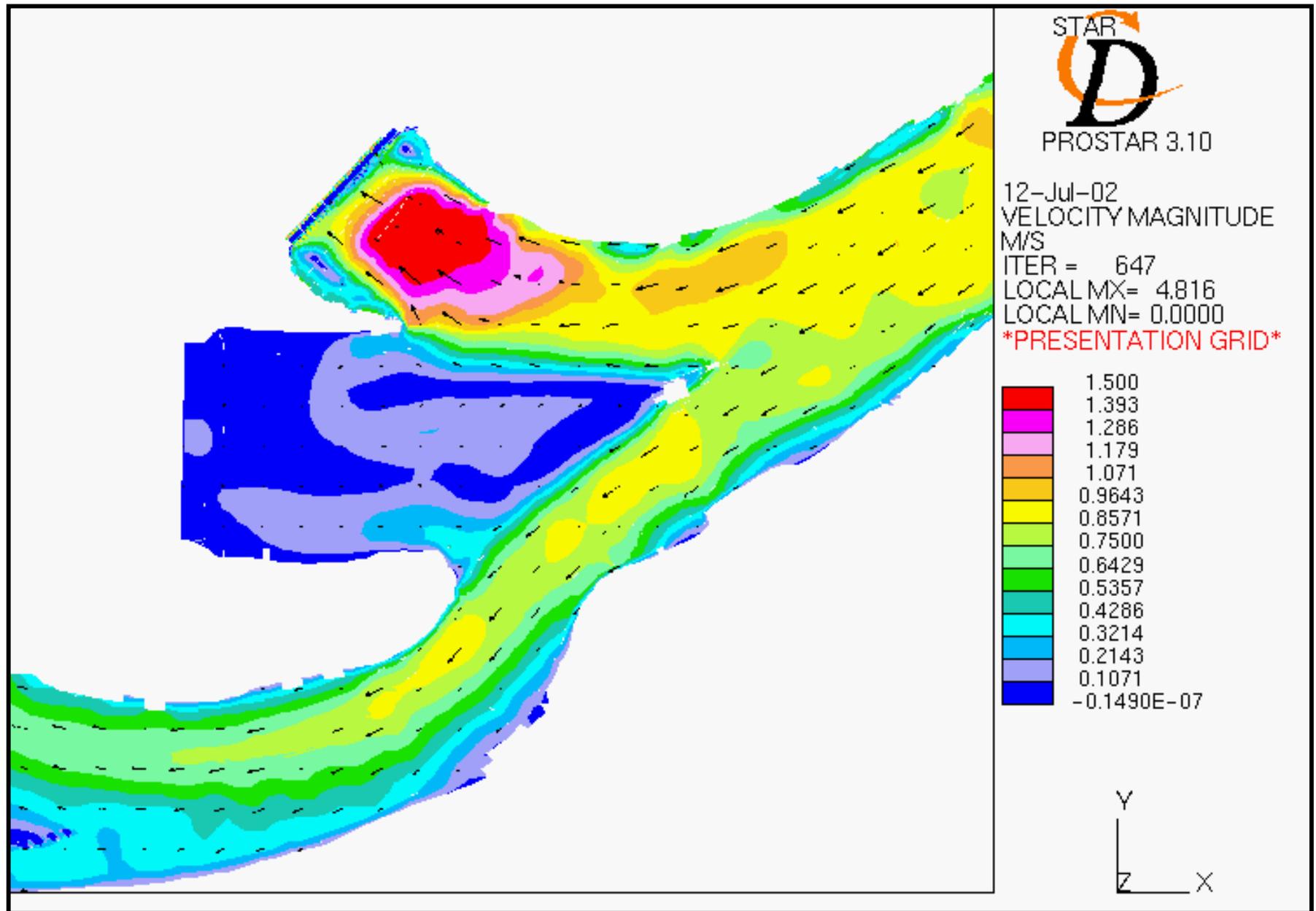


Figure 8

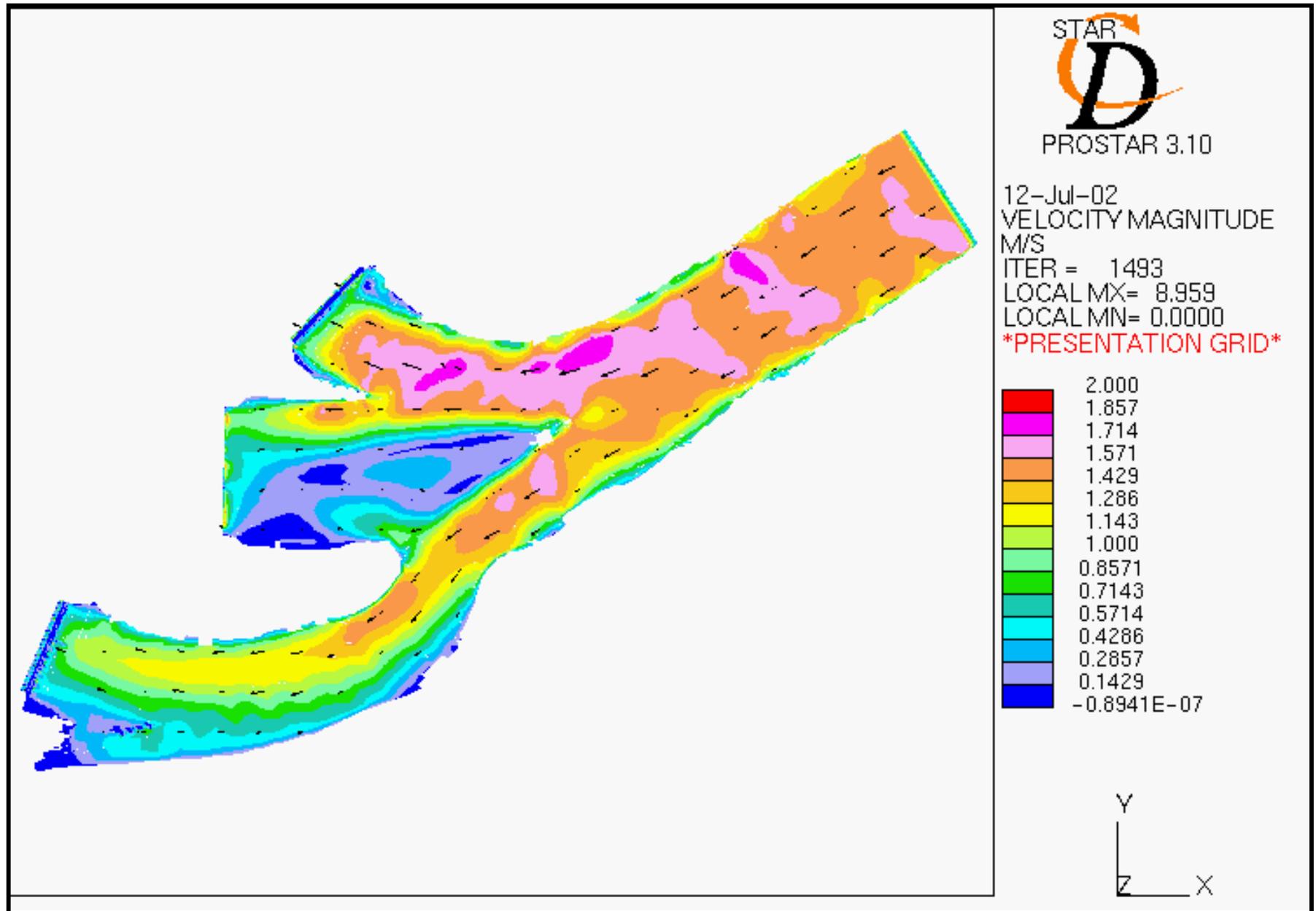


Figure 9

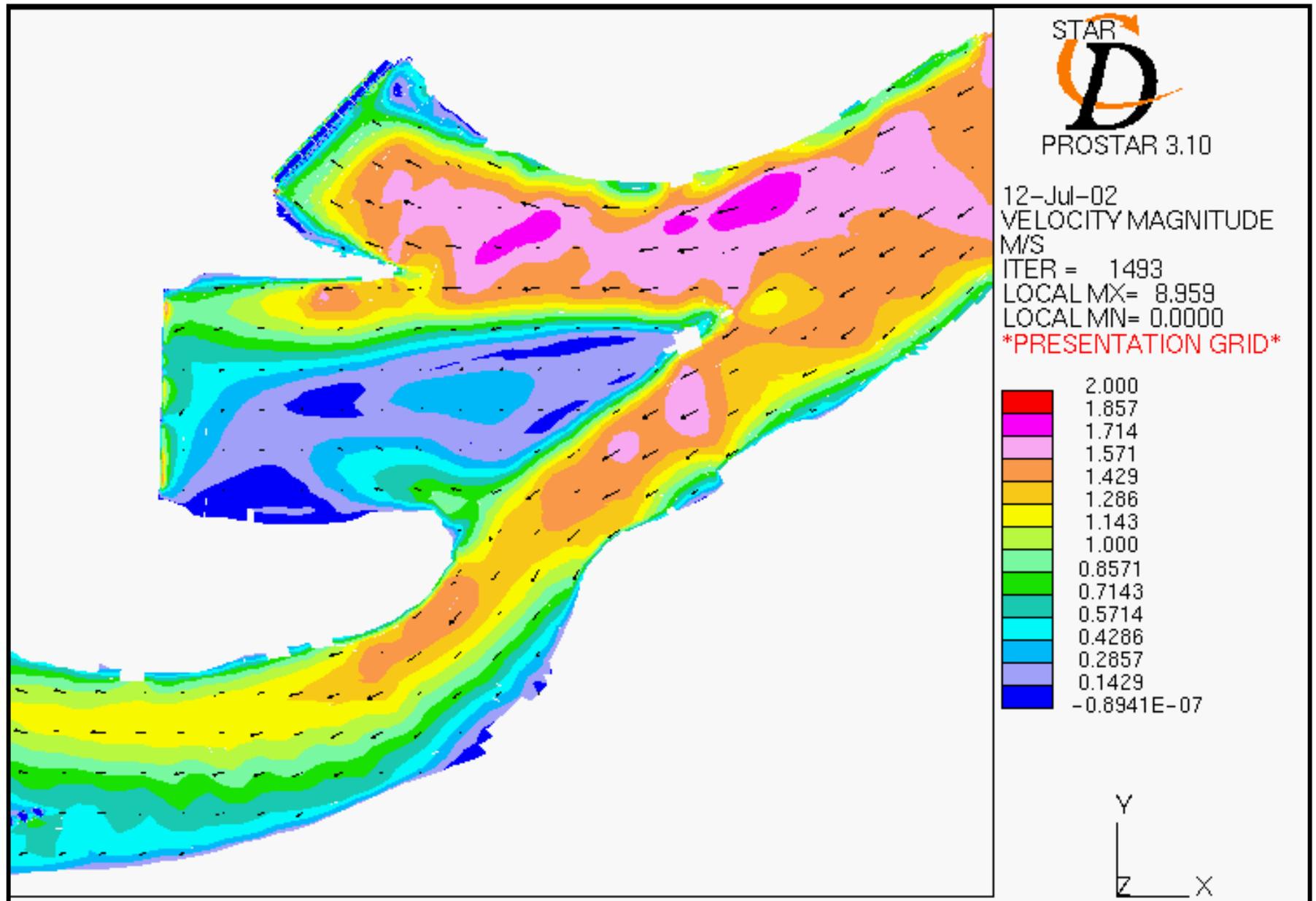


Figure 10

