Upper Columbia River
Expanded Site Inspection Report
Northeast Washington
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Region 10

START-2

Superfund Technical Assessment and Response Team

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UPPER COLUMBIA RIVER
EXPANDED SITE INSPECTION REPORT
NORTHEAST WASHINGTON

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LIST OF ACRONYMS

Acronym	Definition
AMSL	above mean sea level
B.C.	British Columbia
BOR	Bureau of Reclamation
Celgar	Celgar Pulp Company
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CLP	Contract Laboratory Program
COCs	contaminants of concern
Cominco	Teck Cominco Metals, Ltd.
CRDL	Contract Required Detection Limit
CSR	Contaminated Sites Regulation
CWA	Clean Water Act
DFAIT	Canadian Department of Foreign Affairs and International Trade
dioxins	polychlorinated dibenzo-p-dioxins
DQOs	data quality objectives
E & E	Ecology and Environment, Inc.
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
ERA	ecological risk assessment
ESI	expanded site inspection
FSQVs	freshwater sediment quality values
furans	polychlorinated dibenzofurans
GPS	Global Positioning System
HRS	Hazard Ranking System
ID	identification
IDW	investigation-derived waste
IJC	International Joint Commission
kg/d	kilograms per day
LRWQC	Lake Roosevelt Water Quality Council
MEL	Environmental Laboratory

LIST OF ACRONYMS (CONTINUED)

Acronym	Definition
mg/kg	milligrams per kilogram
MHW	mean high water
MRL	method reporting limit
MS	matrix spike
MSD	matrix spike duplicate
NCA	North Creek Analytical
NPS	National Park Service
NPL	National Priorities List
PA	preliminary assessment
PCBs	polychlorinated biphenyls
pesticides	chlorinated pesticides
QA	quality assurance
QC	quality control
%R	percent recovery
RM	river mile
RPD	relative percent difference
SARA	Superfund Amendments and Reauthorization Act of 1986
SOW	statement of work
SQAP	sampling and quality assurance plan
SQGs	sediment quality guidelines
SQLs	sample quantitation limits
START	Superfund Technical Assessment and Response Team
SVOCs	semivolatile organic compounds
TAL	Target Analyte List
TDD	Technical Direction Document
TDL	target distance limit
TECs	threshold effects concentrations
TOC	total organic carbon
U.S.	United States

LIST OF ACRONYMS (CONTINUED)

Acronym	Definition
USGS	United States Geological Survey
VOCs	volatile organic compounds
WESTON	Roy F. Weston, Inc.
WSDFW	Washington State Department of Fish and Wildlife
WSDH	Washington State Department of Health

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1. INTRODUCTION

Pursuant to United States Environmental Protection Agency (EPA) Superfund Technical Assessment and Response Team (START)-2 Contract Nos. 68-S0-01-01 and 68-S0-01-02, Ecology and Environment, Inc. (E & E) and Roy F. Weston, Inc. (WESTON) conducted an expanded site inspection (ESI) of sediment contamination in the upper Columbia River and its tributaries from the United States (U.S.)-Canada border downstream to approximately river mile (RM) 675 near Inchelium, Washington.

The ESI, under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA), is intended to collect sufficient data to determine a site's potential for inclusion on the National Priorities List (NPL) and establish priorities for additional action, if warranted. The assessment process does not include extensive or complete site characterization, contaminant fate determination, or quantitative risk assessment.

The EPA assessment of hazardous substance contamination in the upper Columbia River area was conducted in response to a formal Preliminary Assessment (PA) Petition submitted by the Confederated Tribes of the Colville Indian Reservation (also known as the Colville Confederated Tribes) under Section 105(d) of CERCLA, 42 U.S.C. § 9605(d). A copy of the PA Petition dated August 2, 1999, is provided in Appendix A. Under the authority of CERCLA and SARA, the EPA completed a PA of the upper Columbia River, from the U.S.-Canada border to the Grand Coulee Dam (E & E 2000). The PA, which is the first phase in the site assessment process, was completed in December of 2000 and included an evaluation of information and data from previous studies.

Based on the findings of the upper Columbia River PA, the EPA determined that sediment sampling of the upper Columbia River was necessary to determine if releases of hazardous substances are occurring and if there is a potential for releases to affect human health and the environment. Sampling activities associated with the ESI occurred in the upper Columbia River and its tributaries from the U.S.-Canada border to RM 675 near Inchelium, Washington. However, previous studies indicate that hazardous substances are present to the Grand Coulee Dam. Field sampling of the upper Columbia River was conducted in the spring and summer of 2001.

Sediment sampling activities in the upper Columbia River were carried out by WESTON under Technical Direction Document (TDD) No. 01-02-0001. Efforts to identify potential sources of contamination to the upper Columbia River, including visits to 60 mines and mills in Stevens County and Pend Oreille County, Washington, were conducted by E & E under TDD Nos. 01-02-0028 and 01-08-0009, respectively.

A summary of findings and recommendations for each of the 39 mine and mill sites visited in Stevens County, Washington, can be found in the *Upper Columbia River Mines and Mills Preliminary Assessments and Site Inspections Report* (E & E 2002a). A summary of findings and recommendations for each of the 21 mine and mill sites visited in Pend Oreille County, Washington, can be found in the *Lower Pend Oreille River Mines and Mills Preliminary Assessments and Site Inspections Report* (E & E 2002b).

This document presents the objectives, sampling activities, and results of the sediment sampling event conducted by WESTON in the upper Columbia River. Included are background information (Section 2), field activities and analytical protocol (Section 3), quality assurance (QA)/quality control (QC; Section 4), analytical results reporting and background samples (Section 5), analytical results (Section 6), the targets/receptors in the surface water migration pathway (Section 7), conclusions and recommendations (Section 8), and references (Section 9).

2. BACKGROUND

This ESI was intended to collect sufficient data to support a Hazard Ranking System (HRS) evaluation of the upper Columbia River and to assess the need for additional detailed investigation and/or response action. Accordingly, the sampling objectives defined for the upper Columbia River ESI are to:

- Document a threat or potential threat to public health or the environment posed by sediment contamination in the upper Columbia River;
- Assess the need for additional detailed investigation and/or response action in the upper Columbia River; and
- Determine the potential for placement of the Upper Columbia River site on the NPL.

A sampling and quality assurance plan (SQAP) describing field activities to be conducted by WESTON in the upper Columbia River was developed prior to commencement of fieldwork (WESTON 2001a). The SQAP describes the sampling strategy, sampling methodology, and analytical program to be used to investigate sediment contamination in the upper Columbia River.

2.1 REGIONAL CHARACTERISTICS AND DESCRIPTIONS

The Columbia River flows from northern British Columbia (B.C.), Canada, generally south through eastern Washington, and then west, forming part of the border between Washington and Oregon, and eventually emptying into the Pacific Ocean. A reservoir, Franklin D. Roosevelt Lake (commonly known as Lake Roosevelt), was formed on the Columbia River by the construction of the Grand Coulee Dam (USGS 1994). Lake Roosevelt extends about 135 miles upstream from the dam, reaching to within 15 miles of the international boundary with Canada (USGS 1994). The Columbia River is the principal inflow to Lake Roosevelt and contributes about 90% of the flow from a large drainage area in Canada and the U.S. (USGS 1994). In addition to the Columbia River, four other major rivers flow directly into Lake Roosevelt: the Kettle, Colville, Spokane, and Sanpoil rivers (USGS 1994). The Pend Oreille River flows into the main stem of the Columbia River just north of the U.S.-Canada border (Figure 2-1; USGS 1994). The portion of the river addressed in this report, and referred to as the upper Columbia River, extends approximately 70 RMs through northeast Washington from the U.S.-Canada border to

approximately RM 675 near Inchelium, Washington, crossing portions of both Ferry and Stevens counties (Figure 2-2).

The construction of Grand Coulee Dam, a federal reclamation project, was completed in 1940 on a portion of the Columbia River that forms the southern boundary of the Colville Reservation (DOI 1977). A multi-purpose project, it provides flood control, irrigation, hydropower production, recreation, stream flows, and fish and wildlife benefits. Lake Roosevelt, behind the dam, has over 5,000,000 acre feet of active storage (BOR 2003).

In an Act dated June 29, 1940, the U.S. Congress required the Secretary of the Interior to designate the Indian lands to be taken in aid of the project, and granted all right, title, and interest in such designated lands to the U.S., subject to the provisions of the Act. The area designated by the Secretary to be taken by the U.S. in aid of the project included traditional Tribal lands extending from the original bed of the river to the nearest contour line indicating an elevation of 1,310 feet above sea level. Another provision of the Act required the Secretary to set aside approximately one-fourth of the reservoir area above the dam for the paramount use of the Colville Confederated Tribes and the Spokane Tribe for hunting, fishing, and boating purposes. Pursuant to this provision, the Secretary in 1946 designated an area, the so-called "Indian zone," which comprises essentially all of the freeboard, draw down, and water area inside the original boundaries of the reservations except for the area immediately around the dam. The zone extends to the center line of Lake Roosevelt from the Colville side, except where the Colville and Spokane reservations are adjacent to one another across the lake. There, the zone includes the entire reservoir with the exception of a strip in the center of the lake half a mile wide, which was preserved by the Secretary as a navigation lane. (DOI 1977)

Pursuant to a tri-party agreement among the U. S. Department of the Interior National Park Service (NPS), the Office of Indian Affairs, and the Bureau of Reclamation (BOR), dated December 18, 1946, the BOR has primary responsibility for overseeing administration of the reservoir area. The general public is presently permitted to have equal use of the Indian zone with the Indians, under the supervision of the NPS. In addition, the tribes have the power to regulate hunting, fishing, and boating by non-Indians in the Indian zone. (DOI 1977)

The bed of the Columbia River and of its tributary, the Spokane River, was not designated by the Secretary pursuant to the 1940 Act, and the tribes were not compensated for any taking with respect to the riverbed. Accordingly, the action taken by the Secretary pursuant to the 1940 Act has not changed the tribes' title, and the Secretary held that each tribe has full equitable title to that part of the riverbed which is within the exterior boundaries of its reservation. (DOI 1977)

The reservoir developed into a major recreational and economic resource for the surrounding area (E & E 2000). In 1946, the Secretary, by his approval of an agreement between the BOR, the Bureau of Indian Affairs, and the NPS, designated the NPS as the manager of the Lake Roosevelt National Recreation Area (DOI 2000). The Lake Roosevelt National Recreation Area, comprising the lake and its shorelines, attracts more than 1 million visitors per year (E & E 2000). The National Recreation Area ends south of Northport at Onion Creek. The distance from Grand Coulee Dam to Onion Creek is approximately 132 miles (DOI 2000).

Recreational opportunities on or in the National Recreation Area's waters include motorboating, waterskiing, sailing, swimming, and fishing. Land-based activities include camping, hiking, picknicking, wildlife watching, and sightseeing. Lake Roosevelt is one of the few large lakes in northwestern Washington that has an abundance of shoreline that is accessible to the public for recreational use. (DOI 2000)

The National Recreation Area lies within the ancestral homelands of the Colville and Spokane Tribes. The National Recreation Area also contains some of the lands that were originally part of the North Half of the Colville Reservation (DOI 2000). Former reservation lands in the area from the northern border to the Canadian border are referred to by the Colville Confederated Tribes as the "North Half." In 1891, the Colville Confederated Tribes entered into an agreement with the U.S., ceding the 1.5 million acre North Half for one dollar per acre, but reserving hunting, gathering, fishing, and water rights thereon, including within the North Half portions of the Columbia and Okanogan rivers. The U.S. Supreme Court has affirmed the validity and vitality of the Tribes' reserved rights in the North Half (see PA Petition, Appendix A). The Colville Confederated Tribes maintain reserved rights on some of these lands and both the Colville Confederated Tribes and the Spokane Tribe maintain an active interest in their management (DOI 2000).

2.2 PHYSICAL SETTING

The Colville Indian Reservation borders Lake Roosevelt on the north and west for approximately 93 RMs. Within this stretch there are several communities, the largest being Coulee Dam, Keller, and Inchelium. North and west of Lake Roosevelt, the terrain is mountainous and mostly forested, with a small amount of farmland. The area is thinly populated, with about 3.2 persons per square mile. The area is mainly made up of national forest and Colville Indian Reservation lands. Logging and mining dominate the economy. (DOI 2000)

The Spokane Indian Reservation borders Lake Roosevelt to the east for about 8 miles, just north of the Spokane Arm (confluence of the Spokane River with the Columbia River). The area east of Lake Roosevelt is a mixture of forest and farmland, with a population density of 14.3 persons per square mile. Forest products manufacturing dominates the economy. The area south of Lake Roosevelt and the Spokane Arm is generally flat with low rolling hills. The population density is 4.2 persons per square mile, and agriculture is the main livelihood. (DOI 2000)

The study area is within the Okanogan Highlands physiographic province. The Columbia River flows generally south through this province. The Okanogan Highlands province is characterized by rounded mountains with elevations up to 8,000 feet above sea level and deep, narrow valleys. The Columbia River divides the Okanogan Highlands into two regions: to the east of the river are the Selkirk, Chewelah, and Huckleberry mountains; to the west are the Kettle, Sanpoil, and other mountains. (DNR 2003)

The eastern portion of the Okanogan Highlands contains the oldest sedimentary and metamorphic rocks in the state. Miogeosynclinal metasedimentary rocks of the Precambrian Belt Supergroup, Windermere Group, and Deer Trail Group extend from B.C. south to the Columbia River. Precambrian dikes and sills cut these ancient rocks. The Precambrian metasedimentary rocks are overlain by Paleozoic marine rocks. All these rocks were subjected to metamorphism during Jurassic through Eocene time. (DNR 2003)

The western portion of the Okanogan Highlands contains eugeosynclinal metasedimentary rocks. These rocks were juxtaposed with the miogeosynclinal metasedimentary rocks of the eastern Okanogan Highlands by Jurassic-Cretaceous thrust faulting. Permian and Triassic volcanic flows and sedimentary rocks in the western Okanogan Highlands also were subject to diverse intrusive events during the Jurassic and then again in the Cretaceous periods. (DNR 2003)

The Okanogan Highlands were subjected to tectonism, plutonism, volcanism, sedimentation, development of gneiss domes, and epithermal precious metal deposition during the Eocene Epoch. Overprinted on the Okanogan Highlands are massive gneiss domes and north-south trending grabens. (DNR 2003)

The Okanogan Highlands were covered by great ice sheets during the Pleistocene Epoch. As the ice sheets retreated to the north, lakes formed in the valleys of the Columbia and Pend Oreille rivers. Along the Canadian boundary, terrace deposits indicate lake levels 2,000 feet above current sea level. Melt waters filled these lakes with sand, silt, and clay. (DNR 2003)

2.2.1 Regional Land Management

Initially, the NPS managed all the lands surrounding Lake Roosevelt that had been acquired or withdrawn by the BOR for construction of the reservoir. In 1974, the Secretary of the Interior directed that management for all lands within the reservations not needed for operation of the reservoir be returned to the tribes, and a cooperative management agreement be developed. The Lake Roosevelt Cooperative Management Agreement, approved in 1990 by the Secretary of the Interior and signed by the BOR, the NPS, the Bureau of Indian Affairs, the Spokane Tribe of Indians, and the Colville Confederated Tribes, confirms the roles and areas of management responsibility of Lake Roosevelt for the various parties. In addition to delineating management responsibilities, the agreement recognized the Lake Roosevelt National Recreation Area as an existing unit of the National Park system (DOI 2000). A copy of the existing Lake Roosevelt Cooperative Management Agreement is provided in Appendix B.

The Lake Roosevelt Water Quality Council (LRWQC), which includes members from federal, state, and local governments; the Colville Confederated Tribes; the Spokane Tribe of Indians; citizen groups; and individuals, was formed in 1990 to protect and maintain the aquatic environment of Lake Roosevelt. The LRWQC, in conjunction with Washington State University, developed a Management Plan and continues coordination of water quality and air quality studies. The LRWQC has no independent implementation or enforcement authority and leaves these critical functions to the appropriate authorities.

2.3 OPERATIONS AND WASTE CHARACTERISTICS

In late winter through early summer, substantial fluctuations in lake levels can occur due to BOR undertaking flood control measures. The degree of draw down is based on snowmelt predictions. The normal operating range on the lake is between 1,290 feet above mean sea level (AMSL; full pool) to 1,208 feet AMSL, resulting in seasonal lake level fluctuations in excess of 80 feet. During draw down, acres of bed and bank sediments of Lake Roosevelt are exposed. In mid- to late August, BOR can draw down the lake for fisheries management purposes in response to the 2000 National Marine Fisheries Service Biological Opinion concerning operation of the Federal Columbia River Power System which requires draw down as necessary within specified limits in an attempt to meet the summer flow objectives and to provide colder water for the benefit of migrating juvenile salmonids (NMFS 2000). These operations also benefit adults in passage by moderating temperatures (NMFS 2000).

Water quality conditions, including the dispersion of hazardous substances, can be affected by dams and reservoirs (BPA 1994). Coarser sediments entering a reservoir typically deposit at the head of

pools (BPA 1994). The finer sediments, such as silt and clay, are deposited near or transported past the dams (BPA 1994). Pollutants entering the mainstem can adsorb to sediments, mostly to silt and clay, and be transported and accumulate with them (BPA 1994). When lake levels are lowered significantly, the accumulated sediments can be scoured and transported downstream (BPA 1994). During these times, pollutants adsorbed to sediments can become dissolved in the water column (BPA 1994).

Previous studies carried out on the upper Columbia River Basin indicated elevated levels of arsenic, cadmium, copper, lead, and zinc in sediment and fish in Lake Roosevelt and the upper reach of the Columbia River. The Washington State Department of Health currently has fish advisories issued for the consumption of walleye, whitefish, and sturgeon in Lake Roosevelt due to mercury and dioxin concerns (WSDH 2002a). Previous studies have found elevated levels of polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins (dioxins), and polychlorinated dibenzofurans (furans) in water, sediment, and fish samples collected from the upper Columbia River. (E & E 2000)

Sources of contamination that have contributed to this contamination include mining and milling operations, smelting operations, pulp and paper production, sewage treatment plants, and other industrial activities. These contaminant sources are summarized in the following subsections.

2.3.1 Mining and Milling

Numerous mining and milling operations along the tributaries feeding the upper Columbia River in the U.S. and in Canada have existed since the late 1800s. Although claims were staked earlier, development of resources in the area did not become economically feasible until approximately the 1890s, when ore concentration processes were developed. Ores were concentrated in mills built at or close to each mine, significantly reducing transportation costs. Concentrated ores were transported to smelters for further refining. Large amounts of ore process wastes containing arsenic, cadmium, copper, lead, mercury, and zinc were produced during these operations. (E & E 2000)

The Northport area was comprised mostly of lead-zinc mines (Ecology 2000). Low-grade lead and zinc ore concentration processes involved physical crushing, pulverizing, and classifying using a stream of water, followed by a flotation process. Flotation was accomplished by adding reagents to the fines and then skimming off the resulting concentrated metals. Reagents used in this process included pine oil, cresylic acid, alcohols, eucalyptus oils, coal tar (wood creosotes), flotation reagents, xanthates, thiocarbonilides, lime soda ash, copper sulfate, sodium cyanide, and sodium silicate. The cleaned concentrate then was dried on a vacuum filter and sent to a smelter for refining. (Orlob 1950)

Mine and mill sites identified by the EPA as potential sources of contamination to tributaries that discharge to the upper Columbia River were visited as part of the ESI. A summary of the findings and recommendations for each of the mine and mill sites visited in Stevens and Pend Oreille counties, Washington, are presented in separate reports (E & E 2002a; E & E 2000).

2.3.2 Smelters

Smelters in the vicinity of the upper Columbia River watershed include the former Le Roi/Northport Smelter in Northport, Washington, and the Teck Cominco Metals, Ltd. (Cominco) facility in Trail, B.C.

2.3.2.1 Former Le Roi/Northport Smelter

The Le Roi/Northport Smelter is a former smelter located northeast of the town center of Northport, Washington, along Highway 25. The city of Northport is located in Stevens County along the east bank of the Columbia River approximately 7 miles south of the U.S.-Canada border. (URS 1993)

The Northport-Waneta Road borders the Le Roi/Northport Smelter site along the south and east. Highway 25 defines the western boundary of the site. The Burlington Northern Santa Fe Railway (formerly the Spokane Falls and Northern Railroad) runs parallel to the Columbia River and designates the northern property boundary. The Columbia River is located approximately 200 feet north of the Le Roi/Northport Smelter property. Properties west of the site are residential homes. Smelter Hill is located directly east of the site and Silver Crown Mountain is south of the site. A city park with an area of approximately 10 acres is located northwest of the site along the Columbia River, approximately 50 feet from the site. The park is accessed by means of a road on the southwest corner of the site. (Figure 2-1; URS 1993)

The Le Roi/Northport Smelter property encompasses approximately 32 acres and is accessed from the Northport-Waneta Road via Highway 25 (SAIC 1997). Access to the Le Roi/Northport Smelter site is not restricted (URS 1993). The ground surface generally slopes toward the Columbia River in elevation from about 1,360 feet AMSL at the site to 1,290 feet AMSL, the normal pool elevation for the Columbia River (SAIC 1997). The former smelter buildings, which are no longer standing, included the furnace building, the roaster building, and the crusher and ore building (Heritage 1981).

In the 1890s, a flurry of mining activities evolved in northeastern Washington and southern B.C. In 1892, D.C. Corbin, owner of the Spokane Falls and Northern Railroad, built a rail line to reach the town of Northport, then consisting of a lumber mill and several tents. The railroad tracks were located

adjacent to the Le Roi site. In 1896, Mr. Corbin donated the site to the Le Roi Mining and Smelting Company for the construction of the Breen Copper Smelter. The smelter location was chosen because the area contained large quantities of materials necessary for smelting, such as limerock and flux. (URS 1993)

In 1896, the Breen Copper Smelter began refining copper and gold ores from mines in northeast Washington, as well as copper ore from B.C., for the Le Roi Mining and Smelting Company (Northport Pioneers 1981). In 1901, the Le Roi Company Smelting Operations reorganized with the Red Mountain Smelting Operations to become the Northport Smelting and Refining Company (URS 1993). By 1908, it was one of the largest smelters on the West Coast, processing 500 tons of ore per day (URS 1993). In 1909, the smelter closed because of competition from another smelter located in Trail, B.C. (URS 1993). During World War I, the government demand for lead encouraged the Northport Mining and Smelting Company to reopen and process the lead ores that had been discovered at Leadpoint, Washington, approximately 9 miles east of Northport (URS 1993). In September 1914, Jerome Day purchased the smelter and renovated it to accommodate lead ores (URS 1993). The government curtailed its lead purchases in 1921, and subsequently, the smelter closed and was dismantled in 1922, after 24 years of sporadic operation (E & E 2000). After the smelter closed, the American Smelting and Refining Company purchased the site. The company removed the smelting equipment and transported it to a smelter elsewhere (URS 1993). Sometime between 1922 and 1953, the inactive site was purchased by J.D. Harms. Between 1953 and 1969, a lumber mill went into operation on the property (URS 1993). In 1975, Cecil Frazier purchased the property and operated a lumber mill (URS 1993). In 1985, Steve Frazier purchased the property and business and operated the lumber mill under the name SSF Building Materials until the property was sold in 2001 to KES Contracting, Trail, B.C., the current owner.

2.3.2.1.1 Smelter Description/Features

The Breen Copper Smelter treated copper and gold ores transported from Rossland Mine located in B.C. The initial smelter operations were rudimentary and involved releases of large quantities of pollutants. The ore was difficult to process; however, it contained high enough amounts of copper and gold to make the process worthwhile. The ore was burned or heated to release the minerals. The burning released high amounts of sulfur dioxide into the air. (URS 1993)

The copper and gold ore was processed by heap roasting, which involves open burning of the raw ore prior to placing it in a furnace. A slag brick platform was utilized for the initial burning, or heap roasting, of the ore. The ore was piled on the brick platform to an approximate depth of 4 feet. Cord

wood was then stacked on top of the ore pile and ignited. During this process, gold and copper were freed for smelting. The Northport city water wells are currently located on the brick platform area. (Heritage 1981)

The burned ore was then placed into the furnace where the separation of the minerals occurred. Lime rock was used during the flux process. Tap holes were located at different levels in the furnace to draw off the minerals and rocks (including iron, copper, and slag rock). The tap hole for the iron and slag rock was located on the front end of the furnace about six inches higher than the copper tap hole. The iron and slag rock collected was considered waste. The tap hole for the copper was located on the side of the furnace. The copper matte was collected and loaded into box cars for shipment to a copper refinery. (Heritage 1981; URS 1993)

Because gold is heavy, it settled to the bottom of the furnace and formed a gold matte. After the gold accumulated to a thickness of 14 inches, the furnace was shut down. Once the furnace and materials cooled, the sides of the furnace were removed to gain access to the gold matte, which was then pried from the furnace and cut into pieces before being loaded into box cars and shipped to a gold refinery. (Heritage 1981)

In the operational period of the copper and gold smelter, two large steam engines, fueled by coal, provided power. Both flywheel steam engines were hooked onto one long line shaft. On the other end of the line shaft, a dynamo produced 10,000 volts of electricity prior to being boosted by a generator that provided up to 100,000 volts. When the smelter reopened to process lead ores, a high-voltage line from Canada supplied the power, and the steam plant was shut down. (URS 1993)

The lead smelter used a process more sophisticated than that used in the copper and gold process, although a large quantity of sulfur (approximately 30 tons per day) was still being discharged into the air. Filters for the smokestacks were added later. (URS 1993)

The abandoned and dismantled smelter remained inactive after closure in 1922. The town of Northport demolished the buildings for the usable brick. One building retained enough walls to provide an ice-skating rink during the winter. The railroad was abandoned and the tracks salvaged. (URS 1993)

The smelting operations produced a waste referred to as slag. The slag was usually placed in piles near the smelter for temporary or permanent disposal. Slag also was discharged from the furnaces directly into the Columbia River via underground waterways (Sanborn Map Company 1908). The contaminants of concern (COCs) in the slag include arsenic, cadmium, copper, lead, mercury, zinc, and other metals commonly associated with the smelting process.

2.3.2.1.2 START-2 Site Visit

On June 29, 2001, START-2 and EPA personnel visited the sandbar/beach area at the Northport boat launch, located approximately 200 feet north of the Le Roi/Northport Smelter property. START-2 and EPA personnel observed black glassy sand-like material along the bank of the Columbia River at the sandbar/beach and boat launch areas. The START-2 characterized the material as slag. START-2 personnel collected sediment samples at locations along the Columbia River at the sandbar/beach and boat launch areas. Brick remnants were observed scattered along the bank of the Columbia River near the boat launch area.

On September 13, 2001, START-2; EPA personnel; Don Hurst of Fulcrum Environmental; and Murray McConnachie, the property owner representative, conducted a walk-through of the former Le Roi/Northport Smelter site. An area of slag bricks was observed south of the former smelter operations. The slag bricks were observed to be glassy black. A potential former tailings pile was observed west of the slag brick area. Stone foundations and old brick walls from the former smelter facility remain on the site. The majority of these remains are located on the northern portion of the property. One of three original smokestacks is still standing. This remaining stack was reported as the second largest stack, being only half the size of the largest stack. It stands approximately 75 feet high and has a maximum width of approximately 10 feet.

The START-2 collected sediment and soil samples from locations on the property and sediment from the Columbia River (Figure 2-3). The results of the nine sediment samples collected from the sandbar/beach and boat launch areas on the Columbia River are included in Table 6-1. A detailed discussion of sampling activities conducted, sample results, recommendations, and conclusions, can be found in the *Upper Columbia River Mines and Mills Preliminary Assessments and Site Inspections Report* (E & E 2002a).

2.3.2.2 Cominco Smelter

The Cominco smelter is located approximately 10 RMs upstream of the U.S.-Canada border (Figure 2-2). Smelter operations have been underway in Trail, B.C., since 1896 (G3 Consulting 2001a). The smelter became known as Consolidated Mining and Smelting Company of Canada, Ltd. in 1906, was officially renamed Cominco in 1966, and merged with Teck Ltd. to become Teck Cominco Metals, Ltd. in 2001 (G3 Consulting 2001b). The facility primarily produced lead and silver during the first decade of operation, with zinc production initiated in 1916. Fertilizer plants were built at the Trail smelter in 1930, facilitating the production of both nitrogen- and phosphorus-based fertilizers. While the Trail smelter

was originally built to process materials from local mines, ore concentrates are currently obtained from mining operations throughout the world. In addition to lead, zinc, cadmium, silver, gold, bismuth, antimony, indium, germanium, and arsenic, this facility also produces sulfuric acid and liquid sulfur dioxide. Ammonia, ammonium sulfate, and phosphate fertilizers were also produced at the fertilizer plant until August 1994, at which time production of the phosphate-based fertilizer was terminated. (MacDonald 1997)

Historically, effluent from Cominco has been discharged to the Columbia River through five outfalls: one outfall from the Warfield Fertilizer Operation, three submerged outfalls from the metallurgical plants, and one from the slag launder system. A trend graph of metals in effluents from the metallurgical operation from 1980 to 1996 demonstrates that the average discharges for dissolved metals were as high as 18 kilograms per day (kg/d) of arsenic, 62 kg/d of cadmium, 200 kg/d of lead, and 7,400 kg/d of zinc. Additionally, fertilizer plant operations contributed up to 4 kg/d of total mercury and 350 kg/d of dissolved zinc. (Cominco 1997)

The Cominco lead/zinc smelter process produces slag as a by-product. This slag undergoes a fuming process in fuming furnaces which allows recovery of substantial quantities of metals, in particular lead and zinc. This fuming process involves injection of air and coal into molten slag, driving off metals that are then recovered as an oxide fume (Nener 1992). At the end of a fuming cycle, molten-treated slag is granulated with water, and the slurry discharged to the Columbia River (Nener 1992). This procedure of discharging began when operations first started and continued through to mid-1995 (Nener 1992). The slag is a black, glassy material which contains copper, lead, and zinc. Other metals also are present. The bulk of the material has the size and texture of sand; however, approximately 1% by weight consists of fines which have a broken egg-shell or needle-like morphology. (Nener 1992)

Cominco tail slag has been demonstrated to contain concentrations of copper ranging from 1% to 2.99%, lead ranging from 0.1% to 3.38%, and zinc ranging from 2.5% to 15.6% (Nener 1992; Gawryletz 1998). Reports documenting the yearly and daily amount of tail slag released to the Columbia River from the Cominco smelter have not been located, however, these values can be estimated based on the amount of lead produced and the amount of blast furnace slag produced (Logan 1990). Cominco has reported that the amount of blast furnace slag produced is equal to 140% of the amount of lead produced, while the amount of tail slag produced is equal to 85% of the amount of blast furnace slag produced (Logan 1990). Using this information, it is estimated that 13,410,864 tons of tail slag were produced from the Cominco smelter over the course of operations from 1894 to 1994 (Table 2-1; Hurst 2003). Since the completion of the Grand Coulee Dam in 1940, it is estimated that 11,794,455 tons of tail slag

were produced and potentially discharged to the Columbia River by the Cominco smelter. The greatest lead production occurred in 1942, resulting in the generation of approximately 292,502 tons of tail slag. The average daily quantity of slag potentially discharged to the Columbia River for this year is 801 tons. Under the assumption that treated granulated slag was inert, the smelter reportedly was permitted to discharge up to 1,000 tons per day (USGS 1994). The amount of slag discharged was reduced in the mid-1980s to about 450 tons per day (Nener 1992; USGS 1994).

In 1991, concerns expressed by the public and government agencies over the principle of river discharge prompted Cominco to undertake a research program on the metals-related environmental properties of slag and an investigation into systems for slag collection and land disposal. Testing of slag samples was conducted using both the B.C. protocol Special Waste Extraction Procedure and the U.S. version Toxicity Characteristic Leaching Procedure which are utilized to characterize waste materials. Based on the test results, Cominco asserted that the data supported its long held position that granulated slag has a high degree of chemical stability and is essentially inert in the river environment. Cominco recommended that the implementation of land disposal of slag was not an immediate priority and it could be delayed without significant environmental consequences until the completion of Phase II of Lead Smelter Modernization. (Cominco 1991)

A 1992 study by J.C. Nener presents data obtained by the Canadian Department of Fisheries and Oceans as part of its fisheries assessment on the toxicity of fumed slag to aquatic organisms (Nener 1992). Fumed slag was collected from Cominco's lead/zinc smelter located at Trail, B.C. and tested for toxicity using five species of aquatic organisms representative of different levels of the food chain: *Selenastrum capricornutum*, a unicellular green algae; *Daphnia magna*, a zooplanktonic species; *Hyalella azteca*, an epibenthic invertebrate; *Chironomus tentans*, a benthic invertebrate; and *Oncorhynchus mykiss*, rainbow trout fingerlings. Slag was found to be detrimental to all species studied. Results indicate that the five species of organisms tested were all negatively impacted by exposure to slag, or in some cases supernatants prepared from slag, under study conditions. Results of inductively coupled argon plasma scans on bioassay water collected at the completion of each bioassay indicated that elevated levels of copper and zinc may have been at least partly responsible for the acute toxicity observed. Results of histological analyses performed on rainbow trout exposed to slag indicated that slag also caused mortality by abrading delicate exposed surfaces such as gills. Extrapolation of these results to the Columbia River would be speculative; however, bioassay results clearly show that slag is not biologically inert and therefore suggest that there may be some potential to negatively impact organisms in the receiving environment. (Nener 1992)

In 1993, the Washington State Department of Health (WSDH) completed a review of the toxicological effects of Cominco smelter slag on aquatic organisms in the Columbia River. The WSDH concluded that the studies they evaluated contradicted previous conclusions that Cominco slag leaches little and is biologically inert. The laboratory studies they reviewed confirmed that Cominco slag was toxic to the aquatic species tested due to the leaching of significant amounts of copper and zinc and/or physical abrasion of vital tissues such as gills. (Patrick 1993)

According to a summary report prepared by consultants to Cominco, the routine discharge of slag into the Columbia River was discontinued in mid-1995. Prior to this, up to 145,000 tonnes of slag had been discharged annually, which moved downstream to settle out in slower flowing, sandy areas. The amount of slag discharged to the Columbia River may have been as high as 186,703 tons per year based on slag production calculations derived from lead production values. The environmental effects of slag discharge to the river included both chemical and physical components. Chemical effects included increased loads of heavy metals and potential bioaccumulation and toxicity problems in river organisms. Physical effects included scouring of plant and animal life from river substrates, damage to gills and soft tissues of aquatic insects and fish, and smothering of habitat and food sources. (G3 Consulting 2001a)

The B.C. Ministry of Environment, Land, and Parks had required the elimination of slag to the Columbia River by December 1996; however since this time, Cominco has had several releases of slag to the river during upset conditions. Two specific examples of documented releases that occurred after Cominco was required to eliminate discharges are as follows: On January 9, 1998, one to two cubic meters of slag discharged to the river and on April 7, 1998, 1 to 1.5 tonnes of slag were released to the river (Cominco 1998b; Cominco 1998c).

Cominco's operations have been characterized by frequent accidental releases of contaminants into the river (MEL&P 1992, MacDonald 1997). While Cominco has installed alarm systems, as well as containment facilities, in higher risk areas to collect and divert solutions away from the river sewers, numerous spills occur each year (MacDonald 1997). On 86 days between September 1987 and May 2001, Cominco reported spills of pollutants into the Columbia River (MacDonald 1997; Boyd 2003). Of particular concern are spills of mercury and large quantities of sulfuric and phosphoric acids. These substances have a significant impact on effluent quality, ultimately affecting both pollutant loadings and the pH of receiving waters (MacDonald 1997). Table 2-2 lists reported spills that have entered the Columbia River from Cominco operations in Trail from 1987 to 2001.

Between 1995 and 1999, the percent reduction for several key metals from all sources (air, slag, and water) discharged directly into the Columbia River was reported to be 90% for arsenic, 84% for

cadmium, 99% for copper, 77% for lead, 95% for mercury, and 92% for zinc (G3 Consulting 2001a). A new lead smelter was commissioned in 1997 and became fully operational in 1999 (G3 Consulting 2001a). With the exception of releases to the Columbia River during upset conditions, Cominco slag currently is being stockpiled while awaiting purchase (G3 Consulting 2001a; MacDonald 1997). Cominco has an active market development program seeking ways to use the slag beneficially (G3 Consulting 2001a).

Cominco is conducting an ecological risk assessment (ERA) related to the Trail smelter operations under the Contaminated Sites Regulation (CSR), which is a regulation under the B.C. Waste Management Act (Beatty 2003). The CSR incorporates provisions for identifying, assessing, and remediating contaminated sites in B.C. (Beatty 2003). The studies and assessments being conducted for the Teck Cominco-Trail ERA are reviewed by the B.C. Ministry of Water, Land, and Air Protection staff to ensure they meet the requirements and intent of the CSR (Beatty 2003). The results will be integrated with the findings of a human health risk assessment conducted by the Trail Lead Task Force. This task force was composed of representatives from numerous Trail community groups, local government, the Province of B.C., and Cominco. The Trail Cominco Study Area is shown in Figure 2-4. (Cantox 2000)

In 2001, Cominco initiated a groundwater investigation of the Trail Smelter Facility as part of their ongoing work to inventory and characterize potential sources of contamination to the environment. The purpose of the investigation was to obtain an estimate of the quantities of dissolved metals and other substances discharging into the Columbia River, via groundwater, from under the smelter. The investigation consisted of the installation and testing of 18 groundwater monitoring wells at eight locations, including five along the back of the Columbia River. The investigation found evidence of groundwater contamination (Cominco 1998a).

Additional work planned as part of the groundwater investigation at the smelter site includes five more monitoring well sites in 2002 to allow a more complete assessment of the contaminant loadings to the Columbia River. Additionally, regional groundwater investigations will be performed to identify surface water drainages in the Cominco Study Area that may be effected by contaminated groundwater discharge (Cominco 1998a).

2.3.2.2.1 Trail Smelter Case

The Cominco smelter discharged sulphur dioxide into the air through a brick stack 409 feet high. The air pollution traveled south and remained trapped in the northern Stevens County Columbia River Valley. In 1925, the Trail Smelter increased the discharge of sulfur dioxide into the air from 4,700 to

10,000 tons a month. The citizens of Northport complained that sulfur pollution was threatening their health and environment. They insisted that area soils and forests were becoming poisoned with sulfur, causing their crops and forest land to die. They formed a "Citizens Protective Association" of farmers and property owners who sent letters of protest to politicians in both Ottawa and Washington. The matter, known as the Trail Smelter Case of 1926 to 1934, was the first case of air pollution brought before an international tribunal. (Northport Pioneers 1981)

In 1926, a Northport farmer wrote to Cominco complaining about fumes. Cominco offered to buy the property of those that had suffered damage. Washington State alien land laws prohibited foreign corporations from owning American real estate, and the farmer was informed by local officials that he could not sell his land to Cominco. (Northport Pioneers 1981)

The matter moved to the level of international diplomacy. The U.S. State Department opened negotiations to collect damages from the Canadian government for the citizens of Northport. The State Department pressed the case of the U.S. citizens, and the Canadian Consul-General wrote the prime minister that their nation was facing what amounted to an international lawsuit. The Canadian government suggested that the fumes problem should be placed on the agenda of the International Joint Commission (IJC). The IJC did not consider the case until August 1928. In 1931, the IJC recommended that the Canadian government stop polluting the atmosphere and pay damages assessed against the corporation in the amount of $350,000. The U.S. government, speaking for all of the claimants, refused to accept the $350,000 award, and asked that the case be reexamined by an arbitration tribunal. In 1935, President Franklin D. Roosevelt formally announced that the Treaty of Arbitration was in effect (Northport Pioneers 1981). The Tribunal was constituted under, and its powers derived from and limited by, the Convention between the United States of America and the Dominion of Canada signed at Ottawa in 1935, also termed "The Convention" (Cloutier 1941). In 1938, the appointed members of the tribunal announced its decision assessing an additional $78,000 in damages for injuries sustained from 1932 to 1937. They also decided that a regime or measure of control should be applied to the operations of the Trail Smelter and should remain in full force unless and until modified in accordance with the amendment or suspension of the regime. The Tribunal also decided that no damage caused by the Trail Smelter in the Washington State occurred with respect to the period from October 1, 1937 to October 1, 1940. The Tribunal also found that, under the principles of international law, as well as the law of the U.S., no state has the right to use or permit the use of its territory in such a manner as to cause injury by fumes in or to the territory of another or the properties or persons therein, when the case is of serious consequence and the injury is established by clear and convincing evidence. Considering the

circumstances of the case, the Tribunal held that the Dominion of Canada is responsible in international law for the conduct of the Trail Smelter. Apart from the undertakings of the Convention, the Tribunal held that it is the duty of the Government of the Dominion of Canada to see to it that the conduct of the Trail Smelter be in conformity with the obligation of the Dominion under international law. (Cloutier 1941)

2.3.3 Pulp Industry

Celgar Pulp Company (Celgar) operates a bleach kraft pulp mill in Castlegar, B.C., approximately 30 RMs upstream from the U.S.-Canada border (Figure 2-4). From 1961 until mid-1993, the mill primarily used chlorine in its bleaching process. The pulp mill discharged effluent containing chlorinated organic compounds, including dioxins and furans, into the Columbia River (USGS 1994).

As a result of concerns about health implications of dioxin and furan levels in fish downstream of pulp mills, the provincial and federal governments initiated fish sampling in the Columbia River from 1988 to 1990 as part of a nationwide survey. Levels in a variety of species downstream of Celgar, including rainbow trout, showed low or normal background levels of contamination, with the exception of whitefish, which showed levels above background. In response to these findings, a consumption advisory was issued by the local Medical Health Officer recommending that consumers of whitefish caught in the vicinity of the area from the Hugh Keenlyside Dam to the U.S.-Canada border limit their consumption to one meal per week. The 1990 whitefish consumption advisory prompted voluntary changes to the mill's bleach plant to reduce chlorinated furan (i.e., 2,3,7,8-tetrachlorodibenzofurans) effluent discharges into the Columbia River. (Celgar 1994)

In 1993, Celgar completed a major expansion and modernization project including the installation of a new bleach plant that uses chlorine dioxide instead of chlorine for bleaching pulp and a secondary treatment process for plant effluent. According to Celgar, in the process of modernization, which included reduction of chlorine usage, the plant reduced discharges of furans and by 1993 had reduced dioxin and furan concentrations in effluent to below minimum detection limits. In 1995, the Medical Health Officer removed the whitefish consumption advisory (USGS 1994, Celgar 1994).

As a result of pulp process effluent discharges, a fibre mat formed downstream of Celgar's outfalls. Fibre mats often form when effluent containing wood debris and pulp fibres is discharged into an aquatic environment and then settles to the substrate and accumulates. While fibre mats are readily degraded by microorganisms (producing ammonia and hydrogen sulfide by-products), they often contain persistent chemicals from pulp production and bleaching processes. Persistent chemicals documented in

other fibre mats have included polynuclear aromatic hydrocarbons, tetrachlorodibenzo-p-dioxins, and heavy metals. (USGS 1994)

In 1994, a physical, chemical, and video survey of the fibre mat located downstream of Celgar's discharge was conducted for comparison with similar surveys done in 1990 and 1992. EVS Consultants prepared a report on the fibre mat for Celgar which was submitted to the B.C. Ministry of Environment, Land, and Parks in 1995. The study states that the fibre mat adjacent to the mill had decreased in size and character as a result of process changes, and that the remaining mat now consisted of black silt (flyash) and a wood debris mix. Recommended areas of study identified by EVS Consultants include: characterize the fibre mat for organic contaminants, especially dioxins and furans; assess the toxicity of the fibre mat to benthic invertebrates; monitor contaminant concentrations of dioxin and furan in mountain whitefish and suckers for comparison with historical data; conduct an intensive survey of benthic macroinvertebrates; and, describe and determine the physical extent of the fibre mat. (Celgar 1994)

In July 1998, October 1998, and September 1999, Hatfield Consultants Ltd, consultants for Celgar, conducted additional field surveys including sublethal toxicological testing of final effluent, an adult fish survey to evaluate the effects of effluent on fisheries resources, an erosional benthic invertebrate survey, fibre mat monitoring, and dioxin and furan monitoring of fish tissues and sediments. As a result of these investigations, Hatfield Consultants LTD concluded the following:

- Celgar effluent did not negatively impact aquatic life;
- Nutrient enrichment was not indicated for benthic invertebrate communities near the facility;
- Mountain whitefish and largescale suckers near the facility did not appear to be negatively impacted;
- Algae (*Selenastrum*) and invertebrate (*C. dubia*) reproduction exhibited a very low toxicity to final effluent within 120 meters of the diffuser;
- Organochlorine concentrations in the fibre mat had declined, however, downstream stations (at 120 meters and 160 meters) indicated some toxicity and reduced benthic invertebrate communities; and
- Sediment and fish tissue dioxin and furan levels were below the B.C. Ministry of Environment, Lands, and Parks objectives. (Celgar 2000)

2.3.4 Other Potential Sources of Contamination

Cominco's 1997 environmental report identified Stoney Creek, located just upstream of the Cominco smelter near RM 755, as a significant contributor of contaminants to the Columbia River (Cominco 1998a). Data collected in 1995 show that the concentrations of dissolved arsenic, cadmium, and zinc in Stoney Creek (Topping Creek) are higher than those in the effluents from the metallurgical sewers (MacDonald 1997). The Stoney Creek watershed is affected by Teck Cominco's historic waste dumping and current storage activities, which contribute metal-laden drainage from seepage and surface runoff, as well as runoff from the urban area and a municipal landfill (G3 Consulting 2001b). Cominco's 1997 environmental report identified seepage from an old landfill site and an old arsenic storage site as the source of contaminants from Stoney Creek (Cominco 1998a). Teck Cominco completed installation of a seepage collection system in 1999 to collect and divert water from Stoney Creek (G3 Consulting 2001b). Water and sediment in Stoney Creek contained elevated arsenic, cadmium, copper, lead and zinc levels compared to other tributaries. Stoney Creek metal levels in both water (loads, calculated as concentration multiplied by flow) and sediment were reportedly reduced substantially between 1995 and 1999, with the exception of copper levels, which increased in sediment. (G3 Consulting 2001b)

There are 54 storm sewers draining into the Columbia River from the City of Trail, B.C. (MacDonald 1997). It is likely that stormwater and snowmelt drainage from the cities of Trail and Rossland also contribute significant quantities of contaminants (suspended solids, polynuclear aromatic hydrocarbons and other hydrocarbons, and metals) to the river (MacDonald 1997). In addition, the effluents from the municipal sewage treatment plants at Castlegar and Trail contribute to waste loadings in the system (MacDonald 1997). Permitted waste discharges also enter the upper Columbia River indirectly via the Colville River. These are mostly treated municipal wastes discharged into the Colville River from the cities of Colville, Washington, and nearby Chewelah, Washington (USGS 1994).

2.4 PREVIOUS INVESTIGATIONS

Past investigations of the upper Columbia River have been conducted at varying levels of scope. A summary of previous investigations is provided in the *Upper Columbia River/Lake Roosevelt Preliminary Assessment Report* (E & E 2000). Past sediment studies have demonstrated the presence of hazardous substances including arsenic, cadmium, copper, lead, mercury, and zinc in sediments collected from the upper Columbia River.

A 1992 study by the U.S. Geological Survey (USGS) assessed the sediment quality of Lake Roosevelt and the reach of the Columbia River downstream from the U.S.-Canada border. The study

area included Lake Roosevelt and the Columbia River from the Grand Coulee Dam to the international border with Canada. Elevated copper and zinc concentrations were associated with sandy sediment found in the Northport reach of the Columbia River. In the study, the elevated concentrations in bed sediments were explained by the presence of slag particles that contained concentrations of these trace elements as high as 6,000 milligrams per kilogram (mg/kg) for copper and 25,000 mg/kg for zinc. The slag particles, consisting of dark glassy needles and angular grains, were progressively finer at sites with downstream distance.

The presence of slag is likely a major influence on the benthic invertebrate communities in the erosional habitat. A benthic invertebrate community includes the different taxa, or types, of invertebrates that reside in or on the bottom of rivers and lakes. Many invertebrate species that reside in erosional habitats require the spaces that occur in the substrate matrix. Small grain particles, as in silt or slag, can reduce liveability by altering water movement, food quality, oxygen availability, and interstitial areas. An analysis of benthic invertebrate communities in the Columbia River showed evidence of environmental stress, most likely due to the presence of trace elements in bed sediments or the loss of physical habitat from slag deposition. The benthic invertebrate communities observed in the erosional habitats of the study area include midges (chironomids), worms (nematodes), and snails (gastropods). Aquatic earthworms (oligochaetes), a common component of benthic communities, were not observed from any of the erosional habitats. Lethal and sublethal effects were observed in laboratory toxicity tests of selected aquatic organisms exposed to bed sediments collected from the Columbia River near the U.S.-Canada boundary and from some sites in other reaches of Lake Roosevelt. A detailed discussion of the study by the USGS can be found in the USGS Open File Report 94-315. (USGS 1994)

In 1994, the USGS, in cooperation with the LRWQC, analyzed a limited amount of fish tissue to determine levels of mercury and other metals in three fish species (walleye, smallmouth bass, and rainbow trout) in three reaches within the Columbia River: the reach between Northport and Kettle Falls, the Spokane River Arm reach, and the Sanpoil reach. The highest concentrations of mercury were found in walleye samples, with concentrations ranging from 0.11 mg/kg to 0.44 mg/kg. Smallmouth bass and rainbow trout samples also contained mercury, but at lower concentrations. Although the Federal Food and Drug Administration standard of 1.0 parts per million was not exceeded, the USGS and WSDH issued a fact sheet that advised the public to limit consumption of walleye taken from Lake Roosevelt (USGS 1997). In 1998, the USGS initiated a follow-up fish tissue study to determine present concentrations of mercury, dioxins and furans, and PCBs, and if possible, determine if concentrations have changed since the 1994 studies. The study concluded that the concentrations of contaminants in

fish that were identified as a potential threat to human health have either not changed since the 1994 studies, or have decreased. The study found that concentrations of PCBs in rainbow trout remained elevated and did not appear to be decreasing. Although dioxins and furans were still present in sport fish, concentrations of 2,3,7,8-tetrachlorodibenzofurans had decreased in rainbow trout, although not in whitefish. The study found that concentrations of total mercury in walleye decreased by about 50% from 1994 to 1998. However, the WSDH determined that the small sample size collected for this study (eight fish per reach) was not adequate to change the current consumption recommendations for this species (Duff 2002).

The WSDH currently has a health advisory in place for the consumption of walleye, whitefish, and sturgeon from Lake Roosevelt due to mercury and dioxin concerns. The health advisory for mercury in these fish is a state-wide advisory. (WSDH 2002a)

Studies conducted by the Washington State Department of Ecology (Ecology) and the USGS have included bioassay tests on Lake Roosevelt and upper Columbia River sediments (Ecology 2001). Significant toxicity was reported at seven main stem Columbia River locations and near the mouths of the Kettle and Sanpoil rivers, which are tributaries to the Columbia River (Ecology 2001). Based on the toxicity results, these nine sediment sites were included on the federal Clean Water Act (CWA) Section 303(d) list of impaired water bodies for 1998 (Ecology 2001). Ecology's new listing policy as it relates to sediments in Lake Roosevelt remains the same (White 2002).

In May 2001, Ecology conducted a reassessment of sediment toxicity in Lake Roosevelt and the upstream reach of the Columbia River by analyzing sediment metals and toxicity at the nine sites previously found to have sediment toxicity, and at a reference site located at Lower Arrow Lake in Canada. A map showing Ecology's approximate sediment sampling locations is presented in Figure 2-5. The objectives of the survey were to obtain current data on sediment metals concentrations and toxicity on the nine CWA 303(d) listed sites within Lake Roosevelt and the upstream reach of the Columbia River, and to determine if the sites should remain on the CWA 303(d) list. (Ecology 2001)

Sediment samples were analyzed for arsenic, cadmium, copper, lead, mercury, and zinc. Bioassays for sediment toxicity included *Chironomus tentans* 20-day survival and growth, *Hyalella azteca* 10-day survival, and Microtox® 100% porewater. Ecology noted that sediment samples taken at the upper Columbia River sampling sites (sites 1 to 3) consisted of a visibly dark sandy mixture, which Ecology determined could possibly indicated the presence of slag from the Cominco smelter. Elevated levels of copper and zinc were found at these same three sites. From this information, Ecology concluded that slag material may still be present in the upper Columbia River. (Ecology 2001)

The study found that metals concentrations and toxicity levels in Lake Roosevelt and upper Columbia River sediments remain relatively high. All but one sampling site (near Grand Coulee Dam) had at least one elevated toxicity level from the suite of bioassay tests performed on the sediments. In Lake Roosevelt, cadmium, mercury, and zinc concentrations were elevated. In the upper Columbia River reach, cadmium, copper, lead, and zinc concentrations were elevated. (Era and Serdar 2001)

Although the bioassay listing decisions for the study did not depend on the results of metal concentrations for Lake Roosevelt sediments, Ecology noted the relationship between sediment toxicity and metals concentrations. Ecology compared metals concentrations to Freshwater Sediment Quality Values (FSQVs) for metals in Washington State and to Consensus-Based Threshold Effects Concentrations (TECs) for freshwater sediments shown in Table 2-3.

Ecology's 2001 sampling found that metals concentrations and toxicity levels in Lake Roosevelt and the upper Columbia River remain relatively high. Based on the existing policy for CWA 303(d) listings, eight of the nine sediment sites should be listed on the CWA 303(d) list of impaired water bodies (Ecology 2001).

Table 2-1

TONS OF TAIL SLAG PRODUCED BY THE COMINCO SMELTER
1894 to 1994
UPPER COLUMBIA RIVER EXPANDED SITE INSPECTION
STEVENS COUNTY, WASHINGTON

Year	Lead (tons)	Blast Furnace Slag (tons)	Tail Slag (tons)	Average Tail Slag per Day (tons)
1894 to 1905	33,577	47,008	39,957	9
1906	7,567	10,594	9,005	25
1907	10,192	14,269	12,128	33
1908	16,078	22,509	19,133	52
1909	21,838	30,573	25,987	71
1910	21,184	29,658	25,209	69
1911	12,013	16,818	14,295	39
1912	13,036	18,250	15,513	43
1913	24,163	33,828	28,754	79
1914	17,309	24,233	20,598	56
1915	20,089	28,125	23,906	65
1916	19,987	27,982	23,785	65
1917	22,130	30,982	26,335	72
1918	19,423	27,192	23,113	63
1919	20,855	29,197	24,817	68
1920	13,237	18,532	15,752	43
1921	28,842	40,379	34,322	94
1922	42,176	59,046	50,189	138
1923	47,971	67,159	57,085	156
1924	80,700	112,980	96,033	263
1925	118,040	165,256	140,468	385
1926	131,053	183,474	155,953	427
1927	145,521	203,729	173,170	474
1928	159,416	223,182	189,705	520
1929	150,217	210,304	178,758	490
1930	151,492	212,089	180,275	494
1931	138,843	194,380	165,223	453
1932	126,619	177,267	150,677	413
1933	127,319	178,247	151,510	415
1934	157,674	220,744	187,632	514
1935	164,329	230,061	195,552	536
1936	182,541	255,557	217,224	595
1937	206,579	289,211	245,829	674
1938	201,574	282,204	239,873	657
1939	191,439	268,015	227,812	624
1940	220,602	308,843	262,516	719
1941	229,203	320,884	272,752	747
1942	245,800	344,120	292,502	801
1943	224,845	314,783	267,566	733
1944	144,267	201,974	171,678	470
1945	163,266	228,572	194,287	532
1946	165,849	232,189	197,360	541

Table 2-1

TONS OF TAIL SLAG PRODUCED BY THE COMINCO SMELTER
1894 to 1994
UPPER COLUMBIA RIVER EXPANDED SITE INSPECTION
STEVENS COUNTY, WASHINGTON

Year	Lead (tons)	Blast Furnace Slag (tons)	Tail Slag (tons)	Average Tail Slag per Day (tons)
1947	162,155	227,017	192,964	529
1948	160,107	224,150	190,527	522
1949	146,176	204,646	173,949	477
1950	170,364	238,510	202,733	555
1951	162,712	227,797	193,627	530
1952	183,389	256,745	218,233	598
1953	166,356	232,898	197,964	542
1954	166,379	232,931	197,991	542
1955	149,795	209,713	178,256	488
1956	149,262	208,967	177,622	487
1957	144,017	201,624	171,380	470
1958	134,827	188,758	160,444	440
1959	140,881	197,233	167,648	459
1960	160,079	224,111	190,494	522
1961	171,833	240,566	204,481	560
1962	152,217	213,104	181,138	496
1963	155,001	217,001	184,451	505
1964	151,372	211,921	180,133	494
1965	186,484	261,078	221,916	608
1966	184,871	258,819	219,996	603
1967	187,567	262,594	223,205	612
1968	199,258	278,961	237,117	650
1969	195,822	274,151	233,028	638
1970	219,396	307,154	261,081	715
1971	163,000	228,200	193,970	531
1972	170,000	238,000	202,300	554
1973	172,000	240,800	204,680	561
1974	95,000	133,000	113,050	310
1975	138,000	193,200	164,220	450
1976	142,000	198,800	168,980	463
1977	150,000	210,000	178,500	489
1978	147,000	205,800	174,930	479
1979	140,000	196,000	166,600	456
1980	130,000	182,000	154,700	424
1981	131,500	184,100	156,485	429
1982	126,600	177,240	150,654	413
1983	132,300	185,220	157,437	431
1984	129,700	181,580	154,343	423
1985	132,300	185,220	157,437	431
1986	122,300	171,220	145,537	399
1987	87,700	122,780	104,363	286
1988	132,400	185,360	157,556	432

Table 2-1

TONS OF TAIL SLAG PRODUCED BY THE COMINCO SMELTER
1894 to 1994
UPPER COLUMBIA RIVER EXPANDED SITE INSPECTION
STEVENS COUNTY, WASHINGTON

Year	Lead (tons)	Blast Furnace Slag (tons)	Tail Slag (tons)	Average Tail Slag per Day (tons)
1989	114,100	159,740	135,779	372
1990	71,800	100,520	85,442	234
1991	96,000	134,400	114,240	313
1992	100,900	141,260	120,071	329
1993	96,130	134,582	114,395	313
1994	109,729	153,621	130,578	358
Total	**11,269,634**	**15,777,488**	**13,410,864**	

Source: Hurst 2003.

Table 2-2

REPORTED SPILLS FROM THE COMINCO SMELTER TO THE COLUMBIA RIVER
1987 TO 2001
ADAPTED FROM ENVIRONMENT CANADA SPILLTRACKER DATABASE
UPPER COLUMBIA RIVER EXPANDED SITE INSPECTION
STEVENS COUNTY, WASHINGTON

Year	Date	Contaminant	Reported Quantity
1987	September 2	Sulphuric acid (50%)	15 metric tons
1988	November 25	Zinc solution (150 grams per liter)	5 metric tons[a]
1989	May 1	Neutral thickener	60,000 liters
	July 16	Gypsum and phosphoric acid	unknown[a]
	July 17	Arsenic	unknown[a]
	August 18	Yellow substance	305 meters long
1990	January 20	Sulphuric acid (93%)	unknown[a]
	March 6	Mercury	14 kilograms
	June 11	Sulphuric acid	909 liters
	August 24	Sulphuric acid	16,000 liters
	September 4	Zinc electrolyte	unknown
1991	January 30	Zinc	576 kilograms
	February 5	Copper sulphate solution	3,000 liters
	February 7	Phosphoric acid	0.9 to 1.8 metric tons
	February 11	Sulfide residue (zinc)	4,546 liters
	March 16	Sulphuric acid	4.54 metric tons
	April 2	Phosphoric acid	15 metric tons
	April 6	Phosphoric acid	1.35 metric tons
	April 13	Sulphuric acid (15%)	1,000 liters
		Sulphuric acid (160 grams per liter)	unknown
	April 21	Zinc return acid (160 grams per liter)	220 liters
	May 13	Zinc slurry	22.7 liters
		Ammonia	90.9 liters
	June 15	Phosphoric acid (weak)	2 metric tons
	June 21	Phosphoric acid	unknown
		Phosphates	6.7 metric tons
	June 24	Phosphoric acid (27%)	2.72 to 3.63 metric tons
	August 1	Coal dust/water	220 liters
	September 9	Furnace oil	50 metric tons
	September 16	Sodium bisulphite (20 liters per minute)	unknown
		Sulphuric acid	132 to 176 liters
	December 7	Zinc electrolyte	881 liters
	December 20	Zinc pressure leach slurry	2,273 liters
1992	March 11	Phosphate	unknown
	April 2	Phosphate	unknown
	April 20	Zinc electrolyte solution	25,000 liters
	April 22	Sulfide leach residue	unknown[a]
	May 23	Zinc electrolyte solution	350 liters[a]
	May 26	Phosphoric acid (21%)	5 metric tons
	July 11	Phosphoric acid	unknown
	July 23	Compressor oil	25 liters
	August 3	Sulphuric acid	unknown[a]
	September 30	Mercury	15 kilograms
	November 3	Sulphuric acid	434 kilograms

Table 2-2

REPORTED SPILLS FROM THE COMINCO SMELTER TO THE COLUMBIA RIVER
1987 TO 2001
ADAPTED FROM ENVIRONMENT CANADA SPILLTRACKER DATABASE
UPPER COLUMBIA RIVER EXPANDED SITE INSPECTION
STEVENS COUNTY, WASHINGTON

Year	Date	Contaminant	Reported Quantity
1992 (cont.)	December 8	Ammonium sulphate	12.3 metric tons
	December 11	Ammonium sulphate	12 metric tons
	December 16	Sulphuric acid (93%)	25 to 30 metric tons
1993	January 5	Mercury	up to 7 kilograms
	January 7	Sulphuric acid (50 grams per liter)	13,000 metric tons
		Zinc sulphate (150 grams per liter)	600 kilograms
	March 14	Ammonia	unknown
	June 10	Mercury	18 kilograms
	July 30	Sulphuric acid	10 metric tons
	September 4	Arsenic (dissolved)	60 to 65 kilograms
	November 3	Cadmium oxide	unknown
	December 9	Arsenic (dissolved)	22 kilograms
1994	February 9	Arsenic	20 kilograms
	February 10	Mercury	1.3 kilograms
	March 5	Chlorine	< 1 kilogram
	June 1	Ammonium sulphate	2 cubic meters
	June 13	Ammonium sulphate	unknown
	July 4	Mercury	< 1 kilogram
	October 5	Ammonia	3,500 kilograms
	October 24	Zinc oxide	unknown
1995	March 10	Dissolved cadmium	70 kilograms
	May 22	Coal dust suspected	unknown
	June 13	Zinc	960 kilograms
	June 25	Sulphuric acid	~1,000 liters
1996	January 17	Sulphuric acid and zinc	40,000 liters
	February 26	Fume lead slurry	3 cubic meters
	February 27	Sodium carbonate	3 cubic meters
		Zinc	0.5 kilogram
		Lead	0.3 kilogram
		Cadmium	0.01 kilogram
	April 7	White solution and foam	unknown
	May 23	White discoloration	unknown
	May 10	Slag	25 metric tons
	November 8	Barren slag	35 metric tons
	December 31	White oxide dust	unknown
1997	March 13	Dissolved cadmium and mercury	3,000 kilograms
	March 25	Dissolved cadmium	22 kilograms
	May 20	Acidic solution	unknown
	July 23	Zinc slurry	500 kilograms
	December 17	Zinc and mercury	700 liters
1998	March 6	Slurry with arsenic	5 cubic meters
	April 7	Barren slag	1 metric ton
	May 3	Cadmium solution	15 kilograms
	June 2	Total arsenic	20.36 kilograms
	August 20	Slag, lead, zinc, water	~25,000 liters

Table 2-2

REPORTED SPILLS FROM THE COMINCO SMELTER TO THE COLUMBIA RIVER
1987 TO 2001
ADAPTED FROM ENVIRONMENT CANADA SPILLTRACKER DATABASE
UPPER COLUMBIA RIVER EXPANDED SITE INSPECTION
STEVENS COUNTY, WASHINGTON

Year	Date	Contaminant	Reported Quantity
1998 (cont.)	October 24	Granulated slag	15 minutes duration
	November 24	Arsenic	20 kilograms
	December 25	Zinc	87 kilograms
		Cadmium	3 kilograms
2000	February 18	Zinc	350 kilograms
		Cadmium compound	10.5 kilograms
2001	May 27	Oil	10 liters

Source: MacDonald 1997; Boyd 2003

[a] Surface spills - potential for groundwater contamination.

Table 2-3

WASHINGTON STATE DEPARTMENT OF ECOLOGY
2001 SAMPLING EVENT
COMPARISON OF METALS IN LAKE ROOSEVELT SEDIMENTS TO TECs and FSQVs
FOR FRESHWATER SEDIMENTS
UPPER COLUMBIA RIVER EXPANDED SITE INSPECTION
STEVENS COUNTY, WASHINGTON

Site Name	Station Number	(mg/kg)					
		Arsenic	Cadmium	Copper	Lead	Mercury	Zinc
Lower Arrow Lake	10	2.0 U	0.47	3.5	11	0.0004 U	26.9
Boundary	1	6.6	**6.7**	**494**	182	0.10	**3730**
Auxiliary Gage	2	5.0	**18.0**	**2210**	324	0.02	**16100**
Goodeve Creek	3	20.0	**16.2**	**2210**	344	0.08	**12200**
Kettle River	4	2.0 U	1.0	16	5	0.0007 U	34
Castle Rock	5	8.3	**7.1**	66	173	**0.68**	**471**
Whitestone Creek	6	13.0	**11.9**	74	285	**1.25**	**952**
Whitestone Creek (duplicate)	6	13.0	**12.4**	76	292	**1.07**	**979**
Sanpoil	7	3.5	1.9	20	19	0.03	70
Swawilla Basin	8	11.0	**12.4**	73	295	**1.25**	**1040**
Grand Coulee Dam	9	9.2	1.8	11	17	0.03	86
Consensus-Based TECs[a]		9.79	0.99	31.6	35.8	0.18	121
FSQVs[b]		57	5.1	390	450	0.41	410

Source: Ecology 2001.

Note: Bold type indicates sample concentration is above the FSQV.

a Guideline used to evaluate the relationship between metals concentrations and the possibility of effects to benthic life. TECs are concentrations below which harmful effects on sediment dwelling organisms are not expected to occur. Underlined type indicates the sample concentration is above the TEC.

b Value used to evaluate potential effects of metals concentrations to benthic life.

Key:

FSQV = Freshwater Sediment Quality Values.
mg/kg = milligrams per kilogram.
TEC = Threshold Effects Concentrations.
U = The analyte was not detected. The associated numerical value is the contract required detection limit.

3. FIELD ACTIVITIES AND ANALYTICAL PROTOCOL

A SQAP for the upper Columbia River ESI activities was developed by WESTON prior to performing the field sampling (WESTON 2001a). The SQAP was based on background information collected by E & E. The SQAP describes the sampling strategy, sampling methodology, and analytical program used to identify hazardous substances potentially present in sediments within the upper Columbia River and the potential impact to targets. A detailed discussion of field activities and analytical protocol for the nine sediment samples collected from the sandbar/beach and boat launch areas at Le Roi/Northport Smelter can be found in the *Upper Columbia River Mines and Mills Preliminary Assessments and Site Inspections Report* (E & E 2002a).

The field sampling event was conducted with the assistance of various organizations and individuals. Mark Munn and Gil Bortleson (retired) of the USGS provided planning and logistical advice to the field crew. Craig Sprankle of the BOR, provided updated information on lake levels and draw down operations. Adeline Fredin of the Colville Confederated Tribes History/Archaeology Department facilitated coordination of the EPA's planned sampling activities with the Colville Confederated Tribes' Archaeology Department. Steve Tromly, archaeologist with the Colville Confederated Tribes' History/Archaeology Department provided archaeology assistance in the field. Ray DePuydt, NPS Archaeologist and Scott Hebner, NPS Natural Resource Specialist, provided archaeology assistance in the field, and reviewed all proposed river sediment sampling locations. Approximately 15 sampling locations were offset in order to avoid known cultural resources. Vaughn Baker, Gig LeBret, and Dan Mason of the NPS made park resources available to the field sampling crew, including provisions for back-up vessels and emergency assistance, and secure overnight equipment storage. Al Johnson of the U.S. Forest Service assisted with sample collection. Dennis Francis of the City of Grand Coulee assisted in locating and providing access to drinking water supply sampling points at the City of Grand Coulee. Sampling was conducted using EPA research vessels (R.V. *Monitor*, and a 17-foot Boston Whaler) operated by Doc Thompson and Dave Terpening of the EPA.

The field event was conducted by WESTON from May 14 to June 28, 2001. In total, 195 samples were collected (Figure 3-1) from the upper Columbia River and potential receptors/targets. Potential receptors/targets may include wetland areas, fisheries, surface water intakes, sensitive

environments, etc. as defined in the EPA *HRS; Final Rule* (EPA 1990). Samples were analyzed for Target Analyte List (TAL) metals, chlorinated pesticides (pesticides)/PCBs, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and total organic carbon (TOC). The samples collected consist of:

Upper Columbia River and its Tributaries

- 49 surface sediment samples between RM 675 and the U.S.-Canada border.
- 110 surface sediment samples from tributaries to the upper Columbia River between RM 675 and the U.S.-Canada border.
- 9 sediment samples from the sandbar/beach and boat launch areas at the Le Roi/Northport Smelter collected by E & E during the June 29, 2001 sampling event.

Grand Coulee Dam

- 3 sediment samples near the Grand Coulee Dam.
- 1 surface water sample from the City of Grand Coulee municipal drinking water system distribution point (CW001) and 1 surface water sample from Lake Roosevelt near the system intake (CW002).

Pend Oreille County and Stevens County (in conjunction with mine and mill site visits)

- 10 sediment/soil samples from locations upstream/upland of mine and mill sites visited in Pend Oreille County and Stevens County.
- 7 surface water samples from tributaries to the lower Pend Oreille River and upper Columbia River.
- 6 soil samples from mine and mill sites visited.

Discussions of analytical results in this report will be limited to only TAL metals results from the sediment samples collected in the upper Columbia River. Tributary sediment sample results are presented in a December 2001 trip report prepared for the EPA by WESTON (WESTON 2001b). A copy of analytical results tables from this report are included in Appendix C. Figures depicting data results of arsenic, cadmium, copper, lead, mercury, and zinc in tributary sediment samples are provided in Appendix D.

Samples near the Grand Coulee Dam were collected to determine the concentration of potential hazardous substances near or at the municipal intake. Since these samples were collected outside the ESI study area (i.e., the U.S.-Canada border to RM 675), they will not be included in the surface water targets discussed in Section 7 of this report. However, analytical data summary tables for these samples are provided in Appendix C. The two surface water samples collected from the City of Grand Coulee

municipal drinking water system distribution point (CW001) and from Lake Roosevelt near the system intake (CW002) did not contain pesticide/PCBs or SVOCs at concentrations above detection limits. The analysis for VOCs revealed the presence of chloroform at 26 micrograms per liter in water sample CW001. The concentration of chloroform and detected metal concentrations were not above existing federal drinking water standards.

A discussion of analytical results for samples collected in conjunction with the Stevens County and Pend Oreille County mine and mill site visits can be found in the *Upper Columbia River Mines and Mills Preliminary Assessments and Site Inspections Report*, dated October 2002 and the *Lower Pend Oreille River Mines and Mills Preliminary Assessments and Site Inspections Report*, dated April 2002 (E & E 2002a; E & E 2002b).

3.1 SAMPLING METHODOLOGY

ESI sample identification, types, and methods of collection are described below. A list of all samples collected for laboratory analysis are contained in Table 3-1. A discussion of the upper Columbia River sediment sample results is contained in Section 6. Photographic documentation of ESI field activities are contained in Appendix E.

3.1.1 Sample Identification

At the request of the EPA, station identification (ID) codes applied in the field were revised for reporting purposes to follow a sequential order from downstream to upstream along the river. Table 3-1 presents the original station codes (listed as the Internal Sample ID) and its corresponding new station code (listed as the Station ID). The sample IDs consist of a two-letter code indicating the station type, followed by a three-digit sequential number. The following station type codes were used:

CS	—	Columbia River sediment
CW	—	Columbia River surface water
TS	—	Tributary sediment
US	—	Tributary sediment/soil (upstream/upland sampling location)
UW	—	Upland surface water
RS	—	Rinsate of sediment sampling equipment
RW	—	Rinsate of water sampling equipment
TB	—	Trip Blank

3.1.2 EPA Contract Laboratory Program Sediment Sampling

Sediment samples were collected from the upper Columbia River, including Lake Roosevelt, during a period of draw down/rapid refill. The mean high water (MHW) or average annual full pool elevation for Lake Roosevelt is 1,290 feet AMSL. All sediment samples from the river were collected from locations below the apparent MHW elevation, as determined by estimated water level elevations and observed shoreline MHW level indicators (e.g., watermarks on shoreline, tree lines). Water levels measured at Grand Coulee Dam during the river sediment sampling period ranged from 1,237.01 feet AMSL on May 14, 2001, to 1,277.88 feet AMSL on June 8, 2001. Many of the sampling locations were subaerially exposed during the sampling event because of the low water levels. Both exposed and submerged sediment samples were collected. The sediment samples were collected from the most downstream locations to the most upstream locations.

All sediment samples were collected using stainless steel sampling equipment, including a petit ponar dredge, hand auger, and/or bowls and spoons. All sampling was conducted in accordance with the procedures outlined in the SQAP (WESTON 2001a).

Submerged stations were sampled using a petit ponar dredge sampler deployed from the EPA research vessel *Monitor*. Sampling with the petit ponar dredge required between one and five grabs to collect the required sample volume. Penetration depths using the dredge ranged from 0 to 5 inches below the sediment surface. The sediment samples at Haag Cove (CS017) and Pingston Creek (CS024) were collected from depth intervals ranging from 18 to 24 inches below the sediment surface. All other sediment samples were collected from 0 to 8 inches below the sediment surface.

Tributary sampling locations were identified based on USGS 7.5-minute series topographic maps. Samples from tributaries were collected using a bowl and spoon. Water depths at tributary sampling locations were generally 0 to 4 inches, but depths up to 12 inches were recorded. Depths of tributary sediment samples ranged from 0.5 to 10 inches below the sediment surface.

Observations of sample material characteristics such as grain size, color, odor, and the presence of debris (including suspected slag material) were noted on a Field Sampling Record Form for each sample (Appendix F). Sample grain size was described according to visually estimated percentages of gravel, sand, silt, and clay.

After the sample containers were filled, the samples were photographed and packed in coolers with ice for shipment to analytical laboratories.

3.2 ANALYTICAL PROTOCOLS

In general, all samples were analyzed in accordance with the methods and procedures specified in the SQAP (WESTON 2001a). A summary of chemical analyses performed on each sample and a summary of sample QA/QC analysis is presented in Appendix G.

3.3 GLOBAL POSITIONING SYSTEM

The locations illustrated in the figures are based on differentially corrected Global Positioning System (GPS) data recorded in the field using NAD 83 datum and on location notes recorded on Field Sample Record forms. A table of corrected GPS coordinates and location notes for each sampling station is provided in Appendix H. Copies of the Field Sample Record Forms for each sample are provided in Appendix F.

3.4 EQUIPMENT DECONTAMINATION AND INVESTIGATION-DERIVED WASTE

Procedures specified in the SQAP (WESTON 2001a) for decontaminating equipment and disposing of investigation-derived waste (IDW) were followed during field activities. Every effort was made to minimize the need for decontamination of sampling equipment through the use of dedicated pre-cleaned sampling equipment (e.g., bowls, spoons); however, the use of non-dedicated sampling equipment (e.g., dredge samplers) was required in some locations, as discussed previously. When used, the non-dedicated sampling equipment was decontaminated prior to each use to avoid sample cross-contamination.

WESTON made every effort to minimize the generation of IDW that could not be disposed of as solid waste. All extra sediment volume collected for a sample remained at the sampling location. Disposable personal protective equipment generated during field activities was double-bagged in plastic garbage bags and disposed of at a solid waste disposal facility. No IDW water was generated during the investigation.

Table 3-1

UPPER COLUMBIA RIVER SEDIMENT SAMPLE SUMMARY TABLE
UPPER COLUMBIA RIVER EXPANDED SITE INSPECTION
STEVENS COUNTY, WASHINGTON

			Sample Identification				Analyses				
Station ID	Station Description	Sample Interval (inches below media surface)	Regional Tracking #	Inorganic CLP #	Organic CLP #	Internal Sample ID	TAL Metals	pesticide/ PCBs	TOC	Sample Date	Sample Time
CS004	Lake Roosevelt near Inchelium	0 - 4"	01204110	MJ08Z0	JX433	CR-005-SD	X	X	X	17-May-01	1000
CS005	Lake Roosevelt at point south of Hall Creek	0 - 4"	01204111	MJ08Z1	JX434	CR-006-SD	X	X	X	17-May-01	1045
CS006	Lake Roosevelt at Mission Point	0 - 4"	01204112	MJ08Z2	JX435	CR-007-SD	X	X	X	17-May-01	1130
CS007	Lake Roosevelt north of Daisy Station	0 - 2 "	01204113	MJ08Z3	JX436	CR-008-SD	X	X	X	17-May-01	1330
CS008	Lake Roosevelt south of Cheweka Creek	0 - 4"	01204114	MJ08Z4	JX437	CR-009-SD	X	X	X	17-May-01	1415
CS009	Lake Roosevelt south of Chalk Grade Point	0 - 7 "	01204115	MJ08Z5	JX438	CR-010-SD	X	X	X	17-May-01	1445
CS010	Lake Roosevelt south of Barnaby Island	0 - 0.5"	01204116	MJ08Z6	JX439	CR-011-SD	X	X	X	17-May-01	1600
CS011	Lake Roosevelt on flats north of Quillisascut Creek	0 - 2 "	01204117	MJ08Z7	JX440	CR-012-SD	X	X	X	17-May-01	1700
CS012	Lake Roosevelt on flats north of Quillisascut Creek	0 - 3 "	01204118	MJ08Z8	JX441	CR-013-SD	X	X	X	18-May-01	1030
CS013	Lake Roosevelt on flats between French Point Rocks and La Fleur Creek	0 - 4 "	01204119	MJ08Z9	JX442	CR-014-SD	X	X	X	18-May-01	1100
CS014	Lake Roosevelt on mid-channel bar east of French Point Rocks	0 - 4 "	01204120	MJ0900	JX443	CR-015-SD	X	X	X	18-May-01	1230
CS015	Lake Roosevelt north of French Point	0 - 8 "	01204121	MJ0901	JX444	CR-016-SD	X	X	X	18-May-01	1330
CS016	Lake Roosevelt on flats North of Bradbury Beach	0 - 1"	01204122	MJ0902	JX445	CR-017-SD	X	X	X	18-May-01	1430
CS017	Lake Roosevelt on flats fronting Haag Cove	0 - 6 "	01204123	MJ0903	JX446	CR-018-SD	X	X	X	18-May-01	1530
CS017	Lake Roosevelt on flats fronting Haag Cove	18-24"	01204124	MJ09E2	JX550	CR-066-SD	X	X	X	18-May-01	1545
CS018	Lake Roosevelt on flats south of Colville River	0 - 6.5 "	01204125	MJ0904	JX447	CR-019-SD	X	X	X	19-May-01	900
CS019	Lake Roosevelt in bay at Colville River mouth	0 - 5 "	01204126	MJ0905	JX448	CR-020-SD	X	X	X	19-May-01	1045
CS020	Lake Roosevelt south of Boise Cascade Log Boom	0 - 4"	01204127	MJ0908	JX451	CR-023-SD	X	X	X	19-May-01	1130
CS021	Lake Roosevelt, Marcus Flats, northwest of Martin Spring Creek	0 - 4"	01214102	MJ0907	JX450	CR-022-SD	X	X	X	21-May-01	1030

Table 3-1

UPPER COLUMBIA RIVER SEDIMENT SAMPLE SUMMARY TABLE
UPPER COLUMBIA RIVER EXPANDED SITE INSPECTION
STEVENS COUNTY, WASHINGTON

			Sample Identification				Analyses				
Station ID	Station Description	Sample Interval (inches below media surface)	Regional Tracking #	Inorganic CLP #	Organic CLP #	Internal Sample ID	TAL Metals	pesticide/ PCBs	TOC	Sample Date	Sample Time
CS022	Lake Roosevelt, Marcus Flats, southwest of Pingston Creek	0 - 4"	01214104	MJ0909	JX452	CR-024-SD	X	X	X	21-May-01	1050
CS023	Lake Roosevelt, Marcus Flats (west bank)	0 < 0.25"	01214106	MJ0910	JX453	CR-025-SD	X	X	X	21-May-01	1200
CS024	Marcus Flats, north of Pingston Creek	18 - 24"	01234124	MJ0BK4	JX804	CR-062-SD	X	X	X	8-Jun-01	945
CS025	Lake Roosevelt on Marcus Flats west of Pingston Creek	0 - 3"	01214108	MJ0911	JX454	CR-026-SD	X	X	X	21-May-01	1245
CS026	Lake Roosevelt, Marcus Flats, south of Marcus Island	0 - 3"	01214114	MJ0914	JX457	CR-029-SD	X	X	X	21-May-01	1415
CS027	Lake Roosevelt, Marcus Flats, east of Kamloops	0 - 4"	01214110	MJ0912	JX455	CR-027-SD	X	X	X	21-May-01	1330
CS028	Lake Roosevelt, Marcus Flats northeast	0 - 2"	01214112	MJ0913	JX456	CR-028-SD	X	X	X	21-May-01	1445
CS029	Lake Roosevelt north of Summer Island	0 - 2"	01214116	MJ0915	JX458	CR-030-SD	X	X	X	21-May-01	1545
CS030	Lake Roosevelt on flats at Evans Campground	0 - 1"	01214118	MJ0916	JX459	CR-031-SD	X	X	X	21-May-01	1645
CS031	Lake Roosevelt east of Snag Cove	0 - 2"	01214120	MJ0917	JX460	CR-032-SD	X	X	X	21-May-01	1800
CS032	Lake Roosevelt on flats south of Bossburg	0 - 1"	01214122	MJ0918	JX461	CR-033-SD	X	X	X	22-May-01	1000
CS033	Lake Roosevelt on flats north of Bossburg	0 - 5"	01214124	MJ0919	JX462	CR-034-SD	X	X	X	22-May-01	1100
CS034	Lake Roosevelt on flats south of North Gorge (east bank)	0 - 1"	01214128	MJ0921	JX464	CR-036-SD	X	X	X	22-May-01	1400
CS035	Lake Roosevelt on flats south of North Gorge (west bank)	0 - 0.25 "	01214126	MJ0920	JX463	CR-035-SD	X	X	X	22-May-01	1200
CS036	Lake Roosevelt east of Flat Creek (north bank)	0 - 2"	01214130	MJ0922	JX465	CR-037-SD	X	X	X	22-May-01	1500
CS037	Lake Roosevelt at China Bar	0 - 2"	01214132	MJ0923	JX466	CR-038-SD	X	X	X	22-May-01	1630
CS038	Lake Roosevelt near navigation light south of Crown Creek	0 - 3"	01214134	MJ0924	JX467	CR-039-SD	X	X	X	23-May-01	1015
CS039	Lake Roosevelt north of Rattlesnake Creek (east bank)	0 - 4"	01214136	MJ0925	JX468	CR-040-SD	X	X	X	23-May-01	1130

Table 3-1

UPPER COLUMBIA RIVER SEDIMENT SAMPLE SUMMARY TABLE
UPPER COLUMBIA RIVER EXPANDED SITE INSPECTION
STEVENS COUNTY, WASHINGTON

			Sample Identification				Analyses				
Station ID	Station Description	Sample Interval (inches below media surface)	Regional Tracking #	Inorganic CLP #	Organic CLP #	Internal Sample ID	TAL Metals	pesticide/ PCBs	TOC	Sample Date	Sample Time
CS040	Lake Roosevelt north of Onion Creek	0 - 2"	01214138	MJ0926	JX469	CR-041-SD	X	X	X	23-May-01	1245
CS041	Upper Columbia River southern tip of island northwest of Onion Creek	0 - 3"	01214140	MJ0927	JX470	CR-042-SD	X	X	X	23-May-01	1330
CS042	Upper Columbia River southern tip of island south of Squaw Creek	0 - 2"	01214142	MJ0928	JX471	CR-043-SD	X	X	X	23-May-01	1400
CS043	Upper Columbia River north of Fivemile Creek	0 - 2"	01214144	MJ0929	JX472	CR-044-SD	X	X	X	23-May-01	1515
CS044	Upper Columbia River on beach at Northport	0 - 4"	01224150	MJ0930	JX473	CR-045-SD	X	X	X	31-May-01	1045
CS045	Upper Columbia River north of Big Sheep Creek	0 - 3"	01224151	MJ0931	JX474	CR-046-SD	X	X	X	31-May-01	1215
CS046	Upper Columbia River south of Steamboat Rock	0 - 1"	01224154	MJ0932	JX475	CR-047-SD	X	X	X	31-May-01	1430
CS047	Upper Columbia River northeast of Steamboat Rock	0 - 1"	01224155	MJ0933	JX476	CR-048-SD	X	X	X	31-May-01	1515
CS048	Upper Columbia River north of Goodeve Creek	0 - 3"	01224157	MJ0934	JX477	CR-049-SD	X	X	X	31-May-01	1630
CS049	Upper Columbia River on point bar southwest of Scriver Creek	0 - 2"	01224160	MJ0935	JX478	CR-050-SD	X	X	X	1-Jun-01	930
CS050	Upper Columbia River south of Tom Bush Creek	0 - 2"	01224162	MJ0936	JX479	CR-051-SD	X	X	X	1-Jun-01	1145
CS051	Upper Columbia River at "Black Sand Beach"	0 - 4"	01224163	MJ0937	JX480	CR-052-SD	X	X	X	1-Jun-01	1230
CS052	Upper Columbia River on boulder bar near border	0 - 3"	01224164	MJ0938	JX481	CR-053-SD	X	X	X	1-Jun-01	1415
NSSL01	Near Northport Smelter	0 - 6"	01264431	MJ0GP0		NSSL01SD	X			28-Jun-01	1315
NSSL02	Near Northport Smelter	0 - 6"	01264432	MJ0GP1		NSSL02SD	X			28-Jun-01	1350
NSSL03	Near Northport Smelter	0 - 6"	01264433	MJ0GP2		NSSL03SD	X			28-Jun-01	1410
NSSL04	Near Northport Smelter	0 - 6"	01264434	MJ0GP3		NSSL04SD	X			28-Jun-01	1420
NSSL05	Near Northport Smelter	0 - 6"	01264435	MJ0GP4		NSSL05SD	X			28-Jun-01	1430
NSSL06	Near Northport Smelter	0 - 6"	01264436	MJ0GP5		NSSL06SD	X			28-Jun-01	1515
NSSL07	Near Northport Smelter	0 - 6"	01264437	MJ0GP6		NSSL07SD	X			28-Jun-01	1530
NSSL08	Near Northport Smelter	0 - 6"	01264438	MJ0GP7		NSSL08SD	X			28-Jun-01	1545
NSSL09	Near Northport Smelter	0 - 6"	01264439	MJ0GP8		NSSL09SD	X			28-Jun-01	1625

Key:

#	= Number.
CLP	= Contract Laboratory Program.
ID	= Identification.
pesticide	= Chlorinated pesticides.
PCB	= Polychlorinated biphenyls.
TAL	= Target analyte list.
TOC	= Total organic carbon.

4. QUALITY ASSURANCE/QUALITY CONTROL

QA/QC data are necessary to determine precision and accuracy of analytical results and to demonstrate the absence of interferences and/or contamination of sampling equipment, glassware, and reagents. Specific QC requirements for laboratory analysis are incorporated in the *USEPA Contract Laboratory Program* (CLP) *Statement of Work* (SOW) *for Inorganics Analysis* ILM04.1 (EPA 2000), *USEPA Contract Laboratory Program Statement of Work for Organics Analysis* OLM04.2 (EPA 1999a), and requirements listed in the other EPA analytical methods and laboratory standard operating procedures. These QC requirements or other equivalent requirements were followed for analytical work performed on the upper Columbia River ESI, unless otherwise noted. This section describes the QA/QC measures taken for the ESI and provides an evaluation of the usability of data presented in this report. A detailed discussion of QA/QC for the nine sediment samples collected from the sandbar/beach and boat launch areas at Le Roi/Northport Smelter can be found in the *Upper Columbia River Mines and Mills Preliminary Assessments and Site Inspections Report* (E & E 2002a).

4.1 LABORATORY ANALYSES

A total of 212 samples (187 soil/sediment, 15 water including 7 QA/QC samples) were submitted to laboratories for analysis. Inorganic analyses of TAL metals were performed at Sentinel, Inc., of Huntsville, Alabama, and at DataChem Laboratories of Salt Lake City, Utah, following CLP SOW ILM04.1 (EPA 2000). Inorganics analyses of TOC were performed by North Creek Analytical (NCA) of Bothell, Washington, following EPA SW-846 Method 9060 (modified). Organics analyses for VOCs, SVOCs, and pesticide/PCBs were performed by Compuchem, Inc., of Cary, North Carolina. Additional pesticide/PCBs analyses were conducted by Mitkem, Inc., of Warwick, Rhode Island. All organics analyses followed CLP SOW OLM04.2 (EPA 1999a).

4.2 QA/QC SAMPLES

QA/QC samples included laboratory duplicate samples, matrix spike (MS) and matrix spike duplicate (MSD) samples at a rate of one duplicate and one MS per 20 samples submitted to CLP laboratories for metals analysis. For organics and TOC analyses, QA/QC samples included MS and

MSD samples at a rate of one MS and one MSD per 20 samples submitted to CLP or commercial laboratories.

4.3 DATA VALIDATION

All data from analyses performed at the CLP laboratories were reviewed and validated by EPA chemists or by chemists from their Environmental Services Assistance Team contractor. In the latter case, EPA chemists provided a QA review of the data deliverables generated by the contractor. Data qualifiers were applied as necessary according to the following guidance:

USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (EPA 1994),
USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (EPA 1999b), and
The Manchester Environmental Laboratory Quality Assurance Manual (rev May 1995).

In the absence of other QC guidance, method-specific QC limits also were utilized to apply qualifiers to the data. The START-2 reviewed EPA data validation reports to check for consistency and to add bias qualifiers as necessary. Results of these reviews and the associated data validation QA memoranda are provided with the laboratory forms in Appendix I.

4.4 SATISFACTION OF DATA QUALITY OBJECTIVES

The laboratory data were reviewed to ensure that the data quality objectives (DQOs) were met for the project. The following EPA guidance document was used to establish DQOs for the project: *Data Quality Objectives Process for Superfund, Interim Final Guidance* (EPA 1993).

4.4.1 Precision and Accuracy

Precision measures the reproducibility of sampling and analytical methodology. Accuracy measures the degree of conformity of a measured or calculated value to its actual or specified value. Precision is defined as the relative percent difference (RPD) between duplicate sample analyses. The laboratory duplicate samples measure the precision of the analytical method (both preparation and analysis), and RPD values are reviewed for each sample delivery group and analyte. The following analytes failed to meet duplicate precision criteria for the indicated number of samples: iron (20 samples), calcium (36 samples), cadmium (16 samples), copper (16 samples), and lead (13 samples).

These sample results were qualified as estimated (J or UJ) based on duplicate sample analysis. Overall, the project DQOs for precision of 85% were met.

Accuracy is measured as the MS and MSD percent recovery (%R) for each analysis. Together, laboratory MS/MSD samples and native spike samples measure the accuracy of the analytical method. The %R values were reviewed for all appropriate sample analyses. The following analytes failed to meet matrix spike recovery for the indicated number of samples: antimony (123 samples), arsenic (27 samples), barium (20 samples), copper (16 samples), lead (29 samples), silver (16 samples), and selenium (28 samples). Overall, the project DQOs for accuracy of 85% were met.

4.4.2 Completeness

Data completeness is defined as the percentage of usable data (usable data divided by total possible data). All laboratory data were reviewed for data validation and usability. All of the data, with the exception of one result for mercury (which was rejected due to low percent solids), were determined to be usable; therefore, the project DQO for completeness of 90% was met.

4.4.3 Representativeness

Data representativeness expresses the degree to which sample data accurately and precisely represent the characteristic of a population, parameter variations at a sampling point, or an environmental condition. The number and selection of samples were determined in the field to accurately account for site variations and sample matrices. The DQOs for representativeness of 85% were met.

4.4.4 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another. Data produced for this project followed applicable field sampling techniques and specified analytical methodology. Therefore, the DQOs for comparability were met.

4.5 LABORATORY AND FIELD QA/QC PARAMETERS

The laboratory data also were reviewed for holding times and blank sample analysis. These QA/QC parameters are summarized below. In general, these parameters were considered acceptable. See Appendix I for sample results that were qualified based on these QA/QC exceedances.

4.5.1 Holding Times

All samples met EPA, Region 10, and method specific holding time criteria.

4.5.2 Initial and Continuing Calibration

With few exceptions, all initial and continuing calibration and check sample acceptance criteria were met. Following are those analytes whose concentrations were qualified as estimated (J) due to QC exceedances: 4-chloroaniline (2 samples), 2,4-dinitrophenol (2 samples), benzo(k)fluoranthene (2 samples), indeno(c,d-1,2,3)pyrene (2 samples), hexaclorocyclopentadiene (2 samples), and pentachlorophenol (2 samples). All atrazine results (4 samples) were rejected based on QC check failure. See Appendix I for sample results that were qualified based on QC exceedances.

4.5.3 Laboratory Blanks

All laboratory blanks met frequency criteria. The following COCs were detected in the laboratory blanks associated with metals and organic analyses:

- Metals - Antimony, arsenic, aluminum, beryllium, cadmium, calcium, copper, iron, lead, manganese, silver, sodium, thallium, and vanadium.
- Organic Compounds - Acetone, methyl acetate, di-n-butylphthalate, and bis(2-ethylhexyl)phthalate.

Any associated sample result less than five times the blank contamination were qualified as not detected (U). Associated sample results were qualified as estimated quantities (J or UJ) if the sample result was less than five times the absolute value of the negative blank concentration. See Appendix I for sample results that were qualified based on laboratory blank contamination.

4.5.4 Trip and Rinsate Blanks

During the ESI, two trip blank samples and five rinsate samples were collected. No analytes were detected above sample quantitation limits (SQLs) in any trip or rinsate blank samples.

5. ANALYTICAL RESULTS REPORTING AND BACKGROUND SAMPLES

This section describes the reporting and methods applied to analytical results presented in Section 6 of this report, and discusses background sediment samples. A list of all samples collected for laboratory analysis is presented in Table 3-1.

5.1 ANALYTICAL RESULTS EVALUATION CRITERIA

Analytical results presented in the data summary tables in Section 6 show all analytes detected above laboratory detection limits in bold type. The analytical results of sediment samples collected from the upper Columbia River project area (i.e., CS004 through CS052) were compared to background concentrations. Analytical results indicating significant concentrations of contaminants in sediment samples with respect to background concentrations are shown underlined and in bold type. The analytical summary tables present all detected analytes; however, this report only discusses those analytes that were detected at significant concentrations. For purposes of this investigation, significant/elevated concentrations are defined, using criteria in Table 2-3 of the EPA *HRS; Final Rule* for determining observed releases (i.e., significant or elevated concentrations), as follows:

- Equal to or greater than the sample's Contract Required Detection Limit (CRDL) or the SQL when a non-CLP laboratory was used; and
- Equal to or greater than the background sample's CRDL or SQL when the background concentration is below detection limits; or
- At least three times greater than the background concentration when the background concentration equals or exceeds the detection limit.

All hazardous substances detected at target locations and meeting evaluation criteria can be used to document an observed release to the target/receptor.

5.2 DATA PRESENTATION

Based on QC data provided by the laboratory, analytical results can be qualified during data validation. The following data qualifiers were used:

B	—	Detected inorganic concentration is below the method reporting limit (MRL)/CRDL but is above the instrument detection limit.
H	—	High bias.
J	—	The analyte was positively identified, but the associated numerical value is an estimated quantity because QC criteria were not met or because concentrations reported are less than the quantitation limit or lowest calibration standard.
K	—	Unknown bias.
L	—	Low bias.
NJ	—	The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.
R	—	QC indicates that data are unusable (compound may or may not be present). Resampling and reanalysis are necessary for verification.
U	—	The compound was analyzed for, but not detected.
UJ	—	The compound was analyzed for, but was not detected; the associated quantitation limit is an estimate because QC criteria were not met.

5.3 BACKGROUND SEDIMENT

For HRS purposes, background sediment samples are typically collected from locations upstream of potential sources of contamination and upstream of areas of known sediment contamination. For purposes of this ESI, EPA identified Lower Arrow Lake in Canada as an ideal location for the collection of background sediment samples (see Figure 2-2). Lower Arrow Lake is upstream of potential sources of contamination to the Columbia River and areas of known sediment contamination south and north of the U.S.-Canada border. Since the Spring of 2001, the U.S. Government made repeated requests to the Canadian Department of Foreign Affairs and International Trade (DFAIT) for permission to conduct sampling at Lower Arrow Lake in Canada. At the time of the field sampling event, a decision from DFAIT still had not been provided. In January 2003, subsequent to the field event, DFAIT communicated its decision refusing this request from the U.S. Government (Appendix J). For this reason, existing data for a sediment sample collected from Lower Arrow Lake by Ecology in May 2001 will be used as the background sediment sample for this report (Ecology 2001; Appendix K).

5.3.1 Background Sample Location and Description

The background sediment sample collected by Ecology from Lower Arrow Lake in Canada was determined to be located at latitude 49°20.379' and longitude 117°52.452' using GPS data (NAD83 datum; see Figure 2-4). The sample was collected 20 feet off the left bank and 0.1 mile upstream of a boat ramp. The depth of water was estimated to be 7 feet (Ecology 2001).

5.3.2 Background Sampling Method

The sediment sample was collected using a 0.1 square meter van Veen grab sampler. The van Veen grab sampler was lowered three times and the top 10 centimeter layer of each grab was removed with a stainless steel spoon or scoop, placed in a stainless steel bowl, and homogenized by stirring. The homogenized sediment was placed in an 8-ounce glass container with a Teflon lid liner. The glass container was precleaned to EPA QA/QC specifications. (Ecology 2001)

Stainless steel implements used to collect the sediment sample were cleaned by washing with Liquinox detergent, followed by sequential rinses with tap water, 10% nitric acid, and deionized water. The equipment was then air-dried and wrapped in aluminum foil. Between-sample cleaning of the van Veen grab sampler consisted of thorough brushing and rinsing with on-site water. (Ecology 2001)

Puget Sound Estuary Protocols procedures (EPA 1996) for collection, preservation, transportation, and storage of the sediment sample were followed in an effort to limit sources of bias. The sediment sample was placed on ice immediately after collection and transported to the Ecology/EPA Manchester Environmental Laboratory (MEL) within two days of collection. Chain-of-custody was maintained throughout the sampling and analysis. (Ecology 2001)

5.3.3 Background Sample Laboratory Analysis

Table 5-1 shows the reporting limits, analytical methods, and laboratories used by Ecology during the May 2001 sampling event. Chemical analysis was conducted by Ecology/EPA MEL in Port Orchard, Washington. Grain size analysis was conducted by Rosa Environmental and Geotechnical Laboratory in Seattle, Washington (Ecology 2001). The sediment sample was analyzed for the metals listed in Table 6-1.

5.3.4 Data Quality

Chemical data relating to the 2001 Ecology study met laboratory QC analysis requirements (Table 5-1). QC samples for the chemical analysis included a laboratory duplicate, one MS, one MSD,

method blanks, and laboratory control samples. A laboratory triplicate analysis was conducted for grain size. (Ecology 2001)

MS recovery values for the metals data were consistently near 100%, indicating little or no bias due to possible sample matrix interference (Ecology 2001).

Replicate field samples were compared to determine the overall precision of the data (sampling techniques and laboratory analysis). The RPD for each replicate was well within the DQO of 25%. (Ecology 2001)

5.3.5 Background Sediment Sample Analytical Results

Analytical results of sediment sample 01198040 collected by Ecology in May 2001 are presented in Table 6-1.

Table 5-1

ANALYTICAL METHODS, REPORTING LIMITS, AND LABORATORIES
UPPER COLUMBIA RIVER EXPANDED SITE INSPECTION
STEVENS COUNTY, WASHINGTON

Analysis	Reporting Limit	Method	Laboratory
Arsenic	4 mg/kg, dry	ICP/AES - EPA 3050B/6010B	Manchester
Cadmium	0.5 mg/kg, dry	ICP/AES - EPA 3050B/6010B	Manchester
Copper	1 mg/kg, dry	ICP/AES - EPA 3050B/6010B	Manchester
Lead	3 mg/kg, dry	ICP/AES - EPA 3050B/6010B	Manchester
Mercury	0.003 mg/kg, dry	CVAA - EPA 7471A/245.5	Manchester
Zinc	0.5 mg/kg, dry	ICP/AES - EPA 3050B/6010B	Manchester
TOC	0.1%	Combustion/CO2 - EPA (1996)	Manchester
Solids	0.1%	Gravimetric - EPA (1996)	Manchester
Grain Size	0.1%	Sieve & Pipet - EPA (1996)	Rosa Environmental

Key:

AES = Atomic emission spectroscopy.
CO2 = Carbon dioxide.
CVAA = Cold vapor atomic absorption spectroscopy.
EPA = United States Environmental Protection Agency.
ICP = Inductively coupled argon plasma.
mg/kg = Milligrams per kilogram.
TOC = Total Organic Carbon.

6. ANALYTICAL RESULTS

The following subsections describe the results of samples analyzed by EPA CLP methods. Analytical results presented in this section were evaluated according to criteria as previously described in subsection 5.1.

6.1 SAMPLE LOCATIONS

A total of 58 sediment samples were collected from the upper Columbia River (CS004 to CS052 and NSSL01SD through NSSL09SD) to determine whether hazardous substances are present in this area of the river at significant concentrations relative to background concentrations. The portion of the river addressed in this report, referred to as the upper Columbia River, extends approximately 70 RMs through northeast Washington from approximately RM 675 near Inchelium, Washington, to the U.S.-Canada border (see Figure 2-2). Four sampling locations were within the Colville Reservation boundaries, 34 locations were within the Lake Roosevelt National Recreation Area, and 20 locations were north of the recreation area. A brief description of each sample location is provided in Table 3-1. Sample locations (except NSSL01SD through NSSL09SD) are presented in Figure 3-1.

The approximate location of sediment samples NSSL01SD through NSSL09SD, collected from the sandbar/beach and boat launch areas along the Columbia River adjacent to the Le Roi/Northport Smelter, are presented in Figure 2-3. The samples were collected within the overland surface water drainage routes identified by E & E. The samples appeared to consist of dark brown to black medium sand. No odor or staining was noted during sample collection.

6.2 ANALYTICAL RESULTS

Table 6-1 presents results for all TAL metals detected and Figures 6-1 and 6-2 provide data results for arsenic, cadmium, copper, lead, mercury, and zinc at each sample point for sample locations CS004 through CS052.

Antimony was detected at significant concentrations at 20 locations ranging from 4.1 mg/kg to 61.3 mg/kg. Arsenic was detected at significant concentrations at 51 locations ranging from 2.8 mg/kg to 42.8 mg/kg. Barium was detected at significant concentrations at 54 locations ranging from 105 mg/kg to

2,440 mg/kg. Cadmium was detected at significant concentrations at 40 locations ranging from 1.5 mg/kg to 11.1 mg/kg. Chromium was detected at significant concentrations at 15 locations ranging from 38.0 mg/kg to 165 mg/kg. Cobalt was detected at significant concentrations at 18 locations ranging from 10.6 mg/kg to 85.7 mg/kg. Copper was detected at significant concentrations at 56 locations ranging from 11.8 mg/kg to 3,300 mg/kg. Iron was detected at significant concentrations at 57 locations ranging from 11,500 mg/kg to 245,000 mg/kg. Lead was detected at significant concentrations at 51 locations ranging from 86.6 mg/kg to 1,590 mg/kg. Magnesium was detected at significant concentrations at 49 locations ranging from 5,190 mg/kg to 26,600 mg/kg. Manganese was detected at significant concentrations at all 58 locations ranging from 181 mg/kg to 4,360 mg/kg. Mercury was detected at significant concentrations at 28 locations ranging from 0.13 mg/kg to 1.7 mg/kg. Potassium was detected at significant concentrations at 40 locations ranging from 1,400 mg/kg to 4,330 mg/kg. Silver was detected at significant concentrations at 25 locations ranging from 2.1 mg/kg to 12.6 mg/kg. Vanadium was detected at significant concentrations in 55 locations ranging from 19.2 mg/kg to 45.0 mg/kg. Zinc was detected at significant concentrations at 55 locations ranging from 84.2 mg/kg to 24,900 mg/kg.

Estimations of grain size were performed visually and recorded at all sediment sampling stations. The grain size estimates indicate that river sampling stations averaged 54% total fine-grained sediment (silt and clay, i.e., "fines"), and 45% total sand. Grain size estimates for sample locations CS004 through CS052 are included in Appendix L.

Previous surveys of the upper Columbia River and Lake Roosevelt have suggested that sediment toxicity may be attributed to metals contamination of sediments (Ecology 2001). Although this sampling investigation did not include bioassay tests on river sediments, it is worth comparing the ESI metals concentrations to sediment quality values and guidelines as provided in Table 6-2 for arsenic, cadmium, copper, lead, mercury, and zinc. Although there are no Washington standards or EPA national criteria for metal contamination in freshwater sediments, there have been many different freshwater sediment quality guidelines created in the U.S. In Table 6-2, select ESI TAL metals results are compared to FSQVs for metals in Washington and to Consensus-Based TECs for freshwater sediments. FSQVs and TECs represent different analytic approaches to evaluate the relationship between metals concentrations and the possibility of effects to benthic life (Johnson et al. 2001, Serdar et al. 2000).

The Washington FSQVs are guidelines, not standards. The FSQVs were derived by analyzing freshwater bioassay and chemistry data sets collected in Washington, and by reviewing freshwater and marine sediment criteria developed in Canada and the U.S., including Washington standards for marine

waters. The creators of the FSQVs concluded that, when applied to freshwater, the existing sediment management standards for marine waters provided the best mix of sensitivity and efficiency in predicting effects to the bioassay organism *Hyalella azteca* and essentially minimum chemical concentrations expected to cause adverse effects on biological resources. (Ecology 2001)

TECs are consensus-based standards derived from existing sediment quality guidelines (SQGs) that have been established for the protection of sediment-dwelling organisms. The consensus-based approach involves collecting, evaluating, and grouping existing standards. Consensus-based standards are then calculated by determining the geometric mean of the grouped SQGs. The geometric mean, rather than the arithmetic mean, is calculated because it provides an estimate of central tendency that is not unduly affected by outliers and because the SQGs may not be normally distributed. As the term implies, consensus-based SQGs are intended to reflect the agreement among the various SQGs by providing an estimate of their central tendency. TECs are intended to identify contaminant concentrations below which harmful effects on sediment-dwelling organisms are unlikely to be observed. (MacDonald et al. 2000).

Table 6-1

UPPER COLUMBIA RIVER SEDIMENT SAMPLES ANALYTICAL RESULTS DATA SUMMARY
UPPER COLUMBIA RIVER EXPANDED SITE INSPECTION
STEVENS COUNTY, WASHINGTON

EPA Sample ID		01204110	01204111	01204112	01204113	01204114	01204115	01204116	01204117	01204118
CLP Inorganic ID		MJ08Z0	MJ08Z1	MJ08Z2	MJ08Z3	MJ08Z4	MJ08Z5	MJ08Z6	MJ08Z7	MJ08Z8
CLP Organic ID		JX433	JX434	JX435	JX436	JX437	JX438	JX439	JX440	JX441
Station Location ID	Background	CS004	CS005	CS006	CS007	CS008	CS009	CS010	CS011	CS012
Metals (mg/kg)										
Aluminum		13700	12100	4430	4700	8240	7440	21200	14300	14300
Antimony	4 UJ	1.5 JL	1.6 JB	0.76 UJK	0.85 UJK	0.97 JB	0.65 UJK	0.63 UJK	3.6 JB	3.3 JB
Arsenic	2.0 U	7.7 U	8.1 U	2.2 U	4.0 U	5.1 U	6.6	5.0	13.7	14.9
Barium	27.2	230	269	42.2 JB	57.4	105	61.1	227	512	596
Cadmium	0.46	3.6	4.0	0.12 JB	0.33 JB	0.73 JB	0.25 JB	4.4	8.1	9.4
Calcium		5970	7670	4420	2510	13200	3350	4920	14100	15900
Chromium	12.0 J	30.1	29.8	8.8	15.7	23.3	20.4	14.0	35.7	35.9
Cobalt	2.1	8.5 JB	8.1 JB	3.3 JB	3.6 JB	6.9 JB	6.7 JB	5.8 JB	9.4 JB	9.4 JB
Copper	4	48.5 JL	41.6 JL	10.4 JL	11.8 JL	22.5 JL	21.9 JL	33.9 JL	91.7 JL	86.8 JL
Iron	3650 J	23400	22300	8630	14400	16600	16500	14300	28300	29600
Lead	12	219	238	6.2	21.5	24.4	16.7	86.6	464	535
Magnesium	1690 J	6990	7720	3140	2760	5990	4860	3220	11200	12400
Manganese	47.0	719	533	181	267	376	250	347	808	698
Mercury	0.0004 U	0.66	0.49	0.06 U	0.07 U	0.08 U	0.05 U	0.14	1.7	0.97
Nickel	13.4	24.6	24.1	9.6 JB	10.5 JB	21.0	21.0	14.4	27.0	27.4
Potassium	447 J	2570 JL	2230 JL	763 JB	672 JB	1770 JL	1070 JB	1400 JL	2520 JL	2500 JL
Selenium	5.0 U	1.3 U	1.2 U	0.87 U	0.96 U	1.1 U	0.74 U	0.72 U	1.5 U	1.4 U
Silver	0.5 UJ	1.7 JB	1.6 JB	0.48 JB	0.71 JB	0.94 JB	0.85 JB	0.76 JB	2.7 JB	2.7 JB
Sodium		345 JB	359 JB	197 JB	200 JB	289 JB	231 JB	287 JB	406 JB	429 JB
Thallium	5.0 U	1.5 U	1.4 U	0.99 U	1.1 U	1.3 U	0.85 U	0.82 U	1.7 U	1.7 U
Vanadium	5.93	36.9	36.2	17.3	27.7	32.0	27.9	26.7	39.9	40.6
Zinc	27	523	600	36.8	77.9	99.0	90.9	230	1060	1210

Table 6-1

UPPER COLUMBIA RIVER SEDIMENT SAMPLES ANALYTICAL RESULTS DATA SUMMARY
UPPER COLUMBIA RIVER EXPANDED SITE INSPECTION
STEVENS COUNTY, WASHINGTON

EPA Sample ID		01204119	01204120	01204121	01204122	01204124	01204125	01204126	01204127	01214102
CLP Inorganic ID		MJ08Z9	MJ0900	MJ0901	MJ0902	MJ09E2	MJ0904	MJ0905	MJ0908	MJ0907
CLP Organic ID		JX442	JX443	JX444	JX445	JX550	JX447	JX448	JX451	JX450
Station Location ID	Background	CS013	CS014	CS015	CS016	CS017	CS018	CS019	CS020	CS021
Metals (mg/kg)										
Aluminum		12800	15400	9120	13600	15600	8180	11900	6670	12800
Antimony	4 UJ	3.2 JB	4.1 JL	1.5 JB	1.5 JB	0.72 UJK	1.7 JL	2.1 JL	5.4 JB	3.6 JL
Arsenic	2.0 U	19.0	12.3	6.2	8.5	2.8	7.8	4.5 JB	6.8	9.5
Barium	27.2	755	468	229	261	175	422	231	180	364
Cadmium	0.46	11.1	7.5	3.4	3.8	0.43 JB	4.9	1.4 JB	1.8 JB	6.5
Calcium		27000	12100	7040	7150	5560	12400	9340	7630	8230
Chromium	12.0 J	25.9	38.0	21.1	28.6	9.4	18.9	20.4	17.0	33.1
Cobalt	2.1	7.4 JB	10 JB	5.9 JB	8.7 JB	4.0 JB	5.4 JB	7.4 JB	5.4 JB	9.2 JB
Copper	4	73.4 JL	111 JL	49.2 JL	73.0 JL	15.6 JL	40.6 JL	41.8 JL	66.7 JL	88.2 JL
Iron	3650 J	26800	29400	16800	23800	11500	17400	20400	15500	25200
Lead	12	841	440	190	162	26.8	232	64.9	72.7	441
Magnesium	1690 J	18100	10300	6130	7240	2970	8970	7000	5610	8200
Manganese	47.0	515	610	294	572	315	337	392	303	673
Mercury	0.0004 U	1.6	1.0	0.54	0.31	0.06 U	0.43	0.14 U	0.13 U	1.2
Nickel	13.4	21.9	28.5	16.5	24.0	9.2 JB	16.6	18.7 JB	13.6 JB	25.9
Potassium	447 J	1970 JL	2680 JL	1630 JL	2290 JL	1060 JB	1490	2020 JB	1270 JB	2440
Selenium	5.0 U	0.83 U	1.7 U	0.76 U	0.84 JB	0.82 U	0.77 U	1.9 U	1.9 U	1.5 U
Silver	0.5 UJ	1.9 JB	2.9 JB	1.4 JB	1.7 JB	0.32 JB	0.78 JB	0.75 JB	1.1 JB	2.0 JB
Sodium		301 JB	490 JB	249 JB	248 JB	381 JB	242 JB	480 JB	426 JB	471 JB
Thallium	5.0 U	0.95 U	1.9 U	0.87 U	0.80 U	0.94 U	0.89 U	2.2 U	2.2 U	1.8 U
Vanadium	5.93	38.5	42.4	25.8	37.2	19.2	24.2	26.7 JB	20.2 JB	35.8
Zinc	27	1460	1000	470	462	84.2	581	250	455	901

Table 6-1

UPPER COLUMBIA RIVER SEDIMENT SAMPLES ANALYTICAL RESULTS DATA SUMMARY
UPPER COLUMBIA RIVER EXPANDED SITE INSPECTION
STEVENS COUNTY, WASHINGTON

EPA Sample ID		01214104	01214106	01234124	01214108	01214114	01214110	01214112	01214116	01214118
CLP Inorganic ID		MJ0909	MJ0910	MJ0BK4	MJ0911	MJ0914	MJ0912	MJ0913	MJ0915	MJ0916
CLP Organic ID		JX452	JX453	JX804	JX454	JX456	JX455	JX456	JX458	JX459
Station Location ID	Background	CS022	CS023	CS024	CS025	CS026	CS027	CS028	CS029	CS030
Metals (mg/kg)										
Aluminum		11600	10400	6810	9920	8000	9090	12400	7150	11200
Antimony	4 UJ	3.4 JB	1.0 JB	1.6 UJK	4.9 JB	4.8 JB	1.3 JB	3.9 JB	1.9 JB	4.7 JB
Arsenic	2.0 U	10.3	4.2	5.8	10.6	9.5	3.4 JB	9.7	7.0	11.1
Barium	27.2	240	190	147	505	375	113	370	342	624
Cadmium	0.46	5.9	1.6	0.10 U	4.3	2.9	0.29 JB	2.8	3.2	7.2
Calcium		7740	5470	162000	21200	16600	4800	16100	11500	20500
Chromium	12.0 J	30.4	25.7	12.9	25.0	21.9	21.1	30.1	17.7	30.6
Cobalt	2.1	7.9 JB	8.2 JB	4.7 JB	7.9 JB	7.7 JB	6.0 JB	9.6 JB	5.0 JB	9.0 JB
Copper	4	67.6 JL	53.9 JL	18.1 JL	120 JL	118 JL	25.0 JL	114 JL	65.7 JL	205 JL
Iron	3650 J	22400	18000	11700	27500	23000	16000	29000	15900	26800
Lead	12	282	93.8	6.7 JL	211	159	21.3	149	208	369
Magnesium	1690 J	7930	6150	5090	13800	11100	5190	11900	7940	14200
Manganese	47.0	392	392	327	528	411	284	589	256	388
Mercury	0.0004 U	0.90	0.25	0.08 U	0.49	0.20	0.09 U	0.17 JB	0.53	1.1
Nickel	13.4	23.2 JB	23.0	14.3	21.4	18.0	16.2	24.8	14.1	23.1
Potassium	447 J	2280 JB	2390	1330 JB	1960 JB	1560 JB	1380 JB	2480	1250	1820
Selenium	5.0 U	2.0 U	0.68 U	1.2 U	1.8 U	1.2 U	1.3 U	1.6 U	0.68 U	1.1
Silver	0.5 UJ	1.5 JB	0.98 JB	0.32 U	2.0 JB	1.8 JB	0.52 JB	1.7 JB	1.5 JB	3.1
Sodium		623 JB	186 JB	377 U	483 JB	354 JB	385 JB	397 JB	200 JB	258 JB
Thallium	5.0 U	2.3 U	0.78 U	1.3 U	2.1 U	1.4 U	1.5 U	1.9 U	0.78 U	0.80 U
Vanadium	5.93	33.7	32.1	16.6 JB	30.5	25.6	29.0	36.7	21.4	33.1
Zinc	27	617	280	42.3	855	940	104	787	600	1250

Table 6-1

UPPER COLUMBIA RIVER SEDIMENT SAMPLES ANALYTICAL RESULTS DATA SUMMARY
UPPER COLUMBIA RIVER EXPANDED SITE INSPECTION
STEVENS COUNTY, WASHINGTON

EPA Sample ID		01214120	01214122	01214124	01214128	01214126	01214130	01214132	01214134	01214136
CLP Inorganic ID		MJ0917	MJ0918	MJ0919	MJ0921	MJ0920	MJ0922	MJ0923	MJ0924	MJ0925
CLP Organic ID		JX460	JX461	JX462	JX464	JX463	JX465	JX466	JX467	JX468
Station Location ID	Background	CS031	CS032	CS033	CS034	CS035	CS036	CS037	CS038	CS039
Metals (mg/kg)										
Aluminum		6940	9410	9240	8720	8540	8790	18900	12400 JL	4950 JL
Antimony	4 UJ	21.5 JL	4.7 JB	7.0 JB	5.7 JB	2.2 JB	10.8 JB	17.2 JL	10.4 JB	3.4 JB
Arsenic	2.0 U	11.5	8.7	13.0	10.7	7.9	10.4	26.9	17.3 JH	9.6 JH
Barium	27.2	533	295	618	391	255	438	1070	603 JK	768 JK
Cadmium	0.46	4.3	3.5	6.9	3.6	2.3	2.8	2.8	2.1	5.3
Calcium		26300	15400	26100	19600	10800	22300	49600	28900 JL	46900 JL
Chromium	12.0 J	29.9	26.4	29.4	25.8	23.4	28.1	59.1	35.1 JL	12.5 JL
Cobalt	2.1	10.7 JB	8.6 JB	9.0 JB	8.6 JB	7.3 JB	10.6	22.3	15.1 JL	4.1 JB
Copper	4	387 JL	150 JL	251 JL	156 JL	76.8 JL	309 JL	1460 JL	823	102
Iron	3650 J	36300	24700	28900	25500	19800	42300	176000	109000 JL	25000 JL
Lead	12	256	165	392	190	112	209	1590	784 JL	289 JL
Magnesium	1690 J	11800	10200	15300	12800	8570	10300	7230	5020 JL	25000 JL
Manganese	47.0	661	481	435	545	467	946	3390	2090 JL	442 JL
Mercury	0.0004 U	0.40	0.19	0.73	0.32	0.16	0.16	0.07 JB	0.13	0.29
Nickel	13.4	16.0	21.1	20.9	19.8	19.1	15.0	10.3	8.5	10.9
Potassium	447 J	1440 JB	1900	1620	1760	1610	1400	3620	2300 JL	883 JB
Selenium	5.0 U	1.6 JB	0.97 JB	1.2	0.69 U	0.68 U	1.4	0.68 U	4.2	0.82 JB
Silver	0.5 UJ	3.4	2.1 JB	3.2	2.2	1.2 JB	2.1	4.0	2.9	0.63 JB
Sodium		374 JB	266 JB	269 JB	207 JB	237 JB	384 JB	1310	723 JB	228 JB
Thallium	5.0 U	1.6 JB	0.84 U	0.92 U	0.79 U	0.78 U	0.81 JB	4.0	2.4	1.1 JB
Vanadium	5.93	23.6	29.4	30.2	28.6	28.3	27.1	39.0	29.5 JL	23.0 JL
Zinc	27	2560	1030	1660	1100	592	3090	24900	13900	1990

Table 6-1

UPPER COLUMBIA RIVER SEDIMENT SAMPLES ANALYTICAL RESULTS DATA SUMMARY
UPPER COLUMBIA RIVER EXPANDED SITE INSPECTION
STEVENS COUNTY, WASHINGTON

EPA Sample ID		01214138	01214140	01214142	01214144	01224150	01224151	01224154	01224155	01224157
CLP Inorganic ID		MJ0926	MJ0927	MJ0928	MJ0929	MJ0930	MJ0931	MJ0932	MJ0933	MJ0934
CLP Organic ID		JX469	JX470	JX471	JX472	JX473	JX474	JX475	JX476	JX477
Station Location ID	Background	CS040	CS041	CS042	CS043	CS044	CS045	CS046	CS047	CS048
Metals (mg/kg)										
Aluminum		6520 JL	6550 JL	9280 JL	15500 JL	21100	4710	17400	17800	18100
Antimony	4 UJ	19.2 JL	17.2 JL	20.7 JL	27.1 JL	53.5	9.9 JB	57.5	45.2	34.9
Arsenic	2.0 U	9.1 JH	8.7 JH	13.9 JH	20.3 JH	25.5	7.6	30.3	21.6	30.3
Barium	27.2	452 JK	495 JK	632 JK	1140 JK	2160	486	1970	1690	1660
Cadmium	0.46	1.9	2.1	1.6	1.6	0.06 U	4.8	0.07 U	0.19 JB	0.06 U
Calcium		24700 JL	28200 JL	26500 JL	46900 JL	69900	54000	57600	66400	58600
Chromium	12.0 J	27.1 JL	32.8 JL	44.8 JL	76.8 JL	142	20.7	135	112	113
Cobalt	2.1	12.0 JL	13.7 JL	17.7 JL	35.2 JL	59.0	8.4 JB	73.5	47.3	33.8
Copper	4	362	451	720	1550	2900 JL	245 JL	2520 JL	2160 JL	2160 JL
Iron	3650 J	37600 JL	48200 JL	79700 JL	137000 JL	239000	28000	176000	178000	179000
Lead	12	172 JL	175 JL	446 JL	1040 JL	316	199	409	417	317
Magnesium	1690 J	9750 JL	9960 JL	5520 JL	5780 JL	5770 JL	26600 JL	5040 JL	10000 JL	6030 JL
Manganese	47.0	743 JL	908 JL	1500 JL	3060 JL	4040	585	3680	3240	3130
Mercury	0.0004 U	0.08 JB	0.07 JB	0.13	0.06 JB	0.05 U	0.06 JB	0.06 U	0.05 U	0.05 U
Nickel	13.4	11.1	10.2	9.6	12.2	17.0	10.4	15.6	14.4	13.0
Potassium	447 J	1330 JL	1260 JL	1740 JL	3750 JL	4300	888 JB	3580	3490	3480
Selenium	5.0 U	1.8	2.1	3.2	4.5	0.68 UJK	0.67 UJK	1.4 JL	0.68 UJK	1.4 JL
Silver	0.5 UJ	2.1	2.2	3.9	5.7	7.5	1.6 JB	10.2	7.4	5.9
Sodium		377 JB	475 JB	666 JB	1660	2210	269 JB	2230	1610	1530
Thallium	5.0 U	1.2 JB	0.78 U	2.3	4.6	0.78 U	0.77 U	0.87 U	0.78 U	0.76 U
Vanadium	5.93	21.5 JL	21.4 JL	26.2 JL	39.2 JL	42.3	22.1	39.1	37.7	36.3
Zinc	27	2770	3760	8710	15000	20100	2430	17500	18200	16500

Table 6-1

UPPER COLUMBIA RIVER SEDIMENT SAMPLES ANALYTICAL RESULTS DATA SUMMARY
UPPER COLUMBIA RIVER EXPANDED SITE INSPECTION
STEVENS COUNTY, WASHINGTON

EPA Sample ID		01224160	01224162	01224163	01224164	01264431	01264432	01264433	01264434	01264435
CLP Inorganic ID		MJ0935	MJ0936	MJ0937	MJ0938	MJ0GP0	MJ0GP1	MJ0GP2	MJ0GP3	MJ0GP4
CLP Organic ID		JX478	JX479	JX480	JX481	NA	NA	NA	NA	NA
Station Location ID	Background	CS049	CS050	CS051	CS052	NSSL01SD	NSSL02SD	NSSL03SD	NSSL04SD	NSSL05SD
Metals (mg/kg)										
Aluminum		18700	8170	21100	11000	6170	13400	15700	17800	19200
Antimony	4 UJ	7.4 JB	20.0	61.3	51.4	18.8 JL	40.1 JL	49.1 JL	44.9 JL	59.4 JL
Arsenic	2.0 U	7.6	11.8	42.8	23.1	7.5	15	19.3	23.9	41.4
Barium	27.2	681	763	2440	989	255	1270	1610	1910	2150
Cadmium	0.46	0.06 U	2.4	0.06 U	0.07 U	1.6	0.81 JB	0.74 JB	1.5	1.7
Calcium		46900	25300	72400	30800	29100 JL	47600 JL	56000 JL	63900 JL	70200 JL
Chromium	12.0 J	64.0	30.2	165	72.0	18	85	103	121	139
Cobalt	2.1	15.0	7.9 JB	85.7	33.4	7.4 JB	34.6	41.1	45.9	54.2
Copper	4	997 JL	444 JL	3300 JL	1330 JL	238 JL	1540 JL	2070 JL	2530 JL	2960 JL
Iron	3650 J	165000	67100	245000	96900	25000	134000	167000	193000	212000
Lead	12	282	309	512	276	230 JK	246 JK	292 JK	388 JK	507 JK
Magnesium	1690 J	5750 JL	8540 JL	5970 JL	3990 JL	12300 JK	6900 JK	5960 JK	5800 JK	5830 JK
Manganese	47.0	2950	1080	4360	1990	477	2540	3140	3630	4130
Mercury	0.0004 U	0.05 U	0.29	0.05 U	0.06 U	0.06 U	0.06 U	0.07 U	0.06 U	0.06 U
Nickel	13.4	8.1 JB	12.5	19.4	13.6	8.4 JB	13.1	14.7	15.8	17.6
Potassium	447 J	3770	1400	4330	2160	1170 JB	2800	3340	3870	4260
Selenium	5.0 U	2.1 JL	1.4 JL	0.68 UJK	1.5 JL	0.85 U	0.91 U	0.91 U	0.89 U	0.86 U
Silver	0.5 UJ	3.7	2.7	12.6	8.5	1.9 JB	7.8	7.8	8.2	10.3
Sodium		1050	385 JB	2630	1000 JB	463 JB	1430	1760	1960	2400
Thallium	5.0 U	0.79 U	0.91 U	0.78 U	0.89 U	1.3 U	1.4 U	1.4 U	1.3 U	1.3 U
Vanadium	5.93	38.2	28.8	45.0	28.6	20.8	31.7	33.4	36.5	39.8
Zinc	27	15400	4900	22300	8820	1520	10500	13000	15100	16900

Table 6-1

UPPER COLUMBIA RIVER SEDIMENT SAMPLES ANALYTICAL RESULTS DATA SUMMARY
UPPER COLUMBIA RIVER EXPANDED SITE INSPECTION
STEVENS COUNTY, WASHINGTON

EPA Sample ID		**01264436**	**01264437**	**01264438**	**01264439**
CLP Inorganic ID		**MJ0GP5**	**MJ0GP6**	**MJ0GP7**	**MJ0GP8**
CLP Organic ID		**NA**	**NA**	**NA**	**NA**
Station Location ID	**Background**	**NSSL06SD**	**NSSL07SD**	**NSSL07SD**	**NSSL08SD**
Metals (mg/kg)					
Aluminum		**7170**	**7250**	**7180**	**7530**
Antimony	4 UJ	**10.9 JB**	**19.2 JL**	8.6 JB	9.4 JB
Arsenic	2.0 U	**10.9**	**12.3**	**11.1**	**15.9**
Barium	**27.2**	**582**	**762**	**804**	**411**
Cadmium	**0.46**	**3.3**	**4.9**	**3.0**	**3.2**
Calcium		**33300 JL**	**40500 JL**	**38400 JL**	**21300 JL**
Chromium	**12.0 J**	**25.9**	**22.4**	**24.8**	**20**
Cobalt	**2.1**	9.8 JB	8.8 JB	7.9 JB	11.4 JB
Copper	**4**	**349 JL**	**257 JL**	**347 JL**	**357 JL**
Iron	**3650 J**	**44900**	**35900**	**54600**	**54200**
Lead	**12**	**470 JK**	**548 JK**	**597 JK**	**845 JK**
Magnesium	**1690 J**	**13900 JK**	**18700 JK**	**15500 JK**	**6680 JK**
Manganese	**47.0**	**864**	**617**	**1190**	**1170**
Mercury	0.0004 U	0.08 JB	0.11 JB	0.08 JB	**0.29**
Nickel	**13.4**	10.5 JB	**14.7**	9.2 JB	**12.8**
Potassium	**447 J**	**1570**	**1520**	**1450**	**1830**
Selenium	5.0 U	0.99 U	0.91 U	1.1 JB	0.83 U
Silver	0.5 UJ	2.8 JB	2.3 JB	**2.8**	**3.1**
Sodium		807 JB	528 JB	695 JB	870 JB
Thallium	5.0 U	1.5 U	1.4 U	1.4 U	1.3 U
Vanadium	**5.93**	**28.6**	**28.4**	**28.1**	**24.5**
Zinc	**27**	**3920**	**2800**	**5430**	**5280**

Key:

B	= Detected inorganic concentration is below the method reporting limit/contract required detection limit but is above the instrument detection limit.
CLP	= Contract Laboratory Program.
EPA	= United Stated Environmental Protection Agency.
H	= High bias.
ID	= Identification.
J	= The analyte was positively identified, but the associated numerical value is an estimated quantity because quality control criteria were not met or because concentrations reported are less then the quantitation limit or lowest calibration standard.
J	= The analyte was positively identified. The associated numerical result is an estimate. (Ecology 2001)
K	= Unknown bias.
L	= Low bias.
mg/kg	= Milligrams per kilogram.
U	= The compound was analyzed for, but was not detected.
UJ	= The analyte was not detected at or above the reported estimated result. (Ecology 2001)

Table 6-2

COMPARISON OF COLUMBIA RIVER SEDIMENT SAMPLES RESULTS TO TECs AND FSQVs FOR FRESHWATER SEDIMENTS
UPPER COLUMBIA RIVER EXPANDED SITE INSPECTION
STEVENS COUNTY, WASHINGTON

Analyte	Range of Detected Concentrations (mg/kg)	Detection Frequency	Consensus-Based Threshold Effects Concentrations[a] (mg/kg)	Freshwater Sediment Quality Values for Metals in Washington State[b] (mg/kg)
Arsenic	2.8 - 42.8	51/58	9.79	57
Cadmium	1.5 - 11.1	40/58	0.99	5.1
Copper	8.8 - 3,300 JL	58/58	31.6	390
Lead	6.2 - 1,590	58/58	35.8	450
Mercury	0.13 - 1.7	28/58	0.18	0.41
Zinc	34.5 - 24,900	58/58	121	410

[a] Guideline used to evaluate the relationship between metals concentrations and the possibility of effects to benthic life. TECs are concentrations below which harmful effects on sediment dwelling organisms are not expected to occur.

[b] Value used to evaluate potential effects of metals concentrations to benthic life.

Key:

FSQV = Freshwater Sediment Quality Value.
J = The analyte was positively identified, but the associated numerical value is an estimated quantity because quality control criteria were not met or because concentrations reported are less then the quantitation limit or lowest calibration standard.
L = Low bias.
mg/kg = Micrograms per kilogram.
TEC = Threshold Effects Concentration.

7. TARGETS/RECEPTORS SURFACE WATER MIGRATION PATHWAY

7.1 SURFACE WATER MIGRATION PATHWAY

Sediment contamination in the upper Columbia River has been documented in this ESI near the U.S.-Canada border at RM 745, and at sample intervals downstream to Inchelium, Washington at RM 675. The surface water pathway target distance limit (TDL) is defined as the section of the upper Columbia River from RM 745 to RM 675. An observed release to the surface water migration pathway has been documented by sampling and analysis of sediments in the upper Columbia River by the EPA (Section 6).

The average annual precipitation is 17.20 inches in Colville, Washington (WRCC 2002). The 2-year, 24-hour rainfall event for the area ranges from 1.4 to 2.0 inches (NOAA 1973). The flow rate of the Columbia River at the U.S.-Canada border averages 116,500 cubic feet per second (USGS 2002). The upland drainage area is estimated to be 59,700 square miles (USGS 2002).

Surface water is used for domestic purposes, such as irrigation, livestock watering, fire protection, power generation, and commercial purposes within the surface water TDL (E & E 2000). The average number of people per housing unit in Stevens and Ferry counties is 2.64 and 2.49, respectively (USCB 2000). There are four domestic intakes from the Columbia River in Stevens County serving an estimated population of 11 people and seven domestic intakes in Ferry County serving an estimated population of 17 people (WSDH 2002b). One municipal intake is present at Kettle Falls (WSDH 2002b). This intake is not used for drinking water purposes, but is maintained for emergency use to augment fire suppression water supplies (Gassaway 2002). Since other listed surface water intake applications did not specify the source of the surface water, and therefore were not counted in this estimate, the actual number of people served by drinking water intakes on the Columbia River may be higher.

Portions of the upper Columbia River ESI study area are located within the Lake Roosevelt National Recreation Area (i.e., from RM 675 to Onion Creek which is located just south of Northport, Washington). The Lake Roosevelt National Recreation Area, comprising the lake and its shorelines, attracts more than 1 million visitors per year. Recreational activities include boating, swimming, hunting, fishing, and camping. Lake Roosevelt, including the upper Columbia River and its tributaries in the Lake Roosevelt National Recreation Area, support a varied fish community that today is considerably

different from the native fish community of the early 1900s. Changes over time have been caused by the introduction of nonnative species and habitat alterations such as water pollution, the damming of rivers, and reservoir draw downs. Today, there are possibly 28 native and 12 nonnative species of fish that inhabit the recreation area's waters. (DOI 2000)

Between 1990 and 1996, the number of angler trips to Lake Roosevelt ranged from 171,725 to 594,508 per year (DOI 2000). Walleye, rainbow trout, and kokanee were the fish most often caught and harvested by anglers (DOI 2000). The Spokane Tribe of Indians reported in the *Lake Roosevelt Fisheries Monitoring Program 1993 Annual Report* (the latest year available) prepared for the Bonneville Power Administration, that approximately 33,959 fish were harvested from Columbia River within Section 1, which is the section from approximately Little Jim Creek at RM 681 to approximately Ryan Creek at RM 723 (Underwood and Shields 1996). This section is completely within the ESI study area representing a harvest of approximately 40,820 pounds of fish for that year as demonstrated in Table 7-1. More current fish catch harvest data was provided to the EPA by the Lake Roosevelt Fisheries Evaluation Project, a cooperative project amongst the Spokane Tribe of Indians, the Colville Confederated Tribes, and the Washington State Department of Fish and Wildlife (WSDFW). This data indicates that over a 10-week period from July 13, 2002 to September 20, 2002, anglers caught 576 fish from Lake Roosevelt (Lee 2002). These fish consisted of 338 walleye, 221 rainbow trout, and 17 kokanee salmon (Lee 2002).

The WSDFW only tracks sturgeon, salmon, and steelhead in its freshwater sport fishing data. They list that four sturgeon were harvested between Grand Coulee Dam and the Canadian border in 1998. No steelhead or salmon are reported to have been harvested during 1998 (WSDFW 2001).

Tribally-sensitive areas of central importance to the Colville Confederated Tribes include those areas used for ceremonial, cultural, traditional, subsistence, or economic purposes. Tribal lands and the North Half are areas where tribal members utilize the river for subsistence, economic, and cultural purposes. The Colville Confederated Tribes' ancient hunting and fishing camps are located throughout the river as well as the final resting place for the Tribes' ancestors (Stone 2003).

The fisheries, wildlife, and plant materials of the upper Columbia River basin are of central importance to the Tribes' subsistence and culture. The fisheries of Lake Roosevelt provide sustenance to many tribal members, and the economic opportunities presented by the lake in the form of tourist and recreation enterprises are increasingly relied upon by the tribal membership and tribal government. (see PA Petition, Appendix A)

Historically, tribal members consumed large numbers of anadromous and resident fish species (Ray 1972). Salmon were the primary species sought but other species including steelhead trout,

sturgeon, white fish, bull trout, and various rough fish species were captured and consumed (LeCaire 2001). Today, resident fish species play a large role in subsistence fishing by tribal members (LeCaire 2001). Tribal members who fish for subsistence in the "blocked area" above Chief Joseph and Grand Coulee Dams including Lake Roosevelt rely on resident fish species such as rainbow trout (*Oncorhynchus*), kokanee salmon (*Oncorhynchus nerka*), white sturgeon (*Acipenser transmontanus*), walleye (*Stizostedion vitreum*), and white fish (*Prosopium williamsoni*) (LeCaire 2001). Bull trout (*Salvelinus confluentus*), until very recent times, was also used for subsistence and played a significant role in tribal culture (LeCaire 2001). Salmon and the river are still a large part of tribal life and culture (Stone 2003). Tribal members fish for salmon to the base of Chief Joseph Dam and in the Okanogan River (Stone 2003).

Kokanee salmon are of special interest to tribal members because they are a landlocked or resident form of the sockeye salmon that used to migrate past Kettle Falls in great numbers (LeCaire 2001). Kokanee salmon have dwindled to a point that there may not be sufficient numbers to prevent extirpation (LeCaire 2001). Kokanee salmon survive in Lake Roosevelt despite contamination, heavy fishing pressure, and the lack of a natural-production kokanee run (Scholz et al. 1985). Mountain whitefish have always been present in the upper Columbia River basin (Scholz et al. 1985). Mountain whitefish were an integral part of the Columbia River fishery critical to the subsistence of the River Indian bands (Scholz et al. 1985). Mountain whitefish numbers are depressed (Stone 2003). Walleye, a non-native species, illegally introduced to Lake Roosevelt during the late 1950s, have become numerous and are an important fish resource on Lake Roosevelt (Scholz et al. 1985). The walleye fishery is important to the regional economy through fish license sales and through fuel, grocery, motel, and tourism expenditures (Stone 2003).

The Spokane Tribe, the Colville Confederated Tribes, and the WSDFW are the primary agencies directly involved in managing the Lake Roosevelt fisheries. The Spokane Tribe is coordinating the development of a Lake Roosevelt fisheries plan, funded by the Bonneville Power Administration in cooperation with the WSDFW, the Colville Confederated Tribes, and other involved parties. Two kokanee salmon hatcheries are operated by the Spokane Tribe and the WSDFW to support the resident fishery in Lake Roosevelt. The hatcheries produce thousands of kokanee for release into Lake Roosevelt annually. The Spokane Tribe also has initiated a program of rearing rainbow trout at its hatchery for release into Lake Roosevelt. (DOI 2000)

In addition to the hatchery operations, there are numerous rainbow trout pens on Lake Roosevelt. These fish-rearing pens provide thousands of trout annually to support the recreational fishery (DOI

2000). The resident rainbow trout fishery is managed as a "put and take" fishery supported by various Bonneville Power Administration-funded projects and hatcheries (with the exception of the Sanpoil River adfluvial rainbow trout; Stone 2003). The success of this project in providing catchable-size rainbow trout resulted in its expansion to more than 30 net pens in several locations on Lake Roosevelt by 1995 (DOI 2000). In addition, some of the net pens are now being used to rear kokanee before release (DOI 2000).

Three species protected under the Endangered Species Act are present in or along the upper Columbia River. Of these, peregrine falcons (*Falco peregrinus*) are endangered, and the bald eagle (*Haliaeetus leucocephalus)* and bull trout (*Salvelinus confluentus)* are threatened. The WSDFW also lists peregrine falcons as endangered and the bald eagle as threatened. (DOI 2000)

Peregrine falcon nests have been found in the areas surrounding the Lake Roosevelt Reservoir. Use of the area by peregrine falcons normally occurs during spring and fall migrations. Peregrine falcon foraging and nesting habitats are usually associated with tall cliffs near water. Their diet consists primarily of waterfowl, shorebirds, and passerine species commonly found on and around lakes and streams. (DOI 2000)

The U.S. Fish and Wildlife Service has guidance policies for conducting activities within a 400-meter zone of sight avoidance distance for disturbing activities to nesting bald eagles (USFWS 1986). The recommended policy of work in the impact zone of the wintering bald eagle period is late November to March on Lake Roosevelt (LRNRA Files 2000 and CCT Survey of 2000 Maureen Murphy). More than 21 bald eagle nests are in the vicinity of the project area and bald eagles appear to be becoming more productive each year. A maximum of 15 territories have been occupied in any one year. Bald eagle habitat is usually associated with large bodies of water that provide an abundant source of food. Bald eagles feed primarily on fish, waterfowl, and carrion. (DOI 2000)

Bull trout historically occupied a vast geographic area of the Columbia River (DOI 2000). Today the remaining populations are isolated and remnant (DOI 2000). Native bull trout have declined significantly in the last 10 years, in part due to predation by and competition with introduced species such as walleye (DOI 2000). No bull trout hatcheries are present on the Columbia River or its tributaries between the U.S.-Canada border and RM 675 (Buckley 2003). Further, no efforts have been made to reintroduce bull trout into this segment of the river (Buckley 2003). A representative from the U. S. Fish and Wildlife Service stated that any bull trout found in this segment of the river would be wild and therefore protected under the endangered species act (Buckley 2003). Bull trout typically migrate from lakes in the fall to spawn in clear streams with flat gradient, uniform flow, and uniform gravel or small

cobble (DOI 2000). Each year a few bull trout have been observed in the Columbia River north of Inchelium, Washington, primarily at the mouths of tributaries to the Columbia River (Scholz 2003). Adult kokanee trapping in Big Sheep Creek documented the presence of two adult bull trout in spawning condition during the fall 2000 (LeCaire 2001). The presence of juvenile bull trout was recorded during 1990 in Onion Creek (LeCaire and Peone 1999). A bull trout was documented at Hawk Creek by Eastern Washington University (Scholz 2001).

The white sturgeon is listed by the Colville Confederated Tribes as a protected sensitive species due to its cultural importance and its serious decline in Lake Roosevelt. In January 2001, the Colville Confederated Tribes' Colville Business Council approved and enacted a resolution for the total closure of all white sturgeon fisheries in all waters within the exterior boundaries of the Colville Reservation. (Cawston 2001)

Additional sensitive environments within the surface water TDL include 5.97 linear miles of wetland frontage (USFWS various dates).

Table 7-1

1993 FISH HARVEST DATA
UPPER COLUMBIA RIVER EXPANDED SITE INSPECTION
STEVENS COUNTY, WASHINGTON

Species	Numbers Harvested	Average Weight (pounds)	Harvest in Pounds
Kokanee	27	4	108
Rainbow trout	7,071	2	14,142
Walleye	26,232	1	26,232
Smallmouth bass	267	0.6	160
Sturgeon	66	Not Available	----
Other species	296	0.6	178
Total	**33,959**		**40,820**

Source: Underwood and Shields 1996.

8. CONCLUSIONS AND RECOMMENDATIONS

In the spring and summer of 2001, the EPA and its authorized contractors conducted an investigation of hazardous substance contamination in the upper Columbia River beginning near Inchelium, Washington, and extending approximately 70 RMs upstream to the U.S.-Canada border. The site investigation involved an evaluation of 58 sediment samples collected along intervals within the upper Columbia River. The evaluation of the technical data was conducted using the EPA HRS model criteria as described in subsection 5.1 of this report.

Analytical data show that widespread contamination is present in lake and river sediments throughout the upper Columbia River between Inchelium, Washington, and the U.S.-Canada border. An evaluation of the analytical data relative to background sediment shows elevated concentrations of arsenic, cadmium, copper, lead, mercury, and zinc in the majority of samples ranging from 48% of all samples for mercury to 97% of all samples for copper. The area of elevated contamination extends from sample point CS004 located near Inchelium, Washington, to sample point CS052 at the U.S.-Canada border and includes sediments within the boundaries of the Colville Confederated Tribes' Reservation (as documented by the presence of contamination in sediment samples CS004, CS005, CS006, and CS010 located within reservation boundaries; Stone 2003). Concentration gradient maps for copper, lead, and zinc are presented as Figures 8-1 through 8-6. These maps demonstrate that the concentrations of these three analytes tend to increase with distance upstream. The highest concentrations of copper and zinc were found near the U.S.-Canada border with elevated concentrations approximately two orders of magnitude over other elevated concentrations located further downstream. Concentrations of cadmium and mercury tend to be highest toward the downstream portion of the study area.

During the 2001 EPA sampling event, several sediment samples collected at the upper Columbia River consisted of a visibly dark glassy sandy mixture characterized by EPA field personnel as slag. Slag is a by-product of the smelting furnaces, principally a black sand-size material, containing glassy particulate matter and metals. The presence of slag in upper Columbia River sediment has been documented by prior studies conducted by other federal and state agencies. Canadian government staff and Cominco personnel observed deposits of slag during a 1991 boat trip into the U.S. conducted for purposes of examining slag and gypsum deposits in back eddy areas and on sand and gravel bars

(BC Environment 1991). The largest deposit in Washington of what appeared to be predominantly slag was observed on the southwest side of a large sand/gravel bar located just north of Northport, Washington. Samples were collected at several locations for analysis (BC Environment 1991).

A previous study by the USGS documented that benthic invertebrate communities in the erosional habitats of the Northport reach of the Columbia River resembled those often associated with contaminated or habitat-degraded areas. Benthic invertebrate communities were relatively low in abundances and diversity. Although it is not possible to state definitively the degree to which elevated trace-element concentrations have influenced the present structure of the benthic community, results from the benthic invertebrate, sediment chemistry, and sediment toxicity parts of this study indicate that concentrations of trace elements may have affected the benthic community. The presence of slag in the erosional habitats of the Northport reach of the Columbia River may also be a factor because slag has filled in interstitial spaces, thereby reducing available habitat. (USGS 1994)

Benthic organism groups found in substrate samples collected from Lake Roosevelt in 1992 include snails, midges, caddisflies, worms, and scuds (Griffith and McDowell 1992). Worms (*Oligochaeta*) can accumulate toxins that are attached to sediment particles that the worms ingest (COA 2003). Accumulation of contaminants in sediments can cause death, reproduction failure, growth impairment, or other detrimental changes in the organisms exposed to these contaminants (COA 2003). The toxins accumulated in worms can be transferred up the food chain to higher predators such as fish (COA 2003). Potential sources of contamination to the upper Columbia River include industries such as mining, milling, smelting, pulp, and others that have discharged hazardous substances into the river. A discussion of operations and processes at the former Le Roi/Northport Smelter in Northport, Washington, the Cominco smelter in Trail, B.C., and the Celgar Pulp Mill in Castlegar, B.C., is included in subsection 2.3. A discussion of active, inactive, and abandoned mines and mills in Stevens County and Pend Oreille County can be found in separate reports (E & E 2002; E & E 2001).

Other potential sources of contamination to the river include permitted waste discharges in the Columbia River from the municipal wastewater treatment facilities in Castlegar and Trail, B.C., seepage from an old landfill site and an old arsenic storage site located upstream of the Cominco smelter, and the wastes from the cities of Colville and Chewelah, Washington, discharged into the Colville River tributary. (G3 Consulting 2001b)

Results of the EPA site investigation indicate that the Cominco smelter in Trail, B.C., is a primary source of contamination to the upper Columbia River (G3 Consulting 2001b). Smelter operations have been underway in Trail, B.C., since 1896 with the direct discharge of slag into the

Columbia River (G3 Consulting 2001b). In late-1996, the B.C. Ministry of Environment, Land, and Parks prohibited continued discharge of slag into the Columbia River, however; slag has continued to be released into the river during upset conditions (MEL&P 1992; MacDonald 1997). Reportedly, up to 145,000 tons of slag, and possibly 186,703 tons of slag (see subsection 2.3.2.2), had been discharged annually which moved downstream to settle out in slower flowing, sandy areas (G3 Consulting 2001b). The environmental effects of slag discharge to the river includes both chemical and physical components (G3 Consulting 2001b). Chemical effects include increased loads of heavy metals and potential bioaccumulation and toxicity problems in river organisms (G3 Consulting 2001b). Physical effects include scouring of plant and animal life from river substrates, damage to gills and soft tissues of aquatic insects and fish, and smothering of habitat and food sources (G3 Consulting 2001b).

Cominco's 1996 environmental report includes a trend graph of metals in effluents from the metallurgical operation from 1980 to 1996. According to the 1996 report, the average discharges for total dissolved metals were as high as 18 kg/d of arsenic, 62 kg/d of cadmium, 200 kg/d of lead, 4 kg/d of mercury, and 7,400 kg/d of zinc. Additionally, fertilizer plant operations contributed up to 4 kg/d of mercury and 350 kg/d of zinc. A new lead smelter was commissioned in 1997 and became fully operational in 1999, reportedly providing improved air emission and effluent treatment controls.

Eleven domestic intakes serving an estimated population of 28 people are located within the area of contamination. Sport, subsistence, and commercial fishing is conducted within the area of actual contamination. The Federal endangered peregrine falcon, and the Federal threatened bald eagle and bull trout use this area of the river. Approximately 5.97 linear miles of wetlands are located within the area of contamination. Sediment contamination is present within the Lake Roosevelt National Recreation Area. The Lake Roosevelt National Recreation Area, comprising the lake and its shorelines, attracts more than 1 million visitors per year. Lake Roosevelt is one of the few large lakes in northeastern Washington that has an abundance of shoreline that is accessible to the public for recreational use. Recreational activities include boating, waterskiing, sailing, swimming, fishing, camping, hiking, picknicking, wildlife watching, and sightseeing.

Between 1990 and 1996, walleye, rainbow trout, and kokanee were the fish most often caught and harvested by anglers in Lake Roosevelt. In 1998, sturgeon were harvested between Grand Coulee Dam and the U.S.-Canada border. The area is also of economic and cultural significance to Native American populations. Tribally sensitive areas of central importance to the tribes include areas used for cultural, ceremonial, traditional, subsistence, and economic purposes. Subsistence fishing constitutes a major portion of some residents' diets.

A 1994 study by the USGS to determine concentrations of mercury and other metals in three fish species (walleye, smallmouth bass, and rainbow trout) found mercury in the walleye samples at concentrations ranging from 0.11 mg/kg to 0.44 mg/kg. While the Federal Food and Drug Administration standard of 1.0 parts per million was not exceeded, the USGS and the WSDH issued a fact sheet summarizing the study and advising the public to limit consumption of Lake Roosevelt walleye (E & E 2000). Currently, the WSDH has health advisories issued for the consumption of walleye, whitefish, and sturgeon from Lake Roosevelt due to mercury and dioxins concerns (WSDH 2002a).

Additional concerns include potential threats to human health posed by contact with slag on the beaches of the upper Columbia River and contact with contaminated sediments exposed during low draw down periods. Routes of human exposure to slag and contaminated sediment include inhalation of airborne particles, dermal contact, and ingestion. There is also a concern of human exposure from ingestion of lake/river water contaminated as a result of contact with slag or contaminated sediments.

Further detailed investigation of the upper Columbia River under CERCLA is recommended, including consideration of the site for proposal to the NPL, based on an evaluation of hazardous substances found in sediment samples collected from the upper Columbia River and based on a review of prior studies conducted documenting elevated levels of metals, dioxins, and furans in sediment samples at numerous locations from the U.S.-Canada border to Lake Roosevelt.

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