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UPPER COLUMBIA RIVER

Quality Assurance Project Plan for the 2009 Fish Tissue Study

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EXECUTIVE SUMMARY

This document presents the 2009 fish tissue quality assurance project plan (QAPP) for the Upper Columbia River (UCR) Site remedial investigation and feasibility study (RI/FS). The primary objectives of the RI/FS are to investigate the nature and extent of contamination at the Site and to assess risks to human health and the environment to an extent sufficient to develop and evaluate potential remedial alternatives for the Site that will meet applicable or relevant and appropriate requirements (ARARs), and statutory and regulatory requirements.

WHAT is the purpose?

The primary purpose of the 2009 fish tissue QAPP is to collect information on chemical concentrations in fish tissues from the UCR that will be used to fulfill the data needs of the RI/FS and ecological and human health risk assessments.

WHY is fish tissue sampling being done?

The primary data gaps identified from existing studies include: 1) the lack of data from smaller sized fish to evaluate risks to piscivorous fish and wildlife; 2) the lack of data on some sport fish species (i.e., smallmouth bass and kokanee); 3) the lack of data for fillet tissues of important sport fish; and 4) the lack of data on some chemicals of interest identified during the draft screening-level ecological risk assessment (TCAI 2008).

In addition, results of Phase II sediment studies will provide data on spatial distributions of chemicals of interest (COIs) that will guide the locations for benthic macroinvertebrate tissue collections. Evaluation of COI concentrations in bottom-dwelling fish species with small home ranges such as sculpin will be considered for inclusion in the design of Phase III benthic tissue data collection.

WHERE will the fish be collected?

In order to fill the data gaps described above, the 2009 fish tissue QAPP intends to sample a variety of fish from six locations throughout the UCR. The six locations (fish sample collection areas, FSCAs) are the same locations as sampled by the U.S. Environmental Protection Agency (EPA) in 2005.

HOW will the sampling be designed?

The 2009 sampling event will target the following fish size classes, based on total length:

- <15 centimeters (cm)
- ≥15 to ≤30 cm
- >30 cm

These size classes correspond to the sizes of fish that are typically consumed by piscivorous fish and wildlife or human receptors. The fish species targeted within each size class represent varying feeding guilds (e.g., omnivores and piscivores). The target species are:

<15 cm size class – A goal of six whole body composites (minimum of five fish per composite) consisting of one species per composite will be targeted. A goal of six species from three feeding guilds will be targeted to achieve representation across guilds:

- Primary species
  - Omnivore – yellow perch
  - Insectivore – rainbow trout
  - Benthivore/detritivore – largescale sucker
- Secondary species
  - Omnivore – bluegill
  - Insectivore – whitefish
  - Benthivore/detritivore – longnose or bridgelip sucker
- Tertiary Species (may include)
  - Omnivore – redside shiner, crappie, pumpkinseed, and smallmouth bass
  - Insectivore – pikeminnow
  - Benthivore/detritivore – sculpin

≥15 to ≤30 cm size class – A goal of six whole body composites (minimum of five fish per composite) consisting of one species per composite will be targeted. A goal of six species from three feeding guilds will be targeted to achieve representation across guilds:

- Primary species
  - Benthivore/detritivore – largescale sucker
  - Insectivore – kokanee
  - Piscivore – walleye
- Secondary species
  - Benthivore/detritivore – longnose or bridgelip sucker
  - Insectivore – lake whitefish
  - Piscivore – smallmouth bass
- Tertiary species (may include)
  - Benthivore/detritivore – sculpin
  - Insectivore – Mountain whitefish
  - Piscivore – Pikeminnow

>30 cm size class — Six single-species composite samples (minimum of five fish) will be collected for each of the following species:

- Walleye – piscivore – fillet and remainder
- Burbot – piscivore - fillet and remainder
- Smallmouth bass – piscivore - fillet and remainder
- Largescale sucker – benthivore/detritivore - fillet and remainder (without gut contents)
- Rainbow trout – omnivore - fillet and remainder
- Kokanee – insectivore - fillet and remainder
- Whitefish – insectivore - fillet and remainder

A goal of six composite samples (with a minimum of five individual fish per composite) for the <15 and ≥15 to ≤30 size classes and six composite samples for each species of the >30 cm size class will be collected at each of the six FSCAs, for a total of 576 composite samples (whole body, fillet, and remainder composites). Whole body composite samples will be collected for fish in the two smallest size classes, while fillet (skin on) and remainder samples will be evaluated for the >30 cm composite samples.

The analytical suite of chemicals that will be analyzed in fish tissues will include metals/metalloids (including mercury), inorganic arsenic (arsenic speciation for burbot >30 cm), dioxins/furans, total polychlorinated biphenyls (PCBs), PCB congeners, polybrominated diphenylethers, organochlorine pesticides, polyaromatic hydrocarbons, and some semivolatile organic compounds.

WHEN will the fish be collected?

The 2009 fish tissue sampling event is planned for the fall of 2009 (September/October).

SECTION A: PROJECT MANAGEMENT

A1: TITLE AND APPROVAL SHEET

QUALITY ASSURANCE PROJECT PLAN
FOR THE 2009 FISH TISSUE STUDY

Quality Assurance Project Plan Approvals

EPA Project Coordinator:	Helen Boltcher	Helen A. Boltcher	Date: 9/8/2009
EPA Quality Assurance (QA) Manager:	Gina Grepo-Grove		Date: 9/16/2009
Teck Project Coordinator:	Marko Adzic		Date: 09-01-09
Technical Team Coordinator:	Anne Fairbrother	Anne Fairbrother	Date: 9/10/09
Task Manager:	David Mayfield		Date: 9/10/09
Task QA Coordinator:	Rock Vitale		Date: 9/14/09
Columbia Analytical Services Project Manager:	Jeff Christian		Date: 9/14/09
Columbia Analytical Services QA Manager:	Julie Glish	Julie Glish	Date: 9/14/09
SGS Environmental Services Project Manager:	Linda McWhirter		Date: 9/14/09
SGS Environmental Services QA Manager:	Jennie Milholland	Jennie Milholland	Date: 9-14-2009
Frontier Geosciences Project Manager:	Patrick Garcia-Strickland		Date: 9/15/09
Frontier Geosciences QA Manager:	Kristina Spadafora	Kristina Spadafora	Date: 9/15/09

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ACRONYMS AND ABBREVIATIONS

Agreement	June 2, 2006 Settlement Agreement
ACG	analytical concentration goal
ANOVA	analysis of variance
ARARs	applicable or relevant and appropriate requirements
ARNT	aryl hydrocarbon receptor nuclear translocator
AWQC	ambient water quality criteria
BERA	baseline ecological risk assessment
BEST	Biomonitoring of Environmental Status and Trends
BWMP	Basic Water Monitoring Plan
CBR	critical body residue
COC	chain-of-custody
COI	chemical of interest
CSM	conceptual site model
DDT	dichlorodiphenyltrichloroethane
DQO	data quality objective
DMP	data management plan
Ecology	Washington State Department of Ecology
Eco-SSL	Ecological Soil Screening Level
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
EROD	ethoxyresorufin-o-deethylase
ESI	Environmental Services, Inc.
FDA	Food and Drug Administration
FSCA	fish sample collection area
FSP	field sampling plan
GC/MS	gas chromatography/mass spectrometry
GIS	geographic information system
HHRA	human health risk assessment

HIS	hepatosomatic index
HQ	hazard quotient
Integral	Integral Consulting Inc.
Lake Roosevelt	Franklin D. Roosevelt Lake
LCS	laboratory control sample
LOAECs	lowest observed adverse effect concentrations
MDL	method detection limit
MQOs	measurement quality objectives
MRL	method reporting limit
NASQAN	National Stream Quality Accounting Network
NCBP	National Contaminant Biomonitoring Program
NFGs	national functional guidelines
NIST	National Institute of Standards and Technology
NOAEC	no observed adverse effect concentration
PAH	polycyclic aromatic hydrocarbon
Parametrix	Parametrix, Inc.
PARCC	precision, accuracy or bias, representativeness, completeness, and comparability
PBDE	polybrominated diphenylether
PCB	polychlorinated biphenyl
QA	quality assurance
QA/QC	quality assurance and quality control
QC	quality control
QAPP	quality assurance project plan
RBCs	risk-based-concentrations
RI/FS	remedial investigation and feasibility study
RPD	relative percent difference
RM	river mile
RSD	relative standard deviation
SAB	Science Advisory Board

SEV	screening ecotoxicity value
SHSP	site health and safety plan
Site	Upper Columbia River site
SLERA	screening-level ecological risk assessment
SOP	standard operating procedure
SSI	splensomatic index
SVOC	semivolatile organic compound
TAL	Target Analyte List
TAI	Teck American Incorporated
TCDD	2,3,7,8-tetrachlorinated dibenzo-*p*-dioxin
TCDF	tetrachlorodibenzofuran
TEF	toxic equivalency factor
TEQ	2,3,7,8-tetrachlorinated dibenzo-*p*-dioxin toxic equivalent
TRV	toxicity reference value
UCL	upper confidence limit
UCR	Upper Columbia River
USGS	U.S. Geological Survey
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife

UNITS OF MEASURE

cm	centimeter(s)
dw	dry weight
g	gram(s)
in.	inch(es)
kg	kilograms
mg	milligram(s)
mg	microgram(s)
ml	milliliter(s)
mm	millimeter(s)
ng	nanogram(s)
pg	picograms
ww	wet weight

A3 DISTRIBUTION LIST

EPA Project Coordinator:	Helen Bottcher
EPA QA Manager:	Gina Grepo-Grove
Teck Project Coordinator:	Marko Adzic
Technical Team Coordinator:	Anne Fairbrother
Task Manager:	David Mayfield
Task QA Coordinator:	Rock Vitale
Field Supervisor:	Joe Volosin/Jesse Bennett
Database Administrator:	Dreas Nielsen
Parametrix, Inc. Project Manager:	David Mayfield
Columbia Analytical Services Project Manager:	Jeff Christian
Columbia Analytical Services QA Manager:	Julie Gish
SGS Environmental Services Project Manager:	Linda McWhirter
SGS Environmental Services QA Manager:	Jeannie Milholland
Frontier Geosciences Project Manager:	Patrick Garcia-Strickland
Frontier Geosciences QA Manager:	Kristina Spadafora

A4 INTRODUCTION AND TASK ORGANIZATION

A4.1 Introduction

This document presents the quality assurance project plan (QAPP) for the 2009 fish tissue study of the Upper Columbia River (UCR) (hereafter the Site[1]), which extends from river mile (RM) 745[2] to RM 596 near the Grand Coulee Dam. This study is one of the tasks that will be completed as part of the remedial investigation and feasibility study (RI/FS) that is being conducted by Teck American Incorporated (TAI) for the Site. The objective of the RI/FS is to investigate and describe the nature and extent of contamination at the Site and assess risks to human health and the environment to an extent sufficient to develop and evaluate potential remedial alternatives for the Site that will meet applicable or relevant and appropriate requirements (ARARs), and statutory and regulatory requirements. The human health risk assessment will be completed by the U.S. Environmental Protection Agency (EPA), and the remaining RI/FS tasks will be completed by TAI, with EPA oversight.

This QAPP describes the organization, data quality objectives (DQOs), study design, analytical procedures, and quality assurance and quality control (QA/QC) procedures upon which the 2009 fish tissue study will be based. The field sampling plan (FSP) describes field sampling protocols that will be followed when fish tissue samples are collected; the FSP is presented as an appendix to this QAPP (Appendix A). This format was adopted to provide a stand-alone document for use in the field during sample collection activities.

The primary objective of the 2009 fish tissue study is to collect information on chemicals of interest (COIs) in fish tissues from the Site for use in assessing potential risks to ecological receptors and people. An additional objective is to collect information on COIs in prey items for fish, including small-sized fish. Preliminary COI lists have been presented and discussed in the draft UCR RI/FS Work Plan and the draft UCR Screening-

[1] The Site is located wholly within Washington State and includes the portion of the UCR extending from the U.S.-Canadian border to Grand Coulee Dam, including Franklin D. Roosevelt Lake (Lake Roosevelt), and the areal extent of related contamination within the United States adjacent to the UCR. The Site includes the areal extent of contamination and all suitable areas in proximity to such contamination necessary for implementation of the response actions described in the Settlement Agreement.

[2] There is a discrepancy in river mile designations by U.S. Geological Survey (USGS) and by USEPA (2006a). USGS river miles increase from RM 680 to RM 682 over a less than 1 river mile segment when transitioning between the Inchelium and Rice USGS quadrants, whereas USEPA (2006c) increases from RM 680 to RM 681 over the same segment. To remain consistent with international borders, the USGS river mile designations are used herein.

Level Ecological Risk Assessment (SLERA) (TCAI 2008)[3]. EPA's DQO process (USEPA 2006b) was used to guide the development of the requirements and design rationale for data collection activities presented in this QAPP and associated FSP. Detailed discussions of the various study components are presented in subsequent sections of this QAPP and associated FSP.

A4.2 Task Organization

This section presents the organizational structure for activities associated with the 2009 fish tissue study, including task planning, management and oversight, fieldwork, sample analysis, and data management. TAI and its technical team are conducting this work with oversight from EPA. The overall organizational structure for the project is provided in the RI/FS Work Plan, which also describes the qualifications of TAI's technical team members. The TAI technical team organizational structure and its relationship to the overall project organization for this study are illustrated in Figure A-1. Contact information for TAI technical team task members is provided in Table A-1.

The fish tissue study planning team includes the following personnel and roles:

- EPA and TAI project coordinators
- TAI technical team coordinator
- EPA quality assurance (QA) manager
- TAI technical team task manager and field supervisor
- TAI technical team task senior technical advisor
- TAI technical team task QA coordinator
- TAI technical team database administrator
- Project managers and QA managers for the subcontractor laboratories.

Responsibilities associated with these roles are described below.

A4.2.1 EPA Organization and Responsibilities

EPA will oversee TAI activities associated with the 2009 fish tissue study and will coordinate U.S. Department of the Interior, Washington State Department of Ecology (Ecology), and tribal (i.e., the Confederated Tribes of the Colville Reservation and the Spokane Tribe of Indians) input with respect to the review of technical documents prepared and submitted by TAI consistent with the June 2, 2006 Settlement Agreement

[3] The draft SLERA is still under EPA review and has not been officially approved. Development of data gaps addressed in this QAPP were developed from information presented in the draft SLERA.

(Agreement). The EPA project coordinator is Helen Bottcher. Ms. Bottcher will also be responsible for ensuring that the work performed is consistent with all applicable EPA guidance. The EPA QA manager will be assigned by EPA.

A4.2.2 TAI Organization and Responsibilities

With the support of its technical team, TAI is responsible for conducting the 2009 fish tissue study with oversight provided by EPA. Marko Adzic will serve as TAI's project coordinator and will have the primary responsibility for ensuring that TAI meets all the requirements and associated deliverables specified within the Agreement (USEPA 2006c). Mr. Adzic will also be responsible for overseeing all technical aspects of this task, coordinating with EPA, and managing the overall task schedule. Assisting Mr. Adzic in coordinating efforts of the technical team, ensuring that internal deadlines and milestones are met, and tracking the overall task budget is Kris McCaig of TAI.

A4.2.3 Key Task Personnel

TAI technical team members for the 2009 fish tissue study and their respective responsibilities are identified below.

Technical Team Coordinator—Anne Fairbrother (Exponent) is responsible for coordinating the tasks of all the team members to ensure that required activities are completed in sequence and on time. Dr. Fairbrother will work closely with the task manager and QA coordinator to ensure that all requirements are met and study objectives achieved.

Task Manager—David Mayfield (Parametrix, Inc. [Parametrix]) is the task manager and is responsible for conducting the 2009 fish tissue study. Mr. Mayfield will work closely with the technical team coordinator, senior technical advisor, and the task QA coordinator to ensure that the objectives of the study are achieved.

Field Supervisor—Joe Volosin (Parametrix) and Jesse Bennett (Parametrix) are responsible for overseeing the planning and coordination of the fish tissue sampling efforts, and for all aspects of sample collection activities to ensure that appropriate sampling, quality assurance, and documentation procedures are used. In the event that changes in the QAPP or FSP are needed, Mr. Volosin (or Mr. Bennett) will ensure that proposed changes are coordinated with EPA's project coordinators or other designated EPA staff according to the established lines of communication among the TAI technical team, TAI, and EPA as noted in Figure A-1 and approved for the RI/FS. David Serdar (Integral Consulting Inc. [Integral]) will provide familiarity and expertise on fish sampling locations and methodologies.

Senior Technical Advisor(s)—Rick Cardwell (Cardwell Consulting, LLC) and Rosalind Schoof (Integral) are senior technical advisors for the 2009 fish tissue study, and are responsible for providing technical oversight in the design and implementation of the study, and ensuring that it meets the objectives of the RI/FS.

Task QA Coordinator—Rock Vitale (Environmental Services, Inc. [ESI]) is the task QA coordinator and is responsible for providing overall QA support for the 2009 fish tissue study; ensuring that the QAPP and FSP contain all components necessary to meet EPA guidelines (USEPA 2002a); coordinating the validation of laboratory data; communicating data quality issues to the data users; and working with data users and EPA to address any data limitations. Mr. Vitale will report directly to the project coordinator, and will work closely with the laboratory coordinator, the task manager, and the field supervisor to ensure that the objectives of the QAPP are met.

Analytical Chemistry Laboratory Coordinator—Stuart Currie (Parametrix) is the analytical chemistry laboratory coordinator and is responsible for ensuring that laboratory method selection and/or development is satisfactorily completed prior to the analysis of samples collected for this task; coordinating with the testing laboratory and tracking the laboratory's progress; verifying that the laboratory has implemented the requirements of this QAPP; addressing QA issues related to the laboratory analyses; ensuring that laboratory capacity is sufficient to undertake the required analyses in a timely manner; and addressing scheduling issues related to laboratory analyses. Mr. Currie will report directly to the Parametrix task manager.

Database Administrator—Dreas Nielsen (Integral) is the database administrator and will have primary responsibility for data management and database maintenance and development. Mr. Nielsen will be responsible for overseeing and/or conducting the following activities: establishing storage formats and procedures appropriate for all data collected during the RI/FS, including fish tissue; working with the field crew, laboratories, and data validators to ensure all data entries are correct and complete and are delivered in the correct format; maintaining the integrity and completeness of the database; and providing data summaries to data users in the required formats for interpretation and reporting. Mr. Nielsen will report directly to the TAI technical team coordinator and will work closely with the field supervisor, task QA coordinator, and the data validation firm.

Task Safety Officer—Ms. Sheila McConnell (Parametrix) is the task safety officer for the 2009 fish tissue study, and is responsible for providing health and safety oversight for the field staff that will be collecting the fish tissue samples.

A4.2.4 Laboratories

The following responsibilities apply to the project managers and QA manager at the analytical laboratories used for the 2009 fish tissue study. The laboratories will be selected prior to initiation of field work. The laboratories will have the following staff available for this project.

Laboratory Project Manager—The laboratory project manager is responsible for the successful and timely completion of sample analyses, as well as the following actions:

- Ensure that samples are received and logged in correctly, that the correct methods and modifications are used, and that data are reported within specified turnaround times
- Review analytical data to ensure that procedures were followed as required in this QAPP, the cited methods, and laboratory standard operating procedures (SOPs)
- Apprise the chemical laboratory coordinator of the schedule and status of sample analyses and data package preparation
- Notify the chemical laboratory coordinator if problems occur in sample receiving, analysis, or scheduling, or if control limits cannot be met
- Take appropriate corrective action as necessary
- Report data and supporting QA information as specified in this QAPP
- Provide electronic data deliverables (EDDs) with the analytical data in a database format.

Laboratory QA Manager—The laboratory QA manager is responsible for overseeing the QA activities in the laboratory and ensuring the quality of the data for this task. Specific responsibilities include the following:

- Oversee and implement the laboratory's QA program
- Maintain QA records for each laboratory production unit
- Ensure that QA/QC procedures are implemented as required for each method and provide oversight of QA/QC practices and procedures
- Review and address or approve non-conformity and corrective action reports
- Coordinate responses to any quality control (QC) issues that affect this task with the laboratory project manager.

A5 PROBLEM DEFINITION AND BACKGROUND

Chemicals present in fish tissues have the potential to adversely affect ecological receptors and human health. The preliminary conceptual site model (CSM) for the Site provides the

framework for considering the relationships between fish tissues and people or ecological receptors (Figure A-2). The preliminary CSM was developed in the UCR RI/FS Work Plan and will undergo refinement throughout the RI/FS. Available fish tissue data were identified and evaluated in the RI/FS Work Plan, and screened against conservative benchmarks for wildlife within the draft SLERA (TCAI 2008) and for fish in Appendix B of this QAPP. In this section, information on existing data is reviewed. In subsequent sections, data gaps are discussed, and DQOs are developed.

In the next subsections, the following information is provided:

- The preliminary CSM, which frames the potential issues associated with COIs in fish tissue
- Overview of patterns that can be observed from existing fish tissue data
- Screening against conservative screening ecotoxicity values (SEVs)
- Important observations and issues related to fish tissue problem definition and study design.

A5.1 Preliminary Conceptual Site Model

The preliminary CSM provides a framework within which complex chemical, physical, and biological processes and interactions can be viewed in a systematic and organized manner. For the UCR RI/FS, the preliminary CSM is intended to evolve as additional information is collected. The preliminary CSM (Figure A-2) identifies fish tissue as a potentially important exposure medium and transport pathway for COIs. In addition, transport of COIs from zooplankton to fish tissues is also depicted on the preliminary CSM. Aspects of the preliminary CSM that relate specifically to fish tissue (Figures A-3, A-3.1, A-3.2, and A-3.3) provide the foundation for problem definition and are discussed in detail in Steps 1 and 2 of the DQO process (Sections A9.1 and A9.2).

A5.2 Overview of Existing Fish Tissue Data

The following is a brief overview of the historical fish tissue data (i.e., collected pre-2005) and data collected by the EPA in 2005; details of the analyses of fish tissue data that are available for the Site are provided in Appendix B. Several studies involving the collection and chemical analyses of fish tissue have been conducted at the Site since the early 1970s. Target chemical analytes have included metals, polychlorinated biphenyls (PCBs), dioxins and furans, and organochlorine pesticides. Fish tissue data for the Site are available from the following studies and memoranda:

- Hopkins et al. (1985)

- Johnson (1991a)
- Johnson and Yake (1989)
- Johnson et al. (1988; 1990; 1991a,b)
- Johnson and Serdar (1991)
- Serdar et al. (1991; 1994)
- Munn et al. (1995)
- EVS (1998)
- Hinck et al. (2004)
- Hinck et al. (2006)
- USGS (2006)
- USEPA (2007a) (2005 Phase I Fish Tissue Study)

All of the historical documents containing fish tissue data have been individually summarized by EPA (USEPA 2005a). Section A5.3 provides a summary of each of these studies, including methods, results, and author conclusions.

In addition to these historical studies, EPA collected and analyzed fish tissue from six locations across the Site in 2005 and issued a summary of the results (USEPA 2007a). Tissue samples from six species (burbot, largescale sucker, rainbow trout, lake whitefish, mountain whitefish, and walleye) consisting of both fillet and whole body samples, primarily as composites of five fish each, were collected. Additional evaluation of both the historical and the 2005 data has been carried out (see Appendix B) to help define data gaps and develop DQOs for fish sampling. Analyses that have been conducted to improve understanding of patterns relevant to the fish tissue sampling design include evaluation of:

- Applicability of available data to risk assessment (Section A5.4)
- Temporal and spatial patterns or trends of inorganic and organic COI concentrations in tissues of individual species (Section A5.5)
- Relationships between COI concentrations in fish tissue and relevant SEVs and critical body residues (CBRs) (Section A5.6).

A detailed description of analyses conducted and results produced is provided in Appendix B. For the purposes of designing the fish tissue sampling program, notable results and some key uncertainties are summarized below.

A5.3 Summary of Historic Fish Tissue Studies

Hopkins, B.S., D.K. Clark, M. Schlender, and M. Stinson. 1985. Basic water monitoring program, fish tissue and sediment sampling for 1984. Publication No. 85-7. Washington State Department of Ecology, Olympia, WA.

This document is a result of Ecology's Basic Water Monitoring Plan (BWMP) that was initiated in 1978. Fish tissues were analyzed to obtain information on the incidence and distribution of metals and synthetic organic compounds in the aquatic environment. The data collected were used to identify potential problem areas requiring further investigation. This document reports data from the 1984 field season, and BWMP data from 1978 to 1983 for reference. The 1984 BWMP effort was the first year that stream sediments were sampled at each station where fish were collected.

Methods. Twelve stations were selected for sampling based on the 1983 BWMP results. Two sites were not sampled, however, due to field conditions. Sampling locations included: Wenatchee River at Wenatchee; Lake Chelan at outlet; Okanogan River near Malott; Columbia River at Northport; Palouse River at Hooper; Walla Walla River below Warm Springs; Yakima River below Kiona; Yakima River at Birchfield Drain; Skagit River near Mount Vernon; and the Green/Duwamish River.

At each station fish species were collected representing two trophic levels; the same species were collected at each station when possible to provide comparability. Six species were collected overall: bridgelip sucker, longnose sucker, mountain sucker, mountain whitefish, northern pikeminnow, and largemouth bass. Sediment was also collected from the stream channel at each station. Three tissue types were isolated from each composite (liver, gill, fillet with skin) and analyzed for pesticides and metals.

Conclusions. The authors concluded that for samples collected at Northport, Washington (in the UCR) fillet tissue contained an average lead level that was 90 percent of the unofficial Food and Drug Administration (FDA) guideline for other food types. Cadmium, copper, and zinc concentrations were also considered to be elevated by the authors.

Johnson, A. and W. Yake. 1989. Survey of mercury and dioxin in Lake Roosevelt sport fish in 1989. Preliminary results for mercury. Publication No. 89-e29. Washington State Department of Ecology, Olympia, WA.

The purpose of this survey was to address concerns raised by the Colville Tribes and the Lake Roosevelt Water Quality Council. A previous mercury analysis was performed in 1988 showing uniformly low concentrations of mercury, but because of elevated

concentrations in the lake's bottom sediments and discharge of mercury from the Cominco lead-zinc smelter and refinery at the time, another survey was considered justified. Muscle tissue samples were collected off Marcus Island (sturgeon), at the Colville River mouth (walleye), and at the mouth of Hawk Creek (walleye). Mercury concentrations, expressed in wet weight (ww), ranged from 0.05 to 0.24 micrograms per gram (μg/g) (mean of 0.155 μg/g) in walleye and 0.02 to 0.10 μg/g (mean of 0.05 μg/g) in white sturgeon.

Conclusions. The authors concluded: 1) none of the samples exceeded the FDA action level of 1.0 μg/g of mercury for commercially marketed fish at that time; 2) results are consistent with the 1986 survey and posed no threat to human health; and 3) mercury concentrations in other sport fish species in Lake Roosevelt were expected to be equal or lower.

Johnson, A., D. Serdar, and D. Norton. 1991a. Spatial trends in TCDD/TCDF concentrations in sediment and bottom fish collected in Lake Roosevelt (Columbia River). Publication No. 91-29. Washington State Department of Ecology, Olympia, WA.

In June of 1990, Ecology collected sediment and fish tissue samples from Lake Roosevelt for analysis of PCDDs and PCDFs. The authors' objective was to evaluate the transport and distribution of these chemicals throughout the lake.

Methods. Largescale sucker were collected from six locations in Lake Roosevelt, including Northport (RM 735), China Bend (RM 724), Marcus Flats (RM 709), French Point Rocks (RM 692), Hunters (RM 661), and the Grand Coulee Dam (RM 601). Whole-fish composites consisting of five fish each were analyzed for 2,3,7,8- substituted dioxin and furan compounds, and percent lipids.

Results. Concentrations of 2,3,7,8-TCDD in whole sucker ranged from 0.9 to 2.6 picograms per gram (pg/g) ww, with the highest concentrations occurring in fish collected from Marcus Flats (RM 709). Concentrations of 2,3,7,8-TCDF in whole sucker composites ranged from 17 pg/g ww to 48 pg/g ww, again with the maximum at Marcus Flats.

Conclusions. The authors concluded that TCDD and TCDF had been transported up to 200 miles from the presumed source (the Celgar Pulp mill). Significant deposition of the chemicals was first observed near Kettle Falls, about 53 miles south of the U.S.-Canadian border. The authors also concluded that the distribution of TCDD and TCDF in fish tissue resembled that of the sediments, and indicated that there was a consistent tissue (lipid weight) to sediment (TOC-normalized) ratio of 0.07 throughout the study area.

Johnson, A., D. Serdar, and S. Magoon. 1991b. Polychlorinated dioxins and furans in Lake Roosevelt (Columbia River) sport fish, 1990. Publication No. 91-4. Washington State Department of Ecology, Olympia, WA.

The objective of this study was to estimate the mean concentrations of TCDD and TCDF in muscle tissue of major sport fish in Lake Roosevelt.

Methods. Muscle tissue samples of 12 walleye, 12 rainbow trout, 12 lake whitefish, 4 white sturgeon, 2 kokanee, and 2 burbot from two areas of Lake Roosevelt were collected. Each sample was a composite of 5 fish (4 fish were used in burbot composites). The two parts of the reservoir sampled included "upper" Lake Roosevelt from Northport to Kettle Falls (RM 735 to RM 700), and "lower" Lake Roosevelt (RM 637 to RM 600). Lake Rufus, downstream of Lake Roosevelt, was also sampled.

PCDD and PCDF compounds were analyzed by EPA Method 8290 (isotope-dilution, high resolution gas chromatography/mass spectrometry [GC/MS]). Lipid content was analyzed.

Results. TCDD was detected in all samples of kokanee, lake whitefish, and white sturgeon, and in the majority of rainbow trout samples. TCDF was detected in all species, and were generally higher than TCDD concentrations. Mean 2,3,7,8-TCDD TEQ concentrations ranged from 0.3 pg/g in burbot in the upper reservoir to 17 pg/g in white sturgeon, also in the upper reservoir.

Conclusions. Concentrations of dioxins and furans in fish from Lake Roosevelt were compared to those provided by several national data sets. The authors concluded that TCDF in lake whitefish and white sturgeon was elevated relative to local and national data. TEQ concentrations in lake whitefish and white sturgeon from Lake Roosevelt were the highest that had been reported in the Columbia River at the time the report was published. The authors recommended wastewater treatment at the Celgar Pulp Company mill, establishment of a fish tissue monitoring program, and evaluation of adverse biological effects.

Johnson, A. 1991b. Review of metals, bioassay, and macroinvertebrate data from Lake Roosevelt benthic samples collected in 1989. Publication No. 91-e23. Washington State Department of Ecology, Olympia, WA.

The purpose of this screening survey was to address concerns raised by the Colville Tribes and the Lake Roosevelt Water Quality Council about dioxin and furan contamination in Lake Roosevelt sport fish. A previously planned investigation of mercury concentrations in walleye and white sturgeon was combined with this study.

The concerns raised about the dioxin and furan contamination stemmed from a 1989 Environment Canada report of elevated concentrations of TCDD and TCDF in lake whitefish. Because this study was an initial screening, muscle tissue for two of each species were collected. A duplicate sample was run on one of the white sturgeon samples. Tissue samples were collected from Lake Roosevelt near Kettle Falls. The results of the study, expressed in ww, were:

- White sturgeon – Mean TCDD concentrations (nanogram per kilogram [ng/kg]) in the two fish were 2.4 ng/kg and 0.1 ng/kg. Mean TCDF concentrations in the two fish were 271 ng/kg and 3.9 ng/kg.
- Walleye – TCDD concentrations in the two fish were 0.21 ng/kg and 4.0 ng/kg. TCDF concentrations in the two fish were 8.9 ng/kg and 326 ng/kg.

Samples were reanalyzed because of the large differences in results. The re-analysis confirmed the validity of the original results. The authors suggested that a potential reason for the disparity of the sampling results could be related to movements of the fish, because the species are known to have large ranges.

Conclusions. The authors concluded that the sample size was too small and the results too varied to consider a health advisory for consumption of Lake Roosevelt fish. In comparison to the 1989 Environment Canada results, the two elevated TCDD and TCDF results were approximately one-third to one-half of the whitefish collected below the Celgar mill. The low to non-detectable TCDD and TCDF results were comparable to fish collected above the Celgar mill.

Johnson, A. and D. Serdar. 1991. Metals concentrations in Lake Roosevelt (Columbia River) largescale suckers. Memorandum to Carl Nuechterlein, June, 21, 1991. Publication 91-e26. Washington State Department of Ecology, Olympia, WA.

Largescale suckers had been collected from Lake Roosevelt and Lower Arrow Lake in September 1989 and kept frozen as part of a British Columbia Ministry of Environment study. The fish were given to Ecology in 1990 to be analyzed for metals. The muscle tissue from suckers collected at Lake Roosevelt was analyzed for mercury, bone tissue was analyzed for lead, and liver tissue was analyzed for cadmium; muscle tissue from suckers collected at Lower Arrow Lake was analyzed for mercury and bone tissue was analyzed for lead.

Results. Results from the Lake Roosevelt specimen for lead, mercury, and cadmium were 36.9, 1.59, and 10 milligrams per kilogram (mg/kg) dry weight (dw), respectively. Results from the Lower Arrow Lake specimen for lead and mercury were 0.35 and 1.17 mg/kg dw, respectively. The dw results converted to ww, assuming 70 percent moisture, from

the Lake Roosevelt specimen for lead, mercury, and cadmium were 11.1, 0.48, and 3 mg/kg ww, respectively. Results from the Lower Arrow Lake specimen for lead and mercury were 0.11 and 0.35 mg/kg ww, respectively.

Conclusions. The authors concluded that lead in bone samples from the Lake Roosevelt fish were two orders of magnitude higher than samples from the Lower Arrow Lake and that muscle tissue samples from Lake Roosevelt have slightly higher mercury concentrations than from Lower Arrow Lake.

Serdar, D., B. Yake, and J. Cubbage. 1994. Contaminant trends in Lake Roosevelt. Publication No. 94-185. Washington State Department of Ecology, Olympia, WA.

The purpose of this study was to evaluate changes in pollutant loads to Lake Roosevelt over time in lake whitefish and largescale suckers; and thereby document the effects of pollution controls being implemented by Canadian industries.

Methods. The fish were collected from the UCR (from the U.S.-Canadian border south to Kettle Falls) in 1992 and 1993. Largescale suckers were analyzed as whole fish and lake whitefish as muscle tissue and eggs. Chemical analytes included dioxins, furans, cadmium, copper, lead, mercury, and zinc. Results were compared to prior studies and national averages.

Conclusions. The authors concluded that:

- Concentrations of TCDD and TCDF in 1992 and 1993 were well below values from 1990 in both whitefish muscle and egg tissue. TCDD and TCDF concentrations in egg tissue rose in 1993 from 1992 levels. The reduction in TCDD and TCDF concentration are largely a result of modifications at the Celgar Pulp mill.
- 2,3,7,8-TCDD and 2,3,7,8-TCDF are responsible for nearly all of the whitefish muscle TEQ.
- Concentrations of copper, lead, and zinc in whole largescale suckers were higher at Northport (near the U.S.-Canadian border) than at Kettle Falls.
- Concentrations of mercury in whole largescale suckers were 50 percent higher at Kettle Falls than at Northport.
- Concentrations of cadmium, copper, lead, and zinc in Northport and Kettle Falls were very high compared to national averages.

USGS. 1995. Concentrations of mercury and other trace elements in walleye, smallmouth bass, and rainbow trout in Franklin D. Roosevelt Lake and the Upper Columbia River, Washington 1994. 95-195. U.S. Geological Survey, Tacoma, WA. 35 pp.

The purpose of this study was to determine the concentrations of mercury and other trace elements in sport fish in the Columbia River. Prior studies identified concerns about bioaccumulation of trace elements in sport fish in the Columbia River posing a risk to human and environmental health. The primary objectives of the study were to 1) determine the concentrations of total mercury, arsenic, cadmium, copper, lead, manganese, selenium, and zinc in fillets of walleye, smallmouth bass, and native and net-pen rainbow trout; and 2) determine the liver tissue concentrations of cadmium, copper, lead, and zinc in the same species as a point of comparison for future studies. Walleye, smallmouth bass, and rainbow trout were chosen for this study because of historically high concentrations of mercury (walleye) and popularity as sport fish (smallmouth bass and rainbow trout).

Methods. Composites of fish muscle tissue were collected in 1994 from three areas:

- Upper reach—Columbia River and Lake Roosevelt near Kettle Falls
- Middle reach—Lake Roosevelt and lower Spokane River
- Lower reach —Sanpoil River embayment.

Four size classes of walleye were collected: 10 to 13 inches (in.), 13 to 16 in., 16 to 19 in., and 19 to 22 in. A total of 34 walleye composites were collected, with each composite consisting of 8 individual fillets from fish of the same size class. Individual fillets were also analyzed from the 13 to 16 in. size class. Smallmouth bass were sampled the same as walleye, but with only a single size class of 8 to 12 in. Rainbow trout were not sorted into size classes, but were analyzed as individuals. Fillet samples included the belly flap, but the skin had been removed.

Results. Mercury concentrations ranged from 0.11 to 0.44 mg/kg, with the lowest concentrations reported from the 10 to 13 in. size class, and the highest concentrations in the 19 to 22 in. size class. Concentrations of mercury in smallmouth bass ranged from 0.16 to 0.62 mg/kg, native rainbow trout from 0.16 to 0.24 mg/kg, and net-pen rainbow trout from 0.11 to 0.16 mg/kg.

Concentrations of other trace elements in walleye, smallmouth bass, and rainbow trout fillets are shown in Table 7 of USGS (1995), and include:

- Arsenic – below detection
- Cadmium – below detection

- Copper – 0.27 to 0.68 mg/kg
- Lead – below detection (0.05) to 0.1 mg/kg
- Manganese – 0.09 to 0.54 mg/kg
- Selenium – below detection to 0.39 mg/kg
- Zinc – 3.7 to 6.1 mg/kg (11 samples outside laboratory control limits).

Cadmium, copper, lead, and zinc in liver tissue are provided in Table 10 of USGS (1995) and include:

- Cadmium – 0.9 to 15.7 μg/g (highest in walleye and native rainbow trout)
- Copper – up to 140 μg/g (highest in native rainbow trout)
- Lead – 0.03 to 10.9 μg/g (similar among species)
- Zinc – 64.6 to 622 μg/g.

Conclusions. The authors concluded that walleye fillets had a higher concentration of total mercury in larger fish although concentrations of trace elements generally were low. Concentrations of zinc may have been overestimated because 11 of 16 samples were noted by the lab as having spike sample recoveries associated with them outside of the lab control limits.

EVS. 1998. Assessment of dioxins, furans, and PCBs in fish tissue from Lake Roosevelt, Washington, 1994. Final Report. December. EVS Environmental Consultants, Inc., Seattle, WA.

In 1994, EPA initiated a study to measure concentrations of dioxins, furans, and PCBs in fillet tissue of kokanee, rainbow trout (wild and hatchery-raised), smallmouth bass, walleye, lake whitefish, and white sturgeon. The primary objective of the study was to collect information to evaluate the potential human health risks associated with these organochlorines; therefore, the first four of these fish species were targeted (because they were the most common in creels at the time preceding this study). White sturgeon were included because of their longevity and lake whitefish were included because of the availability of historical data preceding this study. Other objectives were to compare tissue concentrations between different geographic areas, between size classes, between composite and individual fish samples, and to compare these results with historical data for whitefish. Samples were primarily for fillet with skin, but there were whitefish samples without skin, and the white sturgeon samples included only muscle tissue. All samples were within fixed size categories; both composites (of eight fish each) and individual fish fillets were analyzed. Fish were collected from four areas spanning the

UCR (at Northport, at the mouth of the Colville River, in the Seven Bays area, and near the Grand Coulee Dam) and in the Sanpoil Arm.

Results and Conclusions. Dioxins and furans were detected in all of the fish species evaluated, and 2,3,7,8-TCDF was the most commonly detected congener among the dioxins/furans found in UCR fish. More dioxin and furan congeners were detected in hatchery rainbow trout than in wild rainbow trout. 2,3,7,8-TCDD TEQ were also calculated and used in comparisons. The highest TEQ concentrations were measured in white sturgeon and lake whitefish. Statistical comparisons showed no significant differences in TEQ concentrations among the groups compared.

The authors also reported PCB concentrations in tissues from kokanee, lake whitefish, rainbow trout, smallmouth bass, walleye, and white sturgeon. PCB concentrations in wild rainbow trout fillets were higher in the upper reach of the UCR, near Northport (mean total PCB concentration = 88 µg/kg ww), than in hatchery rainbow trout in parts of the lower reservoir (mean total PCB concentration = 22 µg/kg ww). The authors concluded that mean concentrations of 2,3,7,8-TCDF in lake whitefish declined either 7-fold (on a wet-weight basis) or 34-fold (when normalized for lipid content) from 1990 to 1994. These differences were highly significant ($p \leq 0.01$; Spearman's rank correlation coefficient).

> *Munn, M.D. 2000. Contaminant trends in sport fish from Lake Roosevelt and the Upper Columbia River, Washington, 1994-1998. Report 00-4024. U.S. Geological Survey, Water Resources Division, Tacoma, WA.*

The objective of this study was to collect and analyze fish tissue data to compare to and follow up on prior fish tissue studies in the Columbia River area. Studies in the 1980s were the first to report that concentrations of certain contaminants in fish tissue from the Columbia River posed a risk to human health. This study was to determine if the concentrations of mercury, PCBs, dioxins, and furans had changed in fish tissue from previous work (specifically EVS [1998] and USGS [1995]). Species collected, locations of sampling, and chemical analysis were chosen based on the past studies to allow comparisons across time periods.

Methods. The sampling locations were:

- Upper reach—Northport south to Kettle Falls
- Lower reach —Spokane River west to Grand Coulee Dam.

Muscle tissue samples from walleye, wild and net-pen rainbow trout, and mountain whitefish were collected. Total length (centimeters [cm]) and total weight (grams [g]) were recorded for each fish. Individual fillet samples were removed using standard

procedures; samples included the belly flap. For mercury samples, skin was removed on the individual walleye fillets; for the other chemicals and species, the skin was left on the muscle tissue sample.

Rainbow trout and mountain whitefish were analyzed for dioxins and furans (EPA Method 1613B for 17 dioxin and furan congeners). Rainbow trout were analyzed for PCB Aroclors (EPA method 8082) and a small subset of samples analyzed for 13 individual dioxin-like PCB congeners (EPA Method 1668). All chemical concentrations were reported as ww. Standard QA/QC procedures were used for all laboratory analysis and resulted in all data meeting quality criteria.

Results and Conclusions. The authors concluded that concentrations of contaminants in fish that were identified as a potential threat to human health had either not changed since the 1994 studies or had decreased. Specifically,

- Mercury concentrations in walleye decreased by about 50 percent from 1994 to 1998.
- Dioxins and furans, as indicated by 2,3,7,8-TCDF, decreased significantly in rainbow trout fillets from 1994 to 1998. There was no apparent change in the average 2,3,7,8-TCDF concentrations in mountain whitefish. Average concentrations of 2,3,7,8-TCDF were higher in mountain whitefish than in rainbow trout.
- Rainbow trout from the upper reach had a higher TEQ concentration than rainbow trout from the lower reach, with trout from the upper reach having a higher percentage of the toxicity from dioxin-like PCBs than dioxin and furan compounds.
- PCB concentrations in rainbow trout (both wild and pen) remained elevated and not significantly changed.

The authors concluded that decreases in some of the contaminants could be a function of reductions in industrial loadings to the Columbia River and/or changes in reservoir management practices.

Hinck, J.E., C.J. Schmitt, T.M. Bartish, N.D. Denslow, V.S. Blazer, P.J. Anderson, J.D. Coyle, G.M. Dethloff, and D.E. Tillitt. 2004. Biomonitoring of Environmental Status and Trends (BEST) Program: Environmental contaminants and their effects on fish in the Columbia River Basin. Scientific Investigations Report 2004 – 5154. U.S. Geological Survey, Washington, D.C.

Hinck, J.E., C.J. Schmitt, V.S. Blazer, N.D. Denslow, T.M. Bartish, P.J. Anderson, J.J. Coyle, G.M. Dethloff, and D.E. Tillitt. 2006. Environmental contaminants and

biomarker responses in fish from the Columbia River and its tributaries: Spatial and temporal trends. Sci. Tot. Environ. 366 (2006):549–578.

The primary objective of this study was to document and assess spatial and temporal trends in the concentrations of environmental contaminants and their effects in fish throughout the Columbia River Basin. Secondary objectives were to compare results from the Columbia River Basin to other U.S. river systems and to further define benchmarks for the quantification of long-term trends and interpretation of biomarker results.

Methods. Fish were collected at sixteen sites in the Columbia River Basin. Eight of the 16 sites were located on the Columbia River, two were on the Willamette River in western Oregon, three were on the Snake River in Idaho and Washington, and one site each were on the Yakima River in Washington, Salmon River in Idaho, and Flathead River in Montana. Ten sites were National Contaminant Biomonitoring Program (NCBP) stations where contaminants in fish were monitored from the late 1960s to the mid-1980s. These sites were selected to ensure spatial and temporal continuity with historical data and to facilitate trend analysis. Five stations were National Stream Quality Accounting Network (NASQAN) sites. Most fish were collected between early September and November 1997. Carp and largemouth bass were the preferred taxa at all sites due to prevalence, distribution, and extant contaminant and biological endpoint data. Hinck et al. (2004) sampled largescale sucker, walleye, and rainbow trout in the UCR as whole body, single-gender composites of 2 to 10 individuals per composite. Data were generated for metals, pesticides, and PCBs in these UCR fish.

A suite of chemical and biological methods was used to characterize the exposure of fish to chemicals including reproductive biomarkers, measures of cytochrome P450 enzyme induction, and concentrations of chemicals in whole fish. Measures of potential effects of chemical exposures included fish health assessments; measures of fish health included 1) gross abnormalities; 2) condition factor (CF), hepatosomatic index (HSI), and splenosomatic index (SSI); 3) histopathology; and 4) several measures of reproductive condition.

Conclusions. The authors provided the following conclusions about chemical concentrations in fish of the Columbia Basin:

- Overall, fish from middle Columbia River and lower Columbia River had higher concentrations of organochlorine contaminants than fish from the UCR.
- Where historical data were available, concentrations of PCBs declined in fish at all sites. This was not the case for p,p'-DDE, which remained consistent from 1967 to 1997.

- Except for mercury, selenium, and lead, concentrations of metals were relatively low and stable or declining relative to historical levels at most sites.
- Concentrations of PCBs and TEQ were low in most samples, but ethoxyresorufin-o-deethylase (EROD) rates in bass, carp, and largescale sucker exceeded threshold levels reported in 1995.
- Concentrations of mercury in the Columbia River Basin accumulated more in bass than in carp and largescale sucker as reported in other studies.
- Carp and sucker had greater concentrations of cadmium, copper, chromium, and nickel compared to bass, and concentrations of zinc in carp were consistently five times higher than in other species.
- Concentrations of pesticides were similar among bass, carp, and sucker.
- Pesticide concentrations were greatest in fish from lower Columbia River Basin sites and elemental concentrations were greatest in fish from upper Columbia River Basin sites; these patterns reflected land uses.
- Lead concentrations in fish from the Columbia River at Northport and Grand Coulee, Washington exceeded fish and wildlife toxicity thresholds (>0.4 μg/g).
- Mercury concentrations in fish were elevated throughout the basin but were greatest (>0.4 μg/g) in predatory fish from the Salmon River at Riggins, Idaho, the Yakima River at Granger, Washington, and the Columbia River at Warrendale, Oregon.
- Other organochlorine pesticides did not exceed toxicity thresholds in fish or were detected infrequently.
- Total polychlorinated biphenyls (PCBs >0.11 μg/g) and 2,3,7,8-TCDD equivalents (>5 pg/g) exceeded wildlife guidelines in fish from the middle and lower Columbia River Basin.
- Temporal trend analysis indicated decreasing or stable concentrations of lead, selenium, mercury, p,p'-DDE, and PCBs at most sites where historical data were available.
- A total of 74 percent of all fish sampled throughout the Columbia River Basin had some type of external anomaly, and 50 percent or more of fish had external anomalies at any given station. Many largescale sucker from the Columbia River at Northport and Grand Coulee, Washington had external lesions and enlarged spleens. The majority of external and internal lesions observed were the result of inflammatory responses to parasitic or bacterial infections.

The authors concluded that results from this study and other investigations indicate that continued monitoring in the Columbia River Basin is warranted to identify consistently degraded sites and those with emerging problems.

USEPA. 2007a. Phase I fish tissue sampling data evaluation report, Upper Columbia River site CERCLA RI/FS. Prepared by CH2M HILL. U.S. Environmental Protection Agency, Region 10, Seattle, WA. October 30, 2007.

EPA collected and analyzed fish tissues from six locations throughout the Site in 2005 and issued a summary of the results (USEPA 2007a). Tissue samples from six species (burbot, largescale sucker, rainbow trout, lake whitefish, mountain whitefish, and walleye) consisting of both fillet and whole body samples, primarily as composites of five fish each, were collected and analyzed for a selected list of chemicals. Fish also were observed for the presence of external lesions.

Methods. Fish were collected in October 2005 by a variety of methods (gill nets, line fishing, traps) from six fish sample collection areas (FSCAs) within the Site. Each FSCA was in a separate reach of the river and represented an area sufficiently large to catch the required number of fish. The size range of fish collected in this study approximately bracketed a mean size determined from UCR creel census data and/or reports of mean size from scientific collections. The study included chemical analysis of whole body fish from six fish species (walleye, rainbow trout, lake whitefish, mountain whitefish, largescale sucker, and burbot) and both whole body and fillet tissue from two species (walleye and rainbow trout). For fish from which fillets were analyzed, the offal (the remainder of the fish after removing fillets) was also analyzed to facilitate estimation of whole body concentrations. Five fish from the same species were composited in each sample, and four to five samples were collected within each FSCA. Tissues were analyzed for 23 metals, total mercury, PCB, aroclors, and PCDDs and PCDFs. One composite sample of each species from each collection area was analyzed for PCB congeners and approximately 10 percent of all samples were analyzed for inorganic arsenic and organic arsenic species. The occurrence and types of external lesions observed on fish were recorded prior to processing fish for chemical analysis. Tissue anomalies recorded included lesions, deformities, abnormalities, fin erosion, and visible external parasites. Examination of fish for external lesions followed the protocol described by Smith et al. (2002).

Results. For most metals, the results for all samples analyzed were greater than the detection limit. Silver and beryllium were reported as non-detected for all samples of each species. Antimony was detected in two of the four composite samples of largescale suckers at the most upstream collection area (FSCA 1). Thallium was detected only in the fillets of walleye at the collection area nearest Grand Coulee Dam (FSCA 6); concentrations reported were lower than the detection limit for this metal in many other tissue/area combinations. Uranium and vanadium results were mostly reported as non-

detected in some fishes and/or tissue types, and in samples where these compounds were detected, variation was limited. Lead concentrations in whole-body samples of largescale suckers were more than 10 times greater than that of all other species of fish sampled in each collection area. Largescale suckers also had the greatest concentrations of cadmium, chromium, cobalt, manganese, and nickel at every site. Burbot had total arsenic concentrations two to three times greater than other species throughout the study area. For walleye and rainbow trout, metal concentrations in fillets were lower than in whole body samples from the same location. The exception was for mercury, for which concentrations in fillets were generally greater than concentrations in whole bodies.

TCDD was detected in whole body tissues at a frequency of 9 percent. Other dioxins/furans were detected between 0 and 73 percent in UCR fish tissues. Aroclors 1254 and 1260 were summed and were detected in all species and tissues. All other aroclors (except Aroclor 1016) were never detected. Most congeners were detected at a frequency greater than 10 percent. Whole-body wet-weight TCDF concentrations were highest in lake whitefish, followed by burbot and largescale suckers. Lipid-normalized TCDF concentrations were highest in burbot compared to other species. Fillet concentrations of TCDF were higher in rainbow trout than walleye, and hatchery and wild rainbow trout concentrations were comparable. Walleye fillet tissues had higher TCDF concentrations per lipid content than rainbow trout fillets. Aroclor 1254/1260 wet-weight concentrations in whole body tissues were highest in largescale suckers. Burbot, walleye, and largescale suckers had higher aroclor concentrations per lipid content than other fish species. Rainbow trout fillet tissues contained higher concentrations of aroclors than walleye, and wild rainbow trout concentrations were higher than hatchery concentrations. Walleye fillets had higher aroclor concentrations per lipid content than rainbow trout.

Spatial variation of metal concentrations among collection areas in the UCR was common. For largescale suckers, the species with the most spatial variation in concentrations, most metal concentrations were greater at upstream sites, with some exceptions for mercury, selenium, and arsenic. Copper, lead, and zinc in whole body samples (including gut contents) of largescale sucker declined with distance downstream from the U.S.-Canadian border. Largescale suckers, walleye, burbot, and to some degree rainbow trout consistently showed the highest spatial variability.

Spatial differences within species and among sites for organic chemicals did not indicate a consistent trend. Differences in concentrations of organics among FSCAs were variable and did not constitute a significant declining or increasing trend when comparing upstream versus downstream collection areas.

EPA recorded results of external examinations of individual fish for all fish that were used in the composite samples plus a random selection of additional fish that were available; selection of fish was not dependent upon whether or not external anomalies were apparent. Lesions were counted individually, but in many cases more than one lesion occurred on a single fish. The percent of all fish examined in each FSCA that had external anomalies was highest in FSCA 5 at 81 percent. When the percent of anomalies is considered by species, the maximum for each species is also in FSCA 5, with the exception of lake whitefish. For all species combined, the average number of lesions per fish (within species) generally increased moving downstream.

Conclusions. The authors suggested that the results supported the preliminary CSM and the assumption that UCR fish are exposed via surface water (i.e., surface water and suspended particulates), sediment, and diet. The results indicate that the exposure varies depending on species and location within the reservoir. The authors also recommended that additional data should be collected to support the evaluation of human health and ecological risk including additional sample locations, additional target species, expanded fish sizes, sampling individual fish, an expanded analyte list (including PCBs and arsenic speciation), further investigation of the potential effects of gut contents on largescale sucker whole body measurements, and measurements of temporal trends in fish tissue concentrations.

A5.4 Applicability of Available Data to Risk Assessment

The data on chemical concentrations in fish tissues from the Site prior to 2005 were available primarily for fillet tissue and for species and sizes more likely to be eaten by people than by piscivorous fish and wildlife. A few of the historical (pre-2005) studies provided data for COI concentrations in whole bodies of largescale sucker. The USGS database provides whole body samples for several species collected between 1969 and 1986; the most recent data of this kind were published in 1997, and only for largescale suckers. Generally, the pre-2005 data sets are not quantitatively useful for the RI/FS baseline ecological risk assessment (BERA) because they are more than 10 years old and therefore are not representative of current conditions. These data sets differ with respect to target species, fish size, and sampling locations, and they do not encompass species and size ranges commonly consumed by piscivorous fish and wildlife. However, historical data may be used qualitatively in the BERA (e.g., to inform future sampling programs or to examine temporal changes in COI concentrations).

EPA (USEPA 2007a) provides a robust data set (e.g., recent data for several target species and COI groups collected throughout the river) for fish tissue for the Site (see Appendix B

for data summaries) based on collections in 2005. The EPA data set is considered useful for the BERA and for representing baseline conditions at the Site.

Although the available historical fish tissue data (1995 to pre-2005) are useful for the RI/FS baseline human health risk assessment (HHRA), these data may not be representative of current conditions and were fairly limited, representing only a limited number of species, analytes, and tissue types. The Phase I 2005 Fish Tissue Study was designed specifically to collect data in support of the baseline HHRA. As such, these data will be useful in quantifying exposure estimates for fish tissue in the baseline HHRA. However, as noted in the HHRA work plan (USEPA 2009), data for additional species (e.g., kokanee), tissue types, and analyses (e.g., arsenic speciation) were recommended for future data collection efforts to support risk management decisions in the baseline HHRA.

A5.5 Temporal, Spatial, and Interspecies Patterns in Fish Tissue Chemistry

A limited analysis of temporal patterns was conducted (Appendix B). Qualitative comparisons between the pre-2005 and 2005 data for chemical concentrations in UCR fish suggest that tissue concentrations of copper, lead, and mercury have generally declined, from the mid- to late-1990s to 2005; patterns for arsenic and cadmium are equivocal due to high detection limits for the pre-2005 data. Lipid-normalized concentrations of 2,3,7,8-TCDF have declined in the middle reach, and lipid-normalized concentrations of PCBs appear to have decreased in the middle and lower portions of the Site between 1994 and 2005[4].

The 2005 fish tissue data show several species-specific patterns in the spatial distribution of fish tissue concentrations:

- The highest concentrations of most metals occurred in largescale sucker, burbot, and walleye. Consistent with trends apparent from the pre-2005 data, the highest mercury concentrations among whole fish samples were found in walleye and largescale sucker. In 2005, mercury concentrations in burbot were also among the highest of the species evaluated (mercury was not measured in this species before 2005). The elevated concentrations in walleye and burbot likely reflect their high trophic level as piscivores. The relatively long lifespan of the benthivorous largescale sucker may affect concentrations of mercury in that species.

[4] Comparisons between 2005 and 1994 were made using data from EPA (2007a) and EVS (1998). EPA (2007a) identified fish sample collection areas (FSCAs), as shown in Figure A-4. EVS (1998) does not specify the river miles sampled, but data provided are from a reach near Northport, centered approximately at RM 730 (upper); a reach at the mouths of the Colville River and Sherman Creek and centered approximately at RM 700 (middle); and three separate sampling areas consisting of waters just upstream of the Grand Coulee Dam, the mouth of the Sanpoil Arm, and the Seven Bays area (lower).

- As observed in the pre-2005 data, the 2005 data also showed that tissue concentrations of copper, lead, and zinc in whole body samples (including gut contents) of largescale sucker declined with distance downstream from the U.S.-Canadian border. This pattern was not consistently observed for other fish species.
- Differences among species in the locations and magnitudes of peak tissue concentrations of both metals and organic compounds suggest different pathways and mechanisms of exposure. Benthic fish (e.g., largescale suckers) and top predators (i.e., walleye, burbot, and to some degree rainbow trout) consistently showed the most pronounced spatial patterns (e.g., high spatial variability). Some of these spatial differences were statistically significant ($p \leq 0.05$). Whether these differences reflect variation in age, life history, and diet of each species across the UCR is uncertain.
- Understanding the spatial patterns of exposure for each fish species may be confounded to some degree by the possible presence of age-related (as indicated by length measurements) differences in bioaccumulation kinetics and the related effects on tissue concentrations. This is most likely an issue for largescale sucker, because individual ages were the most variable, but were not accounted for when making composites. In addition, understanding the spatial patterns for whole bodies of largescale sucker may be confounded by the presence of sediment in the stomachs of whole body samples (USEPA 2007a).

A5.6 Relationships Between COIs in Fish Tissue and Relevant SEVs

A draft screening level risk assessment for aquatic-associated wildlife has been performed using the available data for COIs in fish, sediments, and surface water, and conservative assumptions about wildlife exposures. Detailed discussion of the methods and results are provided in the draft SLERA (TCAI 2008); results that inform the fish sampling design are provided in Section A7.

Although the draft SLERA evaluates bioaccumulative chemicals without directly addressing risks to fish; Appendix B of this QAPP provides an evaluation of available data to assess risks to fish from exposure to some metals, PCBs, and 2,3,7,8-TCDD TEQs[5]. Three general lines of evidence for assessing risks to fish were considered: 1) concentrations of chemicals in water relative to ambient water quality criteria (AWQC) for

[5] TEQs are 2,3,7,8-tetrachlorinated dibenzo-p-dioxin (2,3,7,8-TCDD) toxic equivalents. To compute TEQ concentrations, the potency of each dioxin and furan congener relative to 2,3,7,8-TCDD is quantified using toxic equivalency factors (TEFs), provided by van den Berg et al. (1998, 2006). The concentration of each congener in each sample is multiplied by the congener-specific TEF, and all adjusted congener concentrations are added to derive a TEQ concentration for the sample. TEQ concentrations for this analysis were calculated using dioxins, furans, and dioxin-like PCBs, and the TEF values for fish provided by van den Berg et al. (1998).

the protection of aquatic life; 2) comparison of concentrations in prey tissue to SEVs expressed as prey concentrations (for metals); and 3) comparison of concentrations in fish to CBR values for fish (for organic compounds). Findings of the analysis include the following:

- As described in the draft SLERA (TCAI 2008), concentrations of metals in surface waters of the Site generally were below water quality criteria, suggesting that they do not pose unacceptable risks to aquatic life. The existing data, however, are limited to a small number of analytes measured at a single station at Northport, Washington near the upstream boundary of the Site, and as such considered insufficient for risk characterization (TCAI 2008). Therefore, additional water quality data will be collected at the Site as part of the RI/FS and will allow a more definitive evaluation of potential risks to fish (and other aquatic organisms) posed by chemicals in surface waters from the Site.
- For the metals for which SEVs in prey tissue are available, the maximum concentrations in whole body fish tissue from a data set of all species combined were all below no observed adverse effect concentration (NOAEC) SEVs for fish, except chromium, copper, and vanadium.
- Concentrations of selected metals in gut/gut contents samples from individual largescale suckers in FSCAs 1, 3, and 6 were compared with NOAEC-based SEVs for fish to provide an initial evaluation of whether the gut contents (which included sediment) may pose an unacceptable risk to suckers. This analysis was very conservative because metals bioavailability from sediment in the gut was assumed to be the same as for food in the gut. Results of this evaluation showed that concentrations of four metals (i.e., arsenic, cadmium, lead, and silver) in gut/gut contents samples did not exceed their SEVs, whereas concentrations of four other metals (i.e., chromium, copper, vanadium, and zinc) exceeded their SEVs.
- Concentrations of selected metals in a surrogate prey for benthivorous fish (i.e., oligochaetes) were exposed in the laboratory for 28 days to sediments from the Site (Besser et al. 2008). Oligochaete concentrations from this study were generally below NOAEC-based SEVs for fish prey (see Appendix B). Exceptions included arsenic at two of the seven stations evaluated (although arsenic also exceeded its SEV in the Sanpoil Arm reference area), and copper at the station closest to the U.S.–Canadian border (RM 734).
- Total PCB concentrations in all but one of the whole body fish samples collected in 2005 by EPA (USEPA 2007a) were below conservative NOAEC-based CBRs for fish (Hugla and Thome 1999).
- Measured TEQ concentrations in all of the whole body fish samples collected by EPA in 2005 were below a CBR concentration protective of 97.5 percent of fish

species (as reported by Steevens et al. 2005). TEQ concentrations account for all dioxin-like congeners of dioxins, furans, and PCBs.

A5.7 Other Information

In addition to the analyses described above, research has been conducted on the concentrations of polybrominated diphenylethers (PBDEs) in fish tissue from water bodies in the region, and on the availability of data for water bodies with no known major sources of contaminants. Details are reported in Appendix B, with the information that directly relates to the 2009 fish tissue sampling program summarized below.

A6 DATA GAPS

The historical data set (prior to 2005) provides a spatially and temporally uneven representation of COI levels in fillet of larger fish, including several that are considered to be species harvested by people or consumed by some piscivorous wildlife (e.g., rainbow trout, walleye); and a limited data set for whole body largescale sucker. EPA's 2005 fish tissue study (USEPA 2007a) is more systematic and complete than the historical data set, and has applicability to a baseline risk assessment for the Site. Neither the historical data nor EPA's (USEPA 2007a) fish tissue data provide an adequate basis from which risks to piscivorous ecological receptors (fish, birds, and mammals) can be estimated. With respect to prey for fish species, COI data are not available for small-sized fish tissues. (Note: It is recognized that fish prey on other biota such as zooplankton and macroinvertebrates, but these are not considered here because this QAPP addresses fish tissue residues only). Thus, fish tissue (described herein) will be collected to fill these data gaps. The following summarizes the data gaps identified from extant data.

A6.1 Species and Size of Fish

To date, species sampled tend to be those targeted by anglers and as a result, are relatively large (35 to 60 cm in length). Although some of the previously sampled fish species may represent prey of piscivorous fish and wildlife (e.g., bald eagle or osprey), smaller fish (<30 cm) are more likely to be prey for wildlife such as belted kingfisher, great blue heron, lesser scaup, otter, raccoon, and mink, and for piscivorous fish (e.g., walleye). These size classes are not well represented in either the historical data set or in the study conducted by EPA (USEPA 2007a).

Despite the previous focus on game fish, limited data are available for some fish species that may be consumed by people (e.g., smallmouth bass, kokanee, and/or yellow perch). Therefore, the lack of data on some sport fish is recognized as a data gap.

A6.2 Tissue Types

Most of the historical fish tissue data are for fillet samples. For the assessment of risks to piscivorous fish and wildlife, and for assessing exposures and toxicity of some chemicals to fish, whole body concentrations are more relevant.

The 2005 data set (USEPA 2007a) contains information for whole body concentrations, but only for large (>30 cm) fish. Therefore, there is a data gap in whole body concentrations of smaller size-class fish. In addition, the number of fillet samples was limited in 2005 and is considered by EPA to provide insufficient data for human health exposure and risk assessment (personal communication, Marc Stifelman [March 2008 technical work shop, Seattle, WA]).

A6.3 Chemicals of Interest

The recent study of fish tissues by EPA (USEPA 2007a) evaluated a limited suite of COIs (e.g., metals, dioxins/furans, and PCBs). The list of COIs developed in the draft UCR RI/FS Work plan and draft SLERA (TCAI 2008) is larger than that of any previous study conducted at the Site. As a result, there is a gap in the current fish tissue data for some other metals, organochlorine pesticides, polycyclic aromatic hydrocarbons (PAHs), PBDEs, and semivolatile organic compounds (SVOCs). A summary of the analyte list is presented in Table A-2. The current study will analyze fish tissues for a broader list of analytes (analysis will be conducted as shown in Table A-2) to fulfill this data need for RI/FS planning and risk assessment activities. Two analyte lists are proposed (Table A-2) for fish tissue samples: standard list and expanded list. The standard analyte list represents COIs that will be evaluated in all fish tissue samples and includes the following COI groups:

Conventional Parameters

- Total length and mass
- Percent (%) moisture
- Percent (%) lipids.

Metals/Metalloids

- Common (Target Analyte List [TAL]) metals/metalloids[6]

[6] From EPA's Target Analyte List for Superfund: USEPA. 2009. Contract laboratory program: statement of work with inorganic Superfund methods. (http://www.epa.gov/superfund/programs/clp/mtarget.htm). Metals include aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc.

- Uranium and molybdenum.

Organic Compounds with a log K_{ow} > 4.0

- Polychlorinated dibenzo-p-dioxins and furans (17 dioxin-like congeners)
- Polychlorinated biphenyls (209 congeners including the 12 dioxin-like PCB congeners).

The expanded analyte list includes all the COIs in the standard list plus a number of additional COIs (other metals, organochlorine pesticides, PAHs, SVOCs, PBDEs) that will be evaluated in a subset (33 percent[7]) of samples collected at each FSCA. These additional COIs are analyzed only in a subset of the fish samples due to their low frequency of detection in Phase I sediment samples, a lack of toxicity information (particularly other metals/metalloids), and because they are not known to be released from the Trail facility (TCAI 2008). The fish samples that will be analyzed for the expanded analyte list will be selected randomly by the field team. Thus, the expanded list is intended to provide additional data to characterize the occurrence of all COIs in fish tissues. If any of these COIs are detected in the subsample, the remainder of the fish may be tested for them as well. The expanded analyte list includes the following COI groups:

Conventional Parameters

- Total length and mass
- Percent (%) moisture
- Percent (%) lipids.

Metals/Metalloids

- Common TAL metals/metalloids
- Inorganic arsenic[8]—all burbot will be analyzed for inorganic arsenic
- Other metals/metalloids.

Organic Compounds with a log K_{ow} > 4.0

- Polychlorinated dibenzo-p-dioxins and furans (17 dioxin-like congeners)
- PCBs (all PCB congeners [209 forms])
- PBDE-17, 28, 47, 49, 66, 71, 85, 99, 100, 128, 138, 153, 154, 183, 184, 190, 191, 203, 206, and 209
- PAHs (acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, chrysene,

[7] Two composite samples (33 percent) was selected arbitrarily as a first tier screening for the expanded analyte list.

[8] Arsenic speciation will be conducted to evaluate inorganic arsenic (As^{+3} and As^{+5}) and organic arsenic (monomethylarsonate and dimethylarsinate) species.

dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno[1,2,3-cd]pyrene, phenanthrene, pyrene)

- Organochlorine pesticides (dichlorodiphenyltrichloroethane [DDT] and metabolites, aldrin, delta-BHC, alpha-chlordane (cis-), gamma-chlordane (trans-), cis-nonachlor, trans-nonachlor, oxychlordane, dieldrin, endrin, endrin aldehyde, endrin ketone, heptachlor, heptachlor epoxide, hexachlorobenzene, hexachlorobutadiene, methoxychlor, and toxaphene)
- SVOCs (1,1'-biphenyl, 1,2,4-trichlorobenzene, 4-bromophenyl-phenylether, 4-chlorophenyl-phenyl ether, bis(2-ethylhexyl)phthalate, butyl benzyl phthalate, dibenzofuran, di-n-butyl phthalate, di-n-octylphthalate, hexachlorocyclopentadiene, hexachloroethane, and pentachlorophenol).

A6.4 Age of Fish

Assessing fish exposure to all the chemicals EPA included in their 2005 study (USEPA 2007a) may be confounded for some species when a composite sample was created with individuals that have widely varying ages. Among the 2005 data, this issue primarily affects the largescale sucker because individuals of similar size may differ greatly in age, but could be an issue for any long-lived species in the 2005 data set. The uncertainty resulting from compositing fish of substantially different ages will affect both the comparability of samples in space and time, and the interpretation of the importance of the exposure relative to other species and to toxicity benchmarks. While there is no *a priori* method for aging live fish prior to collection, separating fish into different size classes will help reduce the age range within each composite. Measurements of otolith size of each of the fish that have been composited will allow *a posteriori* age determination and provide additional insight for interpretation of fish tissue residues. While it is recognized that people and wildlife do not consume fish based on solely on age, the age of fish can be used to assist in the evaluation of variability and uncertainty in the fish tissue residue concentrations and can be used to interpret the data in either the ecological or human health risk assessment.

Data Gaps

Despite their limitations, the EPA (USEPA 2007a) tissue chemistry data provide information useful for exposure and risk assessments for piscivorous fish and wildlife, and for characterizing spatial and species-specific patterns of exposure. However, the overall 2005 data set is considered insufficient to complete a baseline evaluation of risks to piscivorous fish and wildlife. As a result, the following data gaps indicate that additional information should be collected to support the BERA:

- Data gap 1 – A number of COIs have not been analyzed to date. Specifically, these include a number of the non-TAL metals, dioxins/furans, organochlorine pesticides, PBDEs, and SVOCs.
- Data gap 2 – The current fish tissue database does not include data on smaller fish (<30 cm) that are frequently consumed by piscivorous fish and aquatic-associated wildlife.
- Data gap 3 – Several important sport fish species have been sampled infrequently or have not been evaluated (e.g., burbot and kokanee).

This document describes the approach and methods for collecting fish tissue chemistry data to fill the above-mentioned data gaps, in support of conducting a complete BERA for fish and wildlife, and to support the HHRA being conducted by EPA.

A7 FISH TISSUE ECOLOGICAL SCREENING

The primary method for screening neutral organic COIs in fish tissues in the draft SLERA consisted of evaluating the bioaccumulation potential (i.e., log K_{ow}). The log K_{ow} represents the logarithm of the ratio of concentrations in a lipid (fat) substitute, octanol, and in water. For example, a K_{ow} of 10,000 means that the amount of chemical in octanol is 10,000 times higher than the concentration that is in equilibrium with it in water. This frequently is reported on a log scale, as log K_{ow} (i.e., K_{ow} = 10,000 would be equivalent to log K_{ow} = 4.0). All organic chemicals have the potential to bioaccumulate to some extent. For screening purposes in the ecological risk assessment and as recommended by the EPA, any organic chemical that has a log $K_{ow} \geq 4.0$ will be considered a bioaccumulative substance requiring further evaluation in the BERA. A summary of the COIs with log $K_{ow} \geq 4.0$ is presented in Table A-2. The log K_{ow} criterion is not considered to be applicable to metals/metalloids and all were carried forward in the draft SLERA. Some inorganics are recognized as bioaccumulative, such as cadmium, mercury, and selenium.

In addition to the bioaccumulation potential screen, screening of piscivorous wildlife was conducted in the draft SLERA for COIs measured in fish tissues collected by EPA in 2005 (TCAI 2008). Representative wildlife receptors that consume fish as part or all of their diet examined in the draft SLERA included the following: great blue heron, osprey, bald eagle, belted kingfisher, lesser scaup, mink, otter, and raccoon. The COIs measured in fish tissues for which SEVs were available for comparison for avian and mammalian receptors included antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), chromium^{+3} (Cr^{+3}), cobalt (Co), copper (Cu), lead (Pb), manganese (Mn), methylmercury (MeHg), nickel (Ni), selenium (Se), silver (Ag), vanadium (V), zinc (Zn), dioxins/furans, and total PCBs. Results of the draft SLERA (TCAI 2008) indicated that

dietary exposure of birds and mammals (i.e., from fish, sediment, surface water, and/or other prey items) to the following COIs exceeded a hazard quotient (HQ) of 1.0 for at least one of the piscivorous ecological receptors evaluated: Ba, Cd, Cu, Cr^{+3}, Mn, MeHg, Pb, Sb, Se, V, Zn, and total PCBs. The COIs not passing these screening steps will be further evaluated in the BERA and are included among the analytes for all fish in the 2009 fish tissue study (Table A-2).

For whole body fish collected in 2005 (USEPA 2007a), total PCB and TEQ concentrations were below CBR values associated with no adverse effects on fish. There was insufficient information to make similar inferences about other bioaccumulative COIs, so all of the COIs with a log $K_{ow} \geq 4.0$ will be analyzed. Because of the lack of data on metal concentrations in fish of smaller size-classes, all fish will be analyzed for the EPA's TAL metals/metalloids.

For human health risk assessments, fish fillets will be analyzed for metals/metalloids (see Section A8.2), plus all organic substances with a log $K_{ow} \geq 4.0$. Inorganic arsenic species will be measured in all burbot and in a subset of samples for other species; mercury will be measured as total mercury. Individual fillet samples of smallmouth bass and walleye will be collected and analyzed for total mercury prior to composite homogenization.

A8 TASK DESCRIPTION

The 2009 fish tissue data will be collected in a manner that will support description of the nature and extent of contamination, and human health and ecological risk assessments to be conducted as part of the RI/FS. The DQOs and rationale for the sampling design are provided in Section A9.

A8.1 Overview of Field Activities

Tasks that will be completed in the field, including related documentation and QA/QC activities, are described in detail in the FSP (Appendix A). The following sections provide a brief overview of the specific elements for the scope of the 2009 study. Details on study design rationale and specific information inputs are described in Sections A9 and B.

A8.1.1 Fish Tissue Samples

Six FSCAs (consistent with the six areas sampled by EPA in 2005 that represent locations where fish are most likely to be caught) will be sampled at the Site between the U.S.-Canadian border (RM 745) and RM 596 near the Grand Coulee Dam (Figure A-4). Six composite samples (minimum five fish per composite) of several fish species representing

different feeding guilds of varying size classes will be sampled to provide information to support the aquatic, wildlife, and human health risk assessments (Table B-1).

A8.1.2 Number of Sampling Events

The start date for each sampling event will be determined following EPA approval of this QAPP. However, for planning purposes, each collection area is expected to be sampled during September/October 2009. This timeframe is near the end of the growing season for fish in the UCR (i.e., captured fish will have had almost an entire season of feeding and growth before being analyzed for contaminants) (USEPA 2005a). In addition, this time period corresponds to the sampling window used by EPA in 2005 (USEPA 2007a). The 2009 study is anticipated to be conducted under similar conditions as the 2005 study and will develop a comparable data set that can be used for risk assessment purposes. If further data gaps are identified through this or other studies, then additional fish sampling may be required.

A8.2 Laboratory Analyses

Current EPA analytical methods for analysis of metals, metalloids, and organic compounds in fish tissues will be used (Table A-3). Not all COI groups will be evaluated in every sample; see Section A6.3 for a discussion and rationale for selecting the COIs to be analyzed in fish tissue samples. Detection limits for the analytical methods are described in Section A9.6. The following groups of analytes will be analyzed in fish tissues (see Table A-2 for a complete list of analytes).

<u>Conventional Parameters</u>

- Total length and mass
- Percent (%) moisture
- Percent (%) lipids.

<u>Metals/Metalloids</u>

- Common TAL metals/metalloids, uranium, and molybdenum will be measured in all tissue samples
- Inorganic arsenic[9]
- Other metals/metalloids.

[9] Arsenic speciation will be conducted to evaluate inorganic arsenic (As^{+3} and As^{+5}) and organic arsenic (monomethylarsonate and dimethylarsinate) species. Arsenic speciation will be conducted in 100 percent of burbot samples and 33 percent of other species samples, due to human health concerns with inorganic arsenic in burbot.

Organic Compounds with a log K_{ow} > 4.0

- Polychlorinated dibenzo-p-dioxins and furans (i.e., 17 dioxin-like congeners)
- PCBs (PCB congeners [209 forms])
- PBDEs
- PAHs
- Organochlorine pesticides
- SVOCs.

Sample analysis and data validation for all laboratory analyses are each expected to require approximately 8 to 14 weeks for completion, from the time that sample collection is completed until finalization of the database. This time period is commensurate with the 90-day reporting requirement as defined in the Agreement.

A9 DATA QUALITY OBJECTIVES, CRITERIA, AND DESIGN RATIONALE

EPA's seven-step DQO process (USEPA 2006b) was used to guide the design rationale for the fish tissue study. The DQO process is a tool to determine the type, quantity, and quality of data. This process establishes performance and acceptance criteria for the data to promote achievement of study goals.

A9.1 Step 1—State the Problem

The preliminary CSM for the UCR RI/FS has identified consumption of fish tissue as a potential exposure pathway for piscivorous fish and wildlife, and people (Figure A-2). A relatively large amount of information has previously been collected on the characteristics of the UCR fish communities and their major species (e.g., Lee et al. 2003, 2006; Scofield et al. 2004; Black et al. 2003). The fish tissue study conducted by EPA in 2005 (USEPA 2007a), as well as several earlier studies, identified the presence of some COIs in fish tissues. Despite this large amount of existing information, a number of data gaps remain that will be addressed in this fish tissue sampling study (see Section A.6 and Appendix B). For example, the EPA 2005 study primarily evaluated larger individuals (13 to 22 in.) of recreationally important species. Although these data are useful in evaluating potential risks to humans, they are less useful for evaluating potential risks to ecological receptors that prey largely or entirely on smaller fish. The proposed 2009 fish tissue study will supplement the 2005 data set and provide additional data to support both the ecological and human health baseline risk assessments.

A9.1.1 Conceptual Model

The preliminary CSM for the UCR RI/FS (Figure A-2) and the focused fish CSM (Figure A-3) present the pathways through which ecological receptors and people may be exposed. Most of the available data for COIs in fish tissues from the Site were collected for a select group of fish species and only large-sized fish (>30 cm). Additional fish species, target size classes, and COI tissue concentration data are needed to adequately characterize the nature and extent of contamination, as well as estimate potential risks posed by COIs to piscivorous fish, wildlife receptors, and people as depicted on the CSMs (Figures A-3, A-3.1, A-3.2, and A-3.3).

A9.1.2 Team Members and Roles

One of the goals of Step 1 of the DQO process is to establish a planning team and identify decision makers. Team members and their roles were previously described in Section A4.2 of this QAPP.

A9.1.3 Resources and Deadline

The most effective use of resources occurs when the sampling design is optimized to address and fulfill the data gaps needed to examine potential COI exposure and risk to fish, wildlife, and people simultaneously. The collection of fish tissue is being proposed for September/October 2009, and is planned for that time of the year to maximize the comparability of data to samples collected by EPA in 2005. This sampling event will repeat the collection of large-sized fish (>30 cm) collected by EPA in 2005 and expand and enhance that data set. Collection of smaller size-classes will increase the accuracy of risk predictions of piscivorous wildlife and for fish. In addition, the fish collected during the proposed time frame will have had almost an entire season of feeding and growth before being analyzed for contaminants (USEPA 2005a). The target species, size ranges, and COI analytes targeted for 2009 are intended to provide data to fill the data gaps identified for fish, wildlife, and people as described herein.

A9.2 Step 2—Identify the Goal of the Study

The goal of this study is to support a decision of whether potential corrective actions are warranted due to unacceptable risks posed by the COIs to fish and piscivorous wildlife in the six reaches of the Site. The primary study goal is to address risk-related questions; questions related to the nature and extent of contamination are secondary. EPA may choose to use these data in support of similar objectives for the HHRA.

Specific risk-related questions that will be addressed through collection of data on concentrations of COIs in fish tissues are:

- Will reproduction, growth, or survival of aquatic-associated wildlife be adversely affected by the concentration of COIs in the fish consumed from the Site?
- Will growth, reproduction, or survival of fish be adversely affected by the concentration of COIs in their bodies or in prey fish?
- Will the health of recreational anglers or subsistence harvesters be adversely affected when they consume fish caught from within the Site and, if so, which species and size classes are contributing the most to risk estimates?

Table A-4 lists potential alternative actions for the principal questions.

A9.3 Step 3—Identify Information Inputs

Step 3 of the DQO process (USEPA 2006b) requires consideration of:

- The types and potential sources of information (e.g., site characteristics or variables) that should be measured to provide estimates or resolve decisions
- Information to provide a basis for specifying performance or acceptance criteria
- Information on the performance of appropriate sampling and analyses methods.

Determination or estimation of risks (as described in Section A9.2) requires representative data for COIs in Site fish tissues. Information inputs that are needed to conduct an analysis of dietary risks to piscivorous fish and wildlife includes: 1) knowledge about the size and species of fish preferred by the various feeding guilds; 2) the species and size of fish found in the UCR; 3) fish movement and habitat preference; and 4) COI concentrations in fish (by size and location). Existing information is provided in Sections A9.3.1 and A9.3.2 with regard to characterizing the feeding and habitat preferences and fish species at the Site. Representative COI concentrations (Item 4 from above) from appropriate fish species and size classes will be determined through new data collection as set forth in this QAPP in combination with data collected by EPA in 2005.

Toxicity benchmarks for fish, wildlife, and people are information inputs to aid in specifying performance or acceptance criteria (i.e., determination of risk or no risk). Existing information with regard to toxicity benchmarks is presented in Section A9.3.3.

Sampling and analytical methods must be appropriate to ensure that chemical measures of exposure can be properly estimated and compared to toxicity benchmarks or other acceptance criteria. The analytical procedures for this study will be standard EPA approved analytical protocols (Table A-3) with detection limits sufficiently low to provide concentration data that are below risk-based benchmarks (see Table B-2). In addition, the sampling scheme must be sufficiently robust to allow for statistical analyses that have a

low probability of both Type I and Type II errors[10] and to provide adequate exposure concentration estimates. Section A9.3.4 provides further information on the fish compositing scheme that will provide appropriate data to satisfy the goals of this QAPP.

A9.3.1 Feeding Preferences of Wildlife

The draft SLERA (TCAI 2008) identified major feeding guilds of aquatic wildlife associated with the Site, and which, wholly or in part, depend upon fish as a component of their diet. From these, several species were selected as representative of the relevant feeding guilds (Table A-5).

The relative importance of various sizes of fish in the diet of these representative wildlife species are shown in Table A-6. Based on these data, and the rationale described below, fish will be collected in the following size classes:

<15 cm (<~6 in.), ≥15 to ≤30 cm (~≥6 to ≤~12 in.), and >30 cm (>~12 in.)

Because metals do not linearly accumulate with fish size (Bradley et al. 1980; Luczynska and Tonska 2006; Tong et al. 1974), this division of fish into three size classes will be sufficient to differentiate diets among the wildlife feeding guilds. Lipophilic bioaccumulative organic chemicals (i.e., those chemicals with log K_{ow} ≥ 4.0) may accumulate to higher levels in larger fish as the amount of lipid increases with increasing age and size (although it may be that on a lipid-normalized basis there is a less dramatic or no increase)[11].

Selection of three size classes to represent fish diets is anticipated to be sufficiently realistic for making a decision on the need for corrective action. As presented within the draft SLERA (TCAI 2008), the highest HQ for a bioaccumulative organic evaluated was 3.2 for mink exposed to total PCBs in the total diet (including fish and sediment), while none of the piscivorous birds exceeded a HQ of 1 for any of the organic chemicals that were assessed. As previously mentioned, the screening level analysis was based solely on data from fish >30 cm collected by EPA in 2005 (USEPA 2007a), although over 90 percent

[10] A type I error is when a statistical test indicates a differences between two groups when in reality there is no difference. This would result in a conclusion of significant risk, when actually there is none. A type II error is when a statistical test fails to indicate a difference between two groups when in truth there is a difference. This would result in a statement of "no risk" when there actually is the potential for risk.

[11] The USEPA Science Advisory Board (SAB) (1995) believed that existing data and models were applicable for "...deriving order-of-magnitude estimates of bioaccumulation for a class of chemicals with log K_{ow} of 3.5 to 6.0 and for chemicals that do not degrade or transform [i.e., are neutral organic chemicals]." They concluded that K_{ow}-based models do not accurately predict bioaccumulation potential for chemicals that are significantly metabolized by food web organisms, degraded in the environment, or have limited bioavailability. The existing models do not work for chemicals whose fate is NOT governed by equilibrium partitioning (e.g., ionic, reactive inorganics, and organics).

of the mink diet consists of fish species ≤15 cm in length, with the remaining 5 to 10 percent in the range of 15 to 20 cm (Alexander 1977; Erlinge 1969; Wise et al. 1981). A refinement of the analysis in the draft SLERA, based on two additional smaller size classes of fish, will provide a more realistic estimate of exposure.

It is recognized that some of the fish in each size class will be fully grown adults while others will be juveniles or younger fish of species that grow to much larger size. While this may confound the assessment of risks to fish, age analysis (through otolith measurements) will provide information that can inform the risk assessment and reduce uncertainty. The age of the fish is less relevant for wildlife dietary analyses, as birds and mammals primarily key on fish size and will eat whatever is catchable within that size range. Collection of at least some of the same species in the different size classes will aid in comparisons among fish age groups should questions about increasing contamination with age need to be addressed.

Although previously collected data characterize tissue chemistry for fish >30 cm in length, the sampling effort for some fish species conducted by EPA (2007a) will be duplicated during this sampling event (e.g., walleye, burbot, and rainbow trout). This will provide consistent data (e.g., same size class, collection areas, and species) from which calculation of summary statistics can be conducted while minimizing variation due to extraneous factors (e.g., seasonality, location). These data will also augment the database for assessment of risks to larger piscivorous wildlife and to people.

A9.3.2 Species and Size of Fish in the UCR

Table A-7 lists the fish species (and some life history characteristics) known to inhabit the UCR and Table A-8 presents the relative abundance of these species.

Sturgeon are fish of great cultural importance to tribes as a traditional food source and also are a common sport fish along the Columbia River. Although white sturgeon are not currently subject to a legal fishery, they have been in the past and efforts are underway to restore the fishery. Specific DQOs for sturgeon tissue have not yet been developed for the RI/FS and as such sturgeon is not a target species to study. Washington Department of Fish and Wildlife [WDFW] caught sturgeon for research in 2008 and anticipates catching more as part of a study in late 2009. Obtaining sturgeon data could become an objective as the RI/FS proceeds, and those data may complement the current Phase II fish tissue sampling program. During fishing activities, if a white sturgeon is captured its location will be recorded and a photograph taken. Every effort will be made to minimize handling and, as such, no measurements (length, weight, etc) will be recorded.

Wildlife Prey Species

To develop the data needed to assess exposure to piscivorous wildlife, several abundant fish species (Table A-8) will be collected as species-specific composite samples for each of the three size classes described above. The fish species sampled at each location will include fish from several different feeding guilds to represent varying exposure conditions. Thus, the target fish species are intended to be representative of the types of food that will be commonly consumed by wildlife inhabiting the UCR (Table A-6).

Fish Prey Species

To develop the data needed to assess exposure to piscivorous fish, species will be chosen that are representative of the major fish feeding guilds shown in Table A-5 and Figure A-3 (e.g., omnivores and piscivores) and that are available in sufficient abundance to achieve the required sample size (Black et al. 2003; Lee et al. 2006; Wydoski and Whitney 2003). Fish tissue will be used to characterize exposure to piscivorous fish via ingestion, and exposure of fish to organic substances, using concentrations in whole fish samples.

Fish Species Consumed by People

Species that are most relevant to the assessment of risk to people are those that are generally caught by recreational anglers and harvested for subsistence purposes. Fish abundance surveys and creel surveys (Baldwin et al. 2005, 2006; Fields et al. 2004; Scofield et al. 2004; WADOH 1997) have indicated that anglers frequently target the following abundant large fish: walleye, rainbow trout, lake whitefish, largescale sucker, kokanee, and burbot.

Smallmouth bass are increasing in numbers and are becoming a larger proportion of the recreational fishery and are a prey item for larger piscivorous fish (e.g., walleye) (Lee et al. 2006). Therefore, smallmouth bass will be included in the additional fish sampling efforts for characterizing potential exposures to people.

Species-specific size limits for keeping fish caught at Lake Roosevelt as defined by the WDFW (2009; listed as Roosevelt Lake) are as follows:

- Trout can be collected year-round, no minimum size limit, daily limit of 5 fish, and up to 2 fish over 20 in. (50 cm) may be retained.
- Common carp can be collected year-round; no minimum size limit, no daily limit, and no upper size limit restriction.
- Smallmouth bass can be collected year-round; no minimum size limit, daily limit of 10 fish, and up to 1 fish over 14 in. (35 cm) may be retained.

- Walleye can be collected year-round; no minimum size limit, daily limit of 8 fish, and up to 1 fish over 22 in. (56 cm) may be retained.
- Kokanee can be collected year-round; no minimum size limit, daily limit of 2 fish, and no upper size limit restriction.
- Other game fish can be collected year-round, no minimum size limit, no daily limit, and no upper size limit restriction.
- White sturgeon fishing is closed in the UCR including Lake Roosevelt.

While it is anticipated that people will likely target larger fish (>30 cm), catch limits do not prohibit collection and consumption of smaller fish.

Fish will be filleted (with skin) and analyses will be conducted on the fillets (with skin) and on the remainder of the fish (see details in Appendix A). The "remainder" is all remaining portions of the fish after the fillet is removed. The fillet and the "remainder" will each be weighed separately because chemical analysis will be performed on these tissues in separate composites. The whole body concentration can be estimated from these separate composites, as shown in Section B1.3.

A9.3.3 Benchmarks Used for Risk Analysis

The benchmarks described herein provide information that will guide decisions used in the DQO process and may be used to assess risk from exposure to COIs once the 2009 fish tissue data are available. The benchmarks are specifically used to establish analytical concentration goals to ensure that detection limits are sufficiently low to provide data below the benchmarks (e.g., risk-based concentrations) and therefore can be used in the ecological and human health risk assessments. Analytical concentration goals are provided in Table B-2. Benchmarks for wildlife, fish, and people are described below.

Wildlife Toxicity Benchmarks

Concentrations of COIs in fish tissues will be used as inputs to the wildlife dietary risk analyses (i.e., total ingested dose) and compared to SEVs using the methods and toxicity information identified in the draft SLERA (TCAI 2008). Briefly, benchmarks are derived from the EPA Ecological Soil Screening Levels (Eco-SSLs) (USEPA 2007d), and from the original literature sources cited in Sample et al. (1996) or from a *de novo* literature search. Methods for combining these data into an appropriate SEV will be developed in collaboration with EPA. SEVs will be expressed as the cumulative ingested dose (mg/kg food/day). Assumptions about wildlife diets will be refined to reflect appropriate size classes of fish for each feeding guild and other exposure factors (e.g., area use factor) will be refined as appropriate. Additional studies on site-specific bioavailability of metals in sediments and/or biological media may be needed should risk estimates be exceeded.

Fish Toxicity Benchmarks

For lipophilic bioaccumulative organic COIs, the concentration in fish tissue will be compared to concentrations in whole fish associated with no adverse effect on survival, growth, or reproduction of fish, or with the lowest adverse effect level in fish (i.e., the CBR). For reasons discussed below, this approach is not applicable to inorganic metals. As a result, for inorganic metal COIs concentrations in food ingested by fish (e.g., other fish species, invertebrates, and/or plankton) will be required for the risk assessment. Data provided from this fish tissue sampling effort will provide one component (i.e., fish species) of the dietary data required.

Scientific debate about the appropriate applications of CBR values in risk assessments has been ongoing for approximately 20 years, beginning with McCarty (1986) who advocated the CBR as a useful dose metric for non-polar, non-metabolizable compounds. Proponents of this approach have emphasized that the method accounts for the bioavailability of a chemical from different media, and for exposure over protracted periods. Later authors (Barron et al. 2002) discouraged use of tissue residues, pointing to the substantial variability among species and toxicants. Recognizing that further refinements were needed to address the apparent variability in CBRs, later publications (e.g., Landrum and Meador 2002; Meador 2006) provide more specific considerations for application of CBRs to specific compounds in risk assessments:

- Standardization of the response metric
- Standardization of exposure duration
- Lipid normalization for hydrophobic chemicals
- Consistency in the mode of action
- Understanding and accounting for the toxicity of metabolites
- Accounting for the effects of non-toxicant stressors.

Finding CBRs that can be applied successfully in the context of these considerations can be difficult. In June 2007, a Pellston workshop was convened for the purposes of discussing the scientific basis for using tissue residues as a dose metric for toxicity assessment. Results of the workshop were presented at the 2007 Annual Meeting of the Society of Toxicology and Chemistry. Among the nine abstracts presented during this workshop, several themes emerged:

- The CBR approach provides a robust framework from which better understanding of dose/effect relationships can be assessed.
- The CBR approach is increasingly being used and sometimes offers a better model for a dose metric than other surrogates, such as exposure concentration in ambient media or oral dose.

- The CBR approach is most appropriate for organic chemicals acting via baseline toxicity or non-specific toxicity, and for a few substances acting via the Ah[12] receptor. It is less applicable to metals, except for some organometals (e.g., tributyltin and methyl mercury).
- The narcosis model (now called the target lipid model) is being used to fill in data gaps for CBRs. It applies to chemicals acting by what is now called "baseline toxicity mechanism."

EPA (USEPA 2007b) cautions against the use of CBRs for assessment of risk to aquatic organisms from exposure to metals (with the exception of organometals such as tributyltin and methyl-mercury) unless a toxicologically valid residue-response relationship supports the use of the CBR threshold.

For metals, the amount of chemical in the fish diet will be compared to SEVs derived from published laboratory studies (i.e., feeding metal-containing food to fish under controlled conditions and monitoring responses). SEVs derived from such studies can be expressed as the concentration in the ingested medium (mg/kg), or as the cumulative ingested dose (mg/kg food/day). Uncertainties inherent in this approach include:

- Differences in the form of the metal contaminating ingested media between the test environment and the natural environment, as well as variability inherent in any bioassay. Foods given to test animals in the laboratory are often spiked with highly bioavailable or highly toxic forms of the test chemical, while the concentrations reported in environmental samples reflect the sum of numerous forms, some of which are less bioavailable or toxic than others. While this can make SEVs expressed as prey concentrations a more conservative approach, it can also reduce the toxicological realism of the SEV.
- Differences in metal toxicokinetics in different fish species. Physiological mechanisms for regulating metals vary among fish species. This variation will affect the relative sensitivity of any one fish species to toxicity, and create uncertainty when results for one species are extrapolated to other species.

As a result, EPA (USEPA 2007b) acknowledges that SEVs expressed as the ingested dose or as the concentration in ingested media are conservative screening tools when assessing risks to aquatic organisms resulting from exposure to metals.

[12] The Ah Receptor (R) is the aryl hydrocarbon receptor. The AhR is found in the cytosol of most cells and is a transcription factor that is normally inactive. When it binds to 2,3,7,8-TCDD, the Ah Receptor translocates to the nucleus and dimerizes with aryl hydrocarbon receptor nuclear translocator (ARNT) leading to changes in gene transcription, a precursor to cancer or tumor formation.

Total Dioxin Exposure

Total dioxin equivalent concentrations (TEQ) will be calculated by summing each of the dioxin, furan, and dioxin-like PCB congeners based on the potency relative to the toxic equivalency factors (TEFs) for 2,3,7,8 provided by van den Berg et al. (1998, 2006). The TEQ will be calculated on a sample-specific basis by multiplying the measured concentration of each congener by its TEF. For non-detected concentrations, one-half of the detection limit will be used for initial calculations. In addition, the effect of using one-half the detection limit will be explored to determine the effect on overall risk estimates. The TEQs will be estimated separately for each receptor group based on receptor-specific (fish, mammals, or birds) TEFs as provided by van den Berg et al. (1998, 2006).

Human Health Risk Assessment

Fish tissue concentrations will be used by EPA as inputs to estimates of chemical exposure due to fish consumption. The methods are described in the EPA HHRA work plan (USEPA 2009).

A9.4 Step 4—Define the Boundaries of the Study

This step specifies the population of interest for the study, the geographical boundaries of the site, and any temporal considerations that may be required.

A9.4.1 Target Populations for Risk Evaluation

Target populations of interest for risk evaluation are fish that live in the UCR, birds and mammals that live in or near the UCR and eat fish as part or all of their diet, and people who utilize the Site for recreational or subsistence fishing. The study area comprises the entire length of the UCR, although data will be analyzed by river reach to identify the specific areas where unacceptable risk may occur. Species of fish in the UCR are listed in Table A-7, and representative wildlife species potentially found at the Site are identified in Table A-5.

A9.4.2 Geographic Boundaries of the Site

The Site, as stated in Section A4.1 of this document, encompasses the UCR from the U.S.-Canadian border (RM 745) to the Grand Coulee Dam (approximately RM 596). For the purposes of the fish tissue sampling program, the Site has been divided into six reaches as previously identified in the draft RI/FS Work Plan and draft SLERA:

- Reach 1 (U.S.-Canadian Border at RM 745 to RM 730) – riverine
- Reach 2 (RM 730 to RM 712) – transitional (riverine to lacustrine)
- Reach 3 (RM 712 to RM 700) – Marcus Flats [transitional (riverine to lacustrine)]

- Reach 4 (RM 700 to RM 640) – lacustrine
- Reach 5 (RM 640 to RM 617) – lacustrine
- Reach 6 (RM 617 to Grand Coulee Dam near RM 596) – lacustrine.

The approach to be used for the 2009 fish tissue study is to collect fish from the same six FSCAs used by EPA in 2005 (USEPA 2007a) (Figure A-4). However, if target fish species are not found within the FSCA in a particular reach, then the length of the FSCA may be extended to collect the target number of fish.

A9.4.3 Temporal Considerations

Although some wildlife species inhabiting/utilizing the Site are year-round residents, many of the piscivorous birds are migratory and are largely present in the spring, summer, and early fall, and are likely to consume the fish species targeted in this study. The proposed collection period is near the end of the growing season for fish in the UCR, and, therefore, captured fish will have had almost an entire season of feeding and growth before being analyzed for contaminants (USEPA 2005a). Creel surveys of Lake Roosevelt indicate that angling occurs year-round and peaks June through September (Lee et al. 2006; Fields et al. 2004). Therefore, September to October 2009 will be the targeted time frame for sampling to provide data for conservative dietary analyses. This time period is also consistent with the one used by EPA in 2005 (USEPA 2007a).

A9.5 Step 5—Identify the Analytical Approach

Step 5 of the DQO process provides the analytical approach for evaluating the fish tissue data and drawing conclusions on exposure to COIs in this medium. Concentrations of COIs in fish tissue will be used to estimate dietary exposure for fish, wildlife and people, and for comparison to fish CBRs. This information will be used to support a decision of where or whether a corrective action is warranted due to unacceptable risks posed by the COIs to fish and piscivorous wildlife in the six reaches of the Site (see Section A9.4.2). The potential corrective actions can be based on the same set of analytical methods identified herein and these methods will use appropriate detection limits. This approach will avoid creating a data set invalid for applying a potential action.

Conclusions regarding potential risk to ecological receptors will be made using estimates of exposure compared to toxicity benchmarks. Exposure assessment may include estimation of the central tendency (e.g., mean concentration) or reasonable maximum concentration (e.g., 95 percent upper confidence level on the mean). Wildlife dietary exposures will be estimated as in the draft SLERA (TCAI 2008), with fish intake based on appropriate size classes and other site-specific factors. A component of fish exposure will be based on their diet (e.g., for metals) or tissue concentrations relative to CBRs

(e.g., bioaccumulative organic compounds). A potential risk may be indicated using the HQ method (e.g., ratio of exposure estimate to the toxicity benchmark). An HQ of $\leq$1.0 suggests negligible risks to the ecological receptor from the COI evaluated, while an HQ of >1.0 suggests a potential for risk. Findings of negligible risk will result in no further actions, while findings of potential risks will result in consideration of future actions or data gathering activities (e.g., measures of bioavailability, additional tissue sampling, or refinement of dietary composition).

Concentrations of COIs in fish tissue will be compared among reaches for each species to determine if there are geographic trends. This may be done using standard statistical techniques, such as an analysis of variance (ANOVA) test (after any necessary transformations to standardize variance, if required) followed by a post hoc analysis (e.g., Tukey's t-test) to determine which reaches differ from each other. If a COI is found to be significantly different among the various reaches, then this information will be used to inform future actions or data gathering activities.

Exposure estimates and conclusions regarding risks to people will be conducted by EPA according to the HHRA work plan. At the time of writing, EPA has not yet determined the final decision rules that will be used to judge whether risks to humans from eating fish are above a level of concern. However, for the purposes of this planning effort, it is assumed that the decision will be based on the estimated level of cancer and non-cancer risks to an individual with reasonable maximum exposure from the population with the highest fish consumption rate (i.e., traditional subsistence scenario). The level of risk that would be considered unacceptable is a matter of risk judgment. However, for the purposes of planning DQOs, it is assumed that the level of concern is the typical CERCLA risk threshold, where the threshold cancer risk is 1E-04 and the threshold non-cancer hazard quotient is 1.0. Thus, if fish ingestion non-cancer hazard quotients and/or cancer risks based on the 95 percent upper confidence limit (UCL) on the mean are above 1.0 and 1E-04, respectively, then EPA may consider future remedial actions and/or additional data gathering activities.

A9.6 Step 6—Specify Performance or Acceptance Criteria

The goal of Step 6 is to define performance or acceptance criteria to minimize the possibility of either making erroneous conclusions or failing to keep uncertainty in estimates to within acceptable levels (USEPA 2006b). For this study, performance and acceptance criteria will apply to generating appropriate and acceptable data for use

during risk assessment activities and providing sufficient data to reduce uncertainty and the probability for false positive or false negative decision errors[13].

Sampling and analysis of fish tissues will be conducted using standard EPA-approved methods and will be conducted using clean sample handling techniques (as described in Appendix A). Analytical concentration goals (ACGs) are the desired analytical detection limits for the fish tissue study. If possible, ACGs will be sufficiently low to provide reporting limits that are below risk-based concentrations (RBCs) for fish, wildlife and human health (Table B-2). If ACGs are lower than method reporting limits (MRLs), then the MRL will be used as the detection goal. Finally, a compositing scheme will be used to ensure that sufficient sample mass is acquired to meet the ACGs (see Section A9.3.4) and laboratory sample splits from composite homogenates will be required to allow for evaluation of analytical variability. Analytical data meeting the ACGs and found within analytical method performance criteria will be considered adequate to answer the questions defined in Step 2 (see Section A9.2).

The estimated sample size and number of fish per composite were selected based on a statistical analysis of the fish tissue data collected by EPA in 2005 (Appendix D). Based on this analysis, a sample size of six composites (with five fish per composite) will result in an adequate sample size to detect statistical differences (alpha = 0.05, power = 0.80) among river reaches where mean COI concentrations vary by a factor of 1.5-fold or greater. At least five of the six composite samples at each site (per size/species class) are required for sampling to be considered adequate.

Exposure estimation may be conducted using concentration estimates such as a mean and 95 percent UCL. A 95 percent UCL is assumed to provide a conservative estimate of exposure that is more likely to be higher than the true exposure than below, ensuring that the probability of false negatives is reduced. Furthermore, six samples per reach will ensure that the 95 percent UCL is less than the maximum value of any individual sample (Appendix D), reducing the probability of false positives.

A9.7 Step 7—Develop the Plan for Obtaining Data

This final step is the development of a resource-effective design for collecting and processing the proposed samples in a manner that will achieve the specified performance criteria. The plan for obtaining data is described herein in Section A.9 and Section B, and

[13] Because of variability in collected data, statistical analysis can lead to varying decision outcomes. A false negative decision error (Type II), for example, is when examination of the data leads to a conclusion of no risk, when there is a true potential risk, while a false positive decision error (Type I) indicates a potential risk, when the true risk is negligible (USEPA 2006b).

in the FSP (Appendix A). As previously mentioned, a range of fish sample sizes and fish species representing varying feeding guilds are targeted in six river reaches of the Site. A broad range of COIs will be analyzed in fish tissues to provide additional data for risk assessment purposes.

A10 SPECIAL TRAINING/CERTIFICATES

TAI has assembled a technical team with the requisite experience and technical skills to successfully complete the 2009 fish tissue study. All technical team personnel involved in sample collection have extensive environmental sampling experience. Minimum training and certification requirements for laboratory personnel will be provided in the laboratory QA plans (to be submitted under separate cover).

Prior to fish tissue sampling, and in addition to sampling and research permits required under the terms and conditions of the Agreement, it will be necessary to obtain a scientific collection permit from the WDFW (requirements specified in Washington Administration Code [WAC] 220-20-045, WAC 232-12-276, and RCW 77-32-240). The permit will include the applicant's qualifications for conducting the research including previous experience working with target species and proposed research techniques, and other relevant information.

Sampling personnel who enter an exclusion zone or contaminant reduction zone (see Appendix A, Attachment A1 for definition and discussion of these zones) will be required to have completed the 40-hour Hazardous Waste Operations and Emergency Response standard training course and 8-hour refresher courses (see draft general site health and safety plan [SHSP; TAI 2007] for further explanation). The training provides employees with knowledge and skills that enable them to perform their jobs safely and with minimum risk to their personal health. Training is also consistent with the requirements of the Washington Industrial Safety and Health Act. Documentation of course completion will be maintained in personnel files.

A11 DOCUMENTATION AND RECORDS

Records will be maintained documenting all activities and data related to field sampling and to chemical analysis at the laboratories. Results of data verification and validation activities will also be documented. Procedures for documentation of these activities are described in this section. Components of field documentation are discussed in Section 3 of the FSP (Appendix A).

The QAPP, FSP (Appendix A), SHSP (TCAI 2007), and the SHSP addendum (Attachment A1 to Appendix A) will be provided to each person listed in Section A3. Any revisions or amendments to any of the documents that make up the FSP will also be provided to these individuals.

A combined field and data report will be prepared after data validation is completed and the database is finalized. The reporting schedules are discussed further in the RI/FS Work Plan and in Section 5.3 of the FSP (Appendix A).

A11.1 Field Documentation

The TAI technical team field supervisor will ensure that the field team receives the final approved version of the QAPP (including the FSP and SHSP) prior to the initiation of field activities. A relational database will be used to manage the field data as described in the RI/FS Work Plan. Field records that will be maintained include the following:

- Field logbooks
- Photo documentation
- Field data forms
- Sample tracking/chain-of-custody (COC) forms.

The content and use of these documents are described in Section 3 of the FSP. The field reporting schedules are discussed further in Section 5.3 of the FSP (Appendix A).

A11.2 Laboratory Documentation

All activities and results related to sample analysis will be documented at each laboratory. Internal laboratory documentation procedures will be described in the laboratory QA plans (to be submitted following laboratory selection).

The analytical chemistry laboratories will provide a data package for each sample delivery group or analysis batch that is comparable in content to a full Contract Laboratory Program package. It will contain all information required for a complete QA review, including the following:

- A cover letter discussing analytical procedures and any difficulties that were encountered
- A case narrative referencing or describing the procedures used and discussing any analytical problems and deviations from SOPs and this QAPP
- COC and cooler receipt forms

- A summary of analyte concentrations (to two significant figures for results <10, three significant figures for results >10), MRLs, and method detection limits (MDLs)
- Laboratory data qualifier codes appended to analyte concentrations, as appropriate, and a summary of code definitions
- Sample preparation, digestion, extraction, dilution, and cleanup logs
- Instrument run logs
- Initial and continuing calibration data, including instrument printouts and quantification summaries, for all analytes
- Results for method and calibration blanks
- Results for all QA/QC checks, including serial dilutions, laboratory control samples (LCSs), matrix spike samples, laboratory duplicate or triplicate samples, and any other QC procedures required by applicable method protocols and laboratory SOPs
- Original data quantification reports and printouts of chromatograms and mass spectra for all analyses and samples as applicable
- All laboratory worksheets and standards preparation logs
- A page of example calculations for each analytical method included in the data package
- A documented data deliverable for each analytical method performed and reported.

Full laboratory data reports will be provided in both hard copy and electronic format to the task QA coordinator, who will oversee data verification and validation, for the purpose of archiving the final data and data quality reports in the project file. EDDs will be provided in a format that is compatible with the TAI technical team's database. A relational database will be used to manage the laboratory data as described in the RI/FS Work Plan.

A11.3 Data Quality Documentation

Data verification (i.e., confirming the accuracy and completeness of field and laboratory data) will be completed by the TAI technical team for data generated in the field, and by each laboratory for the data that it generates. Data validation and data quality assessment for this task will be completed and provided to the task QA coordinator.

The accuracy of the laboratory EDDs (provided in a database format) will be verified by, or under the direction of, the database administrator. All changes to data stored in the database will be recorded in the database change log. Any data tables prepared from the

database for data users will include all qualifiers that were applied by the laboratories and during data validation.

Data validation reports will be prepared and provided to the QA manager. Results of the validation reports will be summarized in the field report. Any limitation to the usability of the data will also be discussed in this report. Completed data validation checklists will also be provided to the QA coordinator by the data validator.

SECTION B: DATA GENERATION AND ACQUISITION

B1 SAMPLING PROCESS DESIGN AND RATIONALE

This section presents the design and rationale for the 2009 fish tissue sampling program. The approach is designed to collect fish tissue data to augment data collected by EPA in 2005. It will result in a fish tissue data set that supports characterizing the nature and extent of contamination of fish, and assessing risk to fish, wildlife, and humans that consume fish. The sampling approach was developed based on information from previous investigations, the preliminary CSM, the ecology of the UCR, and known information on recreational uses of the UCR fishery. Information specific to tribal fish consumption is anticipated to be provided at a later date by EPA.

B1.1 Investigation Considerations

The UCR supports a variety of fish species, several of which are important to the local sport fishery (Table A-7). In 2005, the EPA targeted fish species that were abundant in the UCR and were known to be commonly consumed by recreational or subsistence anglers (USEPA 2005a). The following species were collected in relatively large sizes (>30 cm): walleye, wild and hatchery rainbow trout, lake and mountain whitefish, largescale sucker, and burbot. As described in previous sections of this document, data collected in 2005 filled some, but not all, of the data needs with respect to evaluating the nature and extent of contamination of fish tissue and risks to piscivorous fish and wildlife or people. Particularly, smaller size classes of fish and alternative fish species are needed to fully evaluate potential risks to fish, wildlife, and human health. The following sampling program is designed to gather data to fulfill the data needs known at this stage of the RI/FS.

B1.2 Target Species, Size Classes, and Rationale

The 2009 fish sampling study targets fish species that are likely to be abundant throughout the UCR (Table A-8), represent varying feeding guilds, and represent likely prey for fish, wildlife, and/or people (Figure A-3). Fish will be collected in three target size classes (<15, ≥15 to ≤30, and >30 cm). The two smaller size classes are intended to sample fish species that will provide data for the evaluation of risk to wildlife and fish species, while the largest size class is intended to provide data to support the human health risk assessment and the ecological risk assessment for selected wildlife species.

To meet the DQOs for collecting data to evaluate risks to wildlife and fish, a minimum sampling effort will be required for each FSCA collection.

1. Minimum required sampling effort (target fish <15 cm)
    - Anticipated sampling gear and effort
        - Beach seines (8 hours or five seine hauls)
        - Electrofishing (3 hours of active electrofishing) – Start by working from a boat and switch if necessary to backpack
        - Contingency rule invoked after initial effort
    - Secondary sampling effort
        - Beach Seines (alternative gear equal effort, 8 hours or five seine hauls)
        - Boat/Backpack electrofishing (3 hours of electrofishing).
2. Minimum required sampling effort (target fish from 15 to 30 cm)
    - Anticipated sampling gear and effort
        - Gill nets (two 12-hour gill net sets with four gills nets per set)
        - Boat electrofishing (two 6-hour periods of active electrofishing)
        - Contingency rule invoked after initial effort
    - Secondary sampling effort
        - Gill nets (two 12-hour gill net sets with three gills nets per set)
        - Boat electrofishing (two 6-hour periods of active electrofishing).
3. Minimum required sampling effort (target fish >30 cm)
    - Anticipated sampling gear and effort
        - Gill nets and electrofishing (same as 15 to 30 cm)
        - Burbot traps (two 12-hour sets with 12 pots per set)
        - Contingency rule invoked after initial effort
    - Secondary sampling effort
        - Gill nets and Electrofishing (same as 15 to 30 cm)
        - Burbot traps (two 12-hour sets with 12 pots per set).

The 2009 sampling event will target the following fish size classes based on total length:

- <15 cm
- ≥15 to ≤30 cm
- >30 cm

These size classes correspond to the sizes of fish that are typically consumed by piscivorous fish and wildlife or people. The fish species targeted within each size class

represent varying feeding guilds (e.g., omnivores and piscivores). The target species are listed below by size class.

<15 cm size class – A goal of six whole body composites (minimum of five fish per composite) consisting of one species per composite will be targeted. A goal of six species from three feeding guilds will be targeted to achieve representation across guilds:

- Primary species
  - Omnivore – yellow perch
  - Insectivore – rainbow trout
  - Benthivore/ detritivore – largescale sucker
- Secondary species
  - Omnivore – bluegill
  - Insectivore – whitefish
  - Benthivore/ detritivore – longnose or bridgelip sucker
- Tertiary species (may include)
  - Omnivore – redside shiner, crappie, pumpkinseed, and smallmouth bass
  - Insectivore – pikeminnow
  - Benthivore/ detritivore – sculpin.

≥15 to <30 cm size class – A goal of six whole body composites (minimum of five fish per composite) consisting of one species per composite will be targeted. A goal of six species from three feeding guilds will be targeted to achieve representation across guilds:

- Primary species
  - Benthivore/detritivore – largescale sucker
  - Insectivore – kokanee
  - Piscivore – walleye
- Secondary species
  - Benthivore/detritivore – longnose or bridgelip sucker
  - Insectivore – lake whitefish
  - Piscivore – smallmouth bass
- Tertiary Species (may include)
  - Benthivore/detritivore – sculpin
  - Insectivore – mountain whitefish
  - Piscivore – pikeminnow.

For the two smaller size classes, composite samples will consist of individual fish of similar size, and the smallest individual in a composite will not be less than 75 percent of the total length (size) of the largest individual in the same composite.

>30 cm size class — Six single-species composite samples (minimum of five fish) will be collected for each of the following species:

- Walleye – piscivore – fillet and remainder
- Burbot – piscivore - fillet and remainder
- Smallmouth bass – piscivore - fillet and remainder
- Largescale sucker – benthivore/detritivore - fillet and remainder (without gut contents)
- Rainbow trout – omnivore - fillet and remainder
- Kokanee – insectivore - fillet and remainder
- Whitefish – insectivore - fillet and remainder.

Species collected in this size class will provide data primarily for the human health risk assessment and may be used in the baseline ecological risk assessment for fish and wildlife risk analysis. Targeted species-specific composites will be collected in this size class to represent species most sought after by anglers and to provide similar data as collected in 2005 by EPA. The targeted species include:

- Walleye (*Sander vitreum*). Walleye represent the top level piscivorous fish (Figure A-3). The walleye is proposed as a target species because they are a top level predator in the UCR, are assumed to have a high bioaccumulation potential because of their trophic position (e.g., elevated metal concentrations as found in 2005, see Appendix B), and are abundant within the Site. In addition, walleye are an important target species of local anglers (Lee et al. 2006; WADOH 1997).
- Burbot (*Lota lota*). Burbot are also top level predators in the UCR (Figure A-3). They are a bottom-dwelling (benthic) fish that consumes primarily other fish, but also feeds on crayfish, amphipods, and fish eggs (Wydowski and Whitney 2003). Burbot are proposed as a target species because they may have a high bioaccumulation potential due to their trophic position (e.g., some COIs were elevated in burbot tissues sampled in 2005, see Appendix B) and are sought after by anglers and tribal members fishing in Lake Roosevelt (Lee et al. 2006; USEPA 2005b).
- Smallmouth Bass (*Micropterus dolomieui*). Smallmouth bass represent the omnivore/piscivore feeding guild (Figure A-3). Smallmouth bass will be targeted because they are an abundant fish species in the UCR and are commonly sought by anglers (Lee et al. 2006; WADOH 1997). They were not sampled in the 2005 collection. Adult fish in this size class feed on fish (e.g., sculpin, perch and salmonids), zooplankton and aquatic insects (Lee et al. 2006; Wydoski and Whitney

2003). Smallmouth bass will be sampled due to the lack of existing data, relative abundance, appropriateness for representing medium to large piscivorous feeding fish, and their importance to the local sport fishery.

- Largescale Sucker (*Catostomus macrocheilus*). Largescale sucker are bottom-dwelling fish that feed on a variety of benthic organisms such as crustaceans, snails, insect larvae, and detritus (Wydoski and Whitney 2003). They are abundant in the UCR (Lee et al. 2006) and were targeted by EPA in 2005. Results from the 2005 study pertaining to whole body samples were confounded by the presence of sediment in the guts of these fish. For the 2009 fish tissue study, largescale suckers will be collected and fillet and remainder (with gut contents) composites will be evaluated to determine the concentration of COIs in fillet tissues without the gut contents. Thus, this species is targeted to provide additional data primarily for the human health risk assessment.
- Rainbow Trout (*Oncorhynchus mykiss)*. Large-sized rainbow trout represent the omnivorous feeding guild (Figure A-3) and are a commonly harvested species from the UCR (Lee et al. 2006; WADOH 1997). Rainbow trout of either hatchery or wild origin will be targeted because consumption by fish, wildlife, or people is not preferential to one stock or the other. However, because the sources of contaminants may be different for the different stocks, composites will consist of only hatchery or wild trout, to the extent possible. It is likely that only one subspecies of rainbow trout will be encountered within each of the FSCAs based on the results of the 2005 study (USEPA 2007a) and McLellan (2008, pers. comm.). Within each FSCA, only six composites will be collected for rainbow trout regardless of hatchery or wild origin. Rainbow trout in this size class are targeted due to their relative abundance, appropriateness in representing large omnivorous fish in the UCR, and their importance to the local sport fishery.
- Kokanee (*Oncorhynchus nerka*). Kokanee also represent omnivorous fish (Figure A-3). Kokanee are the adfluvial life history form of sockeye salmon. Most kokanee in the UCR are hatchery fish, produced from a Lake Whatcom strain, although wild kokanee also are present (McLellan et al. 2001). Kokanee are an important target of anglers in the UCR (Lee et al. 2006; WADOH 1997). Kokanee primarily feed on zooplankton (e.g., cladocerans and copepods) (Wydoski and Whitney 2003). Kokanee will be sampled due to the lack of existing data, their relative abundance, appropriateness for representing large omnivorous fish, and their importance to the local sport fishery.
- Mountain Whitefish (*Prosopium williamsoni)* and Lake Whitefish *(Coregonus clupeaformis).* Whitefish are bottom-feeding invertivores. They are in the salmonid family, but do not migrate long distances. Whitefish are a favorite fish for anglers and these species will be targeted in 2009 due to their importance to the local sport and subsistence fisheries.

For >30 cm fish, composite samples will be determined based on a random approach (using a random number generator to assign individual fish to composites). No size limitation will be applied; therefore, all collected fish have an equal opportunity to be added to a composite.

During field processing and formation of composite samples (see Appendix A), otoliths or opercles (largescale sucker) will be collected from each fish to determine fish age. The otoliths will be sent to the WDFW, along with the fish identification code, for determination of the age of the fish. Information on age provided by WDFW will be entered into the database along with length and weight information.

B1.3 Target Tissue Types and Rationale

The following tissue types are proposed for the target species:

<u>≤15 cm size class</u>

- Whole body composites for all composite samples

<u>≥15 to ≤30 size class</u>

- Whole body composites for all composite samples

Whole body samples are proposed for the smaller size classes because wildlife and piscivorous fish typically consume the whole body. Therefore, whole body samples will be collected to provide a conservative estimate of the likely exposure concentrations for wildlife and piscivorous fish diets.

<u>>30 cm size class</u>

- Walleye—fillet (with skin) and remainder (i.e., head, viscera, fins, skeleton, and musculature not obtained with the fillet) composites. Subsamples from individual walleye fillets will be analyzed for total mercury, prior to compositing.
- Burbot—fillet (with skin) and remainder composites.
- Smallmouth bass—fillet (with skin) and remainder composites. Subsamples from individual bass fillets will be analyzed for total mercury, prior to compositing.
- Largescale sucker—fillet (with skin) and remainder (without gut contents).
- Rainbow trout—fillet (with skin) and remainder composites.
- Kokanee—fillet (with skin) and remainder composites.

Fillets of larger fish will be collected to provide additional data for the human health risk assessment because the number of fillets was limited in 2005. Skin-on fillets were collected in 2005 and are proposed to be collected in 2009 to allow for comparisons.

Both the fillet and remainder (i.e., tissue remaining after filleting) will be analyzed to allow for reconstruction of whole body concentrations using the following equation:

$$C_{ew} = \frac{((C_f \times W_f) + (C_o \times W_o))}{(W_f + W_o)}$$

Where:
C_{ew} = Estimated whole body composite concentration of analyte in ww (mg/kg-ww)
C_f = Concentration in ww of analyte in fillet composite (mg/kg-ww)
W_f = ww of fillet tissue (grams)
C_o = Concentration in ww of analyte in remainder composite (mg/kg-ww)
W_o = ww of remainder tissue (grams)

B1.4 Target Sample Types, Locations, and Rationale

An overview of the proposed sample locations is shown in Figure A-4. As illustrated in Figure A-4, the FSCAs provide sufficient spatial coverage within all reaches of the UCR and correspond to those used by EPA in 2005, allowing for temporal comparability of the 2005 and 2009 fish tissue data.

This time frame is near the end of the growing season for fish in the UCR (i.e., captured fish will have had almost an entire season of feeding and growth before being analyzed for contaminants) (USEPA 2005a). In addition, this time period corresponds to the sampling window used by EPA in 2005 (USEPA 2007a). The 2009 study is anticipated to be conducted under similar conditions as the 2005 study and will develop a comparable data set that can be used for risk assessment purposes. If further data gaps are identified through this or other studies, then additional fish sampling may be required.

A composite sampling approach, as used in 2005, is proposed for each species and FSCA. For each species, six composite samples per species with at least five fish per composite will be targeted within each FSCA. The statistical basis for this composite approach is discussed in Appendix D. For smaller size classes, more than five fish per composite may be required to meet tissue mass requirements for chemical analysis. A total of 576 composite samples are proposed (Table B-1).

B1.5 Target Analyte List (TAL)

The TAL is presented in Tables A-2 and B-2. All samples will be analyzed for EPA's TAL metals, dioxins/furans, PCBs (209 congeners, including dioxin-like PCB congeners), total length and mass, percent lipids, and percent moisture. Observations of condition

and an external examination for health and abnormalities will be recorded and photographed (see Appendix A). Fish will not be excluded from the composites based on the presence of gross abnormalities.

Inorganic arsenic speciation will be conducted on approximately 33 percent (two samples per species per FSCA and 100 percent of burbot samples) of the fillet samples of large fish (>30 cm). Arsenic speciation will primarily be used to assess human health concerns and is therefore not necessary to evaluate in smaller size classes. Total arsenic will be measured in all fish tissue samples.

Total mercury will be analyzed in individual fillets from all walleye and smallmouth bass (>30 cm). Any additional walleye or smallmouth bass in this size class that are caught, but not required for the composite samples, will also have total mercury measured in their fillets.

A subset (two samples per species and size class per FSCA) will be analyzed for a full suite of metals, and the remaining organic chemicals that have log K_{ow} >4.0 (i.e., PBDEs, PAHs, organochlorine pesticides, SVOCs, and any other substance on the COI list with a K_{ow} >4.0) and have standard analytical methods for tissue analysis. These data will provide information on COIs not previously evaluated in 2005 fish tissues. These additional COIs are analyzed only in a subset of the fish samples due to their low frequency of detection in Phase 1 sediment samples, a lack of toxicity information (particularly other metals/metalloids), and because they are not known to be released from the Trail facility (see TAI 2008). The fish samples that will be analyzed for the expanded analyte list will be selected randomly by the field team. If these COIs are detected in the subset of samples, they will be considered for further analysis in the stored homogenates.

A summary of the number of samples that will be analyzed for each of the COI groups is presented in Table B-3.

B2 SAMPLING METHODS

Field sampling methods are described in the FSP (Appendix A) and include the following topics:

- Station positioning (Section 2.1.2)
- Field equipment and supplies (Section 2.1.3)
- Sampling methods (Section 2.1.4)

- Sample containers and labels (sample labels, sample identifier custody seals, sample custody/tracking procedures) (Section 3)
- Field documentation and procedures (field logbooks, photo documentation, COC form) (Section 3).

SOPs for each sampling method are provided in Attachment A2 to the FSP.

In the event that unanticipated or changed circumstances occur in the field, the field supervisor will institute the necessary corrective actions, complete a corrective action record (see Appendix A, Attachment A3), and ensure that the appropriate procedures are followed. If corrective actions require a departure from the FSP, these changes will be documented on a field change request form (see Appendix A, Attachment A3). In any other circumstances where sampling conditions are unexpected, the appropriate sampling actions consistent with this task's objectives will be conducted. This change will be noted in the field log, and a change request form will be completed for the project files and submitted to EPA. Any problems that cannot be easily resolved or that affect the final quality of the work product will be brought to the attention of the TAI technical team coordinator, TAI project coordinator, and EPA. EPA will be notified of any problems that may affect the final outcome of this task. Additional information regarding corrective actions and related documentation is provided in Section C1.

B2.1.1 Sampling Contingencies

For each fish size class, a minimum sampling effort is required after which a contingency rule is invoked if insufficient fish have been captured to complete the required six composites of specified fish species. These contingencies are as follows:

<u>≤15 cm size class</u>

The initial sampling effort will include the use of beach seines and boat electrofishing. Eight hours or four seine hauls will be conducted along with 3 hours of active electrofishing (nearshore). If the resulting catch is insufficient to meet the required number of composites/species, then a second sampling effort will be conducted using the same gear and level of effort. Different types of seines may be used in the secondary effort and/or different locations within the same FSCA may be sampled. The gear and sample locations will be decided in consultation with the TAI technical team task manager and field supervisor.

<u>>15 cm to <30 cm size class</u>

The initial sampling effort will include the use of gill nets and boat electrofishing. Two 12hour gill net sets with four gill nets per set will be conducted along with two 6-hour periods of active electrofishing. If the resulting catch is insufficient to meet the required

number of composites/species, then a second sampling effort will be conducted using the same gear, but only with three gill nets per set. Different locations within the same FSCA may be sampled each time. The gear and sample locations will be decided in consultation with the TAI technical team task manager and field supervisor.

>30 cm size class

The initial sampling effort will include the use of gill nets and boat electrofishing (see Bonar et al. 2000; Appendix A), with the same gear and level of effort as for the intermediate size class. Burbot pot traps will be used for targeted collections of these species. Two 12-hour sets with 12 pots per set will be performed for burbot sampling. If the resulting catch is insufficient to meet the required number of species, then a second sampling effort will be conducted using the same gear and level of effort. Different locations within the same FSCA may be sampled each time. The gear and sample locations will be decided in consultation with the TAI technical team task manager and field supervisor.

B3 SAMPLE HANDLING AND CUSTODY

Fish will be shipped from the field to the offsite processing laboratory (which may be the same as the analytical laboratory). The processing laboratory will prepare homogenized tissue samples from whole fish, fillets, or remainder, and, if at a different location than the analytical laboratory, will then ship the samples to analytical laboratories for chemical analysis. Requirements for sample containers, sample preservation, storage temperature, and holding times are summarized in Table A-3.

Principal documents used to identify samples and to document possession will be field logbooks and COC records. Custody will be documented for all samples at all stages of the analytical or transfer process. COC procedures for sample handling prior to delivery to the laboratories are outlined in Sections 2.2, 2.3, and 3.2 of the FSP.

Upon receipt of samples at each laboratory, the physical integrity of the containers and custody seals will be checked, and the samples will be inventoried by comparing sample labels to those on the COC forms. The laboratories will include the COC and shipping container receipt forms in the data package. Any breaks in the COC or non-conformances will be noted and reported in writing to the laboratory coordinator within 24 hours of receipt of the samples. Each laboratory QA plan (to be provided under separate cover) will include procedures used for accepting custody of samples and documenting samples at the laboratories. The laboratory project manager will ensure

that a sample-tracking record is maintained that follows each sample through all stages of sample processing at the laboratory.

Whole fish will be stored in accordance with Table A-3 (frozen at -20°C) and partially thawed only immediately prior to processing. A single laboratory facility will homogenize the fish for distribution to all the laboratories performing analyses. Subsamples will be packed with dry ice for shipment to other laboratories in glass containers. Homogenized samples will be stored in accordance with Table A-3 (frozen at -20°C). Laboratories will maintain COC documentation and documentation of proper storage conditions for the entire time that the samples are in their possession.

The laboratories will not dispose of the samples for this task until authorized to do so by the task QA coordinator.

B4 ANALYTICAL METHODS

Fish tissue samples collected for this study will be analyzed for chemical parameters shown on Table B-3. Laboratory methods that will be used to complete the respective analyses are described below.

B4.1 Chemical Analyses

Fish tissue samples will be analyzed for metals and metalloids, organic compounds, percent lipids and percent moisture, using the recommended methods listed in Table A-3.

Consistent with the DQOs identified in Section A9, the ACGs for the 2009 fish tissue study are below risk-based-concentrations (RBCs) derived for human and ecological receptors (see Appendix E for human health RBCs). The RBCs are concentrations associated with no significant effect on the receptor, under a given set of assumptions about exposure. The ACGs and the RBCs from which they were derived are presented in Table B-2.

Windward (2004) derived a set of RBCs for both human and ecological receptors. These RBCs are used here for piscivorous fish. To derive the RBCs for metals, Windward conducted a literature search, and literature was reviewed, to identify NOAECs and lowest observed adverse effect concentrations (LOAECs) for the survival, growth, and reproduction of fish exposed to metals through ingestion of food. EPA's ECOTOX database and the general scientific literature were searched. Windward (2004) selected NOAECs and LOAECs for use as risk-based concentrations if a study had adequate control performance, and if the study reported single species exposures. Studies using

live prey to dose test fish were preferred. RBCs were based on NOAECs, unless the MDL was greater than the NOAEC-based RBC, in which case the LOAEC was used. To the extent that both a NOAEC and LOAEC were needed, Windward (2004) chose the study with the lowest LOAEC, and the study with the highest NOAEC that was also lower than the LOAEC. Windward (2004) was consulted for the few organic compounds for which fish RBCs are presented in Table B-2, but the RBCs ultimately used were derived from different sources. The PCB CBR for fish was taken from the most conservative value used in the ecological risk assessment for the Lower Duwamish Waterway (Windward 2007). The value for 2,3,7,8-TCDD was taken from a study combining data on a single exposure pathway and endpoint (early life stage effects) for multiple species to derive a species sensitivity distribution (Steevens et al. 2005). The value for DDT and metabolites was derived following an extensive and detailed review of the literature, and is considered the most technically defensible whole-body CBR for long-term exposures in fish (Jarvinen et al. 1977). This approach is appropriate because it applies risk-based values to help determine the adequacy of laboratory method sensitivity for this fish tissue study. These values are not proposed as the final list of toxicity reference values (TRVs) for the BERA. Additional literature research will be conducted when developing TRVs for the BERA, particularly for metals.

The RBCs for wildlife receptors are those that were used in the draft SLERA (TCAI 2008) with additional RBCs developed from toxicity information[14] reported from Sample et al. (1996). The lowest RBC for human health, fish, and wildlife was selected as the ACG for each COI. The human health RBCs were set equal to an HQ of 0.1 or cancer risk of $1x10^{-6}$ (see Appendix E) and the fish and wildlife RBCs were set at one-fifth the value. The ACGs are provided in Table B-2 alongside expected MDLs and MRLs (as reported by Columbia Analytical Services). These expected MDLs and MRLs are below the ACGs in most cases. Every effort will be made to select laboratories and methodology that will provide MDLs and MRLs that are below the ACGs. Every effort will be made to ensure that MRLs will be no more than 2 times greater than MDLs. Standard laboratory methodology is not expected to be sufficiently sensitive to provide MRLs or MDLs below the ACG for several analytes (Table B-2). For most COIs, however, the standard analytical methods for tissue analysis will provide adequate sensitivity for the risk assessment.

MRLs generally are equivalent to the concentration of the lowest calibration standard (i.e., the practical quantification limit) and represent the low end of the analytical

[14] Toxicity data from Sample et al. (1996) were obtained from the original literature source as cited in this document without applying body-weight scaling adjustments.

calibration range. Analytes that are detected at concentrations below the reporting limit but above the MDL will be reported, but will be qualified as estimated (i.e., a "J" qualifier or equivalent will be appended to the result by the laboratory).

B4.2 Field Measurements

Field operations will include measurement of fish length and weight. Fish length will be measured as total length, from the tip of the tail to the tip of the nose, using a measuring board or standard measuring tape. Lengths will be recorded to the nearest millimeter and fish will be weighed (using a digital scale) to the nearest gram.

External examinations will be conducted according to the procedures of Smith et al. (2002) as outlined in the FSP (Appendix A). This includes an examination of the eyes, skin, fins, parasites, and gills. Photographs will be taken on all sides of each of the fish examined. External abnormalities will be noted for future reference and for general inferences about fish health, but are not intended to derive statistical relationships between contaminants and fish health. Following examination, the fish samples will be prepared for shipment to the offsite processing laboratory.

B5 QUALITY CONTROL

QC samples will be prepared in the laboratories to monitor the precision of the sample homogenization procedures and the bias and precision of the sample analysis procedures. One homogenized composite sample for each tissue type from each species will be used to produce triplicate samples for quality assurance of the homogenization if sufficient tissue mass is available. Details are provided in Section 4.3.1 of the FSP (Appendix A). Laboratory QC procedures are described below.

B5.1 Laboratory Quality Control

Extensive and detailed requirements for laboratory QC procedures are provided in the EPA methods that will be used for this study (Table A-3). Every method protocol includes descriptions of QC procedures, and many incorporate additional QC requirements by reference to separate QC sections. QC requirements include control limits and requirements for corrective action in many cases. QC procedures will be completed by the laboratories, as required in each protocol and their internal SOPs, and as indicated in this QAPP.

The frequency of analysis for laboratory control samples, matrix spike samples, spike or laboratory duplicates, and method blanks will be one for every 20 samples or one per extraction or analysis batch, whichever is more frequent. Calibration procedures will be

completed at the frequency specified in each method description. Equipment blanks will be subjected to the same processes as the fish tissue (e.g., cutting boards, knives, blenders/Tissuemizers™, and bowls) before being poured into a sample bottle.

As required for EPA SW-846 methods (USEPA 2005b), performance-based control limits have been established by the laboratories. These and all other control limits specified in the method descriptions will be used by the laboratories to establish the acceptability of the data or the need for reanalysis of the samples. Laboratory control limits for recovery of internal standards (including certified reference material), matrix spikes, and laboratory control samples, and for relative percent difference of laboratory duplicates, are provided in the analytical laboratory's QA manual (to be submitted following laboratory selection). Because high resolution mass spectrometry (HRMS) analyses 1613B, 1668a and 1614 use isotope dilution techniques, analysis of matrix spike and matrix spike duplicate QC samples are not necessary.

B5.2 Data Quality Indicators for Laboratory

The overall quality objective for this task is to develop and implement procedures that will ensure the collection of representative data of known and acceptable quality. The QA procedures and measurements that will be used for this task are based on EPA guidance. Data quality indicators such as the precision, accuracy or bias, representativeness, completeness, and comparability (PARCC) parameters and analytical sensitivity will be used to assess conformance of data with quality control criteria (USEPA 2002b). Measurement quality objectives (MQOs) for the quantitative PARCC parameters are provided in Table B-4. Data quality indicators and quality control objectives are described in this section.

Precision reflects the reproducibility between individual measurements of the same property. Precision will be evaluated using the results of laboratory duplicates and field splits (for fish samples with sufficient mass). Precision is expressed in terms of the relative percent difference (RPD) for two measurements. The following equation is used to calculate the RPD between measurements:

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

Where: RPD = relative percent difference
C_1 = first measurement
C_2 = second measurement

For three or more measurements, the relative standard deviation (RSD) is used to evaluate precision. The RSD is calculated as the ratio of the standard deviation of three or more measurements to the average of the measurements, expressed as a percentage.

Accuracy and bias represent the degree to which a measured concentration conforms to a reference value. The results for matrix spikes, laboratory control samples, field blanks, and method blanks will be reviewed to evaluate the accuracy and bias of the data. The following calculation is used to determine percent recovery for a matrix spike sample:

$$\%R = \frac{M - U}{C} \times 100$$

Where: %R = percent recovery
M = measured concentration in the spiked sample
U = measured concentration in the unspiked sample
C = concentration of the added spike

The following calculation is used to determine percent recovery for a laboratory control sample or reference material:

$$\%R = \frac{M}{C} \times 100$$

Where: %R = percent recovery
M = measured concentration in the reference sample
C = established reference concentration

Results for field and method blanks can reflect systematic bias that results from contamination of samples during collection or analysis. Detection of any target analytes in field or method blanks will be evaluated as potential indicators of bias.

QC samples and procedures are specified in each method protocol (analytical methods are presented in Table A-3). All QC requirements will be completed by the laboratories as described in the protocols, including the following (as applicable to each analysis):

- Initial calibration
- Initial calibration verification
- Continuing calibration
- Calibration or instrument blanks
- Method blanks
- Laboratory control samples

- Internal standards (including certified reference material)
- Serial dilutions
- Matrix spikes
- Laboratory duplicates.

To alert the data user to possible bias or imprecision, data qualifiers will be applied to reported analyte concentrations when associated QC samples or procedures do not meet each laboratory's internal control limits. Laboratory control limits for the methods that will be used for this study will be provided to EPA under separate cover when laboratories have been selected for this study. Data validation criteria and procedures are described in Sections D1 and D2 of this QAPP.

ACGs provide the target concentration required for the chemical analysis. Methods selected for this study are expected to provide sufficient sensitivity to yield ACGs that are below the lowest reference value for this study (Table B-2).

The laboratory will determine a MDL for each analyte, as required by EPA (USEPA 2004a). MDLs are statistically derived and reflect the concentration at which an analyte can be detected in a clean matrix with 99 percent confidence that a false positive result has not been reported. The analytical laboratory will have established MRLs at levels above the MDLs for the task analytes. These values are based on the laboratory's experience analyzing environmental samples and reflect the typical sensitivity obtained by the analytical system; they represent the level of analyte above which concentrations are accurately quantified. Analyte concentrations for this study will be reported to the MDL. Analytes detected at concentrations between the MRL and the MDL will be reported with a "J" qualifier to indicate that the value is an estimate (i.e., the analyte concentration is below the calibration range). Non-detects will be reported to the MDL and will be adjusted by the laboratory as necessary to reflect sample dilution or matrix interference.

Representativeness and comparability are qualitative QA/QC parameters. Representativeness is the degree to which data represent a characteristic of an environmental condition. In the field, representativeness will be addressed primarily in the sampling design, by the selection of sampling sites and sample collection procedures. In the laboratory, representativeness will be ensured by the proper handling and storage of samples, the use of standard performance-based methods, and initiation of analyses within holding times.

Comparability is the qualitative similarity of one data set to another (i.e., the extent to which different data sets can be combined for use). Comparability will be addressed

through the use of field and laboratory methods that are consistent with methods and procedures recommended by EPA.

Completeness is a measure of the amount of valid data obtained from the analytical measurement system and the complete implementation of defined field procedures. The target completeness objective will be 90 percent; the actual completeness may vary depending on the intrinsic nature of the samples. The completeness of the data will be assessed during QC reviews.

Completeness is defined as follows for all measurements:

$$\%C = \frac{V}{T} \times 100$$

Where: %C = percent completeness
V = number of measurements judged valid
T = total number of measurements

B6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

Analytical instrument testing, inspection, maintenance, setup, and calibration will be conducted by the laboratories in accordance with the requirements identified in the laboratory's SOPs and manufacturer instructions. In addition, each of the specified analytical methods provides protocols for proper instrument setup and tuning and critical operating parameters. Instrument maintenance and repair will be documented in the laboratory's maintenance logs or record books.

B7 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Laboratory instruments will be properly calibrated, and the calibration will be verified with appropriate check standards and calibration blanks for each parameter before beginning each analysis. Instrument calibration procedures and schedules will conform to analytical protocol requirements and descriptions provided in the laboratories' QA plans.

All calibration standards will be obtained from either the EPA repository or a commercial vendor, and the laboratories will maintain traceability back to the National Institute of Standards and Technology (NIST). Stock standards will be used to establish intermediate standards and calibration standards. Special attention will be given to expiration dating, proper labeling, proper refrigeration, and prevention of

contamination. Documentation relating to the receipt, mixing, and use of standards will be recorded in a laboratory logbook. All calibration and spiking standards will be checked against standards from another source, as specified in the methods and the laboratory QA manual.

B8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

The quality of supplies and consumables used during sample collection and laboratory analysis can affect the quality of the data. All equipment that comes into contact with the samples and extracts must be sufficiently clean to prevent detectable contamination, and the analyte concentrations must be accurate in all standards used for calibration and quality control purposes.

The quality of laboratory water used for decontamination will be documented at the laboratory. As discussed in Section B2, cleaned and documented sample containers, if required, will be provided by the laboratory. All containers will be visually inspected prior to use, and any suspect containers will be discarded.

Reagents of appropriate purity and suitably cleaned laboratory equipment will also be used for all stages of laboratory analyses. Details for acceptance requirements for supplies and consumables at the laboratories are provided in the laboratory SOPs and QA plans. All supplies will be obtained from reputable suppliers with appropriate documentation or certification. Supplies will be inspected to confirm that they meet use requirements, and certification records will be retained by the field supervisor (i.e., for supplies used in the field) or the laboratory QA manager (i.e., for supplies used in the laboratory).

B9 NON-DIRECT MEASUREMENTS

Existing chemical data from previous studies will be used for this study (see Appendix B). Historical data will be reviewed for quality assurance and acceptability prior to use in the RI/FS.

B10 DATA MANAGEMENT

Data for this task will be generated both in the field and at the analytical laboratory. The final repository for sample information for the sample collection efforts described in the FSP will be a relational database. Procedures to be used to transfer data from the point of generation to the database are described in this section. The final database will include historical as well as current data.

The TAI technical team will follow the data management plan (DMP) established for the Site as described in the RI/FS Work Plan. The DMP establishes standard procedures for the management of all documents and environmental data (field and laboratory) generated during the UCR RI/FS. The DMP describes data management procedures relating to the creation, acquisition, handling, storage, and distribution of task-related data. The data management systems and procedures described below are intended to establish and maintain an efficient organization of large volumes of complex environmental information for a diverse combination of data types. To accomplish this task, four management systems will be used to provide organized and efficient data management and retrieval:

- **Project database.** Stores environmental sampling and analysis data, information pertaining to geographic information system (GIS) files, and citations of documents related to collection, analysis, or interpretation of environmental data that are stored in the database. A relational[15] database will be used to facilitate data retrieval and interpretation. Both current and historical data will be stored in the project database.
- **Geographic information system.** Stores spatial data and enables the cartographic presentation of data trends and patterns.
- **Hard copy files.** Maintains a record and archive of documents from field studies, contractual agreements, and resulting reports. TAI and its technical team will use various document and reference management software to organize hard copy documents.
- **Web site.** Documents, electronic data, and other project information will be available via the secure project web site. Users with appropriate privileges will be able to download electronic data and documents.

The fish sampling activities will use spatial data sets and analyses for planning, data interpretation, decision support, and data presentation. Links between fish tissue data in the project database and GIS files are established via common identifiers for sampling locations and other geographic features. Spatial data analyses and maps will be prepared using ESRI (or compatible) software.

B10.1 Field Data

Data that are generated during fish tissue collection and sample preparation will be manually entered into the field logbook, field data forms, and COC forms. Data from

[15] A relational database stores distinct types of data (e.g., station descriptions, sample descriptions, and analytical results) in different data tables, where the tables are linked, or related, through shared information (e.g., station identifiers and sample identifiers).

these sources will be entered into the project database directly from the field logbook and field data forms. These data include sample collection coordinates, station names, sampling dates, sample identifiers and numbers, and additional station and sample information. All entries will be reviewed for accuracy and completeness by a second individual, and any errors will be corrected before the data are approved for release to data users.

B10.2 Laboratory Data

A variety of manually entered and electronic instrument data will be generated at the laboratories. Data are manually entered into:

- Standard logbooks
- Storage temperature logs
- Balance calibration logs
- Instrument logs
- Sample preparation and analysis worksheets
- Maintenance logs
- Individual laboratory notebooks
- Results tables for fish measurements (i.e., tissue sample weights during homogenization).

All manual data entry into the laboratory information management system will be proofed at the analytical laboratories. All data collected from each laboratory instrument, either manually or electronically, will be reviewed and confirmed by analysts before reporting. A detailed description of procedures for laboratory data management and data review and verification is provided in the laboratory QA plans (to be submitted following laboratory selection).

Laboratory data will be entered directly into the project database from the EDD. The electronic data for each data package will be provided for QA review in spreadsheet format. These database entries will be verified against the hard-copy laboratory data packages. Data qualifiers will be entered into the spreadsheet and subsequently entered into the database by the data manager. Data management procedures for this project are provided in the RI/FS Work Plan.

SECTION C: ASSESSMENT AND OVERSIGHT

This task will rely on the knowledge and expertise of the TAI technical team, as described in the RI/FS Work Plan. The field team and laboratories will stay in close verbal contact with the task manager and the task QA coordinator during all phases of this task. This level of communication will serve to keep the management team apprised of activities and events, and will allow for informal but continuous task oversight. Few scheduled assessment activities are planned for this task because the scope of the sampling and analysis effort and the size of the team are relatively small.

C1 ASSESSMENTS AND RESPONSE ACTIONS

Assessment activities will include readiness reviews prior to sampling and prior to release of the final data to the data users, as well as internal review while work is in progress. An informal technical systems audit may be conducted if problems are encountered during any phase of this task.

Readiness reviews are conducted to ensure that all necessary preparations have been made for efficient and effective completion of each critical phase of work. The first readiness review will be conducted prior to field sampling. The field supervisor will verify that all field equipment is ready for transfer to the site. The field supervisor will also verify that the field team and subcontractor(s), as required, have been scheduled and briefed (including review of the SHSP) and that the contract for the subcontractor has been signed by both parties. Any deficiencies noted during this readiness review will be corrected prior to initiation of sampling activities.

The second readiness review will be completed before final data are released for use. The database administrator will verify that all results have been received from the laboratories, data validation and data quality assessment have been completed for all of the data, and data qualifiers have been entered into the database and verified. Any deficiencies noted during this review will be corrected by the database administrator, the task QA coordinator, or their designee. Data will not be released for final use until all data have been verified and validated. No report will be prepared in conjunction with the readiness reviews. However, the TAI technical team coordinator and data users will be notified when the data are ready for use.

Technical review of intermediate and final work products generated for this task will be completed throughout the course of all sampling, laboratory, data validation, data management, and data interpretation activities to ensure that every phase of work is accurate and complete and follows the QA procedures outlined in this QAPP. Any

problems that are encountered will be resolved between the reviewer and the person completing the work. Any problems that cannot be easily resolved or that affect the final quality of the work product will be brought to the attention of the TAI technical team coordinator and TAI project coordinator. EPA will be notified of any problems that may affect the final outcome of this task, according to the Agreement.

The laboratories will be required to have implemented a review system that serves as a formal surveillance mechanism for all laboratory activities. Each phase of work is reviewed by a supervisor before it is approved for release. Details are provided in the laboratory QA plans (to be submitted following laboratory selection). TAI's QA personnel may elect to observe, witness, and critique a dry run of the laboratory sample processing – filleting, homogenization, and documentation – prior to project initiation.

Technical system audits may be conducted if serious problems are encountered during sampling or analysis operations. Regardless, a technical audit of the fish collection process will be performed by TAI's QA personnel during the first 2 weeks of initiation of field work to assess the quality and documentation of the field sampling; sample handling, processing, and storage; sample collection; and shipment documentation. A verbal debriefing will be provided during which any corrections/improvements will be discussed and implemented by consensus. A formal audit report will be subsequently prepared and issued to the project manager. The field assessment report will include evaluation of performance relative to project SOPs and recommendations for process improvement. These audits will be conducted by the task QA coordinator or designee, or by the analytical laboratory, as appropriate. These audits may consist of onsite reviews of any phase of field or laboratory activities or data management. Results of any audits will be provided in the field sampling report.

Any task team member who discovers or suspects a non-conformance is responsible for reporting the non-conformance to the task manager, the task QA coordinator, or the laboratory project or QA manager, as applicable. The task QA coordinator will ensure that no additional work dependent on the non-conforming activity is performed until a confirmed non-conformance is corrected. Any confirmed non-conformance issues will be relayed to the TAI technical team coordinator. In addition, communication between corrective actions by the field personnel and the laboratory relative to the accuracy and completeness of the chain-of-custody documents will follow corrective-action procedures.

C2 REPORTS TO MANAGEMENT

The laboratories will keep the appropriate technical team laboratory coordinator(s) and QA manager(s) apprised of their progress on a weekly basis. The laboratories will provide the following information:

- Inventory and status of samples held at the laboratory in spreadsheet format by sample delivery group
- Summaries of out-of-control laboratory QC data that resulted in a requirement for corrective action and a description of the corrective actions implemented
- Descriptions and justification for any significant changes in methodology or QA/QC procedures.

The technical team laboratory coordinator and QA manager will provide this information to the task QA coordinator who, in turn, will provide this information to the TAI technical team coordinator.

The laboratory will be required to have implemented routine systems of reporting non-conformance issues and their resolution. These procedures are described in the laboratory QA manuals (to be submitted following laboratory selection). Laboratory non-conformance issues will also be described in the field sampling report if they affect the quality of the data.

Data packages and EDDs will be prepared by the laboratory upon completion of analyses for each sample delivery group. The case narrative will include a description of any problems encountered, control limit exceedances (if applicable), and a description and rationale for any deviations from protocol. Copies of corrective action reports generated at the laboratory will also be included with the data package.

Validated data will be provided electronically to EPA within 90 days of receipt of all validated laboratory data packages for each survey. These data will be provided with the field sampling report containing an overview of the field event, a sampling location map, sample collection methods used, rationale for any deviations from the FSP and QAPP, validated data, and data validation report.

A final data evaluation report will be prepared by the TAI technical team and submitted to EPA within 150 days following submission of the final field sampling report.

SECTION D: DATA VALIDATION AND USABILITY

Data generated in the field and at the laboratories will be verified and validated according to criteria and procedures described in this section. Data quality and usability will be evaluated, and a discussion will be included in the data validation report.

D1 DATA REVIEW, VERIFICATION, AND VALIDATION

Field and laboratory data for this task will undergo a formal verification and validation process. Data validation and data quality assessment will be completed and provided to the task QA coordinator. All errors found during the verification of field data, laboratory data, and the database will be corrected prior to release of the final data.

Data verification and validation for metals and organic parameters will be completed according to methods described in EPA's guidance documents, including EPA's national functional guidelines (NFGs) and EPA Region 10 guidance for inorganic, dioxin/furan, PCB congener, and organic data review (USEPA 1995, 1996, 2002b, 2004a, 2005c, 2007c). Data validation will be performed in accordance with the "*Guidelines Labeling Externally Validated Laboratory Analytical Data for Superfund Use"* (USEPA 2009). Data will be qualified or rejected as necessary if results for laboratory control samples, matrix spike samples, or laboratory duplicates do not meet QC acceptance criteria outlined in the NFGs, the specific analytical methods, or laboratory performance-based control limits, as applicable. Data may also be qualified as undetected based on concentrations of target analytes detected in laboratory or field blanks. Current performance-based control limits will be provided in the laboratory QA plans (to be submitted following laboratory selection), as applicable. All chlorinated pesticide data will undergo Stage 4 data validation. Notwithstanding the chlorinated pesticide data, 20 percent of all other data generated by the laboratories will undergo Stage 4 data validation and the remaining 80 percent will undergo Stage 2B data validation

Equipment rinse blanks will be evaluated and data qualifiers will be applied in the same manner as method blanks. The equipment blank will be subjected to the same processes as the fish tissue (e.g., cutting boards, knives, blenders/Tissuemizers™, and bowls) before being poured into a sample bottle.

D2 VERIFICATION AND VALIDATION METHODS

Field data will be verified during preparation of samples and COC forms. Field notebook entries, field data forms, and COC forms will be checked for consistency daily by the field supervisor or his designee. After field data are entered into the project database, 100 percent verification of the entries will be completed to ensure the accuracy and

completeness of field data in the database. Any discrepancies will be resolved before the final database is released for use.

Approximately 10 percent of the chemistry data will be fully validated, including the first two data packages generated for each chemical analysis type. Validation for the remaining data will be based on review of the summary forms for sample and QC data. In addition, all pesticide chromatograms will be evaluated for interference, particularly by PCBs. If problems or questions are encountered during validation, the laboratory will be contacted for resolution. Additional full or focused validation will be completed if required to fully assess the quality of the data or to verify that laboratory errors have been addressed.

Procedures for verification and validation of laboratory data and field QC samples will be completed as summarized in Section D1 above. The accuracy and completeness of each data set will be verified at the laboratory when the EDDs are prepared and again as part of data validation. EDD completeness will be verified electronically to the sample and analyte level when data from the laboratory and from the data validation firm are entered into the database. Ten percent of entries to the database from the laboratory EDDs will be checked against the hard-copy data packages.

In addition to verification of field and laboratory data and information, data qualifier entries into the database will be verified. Any discrepancies will be resolved before the final database is released for use.

ACGs and targeted MRLs for this task are provided in Table B-2. Any exceedance of actual MRLs over the target MRLs or ACGs will be discussed in the data validation report.

D3 RECONCILIATION WITH USER REQUIREMENTS

The goal of data validation is to determine the quality of each datum and to identify those that do not meet the task measurement quality objectives. Non-conforming data may be qualified as estimated (i.e., a "J" qualifier appended to the result) or rejected as unusable (i.e., an "R" qualifier appended to the result) during data validation if criteria for data quality are not met. Data may also be qualified as undetected during validation based on laboratory and field blank results. Rejected data will not be used for any purpose. A summary of the qualified data and the reasons for qualification will be included in the data validation report.

Data qualified as estimated will be used for all intended purposes and will be appropriately qualified in the final project database. However, these data may be less precise or less accurate than unqualified data. Data users, in cooperation with the TAI

technical team coordinator and the task QA coordinator, are responsible for assessing the effect of the inaccuracy or imprecision of the qualified data on statistical procedures and other data uses. The data quality discussion in the data validation report will include information regarding the direction or magnitude of bias or the degree of imprecision for qualified data to facilitate the assessment of data usability. The data validation report will also include a discussion of data limitations and their effect on data interpretation activities.

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