

# UPPER COLUMBIA RIVER

---

## **FINAL** **Aquatic Baseline Ecological Risk Assessment** **Report Organization and Executive Summary**

*Prepared for*

**Teck American Incorporated**

P.O. Box 3087

Spokane, WA 99220-3087

*Prepared by*



1180 Eugenia Place, Suite 204

Carpinteria, California 93013

*In Association and Consultation with*

*Windward Environmental LLC, Exponent, and Parametrix, Inc.*

July 2026



## CONTENTS

|                                                                                      |              |
|--------------------------------------------------------------------------------------|--------------|
| <b>LIST OF APPENDICES.....</b>                                                       | <b>IV</b>    |
| <b>LIST OF MAPS .....</b>                                                            | <b>V</b>     |
| <b>LIST OF TABLES .....</b>                                                          | <b>VI</b>    |
| <b>ACRONYMS AND ABBREVIATIONS.....</b>                                               | <b>VII</b>   |
| <b>REPORT ORGANIZATION.....</b>                                                      | <b>RO-1</b>  |
| <b>EXECUTIVE SUMMARY .....</b>                                                       | <b>ES-1</b>  |
| <b>1 VOLUME 1: APPROACH AND METHODOLOGY FOR OU 1 AND OU 2 .....</b>                  | <b>ES-3</b>  |
| 1.1 PROBLEM FORMULATION.....                                                         | ES-3         |
| 1.1.1 OU 1 and OU 2 Characteristics.....                                             | ES-3         |
| 1.1.2 Known and Potential Sources of COPCs .....                                     | ES-5         |
| 1.1.3 Ecological Setting.....                                                        | ES-6         |
| 1.2 BERA APPROACH FOR OU 1 AND OU 2 .....                                            | ES-7         |
| 1.2.1 Types of Lines of Evidence .....                                               | ES-7         |
| 1.2.2 Risk Characterization Approach .....                                           | ES-8         |
| <b>2 VOLUME 2: RISK CHARACTERIZATION FOR OU 1.....</b>                               | <b>ES-10</b> |
| <b>3 VOLUME 3: RISK CHARACTERIZATION FOR OU 2.....</b>                               | <b>ES-15</b> |
| <b>4 VOLUME 4: APPROACH, METHODOLOGY, AND FINDINGS FOR<br/>RFDAS AND WSDAS .....</b> | <b>ES-18</b> |
| 4.1 RFDA AND WSDA CHARACTERISTICS .....                                              | ES-18        |
| 4.2 ECOLOGICAL SETTING.....                                                          | ES-19        |
| 4.3 RFDA AND WSDA BERA APPROACH .....                                                | ES-19        |
| 4.4 RISK CHARACTERIZATION FOR RFDAS AND WSDAS.....                                   | ES-20        |
| <b>5 CONCLUSIONS .....</b>                                                           | <b>ES-23</b> |
| <b>6 REFERENCES.....</b>                                                             | <b>ES-25</b> |

## LIST OF APPENDICES

(provided in electronic format on the enclosed disk in Volume 1)

|            |                                                                                                    |
|------------|----------------------------------------------------------------------------------------------------|
| Appendix A | Data Usability Assessment                                                                          |
| Appendix B | BERA Data Set                                                                                      |
| Appendix C | Development of Background Threshold Values                                                         |
| Appendix D | Aquatic Vegetation Growth Zone Delineation                                                         |
| Appendix E | Bioaccumulation Models                                                                             |
| Appendix F | Porewater Benchmarks                                                                               |
| Appendix G | Soil Invertebrate and Plant Toxicity Benchmarks                                                    |
| Appendix H | Wildlife Toxicity, Bioavailability, and Methylmercury Apportionment Methods                        |
| Appendix I | Fish Dietary Toxicity Reference Values                                                             |
| Appendix J | Sediment Bioassay Data Summary and Development of Concentration-Response Modeling Data Sets        |
| Appendix K | Benthic Invertebrate Community Metrics                                                             |
| Appendix L | Statistical Methodology for Benthic Invertebrate Community Ecological Assessment Endpoint Analyses |
| Appendix M | Hazard Quotient Calculations                                                                       |
| Appendix N | Digital Data Exploration Tools                                                                     |
| Appendix O | Uncertainty Evaluations                                                                            |

## **LIST OF MAPS**

|          |                              |
|----------|------------------------------|
| Map ES-1 | Regional Map of the UCR Site |
| Map ES-2 | RFDA Sample Locations        |
| Map ES-3 | WSDA Sample Locations        |

## **LIST OF TABLES**

|            |                                                             |
|------------|-------------------------------------------------------------|
| Table ES-1 | Summary of Risk Conclusions in OU 1                         |
| Table ES-2 | Summary of Risk Conclusions in OU 2                         |
| Table ES-3 | Summary of RFDA and WSDA BERA Risk Conclusions              |
| Table ES-4 | Summary of Risk Conclusions in OU 1, OU 2, RFDAs, and WSDAs |

## ACRONYMS AND ABBREVIATIONS

|      |                                                                       |
|------|-----------------------------------------------------------------------|
| BERA | baseline ecological risk assessment                                   |
| BTV  | background threshold value                                            |
| CB   | Columbia Beach                                                        |
| CBN  | Columbia Beach North                                                  |
| CBS  | Columbia Beach South                                                  |
| COC  | chemical of concern                                                   |
| COI  | chemical of interest                                                  |
| COPC | chemical of potential concern                                         |
| CSM  | conceptual site model                                                 |
| DDD  | dichloro-diphenyl-dichloroethane                                      |
| DDE  | dichloro-diphenyl-dichloroethene                                      |
| DDx  | sum of 2,4'-DDD, 4,4'-DDD, 2,4'-DDE, 4,4'-DDE, 2,4'-DDT, and 4,4'-DDT |
| DU   | decision unit                                                         |
| EAE  | ecological assessment endpoint                                        |
| ELS  | early life stage                                                      |
| EPA  | U.S. Environmental Protection Agency                                  |
| HQ   | hazard quotient                                                       |
| LOE  | line of evidence                                                      |
| MF   | Marcus Flats                                                          |
| MFE  | Marcus Flats East                                                     |
| MFW  | Marcus Flats West                                                     |
| OU   | operable unit                                                         |
| PCB  | polychlorinated biphenyl                                              |
| RFA  | Relict Floodplain A                                                   |
| RFB  | Relict Floodplain B                                                   |

---

|       |                                              |
|-------|----------------------------------------------|
| RFC   | Relict Floodplain C                          |
| RFD   | Relict Floodplain D                          |
| RFDA  | relict floodplain deposition area            |
| RFE   | Relict Floodplain E                          |
| RI    | remedial investigation                       |
| RI/FS | remedial investigation and feasibility study |
| RM    | river mile                                   |
| Site  | Upper Columbia River site                    |
| SLERA | Screening Level Ecological Risk Assessment   |
| TAI   | Teck American Incorporated                   |
| TEQ   | toxic equivalent                             |
| TRV   | toxicity reference value                     |
| UCR   | Upper Columbia River                         |
| WSDA  | windblown sediment deposition area           |



## REPORT ORGANIZATION

This document presents a Final Baseline Ecological Risk Assessment (BERA) for the aquatic portion of the Upper Columbia River (UCR) site (UCR Site or Site<sup>1</sup>) in northeastern Washington. Teck American Incorporated (TAI) has prepared this BERA pursuant to the Settlement Agreement between TAI and the U.S. Environmental Protection Agency (USEPA 2006a) and the Upper Columbia River Work Plan for the Remedial Investigation and Feasibility Study (USEPA 2008). The Aquatic BERA evaluates 1) the Upper Reach Operable Unit (OU 1), which is defined as the UCR from the U.S.-Canada border at river mile (RM) 745 to Marcus Flats at RM 708.7; 2) OU 2, defined as the UCR extending from Marcus Flats (RM 708.7) to Grand Coulee Dam (RM 597) within the current annual full pool elevation of the Lake Roosevelt reservoir; and 3) the river-influenced soils in the relict floodplain deposition areas (RFDAs) and windblown sediment deposition areas (WSDAs) between the annual full pool elevation of the UCR and the maximum UCR flood elevation prior to the establishment of the upriver flood controls in the early 1970s, as delineated by the Final Soil Study Quality Assurance Project Plan (TAI 2014a) for the upland area.

For OU 1 and OU 2, the Aquatic BERA focuses on chemicals of potential concern (COPCs), which are mostly metals but include several organic compounds, in sediment (including beaches), surface water, porewater, and biota. The COPCs originated from historical discharges of slag and liquid effluent from the Teck Metals Ltd. smelter in Trail, British Columbia (Trail Facility), and other sources to OU 1 and OU 2. For RFDAs and WSDAs, the BERA focuses on terrestrial soils derived from river sediments and biota that may contain COPCs (metals) due to historical transport from the river either via flooding at RFDAs before upstream hydrologic controls were in place in the early 1970s or by wind deposition from exposed sediment areas in the river at WSDAs. For upland areas of the Site that are located above the historical flood extent of the UCR, terrestrial exposures to metals in upland soils where metals may be present due to aerial deposition from the Trail Facility and the former Le Roi smelter in Northport,

---

<sup>1</sup> As per the June 2, 2006, Settlement Agreement for Implementation of Remedial Investigation and Feasibility Study (RI/FS) at the Upper Columbia River Site (referred to herein as the UCR Site or Site), the Site consists of the areal extent of hazardous substances contamination within the United States in or adjacent to the Upper Columbia River, including the Franklin D. Roosevelt Lake, from the U.S.-Canada border to Grand Coulee Dam, and all suitable areas in proximity to such contamination necessary for implementation of the response actions (RI/FS) described therein.

Washington, and other sources were evaluated in the Final Baseline Ecological Risk Assessment for Upland Terrestrial Habitat (USEPA 2023)<sup>2</sup>.

The Aquatic BERA report is organized as follows:

- **Report Organization.** Describes the organization of the Final Aquatic BERA.
- **Executive Summary.** Provides the executive summary of the findings for OU 1, OU 2, and the RFDAs and WSDAs.
- **Volume 1: Approach and Methodology for OU 1 and OU 2.**
  - **Section 1 Introduction.** Presents the objectives of the Aquatic BERA, the ecological risk assessment guidance used to guide preparation of this BERA, and a summary of previous screening-level evaluations.
  - **Section 2 Problem Formulation.** Presents the focus of the assessment, including the physical characteristics of the UCR, the ecological setting, COPCs, receptor-specific exposure pathways, and the receptor groups with their respective ecological assessment endpoints (EAEs).
  - **Section 3 Aquatic BERA Data Set.** Presents the data set assessment, including data usability and management for use in the aquatic exposure assessment.
  - **Section 4 Approach to Exposure and Effects Assessments and Analyses.** Outlines the risk assessment approaches used in this BERA, including the exposure and effects assessments and the EAE-specific exposure and effects assumptions used for risk characterization, which includes the weight of evidence evaluation and risk description.
  - **Section 5 References.**
- **Volume 2: Risk Characterization for OU 1.**
  - **Section 1 Introduction.** Presents an overview of the risk characterization approach used in the OU 1 BERA.
  - **Sections 2 through 8 Risk Characterization for Receptors in OU 1.** Presents the risk evaluation for aquatic plants, zooplankton, benthic invertebrates, fish, birds, mammals, and herpetofauna exposed to COPCs in OU 1. Each receptor group is addressed in its own section.

---

<sup>2</sup> TAI has sought technical review of the Upland BERA (TAI 2024) and is currently awaiting responses from EPA's Office of Land and Emergency Management.

- **Section 9 BERA Findings.** Provides a summary of the risk evaluation findings for OU 1.
- **Section 10 References.**
- **Volume 3: Risk Characterization for OU 2.**
  - **Section 1 Introduction.** Presents an overview of the risk characterization approach in the OU 2 BERA.
  - **Sections 2 through 8 Risk Characterization for Receptors in OU 2.** Presents the risk evaluation for aquatic plants, zooplankton, benthic invertebrates, fish, birds, mammals, and herpetofauna exposed to COPCs in OU 2. Each receptor group is addressed in its own section.
  - **Section 9 BERA Findings.** Provides a summary of the risk evaluation findings for OU 2.
  - **Section 10 References.**
- **Volume 4: Terrestrial BERA for River-Influenced Soils Along OU 1 and OU 2 (hereafter, the “RFDA and WSDA BERA”).**
  - **Section 1 Introduction.** Presents the objective of the BERA for the RFDA and WSDAs, ecological risk assessment guidance used for this BERA, and a summary of previous screening-level evaluations.
  - **Section 2 Problem Formulation.** Presents the focus of the terrestrial risk assessment for the RFDA and WSDAs, including their physical characteristics and land uses, ecological settings, COPCs, receptor-specific exposure pathways, and the receptor groups with their respective EAEs.
  - **Section 3 BERA Data Set for RFDA and WSDAs.** Presents the data set assessment, including data usability and management for use in the terrestrial exposure assessment.
  - **Section 4 Approach to Exposure and Effects Assessments and Analyses.** Outlines the risk assessment approaches used in the RFDA and WSDA BERA, including the exposure and effects assessments, risk characterization, and risk conclusions.
  - **Sections 5 through 9 Risk Characterization for Receptors.** Presents the risk characterization for terrestrial plants, soil invertebrates, birds, mammals, and herpetofauna in the RFDA and WSDAs. Each receptor group is addressed in its own section.

- **Section 10 BERA Findings.** Provides a summary of the risk evaluation findings for the RFDAs and WSDAs.
- **Section 11 References.**

In addition to Volumes 1 to 4, this BERA includes the following appendices:

- **Appendix A Data Usability Assessment.** Presents the detailed data usability evaluation for the data sets used in the Aquatic BERA.
- **Appendix B BERA Data Sets.** Provides the chemistry data sets for soil, surface water, sediment, porewater, fish tissue, and macroinvertebrate (crayfish and mussel) tissue.
- **Appendix C Development of Background Threshold Values.** Presents the approach and data used to develop the background threshold values for sediment and porewater.
- **Appendix D Aquatic Vegetation Growth Zone Delineation.** Presents methods for delineating the aquatic vegetation growth zone in the UCR.
- **Appendix E Bioaccumulation Models.** Presents the approach and data used to generate bioaccumulation models used to estimate tissue concentrations of COPCs in plants and invertebrates.
- **Appendix F Porewater Benchmarks.** Presents porewater benchmarks for aquatic receptors along with the derivation approach.
- **Appendix G Soil Invertebrate and Plant Toxicity Benchmarks.** Presents soil invertebrate and terrestrial plant benchmarks derived for use in the RFDA and WSDA BERA along with the derivation approach.
- **Appendix H Wildlife Toxicity, Bioavailability, and Methylmercury Apportionment Methods.** Presents bird and mammal toxicity reference values (TRVs) and an evaluation of metal bioavailability in soil and sediment to birds and mammals.
- **Appendix I Fish Dietary Toxicity Reference Values.** Presents concentration-based and dose-based dietary TRVs for fish along with the derivation approach.
- **Appendix J Sediment Bioassay Data Summary and Development of Concentration-Response Modeling Data Sets.** Presents the approach for evaluating and pooling sediment bioassay results to support the benthic invertebrate evaluations.
- **Appendix K Benthic Invertebrate Community Metrics.** Summarizes how benthic invertebrate community metrics were distilled to identify the priority community metrics and presents the literature reviews conducted to support the assessment of the benthic invertebrate community data in the Aquatic BERA.

- **Appendix L Statistical Methodology for Benthic Invertebrate Community Ecological Assessment Endpoint Analyses.** Describes the statistical approaches and methods used in the analyses of the benthic invertebrate bioassay and community data and provides guidance for interpreting the figures used to present the analyses.
- **Appendix M Hazard Quotient Calculations.** Presents the direct contact and dose model hazard quotient (HQ) calculations used to support terrestrial plant, soil invertebrate, benthic invertebrate, zooplankton, aquatic plant, fish, bird, and mammal risk evaluations. Additionally, this appendix presents cumulative frequency plots for HQs and plots of HQs by river mile.
- **Appendix N Digital Data Exploration Tools.** Contains digital data exploration tools for HQs and a user's guide.
- **Appendix O Uncertainty Evaluations.** Presents the detailed uncertainty evaluation for the Aquatic BERA, including quantitative and qualitative uncertainty analyses.

## EXECUTIVE SUMMARY

This document presents the Final Aquatic Baseline Ecological Risk Assessment (BERA) for the aquatic portion and the river-influenced soils in the relict floodplain deposition areas (RFDAs) and windblown sediment deposition areas (WSDAs) of the Upper Columbia River (UCR) site (UCR Site or Site<sup>1</sup>) in northeastern Washington (Map ES-1). The Columbia River flows from its origin in southeastern British Columbia, Canada, and south through eastern and central Washington State before flowing west along the boundary between Washington and Oregon toward the Pacific

Ocean. The Lake Roosevelt reservoir was formed on the Columbia River by the construction of Grand Coulee Dam approximately 150 miles downstream from the U.S.-Canada border.

The objective of this Aquatic BERA is to assess risks to ecological receptors from hazardous substances in sediment, surface water, porewater, and biota tissues within the UCR under baseline conditions<sup>2</sup>. This BERA identifies which chemicals of potential concern (COPCs) and exposure pathways are associated with unacceptable risks to ecological receptors and provides a basis for informed discussions with risk managers about the causes, nature, and extent of any such risks.

This BERA covers the following geographical parts of the UCR:

- Operable Unit (OU) 1, the Upper Reach OU, which is defined as the UCR from the U.S.-Canada border at river mile (RM) 745 to Marcus Flats at RM 708.7.

---

The Aquatic BERA is presented in four volumes. The objective of the Aquatic BERA is to assess potential risk from hazardous substances in sediment, surface water, porewater, and biota tissues to aquatic ecological assessment endpoints (EAEs) within OU 1 and OU 2 and in river-influenced soils along OU 1 and OU 2 to terrestrial EAEs under baseline conditions. The Executive Summary provides a high-level overview of the approaches, results, and conclusions of the Aquatic BERA.

---

---

<sup>1</sup> As per the June 2, 2006, Settlement Agreement for Implementation of Remedial Investigation and Feasibility Study (RI/FS) at the Upper Columbia River Site (referred to herein as the UCR Site or Site), the Site consists of the areal extent of hazardous substances contamination within the United States in or adjacent to the Upper Columbia River, including the Franklin D. Roosevelt Lake, from the U.S.-Canada border to Grand Coulee Dam, and all suitable areas in proximity to such contamination necessary for implementation of the response actions (RI/FS) described therein.

<sup>2</sup> "Baseline conditions" are defined as current and potential hazards to the environment that may be posed by chemicals of potential concern.

- OU 2, which extends from Marcus Flats (RM 708.7) to Grand Coulee Dam (RM 597) and is within the current annual full pool elevation of the Lake Roosevelt reservoir (1,290 feet above mean sea level).
- The river-influenced soils along OU 1 and OU 2 include regions affected by two distinct processes.
  - The RFDAs are defined as areas that may have been subjected to flooding under historical flow conditions but are not expected to flood under the current regulated flow regime provided by upriver dams, except during extreme flow events.
  - The WSDAs are defined as upland locations adjacent to and downwind from large shallow areas in the UCR that are exposed during the primary Lake Roosevelt reservoir drawdown period (March through July) and may have fine windblown sediments deposited on them.

The Aquatic BERA is presented in four volumes:

- Volume 1 presents the problem formulation and BERA approach for the aquatic portion of the Site (i.e., OU 1 and OU 2).
- Volume 2 and Volume 3 present the risk characterization for the aquatic EAEs in OU 1 and OU 2, respectively.
- Volume 4 presents the terrestrial BERA for river-influenced soils along OU 1 and OU 2 (hereafter, the “RFDAs and WSDAs BERA”) and is focused on terrestrial receptors exposed to metals in soils influenced by material originating from the river and deposited either during historical floods or entrained and deposited by wind.

Within this Executive Summary, the findings and recommendations for chemicals of concern (COCs) to be addressed in more detail in the Aquatic Remedial Investigation (RI) are summarized for OU 1 in Section 2, for OU 2 in Section 3, and for RFDAs and WSDAs in Section 4.

# 1 VOLUME 1: APPROACH AND METHODOLOGY FOR OU 1 AND OU 2

Volume 1 describes the objective of the Aquatic BERA as it pertains to OU 1 and OU 2, summarizes the previous screening-level risk evaluations, and presents the problem formulation and methodology used in this BERA that are common to both OU 1 and OU 2.

The Aquatic BERA builds upon the screening-level risk evaluations for the Site that were completed to focus the list of COPCs for evaluation in this BERA (TAI 2010, 2020a). COPCs and chemicals of interest (COIs) that could not be screened out in the Final Chemicals of Potential Concern Refinement for Aquatic and Terrestrial Receptors, Addendum No. 1 (hereafter, COPC Refinement) (TAI 2020a) are the focus of the Aquatic BERA.

## 1.1 PROBLEM FORMULATION

The Aquatic BERA problem formulation is a refinement based on preliminary problem formulations in the Upper Columbia River Screening Level Ecological Risk Assessment Screening Level Ecological Risk Assessment (hereafter, SLERA) (TAI 2010), the Upper Columbia River Baseline Ecological Risk Assessment Work Plan (hereafter, the BERA Work Plan) (TAI 2011), and the Upper Columbia River Expansion of the Problem Formulation Chapter of the UCR Baseline Ecological Risk Assessment (BERA) Work Plan (hereafter, Expanded Problem Formulation) (TAI 2012).

---

The problem formulation is the basis for the Aquatic BERA and does the following:

- Summarizes the aquatic Site characteristics, including identifying the six conceptual site model (CSM) units
  - Provides a detailed description of the ecological characteristics of OU 1 and OU 2
  - Identifies the COPCs, their potential sources, and the ecological exposure CSM.
- 

### 1.1.1 OU 1 and OU 2 Characteristics

The aquatic portion of the Site includes the approximately 150 river miles of the UCR from the U.S.-Canada border to Grand Coulee Dam (Map ES-1). Grand Coulee Dam impounds the Lake Roosevelt reservoir, which extends approximately 133 river miles upstream of the dam at full pool. River flows in the UCR are controlled by the operation of upstream dams in addition to and in coordination with operations at Grand Coulee Dam. The Columbia and Pend Oreille Rivers are the primary inflows to the UCR, with contributions from the Spokane River and, to a



lesser extent, the Colville, Kettle, and Sanpoil Rivers. Bedrock formations in the region are enriched with metal ores, and there are placer deposits in the UCR and its tributaries. This region has been home to mining, milling, smelting, and prospecting since the mid-1800s (USEPA 2008).

For the Aquatic BERA, the UCR has been divided into smaller geographic sections called CSM units (TAI 2011), which build on the reaches originally designated in RI/FS Work Plan (USEPA 2008), as described below and shown on Map ES-1. There are two CSM units in OU 1 and four CSM units in OU 2. CSM unit boundaries align with the fish sample collection areas and benthic macroinvertebrate collection areas such that each CSM unit contains tissue data from one fish sample collection area and one benthic macroinvertebrate sample area.

## OU 1

- **OU 1 North CSM Unit.** This CSM unit begins at the U.S.-Canada border at RM 745 and ends at RM 729<sup>5</sup> at Little Dalles. While this CSM unit is generally unaffected by operations at Grand Coulee Dam, upstream dam operations associated with power generation result in diurnal changes in flows and water depths in OU 1 North.
- **OU 1 South CSM Unit.** This approximately 20-mile-long CSM unit starts at RM 729 and ends at RM 708.7. This CSM unit is affected by the impoundment of the Lake Roosevelt reservoir behind Grand Coulee Dam and is where the UCR fluvial system begins transitioning from riverine to lacustrine.

## OU 2

- **Transitional CSM Unit.** This approximately 9-mile reach of the river (RM 708.7 to RM 700.1) consists primarily of Marcus Flats and is characterized by a dramatic decrease in flow velocities with the transition from riverine to lacustrine conditions. The Kettle River flows into the UCR in the Transitional CSM Unit near RM 707.
- **Upper Lacustrine CSM Unit.** This portion of the river, extending from RM 700.1 to RM 657, is characterized as lacustrine with low flow velocities (maximum flow rarely

---

<sup>5</sup> In the Draft Aquatic BERA submitted to U.S. Environmental Protection Agency (EPA) in April 2024, the downstream end of the OU 1 North CSM unit was at RM 733.3, in line with the downstream border of the benthic macroinvertebrate tissue sampling area for Reach 1. Following submittal of that Draft Aquatic BERA, Teck American Incorporated (TAI) suggested that the border be shifted downstream to RM 729 to align with Little Dalles, where the effects of reservoir operations become more pronounced. EPA agreed with TAI's request, dated April 8, 2025, to shift the downstream border of OU 1 North to RM 729 in an email on June 5, 2025.

exceeds 2 to 3 feet per second [USEPA 2006b]). The Colville River flows into the UCR in the Upper Lacustrine CSM Unit near RM 699.

- **Middle Lacustrine CSM Unit.** This portion of the river (RM 657 to RM 625.5) is characterized as a lacustrine environment with slow-moving water. The Spokane River joins the Middle Lacustrine CSM Unit at RM 639.
- **Lower Lacustrine CSM Unit.** This portion of the river (RM 625.5 to Grand Coulee Dam near RM 597) is also a lacustrine environment. The Sanpoil River flows into the Lower Lacustrine CSM Unit at RM 616.

### 1.1.2 Known and Potential Sources of COPCs

There are many known and potential significant sources of COPCs and COIs to the UCR (USEPA 2008):

- Historical discharges of slag and liquid effluent from the Teck Metals Ltd. smelter in Trail, British Columbia (Trail Facility)
- Historical discharges of slag and other wastes from the former Le Roi/Northport Smelter in Northport, Washington
- Historical mining and milling operations (including tailings) from the former Young America Mine and Mill located near Bossburg, Washington, and historical mine ore transport operations at Bossburg
- Other mines and mills within tributary basins in the Columbia River watershed
- Historical atmospheric emissions from the Trail Facility (stack) and Le Roi/Northport Smelter (both stack and fugitive) that may have been deposited onto periodically exposed areas along the margins of OU 1
- Additional potential historical and ongoing point and nonpoint sources of COPCs and COIs discharged into the Columbia River watershed, including municipal wastewater treatment plants, pulp mills and other permitted water discharges, and stormwater and agricultural runoff.

In addition to these anthropogenic sources, the metals that are evaluated as COPCs and COIs in this BERA naturally occur in the bedrock, sediments, and soils of northeastern Washington. Thus, a determination of background concentrations for metals in UCR sediments and porewater is an important component of the evaluation and is included in this BERA.

### 1.1.3 Ecological Setting

Damming and water management have had a dramatic effect on aquatic habitat in the UCR. Historically, the UCR was riverine aquatic habitat with associated riverine species. Following construction of Grand Coulee Dam, aquatic habitat in OU 1 South and the Transitional, Upper Lacustrine, Middle Lacustrine, and Lower Lacustrine CSM Units changed from riverine into a mix of transitional and lacustrine habitats. Impacts to natural resources of the UCR from these changes include loss of riverine habitat, loss of shallow-water and wetland habitat along the periphery of the river, blocked fish migration, and extensive aquatic habitat degradation and desiccation due to large winter and spring drawdowns, as well as daily fluctuations.

The fast currents in the riverine portion of OU 1 result in limited spatial distribution of submerged and emergent aquatic vegetation and zooplankton. The southern portion of OU 1 and all of OU 2 are almost continuously inundated by the Lake Roosevelt reservoir during much of the year, with correspondingly low current velocities (TAI 2020b). The base of the aquatic food web transitions from more benthic in the riverine habitats to planktonic in the lacustrine zones. In OU 1 North, the benthic invertebrate community acts as a link between detrital material deposited on the riverbed and higher trophic levels (TAI 2012) and is a food source for benthic-feeding fish and wildlife as well as drift-feeding fish and birds (Naman et al. 2016). In OU 1 South and OU 2, planktonic production has been identified as the primary source of carbon in all Lake Roosevelt reservoir fish species (Black et al. 2003). In fact, even fish that are considered obligate benthivores obtain most of their carbon from pelagic zooplankton sources. However, the fish community in OU 1 South and OU 2 overall is dominated primarily by pelagic species since the installation of Grand Coulee Dam. Aquatic-associated wildlife species (i.e., birds and mammals) that forage within the UCR consume macrophytes, invertebrates, fish, amphibians, and other wildlife.

## 1.2 BERA APPROACH FOR OU 1 AND OU 2

The approach for the Aquatic BERA was established in the BERA Work Plan (TAI 2011) and Expanded Problem Formulation (TAI 2012).

The methodology follows U.S. Environmental Protection Agency guidance for ecological risk assessment, including Superfund (USEPA 1992, 1997, 1998, 2007a, 2016a) and other relevant guidance documents. Additionally, this BERA incorporates the five principles of the Framework for Metals Risk Assessment (USEPA 2007a), which include incorporating background into risk characterization and evaluating sediment characteristics that influence metal bioaccessibility and bioavailability.

---

The Aquatic BERA characterizes risk to the following: aquatic plant, zooplankton, benthic invertebrate, and early life stage (ELS) amphibian community-level EAEs and fish, aquatic-associated avian, and aquatic-associated mammalian population-level EAEs. The assessment of risks for all EAEs includes an LOE where measures of exposure from Site data are divided by measures of potential effects from the literature to calculate hazard quotients (HQs). The benthic invertebrate community EAE has the most LOEs: six in OU 1 (including toxicity bioassays and site-specific ecological community data) and three in OU 2 (including sediment bioassays).

---

The valued aspects of the Site ecology that may be at risk of adverse effects due to exposure to COPCs and COIs are evaluated in the Aquatic BERA as EAEs. The EAEs assessed in this BERA are established for aquatic plant communities, zooplankton communities, benthic invertebrate communities, fish populations, aquatic-associated avian and mammalian populations, and ELS amphibian (herpetofauna) communities.

### 1.2.1 Types of Lines of Evidence

The BERA Work Plan (TAI 2011) established an analysis framework that uses lines of evidence (LOEs) to characterize risk. The assessment of risks for all EAEs include an LOE where measures of exposure from Site data are divided by measures of potential effects from the literature to calculate an HQ. Multiple types of HQ-based LOEs are used in this BERA, including direct contact with abiotic media for aquatic plants, zooplankton, benthic invertebrates, fish, and

herpetofauna; tissue body burdens for fish (mercury and selenium only<sup>6</sup>); and modeled dietary exposure for fish, birds, and mammals. For aquatic plants, zooplankton, fish, birds, mammals, and herpetofauna, this is the only LOE available. For benthic invertebrates, additional LOEs are used to assess risks. In OU 1, data from sediment bioassays and in situ community metrics are used independently and in combination with each other and the metals exposure data as part of six total LOEs. In OU 2, data from sediment bioassays are available and are used independently and in combination with metals exposure data as part of three total LOEs.

Because HQs may be  $\geq 1$  at naturally occurring (background) concentrations of metals in soil, sediment, or porewater (Tannenbaum et al. 2003; Stelljes and Wood 2003; USEPA 2005), background threshold value (BTV) HQs (HQs calculated at the exposure conditions consistent with background levels) are used to provide context for the HQs calculated for each EAE and for the COPC and COI concentrations in exposure media.

## 1.2.2 Risk Characterization Approach

The risk characterization approach integrates the results from LOE analyses with information about background exposure and uncertainties to assess risk for each of the EAEs. Because there are multiple LOEs for benthic invertebrates, the advantages and limitations of each LOE are evaluated using a narrative weight of evidence approach.

Conclusions from the risk characterization fall into one of three categories:

---

Risk conclusions fall into three categories:

- **Negligible risk**
- **Unacceptable risk**
- **Uncertain risk.**

The confidence in the findings are described for each COC-receptor pair where unacceptable risks are identified as low, moderate, or high.

---

- **Negligible risk.** Exposure to the COPC is not expected to elicit adverse effects on the receptor population or community; thus, unacceptable risk can be ruled out. No further evaluation is warranted.

---

<sup>6</sup> The tissue body burden approach for fish is not applicable for most metals. The link between whole-body metal concentrations in aquatic biota and toxicity is highly variable, and it is not possible to develop universally or broadly applicable whole-body critical residuals for all metals. Mercury and selenium are exceptions because they have organic forms in which tissue concentrations are strong indicators of potential toxicity (Beckvar et al. 2005; USEPA 2016b).

- **Unacceptable risk.** Exposure to the COPC has a sufficient likelihood of eliciting an adverse effect on the receptor population or community that consideration of risk management decisions is needed. The COPC is identified as a COC and is recommended for further evaluation in the Aquatic RI with a discussion regarding nature, extent, fate, and transport.
- **Uncertain risk.** Insufficient information is available to assess risk to the receptor-COPC pair. This category is limited to COPCs for which toxicological effects or exposure data are insufficient for a given receptor group to make reliable risk conclusions. The COPC is recommended to be addressed in the Aquatic RI to determine whether it spatially co-occurs with COCs as well as in the feasibility study to ensure that remedial measures address any associated risk.

Finally, confidence in the findings is described for each COC-receptor pair where unacceptable risks are identified. Confidence levels are briefly defined as follows:

- **High(er) Confidence Level.** Site-specific information on effects (such as sediment bioaccumulation, sediment toxicity, and population effect studies) indicates that there are ecologically relevant adverse impacts to the EAE.
- **Moderate Confidence Level.** The COC has multiple samples with HQs  $\geq 1$  and  $>$  BTV HQ as well as robust toxicity data underlying effects levels. Additionally, one or more of the following also apply: 1) widespread occurrences of HQs  $\geq 1$ , 2) site-specific bioavailability adjustments, and/or 3) concentration-response models.
- **Low(er) Confidence Level.** The COC has fewer samples with HQs  $\geq 1$  and  $>$  BTV HQ as well as one or more of the following: 1) limited toxicity data, 2) benchmarks derived for screening purposes, 3) lack of site-specific bioavailability adjustments, and/or 4) lack of concentration-response information. For receptor groups with more than one LOE, there is no coherence among the LOEs.

## 2 VOLUME 2: RISK CHARACTERIZATION FOR OU 1

Volume 2 of the Aquatic BERA evaluates whether exposures to COPCs in OU 1 present unacceptable risks to aquatic plant, zooplankton, and benthic invertebrate community-level EAEs and fish, bird, mammal, and herpetofauna population-level EAEs. Risk conclusions are summarized in Table ES-1 and in the adjacent text box.

In general, reasonable conservative assumptions were made to avoid underestimation of exposure or effects. Some of the specific uncertainties that are important for the risk conclusions in OU 1 include the following:

- **Exposure assessment.** Assumptions such as the delineation of where exposures are likely to occur as well as the location-specific basis for representing exposure areas for birds and mammals with small foraging ranges may overestimate exposure areas or exposure concentrations. In addition, there is substantial variability in the bioaccumulation models, especially those for small aquatic invertebrate prey, used to estimate dietary exposure to fish, birds, and mammals. Actual exposure for invertivores may be either higher or lower than is predicted by the model.
- **Effects assessment.** While the ability of the benchmarks and toxicity reference values (TRVs) used to estimate site-specific adverse effects is unknown, TRVs used to estimate the potential severity of Site exposures were selected using a robust process resulting in reasonable conservative estimates of effects. There are, however, specific TRVs with high uncertainty based on their underlying toxicity data sets. For lead and mercury for birds, alternative reproduction TRVs were derived that are considered more reliable and relevant than the baseline reproduction TRVs.

---

### OU 1 Findings

**Negligible risk:** arsenic, cadmium, chromium, nickel, silver, thallium, total polychlorinated biphenyl (PCB) congeners, and dioxin/furan and total toxic equivalents (TEQs)

**Unacceptable risk (for one or more EAEs):**

*Porewater exposure pathway*—copper and iron

*Sediment/dietary exposure pathway*—aluminum, copper, iron, lead, manganese, mercury, selenium, vanadium, and zinc

Unacceptable risks from these COPCs are identified with low and moderate levels of confidence.

**Uncertain risk:** antimony, barium, beryllium, cobalt, and molybdenum

---

- **Risk characterization.** Where possible, the risk characterizations were refined based on more realistic assumptions. For example, more realistic estimates of methylmercury apportionment in the diets of birds and mammals are used to refine risk findings for those receptors.
- **Additional LOEs.** There are uncertainties associated with the sediment bioassay and in situ community metric LOEs for the benthic invertebrate community. For example, variability in responses in different rounds of bioassays with sediment from the same sample location indicates that there is substantial uncertainty in determinations of whether toxic responses at individual locations are meaningful. Additionally, modeling to identify ecologically meaningful correlations between exposure and in situ community metrics is confounded by the covariation of COPCs with habitat parameters and other non-chemical exposure factors that influence benthic invertebrate community structure.

Unacceptable risks associated with each of the COCs in OU 1 are summarized below.

**Aluminum.** Aluminum is identified as a COC with low confidence in the finding of unacceptable risk for herbivorous and invertivorous birds and with moderate confidence for herbivorous and invertivorous mammals based on the dietary exposure pathway from sediment. Sample locations that have HQs  $\geq 1$  and  $>$  BTV HQs are located from the U.S.-Canada border south to China Bend. There is lower confidence of unacceptable risk for the bird EAEs because of the uncertainty inferring population-level effects from growth endpoints.

**Copper.** Copper is identified as a COC in multiple exposure pathways in OU 1. It is identified as a COC for the porewater exposure pathway, with low to moderate confidence in the finding of unacceptable risk for benthic invertebrate communities in OU 1 North (specifically in coarse sand substrate) and with low confidence for ELS fish and ELS white sturgeon. It is also identified as a COC for the dietary exposure pathway from sediment with moderate confidence for herbivorous and invertivorous birds and mammals.

For the benthic invertebrate community EAE, copper in porewater is identified as a COC based on findings from multiple LOEs (see text box). There is low to moderate confidence that exposure to copper in porewater causes unacceptable risk to the benthic invertebrate community EAE in OU 1 North, specifically in the sand bar downstream of Deadman's Eddy.



For the ELS fish and ELS white sturgeon, there is low confidence in the finding of unacceptable risk because there is a limited frequency of samples with HQs  $\geq 1$  and within or above the BTV HQ range for bioavailable copper in porewater and in preferred habitat (in the case of ELS white sturgeon).

Additionally, porewater exposures for copper in most locations in OU 1 are comparable to reference area exposures and, except for ELS white sturgeon, most ELS fish species in OU 1 are not found beneath the sediment surface where porewater was collected.

For one or more bird and mammal EAEs, copper exposure may reduce growth, reproduction, and survival. The highest frequency of exceedances of HQs  $\geq 1$  are from the U.S.-Canada border south to China Bend. Because there are no additional site-specific data to provide confirmation of the HQ analysis, there is moderate confidence that copper poses unacceptable risk to these EAEs.

**Iron.** Iron is identified as a COC for multiple exposure pathways in OU 1. It is identified as a COC for the porewater exposure pathway with low confidence in the finding of unacceptable risk for aquatic plants. It is also identified as a COC for the dietary exposure pathway from sediment with moderate confidence for herbivorous and invertivorous birds and herbivorous mammals and with low confidence for invertivorous mammals. Confidence is lower for the porewater exposure pathway for plants because of the limited frequency of samples that exceed the BTV HQs and is lower for the

---

### **Benthic Invertebrate Community Assessment in OU 1**

The assessment of the benthic invertebrate community EAE in OU 1 relied on multiple LOEs that include sediment and porewater chemistry, site-specific sediment bioassays, and data on in situ community metrics. The Aquatic BERA concludes with low to moderate confidence that exposure to copper in porewater in the sand bar downstream of Deadman's Eddy poses unacceptable risk to benthic invertebrate communities.

While the largest differences observed in benthic invertebrate communities between the sand bar downstream of Deadman's Eddy and upstream reference areas are most likely related to frequent physical disturbance due to hydraulic conditions, additional analyses suggest that communities in this area lack some species that are highly sensitive to metals but are found in low numbers in the upstream reference locations. The ecological significance of this shift in composition, however, is unclear because these species make up a relatively small proportion of the benthic invertebrate community in the upstream reference areas and, thus, are unlikely to be significant prey resources for higher trophic level organisms.

---

dietary exposure pathway for invertivorous mammals because of the high uncertainty associated with inferring population-level impacts from the growth endpoint only. Sample locations that have iron HQs  $\geq 1$  and  $>$  BTV HQ in porewater for aquatic plants are located in OU 1 South (Evans), while for sediment exposure to birds and mammals, the sample locations are focused in the area from the U.S.-Canada border south to China Bend.

**Lead.** Lead is identified as a COC with moderate confidence in the finding of unacceptable risk for herbivorous, invertivorous, and omnivorous birds as well as herbivorous and invertivorous mammals based on the dietary exposure pathway from sediment. For all wildlife EAEs, the highest HQs occur near Northport.

**Manganese.** Manganese is identified as a COC with moderate confidence in the finding of unacceptable risk for herbivorous and invertivorous mammals in OU 1 based on the dietary exposure pathway from sediment. Sediment sample locations that have manganese HQs  $\geq 1$  and  $>$  BTV HQ are focused in the area from the U.S.-Canada border south to China Bend.

**Mercury.** Mercury is identified as a COC with moderate confidence in the finding of unacceptable risk for invertivorous and aerial insectivorous birds in OU 1 based on the dietary exposure pathway from sediment. The frequency of HQs  $\geq 1$  is higher in OU 1 South compared to OU 1 North.

**Selenium.** Selenium is identified as a COC with low confidence in the finding of unacceptable risk for invertivorous and invertivorous/piscivorous birds and with moderate confidence for herbivorous and invertivorous mammals based on the dietary exposure pathway from sediment. Confidence is lower for the birds due to the high uncertainty associated with inferring population-level impacts based solely on the growth endpoint. HQs  $\geq 1$  occur in both CSM units, with the highest HQs located near Northport.

**Vanadium.** Vanadium is identified as a COC with low confidence in the finding of unacceptable risk for invertivorous birds based on the dietary exposure pathway from sediment. Confidence is low due to the high uncertainty associated with inferring population-level impacts based solely on the growth endpoint. The frequency of HQs  $\geq 1$  is higher in OU 1 North compared to OU 1 South, with the maximum HQs at Northport.

**Zinc.** Zinc is identified as a COC with moderate confidence in the finding of unacceptable risk for herbivorous, invertivorous, and omnivorous birds as well as herbivorous and invertivorous mammals based on the dietary exposure pathway from sediment. Sediment sample locations that have zinc HQs  $\geq 1$  and  $>$  BTV HQ are focused in the area from the U.S.-Canada border south to China Bend.

**Mixtures of copper, lead, and zinc.** Copper, lead, and zinc are identified as COCs for the dietary exposure pathway for birds and mammals, as discussed above. They are also included as COCs for the sediment exposure pathway for benthic invertebrate EAEs because they are components of the excess simultaneously extracted metals exposure metric that is correlated with reductions in survival, growth, and reproduction in sediment bioassays in OU 1 North (specifically in coarse sand substrate). There is low confidence in the finding of unacceptable risk to benthic invertebrate community EAEs in OU 1 North from mixtures of these metals in bulk sediment due to conflicting evidence with other LOEs and the overall low reliability of excess simultaneously extracted metals to predict toxicity in sediment bioassays.

As noted in the COC descriptions above, for most of the OU 1 COCs identified for the sediment exposure pathway (i.e., aluminum, copper, iron, manganese, selenium, and zinc), sediment sample locations that have HQs  $\geq 1$  and  $>$  BTV HQ are most frequent in the area from the U.S.-Canada border south to China Bend. Sediment concentrations and, thus, HQs are lower in the lower portions of OU 1 South. For lead, manganese, selenium, vanadium, and zinc, the maximum HQs occur near Northport. For the porewater exposure pathway, bioavailable porewater copper concentrations are highest in the sand bar downstream of Deadman's Eddy, while for iron they are found in OU 1 South near Evans. Overall, spatial patterns in COC concentrations throughout OU 1 will be further evaluated as part of the nature and extent assessment in the Aquatic RI.

### 3 VOLUME 3: RISK CHARACTERIZATION FOR OU 2

Volume 3 of the Aquatic BERA evaluates whether exposures to COPCs in OU 2 present unacceptable risks to aquatic plant, zooplankton, and benthic invertebrate community-level EAEs and fish, bird, mammal, and herpetofauna population-level EAEs. Risk conclusions are summarized in Table ES-2 and in the adjacent text box.<sup>7</sup>

As noted above for Volume 2, the Aquatic BERA includes analyses of the uncertainty and variability of the underlying assumptions and data to determine whether risk analyses may overestimate or underestimate the potential for adverse effects. In addition to some of the specific uncertainties discussed for OU 1 above (Section 2), there is substantial uncertainty associated with assessment of the porewater exposure pathway in OU 2. There is relatively low spatial coverage of field-collected porewater samples in OU 2, especially in the Middle Lacustrine and Lower Lacustrine CSM Units. In addition, due to the methods for field collection, estimates of exposure for most COPCs in the OU 2 field porewater data set are likely to overestimate risks to aquatic plants, benthic invertebrates, and ELS fish from porewater exposure.

Unacceptable risks associated with each of the COCs in OU 2 are summarized below.

**Aluminum.** Aluminum is identified as a COC with low confidence in the finding of unacceptable risk for invertivorous birds and with moderate confidence for invertivorous mammals based on the dietary exposure pathway from sediment. Confidence is lower for birds

---

#### OU 2 Findings

**Negligible risk:** arsenic, cadmium, chromium, nickel, silver, thallium, methoxychlor, total DDE, total DDT, total DDx, bis(2-ethylhexyl)phthalate, total PCB congeners, PCB TEQ, dioxin/furan TEQ, and total TEQ

#### **Unacceptable risk (for one or more EAEs):**

*Porewater exposure pathway*— iron, lead, and manganese

*Sediment exposure pathway*— aluminum, copper, iron, mercury, selenium, vanadium, and zinc

Unacceptable risks from these COCs are identified with low to moderate levels of confidence.

**Uncertain risk:** antimony, barium, beryllium, cobalt, and molybdenum

---

---

<sup>7</sup> In the text box, DDE is dichloro-diphenyl-dichloroethene. DDx is the sum of 2,4'-DDD, 4,4'-DDD, 2,4'-DDE, 4,4'-DDE, 2,4'-DDT, and 4,4' DDT, where DDD is dichloro-diphenyl-dichloroethane.

due to the high uncertainty associated with inferring population-level impacts based solely on the growth endpoint.

**Copper.** Copper is identified as a COC with moderate confidence in the finding of unacceptable risk for invertivorous mammals based on the dietary exposure pathway from sediment.

**Iron.** Iron is identified as a COC in multiple exposure pathways in OU 2. It is identified as a COC for the porewater exposure pathway with low confidence in the finding of unacceptable risk for aquatic plants. It is also identified as a COC for the dietary exposure pathway from sediment, with low confidence in the finding of unacceptable risk for invertivorous and omnivorous birds and invertivorous mammals. Confidence is low for the porewater exposure pathway due to the high uncertainty associated with the porewater exposure data in OU 2, while confidence is low for birds and mammals due to the high uncertainty associated with inferring population-level impacts based solely on the growth endpoint.

**Lead.** Lead is identified as a COC with low confidence in the finding of unacceptable risk for the porewater exposure pathway for benthic invertebrates. Confidence is low due to the high uncertainty associated with the porewater exposure data in OU 2.

**Mercury.** Mercury is identified as a COC with moderate confidence in the finding of unacceptable risk for invertivorous and aerial insectivorous birds in OU 2 based on the dietary exposure pathway from sediment. The frequency of HQs  $\geq 1$  is higher in the Transitional and Upper Lacustrine CSM Units compared to the rest of OU 2.

**Manganese.** Manganese is identified as a COC with low confidence in the finding of unacceptable risk for the porewater exposure pathway for aquatic plants. Confidence is low due to the high uncertainty associated with the porewater exposure data in OU 2.

**Selenium.** Selenium is identified as a COC with moderate confidence in the finding of unacceptable risk for invertivorous birds and mammals based on the dietary exposure pathway from sediment.

**Vanadium.** Vanadium is identified as a COC with low confidence in the finding of unacceptable risk for invertivorous birds based on the dietary exposure pathway from sediment. Confidence is low due to the high uncertainty associated with inferring population-level impacts based solely on the growth endpoint.

**Zinc.** Zinc is identified as a COC with low confidence in the finding of unacceptable risk for invertivorous birds based on the dietary exposure pathway from sediment. Confidence is low due to the high uncertainty associated with inferring population-level impacts based solely on the growth endpoint.

Among most of the COCs identified above for the sediment exposure pathway (i.e., aluminum, iron, and selenium for birds and mammals as well as copper for mammals and vanadium and zinc for birds), most sample locations have HQs < 1 and/or  $\leq$  BTV HQs. In addition, the frequency of occurrences of HQs  $\geq$  1 and > BTV HQs are similar for each of these COCs (between 6 percent and 9 percent of sample locations) and substantially lower in OU 2 than in OU 1. Within OU 2, the maximum HQs tend to decline through the Transitional CSM Unit and remain relatively low through the three lacustrine CSM units. There are individual sample locations and, in one case, a cluster of sample locations (near RM 664) where there is co-occurrence of HQs  $\geq$  1 and > BTV HQs for multiple COCs. Overall, spatial patterns in COC concentrations throughout OU 2 are difficult to discern but will be further evaluated as part of the nature and extent assessment in the Aquatic RI.

## 4 VOLUME 4: APPROACH, METHODOLOGY, AND FINDINGS FOR RFDA AND WSDAs

The RFDA and WSDA BERA presented in Volume 4 evaluates whether exposures to COPCs in river-influenced soil along OU 1 and OU 2 present unacceptable risks to terrestrial plant, soil invertebrate, bird, mammal, and herpetofauna EAEs. The RFDA and WSDAs are included in the Aquatic BERA because the CSM and aquatic-related exposure media are generally similar to those for OU 1 and OU 2, in that the mechanism for metals enrichment in soils in these areas is primarily through historical fluvial transport and deposition processes in the river.

---

Volume 4 presents the results of the BERA for the RFDA and WSDAs. The RFDA and WSDAs are included in this BERA because the CSM and aquatic exposure media are similar to those for OU 1 and OU 2, in that the mechanism for metals enrichment in soils in these areas is primarily through historical fluvial transport and deposition processes in the river. RFDA are relict floodplains that, historically, may have been subjected to flooding and are primarily found upstream of Little Dalles. WSDAs are areas where windblown sediment from nearshore areas may be deposited. Two locations identified as having the highest probability of deposition of windblown sediments were evaluated at Marcus Flats and Columbia Beach.

---

### 4.1 RFDA AND WSDA CHARACTERISTICS

RFDA are areas that may have been subjected to flooding under historical flow conditions but are not expected to flood under the current flow regulation regime driven by upriver dam operations, except during extreme flow events.<sup>3</sup> Relict floodplains are found upstream of Little Dalles at RM 729 (Map ES-2). WSDAs are areas where windblown sediment from nearshore areas may be deposited. The two locations identified during planning for the 2014 Soil Study as having the highest probability of deposition of windblown sediments are the northwest Marcus Flats and Columbia Beach areas (Map ES-3) (TAI 2014a).

---

<sup>3</sup> One aerial deposition area soil sampling decision unit (ADA-140) from TAI (2015) and one sample from Ecology (2019) are included as RFDA and evaluated in this BERA.

Soil COPCs and COIs evaluated in this BERA are aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc, as identified during the SLERA (TAI 2010) and COPC Refinement (TAI 2020a). Broadly, the sources of COPCs and COIs to the RFDAs and WSDAs are similar to those identified for OU 1 and OU 2 above (Section 1.1.2).

## **4.2 ECOLOGICAL SETTING**

The RFDAs, WSDAs, and surrounding areas are within the Northern Rockies ecoregion (Omernik 1987) and are characterized by coniferous forest ecosystems interspersed with montane grasslands. Ecosystems of the RFDAs and WSDAs are a mix of grasslands, shrub lands, savanna, meadow, and forest. Riparian and wetland ecosystems occur along watercourses and water bodies or where soils are saturated during some or all of the growing season. Portions of the areas surrounding the RFDAs and WSDAs are logged, sometimes by clear cutting.

## **4.3 RFDA AND WSDA BERA APPROACH**

The EAEs assessed in this BERA are terrestrial plant and soil invertebrate communities and terrestrial avian, mammalian wildlife, and herpetofauna populations. Due to the lack of toxicity information, however, herpetofauna are not evaluated quantitatively. The risk findings for avian and mammalian wildlife, therefore, are assumed to be protective of risks to herpetofauna.

The assessment of risks for each of the EAEs in the RFDA and WSDA BERA relies on a single LOE based on HQs, which is consistent with the approach for most EAEs in OU 1 and OU 2. Direct contact with soil is assessed for terrestrial plants and soil invertebrates and modeled dietary exposures are assessed for birds and mammals.



## 4.4 RISK CHARACTERIZATION FOR RFDAs AND WSDAs

This BERA evaluates whether exposures to COPCs in RFDA and WSDA soils present unacceptable risks to terrestrial plant and soil invertebrate community-level EAEs and wildlife population-level EAEs. Risk findings are summarized in Table ES-3 and in the adjacent text box.

As noted above for Volume 2, the RFDA and WSDA BERA includes analyses of the uncertainty and variability of the underlying assumptions and data to determine whether risk analyses may overestimate or underestimate the potential for adverse effects. Consistent with the OU 1 and OU 2 assessments, reasonable conservative assumptions were made to ensure that exposure is not underestimated.

The RFDA and WSDA BERA, particularly for wildlife, relies on many of the same assumptions (e.g., TRVs and methylmercury apportionment) that are used in the OU 1 and OU 2 assessments.

Unacceptable risks associated with each of the COCs in the RFDAs (Relict Floodplain A [RFA] through Relict Floodplain E [RFE]) and WSDAs are summarized below.

**Arsenic.** Arsenic is a COC for terrestrial plants in the RFDAs. Decision units (DUs) with HQs  $\geq 1$  and  $>$  BTV HQ are in Relict Floodplain C (RFC). Because of the limited spatial extent, the low magnitude of HQs, and the overestimation of soil arsenic bioavailability, there is low confidence that arsenic poses unacceptable risk to the terrestrial plant community.

**Barium.** Barium is a COC for soil invertebrates because DUs in RFA have HQs  $\geq 1$ , but confidence in the finding is low due to low bioavailability soil conditions.

---

### RFDA and WSDA Findings

*COCs identified separately for RDSAs and WSDAs*

#### **Negligible risk:**

*Both RFDAs and WSDAs*—aluminum, beryllium, chromium, cobalt, mercury, nickel, silver, thallium, and vanadium

*WSDAs only*—arsenic, barium, copper, iron, manganese, molybdenum, and selenium

#### **Unacceptable risk (for one or more EAEs):**

*RFDAs*—arsenic, barium, cadmium, copper, iron, lead, manganese, molybdenum, selenium, and zinc

*WSDAs*—cadmium, lead, and zinc

Unacceptable risks from these COCs are identified with low to moderate levels of confidence.

#### **Uncertain risk:**

*Both RFDAs and WSDAs*—antimony

---

**Cadmium.** For the RFDAs, cadmium is a COC for invertivore birds and invertivore mammals. Exceedances are widespread, with the highest magnitude HQs for birds and mammals in RFC. Confidence in the findings is considered moderate. Acceptable risk was determined for all other EAEs in the RFDAs. For the WSDAs, cadmium is a COC for invertivore mammals, but there is lower confidence in this finding because of the low magnitude of the  $HQ \geq 1$  in Marcus Flats East (MFE).

**Copper.** For the RFDAs, copper is a COC in all RFDAs for terrestrial plants, soil invertebrates, invertivore birds, carnivore birds, omnivore birds, herbivore mammals, invertivore mammals, aerial insectivore mammals, and omnivore mammals, with the highest magnitude HQs in RFA. Confidence in this finding is considered moderate.

**Iron.** For the RFDAs, iron is a COC for invertivore birds, herbivore mammals, and invertivore mammals in RFA. Confidence in the finding is considered low because  $HQs \geq 1$  are based on the growth endpoint only.

**Lead.** For the RFDAs, lead is a COC in all RFDAs for terrestrial plants, invertivore birds, herbivore mammals, invertivore mammals, and omnivore mammals, with the highest HQs in ADA-140, RFA, and RFC. Confidence in the finding is considered moderate. All other EAEs in the RFDAs have acceptable risk. Lead is a COC for invertivore mammals in MFE, with a moderate confidence in the finding.

**Manganese.** Manganese is a COC for terrestrial plants and soil invertebrates in the RFDAs, specifically RFA. There is low confidence in the finding due to low bioavailability soil conditions in the RFDAs.

**Molybdenum.** For the RFDAs, molybdenum is a COC for terrestrial plants.  $HQs \geq 1$  and  $> BTV$  HQ are in RFA and Relict Floodplain D (RFD), with the highest magnitude HQs in RFA. Confidence in the finding is considered moderate.

**Selenium.** For the RFDAs, selenium is a COC for terrestrial plants, aerial insectivore birds, omnivore birds, invertivore mammals, and aerial insectivore mammals. Confidence in the finding is considered moderate for the mammalian EAEs. For terrestrial plants and the avian EAEs, confidence is lower. This is because  $HQs \geq 1$  for the mammalian EAEs are based on detected values limited to RFA and on the growth endpoint. For terrestrial plants, it is because of the low magnitude of HQs and the overestimation of selenium bioavailability in soils.

**Zinc.** For the RFDAs, zinc is a COC in all RFDAs for all EAEs, except for carnivore mammals, which have acceptable risk. The HQ magnitude is highest in ADA-140, RFA, and RFD. For the WSDAs, zinc is a COC for terrestrial plants in MFE. Confidence in the finding is considered moderate for both RFDAs and WSDAs.

Among the RFDAs, the highest HQs above BTV HQs tend to occur in RFA for most of the COCs, though there are some COCs (e.g., cadmium and lead) where maximum HQs in other RFDAs are either comparable to or greater than in RFA. Among the WSDAs, the maximum COC HQs above background most frequently occur in MFE. Overall, spatial patterns in COC concentrations in the RFDAs and WSDAs will be further evaluated as part of the nature and extent assessment in the Aquatic RI.

## 5 CONCLUSIONS

The Aquatic BERA characterizes risks to aquatic receptors in OU 1 and OU 2 and to terrestrial receptors in the RFDAs and WSDAs. River flows in the UCR are controlled by the operation of upstream dams and by operations at Grand Coulee Dam, which has significantly changed the hydrology and ecology of the UCR. Except for the riverine portion of the UCR in OU 1, the majority of the river is now a reservoir, and the food web has switched from being benthic to pelagic. The CSM for all the areas evaluated in the Aquatic BERA focuses on metals enrichment in sediment and soils that has occurred through fluvial transport and deposition in the UCR. COCs that pose unacceptable risk to one or more EAEs are identified with varying levels of confidence based on the available evidence in each of the assessment areas (i.e., OU 1, OU 2, RFDAs, and WSDAs) (Table ES-4).

In OU 1, most of the COCs from the dietary exposure pathway for wildlife, which are based on concentrations in sediment, show similar spatial patterns consistent with the co-occurrence of these COCs. Sediment sample locations that have HQs  $\geq 1$  above BTV HQs are most frequent in the area from the U.S.-Canada border south to China Bend. Sediment concentrations and, thus, HQs are lower in the lower portions of OU 1 South. Similarly, among the RFDAs, the highest HQs above BTV HQs tend to occur in RFA, adjacent to Deadman's Eddy in OU 1 North.

In OU 1, the benthic invertebrate communities in the sand bar downstream of Deadman's Eddy stand out as the most different from upstream reference areas as well as from the communities observed elsewhere in OU 1. Although those differences are most likely related to frequent physical disturbance due to hydraulic conditions, additional analyses suggest that communities in this area lack some species that are highly sensitive to metals but are found in low numbers in the upstream reference locations. While copper in porewater is identified as a COC based on findings from multiple LOEs, the "missing" species make up a relatively small proportion of the benthic invertebrate community in the upstream reference areas and, thus, are unlikely to be significant prey resources for higher trophic level organisms. There is low to moderate confidence that the slight shifts in community composition in the sand bar downstream of Deadman's Eddy, potentially associated with exposure to metals, have an ecologically meaningful effect on the benthic invertebrate community and their role in the ecosystem.

In OU 2, the COCs resulting in unacceptable risks to aquatic receptors are similar to the COCs from OU 1. However, there tends to be lower confidence in unacceptable risk from exposure to COCs in OU 2 and the frequency of sample locations exceeding benchmarks is substantially lower than in OU 1. Similarly, there are fewer COCs in the WSDAs adjacent to OU 2 than in the RFDAs adjacent to OU 1. Combined, these results suggest that risks are lower in OU 2 than in OU 1. The lower risks in OU 2 and the WSDAs are consistent with the distribution of

slag-related metals in the river, where most slag is present in OU 1 and is less likely to be present in surface sediments past the first few river miles of OU 2 (i.e., within the Transitional CSM Unit).

It is expected that the nature and extent of the COCs identified in the Aquatic BERA will be evaluated in the Aquatic RI along with an evaluation of the transport of sediment and slag in OU 1. Additionally, it is expected that the Aquatic RI will evaluate factors that influence the bioavailability of copper in porewater, with the objective of characterizing what areas in the UCR might have sediment and hydrologic conditions that are conducive to elevated bioavailable copper in porewater.

Finally, the confidence levels with the findings of unacceptable risk take into account the robustness of the exposure and effects data and the potential severity and extent of the effects, and these levels are identified for each EAE-COC pair. The confidence levels provide important information when interpreting risk findings necessary to support decision-making. Specifically, it is important to consider the level of confidence in the nature, magnitude, and extent of potential adverse effects when weighing the costs and benefits of potential remedial actions on the ecosystem (e.g., benthic invertebrates). In addition, for bird and mammal risk conclusions, which lack high confidence, conceptual areas of concern should be refined to reflect where these wildlife receptors are actually known to forage.

## 6 REFERENCES

- Beckvar, N., T.M. Dillon, and L.B. Read. 2005. Approaches for Linking Whole-Body Fish Tissue Residues of Mercury or DDT to Biological Effects Thresholds. *Environ. Toxicol. Chem.* 24(8):2094–2105.
- Black, A.R., G.W. Barlow, and A.T. Scholz. 2003. Carbon and Nitrogen Stable Isotope Assessment of the Lake Roosevelt Aquatic Food Web. *Northwest Sci.* 77(1):1–11.
- Byrne, P., P.J. Wood, and I. Reid. 2012. The Impairment of River Systems by Metal Mine Contamination: A Review including Remediation Options. *Crit. Rev. in Environ. Sci. and Technol.* 42:2017–2077. <https://doi.org/10.1080/10643389.2011.574103>.
- Ecology. 2019. Draft-Final Remedial Investigation, Northport Waterfront, Northport, Washington. File No. 0504-160-00. Prepared for the Washington State Department of Ecology. Prepared by GeoEngineers, Inc., Spokane, WA.
- Mebane, C.A., R.J. Eakins, B.G. Fraser, and W.J. Adam. 2015. Recovery of a Mining-Damaged Stream Ecosystem. *Elementa-Sci. Anthropol.* 3:42. <https://doi.org/10.12952/journal.elementa.000042>.
- Murphy, B.R., D.W. Willis, and T.A. Springer. 1991. The Relative Weight Index in Fisheries Management: Status and Needs. *Fisheries* 16(2):30–38. [https://www.researchgate.net/publication/241026204\\_The\\_Relative\\_Weight\\_Index\\_in\\_Fisheries\\_Management\\_Status\\_and\\_Needs](https://www.researchgate.net/publication/241026204_The_Relative_Weight_Index_in_Fisheries_Management_Status_and_Needs).
- Naman, S.M., J.S. Rosenfeld, and J.S. Richardson. 2016. Causes and Consequences of Invertebrate Drift in Running Waters: From Individuals to Populations and Trophic Fluxes. *Can. J. Fish. Aquat. Sci.* 73:1292–1305.
- Omernik, J.M. 1987. Ecoregions of the Conterminous United States. *Ann. Assoc. Am. Geogr.* 77(1):118–125. <https://doi.org/10.1111/j.1467-8306.1987.tb00149.x>.
- Pope, K.L., S. Lochmann, and M.K. Young. 2010. Methods for Assessing Fish Populations. *Neb. Coop. Fish & Wild. Res. Unit Staff Publ.* Paper 73. [https://www.researchgate.net/publication/228543576\\_Methods\\_for\\_Assessing\\_Fish\\_Populations](https://www.researchgate.net/publication/228543576_Methods_for_Assessing_Fish_Populations).
- Schmidt, T.S., W.H. Clements, and B.S. Cade. 2012. Estimating Risks to Aquatic Life Using Quantile Regression. *Freshw. Sci.* 31(3). <https://www.journals.uchicago.edu/doi/abs/10.1899/11-133.1>.

- Stelljes, M.E., and R.R. Wood. 2003. Applications of Background Data in Ecological Risk Assessment: Various Shades of Gray. *Hum. Ecol. Risk Assess.* 9(7):1609–1621. <https://doi.org/10.1080/714044785>.
- TAI (Teck American Incorporated). 2010. Upper Columbia River Screening Level Ecological Risk Assessment (SLERA). Prepared for Teck American Incorporated (TAI) by Parametrix, Integral, Exponent, and Hydroqual, Bellevue, WA.
- TAI. 2011. Upper Columbia River Baseline Ecological Risk Assessment (BERA) Work Plan, Volumes I–III. Prepared for Teck American Incorporated (TAI) by Parametrix, Bellevue, WA.
- TAI. 2012. Upper Columbia River Expansion of the Problem Formulation Chapter of the UCR Baseline Ecological Risk Assessment (BERA) Work Plan. Prepared for Teck American Incorporated (TAI) by Parametrix, Exponent, and Hydroqual, Bellevue, WA.
- TAI. 2013a. Upper Columbia River Final Surface Water Data Summary and Data Gap Report. Prepared for TAI by Exponent and Parametrix. October.
- TAI. 2013b. Upper Columbia River. Final. Fish Tissue Data Summary and Data Gaps Report. Prepared for Teck American Incorporated by Exponent, Bellevue, WA; Parametrix, Bellevue, WA; Integral Consulting Inc., Seattle, WA.
- TAI. 2014a. Upper Columbia River Final Soil Study Quality Assurance Project Plan. Prepared for TAI by Exponent and HDR, Seattle, WA, in association with Parametrix and Cardwell Consulting, LLC.
- TAI. 2014b. Upper Columbia River Final Beach Sediment Study Field Sampling and Data Summary Report. Prepared for Teck American Incorporated by Integral, Seattle, WA.
- TAI. 2015. Upper Columbia River Final Soil Study Data Summary Report. Prepared for Teck American Incorporated (TAI) by Windward Environmental LLC, Seattle, WA.
- TAI. 2016. Upper Columbia River Final Bossburg Flat Beach Refined Sediment and Soil Study Data Summary Report. Prepared for TAI by Windward Environmental LLC, Seattle, WA.
- TAI. 2017. Final Phase 2 Sediment Study Data Summary and Data Gap Report. Prepared for TAI by Windward Environmental LLC, Seattle, WA, in association and consultation with Exponent, Parametrix, Inc., and HDR Engineering, Inc. <https://www.ucr-rifs.com/assets/Docs/Studies/2017/Final-P2SedDSR-Vol-I.pdf>.

- TAI. 2018a. Upper Columbia River Final Assessment of Sediment Toxicity to White Sturgeon Data Summary Report. Prepared by Cardno Entrix and HDR|HydroQual. Saskatoon, SK.
- TAI. 2018b. Macroinvertebrate Tissue Study Data Summary Report. Final. Upper Columbia River. Prepared by Windward Environmental LLC.
- TAI. 2018c. Final Quality Assurance Project Plan for the Plant Tissue Study. Prepared for Teck American Incorporated (TAI) by Ramboll, Seattle, WA.
- TAI. 2019. Final Quality Assurance Project Plan for the 2019 Phase 3 Sediment Study. August. Prepared for Teck American Incorporated. Prepared by ERM in association and consultation with Windward Environmental LLC, HDR Engineering, Inc., Exponent, Inc., and Parametrix, Inc.
- TAI. 2020a. Upper Columbia River Final Chemicals of Potential Concern Refinement for Aquatic and Terrestrial Receptors. Addendum No. 1. Prepared for Teck American Incorporated by Windward Environmental LLC, Seattle, WA. January. <https://www.ucr-rifs.com/assets/Docs/Studies/2020/2020-01-15-FinalCOPCRefinement.pdf>.
- TAI. 2020b. Final Phase 3 Sediment Study—Sediment Facies Mapping Data Summary Report. <https://www.ucr-rifs.com/assets/Docs/Studies/2021/04-16-21-UCRPh3SFM-Data-Summary-Report-Volume-I.pdf>.
- TAI. 2022. Final 2019 Phase 3 Sediment Study Data Summary Report. Prepared for TAI by ERM, Seattle, WA. <https://www.ucr-rifs.com/assets/Docs/New/01-25-22-Final-Phase3Sediment-DSR-Volume-I.pdf>.
- TAI. 2024. Personal communication (letter to Larry Douchand, Director, Office of Superfund Remediation & Technology Innovation, EPA, dated October 18, 2024, from Rob Orr, TAI, regarding Technical Review, Upper Columbia River Remedial Investigation and Feasibility Study – EPA’s Upland Baseline Ecological Risk Assessment [December 2023]). File No. 01-773180-000. Teck American Incorporated, Spokane, WA.
- Tannenbaum, L.V., M.S. Johnson, and M. Bazar. Application of the Hazard Quotient Method in Remedial Decisions: A Comparison of Human and Ecological Risk Assessments. *Hum. Ecol. Risk Assess.* 9(1):387–401. <https://doi.org/10.1080/713609871>.



- USEPA (U.S. Environmental Protection Agency). 1992. Final Guidance for Data Useability in Risk Assessment (Part A). Publication 9285.7 09A. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, DC.  
<http://www.epa.gov/oswer/riskassessment/datause/parta.htm>.
- USEPA. 1997. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessment, Interim Final. Publication EPA 540/R97/006. Environmental Response Team, U.S. Environmental Protection Agency, Edison, NJ.
- USEPA. 1998. Guidelines for Ecological Risk Assessment. Report No.: EPA/630/R 95/002F. Environmental Protection Agency, Washington, DC. *Federal Register* 63(93):26846–26924.
- USEPA. 2005. Guidance for Developing Ecological Soil Screening Levels. OSWER Directive 9285.7-55. U.S. Environmental Protection Agency, Washington, DC.
- USEPA. 2006a. Settlement Agreement for Implementation of Remedial Investigation and Feasibility Study at the Upper Columbia River Site. U.S. Environmental Protection Agency, Washington, DC.
- USEPA. 2006b. Phase 1 Sediment Sampling Data Evaluation, Upper Columbia River Site, CERCLA RI/FS. Prepared for the U.S. Environmental Protection Agency by Ecology and Environment Inc. and CH2M HILL, Seattle, WA.
- USEPA. 2007a. Framework for Metals Risk Assessment. EPA 120/R-07/001. Office of the Science Advisor, Risk Assessment Forum, U.S. Environmental Protection Agency, Washington, D.C. <https://www.epa.gov/sites/default/files/2013-09/documents/metals-risk-assessment-final.pdf>.
- USEPA. 2007b. Phase I Fish Tissue Sampling Data Evaluation Upper Columbia River Site CERCLA RI/FS. Final. Prepared for U.S. Environmental Protection Agency, Region 10 by CH2M HILL and Ecology and Environment, Inc. <https://www.ucr-rifs.com/assets/Docs/Studies/2007/EPA-2007-Fish-Tissue-Results-Final-Report.pdf>.
- USEPA. 2008. Upper Columbia River Work Plan for the Remedial Investigation and Feasibility Study, Volume I. U.S. Environmental Protection Agency, Washington, DC.
- USEPA. 2012. Summary and Evaluation of Phase 1 (2005) Sediment Toxicity Tests Upper Columbia River Site. <https://www.ucr-rifs.com/assets/Docs/Studies/2012/EPA-2012-SedTox-Results-Final-Report.pdf>.

- USEPA. 2016a. Weight of Evidence in Ecological Assessment. EPA/100/R-16/001. Office of the Science Advisor, Risk Assessment Forum, U.S. Environmental Protection Agency, Washington, DC.  
<https://nepis.epa.gov/Exe/ZyNET.exe/P100SFXR.TXT?ZyActionD=ZyDocument&Client=EPA&Index=2016+Thru+2020&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C16thru20%5CTxt%5C00000000%5CP100SFXR.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL>.
- USEPA. 2016b. Aquatic Life Ambient Water Quality Criterion for Selenium—Freshwater 2016. EPA 822-R-16-006. U.S. Environmental Protection Agency, Office of Water Office of Science and Technology, Washington, DC.  
[https://www.epa.gov/sites/default/files/2016-07/documents/aquatic\\_life\\_awqc\\_for\\_selenium\\_freshwater\\_2016.pdf](https://www.epa.gov/sites/default/files/2016-07/documents/aquatic_life_awqc_for_selenium_freshwater_2016.pdf).
- USEPA. 2023. Final Baseline Ecological Risk Assessment for Upland Terrestrial Habitat. Upper Columbia River Site, Stevens County, Washington. Prepared for U.S. Environmental Protection Agency Region 10 by CH2M HILL, Inc., Greenwood Village, CO. December 15.
- USGS (U.S. Geological Survey). 2016a. Trace Elements Concentrations in Pore Water and Surface Water near the Sediment-Water Interface in the Upper Columbia River, Washington (2015). Cox, S.E., W.G. Brumbaugh, L.S. Balistreri, R.E. Wolfe, M. Adams, and T.D. Olson, authors. DOI: 10.5066/F73N21GJ. <https://www.usgs.gov/data/trace-elements-concentrations-pore-water-and-surface-water-near-sediment-water-interface-upper>.
- USGS. 2016b. Toxicity Evaluation of Metal-Contaminated Sediments from the Upper Columbia River, Washington, to the Amphipod, *Hyalella azteca*, the Midge, *Chironomus dilutus*, and the Mussel, *Lampsilis siliquoidea*. U.S. Geological Survey.
- WDFW (Washington Department of Fish and Wildlife). 2020a. Priority Habitats and Species, web application. <https://wdfw.wa.gov/species-habitats/at-risk/phs/maps>. Accessed 2020.
- WDFW. 2020b. Species in Washington, web application. <https://wdfw.wa.gov/species-habitats/species>. Accessed 2020.

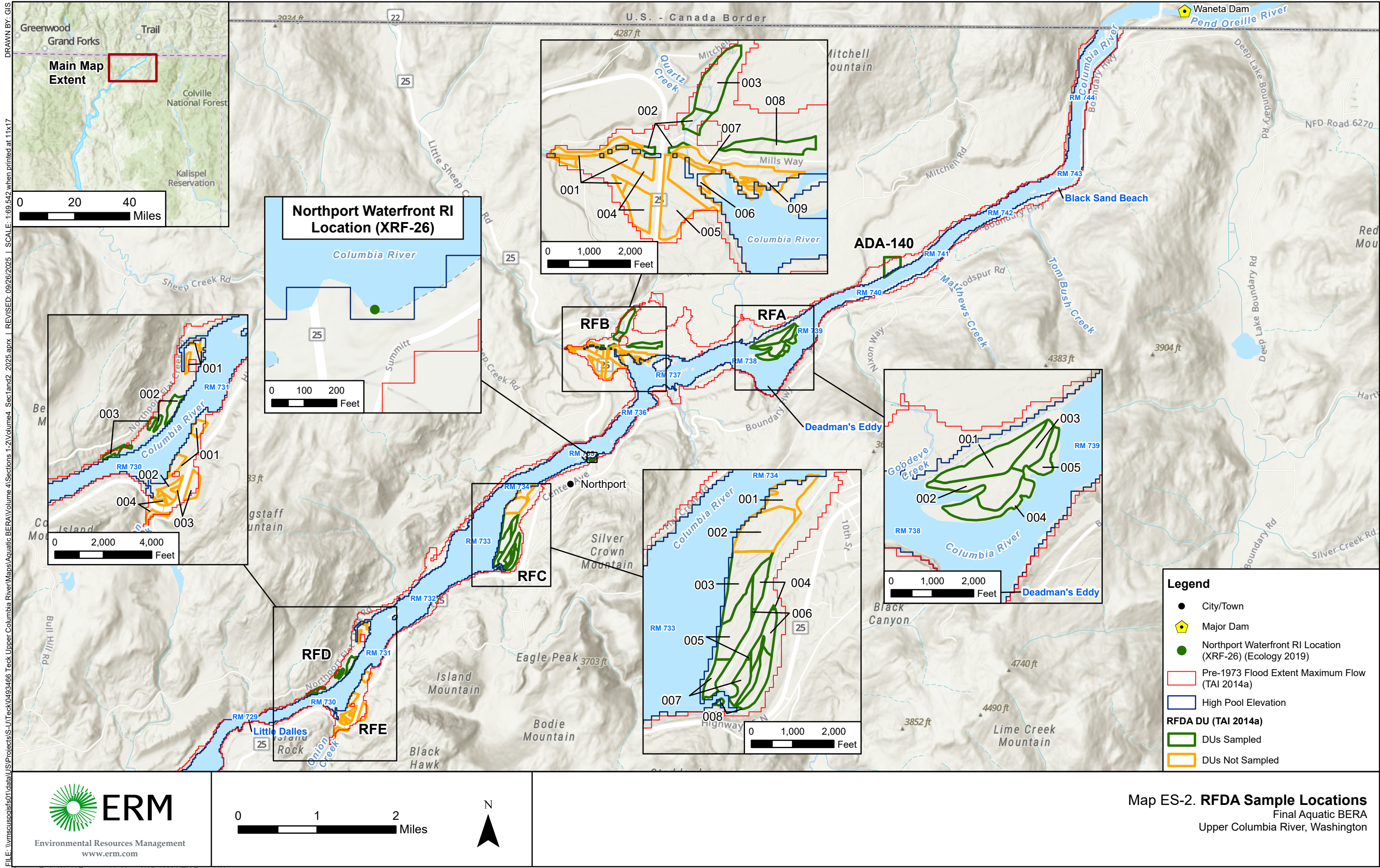
# Maps





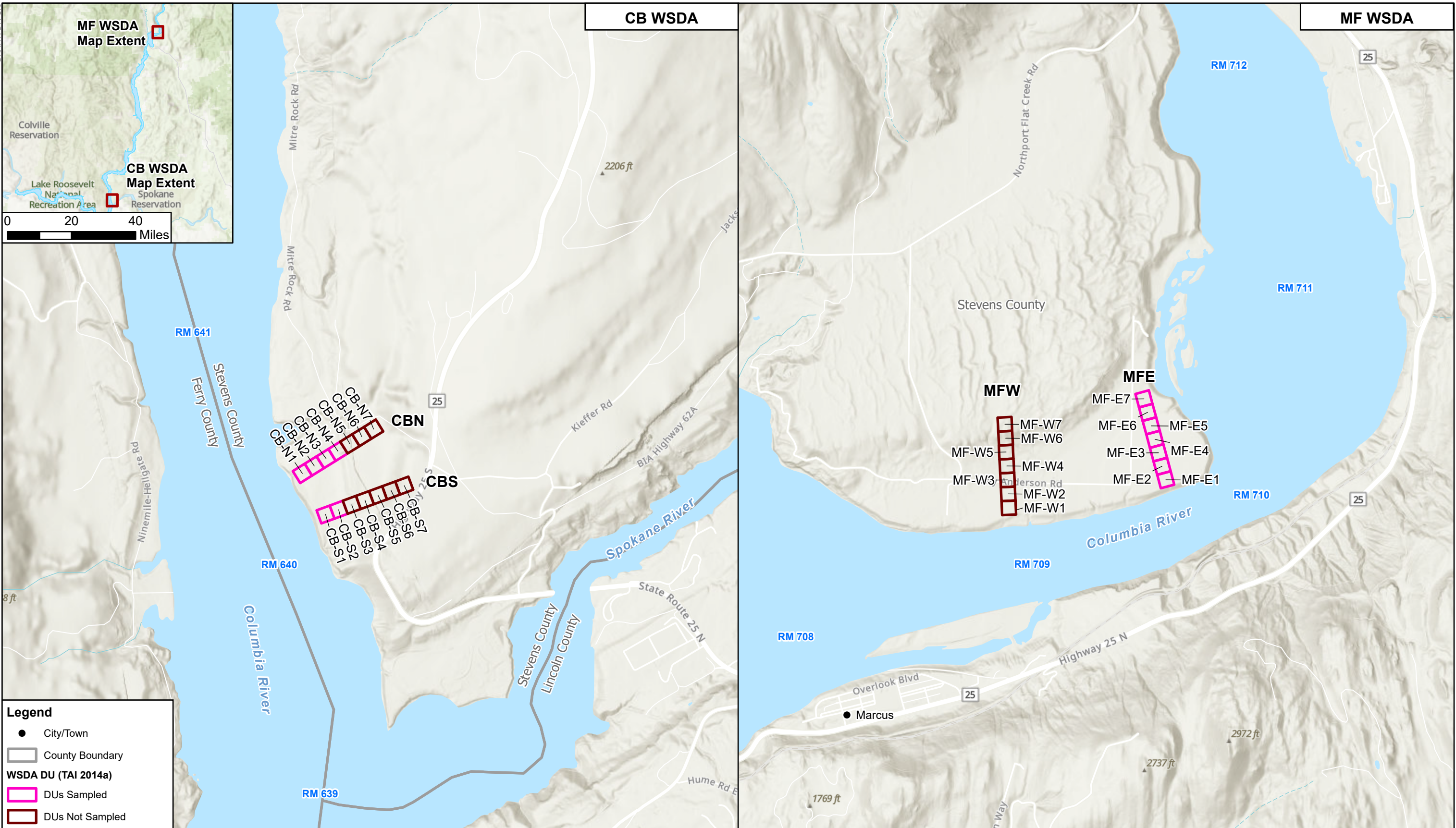


FILE: \\mssc\usdp\p\01\data\USIP\Projects\S-U\T\Tech\0493466\_Teck\_Upper\_Columbia\_River\Maps\Aquatic\_BERA\Volume 4\Sections 1-2\Volume 4\_Sec1and2\_2025.aprx | REVISED: 09/26/2025 | SCALE: 1:69,542 when printed at 11x17





DRAWN BY: GIS



# Tables

Table ES-1. Summary of Risk Conclusions in OU 1

| EAE or Area            |                                           | Metals/Metalloids |          |         |        |           |         |          |        |                |      |                |           |         |            |        |          |        | Organic Compounds |          |      |                     |         |                  |           |  |  |
|------------------------|-------------------------------------------|-------------------|----------|---------|--------|-----------|---------|----------|--------|----------------|------|----------------|-----------|---------|------------|--------|----------|--------|-------------------|----------|------|---------------------|---------|------------------|-----------|--|--|
|                        |                                           | Aluminum          | Antimony | Arsenic | Barium | Beryllium | Cadmium | Chromium | Cobalt | Copper         | Iron | Lead           | Manganese | Mercury | Molybdenum | Nickel | Selenium | Silver | Thallium          | Vanadium | Zinc | Total PCB Congeners | PCB TEQ | Dioxin/Furan TEQ | Total TEQ |  |  |
| Surface Water Exposure |                                           |                   |          |         |        |           |         |          |        |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
|                        | aquatic plants                            |                   |          |         |        |           |         |          |        |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
|                        | zooplankton                               |                   |          |         |        |           |         |          |        |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
|                        | benthic invertebrates                     |                   |          |         |        |           |         |          |        |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
|                        | fish                                      |                   |          |         |        |           |         |          |        |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
|                        | ELS amphibians                            |                   |          |         |        |           |         |          |        |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
| Porewater Exposure     |                                           |                   |          |         |        |           |         |          |        |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
|                        | aquatic plants                            |                   |          |         |        |           |         |          |        |                | c    |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
|                        | benthic invertebrates                     |                   |          |         |        |           |         |          | b/c    |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
|                        | ELS fish                                  |                   |          |         |        |           |         |          | c      |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
|                        | ELS white sturgeon                        |                   |          |         |        |           |         |          | c      |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
| Sediment Exposure      |                                           |                   |          |         |        |           |         |          |        |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
| benthic invertebrates  |                                           |                   |          |         |        |           |         |          |        | c <sup>1</sup> |      | c <sup>1</sup> |           |         |            |        |          |        |                   |          |      | c <sup>1</sup>      |         |                  |           |  |  |
| Dietary Exposure       |                                           |                   |          |         |        |           |         |          |        |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
| Fish Populations       | herbivore (largescale sucker)             |                   |          |         |        |           |         |          |        |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
|                        | herbivore (prickly sculpin)               |                   |          |         |        |           |         |          |        |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
|                        | herbivore (white sturgeon)                |                   |          |         |        |           |         |          |        |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
|                        | insectivore (longnose dace)               |                   |          |         |        |           |         |          |        |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
|                        | omnivore (yellow perch)                   |                   |          |         |        |           |         |          |        |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
|                        | piscivore (burbot)                        |                   |          |         |        |           |         |          |        |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
|                        | piscivore (bull trout)                    |                   |          |         |        |           |         |          |        |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
| Bird Populations       | herbivore (tundra swan)                   | c                 |          |         |        |           |         |          |        | b              | b    | b              |           |         |            |        |          |        |                   |          |      | b                   |         |                  |           |  |  |
|                        | invertivore (spotted sandpiper)           | c                 |          |         |        |           |         |          |        | b              | b    | b              |           |         | b          |        | c        |        |                   |          | c    | b                   |         |                  |           |  |  |
|                        | aerial insectivore (tree swallow)         |                   |          |         |        |           |         |          |        |                |      |                |           |         | b          |        |          |        |                   |          |      |                     |         |                  |           |  |  |
|                        | omnivore (mallard)                        |                   |          |         |        |           |         |          |        |                | b    | b              |           |         |            |        |          |        |                   |          |      | b                   |         |                  |           |  |  |
|                        | piscivore/invertivore (belted kingfisher) |                   |          |         |        |           |         |          |        |                |      |                |           |         |            |        | c        |        |                   |          |      |                     |         |                  |           |  |  |
|                        | piscivore (common merganser)              |                   |          |         |        |           |         |          |        |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
|                        | piscivore (bald eagle)                    |                   |          |         |        |           |         |          |        |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
| Mammal Populations     | herbivore (muskrat)                       | b                 |          |         |        |           |         |          |        | b              | b    | b              | b         |         |            |        | b        |        |                   |          |      | b                   |         |                  |           |  |  |
|                        | aerial insectivore (little brown bat)     |                   |          |         |        |           |         |          |        |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
|                        | benthic invertivore (water shrew)         | b                 |          |         |        |           |         |          |        | b              | c    | b              | b         |         |            |        | b        |        |                   |          |      | b                   |         |                  |           |  |  |
|                        | piscivore (river otter)                   |                   |          |         |        |           |         |          |        |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |
|                        | piscivore (mink)                          |                   |          |         |        |           |         |          |        |                |      |                |           |         |            |        |          |        |                   |          |      |                     |         |                  |           |  |  |

**Notes:**

**Risk findings:**

|                                                                                                                                                                                                                      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Negligible risk. Exposure to chemical of potential concern (COPC) is expected to result in negligible risk. No further evaluation is warranted.                                                                      |
| Unacceptable risk. Exposure to COPC is above toxicity threshold levels and poses unacceptable risk to the population/community. Retained as a chemical of concern (COC) to be evaluated in the Aquatic RI.           |
| Uncertain risk. Exposure to COPC is uncertain because insufficient information is available to assess risks. Retained as a COPC to be evaluated in the Aquatic RI to determine whether it co-occurs with other COCs. |
| Not a COPC or chemical of interest (COI).                                                                                                                                                                            |

**Confidence findings:**

- a - high confidence in risk finding
- b - moderate confidence in risk finding
- c - low confidence in risk finding

<sup>1</sup> COC identified for the sediment exposure pathway based on the excess simultaneously extracted metals exposure metric.

EAE - ecological assessment endpoint

ELS - early life stage

PCB - polychlorinated biphenyl

TEQ - toxic equivalent



Table ES-2. Summary of Risk Conclusions in OU 2

| EAE or Area            |                                           | Metals/Metalloids |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        | Organic Compounds |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|------------------------|-------------------------------------------|-------------------|----------|---------|--------|-----------|---------|----------|--------|--------|------|------|-----------|---------|------------|--------|----------|--------|-------------------|----------|------|--------------|-----------|-----------|-----------|----------------------------|---------------------|---------|------------------|-----------|--|
|                        |                                           | Aluminum          | Antimony | Arsenic | Barium | Beryllium | Cadmium | Chromium | Cobalt | Copper | Iron | Lead | Manganese | Mercury | Molybdenum | Nickel | Selenium | Silver | Thallium          | Vanadium | Zinc | Methoxychlor | Total DDE | Total DDT | Total DDX | Bis(2-ethylhexyl)phthalate | Total PCB Congeners | PCB TEQ | Dioxin/Furan TEQ | Total TEQ |  |
| Surface Water Exposure |                                           |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | aquatic plants                            |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | zooplankton                               |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | benthic invertebrates                     |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | fish                                      |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | ELS amphibians                            |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
| Porewater Exposure     |                                           |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | aquatic plants                            |                   |          |         |        |           |         |          |        |        | c    |      | c         |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | benthic invertebrates                     |                   |          |         |        |           |         |          |        |        |      | c    |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | ELS fish                                  |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
| Sediment Exposure      |                                           |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | benthic invertebrates                     |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
| Dietary Exposure       |                                           |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
| Fish Populations       | benthivore (largescale sucker)            |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | benthivore (prickly sculpin)              |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | benthivore (white sturgeon)               |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | Invertivore (spotted sandpiper)           |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | omnivore (yellow perch)                   |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | piscivore (burbot)                        |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
| Bird Populations       | piscivore (bull trout)                    |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | herbivore (tundra swan)                   |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | invertivore (spotted sandpiper)           | c                 |          |         |        |           |         |          |        |        | c    |      |           | b       |            | b      |          |        |                   | c        | c    |              |           |           |           |                            |                     |         |                  |           |  |
|                        | aerial insectivore (tree swallow)         |                   |          |         |        |           |         |          |        |        |      |      |           | b       |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | omnivore (mallard)                        |                   |          |         |        |           |         |          |        |        | c    |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | piscivore/invertivore (belted kingfisher) |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | piscivore (common merganser)              |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
| Mammal Populations     | piscivore (bald eagle)                    |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | herbivore (muskrat)                       |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | aerial insectivore (little brown bat)     |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | benthic invertivore (water shrew)         | b                 |          |         |        |           |         |          |        |        | b    | c    |           |         |            | b      |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | piscivore (river otter)                   |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |
|                        | piscivore (mink)                          |                   |          |         |        |           |         |          |        |        |      |      |           |         |            |        |          |        |                   |          |      |              |           |           |           |                            |                     |         |                  |           |  |

**Notes:**

**Risk findings:**

- Negligible risk. Exposure to chemical of potential concern (COPC) is expected to result in negligible risk. No further evaluation is warranted.
- Unacceptable risk. Exposure to COPC is above toxicity threshold levels and above background risk levels and poses unacceptable risk to the population/community. Retained as a chemical of concern (COC) to be evaluated in the Aquatic RI.
- Uncertain risk. Exposure to COPC is uncertain because insufficient information is available to assess risks. Retained as a COPC to be evaluated in the Aquatic RI to determine whether it co-occurs with other COCs.
- Not a COPC or chemical of interest (COI).

**Confidence findings:**

- a - high confidence in risk finding
- b - moderate confidence in risk finding
- c - low confidence in risk finding

DDE - dichloro-diphenyl-dichloroethene

DDx - sum of 2,4'-dichloro-diphenyl-dichloroethane (DDD), 4,4'-DDD, 2,4'-DDE, 4,4'-DDE, 2,4'-DDT, and 4,4'-DDT

EAE - ecological assessment endpoint

ELS - early life stage

PCB - polychlorinated biphenyl

TEQ - toxic equivalent

Table ES-3. Summary of RFDA and WSDA BERA Risk Conclusions

| EAE or Area                 |                                                  | Aluminum                                                            | Antimony | Arsenic | Barium  | Beryllium | Cadmium         | Chromium | Cobalt | Copper          | Iron    | Lead                  | Manganese | Mercury | Molybdenum   | Nickel | Selenium        | Silver | Thallium | Vanadium | Zinc                  |
|-----------------------------|--------------------------------------------------|---------------------------------------------------------------------|----------|---------|---------|-----------|-----------------|----------|--------|-----------------|---------|-----------------------|-----------|---------|--------------|--------|-----------------|--------|----------|----------|-----------------------|
| RFDA's                      |                                                  |                                                                     |          |         |         |           |                 |          |        |                 |         |                       |           |         |              |        |                 |        |          |          |                       |
| terrestrial plant community |                                                  |                                                                     |          | c (RFC) |         |           |                 |          |        | b (RFA)         |         | b (wide spread)       | c (RFA)   |         | b (RFA, RFD) |        | c (wide spread) |        |          |          | b (wide spread)       |
| soil invertebrate community |                                                  |                                                                     |          |         | c (RFA) |           |                 |          |        | b (wide spread) |         |                       | c (RFA)   |         |              |        |                 |        |          |          | b (wide spread)       |
| Bird Populations            | herbivore (California quail)                     |                                                                     |          |         |         |           |                 |          |        |                 |         |                       |           |         |              |        |                 |        |          |          | b (RFA)               |
|                             | invertivore (American robin)                     |                                                                     |          |         |         |           | b (wide spread) |          |        | b (RFA)         | c (RFA) | b (ADA-140, RFA, RFC) |           |         |              |        |                 |        |          |          | b (wide spread)       |
|                             | aerial insectivore (tree swallow)                |                                                                     |          |         |         |           |                 |          |        |                 |         |                       |           |         |              |        | c (RFA, XRF-26) |        |          |          | b (ADA 140, RFA, RFD) |
|                             | carnivore (American kestrel)                     |                                                                     |          |         |         |           |                 |          |        | b (RFA)         |         |                       |           |         |              |        |                 |        |          |          | b (ADA 140, RFA, RFD) |
|                             | omnivore (black-capped chickadee)                |                                                                     |          |         |         |           |                 |          |        | b (RFA, RFC)    |         |                       |           |         |              |        | c (RFA, XRF-26) |        |          |          | b (wide spread)       |
|                             | herpetofauna (reptile and amphibian populations) | potential for unacceptable risk to terrestrial herpetofauna unknown |          |         |         |           |                 |          |        |                 |         |                       |           |         |              |        |                 |        |          |          |                       |
| WSDA's                      |                                                  |                                                                     |          |         |         |           |                 |          |        |                 |         |                       |           |         |              |        |                 |        |          |          |                       |
| terrestrial plant community |                                                  |                                                                     |          |         |         |           |                 |          |        |                 |         |                       |           |         |              |        |                 |        |          |          | b (MFE)               |
| soil invertebrate community |                                                  |                                                                     |          |         |         |           |                 |          |        |                 |         |                       |           |         |              |        |                 |        |          |          |                       |
| Bird Populations            | herbivore (California quail)                     |                                                                     |          |         |         |           |                 |          |        |                 |         |                       |           |         |              |        |                 |        |          |          |                       |
|                             | invertivore (American robin)                     |                                                                     |          |         |         |           |                 |          |        |                 |         |                       |           |         |              |        |                 |        |          |          |                       |
|                             | aerial insectivore (tree swallow)                |                                                                     |          |         |         |           |                 |          |        |                 |         |                       |           |         |              |        |                 |        |          |          |                       |
|                             | carnivore (American kestrel)                     |                                                                     |          |         |         |           |                 |          |        |                 |         |                       |           |         |              |        |                 |        |          |          |                       |
|                             | omnivore (black-capped chickadee)                |                                                                     |          |         |         |           |                 |          |        |                 |         |                       |           |         |              |        |                 |        |          |          |                       |
|                             | herpetofauna (reptile and amphibian populations) | potential for unacceptable risk to terrestrial herpetofauna unknown |          |         |         |           |                 |          |        |                 |         |                       |           |         |              |        |                 |        |          |          |                       |

Table ES-3. Summary of RFDA and WSDA BERA Risk Conclusions

| EAE or Area                                      |                                       | Aluminum                                                            | Antimony | Arsenic | Barium | Beryllium | Cadmium | Chromium | Cobalt | Copper | Iron | Lead    | Manganese | Mercury | Molybdenum | Nickel | Selenium | Silver | Thallium | Vanadium | Zinc |
|--------------------------------------------------|---------------------------------------|---------------------------------------------------------------------|----------|---------|--------|-----------|---------|----------|--------|--------|------|---------|-----------|---------|------------|--------|----------|--------|----------|----------|------|
| <b>WSDAs (continued)</b>                         |                                       |                                                                     |          |         |        |           |         |          |        |        |      |         |           |         |            |        |          |        |          |          |      |
| Mammal Populations                               | herbivore (meadow vole)               |                                                                     |          |         |        |           |         |          |        |        |      |         |           |         |            |        |          |        |          |          |      |
|                                                  | invertebrate (masked shrew)           |                                                                     |          |         |        |           | c (MFE) |          |        |        |      | b (MFE) |           |         |            |        |          |        |          |          |      |
|                                                  | aerial insectivore (little brown bat) |                                                                     |          |         |        |           |         |          |        |        |      |         |           |         |            |        |          |        |          |          |      |
|                                                  | carnivore (short-tailed weasel)       |                                                                     |          |         |        |           |         |          |        |        |      |         |           |         |            |        |          |        |          |          |      |
|                                                  | omnivore (deer mouse)                 |                                                                     |          |         |        |           |         |          |        |        |      |         |           |         |            |        |          |        |          |          |      |
| herpetofauna (reptile and amphibian populations) |                                       | potential for unacceptable risk to terrestrial herpetofauna unknown |          |         |        |           |         |          |        |        |      |         |           |         |            |        |          |        |          |          |      |

**Notes:**

When identified as unacceptable risk, the cell is populated with the decision unit(s) (DU[s]) where the hazard quotient (HQ) is  $\geq 1$  and above the background threshold value (BTV) HQ. When "wide spread" is used, there are at least four DUs where unacceptable risk was identified.

**Risk findings:**

|                                                                                                                                                                                                                                             |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Negligible risk. Exposure to chemical of potential concern (COPC) is expected to result in negligible risk. No further evaluation is warranted.                                                                                             |
| Unacceptable risk. Exposure to COPC is above toxicity threshold levels and above background risk levels and poses unacceptable risk to the population/community. Retained as a chemical of concern (COC) to be evaluated in the Aquatic RI. |
| Uncertain risk. Exposure to COPC is uncertain because insufficient information is available to assess risks. Retained as a COPC to be evaluated in the Aquatic RI to determine whether it co-occurs with other COCs.                        |
| Not a COPC or chemical of interest (COI).                                                                                                                                                                                                   |

**Confidence findings:**

- a - high confidence in risk finding
- b - moderate confidence in risk finding
- c - low confidence in risk finding

EAE - ecological assessment endpoint

MFE - Marcus Flats East

RFA - Relict Floodplain A

RFC - Relict Floodplain C

RFD - Relict Floodplain D

RFDA - relict floodplain deposition area

WSDA - windblown sediment deposition area

Table ES-4. Summary of Risk Conclusions in OU 1, OU 2, RFDAs, and WSDAs

| EAE or Area            | Metals/Metalloids |      |       |       |          |      |       |       |         |      |       |       |        |      |       |       |           |      |       |       |         |      |       |       |          |      |       |       |        |      |       |       |        |      |       |       |      |      |       |       |      |      |       |       |           |      |       |       |         |      |       |       |            |  |  |  |        |  |  |  |          |  |  |  |        |  |  |  |          |  |  |  |          |  |  |  |      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|------------------------|-------------------|------|-------|-------|----------|------|-------|-------|---------|------|-------|-------|--------|------|-------|-------|-----------|------|-------|-------|---------|------|-------|-------|----------|------|-------|-------|--------|------|-------|-------|--------|------|-------|-------|------|------|-------|-------|------|------|-------|-------|-----------|------|-------|-------|---------|------|-------|-------|------------|--|--|--|--------|--|--|--|----------|--|--|--|--------|--|--|--|----------|--|--|--|----------|--|--|--|------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
|                        | Aluminum          |      |       |       | Antimony |      |       |       | Arsenic |      |       |       | Barium |      |       |       | Beryllium |      |       |       | Cadmium |      |       |       | Chromium |      |       |       | Cobalt |      |       |       | Copper |      |       |       | Iron |      |       |       | Lead |      |       |       | Manganese |      |       |       | Mercury |      |       |       | Molybdenum |  |  |  | Nickel |  |  |  | Selenium |  |  |  | Silver |  |  |  | Thallium |  |  |  | Vanadium |  |  |  | Zinc |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                        | OU 1              | OU 2 | RFDAs | WSDAs | OU 1     | OU 2 | RFDAs | WSDAs | OU 1    | OU 2 | RFDAs | WSDAs | OU 1   | OU 2 | RFDAs | WSDAs | OU 1      | OU 2 | RFDAs | WSDAs | OU 1    | OU 2 | RFDAs | WSDAs | OU 1     | OU 2 | RFDAs | WSDAs | OU 1   | OU 2 | RFDAs | WSDAs | OU 1   | OU 2 | RFDAs | WSDAs | OU 1 | OU 2 | RFDAs | WSDAs | OU 1 | OU 2 | RFDAs | WSDAs | OU 1      | OU 2 | RFDAs | WSDAs | OU 1    | OU 2 | RFDAs | WSDAs |            |  |  |  |        |  |  |  |          |  |  |  |        |  |  |  |          |  |  |  |          |  |  |  |      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Surface Water Exposure |                   |      |       |       |          |      |       |       |         |      |       |       |        |      |       |       |           |      |       |       |         |      |       |       |          |      |       |       |        |      |       |       |        |      |       |       |      |      |       |       |      |      |       |       |           |      |       |       |         |      |       |       |            |  |  |  |        |  |  |  |          |  |  |  |        |  |  |  |          |  |  |  |          |  |  |  |      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| aquatic receptors      |                   |      |       |       |          |      |       |       |         |      |       |       |        |      |       |       |           |      |       |       |         |      |       |       |          |      |       |       |        |      |       |       |        |      |       |       |      |      |       |       |      |      |       |       |           |      |       |       |         |      |       |       |            |  |  |  |        |  |  |  |          |  |  |  |        |  |  |  |          |  |  |  |          |  |  |  |      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Notes:**

**Risk findings:**

Negligible risk. Exposure to chemical of potential concern (COPC) is expected to result in negligible risk. No further evaluation is warranted.

Unacceptable risk. Exposure to COPC is above toxicity threshold levels and above background risk levels and poses unacceptable risk to the population/community. Retained as a chemical of concern (COC) to be evaluated in the Aquatic RI.

Uncertain risk. Exposure to COPC is uncertain because insufficient information is available to assess risks. Retained as a COPC to be evaluated in the Aquatic RI to determine whether it co-occurs with other COCs.

Not a COPC or chemical of interest (COI).

Confidence findings:

- a - high confidence in risk finding
- b - moderate confidence in risk finding
- c - low confidence in risk finding

<sup>1</sup> COC identified for the sediment exposure pathway based on the excess simultaneously extracted metals exposure metric.

DDE - dichloro-diphenyl-dichloroethene

DDx - sum of 2,4'-dichloro-diphenyl-dichloroethane (DDD), 4,4'-DDD, 2,4'-DDE, 4,4'-DDE, 2,4'-DDT, and 4,4'-DDT

EAE - ecological assessment endpoint

PCB - polychlorinated biphenyl

RFDA - relict floodplain deposition area

TEQ - toxic equivalent

Table ES-4. Summary of Risk Conclusions in OU 1, OU 2, RFDA, and WSDAs

| EAE or Area                               | Organic Compounds |      |      |       |           |      |      |       |           |      |      |       |           |      |      |       |                            |      |      |       |                     |      |      |       |
|-------------------------------------------|-------------------|------|------|-------|-----------|------|------|-------|-----------|------|------|-------|-----------|------|------|-------|----------------------------|------|------|-------|---------------------|------|------|-------|
|                                           | Methoxychlor      |      |      |       | Total DDE |      |      |       | Total DDT |      |      |       | Total DDx |      |      |       | Bis(2-ethylhexyl)phthalate |      |      |       | Total PCB Congeners |      |      |       |
|                                           | OU 1              | OU 2 | RFDA | WSDAs | OU 1      | OU 2 | RFDA | WSDAs | OU 1      | OU 2 | RFDA | WSDAs | OU 1      | OU 2 | RFDA | WSDAs | OU 1                       | OU 2 | RFDA | WSDAs | OU 1                | OU 2 | RFDA | WSDAs |
| Surface Water Exposure                    |                   |      |      |       |           |      |      |       |           |      |      |       |           |      |      |       |                            |      |      |       |                     |      |      |       |
| aquatic receptors                         |                   |      |      |       |           |      |      |       |           |      |      |       |           |      |      |       |                            |      |      |       |                     |      |      |       |
| Porewater Exposure                        |                   |      |      |       |           |      |      |       |           |      |      |       |           |      |      |       |                            |      |      |       |                     |      |      |       |
| aquatic receptors                         |                   |      |      |       |           |      |      |       |           |      |      |       |           |      |      |       |                            |      |      |       |                     |      |      |       |
| Sediment Exposure                         |                   |      |      |       |           |      |      |       |           |      |      |       |           |      |      |       |                            |      |      |       |                     |      |      |       |
| benthic invertebrates                     |                   |      |      |       |           |      |      |       |           |      |      |       |           |      |      |       |                            |      |      |       |                     |      |      |       |
| Soil Exposure                             |                   |      |      |       |           |      |      |       |           |      |      |       |           |      |      |       |                            |      |      |       |                     |      |      |       |
| terrestrial plants and soil invertebrates |                   |      |      |       |           |      |      |       |           |      |      |       |           |      |      |       |                            |      |      |       |                     |      |      |       |
| Dietary Exposure (via Sediment or Soil)   |                   |      |      |       |           |      |      |       |           |      |      |       |           |      |      |       |                            |      |      |       |                     |      |      |       |
| fish populations                          |                   |      |      |       |           |      |      |       |           |      |      |       |           |      |      |       |                            |      |      |       |                     |      |      |       |
| bird populations                          |                   |      |      |       |           |      |      |       |           |      |      |       |           |      |      |       |                            |      |      |       |                     |      |      |       |
| mammal populations                        |                   |      |      |       |           |      |      |       |           |      |      |       |           |      |      |       |                            |      |      |       |                     |      |      |       |

Notes:

Risk findings:

Negligible risk. Exposure to chemical of potential concern (COPC) is expected to result in negligible risk. No further evaluation is warranted.

Unacceptable risk. Exposure to COPC is above toxicity threshold levels and above background risk levels and poses unacceptable risk to the population/community. Retained as a chemical of concern (COC) to be evaluated in the Aquatic RI.

Uncertain risk. Exposure to COPC is uncertain because insufficient information is available to assess risks. Retained as a COPC to be evaluated in the Aquatic RI to determine whether it co-occurs with other COCs.

Not a COPC or chemical of interest (COI).

Confidence findings:

a - high confidence in risk finding

b - moderate confidence in risk finding

c - low confidence in risk finding

<sup>1</sup> COC identified for the sediment exposure pathway based on the excess simultaneously extracted metals exposure metric.

DDE - dichloro-diphenyl-dichloroethene

DDx - sum of 2,4'-dichloro-diphenyl-dichloroethane (DDD), 4,4'-DDD, 2,4'-DDE, 4,4'-DDE, 2,4'-DDT, and 4,4'-DDT

EAE - ecological assessment endpoint

PCB - polychlorinated biphenyl

RFDA - relict floodplain deposition area

TEQ - toxic equivalent

WSDA - windblown sediment deposition area