United States
Environmental Protection
Agency Region 10

Upper Basin of the Coeur d'Alene River, Bunker Hill Mining and Metallurgical Complex Superfund Site

Site Information Package for National Remedy Review Board

CH2MHILL

March 26, 2010

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Acronyms and Abbreviations

µg/dL	microgram(s) per deciliter
µg/L	microgram(s) per liter
AMD	acid mine drainage
ATSDR	Agency for Toxic Substances and Disease Registry
ARAR	applicable or relevant and appropriate requirement
AWQC	ambient water quality criterion/criteria
BEMP	Basin Environmental Monitoring Program
BLM	Bureau of Land Management
CD	compact disk
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	*Code of Federal Regulations*
CIA	Central Impoundment Area
COC	contaminant of concern
COPC	contaminant of potential concern
COPEC	contaminant of potential ecological concern
CTP	Central Treatment Plant, Kellogg, Idaho
EA	each
EcoRA	Ecological Risk Assessment
EMP	Environmental Monitoring Plan/Program
EP	Elizabeth Park
ESA	Endangered Species Act
ESD	Explanation of Significant Difference(s)
FFS Report	Draft Focused Feasibility Study
FS	Feasibility Study
ft	foot/feet

ft/d	foot per day
gpm	gallons per minute
GRA	General Response Action
HDPE	high-density polyethylene
HHRA	Human Health Risk Assessment
I-90	Interstate 90
ICP	Institutional Controls Program
IDAPA	Idaho Administrative Procedures Act
IDEQ	Idaho Department of Environmental Quality
IDHW	Idaho Department of Health and Welfare
IDWR	Idaho Department of Water Resources
IP	Implementation Plan
lb/day	pounds per day
MCL	maximum contaminant level
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter
MOA	Mine Operations Area
N/A	not applicable
NAS	National Academy of Sciences
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
NPV	net present value
NRRB	National Remedy Review Board
O&M	operation(s) and maintenance
OU	Operable Unit
ppm	parts per million
PRB	permeable reactive barrier
PRG	preliminary remediation goal
PTM	Principal Threat Materials
RADER	Risk Assessment Data Evaluation Report

RAO	remedial action objective
RI/FS	Remedial Investigation/Feasibility Study
RME	reasonable maximum exposure
ROD	Record of Decision
SAIC	Science Applications International Corporation
SCA	Smelter Closure Area
SFCDR	South Fork of the Coeur d'Alene River
SRB	sulfate reducing bioreactor
SVNRT	Silver Valley Natural Resource Trust(ees)
TCD	typical conceptual design
TI	Technical Impracticability
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

A. Summary

This Site Information Package provides the U.S. Environmental Protection Agency's (USEPA's) National Remedy Review Board (NRRB) with information about the Upper Basin of the Coeur d'Alene River and the Bunker Hill Mining and Metallurgical Complex Superfund Site ("the Bunker Hill Superfund Site", or "the Site"). The intent of this information is to assist the NRRB in making advisory recommendations regarding the remedy alternatives described and evaluated in the Draft Focused Feasibility Study Report for the Upper Coeur d'Alene Basin (USEPA, 2010, hereinafter referred to as "the FFS Report") and USEPA Region 10's Preferred Alternative that is identified in this Site Information Package. The Preferred Alternative would provide a final remedy for:

- Human health protection for surface water used for drinking purposes;
- Ecological protection for surface water; and
- Human health and ecological protection for soil, sediments, and source material in locations where remedial actions are taken.

The Preferred Alternative would also provide enhanced protection of human health and the environment for portions of previously selected human health remedies that are vulnerable to erosion and degradation of clean barriers.

Further, the Preferred Alternative is expected to significantly reduce both groundwater contamination levels and the contribution of contaminated groundwater to surface water. However, given the pervasive nature of the subsurface contamination, the Preferred Alternative may not achieve the drinking water standards for groundwater at all locations. USEPA will evaluate future monitoring data to determine whether a Technical Impracticability (TI) waiver may be warranted at locations where groundwater does not achieve drinking water standards.

The Preferred Alternative is based on applicable or relevant and appropriate regulatory requirements to achieve tangible progress toward protection of human health and the environment in this highly contaminated area.

In the summer of 2001, while a Remedial Investigation/Feasibility Study (RI/FS) for the Coeur d'Alene Basin was being completed, the NRRB reviewed information regarding a potential comprehensive remedy for addressing contamination within the Basin (see File B2-1 on the Supplemental Compact Disk [CD] included with this Site Information Package for a copy of the 2001 NRRB Presentation Information [USEPA, 2001b]). Because of cost, schedule, and data uncertainty concerns, USEPA Region 10 proposed an incremental approach to implement necessary remedial actions, which was supported by the NRRB. USEPA Region 10's proposal included actions to address both human health and ecological risks in a Basin-wide context. The NRRB supported actions proposed to address human health risks posed by contaminated residential soil, drinking water, dust, and fish, and recommended that the Region proceed with the first phase of the Basin-wide ecological cleanup, referred to as an interim action. The NRRB stated that a better understanding of

additional work needed to address residual ecological risks in the Basin (beyond the first phase) was necessary before those actions could be supported.

In 2002, USEPA issued a Record of Decision (ROD) for Operable Unit 3 (OU 3) of the Bunker Hill Superfund Site, which included a final remedy for human health in the communities and residential areas, including identified recreational areas, and an interim remedy for ecological concerns (USEPA, 2002). Since the 2001 NRRB Presentation Information was submitted and reviewed, substantial portions of the Basin-wide human health risks have been or are being addressed, and additional technical analyses have been performed on the effectiveness of the existing human health remedies for OUs 1, 2, and 3. Over the last 9 years, significantly more knowledge has been gained about the nature and extent of contamination in the Upper Coeur d'Alene Basin and its effects on sensitive ecological receptors. For example, additional data have been collected during the Environmental Monitoring Program for OU 2, the Basin Environmental Monitoring Program for OU 3, the Coeur d'Alene Basin Remedial Action Monitoring Program, and site-specific studies. While data are collected annually at numerous locations, the most comprehensive, synoptic datasets for surface water quality in the Upper Basin were collected in 1997 and 2008. Given the improved knowledge of site conditions in the Upper Basin and in response to recommendations made by the National Academy of Sciences (NAS) following its review of cleanup activities in OU 3 of the Bunker Hill Superfund Site (NAS, 2005), USEPA has updated its cleanup plan for the Upper Basin. This updated plan will be documented in a forthcoming Proposed Plan and ROD Amendment.

Part A of this NRRB Site Information Package provides general information about the Bunker Hill Superfund Site and the Upper Basin; a risk summary; the remediation goals for the Upper Basin; summaries of the evaluated remedy alternatives and USEPA Region 10's Preferred Alternative; and stakeholder views and support. Part B provides more detailed information about these topics. Figures, tables, and a Supplemental CD are provided following Part B.

1. Site Summary

1.1 Site Name and Location

The Bunker Hill Superfund Site lies within the Coeur d'Alene River Basin. The Site was listed on the National Priorities List (NPL) in 1983 and assigned Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) identification number IDD048340921. The entire Coeur d'Alene River Basin includes the Upper Basin (which comprises areas surrounding the South Fork of the Coeur d'Alene River [SFCDR] and the North Fork of the Coeur d'Alene River); the Lower Basin; Coeur d'Alene Lake; and a portion of the Spokane River where Coeur d'Alene Lake drains into Washington State.

For the purposes of this NRRB Site Information Package, the FFS Report (USEPA, 2010), and the forthcoming ROD Amendment, the portion of the Bunker Hill Superfund Site addressed is the SFCDR portion of the Upper Basin. This is the area of historical mining and industrial activities that is the primary source of downstream metals contamination. The North Fork portion is not included because it has been relatively unaffected by mining activities and is

being addressed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) by other (non-EPA) agencies, primarily the U.S. Forest Service. In the remainder of this Site Information Package, "the Upper Basin" refers solely to the area surrounding the SFCDR.

1.2 Key Site Features and Land Use

The Upper Basin occupies approximately 300 square miles of land surface in the Panhandle of northern Idaho (Figure A-1). The area includes the SFCDR and tributaries downstream to the confluence of the South and North Forks of the river. The area addressed by this Site Information Package, the FFS Report, and the forthcoming ROD Amendment extends approximately 1 mile to the west beyond the confluence of the SFCDR and the North Fork of the Coeur d'Alene River. Figure A-2 provides a map of the Upper Basin.

Land uses in the Upper Basin are a mix of residential, commercial, agriculture, mining, forestry, and recreation. Much of the land is under federal management as National Forest. In the headwater and tributary areas, predominant land uses include mining, mineral processing, and forestry with some urban and residential development. Most people live in communities located along the SFCDR, but there are also small communities and dispersed residences in tributary canyons and gulches. The undeveloped areas of the Upper Basin include upland forests and lowland floodplains with riverine and riparian areas and wetlands. The SFCDR has been channelized along much of its reach by railroads and roads, but its numerous tributaries still provide abundant recreational opportunities.

1.3 Contamination History and Contaminants of Concern

The Bunker Hill Superfund Site has a long history of mining and related metals-processing activities. Mining and smelting in the Coeur d'Alene Basin began more than 100 years ago, and the area became one of the leading silver-, lead-, and zinc-producing areas in the world. Overall, the region surrounding the SFCDR produced over 97 percent of the ore mined in the entire Basin. Approximately 1.2 billion ounces (34,000 tons) of silver, 8 million tons of lead, and 3.2 million tons of zinc were produced. The Bureau of Land Management has identified more than 1,000 mining or milling-related features in the area surrounding the SFCDR. The metals-processing facilities included an electrolytic zinc plant, a lead smelter plant, three sulfuric acid plants, a phosphoric acid plant, and a fertilizer plant.

As a result of past mining, milling, and smelting practices, substantial portions of the Basin contain elevated concentrations of lead, zinc, cadmium, and other metals. Within the Upper Basin, elevated concentrations of metals resulted primarily from the discharge or erosion of over 62 million tons of mill tailings and other mine-generated wastes into rivers and streams which, in turn, carried these wastes into downstream streambeds, floodplains, and shorelines throughout the Upper and Lower Basins. Contaminated media in the Upper Basin include surface water, groundwater, soil, and sediments. Contaminants of concern are metals, particularly lead, arsenic, cadmium, and zinc.

1.4 Operable Units Addressed by this Action

USEPA has identified three OUs at the Bunker Hill Superfund Site. OUs 1 and 2 are located within the Bunker Hill "Box", a rectangular 21-square-mile area surrounding the former

smelter complex and shown in Figures A-1 and A-2. The OUs and their regulatory history are summarized as follows:

- **OU 1: Populated areas of the Box**. A ROD for OU 1 was issued in 1991 (USEPA, 1991a). This ROD focused on addressing human health exposures to lead-contaminated residential soils within the Box communities. Remedial activities have been conducted since 1994 and are nearly complete.
- **OU 2: Non-populated areas of the Box**. A ROD for OU 2 was issued in 1992 (USEPA, 1992). Since its publication, a number of remedy changes and clarifications have been documented in two ROD Amendments (USEPA, 1996b and 2001e) and two Explanations of Significant Differences (USEPA, 1996a and 1998b). Remedial activities are being conducted using a phased approach, and Phase I remedial actions are largely complete.
- **OU 3: All areas of the Coeur d'Alene Basin outside the Box where mining-related contamination is present**. OU 3 extends from the Idaho-Montana border into Washington State, and includes floodplains, communities, lakes, rivers, and tributaries. The 2002 ROD for OU 3 (often referred to as "the Interim ROD") included an interim ecological remedy and a final human health remedy for the communities and residential areas, including identified recreational areas (USEPA, 2002). Remedial activities conducted as part of the selected human health remedy are ongoing, while relatively few ecological cleanup actions have been completed to date.

1.5 Why a ROD Amendment is Needed

A ROD Amendment is needed now to reflect USEPA's significantly increased understanding of Upper Basin human health and environmental exposures and the remedial actions needed to address the associated risks. The hazards posed by mining wastes are not hypothetical or potential future risks. Significant and measurable risks are still posed to humans and the environment and should continue to be addressed. A better understanding of the SFCDR portion of the Upper Basin has been gained over the last 9 years from site investigations, groundwater modeling, research into groundwater-surface water interactions, and ecological studies such that USEPA can now develop effective holistic remedies for both OU 2 and OU 3. USEPA also needs to build on the successful implementation of OU 2 Phase I remedial actions to identify a final remedy for surface water in the Upper Basin. In addition, the ROD Amendment is needed to enhance protection of human health and the environment for previously selected human health remedies that are vulnerable to erosion and degradation of clean barriers.

In parallel with the development of the ROD Amendment, USEPA is also developing an Implementation Plan (IP) to prioritize the actions identified in the ROD Amendment and evaluate the effectiveness of actions taken. This IP is described in more detail in Part B, Section 13. The IP incorporates adaptive management in order to continually focus the cleanup work on those actions that prove to be the most effective. It also provides a logical and documented approach to sequencing the large amount of work identified in the ROD Amendment.

2. Risk Summary

Human health risks were evaluated in the 2001 Human Health Risk Assessment (HHRA) for the Coeur d'Alene Basin (Idaho Department of Health and Welfare [IDHW], 2001), and the results of the HHRA were summarized in the 2001 NRRB Presentation Information (Supplemental CD, File B2-1). An Ecological Risk Assessment (EcoRA) (CH2M HILL and URS Greiner, 2001) was prepared as part of the RI/FS for the Coeur d'Alene Basin, and a focused EcoRA was completed in 2006 to evaluate the effects of lead-contaminated soil on songbirds (CH2M HILL, 2006b). As reported in CERCLA Five-Year Review Reports on the Bunker Hill Superfund Site (USEPA, 2000a, 2000c, and 2005), the human health remedies implemented within the Upper Basin communities are protective and are functioning as designed. However, elevated concentrations of mining-related metals remain in surface water, soil, sediments, and biotic tissues that continue to pose significant risks to the survival and growth of animals and plants. These media also continue to pose risks to human health, particularly in areas used for recreation. The Five-Year Review Reports concluded that if surface water remedies are not instituted to control the persistent transport of metals into the Upper Basin, these exposure risks will continue.

2.1 Human Health Risk Summary

The primary human health concern in the Coeur d'Alene Basin was determined by risk evaluations to be excessive lead in the blood of children and pregnant women. Blood lead levels appeared to be most closely related to lead in house dust, which is affected by lead concentrations in surface soil (TerraGraphics and URS Greiner, 2000). The results of the HHRA for non-lead metals indicated that some exposure areas could pose an unacceptable threat of non-cancer effects for some individuals under reasonable maximum exposure (RME) conditions. The HHRA also concluded that arsenic concentrations in some Basin yard soil may need to be addressed, independent of lead, to reduce risks and hazards. Arsenic presented the highest hazards and was also the only carcinogen. Cancer risk estimates for arsenic exceeded 1×10^{-6} for all individuals in all exposure areas under the RME condition.

2.2 Ecological Risk Summary

The results of the 2001 EcoRA indicated ecological degradation of most watersheds where mining has occurred and of a large portion of the Upper Basin downgradient from mining areas. This degradation has resulted in demonstrated, observable effects in the Upper Basin. If remediation is not conducted, these effects can be expected to continue for the foreseeable future. High concentrations of metals are pervasive in the soil, sediments, and surface water that pose substantial risks to ecological receptors, particularly fish and waterfowl. The overall conclusion is that heavy metals, primarily lead and zinc, present the greatest ecological risks. Because fish and birds are among the more vulnerable receptor classes and are closely connected with the human environment (through recreation), key observations from the EcoRA are summarized below.

Fish

- Approximately 20 miles of the SFCDR and 46 miles of its tributaries have limited and impacted fish populations. Some areas with high metals concentrations have been

observed to be essentially devoid of fish and other aquatic life in areas of mining impacts.

- In addition to elevated concentrations of metals in waters of the Upper Basin, fish tissue has elevated metals concentrations.
- Based on comparison of metals concentrations in surface waters to chronic ambient water quality criteria, growth and reproduction of surviving aquatic life would be substantially reduced in several areas.
- Species density and diversity have been reduced throughout the Basin; habitat fragmentation and destruction prevent a sustainable fishery.
- Impacted species include the native bull trout, a "threatened" species under the Endangered Species Act.
- Some more sensitive fish species (e.g., sculpin) are absent from areas with relatively low metals concentrations.

Birds

- Risks to health and survival posed by least one metal in at least one area were identified for 21 of 24 representative avian species.
- The Upper Basin is a significant source of contaminated sediments that are deposited in the Lower Basin. Waterfowl carcasses found in 1997 and 2009 represented some of the largest documented die-offs since 1924. Deaths by lead poisoning from ingestion of contaminated sediments are expected to continue.
- Risks are posed to fish-eating birds by mining wastes in the Upper Basin; lead and zinc present the greatest threats.
- Songbirds in the Basin are accumulating lead in blood and liver tissue from ingesting lead-contaminated soil at levels that indicate injury to songbirds.

The EcoRA benefitted from numerous site-specific studies that were completed as part of the natural resource damage assessment of the Basin. Biological monitoring work conducted since the EcoRA has also demonstrated that ecological receptors using Upper Basin sediments and soil continue to be exposed to elevated metals above thresholds shown to cause injury. The U.S. Fish and Wildlife Service (USFWS) recommends that remedial actions address environmental management issues associated with sediments and soil, not only with surface water.

3. Remedial Action Objectives and Remediation Goals

The remedial action objectives (RAOs) and remediation goals for the Upper Basin are presented in Part B, Section 7 of this Site Information Package. They provide a basis for evaluating the capability of remedial and response actions to achieve compliance with applicable or relevant and appropriate requirements (ARARs) or to provide a desired level of risk protection. Remedial and response actions evaluated in the FFS Report (USEPA, 2010) included containment, treatment, removal, and disposal to meet RAOs based on

reducing or eliminating exposure to contaminated soil, sediments, and surface water by humans and ecological receptors.

4. Description of Alternatives

The FFS Report (USEPA, 2010) describes and evaluates two kinds of alternatives that were developed to protect human health and the environment.

Remedial alternatives were developed to address the widespread contamination that impacts surface water in the Upper Basin. The FFS Report builds upon the National Oil and Hazardous Substances Pollution Contingency Plan (NCP)-compliant Ecological Alternatives 3 and 4 that were presented in the 2001 FS Report for the Coeur d'Alene Basin (USEPA, 2001d), and incorporates new data and study results obtained over the last 9 years. Remedial alternatives were first developed separately for the Upper Basin portion of OU 3 and for OU 2, and then were combined to produce 10 combined remedial alternatives that address surface water in the Upper Basin. Remedial actions that can be applied incrementally by using an adaptive management approach were favored, as was maximizing the effectiveness of limited resources. Figure B8-1 in Part B, Section 8 illustrates how these remedial alternatives were developed. Together with a No Action Alternative that was included for baseline comparison purposes, a total of 11 remedial alternatives for Upper Basin surface water were evaluated in the FFS Report.

In addition to these remedial alternatives, two separate alternatives—referred to as remedy protection alternatives—were developed and evaluated in the FFS Report with the intention of sustaining and enhancing the existing human health remedies that have been and are being implemented within the Upper Basin. These alternatives focus on preventing, limiting, and/or repairing erosion effects on clean barriers caused by localized flooding and high-precipitation (storm) events.

All of the alternatives evaluated in the FFS Report are summarized below. Expanded descriptions of the process used to generate the alternatives and the elements of each alternative are provided in Part B, Section 8 of this Site Information Package.

Remedial Alternative	Description
No Action Alternative	No Action
Alternative 3+(a)	OU 3 Alternative 3+ (More Extensive Removal, Disposal, and Treatment) and OU 2 Alternative (a) – Minimal Stream Lining
Alternative 3+(b)	OU 3 Alternative 3+ and OU 2 Alternative (b) – Extensive Stream Lining
Alternative 3+(c)	OU 3 Alternative 3+ and OU 2 Alternative (c) – French Drains
Alternative 3+(d)	OU 3 Alternative 3+ and OU 2 Alternative (d) – Stream Lining/French Drain Combination
Alternative 3+(e)	OU 3 Alternative 3+ and OU 2 Alternative (e) – Extensive Stream Lining/French Drain Combination

Remedial Alternative	Description
Alternative 4+(a)	OU 3 Alternative 4+ (Maximum Removal, Disposal, and Treatment) and OU 2 Alternative (a) – Minimal Stream Lining
Alternative 4+(b)	OU 3 Alternative 4+ and OU 2 Alternative (b) – Extensive Stream Lining
Alternative 4+(c)	OU 3 Alternative 4+ and OU 2 Alternative (c) – French Drains
Alternative 4+(d)	OU 3 Alternative 4+ and OU 2 Alternative (d) – Stream Lining/French Drain Combination
Alternative 4+(e)	OU 3 Alternative 4+ and OU 2 Alternative (e) – Extensive Stream Lining/French Drain Combination
Remedy Protection Alternative	**Description**
Alternative RP-1	No Further Action (Post-Event Response)
Alternative RP-2	Modifications to Selected Remedies to Enhance Protectiveness (Remedy Protection Projects)

5. Preferred Alternative

The Preferred Alternative for the Upper Basin of the Coeur d'Alene River comprises Remedial Alternative 3+(d) and Remedy Protection Alternative RP-2. These two components of the Preferred Alternative are discussed in the following sections, including the key factors that led to their identification, how they satisfy the CERCLA threshold evaluation criteria, and how they provide the best balance of tradeoffs with respect to the CERCLA primary balancing evaluation criteria. The two components have been identified following evaluation of the groups of remedial alternatives and remedy protection alternatives described above; therefore, Remedial Alternative 3+(d) is also referred to as "the Preferred Remedial Alternative" (Section 5.1), and Remedy Protection Alternative RP-2 is also referred to as "the Preferred Remedy Protection Alternative" (Section 5.2). The estimated costs of implementing the Preferred Alternative are summarized in Section 5.3.

5.1 Alternative 3+(d), Preferred Remedial Alternative

The Preferred Remedial Alternative for the Upper Coeur d'Alene Basin includes remedial actions both in the Upper Basin portion of OU 3 and in OU 2. The OU 3 and OU 2 components of the Preferred Remedial Alternative are described below along with key factors in their identification, estimated benefits, and implementation considerations.

Description of OU 3 Components and Key Factors in Identification

The Preferred Remedial Alternative for the Upper Basin portion of OU 3 is Alternative 3+, which in the FFS Report (USEPA, 2010) builds upon Ecological Alternative 3 in the 2001 FS Report (USEPA, 2001d). Table B8-2 in Part B, Section 8 summarizes the remedial actions that would be implemented under Alternative 3+, which include the following key elements:

- Extensive excavation of waste rock, tailings, and floodplain sediments, and use of local waste consolidation areas and repositories for disposal of the excavated wastes

- Hydraulic isolation of tailings impoundments and along stream reaches to reduce the flow of contaminated groundwater
- Capping, regrading, and revegetation of waste rock areas
- Collection of contaminated adit discharges, seeps, and groundwater, and treatment using semi-passive methods or at the Central Treatment Plant (CTP) in Kellogg, Idaho
- Stream and riparian improvements in every major Upper Basin watershed
- In the Woodland Park area of Canyon Creek, hydraulic isolation of stream reaches using stream liners and French drains, and source control actions to reduce metals loading to groundwater and surface water

The key factors leading to the preference for Alternative 3+ over Alternative 4+ (which, in the FFS Report, builds upon Ecological Alternative 4 in the 2001 FS Report) included the following:

- Nearly the same improvement in water quality, in terms of a substantial reduction in current dissolved zinc loads to the SFCDR. (This improvement is essentially the same for Alternative 3+ or Alternative 4+, but there are fewer implementability concerns with Alternative 3+.)
- Fewer materials to handle, and decades less time to implement
- Fewer short-term negative impacts on the community because of the shorter cleanup time and associated disruptions, and because less land would be needed for waste consolidation areas and repositories
- Substantially lower cost

Description of OU 2 Components and Key Factors in Identification

The Preferred Alternative for OU 2 is OU 2 Remedial Alternative (d), which includes the following key elements:

- A phased approach to address adit drainage from the Reed/Russell adits within the Milo Gulch watershed
- French drain installation along a gaining reach between the Central Impoundment Area and the SFCDR and extending south to the eastern side of the mouth of Government Gulch
- Direct-discharge pipeline installation from the CTP to the SFCDR so that treated CTP effluent would no longer discharge into Bunker Creek and infiltrate into contaminated subsurface materials.
- Stream liners on Government Creek accompanied by an upstream clean groundwater cutoff wall to divert clean groundwater into the lined stream; a line of groundwater extraction wells at the mouth of Government Gulch; and a conveyance system to transport the intercepted contaminated groundwater to the CTP for treatment

The key factors leading to the preference for OU 2 Alternative (d) over the other remedial alternatives for OU 2 were as follows:

- Significant improvements in water quality in both the SFCDR and Government Creek
- Fewer implementability concerns because it is composed of a targeted set of actions that are directed at the most contaminated areas to achieve the most benefits
- Greatest reduction of toxicity, mobility, or volume through treatment because it would remove the largest mass of metals from surface water, and greatest short-term effectiveness because of its relatively short implementation time
- Relatively high long-term effectiveness in terms of the estimated reduction of dissolved zinc load to the SFCDR
- Relatively low cost

5.2 Alternative RP-2, Preferred Remedy Protection Alternative

Alternative RP-2, the Preferred Remedy Protection Alternative, combines various technology and process options (based on hydrologic and hydraulic analyses) to protect the existing selected human health remedies for OUs 1, 2, and 3 against flood and high-precipitation events up to the 50-year storm event.

The key factors leading to the preference for Alternative RP-2 over Alternative RP-1 included the following:

- Greater long-term effectiveness and permanence by enhancing flooding and surface water controls, thereby decreasing the risk of recontamination and damage to the existing selected remedies due to flooding and uncontrolled surface water flow
- Greater short-term effectiveness because remedy protection actions would reduce the mobility of contaminated sediments through Upper Basin communities, thereby limiting the potential routes of exposure
- Fewer implementability challenges because Alternative RP-2 is technically feasible and would have minimal administrative implementability issues
- Substantially lower cost

5.3 Preferred Alternative Costs

Costs for the two components of the Preferred Alternative for the Upper Basin were developed based upon principles outlined in *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (USEPA, 2000b). Part B, Section 14 of this Site Information Package summarizes the cost estimates, as well as the methodology and assumptions used to develop the cost estimates, for the 11 remedial alternatives identified for the Upper Basin portion of OU 3 and for OU 2, as well as for the two remedy protection alternatives. Table B14-1 in Part B, Section 14 provides an overall summary of the costs for each alternative. Costs are presented as total capital cost, annual average and 30-year net present value (NPV) operation and maintenance (O&M) costs, and total 30-year NPV cost for each alternative. The nominal accuracy of the estimates is –30 percent to +50 percent.

The estimated total costs (30-year NPV) for the two components of the Preferred Alternative—Remedial Alternative 3+(d) and Remedy Protection Alternative RP-2—are $1,290 million and $33.9 million, respectively.

6. Stakeholder Views and Support

USEPA works closely with a wide range of stakeholders, including state, tribal, and local governments and communities, to identify and implement cleanup actions in the Coeur d'Alene Basin. This includes coordination with the Coeur d'Alene Basin Environmental Improvement Project Commission (the Basin Commission), which was established by the Idaho State Legislature under the Basin Environmental Improvement Act (Idaho Administrative Procedures Act [IDAPA] Title 39, Chapter 810). The Basin Commission is composed of federal, state, tribal, and local governmental stakeholders, and its purpose is coordination of cleanup activities, environmental restoration, and related measures in the Basin. USEPA serves as the federal government's representative to the Basin Commission. USEPA will continue to be responsible for seeing that cleanup actions in the Coeur d'Alene Basin meet the goals and requirements of decision documents and CERCLA.

Stakeholder support is based on discussions to date during the development and implementation of the RI/FS for the Coeur d'Alene Basin and the FFS for the Upper Basin, and during multiple workshops. Letters of support for the proposed remedy have been recently provided by key stakeholders and are included in Part B, Section 15 of this Site Information Package. Formal public comment will also be solicited when the Proposed Plan is issued.

1. Site Name, Location, and Brief History

The Bunker Hill Mining and Metallurgical Complex Superfund Site ("the Bunker Hill Superfund Site" or "the Site") was listed on the National Priorities List (NPL) in 1983. The Site was assigned Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) identification number IDD048340921. This section provides background information about the Site's location, characteristics, and mining history prior to its inclusion on the NPL as a Superfund site.

This Site Information Package provides the U.S. Environmental Protection Agency's (USEPA's) National Remedy Review Board (NRRB) with information about the Bunker Hill Superfund Site and the Upper Basin of the Coeur d'Alene River. The intent of this information is to assist the Board in making advisory recommendations regarding the remedy alternatives described and evaluated in the Draft Focused Feasibility Study Report for the Upper Basin of the Coeur d'Alene River (USEPA, 2010, hereinafter referred to as "the FFS Report"), and USEPA Region 10's Preferred Alternative that is identified in this Site Information Package.

This Site Information Package is presented in two parts. Part A summarized information about the Bunker Hill Superfund Site and the Upper Basin of the Coeur d'Alene River; human health and ecological risks; the remediation goals for the Upper Basin; the evaluated remedy alternatives and USEPA Region 10's Preferred Alternative; and stakeholder views and support. Part B will provide more detailed information about these topics. Figures, tables, and a Supplemental Compact Disk (CD) are provided following Part B, Section 16.

1.1 Location

The Bunker Hill Superfund Site lies within the Coeur d'Alene River Basin. The entire Coeur d'Alene River Basin includes the Upper Basin (which comprises areas surrounding the South Fork of the Coeur d'Alene River [SFCDR] and the North Fork of the Coeur d'Alene River); the Lower Basin; Coeur d'Alene Lake; and a portion of the Spokane River where Coeur d'Alene Lake drains into Washington State. For the purposes of this NRRB Site Information Package, the FFS Report (USEPA, 2010), and the forthcoming Record of Decision (ROD) Amendment for the Upper Basin, the portion of the Bunker Hill Superfund Site addressed is the SFCDR portion of the Upper Basin. This is the area of historical mining and industrial activities that is the primary source of downstream metals contamination. The North Fork portion is not included because it has been relatively unaffected by mining activities and is being addressed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) by other (non-USEPA) agencies, primarily the U.S. Forest Service. In the remainder of this Site Information Package, "the Upper Basin" refers solely to the area surrounding the SFCDR.

The Upper Basin occupies approximately 300 square miles of land surface in the Panhandle of northern Idaho (Figure A-1). The area includes the SFCDR and tributaries downstream to the confluence of the South and North Forks of the river. The area addressed by this Site

Information Package, the FFS Report, and the forthcoming ROD Amendment extends approximately 1 mile to the west beyond the confluence of the SFCDR and the North Fork of the Coeur d'Alene River. Figure A-2 provides a map of the Upper Basin. The topographic relief in the Upper Basin ranges from approximately 2,000 to 7,000 feet above mean sea level.

1.2 Mining History

The Bunker Hill Superfund Site has a long history of mining and related metals-processing activities. Mining and smelting within the Coeur d'Alene Basin began more than 100 years ago, and the region became one of the leading silver-, lead-, and zinc-producing areas in the world. The area surrounding the SFCDR produced over 97 percent of the ore mined in the entire Basin (Science Applications International Corporation [SAIC], 1993). Approximately 1.2 billion ounces (34,000 tons) of silver, 8 million tons of lead, and 3.2 million tons of zinc were produced (Long, 1998).

The Bureau of Land Management (BLM) of the U.S. Department of the Interior identified more than 1,000 mining or milling-related features in the region surrounding the SFCDR (BLM, 1999). Several of the features were metals-processing facilities that were constructed at various times, including an electrolytic zinc plant, a lead smelter plant, three sulfuric acid plants , a phosphoric acid plant , and a fertilizer plant.

As a result of past mining, milling, and smelting practices, substantial portions of the Coeur d'Alene Basin contain elevated concentrations of lead, zinc, cadmium, and other metals. Within the Upper Basin, elevated concentrations of metals resulted primarily from the discharge or erosion of mill tailings and other mine-generated waste into rivers and streams. These water bodies, in turn, deposited millions of tons of mine tailings into streambeds, floodplains, and shorelines throughout the Upper and Lower Basins. The history of milling and tailings disposal practices in the Basin is summarized in Table B1-1; some significant details are summarized below.

- Approximately 62 million tons of tailings were discharged to the Coeur d'Alene Basin after mining began.
- Tailings were frequently used as fill material for residential and commercial construction projects.
- Until 1968, tailings tended to be discharged directly into the SFCDR or its tributaries. Most of the tailings were transported downstream, particularly during high-flow events, and deposited as solid tailings or as tailings/sediment mixtures in beds, banks, and floodplain areas. Since 1968, all mill tailings have been placed in impoundments or returned as fill to provide structural support to active mines.
- Mining activities generated large volumes of waste rock and discharged water from mine openings (adits) that contained high concentrations of metals.
- Particulates released to the air from smelting operations contained high concentrations of metals. The particulates were transported by the wind and were deposited throughout the Bunker Hill Box area. (The Bunker Hill "Box" is a 21-square-mile area surrounding the former smelter complex.)

- High concentrations of metals are pervasive in the soil, sediments, surface water and groundwater in the Basin; these metals pose substantial risks to the people, plants, and animals that inhabit the Basin.
- Elevated blood levels in children living in the Basin have been documented for more than 15 years.
- Migratory birds and mammals have died due to ingestion of lead-contaminated soil and sediments in the Basin.
- Contamination from mining activities to surface water, soil, sediments, and biotic tissues have caused increased mortality and decreased survival, growth, and reproduction to various plant and animals, particularly fish and waterfowl (Stratus, 2000; USEPA, 2001c, 2001d).

2. Site Regulatory History, Enforcement Activities, and Remedial Actions

2.1 Operable Unit Descriptions

The Bunker Hill Superfund Site is located within northern Idaho, in sections of the Coeur d'Alene Reservation, and in northeastern Washington. The Site has three Operable Units (OUs)—OUs 1, 2, and 3. The 2001 NRRB Presentation Information (USEPA, 2001b; see Supplemental CD, File B2-1)[1] focused primarily on conditions in OU 3, which was the focus of the Remedial Investigation/Feasibility Study (RI/FS) for the Coeur d'Alene Basin completed in 2001 (USEPA, 2001c, 2001d). As noted in Part B, Section 1.1, the focus of the current 2010 NRRB Site Information Package is on the SFCDR portion of the Upper Basin of the Coeur d'Alene River, which includes OUs 1 and 2 and the Upper Basin portion of OU 3. Each OU is briefly described below.

2.1.1 Operable Unit 1

OU 1 is located within the rectangular 21-square-mile area surrounding the former smelter complex, commonly referred to as the Bunker Hill "Box". The Box is located in a steep mountain valley in Shoshone County, Idaho, east of the city of Coeur d'Alene. Interstate 90 (I-90) bisects the Box and parallels the SFCDR. OU 1 is defined as the *populated areas* of the Bunker Hill Box because it is home to more than 7,000 residents of the towns of Pinehurst, Smelterville, Kellogg, and Wardner, as well as the unincorporated communities of Page, Ross Ranch, Elizabeth Park, and Montgomery Gulch. Residential neighborhoods and the former smelter complex are located on the valley floor. Residences also extend up side gulches and adjacent hillside areas. Populated areas of concern include residential yards, commercial properties, public use areas, and street rights of way. Cleanup activities at the Bunker Hill Superfund Site first began in OU 1 because of the risks posed to human health from exposure to mine and smelter wastes. Current land uses in OU 1 are primarily residential and commercial. Future land uses are expected to remain the same.

2.1.2 Operable Unit 2

OU 2 includes the *non-populated, non-residential areas* of the Bunker Hill Box. These non-populated areas include former industrial areas such as the Mine Operations Area (MOA) in Kellogg; Smelterville Flats (the floodplain of the SFCDR in the western half of OU 2); hillsides, creeks, and gulches; the Central Impoundment Area (CIA), an unlined closed impoundment of tailings, slag, and other wastes; the Central Treatment Plant (CTP), a water treatment facility for acid mine drainage (AMD) and other contaminated water flows from source areas; and the Bunker Hill Mine with its associated AMD. Current land uses in OU 2 are primarily non-residential, industrial, and open space. Future land uses are anticipated to

[1] Additional discussion of the 2001 NRRB Presentation Information is provided on pages A-1 and A-2.

also include recreational, residential (single and multi-family), commercial, and light industrial development.

2.1.3 Operable Unit 3

OU 3 consists of mining-contaminated areas in the Coeur d'Alene Basin outside OUs 1 and 2. These areas are primarily the floodplain and river corridor of the Coeur d'Alene River, Coeur d'Alene Lake, and the Spokane River, as well as those areas where mine wastes have come to be located as a result of their use for road building or for fill and construction of residential or commercial properties. The SFCDR within OU 2 and the non-populated areas of the Pine Creek drainage are both addressed as part of OU 3. Spillage from railroad operations has also contributed to contamination across OU 3.

Since 2002, the focus of remedial activities in OU 3 has been implementation of the human health remedy selected in the ROD for OU 3 (USEPA, 2002), which is ongoing, and multiple prioritized actions to protect environmental receptors—for example, a project to create safe waterfowl feeding areas in the Lower Basin. Current land uses in OU 3 are a mix of residential, commercial, forestry, mining, agricultural, and open space. Future land uses are expected to remain the same.

2.2 CERCLA Investigations, Decision Documents, and Enforcement Summary

Since the Bunker Hill Superfund Site was listed on the NPL, numerous technical reports and decision documents related to the three OUs have been prepared. Key documents include the following:

- RI/FS for OU 1:
  - *Residential Soil Feasibility Study for the Bunker Hill CERCLA Site Populated Areas Remedial Investigation/Feasibility Study* (CH2M HILL, 1991)
- ROD for OU 1:
  - *Record of Decision, Bunker Hill Mining and Metallurgical Complex Residential Soils Operable Unit, Shoshone County, Idaho* (USEPA, 1991a)
- RI/FS for OU 2:
  - *Bunker Hill Superfund Site Remedial Investigation Report, Volumes I, II, and III* (McCulley, Frick, and Gilman, 1992a)
  - *Bunker Hill Superfund Site Feasibility Study Report, Volumes I, II, III, and Associated Technical Memoranda* (McCulley, Frick, and Gilman, 1992b)
- ROD for OU 2:
  - *Record of Decision, Bunker Hill Mining and Metallurgical Complex, Shoshone County, Idaho* (USEPA, 1992) (Although not in the title, this ROD for OU 2 addressed the non-populated areas of the Bunker Hill Superfund Site, as well as those aspects of the populated areas that were not addressed in the 1991 ROD for OU 1.)

  - *Explanation of Significant Differences for Revised Remedial Actions at the Bunker Hill Superfund Site, Shoshone County, Idaho* (USEPA, 1996a)
  - *Amendment to the Record of Decision for the Bunker Hill Mining and Metallurgical Complex (Non-Populated Areas) Superfund Site* (USEPA, 1996b)
  - *Explanation of Significant Differences for Revised Remedial Actions at the Bunker Hill Superfund Site OU 2, Shoshone County, Idaho* (USEPA, 1998b)
  - *Record of Decision Amendment: Bunker Hill Mining and Metallurgical Complex Acid Mine Drainage, Smelterville, Idaho* (USEPA, 2001e)

- RI/FS for OU 3:
  - *Final (Revision 2) Remedial Investigation Report, Coeur d'Alene Basin Remedial Investigation/Feasibility Study* (USEPA, 2001c)
  - *Final (Revision 2) Feasibility Study Report, Final Coeur d'Alene Basin Remedial Investigation/Feasibility Study* (USEPA, 2001d)
- ROD for OU 3 (often referred to as "the Interim ROD for OU 3"):
  - *Record of Decision, The Bunker Hill Mining and Metallurgical Complex Operable Unit 3* (USEPA, 2002)

A list of CERCLA-related enforcement actions through 2001 was compiled in the 2001 NRRB Presentation Information (USEPA, 2001b) that is included in File B2-1 on the Supplemental CD provided with this Site Information Package. The major enforcement actions conducted since then at the Bunker Hill Superfund Site, as well as current principal Potentially Responsible Parties, are summarized below.

- On September 3, 2003, the United States District Court for the District of Idaho resolved the liability phase of the Basin litigation by holding that the Hecla Mining Company, Inc. (Hecla) and Asarco, Inc. were CERCLA responsible parties that are responsible for response costs that the United States has and will incur in connection to the Basin. A second phase of this litigation concerns the amount of response costs owed by responsible entities to the United States.
- On August 9, 2005, Asarco filed for reorganization under Chapter 11 of the Bankruptcy Code in the United States Bankruptcy Court for the Southern District of Texas, Corpus Christi Division.
- On August 1, 2006, the United States filed a bankruptcy proof of claim on behalf of USEPA with the United States Bankruptcy Court for the Southern District of Texas, Corpus Christi Division in the Asarco Chapter 11 bankruptcy.
- On June 5, 2009, the Bankruptcy Court approved five settlement agreements that provided recovery on environmental claims at numerous Superfund sites throughout the country. One of these settlements, the Residual Sites Settlement, resolved USEPA's claims related to the Coeur d'Alene Basin.
- On November 13, 2009, the District Court for the Southern District of Texas, Corpus Christi Division accepted the Bankruptcy Court's Recommendation to confirm a Plan of

Reorganization for Asarco. Pursuant to the Residual Sites Settlement and Asarco's Plan of Reorganization, USEPA recovered approximately $485 million that will be used to perform response actions selected by USEPA in the Coeur d'Alene Basin. Of this amount, approximately $436 million was placed in a Trust that will be used to partially fund cleanup work selected by USEPA, and the remainder was placed in an USEPA special account. Approval of the Plan of Reorganization resolved Asarco's liability in the Basin.

Hecla is the one remaining significant responsible party for the Coeur d'Alene Basin. The United States is pursuing settlement discussions with Hecla.

2.3 Actions Completed at the Bunker Hill Superfund Site

2.3.1 Remedial Actions

To date, remedial activities at the Bunker Hill Superfund Site have focused primarily on human exposure. File B2-2 on the Supplemental CD summarizes the remedial actions that have occurred within the Upper Coeur d'Alene Basin. These actions began initially in the Bunker Hill Box; additional actions in OU 1 are nearly complete, with some still ongoing. In addition, a number of remedial actions conducted in a phased manner have been completed in OU 2. Remedial actions in OU 2 have included but are not limited to:

- Hillside erosion control work, hydroseeding, terracing, and revegetation (over 1,000,000 trees planted since 1992)
- Source removal and creek restoration and reconstruction
- Surface drainage improvements
- Upgrades to the CTP
- Removal and consolidation of approximately 4 million cubic yards of contaminated materials in the Smelter Closure Area (SCA), CIA, and Page repositories
- Demolition of structures at Government Gulch and in the MOA
- Capping of more than 800 acres to eliminate direct exposure to contaminants

Prior to issuance of the ROD for OU 3 (USEPA, 2002), cleanup actions conducted in the portion of OU 3 located within the Upper Basin consisted primarily of removal and consolidation within the Site of the most highly impacted source materials to reduce human health and environmental risks. These removal actions were implemented by mining companies, the Silver Valley Natural Resource Trust (SVNRT), the U.S. Forest Service, USEPA, the Idaho Department of Environmental Quality (IDEQ), and BLM. Removal actions in OU 3 have included the following:

- Removal of approximately 1.4 million cubic yards of contaminated materials from stream banks, mine sites, and floodplains, and placement in repositories at Big Creek, Woodland Park, the Osburn Tailings Pond, Day Rock, and the CIA

- Demolition and disposal of many structures and debris, including the Coeur d'Alene Mill and the Silver Crescent and Charles Dickens Mine sites

Figures B2-1 and B2-2 present timelines of the removal and remedial actions conducted in OUs 2 and 3, respectively.

The RODs listed in Section 2.2, as well as the associated ROD Amendments and Explanations of Significant Differences (ESDs), selected remedies and cleanup actions at all three OUs. Substantial progress has been made towards implementing those selected remedies and actions, including the following cleanup accomplishments:

- CERCLA Five-Year Review Reports prepared to date show that the final selected human health remedies for OUs 1, 2, and 3 have functioned as designed and are protective of human health. For example, the Superfund cleanup actions have resulted in significant and well-documented declines in children's blood lead levels, as measured by blood lead concentrations within the communities where cleanup actions have been implemented (USEPA, 2005).
- Institutional controls have been put into place in the Upper Basin and other areas to ensure the protection of the human health remedies. The Institutional Controls Program (ICP) is administered by the Panhandle Health District and provides permitting and educational services that ensure the sustainability of the human health remedies.
- Phase I remedial work in OU 2 is largely complete. The focus of Phase I was on source removal, containment, and consolidation of extensive contamination from various areas, capping source areas, demolition of structures, development and implementation of an ICP for OUs 1 and 2, and corresponding public health response actions. Phase I work was followed by an evaluation of the effectiveness of the implemented actions and studies of long-term water quality improvements that could provide the basis for selecting appropriate Phase II actions to address water quality issues.

The 2002 ROD for OU 3 selected a final human health remedy for community and residential areas, including identified recreational areas, and an interim remedy for protection of the environment that focuses on improving water quality, minimizing downstream migration of metal contaminants, and improving conditions for fish and wildlife populations. USEPA has conducted a few actions at mine and mill sites that addressed recreational as well as ecological exposures (see File B2-2 on the Supplemental CD). USEPA has also conducted studies evaluating key technical aspects of environmental conditions and remedial approaches.

2.3.2 Studies and Investigations

As part of remedy implementation, studies, information gathering, and the performance of remedial actions have added to a greater understanding of site conditions and risk. The resulting information indicates that it is essential to augment established remedies to ensure continued protection of human health and ecological receptors. In addition, the National Academy of Sciences (NAS) reviewed the OU 3 Coeur d'Alene Basin cleanup and the scientific and technical practices used in developing the human health and ecological risk assessments, remedial planning, and decisionmaking. Given improved knowledge of conditions in the Basin and in response to the findings of the NAS (2005), USEPA is

updating its cleanup plan for the Upper Coeur d'Alene Basin by conducting an FFS and issuing a ROD Amendment. The update considers the specific recommendations of the NAS, which included holistic evaluation of the Upper Basin; developing an improved understanding of the distribution, fate, and transport of dissolved metals in the groundwater and surface water systems; considering groundwater treatment approaches; developing predictive tools to assess remedial action effectiveness; improving the use of the adaptive management approach; and considering impacts of flood events on protective barriers.

A summary of studies and investigations that were conducted within the Upper Basin from 2001 through 2008 is provided in File B2-3 on the Supplemental CD. Since the 2002 ROD for OU 3 was issued (USEPA, 2002), most of the studies and investigations have focused on developing a better understanding of the groundwater system in the Upper Basin, how the surface water and groundwater interact, the fate and transport of metals in the subsurface, and the effectiveness of alternative water treatment processes.

2.4 Ongoing Data Collection Efforts

Since the 2002 ROD for OU 3 was issued, more knowledge has been gained regarding the nature and extent of contamination and its effects on sensitive ecological receptors and potential associated effects on human health. Table B2-1 summarizes ongoing data collection programs within the Upper Basin. Existing programs are primarily associated with the Environmental Monitoring Plan (EMP) for OU 2, the Basin Environmental Monitoring Program (BEMP) for OU 3, and the Coeur d'Alene Basin Remedial Action Monitoring Program. These programs use dynamic parameters and monitoring frequencies that are anticipated to detect or predict potential rates of change in environmental conditions in the Upper Basin.

USEPA has considered and used this information to support the development and evaluation of remedial alternatives that make up the comprehensive approach to address surface water within the Upper Basin.

3. Scope and Role of the FFS and ROD Amendment

3.1 Overview

Over the past year, USEPA and others have been evaluating alternatives to develop a final remedy for:

- Human health protection for surface water used for drinking purposes;
- Ecological protection for surface water;
- Human health and ecological protection for soil, sediments, and source material in locations where remedial actions are taken; and
- Enhancing protection of human health and the environment for portions of previously selected human health remedies that are vulnerable to erosion and degradation of clean barriers.

This has been undertaken in part to address recommendations resulting from the 2001 NRRB Presentation Information (USEPA, 2001b; see Supplemental CD, File B2-1) and from the NAS review (2005) to incorporate improved knowledge of the Upper Basin and the Bunker Hill Box, and to move forward on Phase II cleanup activities in OU 2.

As described in Part B, Section 2, since the RODs for OUs 1, 2, and 3 were issued (and the ROD for OU 2 was amended), data collection and pre-remediation studies have continued. A considerable body of information is now available for updating prior analyses, developing and evaluating enhanced remedial alternatives, and selecting a final remedy for the Upper Basin. In addition, new information is now available with which to evaluate alternatives to protect the existing selected human health and ecological remedies for OUs 1, 2, and 3. This additional information was used to develop the FFS Report for the Upper Basin (USEPA, 2010). The FFS Report evaluates alternatives that would address the wide-ranging surface water contamination in the Upper Basin and benefit human and ecological receptors by:

- Addressing the Upper Basin and Bunker Hill Box soil, sediments, source material, and water quality issues in a holistic manner;
- Defining OU 2 Phase II long-term water quality cleanup alternatives now that the Phase I source removal remediation effort is largely complete; and
- Considering the recommendations of the NAS (2005).

In addition, the FFS evaluates options and opportunities to protect current (and future) remedies established to protect human health by enhancing infrastructure for the conveyance of tributary and precipitation runoff during storm events.

The FFS Report was prepared by USEPA working closely with a wide range of stakeholders, including state and tribal representatives, natural resource trustees, and local governments and communities, to identify and implement cleanup actions in the Coeur d'Alene Basin. This included coordination with the Basin Environmental Improvement Project Commission (the Basin Commission), which was established by the Idaho State Legislature under the Basin Environmental Improvement Act (Idaho Administrative Procedures Act [IDAPA] Title 39, Chapter 810). The Basin Commission is composed of federal, state, tribal, and local governmental stakeholders, and its purpose is coordination of cleanup activities, environmental restoration, and related measures in the Basin. USEPA serves as the federal government's representative to the Basin Commission. USEPA will continue to be responsible for seeing that cleanup actions in the Coeur d'Alene Basin meet the goals and requirements of decision documents and CERCLA.

3.2 Scope of the Focused Feasibility Study

The FFS took a broad approach of evaluating remedial actions that will achieve surface water quality standards in the Upper Coeur d'Alene Basin and improve the permanence of in-place human health barriers. The fundamental objective of the FFS was to identify and evaluate a range of alternatives that would (1) reduce the amount of metals entering surface water in order to meet ambient water quality criteria (AWQC); (2) reduce the potential for direct human contact and exposure to mine wastes in the areas addressed; (3) represent a final remedy for surface water and a final remedy for soil, sediments, and source material where remedial actions are taken; and (4) prevent unacceptable risks to human health and the environment through remedy protection that addresses the effects of erosion and degradation of protective clean barriers. As discussed in the FFS Report (USEPA, 2010), there is extensive subsurface contamination under the Upper Basin communities, roadways, and other infrastructure. The actions evaluated in the FFS are expected to significantly reduce both groundwater contamination levels and the contribution of contaminated groundwater to surface water. However, given the pervasive nature of the subsurface contamination, the Preferred Alternative may not achieve the drinking water standards for groundwater at all locations. USEPA will evaluate future monitoring data to determine whether a Technical Impracticability (TI) waiver may be warranted at locations where groundwater does not achieve drinking water standards.

Specific objectives of the FFS Report were as follows:

- **Evaluate and present up-to-date information on water quality and sources of surface water contamination in the Upper Basin, including the Bunker Hill Box.** In the FFS Report, remedial alternatives were developed and evaluated on the basis of current site environmental conditions and the potential benefits of remedial actions throughout the Upper Basin (including the Bunker Hill Box). The potential environmental benefits of the proposed remedial actions in the Upper Basin were assessed on a watershed basis in terms of the estimated resulting water quality at the SFCDR monitoring stations SF-268 (at Elizabeth Park, immediately upstream from the Box) and SF-271 (at Pinehurst, immediately downstream from the Box). As noted previously, the NAS conducted a review of the OU 3 Coeur d'Alene Basin cleanup and documented the results of that review in *Superfund and Mining Megasites: Lessons from the Coeur d'Alene River Basin*

(NAS, 2005). Since the OU 3 ROD was issued in 2002, USEPA has continued data collection efforts throughout the Coeur d'Alene Basin, particularly in the SFCDR portion of the Upper Basin. The additional data have improved USEPA's understanding of the Upper Basin and enabled USEPA to address (in the FFS Report) key NAS recommendations with respect to the fate and transport of dissolved metals in the subsurface, as well as the role that groundwater plays in contaminant loading to surface water.

- **Update previous FS evaluations with new information.** To reflect USEPA's improved knowledge of conditions in the Upper Basin, the FFS updated the evaluations of National Oil and Hazardous Substances Pollution Contingency Plan (NCP)-compliant ecological alternatives that were presented in the 2001 FS Report (USEPA, 2001d). Updates to the previous evaluations included the following:
  - Incorporation of new monitoring data and estimates of site-specific metals loading into the assessment of the potential environmental benefits of the remedial alternatives;
  - Use of updated biological monitoring information to address Upper Basin sediment and soil conditions and ecological exposure issues as part of proposed remedial actions;
  - Use of a numerical groundwater model developed and calibrated for the SFCDR Watershed (CH2M HILL, 2009a) to evaluate groundwater-surface water interactions and potential remedial actions for specific areas where alluvial aquifers exist (Woodland Park in the Canyon Creek Watershed, the Osburn Flats area along the mainstem of the SFCDR, and the Bunker Hill Box); and
  - Review and revision of typical conceptual designs (TCDs) and associated cost estimates presented in the 2001 FS Report based on new information, including revisions of water treatment TCDs based on data obtained from treatability testing and cost-benefit analyses conducted for Woodland Park (CH2M HILL, 2007b).
- **Move forward on Phase II cleanup at OU 2.** A two-phase remediation approach was established for OU 2 (USEPA and Idaho Department of Health and Welfare [IDHW], 1995). Phase I, now largely complete, focused on source control, capping, and removal activities. The effectiveness of Phase I actions was assessed and documented in the *Phase I Remedial Action Assessment Report, Operable Unit 2* (CH2M HILL, 2007c) and the *Source Areas of Concern Report, Operable Unit 2* (CH2M HILL, 2008a). Potential Phase II remedial actions for OU 2 evaluated in the FFS built on the assessment of the effectiveness of Phase I actions to address long-term water quality and environmental management issues.
- **Evaluate remedial alternatives that provide a final cleanup for surface water, soil, sediments, and source material in the Upper Basin.** The remedial alternatives evaluated in the FFS would eventually meet surface water cleanup goals for the SFCDR and all of its major tributaries. In some areas, surface water cleanup goals would be met soon after implementing the remedial actions; in other areas, the achievement of water quality goals would take longer. Ultimately, the remedial actions would attain water quality goals, make significant improvements to water quality throughout the Upper

Basin, and provide final cleanup of soil, sediments, and source material where remedial actions are taken.

- **Refine the riparian preliminary remediation goal (PRG) for the protection of songbirds.** An Ecological Risk Assessment (EcoRA) for the Coeur d'Alene Basin was completed in 2001 (CH2M HILL and URS Greiner, 2001). Since that time, additional site-specific data have been collected that can be used to refine the PRG for the protection of songbirds. Relative to other avian receptors, songbirds are highly exposed to soil contamination. The revised PRG for songbirds is incorporated into the PRGs for remedial actions in the Upper Basin.
- **Evaluate flooding and precipitation events that may erode clean barriers or contaminate clean areas.** Consistent with the 2005 Five-Year Review recommendations (USEPA, 2005), remedy protection alternatives evaluated in the FFS address localized flooding and precipitation events that may substantially affect human health and the environment by eroding clean barriers or contaminating clean areas, thereby making contaminated soil and gravel potentially available for direct contact by humans and ecological receptors.

3.3 Focused Feasibility Study Approach

In conducting the FFS, USEPA built upon the analyses presented in the 2001 FS Report (USEPA, 2001d); the ROD for OU 3 (USEPA, 2002); the *Phase I Remedial Action Assessment Report, Operable Unit 2* (CH2M HILL, 2007c); the *Final Phase I Remedial Action Characterization Report for the Bunker Hill Mining and Metallurgical Complex Superfund Site, Operable Unit 2* (TerraGraphics and Ralston Hydrologic Services, 2006); and the *Source Areas of Concern Report, Operable Unit 2* (CH2M HILL, 2008a). In the 2001 FS Report, six remedial alternatives were evaluated to address ecological risks posed to waterfowl, other birds, fish, and plants in the Upper and Lower Basins. The six ecological alternatives were as follows:

- Alternative 1, No Action;
- Alternative 2, Contain/Stabilize with Limited Removal and Treatment;
- Alternative 3, More Extensive Removal, Disposal, and Treatment;
- Alternative 4, Maximum Removal, Disposal, and Treatment;
- Alternative 5, State of Idaho Cleanup Plan; and
- Alternative 6, Mining Companies' Cleanup Plan.

The ROD for OU 3 predicted that reductions in metals concentrations would occur much sooner under the most aggressive and protective Ecological Alternatives 3 and 4. These two alternatives would address many more sources of contamination than the other alternatives and, in turn, would provide greater human health and environmental protection. Water quality conditions predicted at the completion of remediation would be considerably better under Ecological Alternatives 3 and 4, which would also provide substantially greater protection of the environment and shorter times to achieve compliance with the applicable or relevant and appropriate requirements (ARARs) for OU 3. The ROD for OU 3 also stated that, relative to the other ecological alternatives, Alternatives 3 and 4 would result in more than twice the reduction of metals loadings in surface water immediately following implementation of the actions.

Based upon the comparative analysis presented in the ROD for OU 3, USEPA determined that Ecological Alternative 3 (More Extensive Removal, Disposal, and Treatment) represented the best balance of trade-offs for a long-term cleanup approach, and would best meet the requirements for protection of the environment and compliance with the ARARs. The ROD for OU 3 included an interim ecological remedy that was a prioritized subset of the numerous actions included in Ecological Alternative 3. This interim remedy included cleanup actions that would be both technically and administratively implementable and would achieve significant reduction in residual risks relative to its cost.

As discussed previously, given the NAS recommendations (NAS, 2005) and new information about Upper Basin conditions, USEPA is refining its long-term cleanup plan for the Upper Basin. The FFS Report provides the basis for the refined cleanup plan. Section 300.430(e)(9) of the NCP (40 *Code of Federal Regulation*s [CFR] 300) specifies that "detailed analysis should be conducted on the limited number of alternatives that represent viable approaches to remedial action after evaluation in the screening stage." Based upon the NCP and the findings presented in the 2001 FS Report and the 2002 ROD for OU 3, USEPA determined that it was appropriate to carry forward only the Upper Basin components of Ecological Alternatives 3 and 4 as the basis for remedial alternatives to be considered in the FFS Report. USEPA has also determined that Ecological Alternatives 1, 2, 5, and 6 in the 2001 FS Report would not be sufficiently protective of human health and the environment; therefore, they do not warrant further analysis. Carrying forward both Ecological Alternative 3 and the more extensive cleanup contemplated under Ecological Alternative 4 into the FFS Report was consistent with previous considerations of the CERCLA evaluation criteria and the level of cleanup that will be necessary to meet the ARARs for the Upper Basin. Therefore, the FFS Report updated and expanded Ecological Alternatives 3 and 4 in a consistent manner based on new information obtained for the Bunker Hill Box and other Upper Basin areas since issuance of the 2002 ROD for OU 3.

It is important to note that the Lower Basin of the Coeur d'Alene River is *not* within the scope of the FFS Report or the forthcoming ROD Amendment. Since the ROD for OU 3 was issued, the primary focus of remedial actions in the Lower Basin has been human-health-focused cleanup actions (in residences, recreational areas, and other common-use areas) and the Lower Basin agriculture-to-wetland conversion project. This approach has allowed time to further refine the understanding of the Lower Basin and evaluate the complex remedial actions that are necessary to address contaminated sediment transport. USEPA is continuing to support data collection and analysis efforts in the Lower Basin to provide decisionmakers with an improved understanding of the Lower Basin and to support the evaluation of specific remedial alternatives.

3.4 ROD Amendment

A ROD Amendment will be prepared to document the selection of the amended remedy after consideration of public comments on the Proposed Plan. The ROD Amendment will also update and add to previous cleanup plans described in the RODs for OUs 1, 2, and 3 and related decision documents. In addition, the ROD Amendment will address recommendations made by the NRRB in 2001 and the NAS in 2005. In particular, the ROD Amendment will provide a final remedy for:

- Human health protection for surface water used for drinking purposes;
- Ecological protection for surface water; and
- Human health and ecological protection for soil, sediments, and source material in locations where remedial actions are taken.

The ROD Amendment will also provide enhanced protection of human health and the environment for portions of previously selected human health remedies that are vulnerable to erosion and degradation of clean barriers.

Further, the remedy provided in the ROD Amendment is expected to significantly reduce both groundwater contamination levels and the contribution of contaminated groundwater to surface water. However, given the pervasive nature of the subsurface contamination, the Preferred Alternative may not achieve the drinking water standards for groundwater at all locations. USEPA will evaluate future monitoring data to determine whether a TI waiver may be warranted at locations where groundwater does not achieve drinking water standards.

4. Site Characteristics

The Upper Basin of the Coeur d'Alene River occupies approximately 300 square miles of land surface in the Panhandle of northern Idaho. The area includes the SFCDR and tributaries downstream to the confluence of the South and North Forks of the river. The Upper Basin is also the primary source area for most of the mining-related waste materials; therefore, within the Upper Basin, elevated concentrations of metals are present in waste piles, stream beds, and floodplains primarily from the discharge or erosion of mill tailings and other mine-generated waste into rivers and streams. The SFCDR and many of its tributaries have undergone extensive channelization and additional alterations as a result of mining-related activities and other anthropogenic activities, including the construction of I-90.

Information provided in this section is based on the work documented in the 2001 RI and FS Reports (USEPA, 2001c, 2001d) and the ROD for OU 3 (USEPA, 2002), and incorporates additional study and monitoring data obtained from 2002 through 2009. Specific sources of data used in this analysis include the BEMP for OU 3, the EMP for OU 2, the Coeur d'Alene Basin Remedial Action Monitoring Program, U.S. Geological Survey (USGS) gauging station data as reported on the USGS website, and the results of discrete sampling events.

4.1 Nature and Extent of Contamination

The long history of mining activities within the Upper Basin, combined with the dynamic and complex hydrologic system and anthropogenic modifications to that system, have resulted in widespread and commingled sources of contamination.

4.1.1 Sources and Locations of Mining Wastes

Contaminant sources as identified by BLM in 1999 are widespread in the Upper Basin, extending up nearly every drainage area (Figure A-2) (USEPA, 2001c, 2001d). Several of these sources are not discrete locations, but rather diffuse areas extending along river and creek segments.

Contaminated media that potentially affect human health and the environment are surface water, soil, sediments, and groundwater. During development of the 2001 FS Report (USEPA, 2001d), the contaminated media were grouped by *source type* to help characterize the nature and extent of contamination and to develop remedial alternatives. These contaminant source types, based on the mining-related primary sources and secondary sources, with estimated volumes (for OU 3), are as follows.

- Mining-related primary sources:
  - Tailings: 11 million cubic yards
  - Waste rock: 11.7 million cubic yards
  - Adit drainage: 101 pounds of zinc per day

- Secondary sources:
  - Floodplain sediments: 7.1 million cubic yards
  - Riverbed sediments, wetland sediments, lateral lake sediments, bank wedges: 16 million cubic yards

A significant amount of remediation work has been conducted in OU 2 since Phase I was implemented in 1995. Over 3.3 million cubic yards of contaminated wastes have been removed from OU 2 and consolidated onsite in engineered closure areas (the SCA and the CIA). The use of geomembrane cover systems on these closure areas effectively removed the contaminated wastes from direct contact by humans and ecological receptors. Consolidating these wastes in engineered closure areas also substantially reduced the exposure pathways to surface water and groundwater compared with pre-remediation site conditions. However, significant contamination still remains beneath OU 2 that is not accessible for removal and capping.

Sources and estimated volumes of mining-related contamination within different areas of the Upper Basin for OU 3 are summarized below.

Watershed	Number of Source Areas	Number of Historical Producing Mines	Number of Historical Mills	Ore Produced (tons)	Tailings Produced [a] (tons)
Upper SFCDR	181	11	7	24,464,000	19,911,000
Canyon Creek	127	21	13	34,800,000	27,436,000
Ninemile Creek	70	8	7	4,960,000	4,060,000
Big Creek	68	4	2	12,435,000	11,022,000
Moon Creek	14	2	1	4,600	3,800
Pine Creek	131	14	10	3,160,000	1,634,000
Mainstem SFCDR (not including the Bunker Hill Box)	174	25	4	9,800,000 (upstream from EP); 47,839,000 (downstream from EP)	9,400,000 (upstream from EP)

Source: RI/FS for the Coeur d'Alene Basin (USEPA, 2001c, 2001d)

Notes:

[a] Estimated tailings generated from ore produced from each watershed were not necessarily disposed of within the watershed where the ore was mined.

EP = Elizabeth Park, just upstream from the Bunker Hill Box

The buildup and breaching of dams have played a significant role in placement of mining wastes in the Upper Basin and in the creation of secondary sources (e.g., floodplain and riverbed sediments). Under the auspices of the Mine Owners Association, in 1901 the largest mining companies started to build dams of wood pilings and planks; the intent was to impound tailings along Canyon Creek and the SFCDR. The Canyon Creek dam near

Woodland Park, the Osburn dam on the SFCDR near Osburn, and the Pinehurst dam on the SFCDR near Pinehurst were manmade structures that created large deposits of tailings, especially coarse tailings. Subsequent floods, especially in late 1917, damaged the wood plank dams at Woodland Park and Osburn, and the Mine Owners Association did not make repairs. The Pinehurst plank dam was breached by flood waters in 1917. Meanwhile, millions of tons of tailings had built up on the floodplains above the dams. These dams remained in place for decades, and while the dams are now gone, many of the tailings remain. The dams were breached by flooding and high flows multiple times, resulting in large quantities of contaminated mine wastes being transported downstream to the Lower Coeur d'Alene Basin. Despite the resumed fluvial transport of large amounts of impounded material after the dam breaches, large tailings deposits remained behind the remnants of the dams.

Methods used in the processing and storage of tailings evolved over time as follows, but tailings continued to contribute to metals loading in the SFCDR and its tributaries.

- During the 1920s, a portion of the jig tailings in some of the impoundments were recovered and processed using the flotation method.
- From the 1940s to the 1960s, significant quantities of metals were recovered from the old tailings deposits using a modified "sink-float" method. Despite these reprocessing activities, many tailings were left in place along the streams.
- Between 1933 and 1967, approximately 34.5 million tons of mixed alluvium and tailings were dredged from the lower Coeur d'Alene River (not within the Upper Basin), with the resultant piles covering over 2,000 acres.
- Beginning in 1926, permanent impoundments were created to store mining wastes. The largest of these was the CIA, which began operations in 1928 as an unlined repository for flotation tailings from the Bunker Hill ore concentration mills. Over time, the CIA developed into an approximately 200-acre impoundment for tailings, mine wastes, gypsum, slag, other process wastes, and water and AMD from the Bunker Hill Mine. As part of the OU 2 Phase I remedial actions, approximately 1.2 million cubic yards of mine wastes were placed and graded in the CIA. The top of the CIA was capped with a low-permeability geomembrane cover system except for the CTP sludge disposal cell. The cap reduces infiltration of water and metals migration.
- Other large impoundments include the Page Ponds in the western portion of OU 2 (approximately 85 acres), the Osburn Tailings Pond (approximately 60 acres), the Sunshine Ponds in Big Creek (approximately 55 acres), and the Hecla-Star Tailings Ponds in Woodland Park (approximately 62 acres).

4.1.2 Types of Contamination and Affected Media

Table B4-1 summarizes the contaminants of concern (COCs) and affected media (soil, sediments, groundwater, and surface water). Table B4-2 lists metals with at least one screening-level exceedance by source type.

4.2 Contaminant Fate and Transport

Contaminant fate and transport information provided in this section for Upper Basin surface water and groundwater is based on the additional studies conducted and data collected since the 2001 RI/FS (USEPA, 2001c, 2001d), the 2001 NRRB Presentation Information (USEPA, 2001b; see Supplemental CD, File B2-1), and the 2002 ROD for OU 3 (USEPA, 2002). Contaminant releases within the Upper Basin are controlled primarily by the movement of surface water and groundwater within the environmental system. Primary release mechanisms are defined as acting on primary sources and secondary release mechanisms as acting on secondary sources. Surface water monitoring has shown that the Upper Basin and the SFCDR are the source of the majority of the dissolved zinc in the Coeur d'Alene River at Harrison, the downstream point in the Lower Basin where the Coeur d'Alene River enters Coeur d'Alene Lake. In the Upper Basin, contaminant fate and transport are affected by the following:

- The physical setting, which dictates the movement and interaction of surface water and groundwater
- The physical and chemical properties of the COCs present
- Sources and mechanisms for releases of contaminants to surface water and groundwater

This section includes discussions of surface water quality (Section 4.2.1) and groundwater quality and the impact of groundwater on surface water in the key alluvial areas in the Upper Basin (Woodland Park, Osburn Flats, and OU 2) (Section 4.2.2).

4.2.1 Surface Water Quality

Indicator contaminants for surface water quality in the Upper Basin are dissolved zinc and total (or particulate) lead.[1] For the FFS analyses (USEPA, 2010), the entire Upper Basin was evaluated as a comprehensive system, with data gathered from multiple surface water monitoring locations as shown in Figure B4-1.

Extensive monitoring of the Upper Basin has been conducted, beginning in the early 1990s and continuing to the present time. This has included data collection for the RI/FSs for the Bunker Hill Box and OU 3. Additional data have been collected as part of the OU 2 EMP, the OU 3 BEMP, the Coeur d'Alene Basin Remedial Action Monitoring Program, and site-specific studies (see Figures B2-1 and B2-2).

For evaluating dissolved zinc throughout the Upper Basin, these data were used to calculate SFCDR site-specific AWQC ratios, which are used as an indicator of surface water quality. The AWQC ratio is the concentration of a chemical in surface water divided by the ambient water quality criterion for that chemical. An AWQC ratio of one or less indicates that the water quality criteria are met. The AWQC ratios are less variable than measured concentrations or calculated loads, and are not correlated with discharge except at very high

[1] Dissolved zinc is considered an appropriate indicator for dissolved metals because it is the most ubiquitous of the metals; it occurs at the highest concentrations and AWQC ratios; it is relatively mobile compared to other metals; and dissolved metals (particularly cadmium) appear well correlated with dissolved zinc throughout the Upper Basin (USEPA, 2001d).

discharges (USEPA, 2004). AWQC are based on measured or calculated hardness, which varies by location and sampling event.

Figure B4-2 shows the distribution of AWQC ratios at selected locations for different key time periods. The locations were selected because they have the most robust datasets for evaluating long-term trends. The different time periods are defined as 1987-1995, 1995-2002 (during which time several significant remedial actions were undertaken), and from 2002 to the present. Figure B4-2 uses box plots (in the upper portion of the figure) to group the data by each time period for each location, and scatter plots (below the box plots) to show the general trends over time. Both the box plots and the scatter plots generally show decreasing AWQC ratio trends over time. These results are consistent with previous studies, such as those conducted by USGS (Donato, 2006). The improvements are due, in part, to remedial actions completed in the Upper Basin, including OU 2 Phase I remedial actions, which comprised the majority of remediation actions completed during 1995-2002. The box plots and scatter plots also show the variability in the data between locations and over time, which is consistent with the complexity of the interactions between upland sources, floodplain contaminated sediments, groundwater, and surface water, and how remedial actions affect those interactions.

Figure B4-3 shows the maximum AWQC ratio for data collected from October 2002 to the present (following the time when several significant remedial actions were undertaken), and includes locations throughout the Upper Basin. The intent of this figure is to provide a conservative "snapshot" of current conditions. Maximum AWQC ratios often coincide with low-flow conditions, when contaminated groundwater has the greatest adverse impact on surface water quality. Figure B4-4 shows the same data specifically for OU 2. These figures also display the discrete source areas located within the Upper Basin.

The most contaminated areas upstream of OU 2 include Canyon Creek, Ninemile Creek, and the mainstem SFCDR below Mullan. AWQC ratios have historically been, and continue to be lowest in the SFCDR upstream of Mullan. The most contaminated streams within OU 2 include Government Creek, tributaries to Bunker Creek (including Portal, Railroad, Deadwood, and Magnet Creeks), and Milo Creek. AMD is being discharged directly to Milo Creek, which is the only surface water body in OU 2 where surface water quality was worse following OU 2 Phase I remedial actions. As indicated in Figure B4-3, there are several drainages with numerous discrete source areas where (1) very little data are available (except where they meet the SFCDR), and (2) AWQC ratios are relatively moderate as compared to the most contaminated areas noted above (e.g., Big Creek and Pine Creek). It is important to note that given the numerous source areas in the Upper Basin, there is considerable uncertainty regarding future water quality impacts from dissolved metals, stemming from the complexity of chemical, biological, and environmental factors that influence metal release rates from the variety of source types.

In addition to dissolved zinc, total lead is used as an indicator of surface water quality. Sources, as well as fate and transport mechanisms, are different for total lead than for dissolved zinc. Lead is primarily transported in water in particulate or colloid form, and is measured from unfiltered water samples as total lead (or particulate lead) that also includes any dissolved lead. Particulate lead is typically mobilized during high-energy, high-flow conditions as increased sediments become entrained in streams. Unfortunately, stream discharge is difficult to measure during high flows, and depth- and width-integrated

sampling regimes are challenging to follow. Thus, data collected during high-flow conditions are generally subject to greater uncertainty than those collected under low-energy, low-flow conditions when fewer lead-bearing particulates are typically transported.

Figure B4-5 shows data from Station SF-271 at Pinehurst in the Pine Creek Watershed. These data are typical for the Upper Basin because total lead concentrations are usually greatest on the rising limb of the hydrograph and decrease with time as sediment sources are depleted and flows decrease, and as stream energy dissipates. During first-flush and/or rain-on-snow events, sediments are mobilized by overland flow and from the near-channel floodway, channel banks, and channel beds by elevated instream flows. As a result the eroded sediments are frequently sources of lead.

Figure B4-6 shows a map view of total lead in surface water during high-flow conditions in May 2008.[2] Total lead concentrations upstream of OU 2 are highest in Canyon Creek and Ninemile Creek (consistent with dissolved zinc), but are highly erratic along the SFCDR below Wallace. Widely variable total lead concentrations during high-flow conditions in irregularly shaped, high-gradient streams, common to the Upper Basin, are typical. This is because the ability of the water to transport suspended material varies as a function of flow and velocity, which in turn can vary significantly over short distances due to changes in channel cross section and shape.

In summary, improvements in surface water quality have been made in recent decades as efforts to address the most obvious sources of contamination were implemented, but surface water quality remains seriously impaired in many areas of the Upper Basin.

4.2.2 Groundwater Quality and Impact on Surface Water

Alluvial aquifers within the Upper Basin occur in the valley fill sediments and are typically shallow, unconfined, and long and narrow in dimension. Alluvium and floodplain deposit sources are widespread contaminant sources in the Upper Basin, spreading across the floodplains and valleys of the SFCDR, Canyon Creek, Ninemile Creek, and other SFCDR tributaries. These sediment deposits also underlie developed and/or capped areas in some areas of the Upper Basin, and impact the groundwater quality and eventually surface water quality in these areas.

With the exception of the area immediately surrounding Pinehurst in the Pine Creek Watershed, groundwater quality in the shallow aquifer of the Upper Basin has been affected to the point that groundwater use is impacted and in some areas prohibited for domestic and municipal use.

A high degree of hydraulic interaction exists between the shallow groundwater aquifer and surface water. In general, the following characteristics are important to the interaction of groundwater and surface water in the Upper Basin:

- Groundwater quality in the shallow aquifer is impacted by floodplain deposit sediment sources and, in some cases, contaminated material impoundment areas.

[2] Total lead concentration data represent the maximum values reporting for samples collected in May 2008 as part of the High-Flow and Low-Flow Surface Water Study (CH2M HILL, 2009b) and the Coeur d'Alene Basin Remedial Action Monitoring Program.

- Streams tend to be gaining in areas where the alluvial valley narrows, and losing in areas where the alluvial valley widens.
- During low-flow conditions (late summer/early fall), surface water flow is dominated by groundwater discharge.

The following subsections focus on three areas of the shallow aquifer in the Upper Basin in which groundwater plays a significant role in metals loading to surface water: Woodland Park, Osburn Flats, and OU 2. Various studies, including groundwater modeling, have been conducted in these areas to determine the impact of groundwater on surface water quality.

Woodland Park

Woodland Park is located along Canyon Creek near Wallace (Figure B4-1). Dissolved zinc concentrations in groundwater during October 2008 in the Woodland Park aquifer are shown in Figure B4-7. The highest concentrations in groundwater within Woodland Park were located near gaining sections of Canyon Creek.

A September 2006 study of groundwater-surface water interactions in Woodland Park determined that groundwater discharge to Canyon Creek in Woodland Park significantly increased the surface water load of dissolved zinc during low-flow conditions (CH2M HILL, 2007a). Data from the September 2006 study show the largest zinc load increases in surface water occurring in the reaches between Stations A1 and A1.2. Additional dissolved zinc load was entering Canyon Creek between Stations A4E and A6 primarily due to seeps from the SVNRT repository located in Woodland Park.

Osburn Flats

Osburn Flats is located along the SFCDR in Osburn. Concentrations of dissolved zinc in Osburn Flats groundwater in October 2008 are shown in Figure B4-8. In general, higher dissolved zinc concentrations were found in the area upstream (or east) of McFarren Gulch, which is near the historical location of the Osburn Plank Dam. The lowest concentrations of zinc in groundwater were detected along the south side of Osburn Flats, away from the SFCDR and near the hillsides south of Osburn.

A study of metals loading to the SFCDR in Osburn Flats under low-flow conditions in September 2008 determined that the surface water load of dissolved zinc increased due to groundwater discharge from the area under the former Osburn Plank Dam, resulting in an increase in dissolved zinc concentrations in the SFCDR (CH2M HILL, 2009c). In other gaining reaches in Osburn Flats, stream flow increased without concurrent increases in dissolved zinc concentrations in surface water because concentrations in groundwater were roughly equal to concentrations in the SFCDR, resulting in an increased load of dissolved zinc to the stream by virtue of increasing discharge (CH2M HILL, 2009d). The largest increases in dissolved zinc concentrations in surface water occurred in the primarily gaining reach from Station B3 to Station B5-ALT.

Operable Unit 2

OU 2 is located within the Bunker Hill Box, shown in Figure B4-1. Concentrations of dissolved zinc in OU 2 groundwater under low-flow conditions in October 2008 are presented in Figure B4-9. In general, the highest concentrations of dissolved zinc in

groundwater in OU 2 were in the shallow aquifer near the CIA and Government Creek. Some monitoring locations north of Smelterville and the Page Wastewater Treatment Plant had elevated zinc concentrations in groundwater, but relatively lower concentrations than the CIA.

The groundwater-surface water interaction within OU 2 is significant in terms of the volume exchanged and its water quality impact on the SFCDR. The eastern (upstream) gaining reach in OU 2 (see Figure B4-9) is located near the CIA and results in a major negative impact on water quality due to highly contaminated groundwater entering the SFCDR. Furthermore, the CTP currently discharges treated water to Bunker Creek, and much of this treated water enters the groundwater system through losing reaches of Bunker Creek. This results in additional discharge of high-concentration groundwater to the SFCDR. There are also areas of high dissolved zinc concentrations in groundwater along Government Creek that negatively impact surface water quality in Government Creek and then the SFCDR. In the western (downstream) gaining reach of the SFCDR in OU 2, dissolved zinc loads in surface water increase (Figure B4-9). This increase is driven by the large volumes of groundwater discharging to surface water, and not by greatly elevated dissolved zinc concentrations. As noted earlier, dissolved zinc concentrations in the western portion of OU 2 are considerably lower than those in the eastern portion of OU 2.

4.3 Summary of Site Conditions

Dissolved zinc concentrations in groundwater have generally decreased as a result of Phase I remedial actions completed in OU 2. However, significant quantities of contaminants that contribute to impacted water quality remain located beneath communities and infrastructure and cannot be removed without disruption to the populated communities. Contaminant contributions from groundwater to the SFCDR within OU 2 remain relatively large and have a large negative impact on SFCDR water quality. Summary of Site Conditions

The Bunker Hill Superfund Site is within one of the largest historical mining districts in the world, and mining-related toxic waste materials have been dispersed in nearly every aspect of the environment including air (historically), soil, sediments, surface water, and groundwater. Dozens of extensive and costly remedial actions have been taken to date in the Upper Basin, and improvements in the environmental system have been made. Despite this, contaminant levels in affected streams, soil, sediments, and groundwater remain at levels that are toxic to humans and native organisms. Specific findings of this section have included the following:

- COCs for groundwater and surface water include arsenic, cadmium, lead, mercury, and zinc.
- Surface water meets, or is close to, AWQC upgradient from sources and degrades significantly upon contact with mining wastes.
- Surface water quality in terms of dissolved zinc concentrations has generally been improving in the Upper Basin (including OU 2), but remains severely impaired on the SFCDR mainstem and several tributaries.

- Large loads of particulate total lead are transported through the Upper Basin primarily during high-water events, creating toxic sediment deposits along the SFCDR and its tributaries.
- Groundwater in three major aquifers (Woodland Park, Osburn Flats, and OU 2) is severely affected and contributes to surface water contamination. There is a moratorium on domestic use of these aquifers because of contamination.

5. Current and Potential Future Site and Resource Uses

5.1 Current Land Uses

The Upper Basin of the Coeur d'Alene River is located primarily in Shoshone County in the Panhandle of northern Idaho (Figure A-1). A small area in the Pine Creek headwaters is located in Kootenai and Benewah counties. Much of the land is under federal management as National Forest (including the Clearwater, Coeur d'Alene, and St. Joe National Forests). Land uses are a mix of residential, commercial, agriculture, mining, forestry, and recreation. All of the cities in the Upper Basin are located within Shoshone County (pop. 12,913 [U.S. Census Bureau, 2008]). The majority of these residents live in communities located along the SFCDR, including Kingston, Pinehurst, Smelterville, Kellogg, Wardner, Osburn, Wallace, and Mullan. Table B5-1 shows the population numbers where available for these communities.

The undeveloped areas of the Upper Basin include upland forests and lowland floodplains with riverine and riparian areas and wetlands. The SFCDR has been channelized along much of this reach by railroad and roads (Stratus, 2000; USEPA, 2001c, 2001d), but its numerous streams still provide abundant recreational opportunities. In 2002, a project to convert a railroad right-of-way to a recreational trail system was completed. The Trail of the Coeur d'Alenes follows the Union Pacific Railroad's 72-mile right-of-way from Mullan to Plummer near the border with the State of Washington.

In the headwater and tributary areas, predominant land uses include mining, mineral processing, and forestry with some urban and residential development. The narrow tributary canyons are populated by small communities, dispersed residences, and roads that cross or border streams. The quality of these habitats and their ability to support natural populations of flora and fauna have been impacted to varying degrees by historical mining activity in the Coeur d'Alene Basin.

5.2 Anticipated Future Land Uses

Future land uses in the Upper Basin are anticipated to be similar to the current land uses. Although population levels in the Basin have declined in recent years, the city of Coeur d'Alene has experienced substantial population growth, and it is possible that this population could expand into the Upper Basin. Communities within the Upper Basin, Kellogg in particular, are working to attract tourists for recreational activities such as skiing and biking, and historical activities like mining museums and mine tours. A recent development is the residential community of Galena Ridge, which is composed of homesites, condominiums, and other multi-family units built around an 18-hole golf course and recreational walking and biking trails, including the Trail of the Coeur d'Alenes.

5.3 Groundwater and Surface Water Use

The State of Idaho has identified drinking water as a designated beneficial use for the surface water of the Idaho portion of the Coeur d'Alene Basin. A deep groundwater aquifer and clean surface water tributaries are used as drinking water sources in the Upper Basin. Within the Basin, about 57 percent of residences obtain water from public sources and 43 percent obtain water from private sources. In 1989, the Idaho Department of Water Resources (IDWR) established an Area of Drilling Concern for groundwater within the 21-square-mile Bunker Hill Box area to protect public health in recognition of the existing groundwater contamination. (An area designated as an "Area of Drilling Concern" has additional well construction requirements and prohibitions that must be followed.)

6. Summary of Risks

The Bunker Hill Superfund Site was listed on the NPL in 1983 based upon high levels of lead, arsenic, cadmium, and zinc in the local environment and high blood lead levels in children living in communities near the smelter complex and related mining activities. In the 1970s lead poisoning was widespread, with 75 percent of children exceeding a blood lead level of 40 micrograms per deciliter (µg/dL). The health response has been ongoing for decades, and now area children have blood lead levels close to the national average. Historical mining wastes have created a legacy of pervasive elevated metals concentrations that present significant measureable risks to many animals and plants throughout the Basin. The risks are neither hypothetical nor potential future risks—the risks continue to exist today.

Public health studies and epidemiologic and environmental investigations begun in the 1970s concluded that atmospheric emissions of particulate lead from the active smelter were the primary sources of elevated blood lead levels in local children from the populated areas of the Bunker Hill Superfund Site, later known as OU 1 of the Bunker Hill Box. Associated risks to human health were evaluated through the 1990 Risk Assessment Data Evaluation Report for the populated areas (OU 1) ("the RADER," USEPA, 1990) and in the 1992 Human Health Risk Assessment (HHRA) for the non-populated areas (OU 2) (SAIC, 1992). The RADER evaluated both carcinogenic and noncarcinogenic effects of contaminant exposures. The non-populated areas HHRA evaluated exposures either as baseline (resulting from activities common to all members of the resident population) or as incremental (resulting from potentially high-risk activities by some members of the local population or visitors to the area).

Human health risks were further evaluated in the HHRA for the Coeur d'Alene Basin in 2001 (Idaho Department of Health and Welfare [IDHW], 2001). The results of this HHRA were summarized in the 2001 NRRB Presentation Information (USEPA, 2001b; see Supplemental CD, File B2-1). Subsequently, the ROD for OU 3 (USEPA, 2002) summarized the results of a baseline HHRA of the Harrison to Mullan portion of the Upper Basin (exclusive of the Bunker Hill Box, which was addressed in prior OU 1-specific risk assessment reports), which includes all of the Upper Basin study area. An EcoRA (CH2M HILL and URS Greiner, 2001) was prepared as part of the RI/FS for the Coeur d'Alene Basin. The EcoRA characterized risks to aquatic and terrestrial organisms exposed to hazardous substances associated with mining activities. A focused EcoRA was completed in 2006 to evaluate the effects of lead-contaminated soil on groundfeeding songbirds in the riparian area of the Basin (CH2M HILL, 2006b).

As reported in CERCLA Five-Year Review Reports prepared for the Bunker Hill Superfund Site (USEPA, 2000a, 2000c, and 2005), selected human health remedies that have been implemented within the Upper Basin communities to date are protective, and they are functioning as designed. However, elevated concentrations of mining-related metals in surface water, soil, sediments, and biotic tissues continue to pose risks to people and to the survival and growth of animal and plant species. The Five-Year Review Reports concluded

that if surface water remedies are not instituted to control the persistent transport of metals into the Upper Basin, exposure risks will continue to threaten the well-being of human health and the environment.

6.1 Human Health Risks

The primary human health concern in the Coeur d'Alene Basin was determined by the RADER (USEPA, 1990) and subsequent risk evaluations to be excessive lead in the blood of young children and pregnant women. Site-specific analysis of blood lead data paired with environmental lead data demonstrate that complex exposure pathways exist. Blood lead levels appeared to be most closely related to lead in house dust, followed by independent effects of lead in yard soil, the condition of interior lead-based paint, and the lead content of exterior paint (TerraGraphics and URS Greiner, 2000).

In response to risks posed by lead, USEPA has prioritized cleanup actions to reduce human health exposures and is conducting ongoing analyses of remedy effectiveness to support the Basin-wide Five Year Reviews. Health services such as annual blood lead screening programs are provided throughout the Panhandle Health District. In addition, the ICP, which is also managed by the Panhandle Health District, was established to ensure that remedial technologies retain their integrity and effectiveness, and are not compromised by future actions.

6.2 Identification of Contaminants of Concern

Eight metals (antimony, arsenic, cadmium, iron, mercury, manganese, lead, and zinc) were initially selected as contaminants of potential concern and evaluated in depth in the HHRA. Two metals—lead and arsenic—emerged as the chief COCs for the response actions selected in the ROD for OU 3 (USEPA, 2002). Lead is the primary COC in the Upper Basin because lead exposures exceeded target health goals at the largest number of locations. Arsenic was identified as a COC for OU 3 because its concentrations also exceeded target health goals. Other metals that exceeded health goals, such as cadmium and iron, were limited to isolated locations or were co-located with lead and arsenic; therefore, they were not identified as a primary human health concern by the HHRA. The presence of lead and non-lead metals required different human health risk evaluations, as described in the following sections.

6.2.1 Lead Risk Summary

The conclusions of the RADER stated that subchronic lead absorption among young children was the most significant health risk in the populated areas of the Bunker Hill Superfund Site. The major routes for lead absorption are ingestion of contaminated soil in residential yards and other residential surroundings, ingestion of contaminated house dust, and inhalation and ingestion of airborne particulate matter derived from fugitive dust sources throughout the Bunker Hill Superfund Site (USEPA, 1990).

The most significant risks identified in the 1992 HHRA for the non-populated areas are associated with potential subchronic lead poisoning due to contact with contaminated soil, dust, and sediments. Chronic non-carcinogenic disease could also result from continued consumption of surface water during recreational activities. With respect to potential

occupational uses of the non-populated areas of the Bunker Hill Superfund Site, women of reproductive age who may become pregnant are the population of concern. Common occupational activities by pregnant women could more than double prenatal exposures to lead in all areas except the general hillsides. Especially severe exposures could occur on a short-term basis within the abandoned smelter complex, the CIA, or the MOA. Workers were identified as potentially at-risk for both carcinogenic and chronic non-carcinogenic disease under a 35-year occupational scenario. Excessive risks of acute toxic effects could also result from heavy metals and arsenic exposure in the CIA, Smelterville Flats, and the hillsides adjacent to the industrial complex (SAIC, 1992).

The 1992 HHRA concluded that lead in both soil and paint needed to be addressed to achieve sufficient reductions in house dust lead concentrations. Site-specific analysis of alternative risk reduction scenarios indicate that reduction of soil lead concentrations to less than 700 milligrams per kilogram (mg/kg) is necessary to achieve the 5 percent risk criterion (see below). In addition, the HHRA noted that significant lead exposure may also result from recreation in areas in the Upper Basin with high lead concentrations. USEPA's Integrated Exposure Uptake Biokinetic Model was used to evaluate the lead risks and to develop soil action levels as target health goals for reducing lead exposure pathways for children. These goals are described in USEPA national guidance (1998a), which recommends that a "soil lead concentration be determined so that a typical child would have an estimated risk of no more than 5 percent of exceeding a blood lead of 10 µg/dL ." In OU 3, blood lead and exposure surveys were conducted every summer from 1996 to 2004. During this period, approximately 15 percent of tested children aged 6 months to 6 years had blood lead levels of 10 µg/dL or greater, and 7 percent had levels greater than or equal to 15 µg/dL. In 2000 and 2001, 14 percent and 6 percent, respectively, of 6-month-old to 6-year-old children had concentrations above 10 µg/dL, and 4 percent and 2 percent, respectively, had levels exceeding 15 µg/dL.

Results from these surveys indicated that the selected human health remedies were contributing to reduced blood levels in children:

- In 2000, the geometric mean blood lead level for the Basin was 4.0 µg/dL, a value similar to that noted in the HHRA for the preceding 4 years.
- In 2001, the geometric mean dropped to 3.7 µg/dL, suggesting that blood lead levels had decreased significantly among participating children.
- In 2002, the percentage of young children with levels exceeding 15 µg/dL decreased to 0 to 1 percent in all the communities.
- In 2004, the geometric mean blood lead level decreased from 8 µg/dL in 1996 to 2 µg/dL among children up to 6 years of age (USEPA, 2005). The incidence of blood lead levels greater than 10 µg /dL fell to 2 to 3 percent in the various communities.

6.2.2 Non-Lead Metals Risk Summary

The RADER for the populated areas (USEPA, 1990) identified the following risks from non-lead metals:

- Carcinogenic risks from consuming groundwater with arsenic; inhalation of arsenic and cadmium
- Non-carcinogenic risks from exposure to arsenic, cadmium, and zinc via potential groundwater consumption; antimony, cadmium, mercury, and lead via excessive soil and dust ingestion; and cadmium via local garden produce consumption
- Subchronic, noncarcinogenic risks from exposure to cadmium, lead, and zinc via local garden produce consumption

The 1992 HHRA concluded that antimony, arsenic, cadmium, and mercury levels are highly elevated. Excessive risk of acute toxic effects could also result from heavy metals and arsenic exposure in the CIA adjacent to the industrial complex (SAIC, 1992).

The results of the RI/FS risk characterization for non-lead metals (2001 HHRA; USEPA, 2001c, 2001d) indicated that some exposure areas could pose an unacceptable threat of non-cancer effects for some individuals and media under reasonable maximum exposure (RME) conditions. These included the children exposed to soil (containing arsenic and iron) from yards and side gulches (Osburn, Mullan, and Burke/Ninemile), to groundwater (containing cadmium and zinc), and to homegrown vegetables (containing cadmium). A summary of the non-lead metal pathway/exposure scenarios that exceeded the target risk goals is presented on the Supplemental CD, Files B6-1 through B6-7.

The 2001 HHRA also concluded that arsenic concentrations in some Basin yard soil may need to be addressed, independently of lead, to reduce risks and hazards. Hazards are greatest for children up to 84 months (7 years) of age. Arsenic was the chemical that presented the highest hazards and was also the only carcinogen. Cancer risk estimates for arsenic exceeded 1×10^{-6} for all individuals in all exposure areas under the RME condition. For residential scenarios, yard surface soil contributed the most to this cancer risk. For residents in the side gulches, tap water also contributed significantly to cancer risk. Although tap water was not the primary contributor to cancer risk for residential scenarios, RME cancer risk estimates for tap water exceeded 1×10^{-6} in all exposure areas. These risks were almost entirely due to high concentrations of arsenic in scattered private wells. For the Burke/Ninemile future residential scenario, groundwater contributed nearly all of the cancer risk. Depending on the exposure area, one or more of various media (upland surface soil, soil/sediments, sediments, or waste piles) contributed the most to the arsenic cancer risk for recreational visitors. Although surface water was never the primary contributor to cancer risk, RME cancer risk estimates for "disturbed" surface water exceeded 1×10^{-6} for recreational scenarios in several exposure areas. Surface/subsurface soil presented all of the cancer risk for construction workers.

6.3 Ecological Risks

The 2001 EcoRA (CH2M HILL and URS Greiner, 2001), through consultation with the many stakeholders who participated in the EcoRA Work Group, established ecological management goals, assessment endpoints, and measures that are consistent with the NCP and USEPA guidance. The goals include the need to reduce the toxicity and/or toxic effects of hazardous substances released by mining activities to ecological receptors within the Basin, and also the need to provide habitat conducive to the recovery of special-status species. By

protecting the integrity of the food chain, water, and other natural resources, as well as habitat structure, the ecological management goals should be achieved.

6.3.1 Identification of Contaminants of Potential Ecological Concern and Possible Routes of Exposure

Media evaluated in the EcoRA included soil, sediments, and surface water. Groundwater, although contaminated in the Basin, was not evaluated directly but was considered indirectly by evaluation of contaminants of potential ecological concern (COPECs) in the soil. COPECs carried forward in the EcoRA included the following:

- Soil: Arsenic, cadmium, copper, lead, and zinc
- Sediments: Arsenic, cadmium, copper, lead, mercury, silver, and zinc
- Surface water: Cadmium, copper, lead, and zinc

The routes by which ecological receptors may be exposed to the COPECs in the Coeur d'Alene Basin included the following:

- Birds and mammals: Ingestion of soil-sediments, surface water, and food
- Fish: Dietary pathway; ingestion of and direct contact with sediments and surface water
- Benthic invertebrates: Ingestion of and direct contact with sediments or surface water
- Aquatic plants: Root uptake and direct contact with sediments and surface water
- Amphibians: Direct contact with surface water and soil-sediments
- Terrestrial plants: Root uptake from soil-sediments
- Terrestrial invertebrates: Ingestion of and direct contact with soil-sediments
- Soil processes: Direct contact of microbes with soil-sediments

6.3.2 Summary of Ecological Risk Assessment

The results of the 2001 EcoRA indicated that most watersheds in which mining has occurred and a large portion of the Upper Basin downgradient from mining areas are ecologically degraded as a direct or secondary effect of mining-related hazardous substances. This ecological degradation has resulted in demonstrated, observable effects in the Basin. The results of the EcoRA also showed that if remediation is not conducted in the Basin, effects can be expected to continue for the foreseeable future. High concentrations of metals are pervasive in the soil, sediments, and surface water, and these metals pose substantial risks to the wildlife, fish, and plants that inhabit the Basin. Impacts were evaluated for more than 80 different species, representing numerous trophic levels and hundreds of exposed species. Species evaluated included "special-status species," such as those listed by the U.S. Fish and Wildlife Service (USFWS) as endangered or threatened under the Endangered Species Act (ESA).

The overall conclusion is that heavy metals, primarily lead, zinc, and cadmium, present significant risks to most ecological receptors throughout the Basin, including fish, birds, mammals, amphibians, terrestrial and aquatic plants, soil invertebrates, and microbial soil processes. Receptor classes with close association with aquatic environments and associated soil and/or sediments such as amphibians, benthic macroinvertebrates, and small ground-dwelling mammals are particularly susceptible. See Files B6-8 and B6-9 on the Supplemental CD for a summary of the EcoRA results. Because fish and birds are among the more

vulnerable receptor classes and are closely connected with the human environment (through recreation), key observations from the EcoRA and updated information from environmental monitoring programs conducted since 2001 are summarized below.

Fish and Aquatic Organisms

- Approximately 20 miles of the SFCDR and 46 miles of its tributaries have limited and impacted fish populations. Some areas with high metals concentrations have been observed to be essentially devoid of fish and other aquatic life in areas of mining impacts.
- In addition to elevated concentrations of metals in waters of the Upper Basin, fish tissue has elevated metals concentrations.
- Impacted species include the native bull trout, which is listed as "threatened" under the ESA.
- Some more sensitive fish species (e.g., sculpin) are absent from areas with relatively low metals concentrations.
- Exposure of aquatic organisms to metals was confirmed by the presence of elevated concentrations of metals in fish tissue.
- Toxicity testing using water from heavily contaminated portions of Canyon Creek and the SFCDR indicated that substantial dilution with clean water (10-fold or more) is required to eliminate acute toxicity.
- Based upon comparison of metals concentrations in surface waters to chronic AWQC, growth and reproduction of surviving aquatic life would be substantially reduced in several areas.
- Site-specific toxicity testing and/or biological surveys indicated lethal effects of waters or reduced populations of aquatic life.
- Toxic effects of contaminated sediments are believed to contribute to adverse effects on aquatic life.

Birds

- Risks to health and survival from at least one metal in at least one area were identified for 21 of 24 representative avian species.
- Potential risks to fish-eating birds were noted in the Upper Basin.
- Lead and zinc present the greatest risks to birds in the Coeur d'Alene Basin.
- In the Lower Basin of the Coeur d'Alene River, lead poisoning (primarily due to ingestion of contaminated sediments) is responsible for 96 percent of the total tundra swan mortality, compared to 20 to 30 percent (primarily due to ingestion of lead shot) at the Pacific flyway and national level.
- Since 1981, a total of 27 species of wildlife have been documented with various degrees of lead exposure that exceed background levels.

- The Upper Basin of the Coeur d'Alene River is a significant source of contaminated sediments that are deposited in the Lower Basin. Waterfowl carcasses found in 1997 and 2009 represented some of the largest documented die-offs since 1924. Deaths by lead poisoning from the ingestion of contaminated soil and sediments are expected to continue.
- A USFWS songbird study (Hansen, 2007) and the focused EcoRA (CH2M HILL, 2006b) confirmed that songbirds in the Coeur d'Alene Basin are accumulating lead in blood and liver tissue from ingesting lead-contaminated soil at levels that show injury to songbirds.
- Based upon site-specific data and focused risk assessment, USEPA is proposing to make a risk management decision to use a site-specific protective value of 530 mg/kg lead in soil and sediments as the benchmark cleanup level for the protection of waterfowl that would also be protective of songbirds.

The EcoRA benefitted from numerous site-specific studies that were completed as part of the natural resource damage assessment of the Basin. Biological monitoring work conducted since the EcoRA has demonstrated that ecological receptors using Upper Basin sediments and soil continue to be exposed to elevated metals in soil above thresholds shown to cause injury. USFWS recommends that remedial actions address environmental management issues associated with sediments and soil, not only with surface water.

6.4 Basis for Remedial Action

Based on the continuing risks posed to human health and the environment from elevated concentrations of metals, particularly lead, arsenic, cadmium, and zinc, appropriate response actions are necessary to protect humans, ecological receptors, special status species, and natural resources that contribute to the functional ecosystem of the Upper Basin. These actions will address ongoing and threatened releases of hazardous substances that present an imminent and substantial endangerment to public health, welfare, or the environment.

7. Remedial Action Objectives and Remediation Goals

Remedial action objectives (RAOs) and general response actions (GRAs) for the Upper Basin are presented in this section. Section 300.430(e)(2)(i) of the NCP specifies that RAOs be developed to address COCs, media of concern, potential exposure pathways and remediation goals. The RAOs that were developed for the FFS Report (USEPA, 2010) are presented below. The RAOs provide a basis for evaluating the capability of the response actions to achieve compliance with potential ARARs or an intended level of risk protection. Examples of GRAs considered in the FFS Report for human health and ecological protection include containment, treatment, removal, and disposal and are presented with the RAOs below.

Subject	Remedial Action Objective(s)	General Response Action(s)
Human Health		
Soil/Sediments/Source Material	Reduce human exposure to soil, sediments, and source material, including residential garden soil, that have concentrations of COCs greater than selected risk-based levels for soil.	Containment Removal Disposal
Surface Water	Restore surface water designated as beneficial use for drinking water to meet drinking water and water quality standards. Prevent ingestion of surface water used as drinking water and containing COCs exceeding drinking water standards and associated risk-based levels for drinking water. Prevent discharge of seeps, springs, and leachate that would cause surface water to exceed drinking water and water quality standards.	Source Control Hydraulic Isolation Treatment Removal for Treatment
Groundwater and Surface Water as Drinking Water	Prevent human ingestion of groundwater withdrawn or diverted from a private, unregulated source, used as drinking water, and containing COCs exceeding drinking water standards and associated risk-based levels.	Source Control Hydraulic Isolation Containment Withdrawal Prohibitions (Institutional Controls)
Aquatic Food Sources	Reduce human exposure to unacceptable levels of COCs via ingestion of aquatic foods (e.g., fish and waterfowl)	Source Control

Subject	Remedial Action Objective(s)	General Response Action(s)
Ecological Receptors		
Ecosystem Physical Structure and Function	Remediate soil, sediments, and surface water to mitigate mining impacts and provide habitat capable of supporting a functional ecosystem for the aquatic and terrestrial plant and animal population in the Upper Basin. Maintain (or provide) soil and sediment quality capable of supporting a functional ecosystem for waterfowl and riparian songbirds in the Upper Basin. Maintain (or provide) soil, sediment, and surface water quality supportive of individuals of special-status biota that are protected under the ESA, the Fish and Wildlife Conservation Act, and the Migratory Bird Treaty Act.	Containment Treatment Removal Disposal
Soil/Sediments/Source Material	Prevent ingestion or uptake of and dermal contact with arsenic, cadmium, copper, lead, mercury, silver, and zinc by ecological receptors at concentrations that result in unacceptable risk. Reduce loadings and prevent transport of arsenic, cadmium, copper, lead, mercury, silver, and zinc from soil and sediments into surface water and groundwater to concentrations below applicable ARARs.	Containment Treatment Removal Disposal
Surface Water	Prevent ingestion of surface water with cadmium at a concentration that may cause adverse impacts on bull trout. Prevent ingestion or uptake of arsenic, cadmium, copper, lead, mercury, and zinc by humans, birds, mammals, aquatic invertebrates and fish, aquatic plants, and amphibians at concentrations that exceed applicable AWQC or state water quality standards, including site-specific criteria that will protect designated and existing beneficial uses.	Containment Treatment Removal Disposal
Mine Water, including Adits, Seeps, Springs, and Leachate	Prevent discharge of arsenic, cadmium, copper, lead, mercury, silver, and zinc to surface water at concentrations that exceed surface water quality ARARs.	Treatment
Groundwater	Prevent discharge of arsenic, cadmium, copper, lead, mercury, silver, and zinc in groundwater to surface water at concentrations that exceed surface water quality ARARs.	Containment Treatment Removal Disposal

Attainment of the RAOs would reduce short- and long-term risks posed to human health and ecological receptors by reducing exposure to and contact with (ingestion of) contaminated soil, sediments, and surface water. The PRGs for human health, environmental media, and aquatic receptors in the Upper Basin are presented in Files B7-1

through B7-3 on the Supplemental CD provided with this Site Information Package. The AWQC (Table B7-1) represent the fundamental Upper Basin remediation goal because they are published numeric criteria directly applicable to surface water. However, final site-specific action or cleanup levels developed for the Upper Basin will be established in the ROD Amendment and may differ from the PRGs presented in Files B7-1 through B7-3 on the Supplemental CD.

The 2001 EcoRA (CH2M HILL and URS Greiner, 2001) and the ROD for OU 3 (USEPA, 2002) identified the lack of site-specific riparian and riverine songbird data and a protective cleanup level as data gaps that should be addressed. Based on the findings of the site-specific data gathered in the USFWS songbird study (Hansen, 2007), the focused EcoRA (CH2M HILL, 2006b), and other relevant information, USEPA made a risk management-based determination that a site-specific lead cleanup level of 530 mg/kg for soil will be protective of songbirds in the Coeur d'Alene Basin. This cleanup number is also consistent with the human health approach.

For surface water, AWQC are both the principal ARARs and PRGs for protection of the aquatic environment. The State of Idaho established site-specific aquatic life criteria for cadmium, lead, and zinc in March 2002. Idaho Water Quality Standards and Wastewater Treatment Requirements, 58.01.02.284, apply to the South Fork Coeur d'Alene River sub-basin (Hydrological Unit Code 1710302), which includes the SFCDR and its tributaries. USEPA also recognizes that other requirements are under development but are not yet finalized (e.g., Coeur d'Alene Tribal water quality standards).

8. Description of Alternatives

The overall purpose of the FFS Report (USEPA, 2010) was to identify and evaluate two kinds of alternatives that address unacceptable exposures to human health and the environment in the Upper Coeur d'Alene Basin:

- Remedial alternatives that address the widespread contamination impacting surface water in the Upper Basin; and
- Remedy protection alternatives that enhance the protectiveness of the existing human health remedies for OUs 1, 2, and 3.

As described previously, ecological remedies selected in previous decision documents, like the interim remedy described in the ROD for OU 3 (USEPA, 2002), could not be implemented for several reasons, including availability of funding, cost, and uncertainties involved with predicting their effectiveness, particularly on a Basin-wide basis. Since the 2001 NRRB Presentation Information (USEPA, 2001b; Supplemental CD, File B2-1) was submitted and reviewed, USEPA has conducted studies and collected data with which to identify a comprehensive solution to the ecological conditions in the Upper Basin. At the same time, USEPA has implemented significant portions of the human health remedies and has observed and evaluated impacts to protective barriers that may affect the protectiveness of the remedies. In the development and evaluation of the alternatives in the FFS Report, remedial actions that can be applied incrementally by using an adaptive management approach were favored, as was maximizing the effectiveness of limited resources.

8.1 Remedial Alternatives

A general framework of alternatives to meet CERCLA goals and objectives was developed and evaluated in the FFS Report. Remedial alternatives were first developed separately for the Upper Basin portion of OU 3 and for OU 2. These separate alternatives were then combined to produce 10 combined remedial alternatives that address all of the Upper Basin. These combined remedial alternatives, along with a No Action Alternative included for baseline comparison purposes, were evaluated in the FFS Report, using the CERCLA threshold and primary balancing criteria to identify a comprehensive surface water remedy for the Upper Basin. A detailed description of the FFS approach is provided in Part B, Section 3.3 of this Site Information Package.

The remedial alternatives for the Upper Basin portion of OU 3 and for OU 2 are described in Sections 8.1.1 and 8.1.2, respectively.

8.1.1 Remedial Alternatives for the Upper Basin Portion of OU 3

In the 2001 FS Report (USEPA, 2001d), six remedial alternatives, including Alternative 1 (No Action), were selected for evaluation to address ecological risks posed to fish, waterfowl, other birds, and plants in the Upper and Lower Basins. Of these, Ecological Alternatives 1, 2, 5, and 6 were not retained for further evaluation because they were determined to be

inadequately protective of human health and the environment. Ecological Alternative 3, More Extensive Removal, Disposal, and Treatment, and Ecological Alternative 4, Maximum Removal, Disposal, and Treatment, were determined to be protective of human health and the environment, and were NCP-compliant. The ROD for OU 3 (USEPA, 2002) selected a prioritized subset of actions from Ecological Alternative 3. Ecological Alternatives 3 and 4 were retained for more detailed evaluation in the FFS, and USEPA used data and study results obtained since the 2002 ROD for OU 3 to update and expand these alternatives in the FFS Report.

The sources and types of new information are outlined in File B2-3 on the Supplemental CD provided with this Site Information Package, and have resulted in the following:

- Development of a numerical groundwater model for the SFCDR Watershed (CH2M HILL, 2009a) that can be used to quantitatively assess the effectiveness of various remedial actions targeting groundwater
- Development of new or substantially revised TCDs for remedial actions not covered by TCDs derived from the 2001 FS Report
- Updated TCDs for water treatment based on pilot treatability studies. The updated TCDs include changes in the location of the centralized, active treatment plant and the manner of providing onsite semi-passive treatment
- Modification of the amount of material acted upon based on remedial work conducted since the 2002 ROD for OU 3
- An improved understanding of hydrogeologic conditions, particularly in Woodland Park (within the Canyon Creek Watershed) and Osburn Flats

The updated and expanded remedial alternatives are referred to as Alternatives 3+ and 4+ for the Upper Basin portion of OU 3. The alternative development process included identification and screening of all potentially applicable technologies and process options. The retained technologies and process options were then assembled into TCDs, which were used as building blocks for assembling the remedial alternatives. The TCDs identified in the 2001 FS Report as part of Ecological Alternatives 3 and 4 were retained to develop the remedial alternatives selected in the FFS Report. Table B8-1 lists and describes the selected TCDs.

An overview of the source areas included in Alternatives 3+ and 4+ and the overall distribution of contaminated sites to be addressed under these alternatives are shown in Figure A-2. Alternatives 3+ and 4+ consider the same sites for potential remedies as were considered in Ecological Alternatives 3 and 4 in the 2001 FS Report. As shown below, a total of 760 sites are included.

Sites	Alternative 3	Alternative 3+	Alternative 4	Alternative 4+
Sites with Proposed Action(s)	332	345	699	702
Sites with No Proposed Actions	428	415	61	58
Total	**760**	**760**	**760**	**760**

The differences between Ecological Alternative 3 and Alternative 3+ and between Ecological Alternative 4 and Alternative 4+ are relatively minor in terms of the number of sites that have changed from no proposed actions to proposed action(s). Groups of sites and associated remedial actions in OU 3 that were modified for the FFS evaluation based on the application of new information included the following:

- **Sites added on the basis of relatively high estimated dissolved metals loading to surface water.** Based on analysis of site data that were not available at the time of the 2001 FS Report, 11 sites were added to Alternative 3+ on the basis of relatively high estimated dissolved metals loading to surface water. None of these sites were included in Ecological Alternative 3 in the 2001 FS Report, but seven of them were included in Ecological Alternative 4 in the 2001 FS Report. Therefore, only three sites were added to Alternative 4+.

- **Tailings impoundment closure at active sites.** Actions at four former or currently operating sites were changed from hydraulic isolation to hydraulic isolation and capping in both Alternatives 3+ and 4+. These sites were acknowledged in the 2001 FS Report, but a complete remedial action was not identified.

- **Updated conceptual design for hydraulic isolation.** The method by which hydraulic isolation will be accomplished at six sites along the SFCDR was revised for Alternatives 3+ and 4+. Hydraulic isolation by slurry walls was replaced with hydraulic isolation using stream liners and French drains based on an updated analysis.

- **Updated conceptual design for water treatment.** A total of 60 sites in Alternative 3+ and 99 sites in Alternative 4+ include different water treatment TCDs than those included in Ecological Alternatives 3 and 4, respectively, in the 2001 FS Report. The updated TCDs include changes, resulting from further analysis, in the location of the centralized, active treatment plant, the method of treatment for specific sites (active to semi-passive and vice versa), and the manner of providing semi-passive treatment.

- **Sites changed to No Action.** Two sites in the Pine Creek Watershed were changed to "No Action," and the volume of material to be acted upon at six additional sites was reduced based on remedial work conducted by BLM since issuance of the ROD for OU 3. The same changes to these sites were made in both Alternatives 3+ and 4+.

- **Sites located within the Woodland Park area of Canyon Creek.** Woodland Park has been an area of focused study since the ROD for OU 3 was issued because (1) it is a significant source of dissolved metals loading to surface water in the Upper Basin, and (2) it is an alluvial area where, when the ROD for OU 3 was published, the groundwater system and groundwater-surface water interactions were not well understood. The post-ROD studies included groundwater modeling, groundwater-surface water interaction studies, and water treatability studies. These studies found that the surface water treatment actions included for Woodland Park in Ecological Alternative 3 in the 2001 FS Report were not feasible. It was determined, based on groundwater modeling, that by treating groundwater with relatively high metals concentrations, remedial objectives could be achieved more efficiently. Remedial components for Alternatives 3+ and 4+ for Woodland Park have been developed based on the post-ROD studies and evaluation of remedial options.

As was the case with Ecological Alternatives 3 and 4 of the 2001 FS Report, the primary difference between Alternatives 3+ and 4+ is the extent of excavation and removal of wastes. Alternative 3+ focuses on a combination of in-place containment and excavation of wastes inside the nominal 100-year floodplain, as well as wastes outside the 100-year floodplain that are probable sources of metals loading. Active and semi-passive water treatment of adit drainages and hydraulic isolation of groundwater is also included in Alternative 3+. Under Alternative 3+, an estimated average flow of 12,000 gallons per minute (gpm) of contaminated water would be treated at the CTP located in Kellogg, Idaho, and an additional 800 gpm would be treated by onsite semi-passive systems.

Alternative 4+ focuses on complete excavation and hydraulic isolation of all known wastes that are probable sources of metals loading. Wastes that are outside the 100-year floodplain and probably not significant sources of metals loading would be covered in place. Expanded use of active and semi-passive water treatment of adit drainages and hydraulic isolation of groundwater are also included in Alternative 4+. Under Alternative 4+, an estimated average flow of 14,000 gpm of contaminated water would be treated at the CTP and an additional 1,500 gpm would be treated by onsite semi-passive systems. The remedial actions included in Alternatives 3+ and 4+ are summarized in Table B8-2.

8.1.2 Remedial Alternatives for OU 2

The OU 2 remedial alternatives were developed by taking into consideration Phase I remedial actions completed in OU 2 by USEPA and IDEQ from 1994 to 2002 and the effectiveness of those actions. Considering those, remedial alternatives with the potential to address significant portions of the remaining metals loading to the SFCDR in the Bunker Hill Box were identified for Phase II work in OU 2.

Phase I work at OU 2 focused on remedial actions that removed and/or consolidated contamination from various areas; demolition of structures; development and implementation of an ICP for OUs 1 and 2; studies of long-term water quality improvement; and evaluation of remedial action effectiveness. The Phase I effectiveness evaluation (CH2M HILL, 2007c) indicated that the largest source of dissolved metals contamination to groundwater and surface water at OU 2 is contaminated materials located in floodplains and beneath the populated areas and infrastructure within the Bunker Hill Box. Because of the widespread nature of the contaminated materials and the complexity of contaminant transport within OU 2, a remedial approach focusing on groundwater-based actions was developed. To support this, a groundwater flow model (CH2M HILL, 2009a) was constructed, calibrated, and used to assist with the development of Phase II remedial alternatives. Model simulations were performed on all water management/collection actions, and subsequent load reductions for each action were estimated. A cost-benefit analysis was also performed for each individual action based on the cost per pound of dissolved zinc load reduction to the SFCDR.

The development of remedial alternatives focused on general response actions consisting of source control, water collection and management, and water treatment, which were combined into the five potential OU 2 Alternatives (a) through (e).

One water collection and management action for the Reed and Russell adit discharge (part of the Bunker Hill Mine) would be addressed with the same action in each of the five

defined remedial alternatives. This action comprises a check dam installed in each tunnel in the interior of the mine to keep the Bunker Hill Mine AMD from flowing out of the adit, and instead redirect it back into the mine. If the required water quality criteria were not achieved in the residual Reed and Russell adit discharge, additional measures would be implemented to collect and convey the AMD by constructing a collection system and pipeline that would ultimately drain, along with all other AMD from the Bunker Hill Mine, to the CTP for active treatment.

The five OU 2 remedial alternatives are as follows:

- **OU 2 Alternative (a): Minimal Stream Lining.** OU 2 Alternative (a) consists of limited stream-lining actions in losing reaches of OU 2 streams to reduce recharge to the shallow alluvial groundwater system. Actions would include lining the SFCDR on the north side of the CIA; lining Bunker, Deadwood, and Magnet Creeks where they cross the SFCDR alluvial deposits; and phased implementation of the Reed and Russell Tunnel actions discussed above. No water treatment would occur under this alternative.

- **OU 2 Alternative (b): Extensive Stream Lining.** OU 2 Alternative (b) consists of extensive stream-lining actions in OU 2 streams to reduce recharge to the shallow alluvial groundwater system. Groundwater cutoff walls would be installed at select locations as part of this alternative. Actions would include lining Bunker, Government, Deadwood, and Magnet Creeks over their full length from far up the gulch down to the SFCDR; installing a slurry wall and extraction wells upgradient from tributary stream liners (except Bunker Creek) to direct clean groundwater into the lined channels; and phased implementation of the Reed and Russell Tunnel actions discussed above**.** An estimated average flow of 190 gpm of contaminated groundwater collected in under-liner drains (which would be needed to prevent floating of the liners) would be treated at the CTP. The lining of the SFCDR included in OU 2 Alternative (a) is not part of OU 2 Alternative (b).

- **OU 2 Alternative (c): French Drains.** OU 2 Alternative (c) consists of a French drain system located in the central portion of OU 2, along the northern end of the CIA in the area with the highest dissolved metals load gains observed in the SFCDR. This French drain system would intercept dissolved-metals-contaminated groundwater prior to discharging to the SFCDR. Actions include installing a French drain along the northwest end of the CIA and to the southwest across the SFCDR valley floor, terminating on the west side of Government Gulch; conveyance of collected water to the CTP for treatment; conveyance of the CTP effluent directly to the SFCDR in a pipeline installed on the east side of the CIA (instead of discharging to Bunker Creek as is currently done); and phased implementation of the Reed and Russell Tunnel actions discussed above. An estimated average flow of 4,000 gpm of contaminated groundwater would be treated at the CTP.

- **OU 2 Alternative (d): Stream Lining/French Drain Combination.** OU 2 Alternative (d) consists of French drains, stream linings, cutoff walls, and extraction wells located in the central portion of OU 2, primarily in the area with the highest dissolved metals load gains observed in the SFCDR. Actions would include lining Government Creek; installing a slurry wall and extraction wells across Government Gulch (on the upgradient end of the liner); installing a French drain along the northwest end of the

CIA (that extends south from the drain above and across the SFCDR valley, terminating on the east side of Government Gulch); conveying collected water to the CTP for treatment; installing extraction wells across the mouth of Government Gulch and conveying this water to the CTP for treatment; conveying treated CTP effluent directly into the SFCDR within a pipeline that is installed on the east side of the CIA; and phased implementation of the Reed and Russell Tunnel actions discussed above. An estimated average flow of 4,000 gpm of contaminated groundwater would be treated at the CTP.

- **OU 2 Alternative (e): Extensive Stream Lining/French Drain Combination.** OU 2 Alternative (e) is the most extensive water collection and management alternative, incorporating extensive stream lining of the SFCDR and its tributaries, as well as French drain systems. Actions would include lining of the SFCDR and Bunker, Government, Deadwood, Magnet, Grouse, and Humbolt Creeks; installing a French drain along the northern end of the CIA in the area with the highest dissolved metals load gains observed in the SFCDR, as in OU 2 Alternatives (c) and (d), and conveying the collected water to the CTP for treatment; installing a French drain extending from mid-Smelterville Flats west to the Pinehurst Narrows, and conveying the collected water to the CTP for treatment; installing slurry walls and extraction wells upgradient of tributary liners (except Bunker Creek) to guide groundwater into the lined channels; installing slurry walls and extraction wells across the SFCDR valley floor at Elizabeth Park and Pinehurst Narrows (slurry wall only); and phased implementation of the Reed and Russell Tunnel actions discussed above. An estimated average flow of 2,500 gpm of contaminated groundwater would be treated at the CTP.

8.1.3 Combined Remedial Alternatives for Upper Basin Portion of OU 3 and OU 2

Each combined remedial alternative for Upper Basin surface water consists of components for the Upper Basin portion of OU 3 and for OU 2. The two alternatives for OU 3 (3+ and 4+) are combined with the five alternatives for OU 2 (a through e) to create 10 remedial alternatives that were evaluated in the FFS Report. Figure B8-1 is a schematic illustration of how the 10 remedial alternatives were developed. Together with the No Action Alternative that is included for baseline comparison purposes, a total of 11 alternatives for Upper Basin surface water were evaluated in the FFS Report. These are listed below.

Remedial Alternative	Description
No Action Alternative	No Action
Alternative 3+(a)	OU 3 Alternative 3+ (More Extensive Removal, Disposal, and Treatment) and OU 2 Alternative (a) – Minimal Stream Lining
Alternative 3+(b)	OU 3 Alternative 3+ and OU 2 Alternative (b) – Extensive Stream Lining
Alternative 3+(c)	OU 3 Alternative 3+ and OU 2 Alternative (c) – French Drains
Alternative 3+(d)	OU 3 Alternative 3+ and OU 2 Alternative (d) – Stream Lining/French Drain Combination
Alternative 3+(e)	OU 3 Alternative 3+ and OU 2 Alternative (e) – Extensive Stream Lining/French Drain Combination

Remedial Alternative	Description
Alternative 4+(a)	OU 3 Alternative 4+ (Maximum Removal, Disposal, and Treatment) and OU 2 Alternative (a) – Minimal Stream Lining
Alternative 4+(b)	OU 3 Alternative 4+ and OU 2 Alternative (b) – Extensive Stream Lining
Alternative 4+(c)	OU 3 Alternative 4+ and OU 2 Alternative (c) – French Drains
Alternative 4+(d)	OU 3 Alternative 4+ and OU 2 Alternative (d) – Stream Lining/French Drain Combination
Alternative 4+(e)	OU 3 Alternative 4+ and OU 2 Alternative (e) – Extensive Stream Lining/French Drain Combination

8.2 Remedy Protection Alternatives

The remedy protection alternatives for the Upper Basin focus on soil remedial actions completed as part of the human health remedies (the "selected remedies") identified in the RODs for OUs 1, 2, and 3 (USEPA, 1991a, 1992, and 2002, respectively). The selected remedies include the placement of clean, protective barriers that are installed in residential, commercial, common use, and right-of-way areas to prevent direct contact exposure to mining-related contaminants in soil. Long-term maintenance of these barriers is a key component of the success of these remedies. To date, the selected remedies that have been implemented are functioning as designed and are protective of human health, as documented in CERCLA Five-Year Review Reports (USEPA, 2000a, 2000c, and 2005). However, USEPA is aware of certain limited circumstances where the potential for adverse impacts from erosion has already threatened or could threaten the long-term effectiveness and permanence of these remedies.

Before developing alternatives to enhance the protectiveness of the selected remedies in the Upper Basin, the potential threats of damage posed to the remedies by localized storm events were assessed. The assessment focused on eight of the most densely populated communities in Upper Basin: Pinehurst, Smelterville, Kellogg, Wardner, Osburn, Silverton, Wallace, and Mullan. Erosion (or scour) of clean barriers that exposes contamination and deposition of contaminated sediments on previously clean barriers are the major threats posed to the existing selected remedies. The threat of sediment deposition exists in the following scenarios: (1) deposition of contaminated creek sediments on protective barriers if a creek overtops its banks during a flood; (2) scour of contaminated materials below a protective barrier and deposition of these materials on a previously clean area; and (3) scour of contaminated materials from a nearby hillside or other source and deposition of these materials on previously clean barriers.

The remedy protection alternatives evaluated in the FFS Report focus on localized flooding and high-precipitation (storm) events. These events can impact human health and the environment by eroding protective barriers and/or by depositing contaminated sediments in previously clean areas, thereby exposing contaminated soil and gravel to humans and ecological receptors. Hydrologic and hydraulic model outputs provided the total expected impact area of barrier scouring and resultant deposition of potentially contaminated sediments for 5-, 25-, and 50-year storm events. The results of these analyses were used to

assess whether remedy protection projects could improve the long-term effectiveness and permanence of the in-place barriers within each community.

The two remedy protection alternatives are described below.

Remedy Protection Alternative	Description
Alternative RP-1	No Further Action (Post-Event Response)
Alternative RP-2	Modifications to Selected Remedies to Enhance Protectiveness (Remedy Protection Projects)

- **Alternative RP-1: No Further Action (Post-Event Response).** Alternative RP-1 would not modify any of the existing conditions in the Upper Basin to increase the current level of long-term permanence of the existing selected remedies. Alternative RP-1 assumes that property owners would continue to comply with the ICP. The ICP is implemented by the Panhandle Health District and regulates excavation activities and contaminant migration away from properties for purposes of long-term maintenance of the selected remedies. If the existing selected remedies were damaged during storm events and this damage posed risks to human health and/or the environment that warranted response actions to reduce the risks, USEPA and state agencies would determine the best tools for addressing such contamination. In the event of catastrophic flooding, USEPA, other federal agencies, and state agencies would evaluate response needs as appropriate. Because various amounts of the existing selected remedies are expected to be damaged during storm events, based on hydrologic and hydraulic analyses conducted as part of the FFS, Alternative RP-1 includes the estimated costs for repair of the selected remedies in the eight Upper Basin communities. Although detailed analyses were not conducted for the side gulches (i.e., drainages located outside the eight Upper Basin communities), the expected damage due to storm events was estimated based on the trends found in the hydrologic and hydraulic analyses of the Upper Basin communities.
- **Alternative RP-2: Modifications to Selected Remedies to Enhance Protectiveness (Remedy Protection Projects).** Alternative RP-2 is composed of combinations of various technology and process options to protect the existing selected remedies against flooding and high precipitation events up to the 50-year storm event (Table B8-3). Each community has different water conveyance infrastructure-related issues that pose risks to the selected remedies. These water conveyance issues depend on the geography and changing environmental conditions common to mountainous drainage areas. General technologies and process options that could be applicable to remedy protection projects were developed from common engineering practice for stormwater conveyance projects. The technologies and process options identified to mitigate the risks posed to the existing selected remedies in Alternative RP-2 were determined based on current existing conditions in each community area, and the hydrologic and hydraulic analyses. For the purposes of this evaluation, the Alternative RP-2 remedy protection projects and estimated costs were preliminarily defined for each of the eight communities. Although detailed analyses were not conducted for the side gulches, approximate costs to address problems in the side gulches were developed for Alternative RP-2 based on the trends found in the analysis of the Upper Basin communities. These costs represent estimates of

the resources it would take to implement expected remedy protection projects in the side gulches based on trends observed in the development of Alternative RP-2 for the eight Upper Basin communities.

9. Comparative Analysis of Alternatives

This section compares the alternatives with one another in terms of the CERCLA threshold and primary balancing evaluation criteria required by the NCP. The purpose of this comparative analysis is to identify the relative advantages and disadvantages of the alternatives in terms of these CERCLA criteria. The comparative analysis is also designed to identify the key tradeoffs that decisionmakers must balance in the remedy selection process. Section 9.1 presents the comparative analysis of the 11 remedial alternatives, and Section 9.2 presents the comparative analysis of the two remedy protection alternatives.

9.1 Remedial Alternatives

The comparative analysis of the No Action Alternative and Alternatives 3+(a) through 3+(e) is provided in Table B9-1a, and the comparative analysis for Alternatives 4+(a) through 4+(e) is provided in Table B9-1b.

Key technical issues identified for comparison between the remedial alternatives included the following:

- **Impacted sediment accessibility.** Impacted sediments located in river banks and beds are a major source of dissolved metals loading in the Upper Basin. Many of these impacted sediments are inaccessible, located under I-90 and other infrastructure or on private property. Cleanup or isolation of these impacted sediments is difficult and costly, with impacts on the local communities and the natural environment.
- **Time to achieve ARARs compliance.** None of the alternatives are likely to attain compliance with chemical-specific ARARs immediately following implementation; a period of natural recovery is required for all the alternatives.
- **Availability of materials.** Uncontaminated materials are required for covers, backfill, and revegetation actions included in the alternatives. Obtaining these materials in enough quantity could present challenges in implementing the alternatives and cause environmental impacts at offsite source locations.
- **Repository siting.** Finding suitable available sites and fulfilling substantive permit requirements of action- and location-specific ARARs for siting and construction of repositories may be difficult.
- **Long-term management and associated costs.** Overall operation and maintenance (O&M) requirements are associated with engineered controls such as repositories, groundwater containment systems, and active and semi-passive water treatment systems.
- **Socio-economic impacts.** Construction associated with implementation of the remedy will have short-term "quality of life" and potential economic impacts for the local

communities. These include increased truck traffic, dust, noise, disruption of services and recreational opportunities, and reduced aesthetic quality.

In the following sections, the comparative analysis of the remedial alternatives is presented in terms of the CERCLA threshold criteria in Sections 9.1.1 and 9.1.2, and the CERCLA primary balancing criteria in Sections 9.1.3 through 9.1.7.

9.1.1 Overall Protection of Human Health and the Environment

All of the alternatives, except the No Action Alternative, achieve the criterion of overall protection of human health and the environment. All of the alternatives based on Alternative 3+ rank slightly higher under this criterion than those based on Alternative 4+, regardless of which OU 2 alternative is included. The estimated implementation time frame for Alternative 4+ may be decades longer than that for Alternative 3+ and, during this time, Alternative 4+ would involve construction-related risks for workers, the community, and the environment resulting from the massive extent of long-term construction and hauling involved, which are risks that are considered to outweigh the long-term benefits of the proposed actions. Alternative 4+ would also have the greatest short-term environmental effects at offsite locations where borrow materials would be obtained. Implementation time frames are shorter for Alternative 3+, and the remedial actions are less extensive and carry fewer risks to workers, the community, and the environment.

The differences in ranking under the criterion of overall protection of human health and the environment amongst the OU 2 alternatives do not outweigh the differences between Alternatives 3+ and 4+ overall. However, in balancing the overall effectiveness with short-term risks, the ranking of the OU 2 alternatives under this criterion, from highest to lowest, is as follows: d, c, b, a, and e. The No Action Alternative ranks the lowest under this criterion because of the low level of protectiveness it would provide to human health and the environment.

Remedial action effectiveness was evaluated in the FFS Report (USEPA, 2010) using both numerical groundwater models (CH2M HILL, 2007a, 2009a) and Predictive Analysis (USEPA, 2007; CH2M HILL, 2009f). In general, the groundwater models were used to estimate metals load reductions for actions involving groundwater collection, and the Predictive Analysis was used to estimate load reductions for remaining actions within the alternatives. The Predictive Analysis was initially developed to support the evaluation of alternatives in the 2001 FS Report (USEPA, 2001d), and was subsequently used to support evaluations in the Proposed Plan and ROD for OU 3 (USEPA, 2002). Documentation for the Predictive Analysis (referred to as the Probabilistic Analysis at the time) was initially provided in a 2001 Technical Memorandum titled *Probabilistic Analysis of Post-Remediation Metal Loading* (URS Greiner, 2001b). The Predictive Analysis was evaluated as part of the review conducted by the NAS (2005). Following the NAS review, a second technical memorandum, *A Predictive Analysis for Post-Remediation Metals Loading,* was prepared by USEPA (2007). This second memorandum provided clarification and additional documentation related to the Predictive Analysis, but the fundamentals of the analysis have remained unchanged since its initial development for the 2001 FS Report. To support the current effort, the Predictive Analysis has been updated to include data through August 2009 and modified to include the remedial actions that comprise the remedial alternatives in the FFS Report (USEPA, 2010).

9.1.2 Compliance with ARARs

Based on the results of the Predictive Analysis, none of the alternatives are likely to attain chemical-specific ARARs in the SFCDR at Pinehurst immediately following implementation. However, there are differences between the initial effectiveness of each alternative in reducing AWQC ratios, as shown below. The results of this analysis indicate that all of the action alternatives would meet the threshold criterion of compliance with ARARs for surface water, but only after a natural source depletion period, which is common to all of the alternatives. The period of time required is expected to be related to the water quality improvement achieved.

Alternative	Estimated Post-Remediation AWQC Ratio for Dissolved Zinc at Pinehurst	Post-Remediation Dissolved Zinc Load Reduction at Pinehurst
Alternative 4+(e)	1.1	1,490 lb/day (70%)
Alternative 3+(e)	1.3	1,380 lb/day (66%)
Alternative 4+(d)	1.3	1,410 lb/day (67%)
Alternative 4+(c)	1.4	1,390 lb/day (65%)
Alternative 3+(d)	1.5	1,310 lb/day (62%)
Alternative 3+(c)	1.5	1,280 lb/day (60%)
Alternative 4+(a)	2.7	990 lb/day (47%)
Alternative 4+(b)	2.7	983 lb/day (46%)
Alternative 3+(a)	2.8	884 lb/day (42%)
Alternative 3+(b)	2.8	877 lb/day (41%)
No Action Alternative	4.3	N/A

lb/day = pound(s) per day

Alternatives 4+(c) through (e) and 3+(c) through (e) are estimated to achieve ARARs within approximately the same time frame and within a shorter time frame than is estimated for the other alternatives. Alternatives 4+(a) and (b) and 3+(a) and (b) would require more time to achieve surface water ARARs. The No Action Alternative, because it would have to rely solely upon natural source depletion for achievement of ARARs, would require the most time to achieve surface water ARARs; therefore, it is ranked the lowest of all alternatives under this criterion.

9.1.3 Long-Term Effectiveness and Permanence

All of the alternatives based on Alternative 4+ rank slightly higher under the criterion of long-term effectiveness than those based on Alternative 3+, regardless of which OU 2 alternative it is coupled with. Alternative 4+ affords the highest degree of long-term effectiveness and permanence and would result in the fewest residual risks to human health and ecological receptors. Alternative 4+ has a higher degree of permanence than Alternative 3+ as a result of the much higher volumes of contaminated materials that would be removed as sources of loading from the system and managed in repositories. The

estimated effectiveness at completion of remedial actions is also slightly higher for Alternative 4+ than for Alternative 3+. The differences in ranking among the OU 2 alternatives under this criterion do not outweigh the differences between Alternatives 3+ and 4+. The ranking of the OU 2 alternatives under this criterion, from highest to lowest, is as follows: e, d, c, a, and b. This ranking is based on the relative differences in post-remedial dissolved zinc loads in the SFCDR, immediately following the implementation of remedial actions.

9.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

All the remedial alternatives are considered to satisfy the statutory preference for treatment, and the treated water flow rates are relatively similar for all the alternatives. OU 2 Alternatives (a) and (b) do not include treatment and, therefore, rank lower under this criterion. Alternative 4+ ranks higher than Alternative 3+ because, although the estimated flow rate for treatment at the CTP is very similar, a significantly higher number of adit discharges would be treated under Alternative 4+. The statutory preference for treatment is satisfied through reduction of total volume of contaminated media—in this case, surface water. The water treatment technologies to be employed would separate the metals from the water. These metals would then require disposal in repositories. For each of the remedial alternatives except for No Action, Tables B9-1a and B-91b present an estimate of the total dissolved zinc load removed from the water through treatment (and therefore a reduction in the zinc loading to the surface water). The estimates in Table B9-1a range from 700 pounds per day (lb/day) for Alternative 3+(a) to 1,880 lb/day for Alternative 3+(d); the estimates in Table B9-1b range from 600 lb/day for Alternative 4+(a) to 1,760 lb/day for Alternative 4+(d).

9.1.5 Short-Term Effectiveness

All of the alternatives based on Alternative 3+ rank higher under the criterion of short-term effectiveness than those based on Alternative 4+ because Alternative 4+ would pose much greater short-term negative impacts during construction than Alternative 3+, regardless of which OU 2 alternative it is coupled with. This is primarily due to the extensive nature of the remedial actions that would be conducted under Alternative 4+, which would require a much longer time period to complete (decades longer); the similar water quality expected to be achieved after the implementation of remedial actions; and the similar time frame needed for natural source depletion to further improve water quality and achieve ARARs. The ranking of the OU 2 alternatives from highest to lowest short-term effectiveness is as follows: d, c, b, a, and e. This ranking is based on a balance of implementation time, effectiveness, and short-term risks.

9.1.6 Implementability

All of the alternatives based on Alternative 3+ rank higher under the criterion of implementability than those based on Alternative 4+, because Alternative 4+ would have substantially increased technical and administrative feasibility considerations compared to Alternative 3+. Alternative 4+ has generally the same types of implementability considerations as Alternative 3+, but with much larger quantities and larger repository requirements. The ranking of the OU 2 alternatives from most to least desirable on the basis of implementability is as follows: c, d, b, a, and e.

9.1.7 Cost

Estimated costs for each remedial alternative are presented in Tables B9-1a and B9-1b. As shown, costs for Alternative 4+ are consistently higher than those for Alternative 3+, regardless of which OU 2 alternative it is coupled with. The ranking of the OU 2 alternatives based on lowest cost to highest cost is as follows: b, c, d, a, and e. The cost for OU 2 Alternative (a) is higher than the cost for OU 2 Alternative (b) because, although (b) includes more linear feet of stream liner, (a) includes a liner on the SFCDR that carries a significantly higher cost. In addition, Figure B9-1 depicts the relationship between the total cost (30-year NPV) and the post-remediation AWQC ratios at the Pinehurst monitoring location for each alternative.

9.2 Remedy Protection Alternatives

The remedy protection alternatives aim to enhance the existing selected human health remedies. As discussed in Part B, Section 1, the evaluation of portions of the selected remedies was consistent with USEPA's adaptive management of the Bunker Hill Superfund Site. The existing selected remedies were determined to be protective of human health and the environment in OUs 1, 2, and 3 in the most recent CERCLA Five Year Review Report (USEPA, 2005). In order to identify the best way to augment these remedies, the alternatives were compared using the CERCLA threshold and primary balancing criteria

The comparative analysis of the remedy protection alternatives is presented in Table B9-2 and summarized below.

- Both Alternative RP-1 and Alternative RP-2 would be protective of human health and the environment because the existing selected human health remedies have been shown to be protective (USEPA, 2005). Alternative RP-2 would be more protective of human health and the environment because it would increase the long-term effectiveness and permanence of the existing selected remedies by decreasing the risk of recontamination due to flooding and uncontrolled surface water flow.
- Both Alternative RP-1 and Alternative RP-2 can be implemented in compliance with location- and action-specific ARARs. (Chemical-specific ARARs were not included in the analysis because the remedy protection alternatives would enhance the selected remedies and would not directly address metals contamination.)
- Alternative RP-2 would increase the long-term effectiveness and permanence of the existing selected remedies by enhancing flooding and surface water controls, thereby decreasing the risk of recontamination and damage to the selected remedies due to flooding and uncontrolled surface water flows. Alternative RP-1 would only maintain and repair the existing selected remedies if they were damaged or recontaminated.
- Neither Alternative RP-1 nor Alternative RP-2 would include treatment and, therefore, neither would reduce the toxicity, mobility, or volume of metals contamination through treatment.
- Both alternatives would be effective in the short term because the existing selected remedies have proven effective in protecting human health and the environment.

Alternative RP-2 would reduce the mobility of potentially contaminated sediments transported by floodwaters and surface water flows through the communities by effectively conveying floodwaters up to a 50-year storm event, thereby reducing the potential routes of exposure. Alternative RP-1 would not reduce the current mobility of contaminated sediments transported by floodwaters through the communities.

- Both Alternative RP-1 and Alternative RP-2 are implementable, but each would have typical implementation issues that would need to be addressed. Alternative RP-1 would require cleanup of recontaminated or scoured portions of the selected remedies. The effective implementation of Alternative RP-1 would require a coordinated overall response within the communities. Administrative implementability issues would exist for Alternative RP-1 with respect to the repair and replacement of the selected remedies following storm events. These storm events cannot be predicted, and the availability of funds to repair the selected remedies and maintain their protectiveness in the future is unknown. In some cases, the repair of the protective barriers could be time-sensitive in order to maintain protectiveness and limit community residents' risk of exposure.

  By comparison, Alternative RP-2 would have minimal implementability issues. Alternative RP-2's only technical implementation issue is that it would be beneficial to implement the remedy protection projects during the low-flow season to minimize cost. Alternative RP-2 would have administrative implementability issues associated with O&M of the water conveyance improvement projects. Prior to construction, the local and state agencies would need to determine which parties will perform O&M tasks and ensure that sufficient resources are available. Additionally, there would be logistical feasibility issues associated with construction of the remedy protection projects on private property. Access and easement agreements would have to be obtained prior to the implementation of Alternative RP-2.

- Alternative RP-2 would cost less than Alternative RP-1. Table B9-2 presents a side-by-side comparison of the total costs (30-year net present value [NPV]) for Alternatives RP-1 and Alternative RP-2. The total cost (30-year NPV) for Alternative RP-1 includes the expected cost to repair and re-remediate the existing selected remedies based on model outputs and flood event probabilities. These total costs include estimated costs for the side gulches. Detailed analyses were not conducted for the side gulches, but approximate costs were developed based on trends observed in the Upper Basin communities (see Appendix D of the FFS Report, which has been included as File 14-1 on the Supplemental CD provided with this Site Information Package).

10. Principal Threat Materials

The NCP has established an expectation that USEPA will use treatment to address the principal threats posed by a site wherever practicable (NCP §300.430(a)(1)(iii)(A)). Where USEPA determines that it is not practicable to use treatment to address principal threat materials (PTM), they may be transported offsite, consistent with the Off-Site Disposal Rule, 40 CFR 300.440, or managed safely onsite, consistent with all ARARs. This may include containment and consolidation in a PTM cell that has a secure liner system.

PTM are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained and/or would present a significant risk to human health or the environment if exposure were to occur (USEPA, 1991b). Additional information for defining PTM can be found in *A Guide to Principal Threat and Low Level Threat Wastes* (USEPA, 1991b). The guidance notes that identification of PTM is made on a site-specific basis and is intended to help streamline and focus the remedy selection process.

As noted in the 2002 ROD for OU 3 (USEPA, 2002), it is not believed that PTM will be encountered during cleanup conducted in the Upper Basin. The following concentrations were used to define PTM in the Bunker Hill Box (USEPA, 1992) and OU 3 (USEPA, 2002):

Parameter	PTM Concentrations (parts per million [ppm])
Antimony	127,000 ppm
Arsenic	15,000 ppm
Cadmium	71,000 ppm
Lead	84,600 ppm
Mercury	33,000 ppm

The 1996 ROD Amendment for OU 2 (USEPA, 1996b) required that all PTM be placed in a high-density polyethylene (HDPE) bottom-lined and three-ply copolymer top-lined monocell. The PTM monocell is contained within the larger SCA and under the SCA's HDPE cap, affording an additional layer of protection for the PTM monocell. Because of the mobility and toxicity of mercury, free mercury PTM were stabilized using a specific concrete mix developed as a result of analysis and bench testing prior to placement in the PTM monocell. Other materials classified as PTM due to the presence of one or more other threshold metals (antimony, arsenic, cadmium, and lead) were placed in the monocell without treatment because they were determined to be stable. A time-critical removal action was conducted in 1999 to address all known surface contamination associated with rail transport along the Wallace-Mullan branch of the Union Pacific Railroad.

While additional PTM are not expected, if additional concentrates or other materials that meet the definition of PTM are encountered during remedy implementation, these materials would be managed in a manner that is protective of human health and the environment and

consistent with the NCP. Additional site characterization sampling will likely be required as part of the remedial design process. The resulting data will be reviewed to determine the presence of PTM and, if found, the volume of the PTM will be determined, as will the necessary management and disposal approach.

11. Preferred Alternative

The Preferred Alternative for the Upper Basin of the Coeur d'Alene River represents a final remedy for:

- Human health protection for surface water used for drinking purposes;
- Ecological protection for surface water; and
- Human health and ecological protection for soil, sediments, and source material in locations where remedial actions are taken.

The Preferred Alternative would also provide enhanced protection of human health and the environment for portions of previously selected human health remedies that are vulnerable to erosion and degradation of clean barriers.

Further, the Preferred Alternative is expected to significantly reduce both groundwater contamination levels and the contribution of contaminated groundwater to surface water. However, given the pervasive nature of the subsurface contamination, the Preferred Alternative may not achieve the drinking water standards for groundwater at all locations. USEPA will evaluate future monitoring data to determine whether a TI waiver may be warranted at locations where groundwater does not achieve drinking water standards.

Remedial Alternative 3+(d) and Remedy Protection Alternative RP-2 are the two components of the Preferred Alternative. They are discussed in Sections 11.1 and 11.2, respectively, which include a description of the component, the key factors that led to its identification, and how it satisfies the CERCLA threshold criteria and provides the best balance of tradeoffs with respect to the CERCLA primary balancing criteria. The two components have been identified following evaluation of the groups of remedial alternatives and remedy protection alternatives that are described in Part B, Section 8; therefore, Remedial Alternative 3+(d) is also referred to as "the Preferred Remedial Alternative" (Section 11.1), and Remedy Protection Alternative RP-2 is also referred to as "the Preferred Remedy Protection Alternative" (Section 11.2).

11.1 Remedial Alternative 3+(d), the Preferred Remedial Alternative

The Preferred Remedial Alternative for the Upper Coeur d'Alene Basin includes remedial actions both in the Upper Basin portion of OU 3 and in OU 2. The OU 3 and OU 2 components of the Preferred Remedial Alternative are described below along with key factors in their identification. Estimated benefits and considerations for implementation of the Preferred Remedial Alternative are also presented.

11.1.1 Description of OU 3 Components and Key Factors in Identification

The Preferred Remedial Alternative for the Upper Basin portion of OU 3 is Alternative 3+. Table B8-2 summarizes the remedial action types that would be applied to the waste material quantities in Alternative 3+. Figures B11-1 through B11-7 depict specific source control actions included in Alternative 3+ for each major watershed in OU 3 (the Upper SFCDR, Canyon Creek, Ninemile Creek, Big Creek, Moon Creek, Pine Creek, and Mainstem SFCDR Watersheds, respectively). Table B11-1 provides a key to all of the site names shown on these figures. Figures B11-1 through B11-7 do not include the water treatment actions included in Alternative 3+; these are depicted on Figure B11-8 for the entire Upper Basin.

Alternative 3+ includes the following key elements:

- Extensive excavation of waste rock, tailings, and floodplain sediments. Local waste consolidation areas and regional repositories would be used for disposal of these excavated wastes.
- Hydraulic isolation at existing tailings impoundment facilities to reduce groundwater flow through contaminated materials and along stream reaches to reduce the flow of contaminated groundwater to surface water.
- Capping, regrading, and revegetation in many waste rock areas.
- Collection and treatment onsite using semi-passive treatment methods, or conveyance to the CTP for active treatment of contaminated adit discharges, seeps, and groundwater. The CTP would be expanded to accommodate the additional flow and metals loading associated with OU 3 waters.
- Stream and riparian improvement actions in every major watershed within the Upper Basin.
- Remedial actions in the Woodland Park area of Canyon Creek would be updated from those identified in Ecological Alternative 3 in the 2001 FS Report (USEPA, 2001d). The updated Woodland Park actions would include hydraulic isolation of stream reaches using stream liners and French drains, and targeted source control actions to both reduce metals loading to groundwater and surface water and reduce the risks to humans and wildlife from direct contact with mining-contaminated materials.

Alternative 3+ was identified as the Preferred Remedial Alternative over Alternative 4+ because it would meet the CERCLA threshold criteria and provide the best balance of trade-offs based on the CERCLA primary balancing criteria. Post-remediation water quality, and therefore compliance with ARARs, was assessed in the FFS using numerical groundwater models for the SFCDR Watershed (CH2M HILL, 2007a, 2009a) and Predictive Analysis (USEPA, 2007; CH2M HILL, 2009f). The Predictive Analysis was initially developed (URS Greiner, 2001b) to support the evaluation of alternatives in the 2001 FS Report (USEPA, 2001d), and was subsequently used to support evaluations in the Proposed Plan and ROD for OU 3 (USEPA, 2002).

Alternative 3+ is estimated by the Predictive Analysis to reduce the AWQC ratio for dissolved zinc in the SFCDR at Elizabeth Park from the current value of 5.5 to 1.7 at the completion of remedial actions. Table B11-2 provides a summary of estimated post-

remediation water quality at Elizabeth Park and Pinehurst for each remedial alternative considered. Further reductions in the AWQC ratio, eventually resulting in the attainment of ARARs, are expected as a result of natural source depletion. (Natural source depletion will contribute to reductions in the AWQC ratio during the implementation period, and will continue following the completion of remedial actions.) Particulate lead in streams and rivers would also be significantly reduced as a result of source removal actions within floodplains and adjacent upland areas. In addition, source removal actions included in Alternative 3+ would provide important human health and environmental benefits by reducing the potential for direct contact with mining-contaminated wastes.

The key factors leading to the preference for Alternative 3+ over Alternative 4+ included:

- **Nearly the same improvement in water quality.** Under Alternative 3+, the estimated post-remediation AWQC ratio for dissolved zinc at the completion of remedial actions in the SFCDR at Elizabeth Park is 1.7. This estimated post-remediation AWQC ratio represents a substantial decrease from the current value of 5.5 and is nearly the same as the estimated post-remediation AWQC ratio under Alternative 4+ (1.5).
- **Fewer implementability concerns.** Alternative 3+ would have substantially fewer technical and administrative feasibility difficulties compared to Alternative 4+. The types of implementability considerations are similar for the two alternatives, although the smaller quantities of materials addressed in Alternative 3+ would mean comparatively less repository space, and therefore less difficulty in implementation and long-term management.
- **Fewer short-term negative impacts to the community.** The time required for implementation of Alternative 3+ is likely to be decades shorter than the time needed for implementation of Alternative 4+. In addition, the comparatively smaller quantity of materials that would be handled would translate into less truck traffic and less area within the Upper Basin that would be needed for waste consolidation areas and repositories.
- **Lower cost.** The estimated cost of Alternative 3+, in terms of 30-year NPV, is $1.25 billion, which is substantially ($620 million) less than the estimated cost for Alternative 4+ ($1.87 billion).

11.1.2 Description of OU 2 Components and Key Factors in Identification

The Preferred Remedial Alternative for OU 2 is OU 2 Alternative (d). This alternative consists of the following components that are depicted in Figure B11-9:

- A phased approach to address adit drainage from the Reed/Russell adits within the Milo Gulch watershed.
- French drain installation along a gaining reach between the CIA and the SFCDR and extending south to the eastern side of the mouth of Government Gulch.
- Direct-discharge pipeline installation from the CTP to the SFCDR so that treated CTP effluent would no longer discharge into Bunker Creek and infiltrate into contaminated subsurface materials.

- Stream liners on Government Creek. The stream liners would be accompanied by an upstream clean groundwater cutoff wall that would divert clean groundwater into the lined stream; a line of groundwater extraction wells at the mouth of Government Gulch; and a conveyance system that would transport the intercepted contaminated groundwater to the CTP for treatment.

OU 2 Alternative (d) was identified as the Preferred Alternative for OU 2 because it would meet the CERCLA threshold criteria and provide the best balance of trade-offs based on the CERCLA primary balancing criteria. As shown in Table B11-2, OU 2 Alternative (d) is estimated by the Predictive Analysis to reduce the AWQC ratio for dissolved zinc in the SDCDR at Pinehurst from the current value of 4.3 to 1.5 (when coupled with Alternative 3+ actions in OU 3) at the completion of remedial actions. Further reductions in the AWQC ratio, eventually resulting in the attainment of ARARs, are expected as a result of natural source depletion, which will contribute to reductions in the AWQC ratio during the implementation period and will continue following the completion of remedial actions.

The key factors leading to the preference for OU 2 Alternative (d) over the other remedial alternatives for OU 2 included:

- **Significant improvements in water quality.** OU 2 Alternative (e) would be anticipated to have the greatest positive impact on surface water quality, with an estimated post-remediation AWQC ratio at Pinehurst of 1.3. However, this is only slightly better than the estimated post-remediation AWQC ratios for OU 2 Alternatives (c) and (d), both estimated to be 1.5. Given the uncertainty associated with these estimates, there is relatively little difference in estimated post-remediation water quality between OU 2 Alternatives (c), (d), and (e). OU 2 Alternatives (c) and (d) provide similar benefits in terms of SFCDR water quality; however, in terms of addressing surface water quality in the major OU 2 tributaries, OU 2 Alternative (d) addresses Government Creek while OU 2 Alternative (c) does not. In addition, the Government Gulch component of OU 2 Alternative (d) is consistent with remedial action objectives identified for tributary water quality within OU 2 in the ROD for OU 2 (USEPA, 1992), which states that "…ARARs are expected to be achieved in onsite tributaries to the SFCDR upon successful implementation of remedial actions specified in this ROD." OU 2 Alternatives (a) and (b) are estimated to provide much smaller improvements in water quality than OU 2 Alternatives (c), (d), and (e) (Table B11-2), and therefore were eliminated from further consideration.

- **Fewer implementability concerns.** The extensive and intrusive nature of OU 2 Alternative (e) also carries with it short- and long-term impacts on the surrounding community and environment, as well as technical and administrative challenges associated with the large amount of stream lining identified. Alternative (e) also has the highest potential of any OU 2 alternative to adversely affect the existing SFCDR levee system.. OU 2 Alternative (d) is expected to have relatively few implementability concerns, although slightly more than OU 2 Alternative (c) due to the additional actions included for Government Creek. Due to the additional action in Government Creek, OU 2 Alternative (d) is expected to have slightly more implementability concerns than OU 2 Alternative (c).

- **Greatest reduction of toxicity, mobility, or volume through treatment, and greatest short-term effectiveness.** In the FFS, Alternative (d) was determined to be the most favorable OU 2 alternative with respect to its reduction of toxicity, mobility, or volume through treatment, as well as its short-term effectiveness. OU 2 Alternative (d) is estimated to remove more metal mass (an average of 1,860 lb/day of zinc) from surface water through treatment than any other OU 2 alternative. Alternative (d) also ranked highest among the OU 2 alternatives under the short-term effectiveness criterion because of its relatively short implementation time and associated short-term risks to workers, the community, and the environment, and the additional water quality improvements that would be realized in Government Creek.
- **Relatively high long-term effectiveness.** Alternative (e) was identified as having the greatest benefit of the OU 2 remedial alternatives in terms of long-term effectiveness based on its estimated dissolved zinc load reduction at Pinehurst of 65 percent (assuming Alternative 3+ actions are implemented in OU 3). The dissolved zinc load reduction estimated at Pinehurst for OU 2 Alternative (d) is 62 percent. Given the uncertainty associated with these estimates, there is relatively little difference in terms of long-term effectiveness for reducing dissolved zinc loads between OU 2 Alternatives (d) and (e). The estimated dissolved zinc load reduction in the SFCDR at Pinehurst under OU 2 Alternative (c) (60 percent) is slightly lower than the estimated reduction under OU 2 Alternative (d). Again, given the uncertainty associated with these estimates, there is relatively little difference between the two in terms of SFCDR water quality improvements. However, OU 2 Alternative (d) ranks higher than OU 2 Alternative (c) under the criterion of long-term effectiveness because of the additional improvements in water quality in Government Creek that would be achieved.
- **Relatively low cost**. The estimated cost for OU 2 Alternative (d), in terms of 30-year NPV, is $38.3 million, which is substantially less (approximately $218 million) than the estimated cost for OU 2 Alternative (e). OU2 Alternative (e) with an estimated cost of $256 million is the only alternative predicted to have greater effectiveness than OU 2 Alternative (d). The estimated cost for OU 2 Alternative (d) is greater than the estimated cost for OU 2 Alternative (c) ($38.3 million versus $26.8 million, respectively). The difference in cost between these two alternatives is the result of the additional actions included in Government Gulch under OU 2 Alternative (d).

11.1.3 Estimated Benefits of Alternative 3+(d)

Alternative 3+(d), the Preferred Remedial Alternative, would provide a number of improvements over the existing interim ecological remedy for OU 3. The most important of these improvements is that it is a comprehensive approach to Upper Basin surface water that includes actions in OU 2 and additional actions in OU 3, not merely prioritized actions comprising an interim remedy. The additional actions included in the Alternative 3+(d) would provide greater improvements in water quality, and would do so more efficiently by incorporating groundwater-based approaches and providing treatment for lower-volume, higher-concentration waters. The updated set of actions and the groundwater-based approach included for the Woodland Park area of Canyon Creek is also consistent with eventual ecosystem recovery in the creek. The interim ecological remedy for Canyon Creek included a plan for surface water treatment that consciously sought to provide the most

benefit to water quality in the South Fork of the Coeur d'Alene. It was not designed to provide for ecosystem recovery in Canyon Creek and, as a consequence, did not include stream and riparian improvement actions. In contrast, Alternative 3+(d) includes extensive stream and riparian improvement measures that would be completed in areas following remediation to accelerate ecosystem recovery. The interim ecological remedy for OU 3 only included stream and riparian improvement measures in limited areas.

Alternative 3+(d) is focused on reducing dissolved metals and particulate lead in rivers and streams and risks to humans and wildlife associated with direct contact with mining-contaminated materials. The anticipated benefits of the alternative in addressing these priority issues are described below.

- **Dissolved metals in surface water –** Dissolved metals have harmful effects on fish and other aquatic receptors. Approximately 20 miles of the SFCDR and 10 miles of tributaries have limited and impacted fish populations. Species density and diversity have been reduced throughout the Upper Basin, and Ninemile and Canyon Creeks have been observed to be essentially devoid of fish and other aquatic life in areas of mining impacts. Impacted species include the native bull trout, which is listed as threatened under the ESA. The AWQC for zinc and cadmium have been exceeded throughout the SFCDR downstream of areas of mining impacts. Following the implementation of Alternative 3+(d), the AWQC ratios for dissolved zinc in the SFCDR at Elizabeth Park and Pinehurst are estimated to be 1.7 and 1.5, respectively (Table B11-2). The estimated reduction in AWQC ratios is a function of the reduction in dissolved zinc load estimated for both Elizabeth Park and Pinehurst (65 percent and 62 percent, respectively) following the implementation of Alternative 3+(d) (Table B11-2). Further reductions in the AWQC ratios over time, eventually resulting in the attainment of ARARs, are expected as a result of natural source depletion. The AWQC ratios are also correlated to a set of defined "fishery tiers" for the Coeur d'Alene Basin (URS Greiner, 2001a) that relate to the health of a fishery. Table B11-3 presents the definitions and AWQC ratio ranges for these fishery tiers. The estimated post-remediation water quality for Alternative 3+(d) represents a Tier 4 fishery, a significant improvement over the current Tier 3 ranking. The primary differences between Tiers 3 and 4 are that in the Tier 4 fishery, salmonids are successfully spawning and rearing and sculpin (which are generally absent or present at very low densities under a Tier 3 fishery) are present at moderate to high densities. This increase represents a significant improvement in ecosystem and fishery health.

- **Particulate lead in surface water –** Particulate lead transported downstream from the Upper Basin is a continuing source of contamination to the Lower Basin, Coeur d'Alene Lake, and the Spokane River. Reduction of lead load in sediments transported and deposited in downstream areas is necessary to prevent recontamination of cleaned-up areas and to protect humans and wildlife from exposure. The source control and stream and riparian improvement actions included in Alternative 3+(d) would reduce particulate lead in surface water in the Upper Basin to a greater extent than would be achieved with the interim ecological remedy for OU 3 alone.

- **Direct contact with mining-contaminated wastes –** Heavy metals are present in mining-contaminated materials throughout the Upper Basin and can pose risks to humans and

wildlife through direct contact. Through a combination of excavation and disposal and regrading, consolidation, and revegetation, the risks to humans and wildlife from direct contact with mining-contaminated wastes would be significantly reduced in comparison to current conditions and to estimated reductions that would be achieved with the interim ecological remedy for OU 3 alone.

11.1.4 Considerations for Implementation

In conjunction with development of the FFS Report and the subsequent ROD Amendment for the Upper Coeur d'Alene Basin, USEPA is in the process of planning and prioritizing actions for implementation of the comprehensive surface water remedy for the Upper Basin. The outcome of this effort will be an Implementation Plan (IP) to guide actions identified in the ROD Amendment. Section 13 of this Site Information Package describes the key contents of the forthcoming IP. A number of key factors such as human health access to contaminated mine waste materials, metals loading to surface water, and the potential for recontamination of cleaned areas will be taken into account. In all cases, areas that pose significant human health risks will be considered to have priority over ecological sites for implementation. Other factors to be considered include whether water treatment is necessary, whether repository space is needed, whether restoration work is planned, construction staging and design needs, and stakeholder input. For example, remedial actions involving the removal of floodplain sediments along the SFCDR will need to account for the presence and condition of existing structures like levees. As part of pre-remedial-design data gathering, these details will be evaluated so that the remedial design can be adjusted or possibly deferred until the affected stakeholders, who have a responsibility for the levees, can leverage their resources to collaborate on the work needed on or around the levees. Consideration of these factors will help guide this important cleanup work and, more importantly, provide transparency on how cleanup decisions will be made, the expected outcomes, and progress towards meeting the objectives of the ROD Amendment.

Post-ROD treatability studies must also be considered. A number of treatability studies have been conducted since the ROD for OU 3 was issued (USEPA, 2002), although the implementation of Alternative 3+(d) would require some additional studies. It is envisioned that these studies would be incorporated into the full-scale implementation of remedial actions at some of the smaller sites and/or perhaps within subareas of some larger sites included in Alternative 3+(d), rather than being implemented as stand-alone studies. The initial remedial actions and associated effectiveness and performance monitoring would be designed to provide data needed to optimize the design of subsequent remedial actions at other sites. Specific TCDs for which some treatability testing may be needed include: French drains, stream lining, onsite semi-passive water treatment using lime addition and settling pond(s), onsite semi-passive water treatment using a sulfate-reducing bioreactor (SRB), and various stream and riparian improvement TCDs. This approach is consistent with USEPA's adaptive management strategy for the site and would allow for the simultaneous implementation of small-scale remedial actions and treatability studies.

In addition, a limestone permeable reactive barrier (PRB) was considered in the FFS but not carried forward into the Preferred Remedial Alternative. The limestone PRB is, however, an option for the French drain included in OU 2 Alternative (d), which is a component of

Alternative 3+(d). If interest continues in exploring the limestone PRB as an alternative to the French drain in OU 2, or in other selected discrete areas, treatability testing will be needed to assess its potential effectiveness prior to implementation.

11.2 Alternative RP-2, the Preferred Remedy Protection Alternative

As discussed in Part B, Section 8, the purpose of the remedy protection alternatives is to maintain or increase the long-term effectiveness and permanence of the soil portion of the selected human health remedies being implemented in OUs 1, 2, and 3 of the Bunker Hill Superfund Site. Analyses completed during the FFS found that portions of the existing selected remedies are vulnerable to damage by relatively small storm events. The remedy protection alternatives evaluated in the FFS primarily focused on these issues of localized flooding and high-precipitation events that may impact human health and the environment by eroding clean barriers or contaminating clean areas, thereby making contaminated soil and gravel potentially available for direct contact by and increased risk to people.

11.2.1 Upper Basin Communities

The Preferred Remedy Protection Alternative for the Upper Basin communities is Alternative RP-2. As discussed in Part B, Section 8, Alternative RP-2 is composed of combinations of various technology and process options (Table B8-3), selected based on hydrologic and hydraulic analyses conducted for the eight primary Upper Basin communities, that would protect the existing selected remedies against flood and high-precipitation events up to the 50-year storm event. A summary of the remedy protection projects defined as part of Alternative RP-2 for the eight Upper Basin communities is presented in Table B11-4.

Alternative RP-2 (Modifications to Selected Remedies to Enhance Protectiveness [Remedy Protection Projects]) is preferred over Alternative RP-1 (No Further Action [Post-Event Response]) based on the following key factors:

- **Greater long-term effectiveness and permanence –** Alternative RP-2 would be more protective of human health and the environment than Alternative RP-1 because it would increase the long-term effectiveness and permanence of the existing selected remedies [that have been shown to be protective; USEPA, 2005)] by decreasing the risk of recontamination due to flooding and uncontrolled surface water flow. Alternative RP-2 would enhance the long-term effectiveness and permanence of the existing selected human health remedies, while Alternative RP-1 would only maintain and repair the existing selected remedies when they were damaged or recontaminated. By implementing technologies and process options to enhance the permanence of the selected remedies, the potential damage to the remedies and subsequent routes of exposure to contamination would be mitigated.
- **Greater short-term effectiveness –** Alternative RP-2 would improve short-term effectiveness compared with Alternative RP-1 by reducing the mobility of potentially contaminated sediments transported by floodwaters and surface water flows within the communities by effectively conveying floodwaters up to a 50-year storm event. This

would lower the potential routes of exposure to contamination by humans and ecological receptors and address concerns about the protectiveness of the existing selected remedies.

- **Fewer implementability issues –** Alternative RP-2 would have relatively fewer implementability issues compared to Alternative RP-1. Alternative RP-2's only technical implementation issue is that it would be beneficial to implement the remedy protection projects during the low-flow season in order to minimize cost. Alternative RP-2 would have administrative implementability issues associated with O&M of the water conveyance improvement projects. Prior to construction, the local and state agencies would need to determine which parties would perform O&M tasks and ensure that sufficient resources were available. In addition, there would be issues associated with the construction of remedy protection projects on private property. Access and easement agreements would have to be obtained prior to the implementation of Alternative RP-2. The above implementation issues for Alternative RP-2 are relatively minor.
- **Significantly lower cost –** The estimated cost of Alternative RP-2, in terms of 30-year NPV, is $33.9 million, which is significantly less ($16.2 million) than the estimated cost for Alternative RP-1 ($50.1 million).

11.2.2 Side Gulches

Potential remedy protection actions in the side gulches to the SFCDR would also be included as part of Alternative RP-2, the Preferred Remedy Protection Alternative. Detailed analyses were not conducted for the side gulches in the FFS to determine the area of existing selected remedies that is vulnerable to damage from storm events. The framework for evaluation and implementation of the remedy protection technologies and process options in the side gulches will be applied to these areas in the future as more detailed information is gathered for the side gulches or as the result of changing environmental conditions, stakeholder input, and other emergent considerations. This section describes the general steps and criteria for future evaluation and development of Alternative RP-2 actions for the side gulches similar to those developed and conducted for the eight Upper Basin communities.

It should be noted that the side gulches and associated selected remedies generally have similar physical and topographical characteristics to the drainages that were analyzed in detail in the eight Upper Basin communities. It is expected that similar technologies and process options would be applicable to the side gulches.

The process for applying technologies and process options to the side gulches in the future should include (1) completing hydrologic and hydraulic analyses and field reconnaissance to determine the areas of remedy at risk, and (2) if warranted, mitigating the risks posed to the selected remedies using the results of the hydrologic and hydraulic analyses, the specific physical constraints of the site, and engineering judgment to select appropriate process options. The process for developing these remedy protection projects should follow the framework used to develop Alternative RP-2 for the eight Upper Basin communities.

12. Potential Applicable or Relevant and Appropriate Requirements

Potential ARARs identified for the Upper Coeur d'Alene Basin include chemical-, action- and location-specific requirements for the remedial actions evaluated in the FFS Report (USEPA, 2010).

The potential chemical-specific ARARs for protection of aquatic life and human health in surface water are presented in Table B12-1. Other potential ARARs are presented in Files B12-1 through B12-4 on the Supplemental CD provided with this Site Information Package.

Final ARARs will be identified and documented in the ROD Amendment for the Upper Basin.

13. Technical and Policy Issues

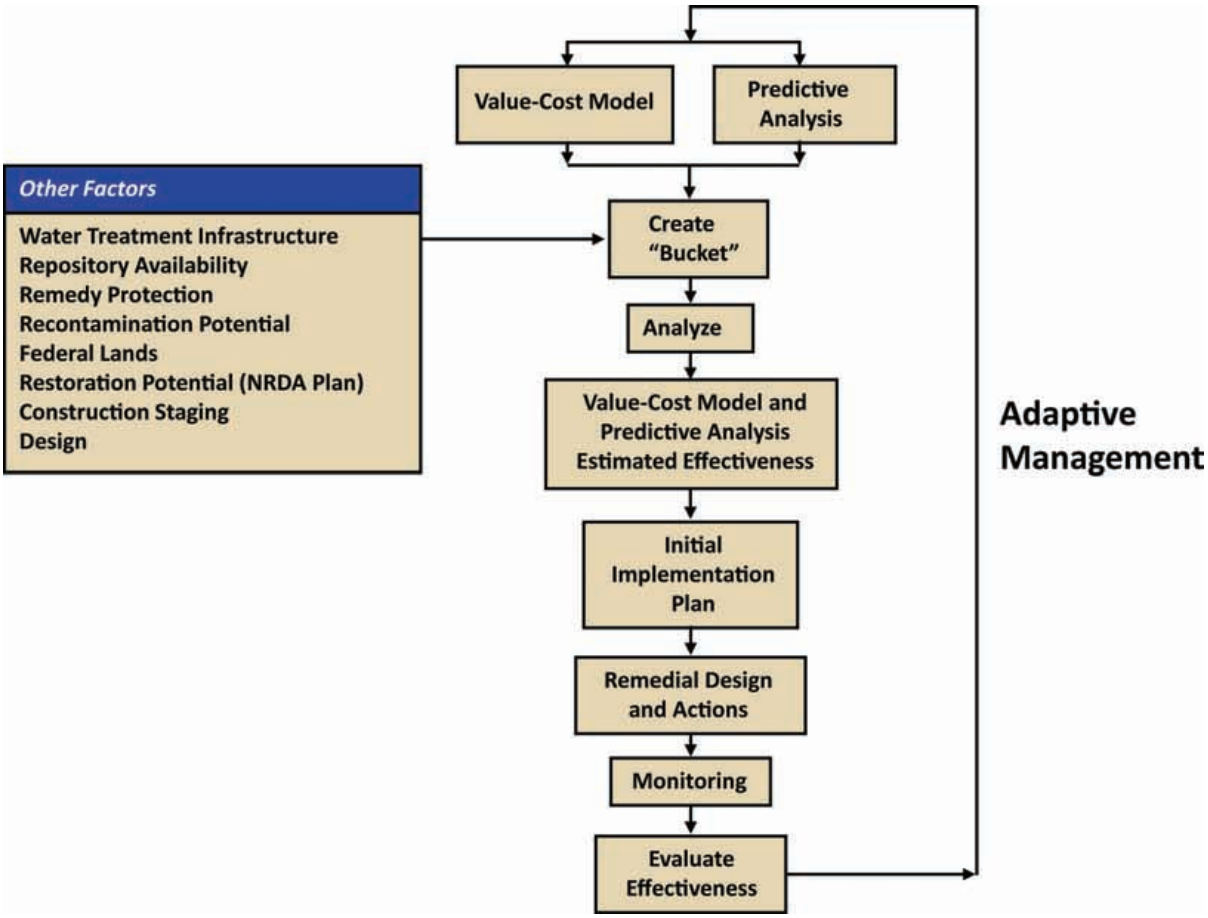
Several technical and policy issues will need ongoing attention and even resolution prior to the implementation of Preferred Alternative activities, including the following:

- Adaptive management coordination with ongoing and future data collection efforts
- Predesign data collection and evaluation
- Waste repository sites and associated disposal requirements
- State Superfund Contract coordination
- Integration with stakeholders including the members of the Basin Commission
- CTP use
- Ongoing site litigation efforts

Establishing how these and other issues are addressed is of great importance to USEPA. In conjunction with the FFS Report (USEPA, 2010) and development of the ROD Amendment for the Upper Coeur d'Alene Basin, USEPA is in the process of planning and prioritizing actions for implementation of the Preferred Alternative. The outcome of this effort will be an Implementation Plan (IP) that will guide the actions selected in the ROD Amendment.

The IP will be a separate "living document" that will lay out a strategy for identifying priority projects that will be implemented in the near term. The IP will describe how adaptive management is used to guide future efforts to prioritize work. Adaptive management is a process wherein decisions are made as part of an ongoing science-based process. It involves testing, monitoring, and evaluating applied strategies, and incorporating new knowledge into management approaches that are based on scientific findings. The IP will be a tool to help USEPA and others make better decisions as more information becomes available on the effectiveness of initial cleanup actions. The IP will be updated and modified on a regular basis to guide future decisionmaking and help document adjustments to project priorities based on new information.

As shown in the flow chart below, the IP will take into account a number of key factors such as human health access to contaminated mine waste materials, metals loading to surface water, and the potential for recontamination of cleaned areas. In all cases, areas that pose significant human health risks will be considered to have priority over ecological sites for implementation. Other factors to be considered include whether water treatment is necessary, whether repository space is needed, whether restoration work is planned, construction staging and design needs, and stakeholder input. For example, remedial actions involving removal of floodplain sediments along the SFCDR will need to account for the presence and condition of existing structures like levees. As part of pre-remedial-design data gathering, these details will be evaluated so that the remedial design can be adjusted or possibly deferred until the affected stakeholders, who have a responsibility for the levees, can leverage their resources to collaborate on the work needed on or around the levees.



Another important consideration that will affect the IP will be the amount of funding available for remedial actions on an annual basis. USEPA recognizes the importance of securing sufficient resources to implement the forthcoming Upper Basin ROD Amendment and other cleanup actions throughout the Coeur d'Alene Basin. Therefore, the IP will include assumptions about annual funding levels: for example, how recent Asarco settlement funds may be used to implement actions.

Consideration of these factors will help guide this important cleanup work and provide transparency on how cleanup decisions will be made, the expected outcomes, and progress towards meeting the objectives of the ROD Amendment for the Upper Basin.

14. Cost Information

This section summarizes the cost estimates, as well as the methodology and assumptions used to develop the cost estimates, for the remedial alternatives defined for OU 2 and the Upper Basin portion of OU 3 as well as for the remedy protection alternatives. Costs were developed based upon principles outlined in *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (USEPA, 2000b).

Cost estimates for each of the remedial alternatives and remedy protection alternatives are summarized in following sections. Table B14-1 provides an overall summary of the costs for each remedial alternative and remedy protection alternative. For the remedial alternatives, Alternative 3+ estimated costs range from $1,280 million for Alternative 3+(c) to $1,520 million for Alternative 3+(e); and Alternative 4+ estimated costs range from $1,930 million for Alternatives 4+(b) and (c) to $2,160 million for Alternative 4+(e).

These costs are presented as total capital cost, annual average and 30-year NPV O&M costs, and total 30-year NPV cost for each alternative. (For detailed cost breakdowns and assumptions, see Appendix D of the FFS Report, which is included as File 14-1 on the Supplemental CD provided with this Site Information Package.) NPV costs are based on a 30-year planning period and a discount rate of 7 percent. The costs listed in Table B14-1 are in 2009 dollars, do not include future escalation, and assume that all construction occurs in year 1. The nominal accuracy of these estimates is –30 percent to +50 percent.

14.1 Remedial Alternative Costs

As described in Part B, Section 8, multiple combinations of remedial alternatives were developed and evaluated to define a comprehensive cleanup approach for Upper Basin surface water. The costs for the remedial alternatives were based on the development of TCDs (see Table B8-1 for descriptions of the TCDs).

Table B14-2 summarizes the unit cost estimates for each TCD. Direct capital costs were calculated for each individual action, characterized by a TCD, on a source material. The direct capital cost was calculated using the TCD unit cost and an appropriate measurement that is specific to the site and source material. The indirect capital costs were assumed to be 70 percent of the direct capital costs for all the TCDs except WT01, active treatment at the CTP. This assumption was based on information provided in USEPA (2000b). O&M costs, varied by TCD, but some examples of O&M activities included repairs, sampling and analysis, and replacement of media. For TCDs retained from the 2001 FS Report (USEPA, 2001d), costs were escalated to 2009 dollars assuming an escalation factor of 1.358. This value was developed from the Engineering News Record *Construction and Building Cost Index* (2008). For new TCDs, costs were developed by calculating unit costs for materials, labor, and equipment. These values were then summed to determine the direct capital unit cost for the TCD.

One TCD or a combination of TCDs was applied at each site. For example, three TCDs were applied to the floodplain waste rock for Alternative 3+ at Moon Creek Segment 01, Source KLE061. Those TCDs are C01 (Excavation), HAUL-2 (Haul to Repository), and C08a (Repository). The volume of floodplain waste rock in cubic yards was multiplied by the TCD unit costs. An assumption was made that the repository would be located 5 miles from the site. The total cost at each site is the sum of direct capital, indirect capital, and O&M costs of applying the TCDs. (See Tables D-37 and D-38 in File 14-1 on the Supplemental CD for detailed breakdowns of the site-specific costs and the assumptions for each TCD.)

The estimated unit costs for each TCD provided in Table B14-2 were then rolled up and presented by remedial alternative, as shown in Table B14-1. Of the Alternative 3+ group of alternatives, the highest cost is $1,520 million for Alternative 3+(e). Of the Alternative 4+ group of alternatives, the highest cost is $2,160 million for Alternative 4+(e). Alternative 3+ would be less expensive than Alternative 4+ because of the much higher volumes of contaminated materials that would be removed under Alternative 4+ as sources of loading from the system and managed in repositories.

Additionally, Alternative 4+ has the higher overall O&M requirements, primarily because it requires more extensive O&M of repositories, groundwater containment systems, and active and semi-passive water treatment systems. The stream and riparian improvement actions under Alternative 4+ are expected to have lower long-term maintenance requirements compared to Alternative 3+. However, until the vegetation becomes established, the short-term O&M requirements of the stream and riparian improvement actions would be somewhat greater than under Alternative 3+.

14.2 Remedy Protection Alternative Costs

The approach used to develop costs for the remedy protection alternatives differed from the TCD approach for the remedial alternatives described above. Detailed hydrologic and hydraulic modeling was conducted (as documented in Appendix G in the FFS Report [USEPA, 2010]) to determine the following:

- The expected damage to the selected human health remedies and subsequent post-event response costs for Alternative RP-1; and
- The specific remedy protection project, which could mitigate the potential risks posed by flood events for Alternative RP-2.

Based on this information, capital costs and O&M costs for Alternatives RP-1 and RP-2 were developed for each Upper Basin community. This detailed approach was determined to be more appropriate for developing costs because (1) only eight Upper Basin communities were evaluated in detail, and (2) hydrologic and hydraulic modeling allowed sufficient data to develop more detailed cost estimates.

Cost estimates developed for Alternatives RP-1 and RP-2 are presented in Table 14-1 and reflect a 30-year project life cycle as recommended by CERCLA guidance. The total cost (30-year NPV) for Alternative RP-1 is $50.1 million. The estimated cost for Alternative RP-2 is $33.9 million.

In reality, the existing protective barriers installed to protect human health will need to be maintained into perpetuity to meet the CERCLA threshold criteria. The existing remedies have already been in place for nearly 15 years in some areas of the Upper Basin. Furthermore, the design life of the remedy protection projects implemented under Alternative RP-2 would be expected to be greater than 30 years.

14.2.1 Alternative RP-1: No Further Action (Post-Event Response)

Alternative RP-1 does not include actions to reduce the potential risk of damage to the existing selected human health remedies, but instead relies on cleanup and re-remediation of damage to the existing selected remedies after the damage occurs. The expected costs to repair existing protective barriers and re-remediate previously clean areas, based on the modeling results, are the costs associated with Alternative RP-1.

A methodology for evaluating the long-term damage to the existing selected remedies that would be expected from storm events in the Upper Basin was developed to complete the NPV cost analysis for Alternative RP-1 (CH2M HILL, 2009e). The methodology used risk analysis principles developed by the U.S. Army Corps of Engineers (1989, 1996) to evaluate flood control projects. Basic probability theory suggests that the "expected" annual damage from extreme weather events can be stated as the sum of all such events, with each of the expected damages multiplied by its probability of occurrence.

The risks posed to the existing selected remedies under Alternative RP-1 are a product of the probability of damage occurring and the consequence, or magnitude, of the damage. The probability of damage is higher for more frequent, smaller storm events. However, the consequence of damage is higher for less frequent, larger storm events. The probability of damage and consequence, or magnitude and damage together make up the risk posed to the existing selected remedies. The evaluation included an analysis of 5-, 25-, and 50-year storm events. The model results from each of these storm events provided a total area that would require re-remediation and/or cleanup following the given storm event.

The probability of damage occurring was based on the probability of occurrence of all different storm events. In any given year, the selected remedies are at risk for damage from storm events of all sizes and frequencies. In a single year, there is a 2 percent probability of experiencing damage from a 50-year storm event. There is also a 20 percent probability of experiencing damage from a 5-year event, added to the probability of the occurrence of the 50-year event. It is this cumulative probability and consequence that is the annual expected damage to the remedy.

Using the methodology described above, the annual expected cost of damage to the selected remedies was calculated based on the potential area of damage estimated by the hydrologic and hydraulic model outputs of the 5-, 25-, and 50-year storm events, and the probability of these floods occurring. The 30-year NPV life-cycle cost was then calculated as the present value of the expected annual damage over the 30-year time horizon. The estimated total cost (30-year NPV) for Alternative RP-1 for the eight Upper Basin communities where detailed analyses were conducted is $50.1 million, including the side gulches.

As discussed in Part B, Section 8, the side gulches were not evaluated to the same level of detail as the eight Upper Basin communities. The portion of the estimated total cost (30-year NPV) for Alternative RP-1 directly related to the side gulches is approximately $16.3

million. Because less information and no hydrologic or hydraulic modeling data are currently available for the side gulches, the cost estimate was developed based on assumptions developed from the expected area of damage during storm events identified for the eight Upper Basin communities. (See File 14-1 on the Supplemental CD for the assumptions made to develop the approximate cost for side gulches under Alternative RP-1.)

14.2.2 Alternative RP-2: Modifications to the Selected Remedies to Enhance Protectiveness (Remedy Protection Projects)

Alternative RP-2 would implement the remedy protection projects selected from the technology and process options (Table B8-3) applied to each watershed included in the detailed evaluation. Although similar types of process options could be used to protect the existing selected remedies in the communities, the geographic variations would cause each remedy protection project to be slightly different. In some cases, multiple process options of similar protectiveness and cost could be applied to protect the existing selected remedies. Assumptions were made, based on the data available, to choose process options that would effectively protect the existing selected remedies, and were applied as a basis for this evaluation. Although the design life of the remedy protection projects is expected to be greater than the 30-year project life used for this cost analysis, the additional value was not accounted for in the cost analysis. The estimated total cost (30-year NPV) for Alternative RP-2 for the eight Upper Basin communities where detailed analyses were conducted is $33.9 million.

As discussed in Part B, Section 8, the side gulches were not evaluated to the same level of detail as the eight Upper Basin communities. The portion of the estimated total cost (30-year NPV) for Alternative RP-2 directly related to the side gulches is approximately $15.1 million. Because less information and no hydrologic or hydraulic modeling data are currently available for the side gulches, the cost estimate was developed based on assumptions developed from the remedy protection projects identified for the eight Upper Basin communities. (See File 14-1 on the Supplemental CD for the assumptions made to develop the approximate cost for side gulches under Alternative RP-2.)

15. Letters from Stakeholders

Stakeholder support is based on discussions to date during the development and implementation of the RI/FS for the Coeur d'Alene Basin and the FFS for the Upper Basin, and during multiple workshops. Letters of support for the proposed remedy have been recently provided by key stakeholders and are included in this section. Formal public comment will also be solicited when the Proposed Plan is issued. The following letters have been received from stakeholders:

- County of Shoshone, Idaho, letter dated March 10, 2010
- Washington Department of Ecology letter dated March 12, 2010
- Idaho Department of Environmental Quality letter dated March 15, 2010
- Coeur d'Alene Tribe letter dated March 17, 2010
- U.S. Department of Interior, Fish and Wildlife Service letter received March 18, 2010

Copies of these letters are provided on the following pages.

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RECEIVED

MAR 1 5 2010

Environmental
Cleanup Office

March 10, 2010

Daniel Opalski, Director
Office of Environmental Cleanup
U.S. Environmental Protection Agency
1200 Sixth Avenue, Suite 900 (MS ECL-117)
Seattle, WA 98101

Dear Mr. Opalski:

From the local perspective an ongoing problem with the Bunker Hill Superfund Site is caused by EPA's policies toward addressing flood control of the South Fork and Pine Creek. In a recent discussion of proposed language for the upcoming ROD Amendment EPA said they did not have the technical expertise or regulatory authority to deal with major flooding of the South Fork or Pine Creek.

Long experience with CERCLA issues tells us this is not true. EPA has the responsibility under CERCLA to manage contaminated sediments in the Silver Valley. Most of the contaminated sediments here originated when mine wastes were dumped into the South Fork and its tributaries as part of historical mining practices. The wastes were then distributed throughout the valley by normal hydrologic processes including floods. The 2001 Feasibility Study and the proposed Focused Feasibility Study both recognize that by describing a great deal of work to be done cleaning up "Impacted Floodplains". In order for this remedy to be protective of human health and the environment the contaminated sediments above the action level have to be removed from the floodplain or immobilized in place. In order to accomplish either of these EPA or its contractors must possess and apply extensive expertise in dealing with river hydrology, sediment transport and flood control.

Following are some specific examples that illustrate the problems.

S. F. Below Terror Gulch

S.F. Terror Gulch Bridge

S. F. Above Terror Gulch USBM Removal Area

After the 1974 flood these levees were dozed up out of contaminated floodplain sediments. Later the U S Bureau of Mines constructed two test cells to contain mill tailings behind the contaminated sediment levees. The mill tailings are highly contaminated and are being used as an informal recreation area. As can be seen in the first picture the levees are being eroded by the South Fork. EPA should excavate these and put them in a secure repository. However, although these are not certified levees, they do provide some protection from flooding. When EPA removes the 70,000 plus cubic yards of contaminated sediment to place in a secure repository, they have a responsibility to thoroughly evaluate the effects that action will have on flooding and to provide the remediated properties shown in the left of the first picture equal or better protection than what is there now.

Reach MG01-1 Above Ninemile

This picture shows the South Fork Channel through Wallace. In the Focused Feasibility Study EPA calls for installing a number of habitat enhancements in this reach as part of the ecological remedy. FEMA says this channel will not convey the 100 year flood as it is now. If EPA is going to put anything into this channel they or their contractors need to do a thorough evaluation of the effects on flood hydrology.

S. F. Above Two Mile Bridge

This is the South Fork Channel above the Two Mile Bridge. There is a large deposit of coarse bedload contaminated with fine metal contaminated sediments that releases contaminates as it is reworked by flood waters. Before EPA designated this material as hazardous waste local contractors mined gravel in this area to maintain the channel depth and prevent flooding in Osburn. This material should be excavated and screened so the contaminated fine fraction could be placed in a secure repository. This cannot be done without EPA accepting responsibility for contaminate management and cooperating with local authorities to develop a long term management strategy. The Pine Creek channel through Pinehurst also has a lot of contaminated sediment deposits in its bed.

S. F. Through Kellogg

East Kellogg

This is the South Fork channel through Kellogg. The banks and levees are made of contaminated sediments. This material should be stabilized in place to prevent it from being remobilized by floods and contaminating or recontaminating other areas. Stream bank stabilization of this area was left out of the Focused Feasibility Study, presumably because it would involve flood control actions. If EPA is going to clean up or stabilize impacted floodplains of the South Fork they need to address all of the impacted floodplains. In doing this they should do a thorough evaluation of the effects of flooding and mitigate those effects as a part of contaminate management.

As can be seen from these examples, management of river hydrology including flooding and management of contaminated sediments are inextricably entwined in the Silver Valley. We strongly urge EPA to do a thorough review of their policies regarding flood control and recognize that in this case dealing with the technical and regulatory aspects of flood control are necessary to accomplishing their statutory responsibility of protecting human health and the environment.

Sincerely,

BOARD OF COMMISSIONERS

Jon Cantamessa, Chairman

Vern Hanson, Commissioner

Vince Rinaldi, Commissioner

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
4601 N Monroe Street • Spokane, Washington 99205-1295 • (509)329-3400

March 12, 2010

Mr. Daniel Opalski, Director
Office of Environmental Cleanup
U.S. Environmental Protection Agency
1200 Sixth Avenue, Suite 900 (MS ECL-117)
Seattle, WA 98101

RE: Stakeholder Comments—National Remedy Review Board Site Information Package, Peer Review Draft, dated March 2, 2010

Dear Mr. Opalski;

Thank you for providing the Washington State Department of Ecology (Ecology) the opportunity to provide stakeholder input for consideration by EPA and its National Remedy Review Board (Board).

The selection of a cleanup approach for surface water in the Upper Coeur d'Alene Basin is of particular importance to the citizens of Washington State. The remedial actions taken in Idaho to manage dissolved and particulate metals loading to the south fork of the Coeur d'Alene River directly affect the water quality of the Spokane River within Washington. The success of Washington's metals Total Maximum Daily Loads (TMDL) largely relies on controlling the upstream contaminant sources in Idaho so that the toxicity criteria of Washington's Water Quality Standards for surface water are met at the Washington/Idaho border. In addition, the long-term integrity of Washington and EPA's joint riverbank and beach cleanup remedies are dependent upon the implementation of a timely and effective cleanup plan.

We have reviewed both the Board package and the Focused Feasibility Report for the Upper Basin of the Coeur d'Alene River. The Preferred Alternative comprises Remedial Alternative 3+(d) and Remedy Protection Alternative RP-2. Remedial Alternative 3+(d) seeks to reduce metals loading to surface water primarily through material removal, hydraulic isolation/redirection, and the focused capture of high metals concentration groundwater. Treatment of metals impacted groundwater will be through either active or passive methods. The majority of impacted water will be captured and conveyed to the Central Treatment Plant for active treatment. Low flow volumes of impacted water at select, remote locations will be addressed using on-site passive systems.

Utilizing passive treatment options (permeable reactive barriers, lime settling ponds, etc.) to treat higher flow volumes of metals-impacted surface and ground water were considered in the draft

Focused Feasibility Study. However, these options were not carried forward for further evaluation. Passive treatment was only recommended for low flow volumes of water in select, remote locations.

Ecology concurs with this assessment. Similar, small-scale, passive treatment systems were field tested in the upper Basin over the last several years. Results were only moderately successful in treating low flow volumes of groundwater. Difficulties associated with reliability, by-pass, flooding, clogging, system footprint area demands, etc., demonstrated that these passive systems were not capable of treating the higher flow rates/volumes of water necessary to meet the ROD requirements and achieve measurable improvements to surface water quality. In addition, they demonstrated the need for effective and continuing, non-inconsequential O & M.

Remedial Alternative 4+ was not selected. Although this option provides for much more extensive material removal and hydraulic isolation through stream lining, little additional reduction of metals loading to surface water is projected (based on focused data evaluation and modeling). The fairly extensive stream lining would limit the ability of the ecosystem to naturally recover over time as the cleanup objectives are realized. Additionally, Alternative 4+ is much more costly, both in funds and implementation time. The Lower Basin of the Coeur d'Alene River awaits an ecological remedy. The judicious use of funding and time for the successful and results-based implementation of the Upper Basin remedy will allow for a more timely and effective remedy for the Lower Basin.

Preferred Alternative 3+(d) represents a reasonably balanced and scientifically grounded approach toward effectively reducing metals loading to surface water. We support this alternative and encourage EPA to move forward expeditiously to address this long-outstanding ecological and human health issue. Given the long timeline estimates to enact the overall remedy, it seems prudent to pursue development of those systems that will provide the greatest reduction in metals loading to surface water as soon as possible. Construction of the pipeline to convey Canyon Creek ground water for active treatment and hydraulic isolation of tailings in The Box would help address a large component of identified loading. Without such prioritization, the Lower Basin, Coeur d'Alene Lake, and Washington State will continue to be heavily impacted for decades. We recommend and encourage EPA to pursue such prioritization.

Sincerely,

Michael A. Hibbler
Section Manager
Toxics Cleanup Program

cc: Grant Pfeifer, Eastern Regional Director, Ecology

STATE OF IDAHO
DEPARTMENT OF
ENVIRONMENTAL QUALITY

1410 North Hilton • Boise, Idaho 83706 • (208) 373-0502

C.L. "Butch" Otter, Governor
Toni Hardesty, Director

March 15, 2010

Daniel Opalski, Director
Office of Environmental Cleanup
U.S. Environmental Protection Agency
1200 Sixth Avenue Suite 900 (MS ECL-117)
Seattle, WA 98101

Dear Mr. Opalski:

This letter provides Idaho DEQ's overarching technical review of the Focused Feasibility Study for the Upper Coeur d'Alene Basin at the Bunker Hill Superfund Site. This review does not address ROD concurrence or State Superfund Contract issues. Our comments on the proposed ROD Amendment for the Bunker Hill Site are consistent with the goals that we set at the beginning of the process. Our goals are listed below.

Protecting the existing remedy is DEQ's first priority.

Cleanup must result in tangible environmental improvements at a reasonable cost.

The ROD must provide for use of innovative methods; examples are the re-processing of contaminated waste to offset cleanup costs and hydro-power generation associated with side drainage remedies.

The implementation plan must take into account factors such as cash flow, low operating and maintenance (O&M) costs, and adaptive management.

Provide clarity and certainty for re-use and recycling of contaminated soil and other wastes under the ICP so that local residents know how to safely manage and utilize these materials.

The ROD must have active community support.

We provided these goals to EPA Region 10 and have participated in the development of the Focused Feasibility Study with these goals as our guiding principles.

Idaho's first two goals are the most germane to the questions before the NRRB. Our technical comments on the FFS are discussed below.

Remedy Protection
Idaho DEQ supports the Remedy Protection (RP) work outlined in Alternative 2. We believe this work is critical to maintaining the human health remedy. Without RP actions, the long-term

sustainability of the cleanup is questionable. The proposed RP work takes a significant step in addressing a conclusion reached by the National Research Council (NRC). In Superfund and Mining Megasites (2005) the NRC noted that none of the remedies at Bunker Hill are permanent (p. 398).

The human health remedy for the Site relies on clean barriers to isolate underlying contaminated materials. The remedy removed the top 6 to 12 inches of contaminated soils based on contamination depth and property use and replaced that material with clean soil or gravel. This created the clean barrier between contaminated materials and human receptors.

The communities in the site are located in narrow mountain valleys with typical surface drainage issues associated with this setting. Local flow conditions during high precipitation events are characterized as steep gradient, high energy environments. Floodwaters may erode or bury the clean soil barriers, rendering the remedy ineffective. In watersheds with upgradient mine and mill site waste piles direct erosion of these piles and deposition of contaminated materials can also occur. The FFS demonstrates the case for Alternative 2 using the EPA evaluation criteria.

The RP work is consistent with DEQ's first goal to protect the human health remedy. However, additional work is needed to maintain the human health remedy. Two examples of additional remedy protection issues of concern for the State are: (1) local paved roads that fail as barriers due to normal wear and tear and expose the underlying contaminated road base materials; and (2) flood threats from the South Fork of the Coeur d'Alene River and Pine Creek. The roads issue will be addressed under existing RODs. DEQ and EPA are working with the Basin Environmental Improvement Project Commission to bring agencies with flood control jurisdiction together to develop a flood control project. Draft language for the ROD Amendment being reviewed by community leaders to address the flooding issues states the following:

"During EPA's Five Year Reviews of the completed portions of the Superfund cleanup, EPA evaluated risks of flooding and related threats to the remedy and recommended follow-up actions, resulting in the selection of remedy protection projects in this Amendment. EPA will continue to evaluate such risks to the Superfund cleanup in future Five Year reviews. However, comprehensive flood control is a complex multi-jurisdictional issue that exceeds the expertise and regulatory authority of EPA's and IDEQ's cleanup programs, and the local communities.

Therefore, the Basin Environmental Improvement Project Commission (BEIPC), consistent with its authority, agreed in November 2009 to take a leadership role in evaluating flooding issues associated with the South Fork and Pine Creek. Flooding is a large, system-wide concern for which a comprehensive review and plan are required to ensure that work with the greatest flood protection potential is ultimately implemented. The BEIPC has engaged a range of entities with the combined required expertise and regulatory jurisdiction. These entities include the Corps of Engineers (COE), Federal Emergency Management Agency (FEMA), Idaho Bureau of Homeland Security (IBHS), EPA, and IDEQ. EPA and IDEQ are committed to assisting the BEIPC led activities to evaluate and plan actions relative to dealing with South Fork and Pine Creek flooding issues. A funding source for the BEIPC led activities will need to be established. If these efforts identify actions that would meet Superfund remedy requirements, EPA could define and select these activities in future decision documents (e.g., ROD amendment)."

DEQ is currently working with EPA to identify potential funding to support the BEIPC efforts.

Mine and Mill Site Remediation
DEQ supports the mine and mill site remediation work in the FFS. This work will not only reduce risks associated with recreational use at these sites, it will help to improve water quality. As work progresses on mine and mill sites, each site will need to be further evaluated as to its contribution to water contamination and the risks it poses to recreationalists. This work will produce tangible environmental benefits at reasonable costs and should be prioritized over active water quality treatment.

Water Quality Remediation
Idaho DEQ supports cost effective and achievable surface and ground water quality improvement at the Bunker Hill Site. It is consistent with our mission. The biggest challenge of addressing water quality at this site is the pervasive nature of contaminant sources from mine wastes. There is no single geographic source of contamination impacting the surface water system. Due to the widespread distribution of contaminated soils in direct contact with groundwater, the surface water contaminant sources are more typically identified with large-volume alluvial deposits. Remediating these wide-spread sources as proposed in Alternative 2 is problematic, costly, and represents an open-ended commitment to active water treatment.

Observed metal levels have generally declined over time in surface- and groundwater at the site. This is believed to be due to previous source removal actions and natural attenuation. DEQ and its contractors have considered action that could harness one of the natural attenuation mechanisms to gain water quality improvements. These considerations were based on the observation that lower zinc concentrations in groundwater were associated with water that had slightly higher pH. This is believed to be due in part to the greater amount of precipitation of ferric hydrous oxides in the higher pH geochemical environment.

A preliminary alternative was developed that called for a permeable reactive barrier (PRB) using limestone to increase pH. DEQ and EPA ultimately agreed this approach needed more work and that it was premature to be part of the preferred alternative because of unknowns related to cost and effectiveness compared to conventional treatment. As indicated in the NRRB package the PRB may be further evaluated and may have particular application at specific areas. The State encourages further evaluation to understand the potential applicability of a PRB and other alternative treatment approaches.

DEQ's interest in exploring action which could take advantage of natural attenuation is not limited to simply addressing the high cost of conventional treatment. It also relates to the pervasive nature of the problem and the insufficiency of technical solutions available today to comprehensively address the problem.

The preferred alternative, Alt 3+, collects large amounts of water for treatment that will continue for the foreseeable future. There is no way to accurately predict how long it would take to meet water quality standards after implementation of the remedy. The Predictive Analysis Tool is useful to compare alternatives, but is not particularly useful in predicting when water quality standards will be

met. What we do know is that it will likely take several decades at a minimum to meet water quality standards at a very high cost.

As listed at the beginning of this letter, DEQ's second goal is to provide tangible environmental improvements at a reasonable cost. The water quality alternatives in the FS push hard against this objective. DEQ does not oppose the water quality alternatives in the FFS. However, we believe the selected remedy from the FFS should be implemented in a deliberative and iterative manner to ensure that the proposed remedies will function as expected. Treatability studies that test the Typical Conceptual Designs should also focus on better understanding of the geochemical and groundwater system to evaluate whether better alternatives are available to improve water quality. As discussed above, we support the prioritization of source control actions related to mine and mill sites over implementation of the water quality treatment remedy. During the period of mine and mill site cleanup, the cleanup project should continue to monitor water quality and evaluate the timing and sequencing of the water quality remedy.

Summary
DEQ supports EPA's technical work in the FFS. Our recommendations would be to prioritize work that protects the investment already made to protect human health. Secondly, we would prioritize the mine and mill site work that will produce tangible results to protect human health and water quality. Finally, we share EPA's concern and mission to meet water quality standards. However, the pervasiveness of the sources creates a complexity that will cost hundreds of millions of dollars and take many decades to meet those standards. There is a risk that scarce dollars could be lost on work that makes little progress in improving water quality. Thus, we encourage a deliberative and measured approach to implementing the remedy associated with water collection and treatment.

Finally, I would like to recognize that this FFS reflects a solid effort to meet EPA's obligation to develop a clean up plan that protects human health and the environment which includes meeting water quality standards. This is a difficult if not almost impossible task at this site. I also appreciate EPA's role in creating an open and constructive working relationship between EPA and DEQ. My intent is to keep working collaboratively to create a cleanup plan that will help make the Silver Valley whole for the benefit of its current and future residents.

Sincerely,

Toni Hardesty
Director

TH:ra

REFERENCE:

COEUR D'ALENE TRIBE

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March 17, 2010

Mr. Dan Opalski
Acting Region 10 Administrator
United States Environmental Protection Agency
1200 Sixth Avenue, Suite 900
MS ECL-117
Seattle, WA 98101

Re: Site Information Package for the EPA National Remedy Review Board

Dear Mr. Opalski:

On March 3, 2010, the Coeur d'Alene Tribe's Lake Management Department received the Upper Basin of the Coeur d'Alene River, Bunker Hill Mining and Metallurgical Complex Superfund Site, Site Information Package for the National Remedy Review Board ("Board"). On March 5th the Tribe submitted preliminary comments on the Draft Focused Feasibility Study Report (DFFS) summarized in this Board package. The DFFS provides EPA's rationale for the selection of what is currently the proposed amendment to the Record of Decision (ROD) #3 for the Upper Coeur d'Alene Basin.

As you are aware, the Coeur d'Alene Basin is the heart and soul of the Tribe's homeland. The cleanup of nearly 100 years of mining pollution throughout the Basin is of paramount concern to us. Therefore, the Tribe supports EPA's efforts to consider conducting far more remedial activities than originally planned in ROD #3. The Tribe appreciates the chance to provide the following written comments. We also look forward to meeting with the Board in Seattle, during the week of April 25th and to providing further comments and engaging in government-to-government consultation and coordination on all aspects of this matter in the future.

Given the magnitude, scope and detail of the EPA documents mentioned above, and the short time frame provided for our review, the Tribe can, at this time, offer the following general comments.

As EPA continues to consider issues as part of the decision making process to finalize the Proposed Plan for the Upper Basin ROD amendment, please consider:

- the Tribe is in favor of cleanup actions that more aggressively remove mining-related contamination from widespread areas throughout the Basin. Remedial actions are favorable as outlined in Alternative 4 of the DFFS.

- the Tribe understands why EPA has focused this amendment on the Upper Basin, but also asks EPA to consider highlighting several Lower Basin remedial activities that have already been outlined in the original ROD #3 (examples include: river dredging, bank remediation and stabilization, splay removal, and floodplain enhancement). These types of projects could be considered "demonstration" projects that could help our understanding of how best to conduct remedial actions in the Lower Basin once the Upper Basin contamination is cleaned up. Recontamination from flooding will remain a concern of the Tribe's.

- the Tribe has concerns about the limited approach EPA is using that seeks to resolve "surface water issues," but not contaminated soils, sediments, and other pathways of contamination. We urge EPA to consider a more holistic and comprehensive approach to resolving all Superfund issues in the Upper Basin. This amendment, once implemented, should address all that is necessary to achieve all appropriate standards.

- the Tribe reserves the right to provide more detailed comments on EPA's "typical conceptual designs" -- especially as they relate to addressing surface water contamination, the Central Treatment Plant, flood control/levee stabilization, repository siting and design, remedy protection, and on-going restoration-remediation coordination and consultation.

- the Tribe remains concerned about the funding of this amendment as it relates to the completion of all remediation actions over the next 50 or more years. As outlined in EPA's options, this Upper Basin remedy is estimated to cost in excess of $1.5 billion dollars. Given that the settlement money received from Asarco is far less, the Tribe urges EPA to consider a long-term strategy to fund its cleanup to include, but not necessarily be limited to, using interest on the principal, so as to allow for more extensive cleanup over the long-term (especially remedial activities in the Lower Basin, and if necessary, Coeur d'Alene Lake).

As the Tribal Chairman, I reflect back when our elders appealed for a remedy for the contamination on our homeland at it was beginning to be understood by the U.S. government. They recognized that it took 100 years to pollute the Basin, and therefore it could take just as long for Mother Earth to repair herself. They spoke of 7-generation solutions that were permanent and holistic. With each passing decade, the Tribe sees EPA's work continuing to make a difference. We see your local and regional staff dedicated to the mission. To this end, we generally support what we have seen thus far in the documents provided. We look forward to meaningful consultation and the continued coordination of our joint efforts towards remediation and restoration.

Sincerely,

Chief J. Allan
Chairman

cc: Eric Van Orden, Legal Counsel, Coeur d'Alene Tribe
Howard Funke, Special Counsel, Coeur d'Alene Tribe

United States Department of the Interior

FISH AND WILDLIFE SERVICE

911 NE 11th Avenue
Portland, Oregon 97232-4181

In Reply Refer to:
FWS/R1/AES

MAR 18 2010

Dennis McLerran, Regional Administrator
US Environmental Protection Agency, Region 10
Office of Environmental Cleanup
1200 Sixth Avenue, Suite 900
Seattle, Washington 98101-3140

Dear Mr. McLerran:

The Department of the Interior (Department) has done a preliminary review of the Site Information Package for the National Remedy Review Board (hereinafter referred to as NRRB Package). Due to the volume of material presented and the short time frame provided for this review, we were unable to provide a detailed review of the NRRB Package. We anticipate providing further comments on the Proposed Record of Decision (ROD) amendment during the upcoming public comment period. Included as an attachment, please find specific comments provide by Department and its component bureaus, the Fish and Wildlife Service and the Bureau of Land Management. As requested, these comments are being provided in the Excel spreadsheet the Environmental Protection Agency distributed for the purpose of capturing comments. We provide our comments under the authority of and in accordance with provisions of the Endangered Species Act of 1973, as amended, (16 U.S.C. 1531 *et seq.*), Fish and Wildlife Coordination Act (16 U.S.C. 661 *et seq.*), Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. 703-712), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended (42 U.S.C. 9601 *et seq.*).

We appreciate the extensive efforts U.S. Environmental Protection Agency (USEPA), Region 10 has made to coordinate and communicate with the Department throughout the Coeur d'Alene Basin (Basin) CERCLA process. Through this process the Department and USEPA have forged strong interagency working relationships that have resulted in successful settlement negotiations, efficient exchange of technical information, collection and analysis of monitoring data, and the first of what we anticipate will be many joint remedial and Natural Resource Damage Assessment and Restoration (NRDA) projects.

In general, we fully support additional cleanup actions in the Upper Basin. As stated in Section 1.5: "Significant and measurable risks are still posed to humans and the environment and should continue to be addressed." We appreciate USEPA's extensive efforts to reevaluate contaminant sources and prioritize cleanup actions in the Upper Basin. Recent environmental monitoring, along with other sources of new information, has allowed USEPA to outline an integrated approach for Operable Unit (OU) 2 and OU3 remedies. Alternative 3+ has many components that we support, as they will reduce ongoing injury to natural resources from mining-related contamination in the Upper Basin. Examples include: extensive excavation of waste rock,

tailings and floodplain sediments; capping, regrading, and revegetation of waste rock areas; collection and treatment of contaminated adit drainages, seeps and groundwater; and stream and riparian improvements. Due to the general nature of the description of the Preferred Alternative actions we have provided some clarifying comments below. We also request the opportunity to provide additional comments on site-specific project designs once they are available.

It is important that the Preferred Alternative include flexibility because currently there is insufficient characterization of primary and secondary source areas and insufficient site characteristics to design site-specific actions. The actions in the Preferred Alternative are reasonable estimates, but more site-specific information is needed before appropriate site-specific actions can be chosen and technically reviewed.

One way the Preferred Alternative does include flexibility is through adaptive management. The Department supports the adaptive management approach included in the Preferred Alternative, and like USEPA, concludes that it is important to use adaptive management to bring about flexible, sound decisions (page 2.6 and Section 13). An example of where the adaptive management approach would be appropriate is in the Woodland Park area of Canyon Creek. The Preferred Alternative uses hydraulic isolation of stream reaches to reduce loading to ground and surface water using stream liners and french drains, together with source control actions (see page A-8). The Department concurs with USEPA and the National Academy of Science (NAS) recommendations (page 2-5, 2-6) to consider groundwater treatment approaches while developing an understanding of the distribution, fate, and transport of dissolved metals in groundwater. We do, however, have initial concerns about whether the liners and drains can capture and isolate a sufficient amount of the contaminated groundwater to result in the predicted improvement in surface water quality. To address the uncertainties of this complex action, we support an adaptive management approach involving incremental structure installation and ongoing effectiveness monitoring of the liners and drains.

We consider more permanent solutions involving source control preferable to actions that require long-term operation and maintenance, where practicable. We have this preference because failure of these systems could lead to additional natural resource injuries and because of the uncertainty of the effectiveness of some of these less permanent actions. The following are two examples that illustrate this point. One, the Preferred Alternative (page A-9) includes construction of a series of groundwater wells at the mouth of Government Gulch to collect contaminated water for pumping to the central treatment facility. Given the limited amount of detailed information provided, our preliminary concerns include the efficiency of ground water collection and the risk associated with long-term operation and maintenance of the required pumping. Two, the source treatment described in Remedy Protection Alternative (Section 11-2) is not clear. We concur with the NAS recommendation to consider the impacts of flood events on protective barriers (page 2-6, line 3-4), and we support the inclusion of the analysis and treatment of contaminated upstream and upslope sources as well as improved downstream conveyance measures.

The Department notes that the Preferred Alternative does not address significant soil and sediment contamination in OU2 and the Lower South Fork Coeur d'Alene River from Smelterville Flats to the confluence with the North Fork Coeur d'Alene River. Backwater effects from the former Pinehurst dam below Smelterville Flats resulted in extensive upstream

floodplain contamination. Downstream transport and deposition of contaminated sediments resulted in contamination of the floodplain of the lower South Fork Coeur d'Alene River. We recommend that the Preferred Alternative include actions to address contaminants in this area.

The Department also recognizes the ongoing significant human health and environmental problems posed by mining-related metals contamination in the Lower Basin described in the OU3 Interim ROD. We support USEPA's ongoing efforts to expeditiously evaluate and address the Lower Basin. We recommend that USEPA balance allocation of their resources among Upper Basin and Lower Basin actions. The Lower Basin wetlands and Federal lands and their associated plants, fish, and wildlife are important natural resources that are continuing to be injured by mining-related hazardous substances. With each passing year more contaminated river bed sediments are deposited onto the floodplains, and into wetlands and lakes. We recommend that some Lower Basin actions included in the Interim OU3 ROD that abate downstream transport of toxic river bed sediments be undertaken as part of the current effort, even if those actions are pilot projects that test techniques and evaluate extent of recontamination.

As you know, the Department is a member of the NRDAR Trustee Council and the Federal Trustees recently received a substantial settlement ($79.5 million) through the ASARCO bankruptcy proceedings for natural resource damages. Although the Trustees have not yet completed the necessary restoration planning processes, it is likely that in some cases, the most efficient use of both remedial and NRDAR funding will be to integrate remedial and restoration actions. We would like to continue discussions with USEPA regarding how best to integrate those actions.

We look forward to continuing to work with USEPA on the cleanup and restoration of the Basin. Thank you for the opportunity to provide these comments. If you have any questions, please contact Kathleen Moynan, our NRDAR Coeur d' Alene Project Manager, at (503) 231-2228.

Sincerely,

Acting

Theresa E Rahal

Regional Director

Enclosures:

cc:
SOL (B. Stein)
IFWO (R. Torquemada)
DEQ (D. Savignano)
BLM (E. Thompson)
EPA (B. Adams, A. Dailey, and A. McCauley)
FS (Bob Kirkpatrick)
BIA (Q. Brown)
Coeur d'Alene Tribe (Phillip Cernera)
DEPC (Preston Sleeger)

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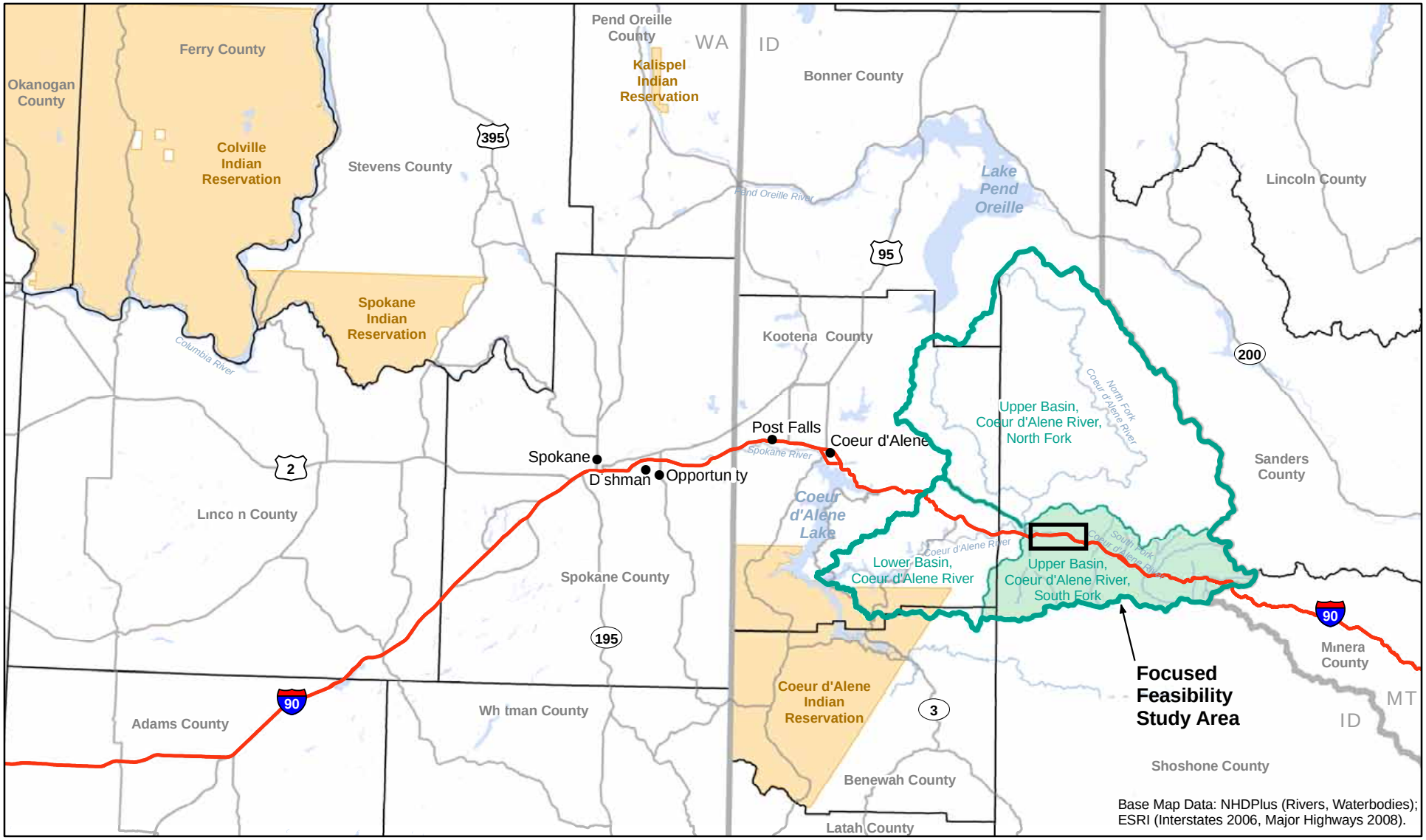

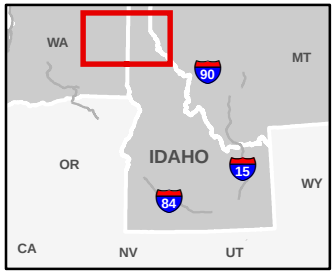

- City
- The Bunker Hill Box: Operable Units 1 (Populated Areas) and 2 (Non-Populated Areas)
- Focused Feasibility Study Area
- Coeur d'Alene Subbasin Boundary
- Tribal Land

Notes:
1. The geographic extent of the Bunker Hill Mining and Metallurgical Complex Superfund Site is defined by Operable Units 1, 2, and 3.
2. Operable Unit 3 is defined as all contaminated areas in the Coeur d'Alene River Basin, Coeur d'Alene Lake, and the Spokane River, outside the Box.

N

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Figure A-1
Location Map: Bunker Hill Mining and Metallurgical Complex Superfund Site
Site Information Package for National Remedy Review Board

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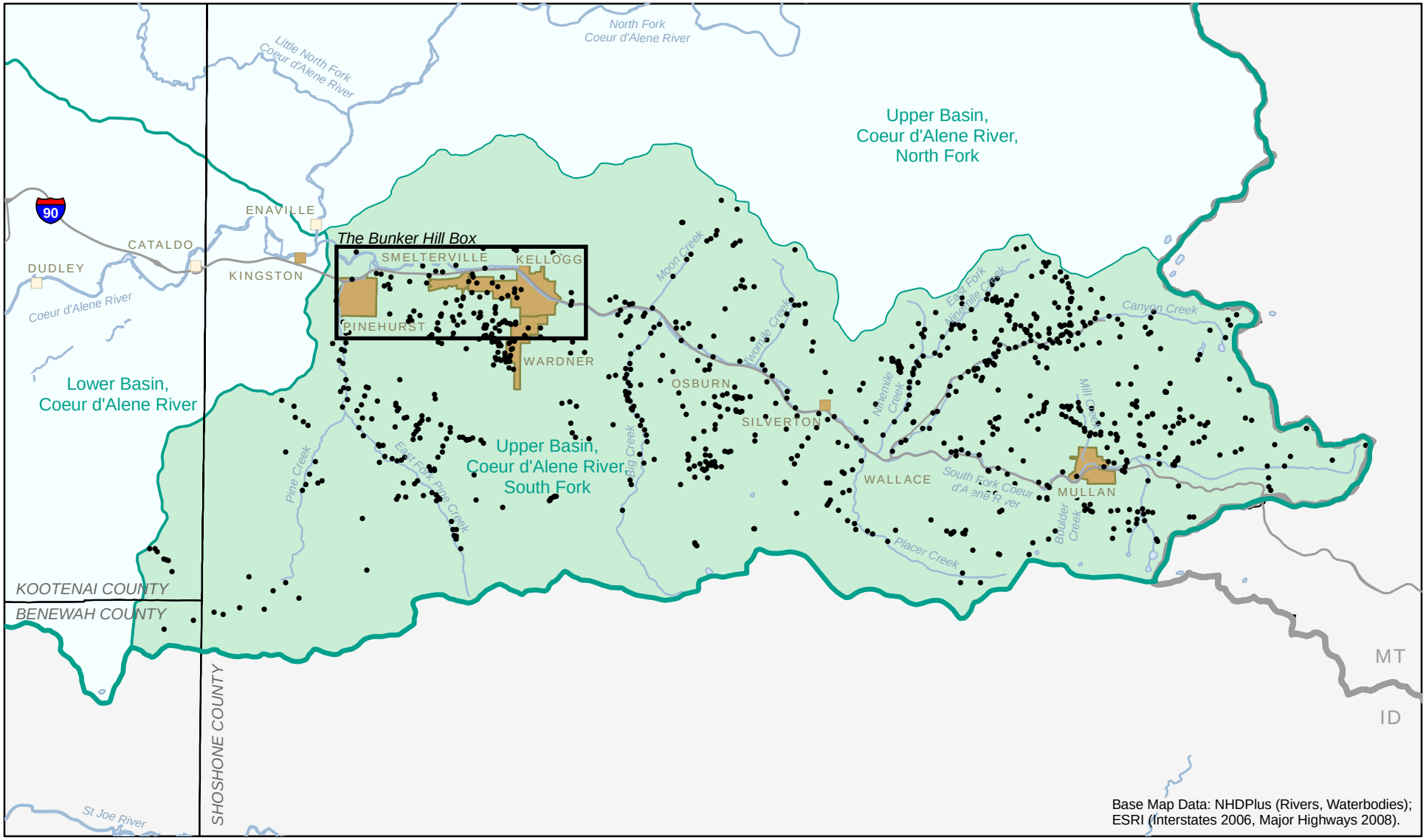

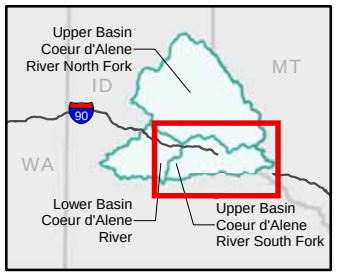

- Source Area
- River/Creek
- Approximate Remedy Protection Study Area
- Focused Feasibility Study Area
- Coeur d'Alene River Subbasin Boundary
- City Limit
- County Boundary
- State Boundary

Note:
Source areas are based on the inventory of source sites conducted by the Bureau of Land Management (BLM) in 1999 in support of the Remedial Investigation/Feasibility Study (RI/FS) for the Coeur d'Alene Basin (U.S. Environmental Protection Agency [USEPA], 2001c, 2001d).

N
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Figure A-2
Focused Feasibility Study Area and Source Sites
Site Information Package for National Remedy Review Board

EPA

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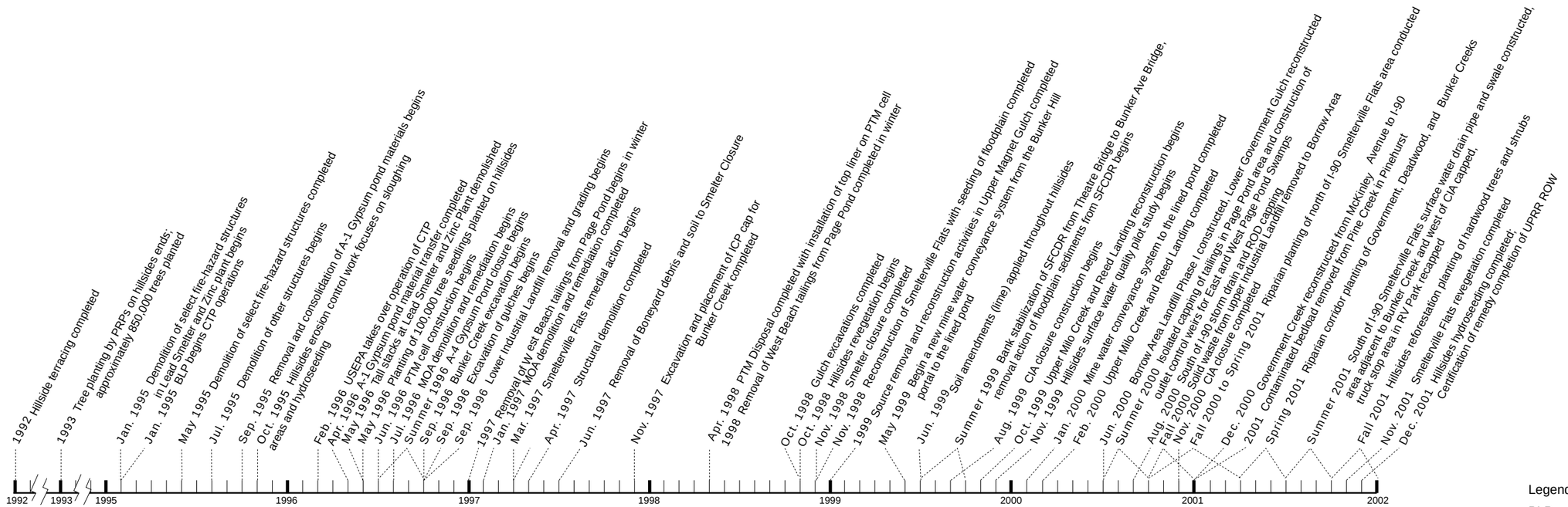
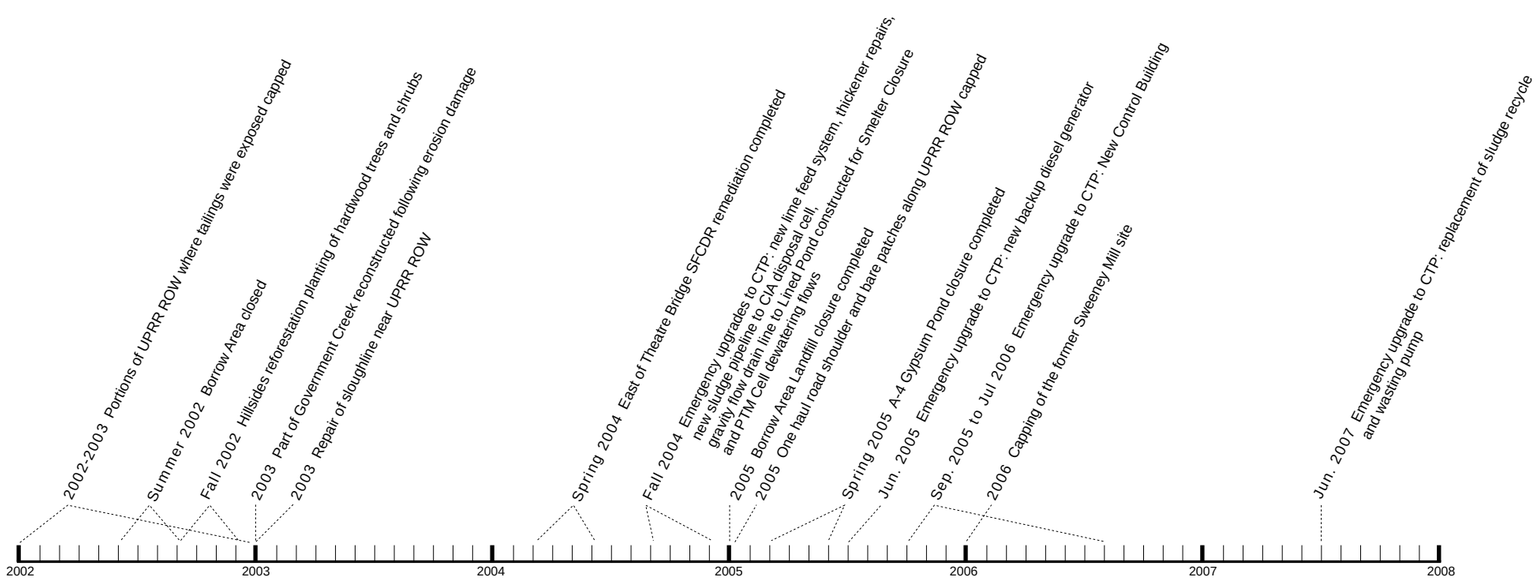
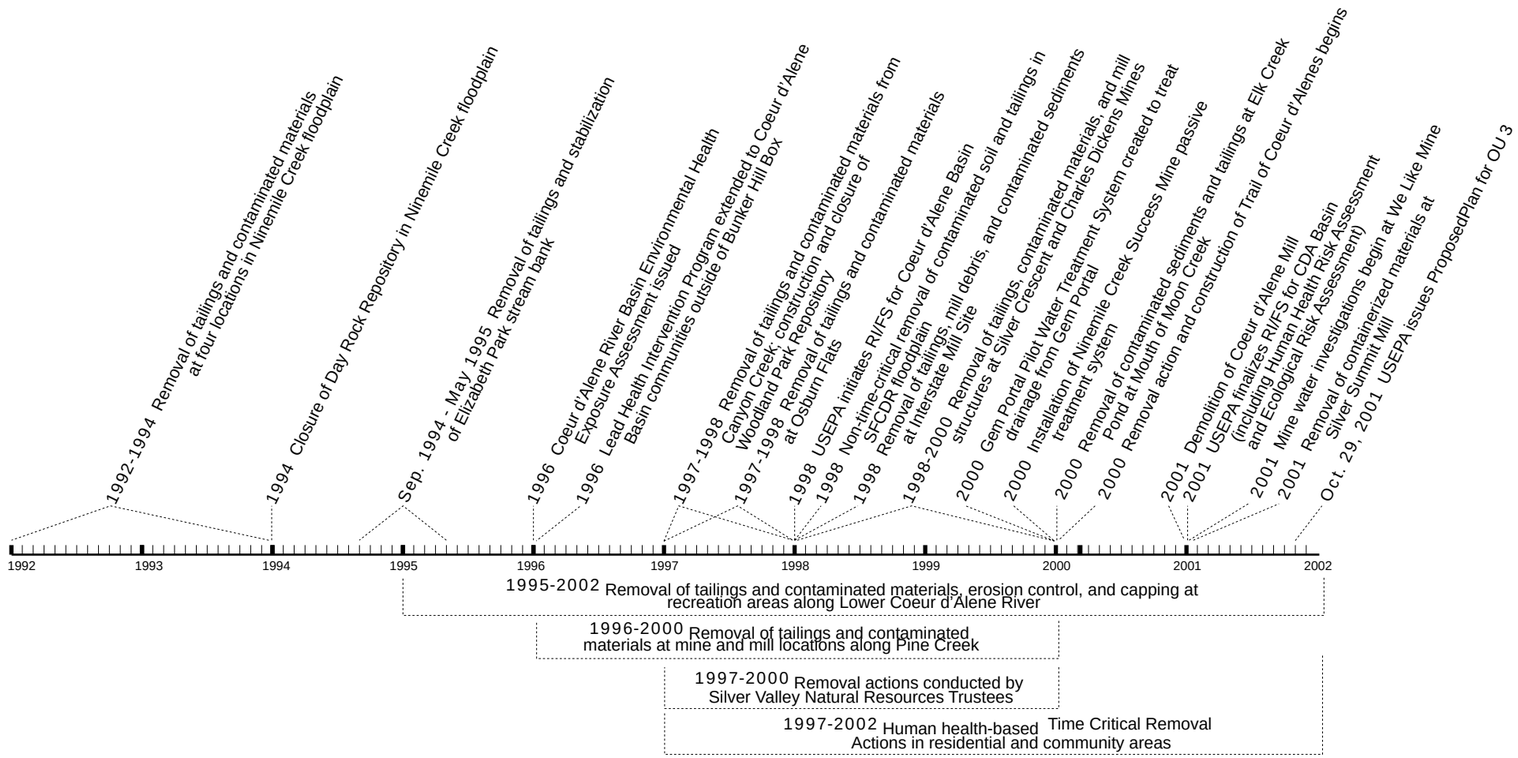




Legend:

BLP	Bunker Limited Partnership
CIA	Central Impoundment Area
CTP	Central Treatment Plant, Idaho
MOA	Mine Operations Area
PRP	Potentially Responsible Party
PTM	Principal Threat Materials
ROD	Record of Decision
ROW	right of way
SFCDR	South Fork of the Coeur d'Alene River
UPRR	Union Pacific Railroad
USEPA	U.S. Environmental Protection Agency

Figure B2-1
OU 2 Removal and Remedial Actions Timeline, Bunker Hill Superfund Site
Site Information Package for National Remedy Review Board



Legend:

OU	Operable Unit
RI/FS	Remedial Investigation/ Feasibility Study
ROD	Record of Decision
SFCDR	South Fork of the Coeur d'Alene River
USEPA	U.S. Environmental Agency

Protection

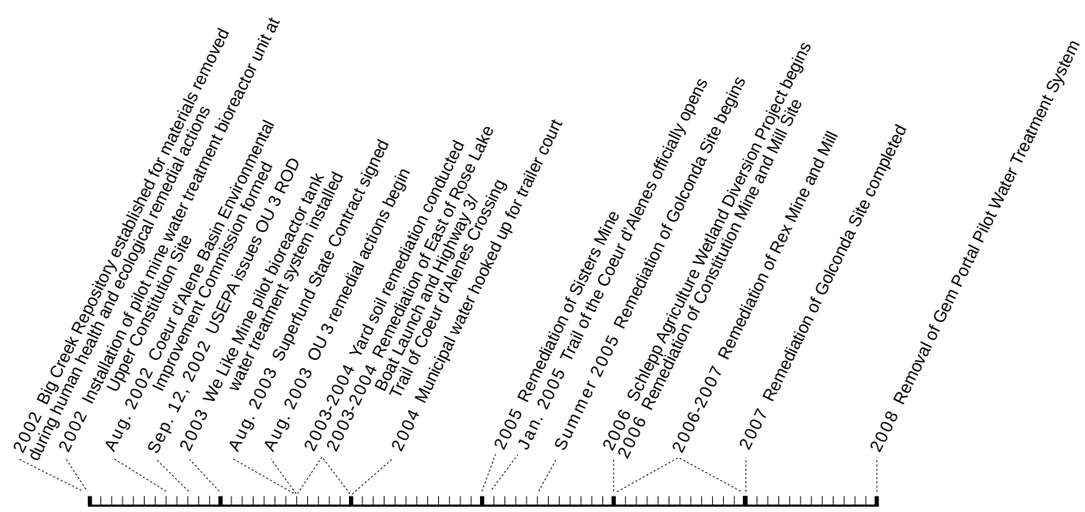
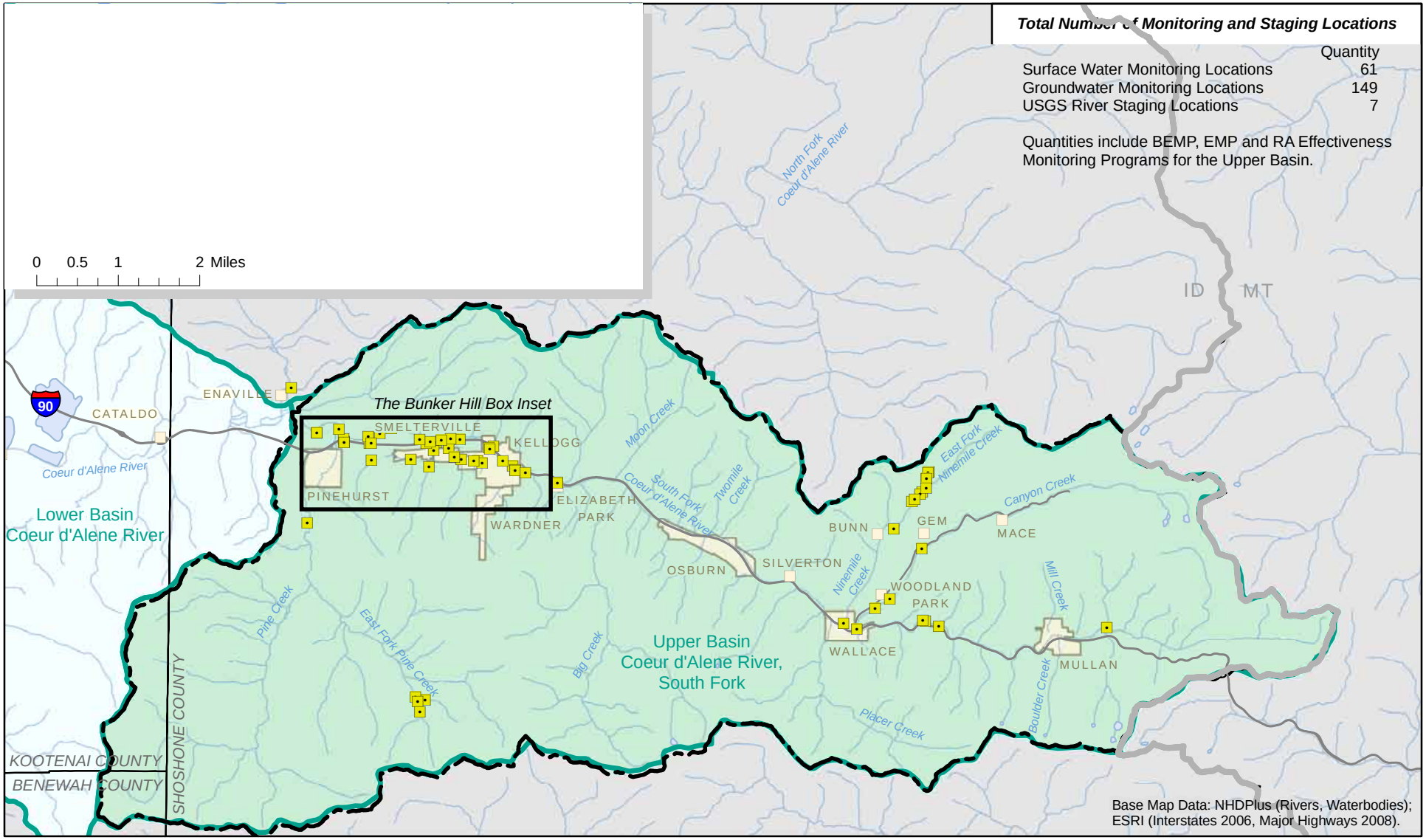
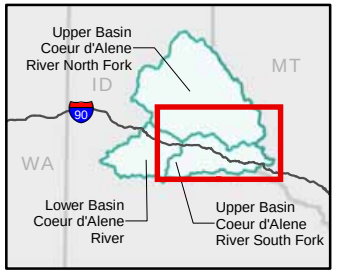


Figure B2-2
OU 3 Removal and Remedial Actions Timeline, Bunker Hill Superfund Site
Site Information Package for National Remedy Review Board





- Surface Water Monitoring Location
- River/Creek
- Watershed Boundary
- Coeur d'Alene River Subbasin Boundary
- Focused Feasibility Study Area
- City Limit

N

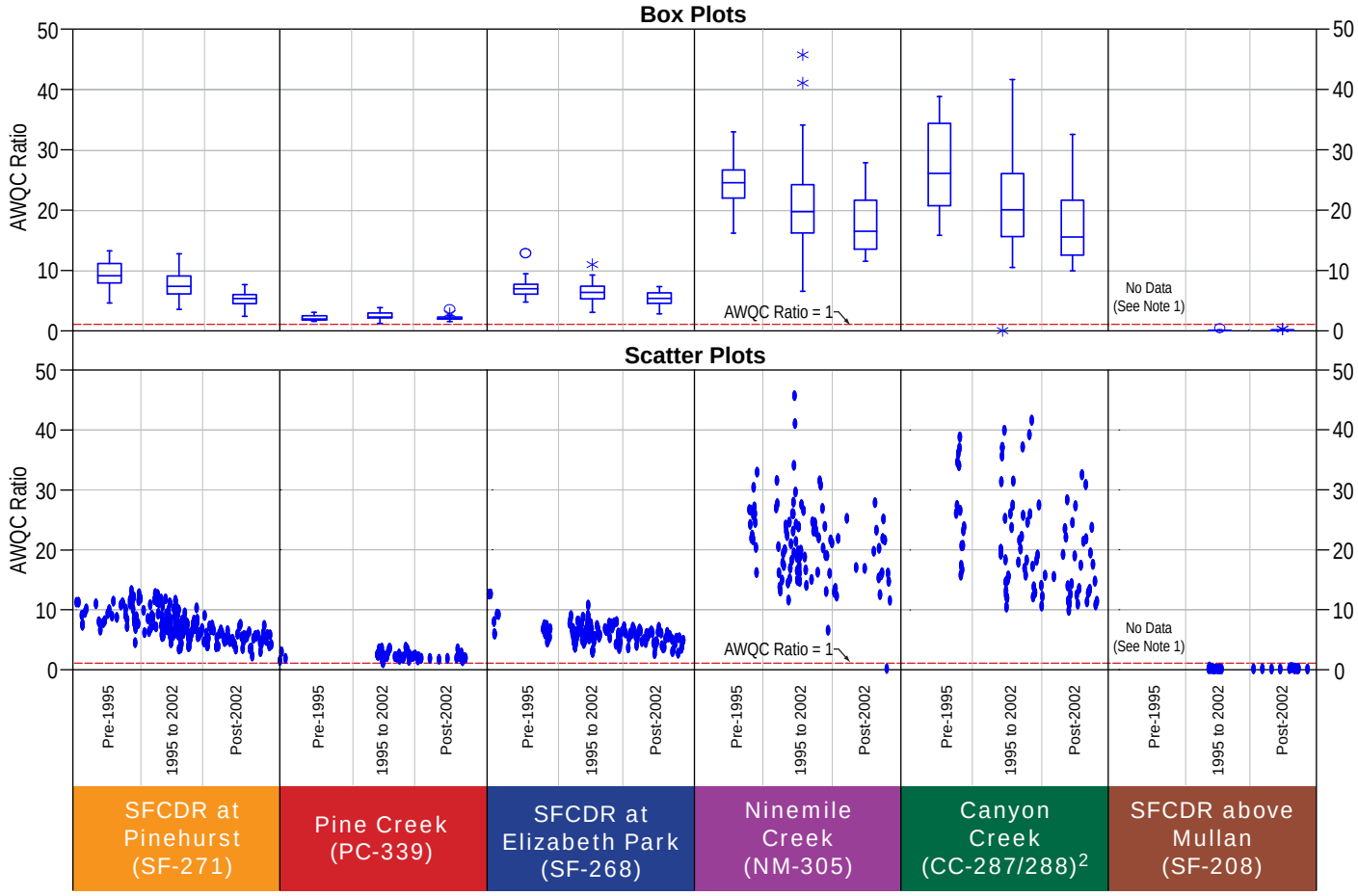
0 1 2 4 Miles

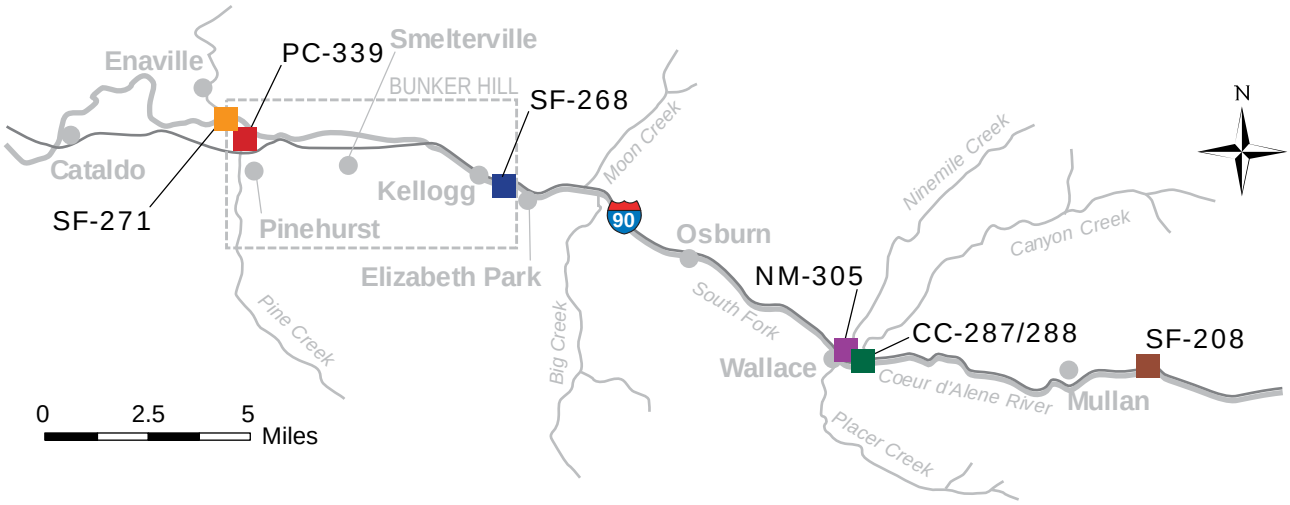
Figure B4-1
Upper Basin Hydrology
Site Information Package for National Remedy Review Board

EPA

How to Read the Box Plots

The box plot shows the median or 50th percentile (line in the middle of the box), along with the 25th and 75th percentiles (top and bottom of box), and the range (extreme spread) of the data. The circles and stars are statistical outliers. Box plots provide a way to see the overall distribution and variability associated with the data, and they help when looking at trends between datasets. For example, if just the median values were compared, trends might appear to be more significant. The boxes show there is often a fair degree of overlap between data from different time periods and locations.





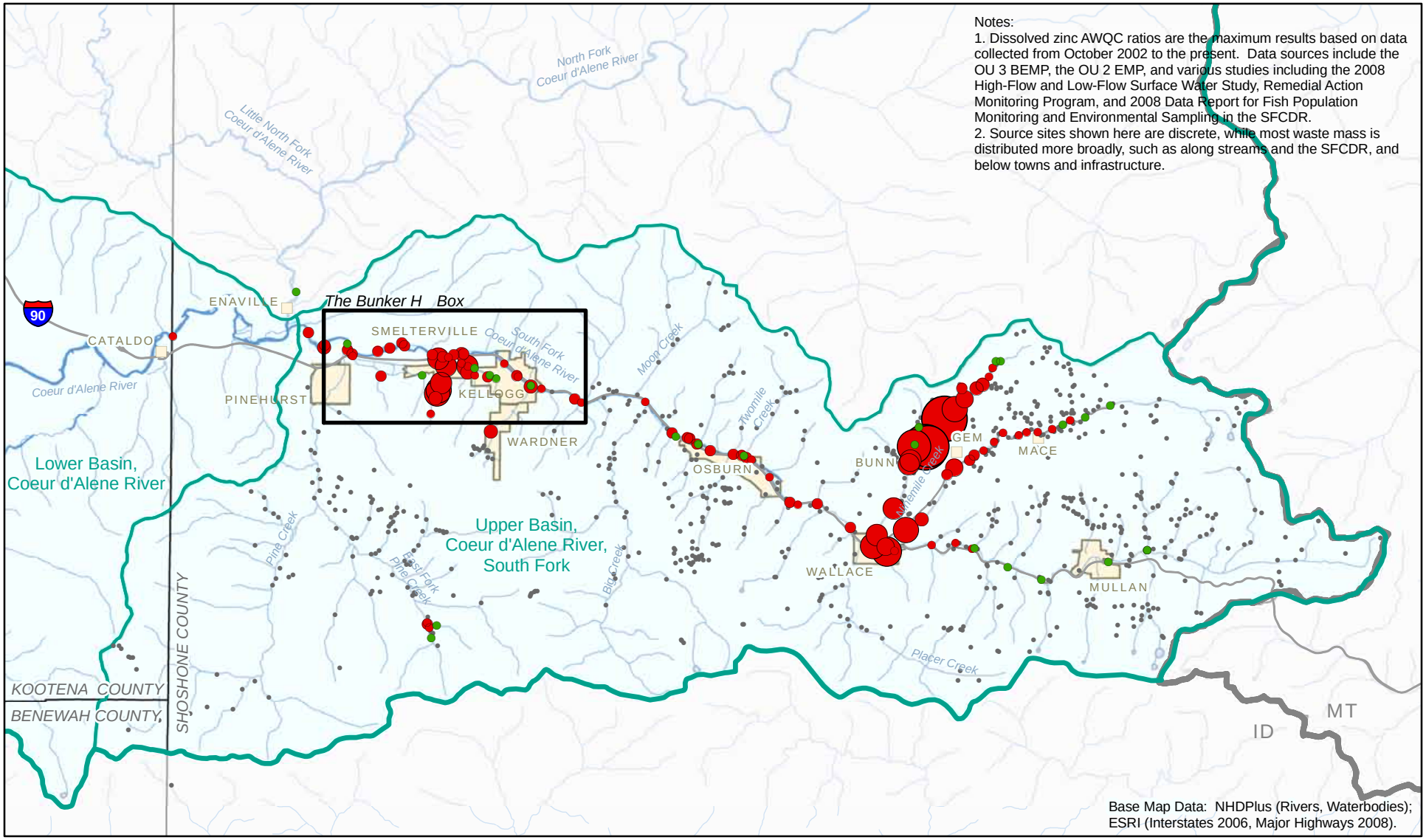
Notes:

1. There are no pre-1995 data for Mullan where dissolved zinc and hardness data are available, both of which are needed to calculate the AWQC ratio.
2. The pre-1995 data are from CC-287, while the post-1995 data are from CC-288.

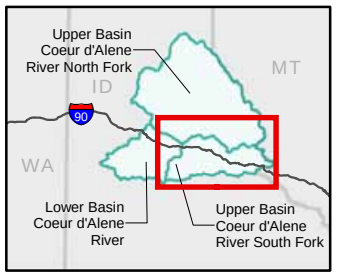
Pre-1995 = 9/15/1987 to 9/15/1995
Post-2002 = 10/2002 to present

Figure B4-2
Zinc AWQC Ratio Distribution at Selected Sites
Site Information Package for National Remedy Review Board

Notes:
1. Dissolved zinc AWQC ratios are the maximum results based on data collected from October 2002 to the present. Data sources include the OU 3 BEMP, the OU 2 EMP, and various studies including the 2008 High-Flow and Low-Flow Surface Water Study, Remedial Action Monitoring Program, and 2008 Data Report for Fish Population Monitoring and Environmental Sampling in the SFCDR.
2. Source sites shown here are discrete, while most waste mass is distributed more broadly, such as along streams and the SFCDR, and below towns and infrastructure.



Base Map Data: NHDPlus (Rivers, Waterbodies); ESRI (Interstates 2006, Major Highways 2008).



AWQC Ratios

- < 1
- 5
- 20
- 50
- 75

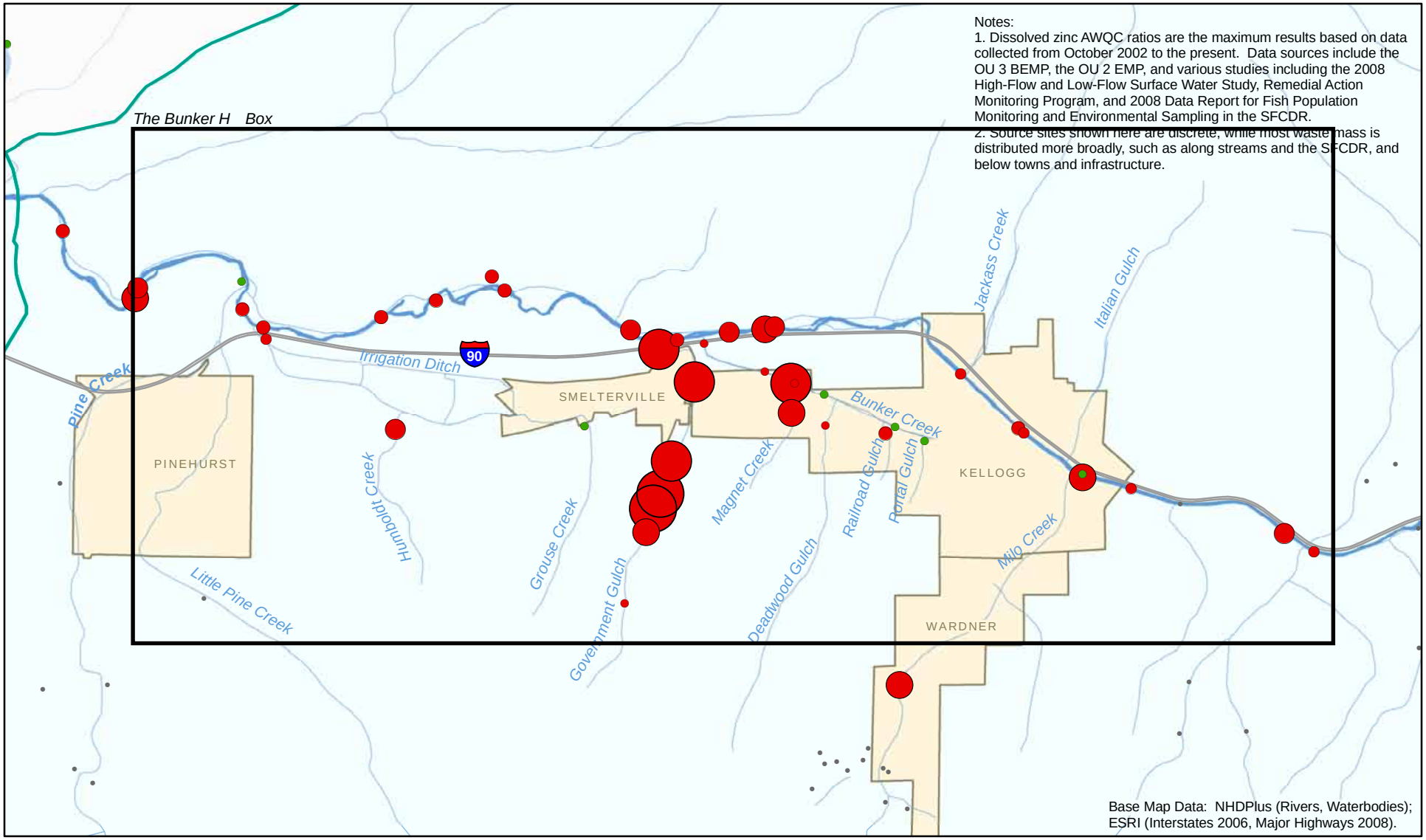
- Source Site
- River/Creek
- Coeur d'Alene River Subbasin Boundary
- City Limit
- County Boundary
- State Boundary

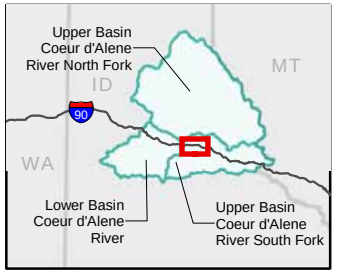
N

0 1 2 4 Miles

Figure B4-3
Maximum Basin-Wide Zinc AWQC Ratios in Surface Water, Post-2002
Site Information Package for National Remedy Review Board

EPA





AWQC Ratios

- <1
- 2
- 8
- 16
- 25

- Source Site
- River/Creek
- Coeur d'Alene River Subbasin Boundary
- City Limit

N

0 0.25 0.5 1 Mile

Figure B4-4
Maximum Bunker Hill Box Zinc AWQC Ratios in Surface Water, Post-2002
Site Information Package for National Remedy Review Board

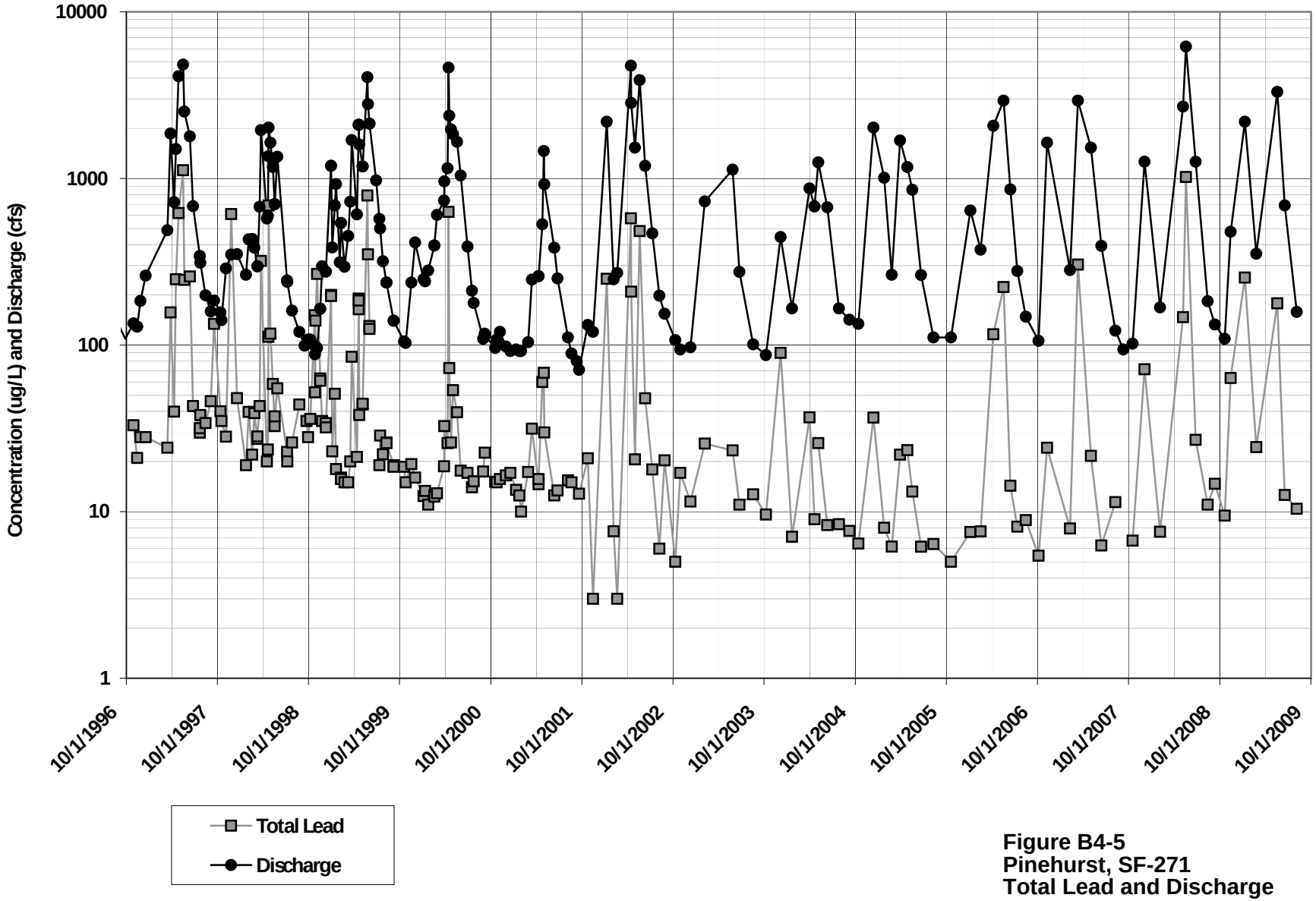
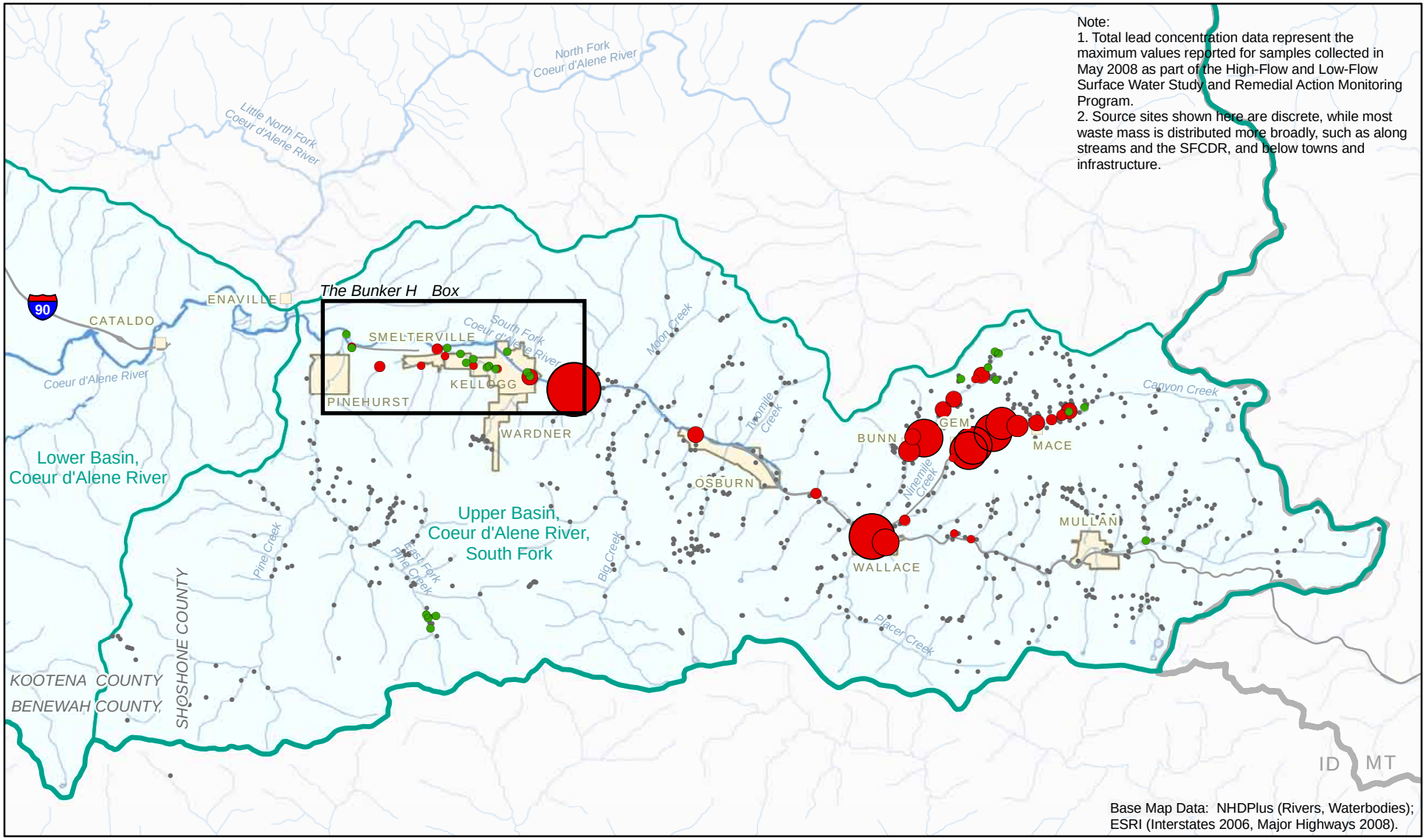
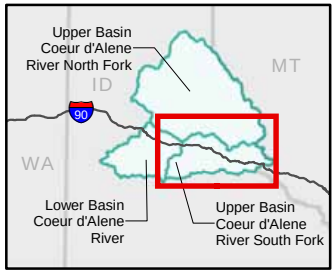


Figure B4-5
Pinehurst, SF-271
Total Lead and Discharge
Site Information Package for
National Remedy Review Board

Note:
1. Total lead concentration data represent the maximum values reported for samples collected in May 2008 as part of the High-Flow and Low-Flow Surface Water Study and Remedial Action Monitoring Program.
2. Source sites shown here are discrete, while most waste mass is distributed more broadly, such as along streams and the SFCDR, and below towns and infrastructure.



Base Map Data: NHDPlus (Rivers, Waterbodies); ESRI (Interstates 2006, Major Highways 2008).



Total Lead Concentration

- <=15
- 25
- 75
- 150
- 500
- 1200

- Source Site
- River/Creek
- Coeur d'Alene River Subbasin Boundary
- City Limit

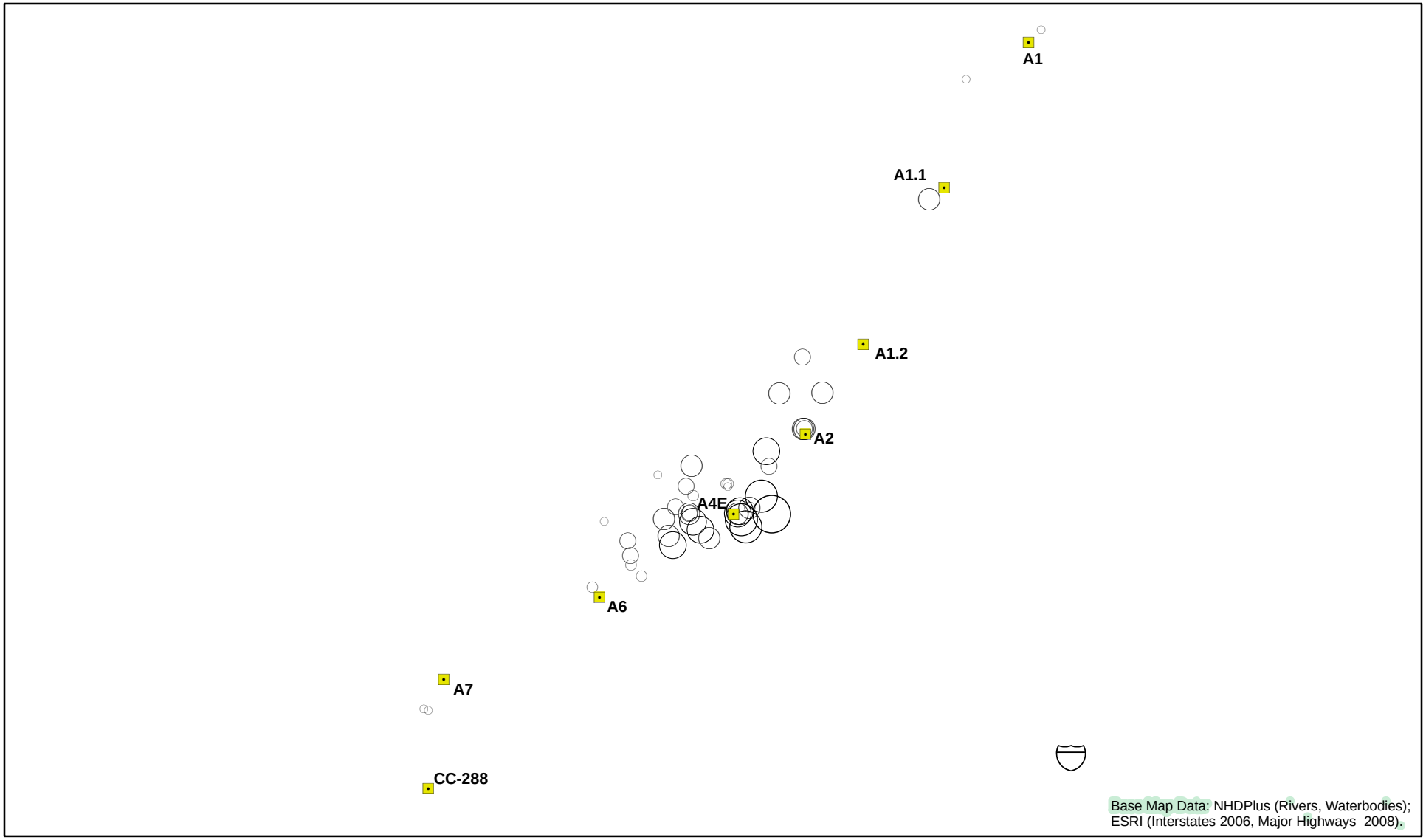
N

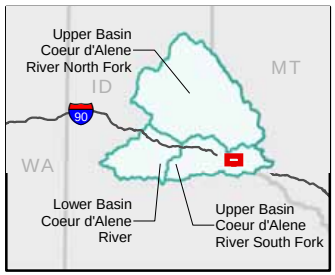
0 1 2 4 Miles

Figure B4-6
Basin-Wide Total Lead Concentrations in Surface Water, May 2008
Site Information Package for National Remedy Review Board

BOI \\CASTAIC\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU3\UPPERBASIN\NRRB\FFS_NRRB_LEADAWQC2008_UB.MXD 3/24/2010

EPA





Dissolved Zinc Concentrations October 2008 (mg/L)

- 1
- 4
- 8
- 25
- 120

A7 Surface Water Monitoring Location

Canyon Creek Primarily Gaining Reach

Canyon Creek Primarily Losing Reach

Former Canyon Creek Plank Dam (Approximate Historical Location)

Approximate Alluvial Aquifer

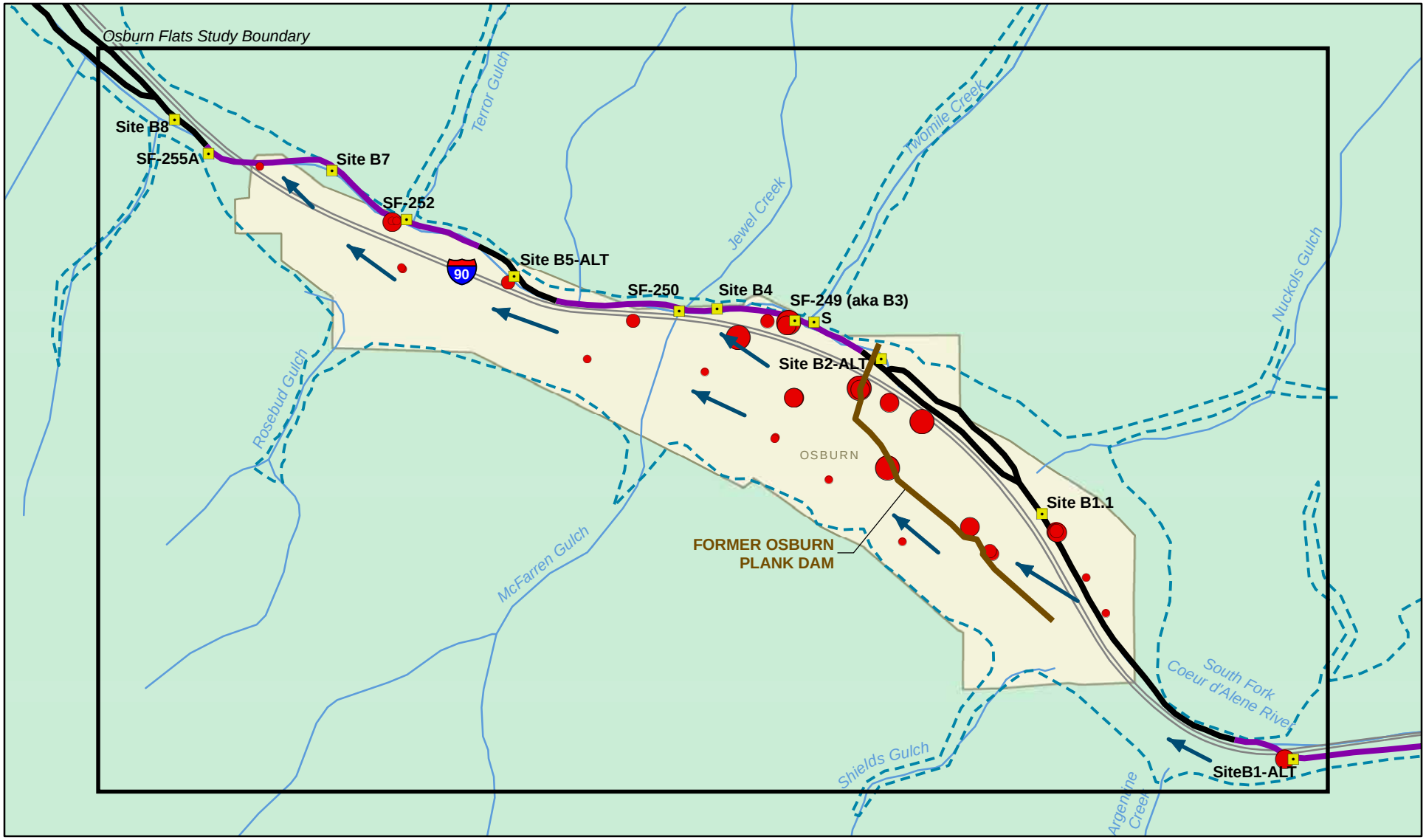
Approximate Groundwater Flow Direction, Base-Flow Conditions

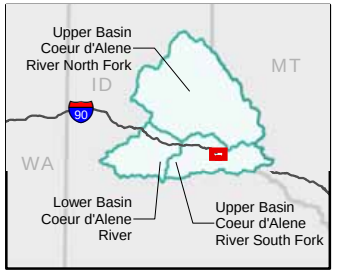
Note:
Gaining and losing reaches were determined from low-flow numerical simulation results, and are presented as approximate conditions during low-flow conditions.

N

0 1,000 2,000 Feet

Figure B4-7
Dissolved Zinc Concentrations in Groundwater and Hydrogeology at Woodland Park
Site Information Package for National Remedy Review Board





Dissolved Zinc Concentrations October 2008 (mg/L)

- 0.5
- 1
- 2
- 3

- Surface Water Monitoring Location
- SFCDR Primarily Gaining Reach
- SFCDR Primarily Losing Reach
- Former Osburn Plank Dam (Approximate Historical Location)
- Approximate Groundwater Flow Direction, Base-Flow Conditions
- Approximate Alluvial Aquifer

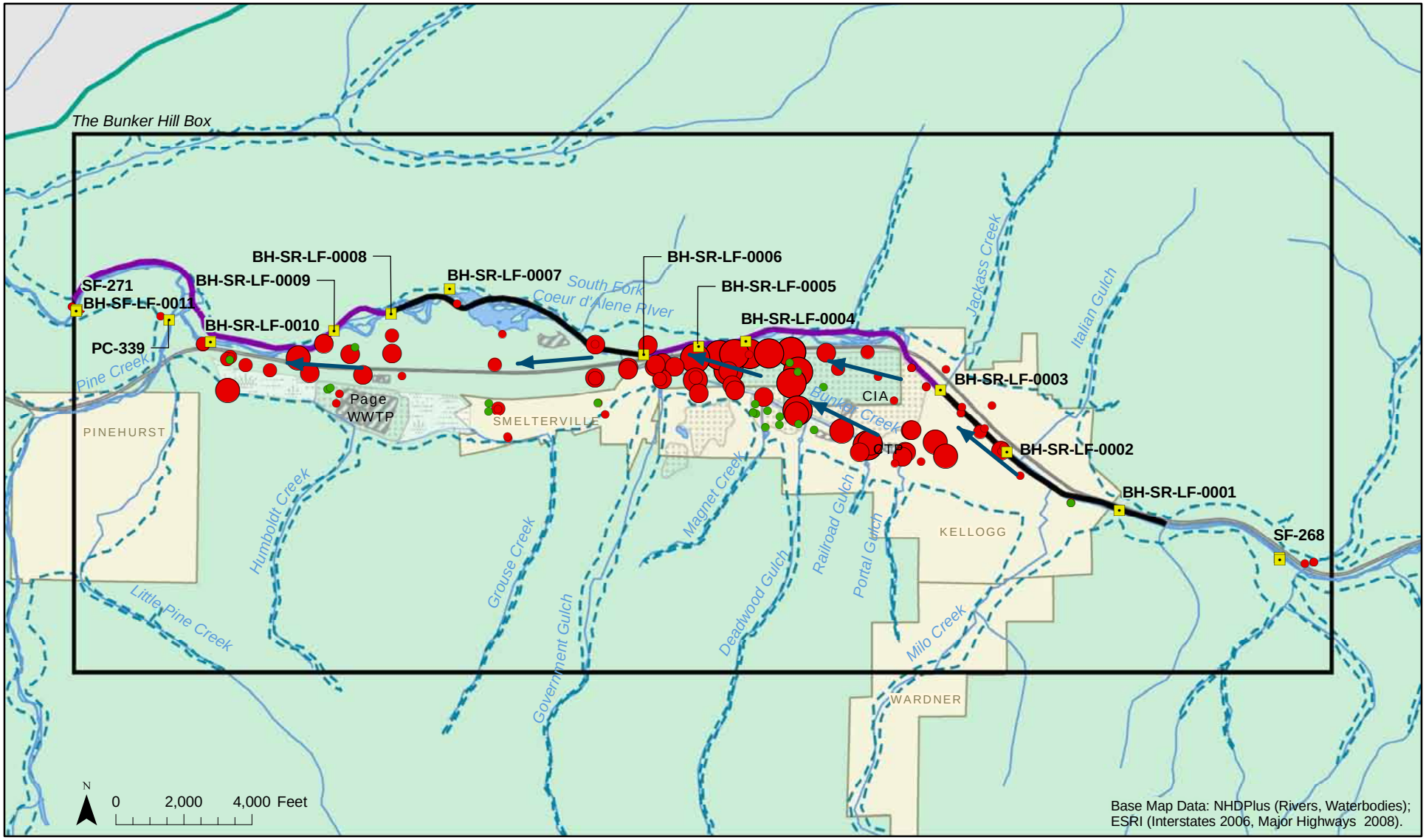
N

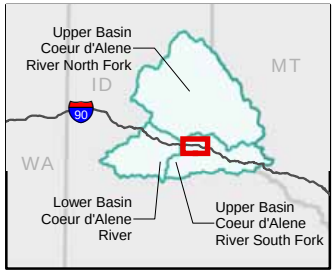
0 1,000 2,000 Feet

Figure B4-8
Dissolved Zinc Concentrations in Groundwater and Hydrogeology at Osburn Flats
Site Information Package for National Remedy Review Board

EPA

BOI \\CASTAIC\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU3\UPPERBASIN\NRRB\FFS_NRRB_ZINCCON2008_OF.MXD 3/22/2010





Dissolved Zinc Concentrations October 2008 (mg/L)

- Nondetect
- 1
- 4
- 8
- 15
- 25

- Surface Water Monitoring Location
- SFCDR Primarily Gaining Reach
- SFCDR Primarily Losing Reach
- Approximate Groundwater Flow Direction, Base-Flow Conditions
- Approximate Alluvial Aquifer
- Swamp
- Industrial Water Body
- Waste Consolidation Area
- Water Body

Note: Gaining and losing reaches were determined from low-flow numerical simulation results, and are presented as approximate conditions during low-flow conditions.

Figure B4-9
Dissolved Zinc Concentrations in Groundwater and Hydrogeology in the Bunker Hill Box
Site Information Package for National Remedy Review Board

[Two Updated Ecological Alternatives from the 2001 FS]		Updated Woodland Park Components of Ecological Alternatives 3 and 4		OU 2[a] [Five Remedial Alternatives]		Combined Remedial Alternatives* [10 Action Alternatives]
Alternative 3+: More Extensive Removal, Disposal, and Treatment	+	Targeted source control, French drains/stream lining	+	Alternative (a): Minimal Stream Lining Alternative (b): Extensive Stream Lining Alternative (c): French Drains[b] Alternative (d): Stream Lining/French Drain Combination[b] Alternative (e): Extensive Stream Lining/French Drain Combination	=	Alternative 3+(a) Alternative 3+(b) Alternative 3+(c) Alternative 3+(d) Alternative 3+(e)
Alternative 4+: Maximum Removal, Disposal, and Treatment	+	Equivalent to 2001 FS Ecological Alternative 4, except for changes to the water treatment TCD			=	Alternative 4+(a) Alternative 4+(b) Alternative 4+(c) Alternative 4+(d) Alternative 4+(e)

[*] The five OU 2 alternatives are combined with each of the two OU 3 alternatives to form 10 action alternatives. With the addition of the No Action Alternative, a total of 11 remedial alternatives were evaluated in the FFS Report (USEPA, 2010).

FS = Feasibility Study
OU = Operable Unit
TCD = typical conceptual design

[a] All the OU 2 alternatives also include the same set of actions for the Reed and Russell Tunnel adit flows: installation of a check dam to reduce or eliminate the flow of contaminated water, with a contingency plan for collection and treatment of discharge water if needed.

[b] A limestone permeable reactive barrier (PRB) was evaluated as a potential option in place of a portion of the French drain in these alternatives (FFS Report [USEPA, 2010], Section 6.3 and Appendix F). However, based on the results of this evaluation, the PRB option has not been retained for direct inclusion in the alternatives. Additional study would be needed to further evaluate the potential effectiveness and cost of the PRB option.

Figure B8-1
Schematic Illustration of the Remedial Alternatives
Site Information Package for
National Remedy Review Board

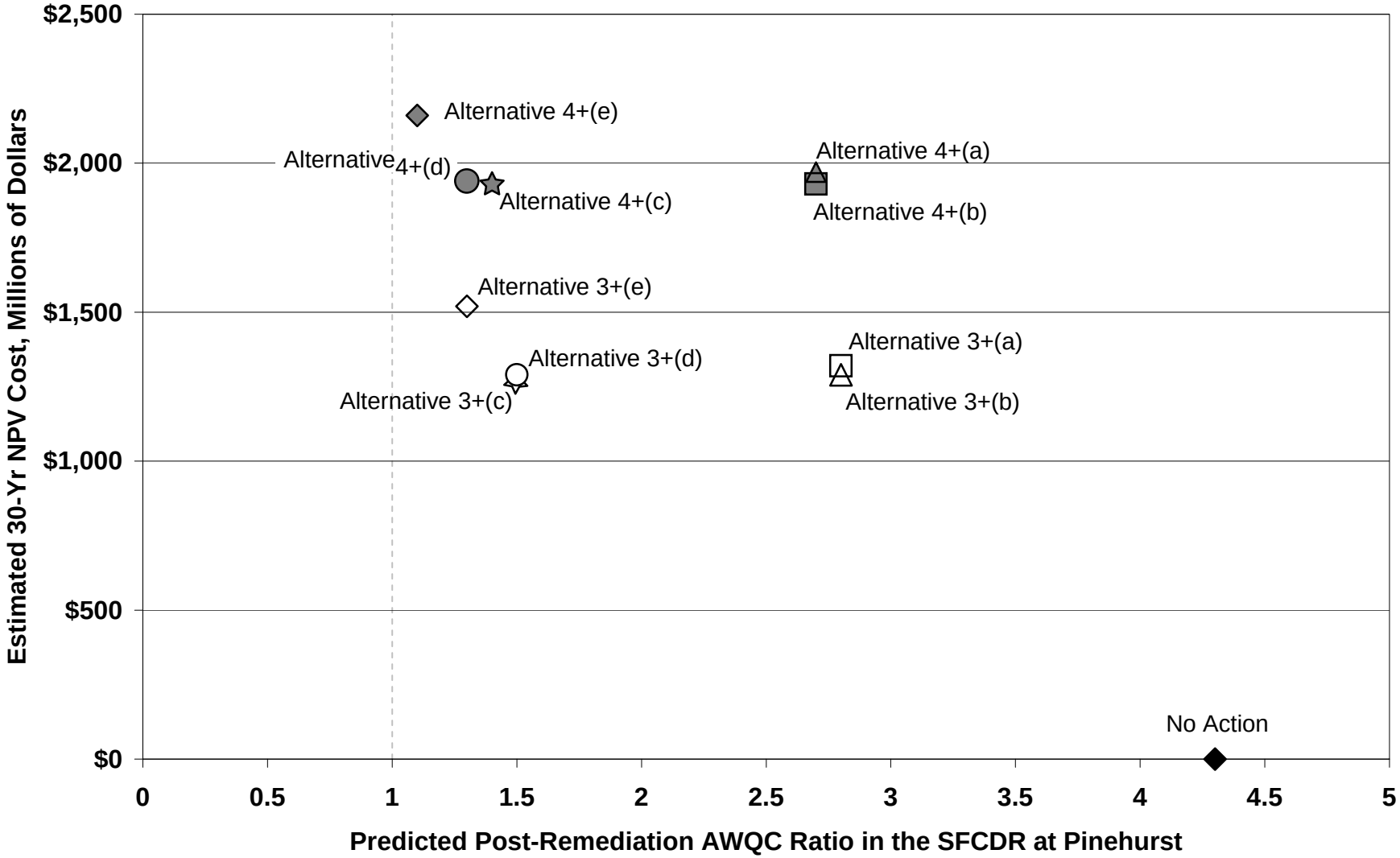
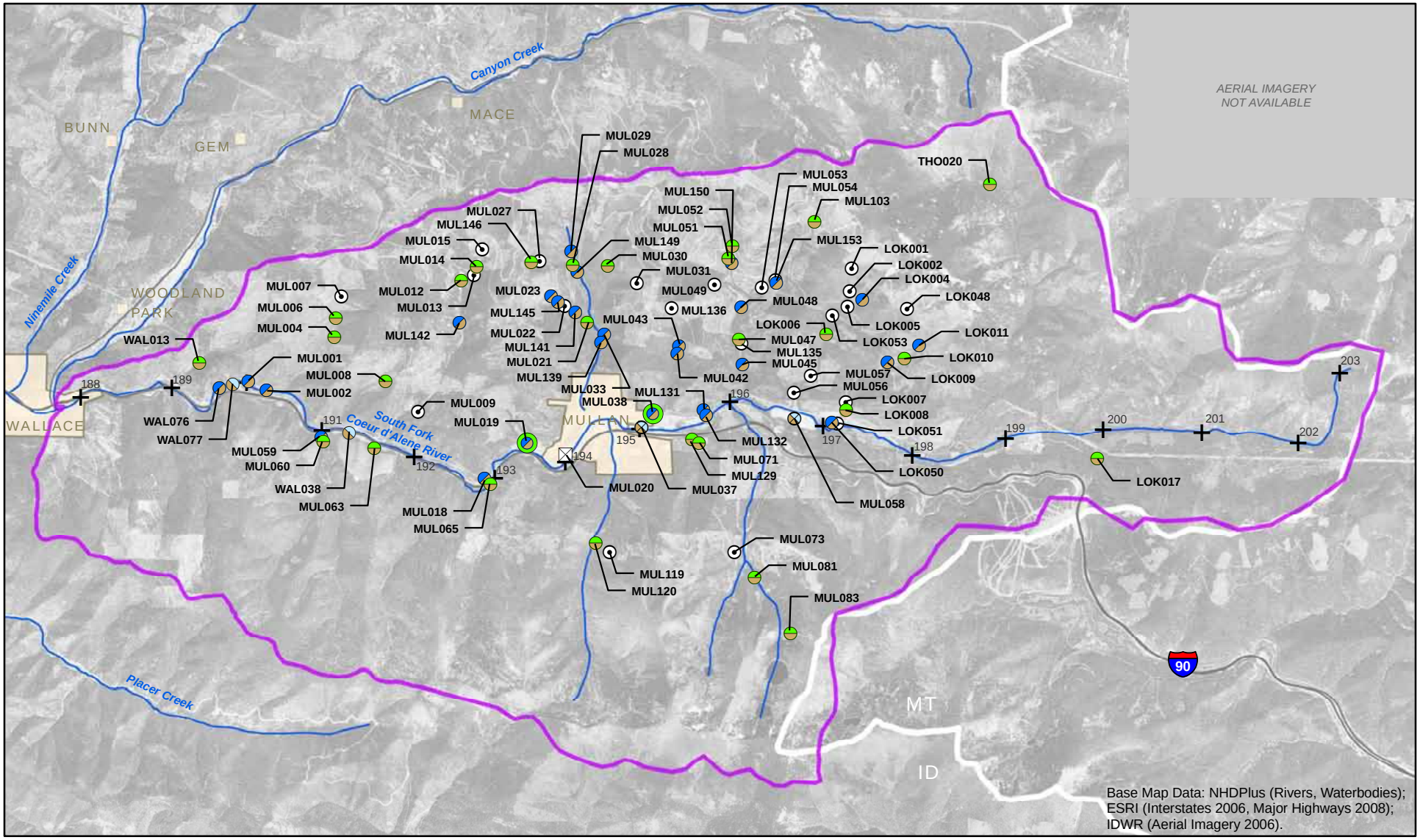
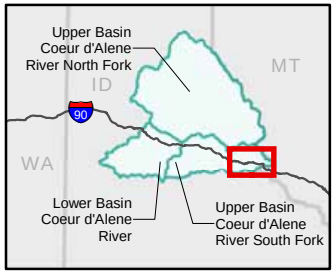


Figure B9-1
Total Net Present Value Costs Versus Predicted Post-Remediation AWQC Ratios at Pinehurst
Site Information Package for
National Remedy Review Board



Base Map Data: NHDPlus (Rivers, Waterbodies); ESRI (Interstates 2006, Major Highways 2008); IDWR (Aerial Imagery 2006).



Remedial Action Types:

- Excavation/Cap
- Excavation/Cap/Local Waste Consolidation Area
- Excavation/Local Waste Consolidation Area
- Excavation/Repository
- Excavation/Repository; Impoundment Closure
- Impoundment Closure; Hydraulic Isolation
- Regrade/Consolidate/ Revegetate
- **LOK011** (Site ID)
- 203 River Mile
- River/Creek
- Watershed Segment
- City Limit
- State Boundary

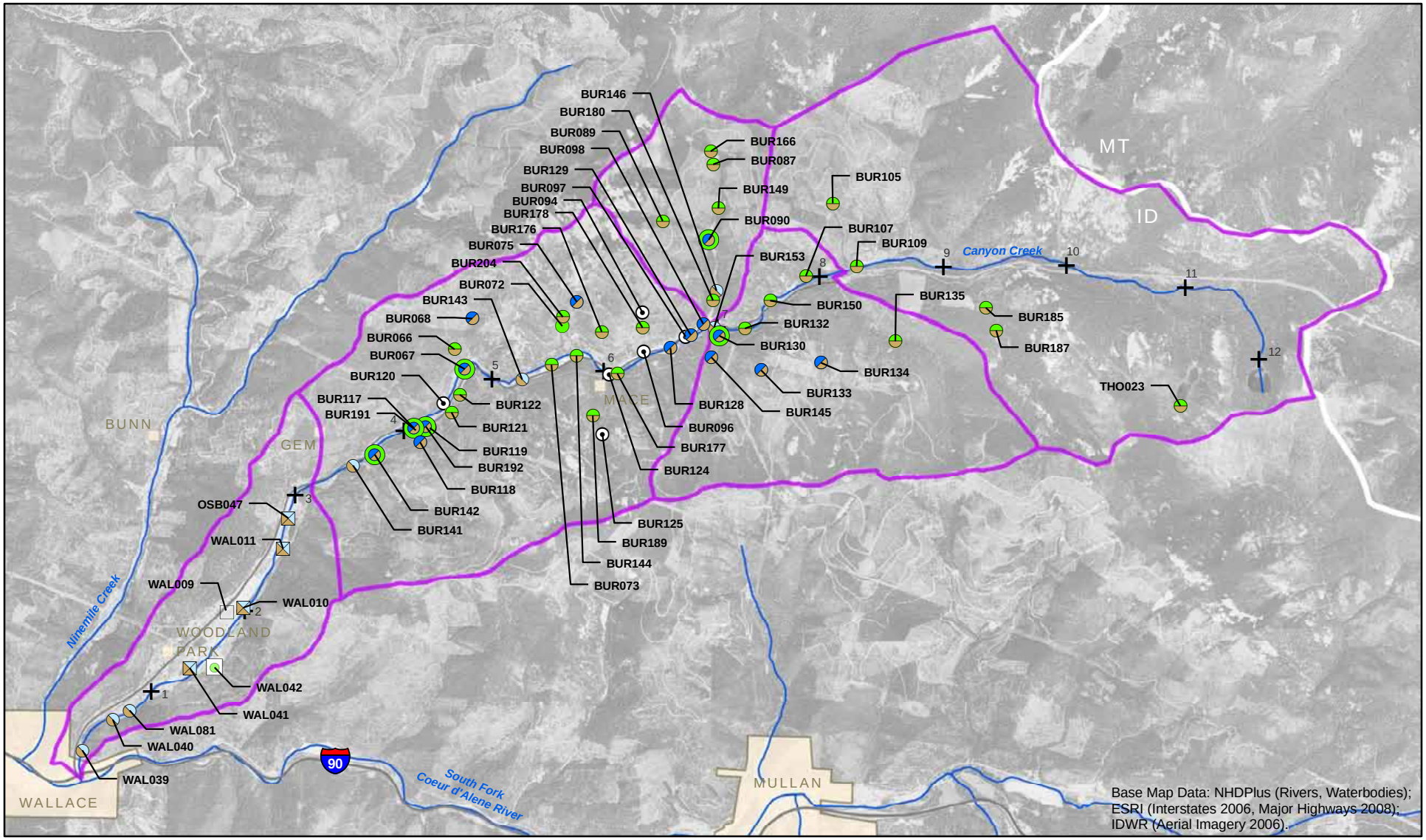
Note: See Table B11-1 for a list of site names.

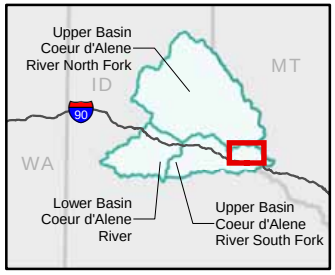
N

0 0.5 1 Miles

Figure B11-1
Overview of Remedial Actions, Alternative 3+, Upper SFCDR Watershed
Site Information Package for National Remedy Review Board

EPA





Remedial Action Types:

- Cap/Hydraulic Isolation
- Cap
- Excavation/Cap
- Excavation/Cap/Local Waste Consolidation Area
- Excavation/Local Waste Consolidation Area
- Excavation/Repository
- Excavation/Repository; Hydraulic Isolation
- Hydraulic Isolation
- Regrade/Consolidate/Revegetate
- **BUR187** (Site ID)
- River Mile
- River/Creek
- Watershed Segment
- City Limit
- State Boundary

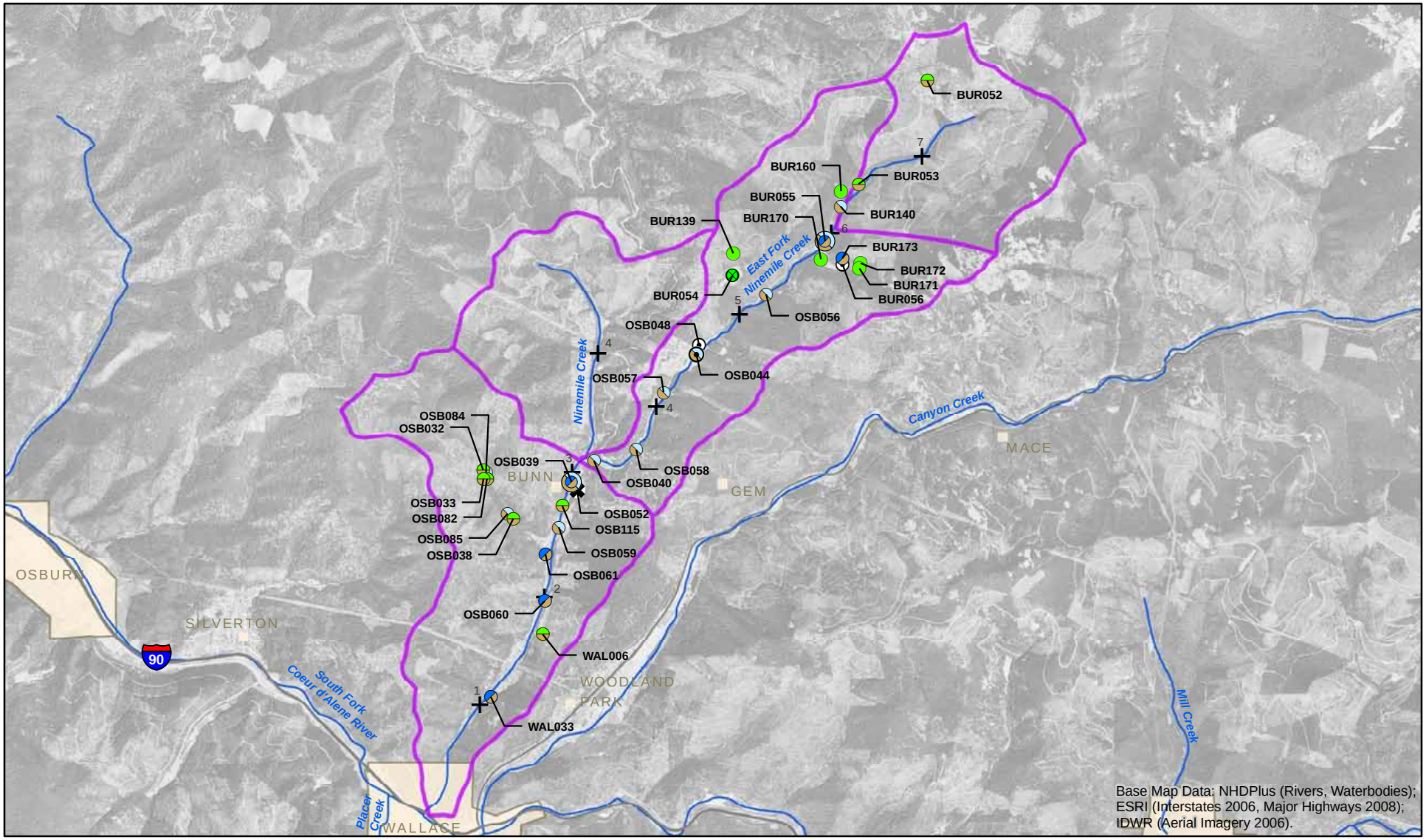
Note: See Table B11-1 for a list of site names.

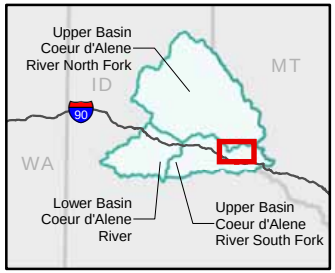
N

0 0.5 1 Miles

Figure B11-2
Overview of Remedial Actions, Alternative 3+, Canyon Creek Watershed
Site Information Package for National Remedy Review Board

EPA





Remedial Action Types:

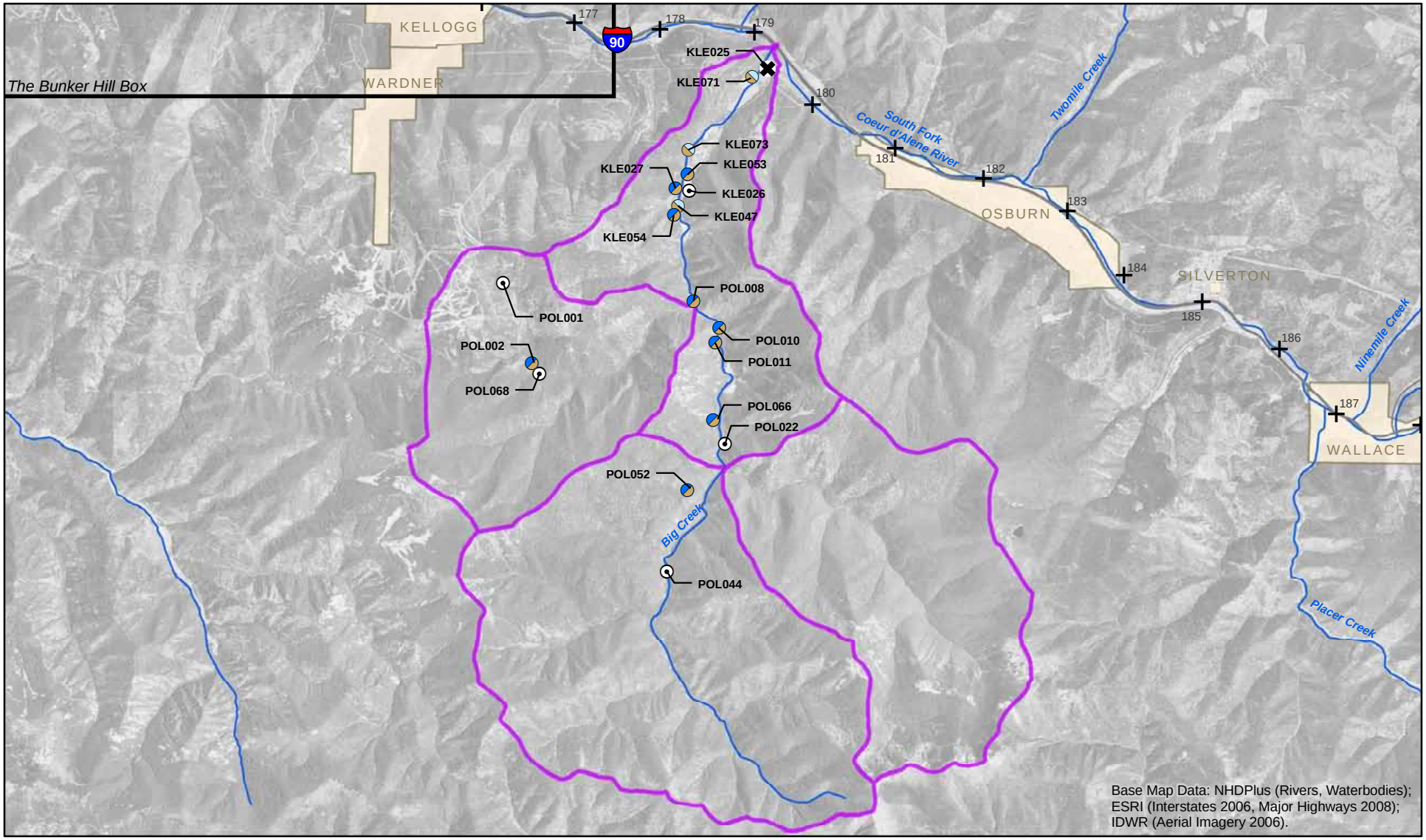
- Cap
- Cap; Impoundment Closure
- Excavation/Cap
- Excavation/Local Waste Consolidation Area
- Excavation/Local Waste Consolidation Area; Excavation/Repository
- Excavation/Repository
- Excavation/Repository; Regrade/Consolidate/Revegetate
- Impoundment Closure
- Regrade/Consolidate/ Revegetate
- **BUR139** (Site ID)
- 4 River Mile
- River/Creek
- Watershed Segment
- City Limit

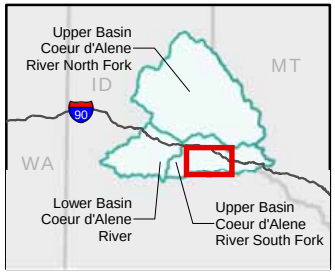
Note: See Table B11-1 for a list of site names.

N

0 0.5 1 Miles

Figure B11-3
Overview of Remedial Actions, Alternative 3+, Ninemile Creek Watershed
Site Information Package for National Remedy Review Board





Remedial Action Types:

- Excavation/Local Waste Consolidation Area
- Excavation/Repository
- Impoundment Closure
- Regrade/Consolidate/Revegetate
- **POL010** (Site ID)

- 184 River Mile
- River/Creek
- Watershed Segment
- City Limit

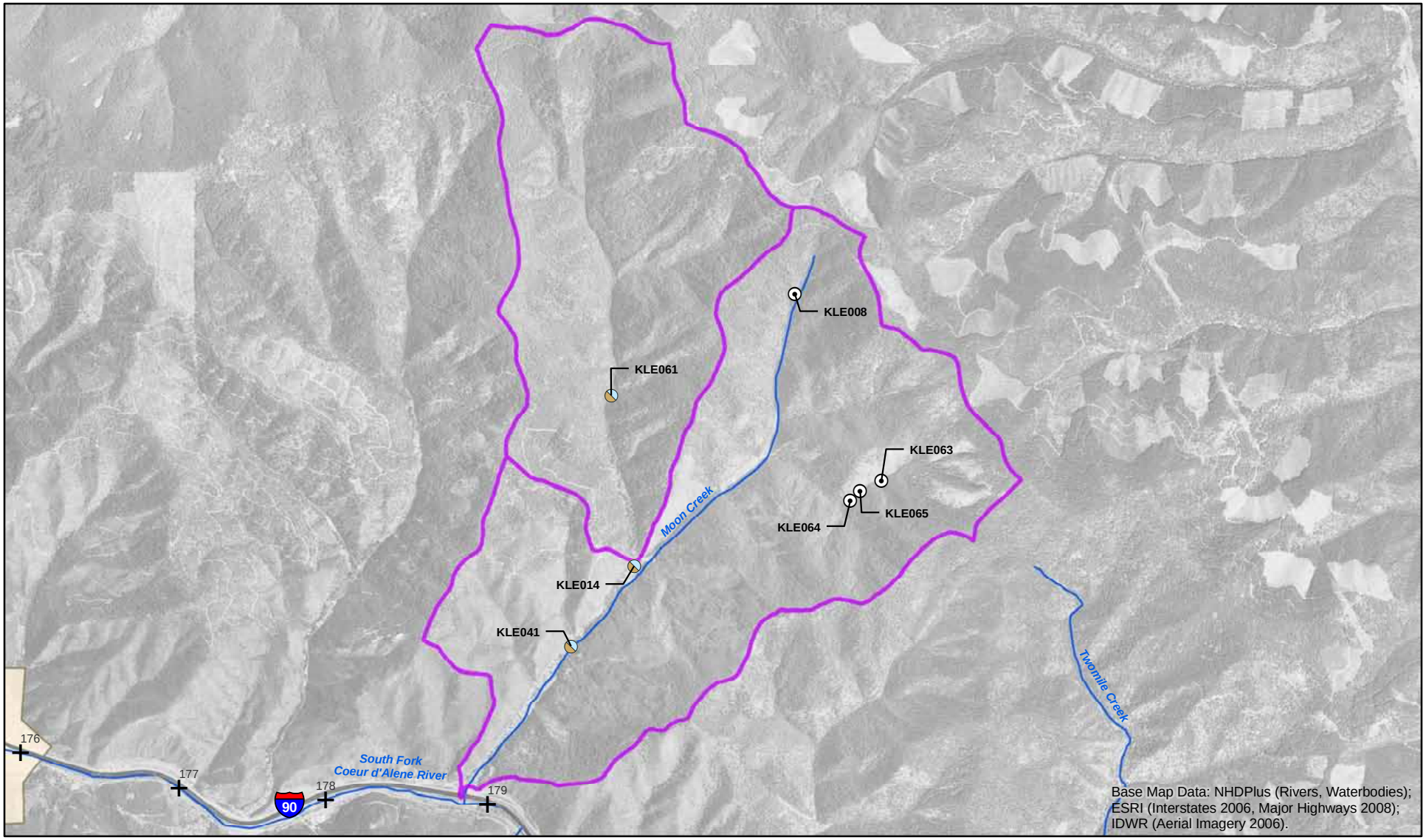
Note: See Table B11-1 for a list of site names.

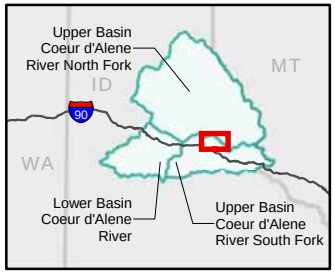
N

0 0.5 1 Miles

Figure B11-4
Overview of Remedial Actions, Alternative 3+, Big Creek Watershed
Site Information Package for National Remedy Review Board

EPA





Remedial Action Types:

- Excavation/Repository
- Regrade/Consolidate/Revegetate
- **KLE063** (Site ID)

- 179 River Mile
- River/Creek
- Watershed Segment
- City Limit

Note: See Table B11-1 for a list of site names.

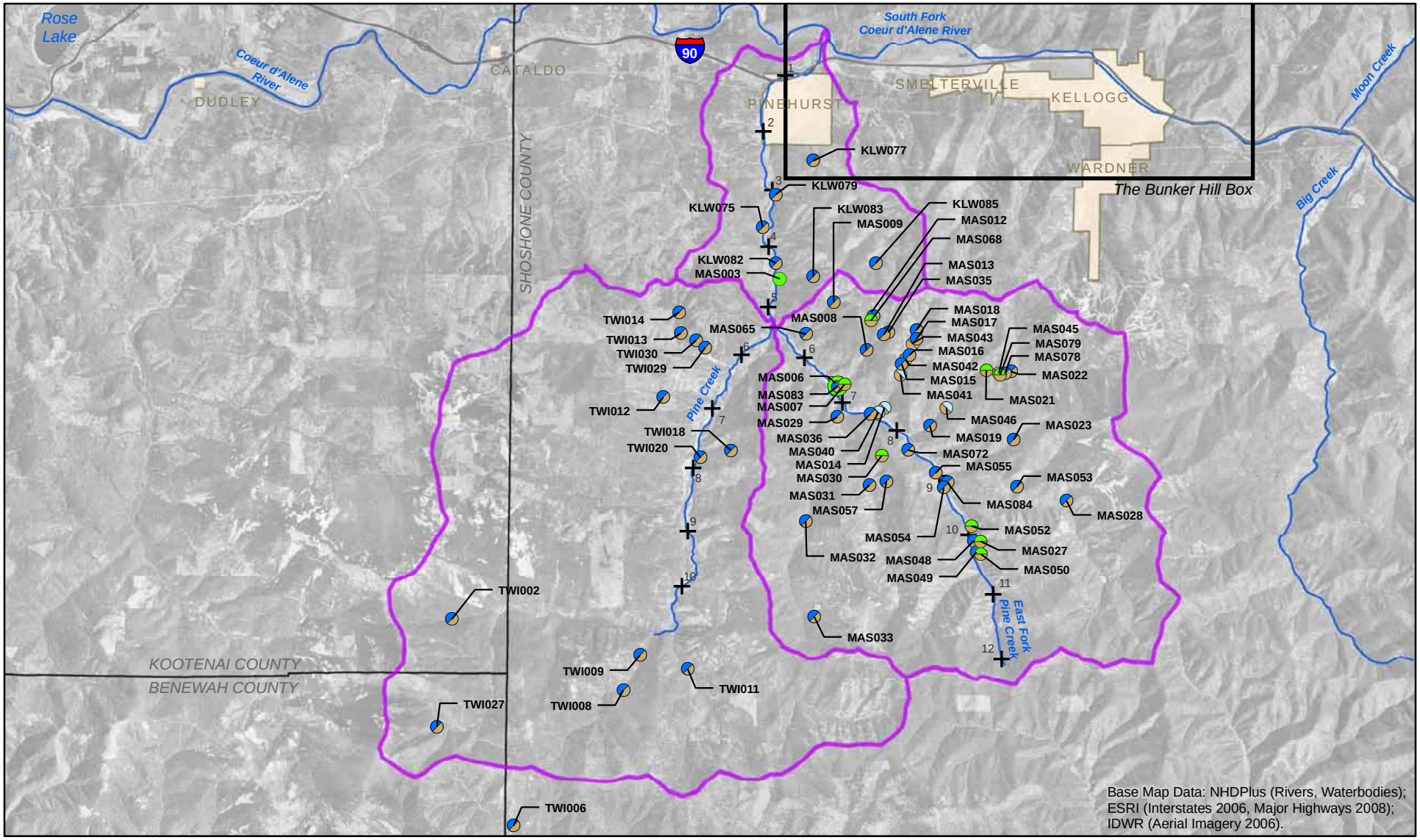
N

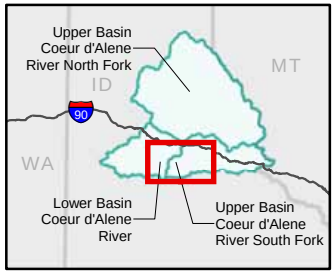
0 0.5 1 Miles

Figure B11-5
Overview of Remedial Actions, Alternative 3+, Moon Creek Watershed
Site Information Package for National Remedy Review Board

EPA

BOI \\CASTAIC\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU3\UPPERBASIN\NRRB\FFS_NRRB_RA_MC_ALT3.MXD 3/22/2010





Remedial Action Types:

- Cap
- Excavation/Cap
- Excavation/Cap/Local Waste Consolidation Area
- Excavation/Local Waste Consolidation Area
- Excavation/Repository
- Impoundment Closure; Hydraulic Isolation

MAS023 (Site ID)

- River Mile
- River/Creek
- Watershed Segment
- City Limit
- County Boundary

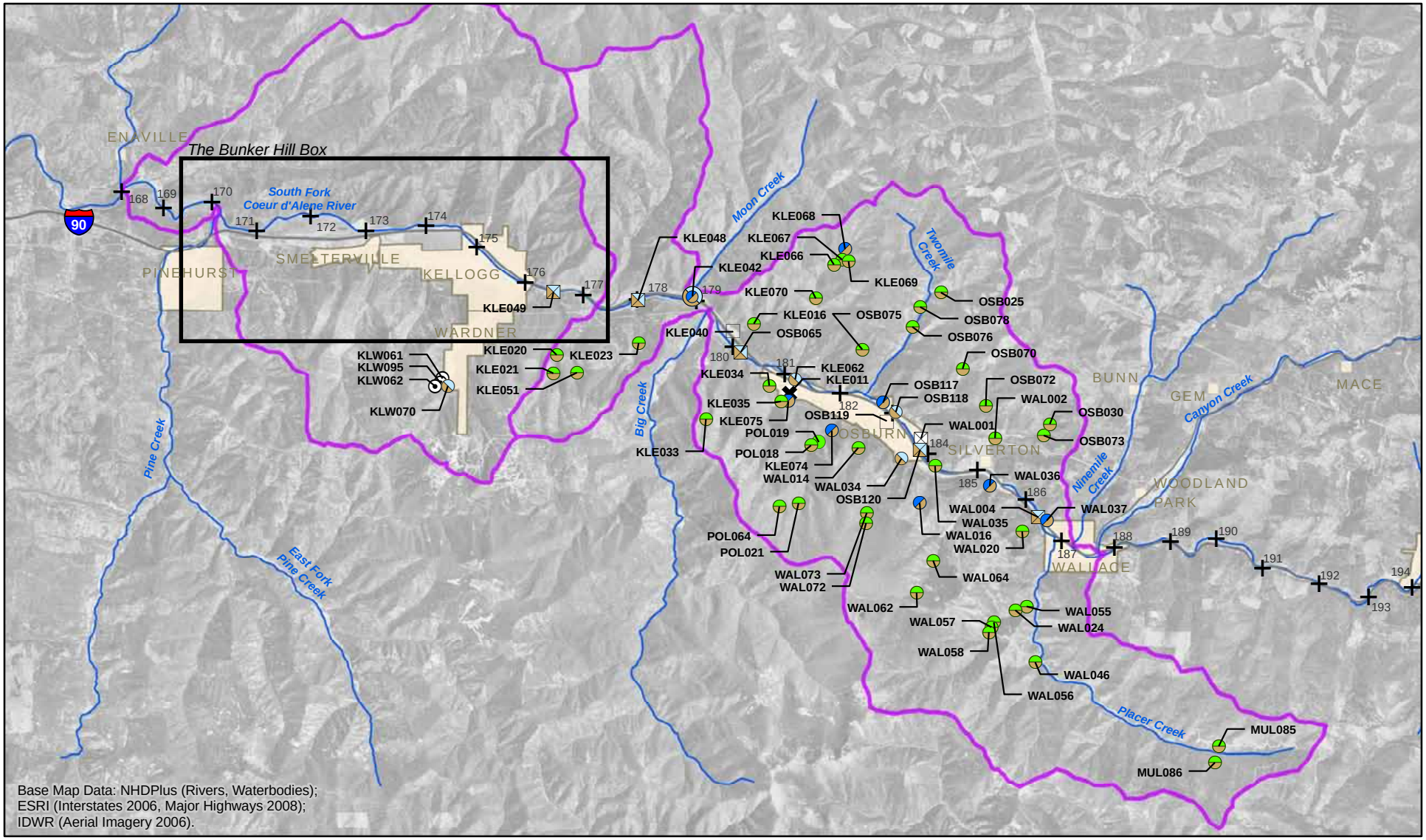
N

0 1 2 Miles

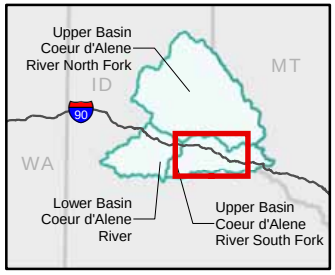
Note: See Table B11-1 for a list of site names.

Figure B11-6
Overview of Remedial Actions, Alternative 3+, Pine Creek Watershed
Site Information Package for National Remedy Review Board

EPA



Base Map Data: NHDPlus (Rivers, Waterbodies); ESRI (Interstates 2006, Major Highways 2008); IDWR (Aerial Imagery 2006).



Remedial Action Types:

- Cap
- Excavation/Cap
- Excavation/Local Waste Consolidation Area
- Excavation/Local Waste Consolidation Area; Excavation/Repository
- Excavation/Repository
- Excavation/Repository; Hydraulic Isolation
- Hydraulic Isolation
- Impoundment Closure
- Impoundment Closure; Hydraulic Isolation
- Regrade/Consolidate/ Revegetate

- 190 River Mile
- River/Creek
- Watershed Segment
- City Limit
- **MUL085** (Site ID)

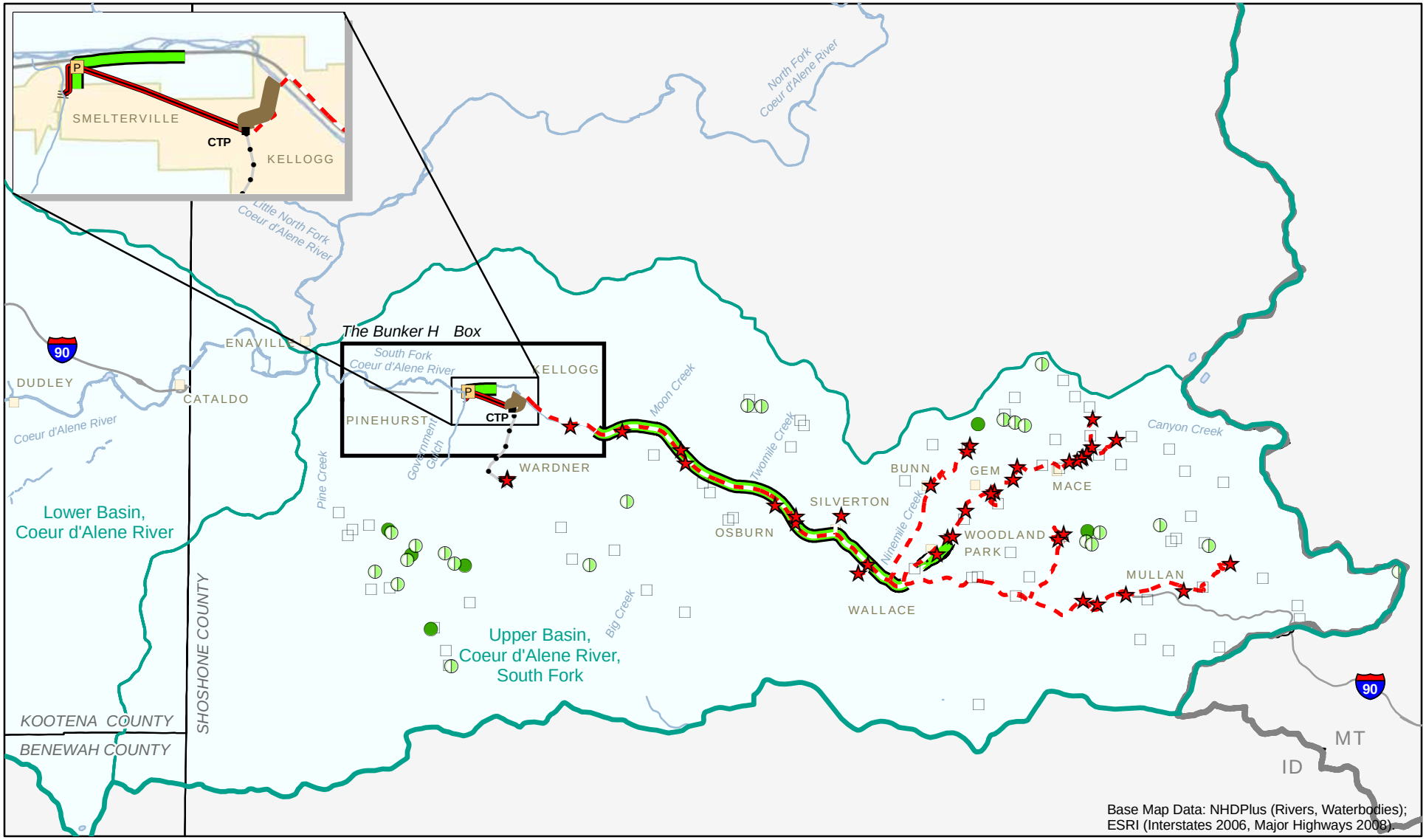
Note: See Table B11-1 for a list of site names.

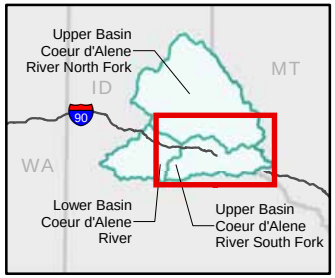
N

0 1 2 Miles

Figure B11-7
Overview of Remedial Actions, Alternative 3+, Mainstem SFCDR Watershed
Site Information Package for National Remedy Review Board

EPA





Water Sources Considered for Treatment

- Active Treatment (WT01)
- Passive Treatment (WT02)
- Passive Treatment (WT03)
- No Action

- Central Treatment Plant (CTP)
- Pump Station
- Gravity Pipeline to CTP
- Pressurized Pipeline to CTP
- Extraction Wells
- CTP Effluent Discharge Pipeline
- French Drain

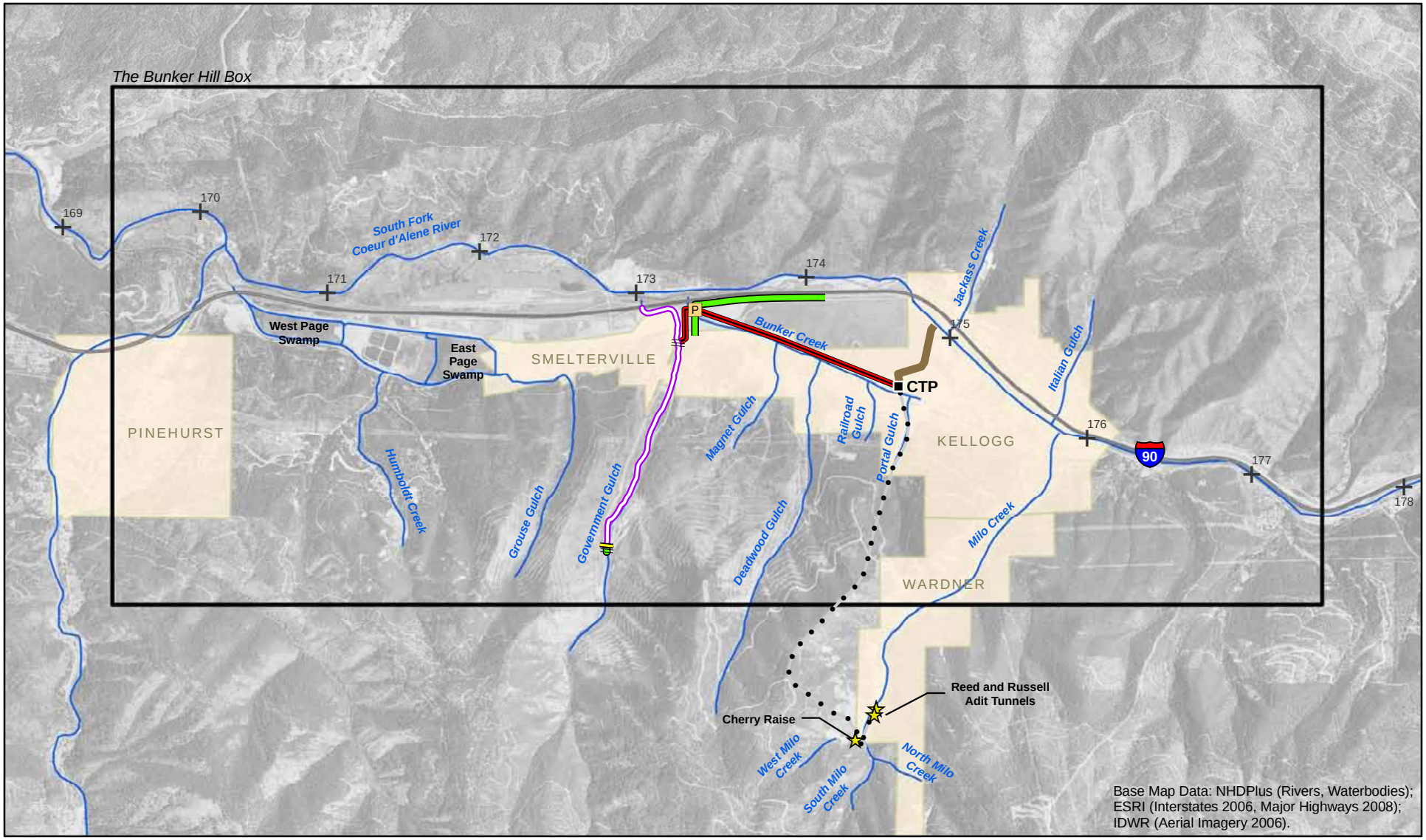
- Conveyance of Reed and Russell Adit Discharge through the Bunker Hill Mine via Cherry Raise and the Kellogg Tunnel to the CTP
- Coeur d'Alene River Subbasin Boundary
- The Bunker Hill Box (which includes Operable Unit 2)
- City Limit

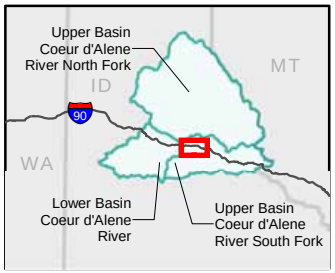
N

0 1 2 4 Miles

Figure B11-8
Water Treatment Approach, Alternative 3+(d)
Site Information Package for National Remedy Review Board

EPA





- Pump Station
- Pressurized Pipeline to CTP
- Extraction Wells
- Slurry Wall
- French Drain
- Stream Liner
- CTP Effluent Discharge Pipeline
- 177 River Mile
- Central Treatment Plant (CTP) in Kellogg, Idaho
- Adit
- Conveyance of Reed and Russell Adit Discharge through the Bunker Hill Mine via Cherry Raise and the Kellogg Tunnel to the CTP
- River/Creek

Note: See Table B11-1 for a list of site names.

N

0 0.5 1 Miles

Figure B11-9
OU 2 Alternative (d): Stream Lining/French Drain Combination
Site Information Package for National Remedy Review Board

EPA

TABLE B1-1
History of Milling and Tailings Disposal Practices in the Coeur d'Alene Basin
Site Information Package for National Remedy Review Board

Date	Milestone
1886	Processing of ore initiated using jigging.
1891	Six mills operating, with a total capacity of 2,000 tons per day
1901-1904	Construction of plank dams on Canyon Creek near Woodland Park and on the SFCDR near Osburn and Pinehurst to control tailings movement. Large volumes of tailings accumulated behind the dams.
1905	Jig tailings from the Morning Mill contained about 8% lead and 7% zinc.
1900-1915	Recovery of zinc initiated during this period. Previously, zinc was not recovered and mills primarily processed low-zinc ores.
1906	Total milling capacity in the basin is 7,000 tons per day.
1910	Flotation introduced in the basin at the Morning Mill. Increased metals recoveries were achieved using flotation. Flotation tailings were finer-grained than jig tailings and were transported greater distances by streams.
1917	Plank dams at Woodland Park, Pinehurst, and Osburn breached by flood waters.
1918	Flotation had been adopted at most mills by this time.
mid-1920s	Tailings observed in Spokane River.
1925	Flotation tailings from the Morning Mill contain <1% each of lead and zinc.
1926-1928	Bunker Hill mills begin placing tailings at Page Pond and the present-day location of the Central Impoundment Area.
1932	Dredging operations initiated in Lower Coeur d'Alene below Cataldo. Dredging continued until 1967. Dredge spoils were placed at Mission Flats.
1940-1942	Addition of 12 new mills with a combined capacity of 2,000 tons per day. Total milling capacity in the Basin increased to 12,000 tons per day.
1940s	A portion of the tailings that had accumulated behind the Osburn and Woodland Park plank dams were reprocessed for metals recovery.
Late 1950s	Reuse of tailings as slope fill initiated.
1960s	Start of I-90 construction. Tailings from Mission Flats and Bunker Hill Tailings Pond used in embankment construction.
1968 to present	All tailings impounded or used as slope fill.

Notes:
SFCDR = South Fork Coeur d'Alene River

TABLE B2-1

Summary of Ongoing Data Collection Programs in the Upper Basin of the Coeur d'Alene River

Site Information Package for National Remedy Review Board

Site Name	Monitored By	Dates	Description	Reference
Operable Unit (OU) 2 Water Quality Monitoring as part of Environmental Monitoring Program	Idaho Department of Environmental Quality, U.S. Environmental Protection Agency (USEPA), U.S. Fish and Wildlife Service (USFWS), U.S. Geological Survey (USGS)	1996 - Present	Groundwater, surface water, groundwater/surface interaction, and biological resources monitoring at several locations throughout OU 2 is conducted to provide water quality data to assess long-term status of trends and post-implementation Phase I remedial action effectiveness.	OU 2 Environmental Monitoring Plan (USEPA, 2006)
OU 3 Basin Environmental Monitoring Program (BEMP)	USEPA, USFWS, USGS	2004 - Present	The OU 3-wide BEMP is designed to monitor and evaluate progress of remedy in terms of improving environmental conditions. The objectives of the BEMP are to assess long-term status and trends of soil, sediments, and surface water conditions in the Basin; complete biological monitoring; evaluate the effectiveness of the selected remedy; evaluate progress toward cleanup benchmarks; provide data for Comprehensive Environmental Response, Compensation, and Liability Act-required five-year reviews of the progress of remedy implementation; and improve the understanding of Basin processes and variability to, in turn, improve the effectiveness and efficiency of subsequent remedial action implementation.	OU 3 Basin Environmental Monitoring Plan (USEPA, 2004)
Remedial Action Monitoring Program	USEPA, USFWS, USGS	2007 - Present	The Remedial Action Monitoring Program was initiated in September 2007 at five Upper Basin remedial action sites selected by USEPA and project stakeholders (Canyon Creek, Constitution Mine, Golconda Mine, Rex Mine, and Success Mine). The pre-remedial action concentration data, loads, and ambient water quality criteria will be compiled and compared to current site conditions to help evaluate remedial action effectiveness. Reports are planned to be developed annually.	2008 Data Summary Report for the Coeur d'Alene Basin Remedial Action Monitoring Program, Shoshone County, Idaho (USEPA, 2009)

TABLE B4-1
Contaminants of Concern and Affected Media
Site Information Package for National Remedy Review Board

	Human Health COCs			Ecological COCs		
Chemical	**Soil/Sediments**	**Groundwater**	**Surface Water**	**Soil**	**Sediments**	**Surface Water**
Antimony	●	●				
Arsenic	●	●	●	●	●	
Cadmium	●	●	●	●	●	●
Copper				●	●	●
Iron	●					
Lead	●	●	●	●	●	●
Manganese	●		●			
Mercury			●		●	
Silver					●	
Zinc	●	●	●	●	●	●

Source: U.S. Environmental Protection Agency, 2001d.

Note:
COC = contaminant of concern

TABLE B4-2
Screening Level Exceedances in Affected Media
Site Information Package for National Remedy Review Board

Affected Media	Antimony	Arsenic	Cadmium	Copper	Iron	Lead	Manganese	Mercury	Silver	Zinc
Sources										
Upland soil	●	●	●	●	●	●	●			●
Floodplain sediments	●	●	●	●	●	●	●	●	●	●
Floodplain tailings	●	●	●	●		●		●	●	●
Adits and seeps	●	●	●	●	●	●	●	●	●	●
Outfalls	●	●	●	●		●	●	●		●
Soil and Sediments										
Upland soil	●	●	●	●	●	●	●	●		●
Residential yards	●	●	●	●	●	●	●	●		●
Common use areas	●	●	●	●	●	●	●	●		●
Sediments	●	●	●	●	●	●	●	●	●	●
Groundwater										
Non-residential	●	●	●	●	●	●	●	●	●	●
Surface Water										
Rivers and lakes	●	●	●	●	●	●	●	●	●	●

Source: U.S. Environmental Protection Agency, 2001d.

TABLE B5-1
Upper Basin Community Populations
Site Information Package for National Remedy Review Board

Community	Population
Pinehurst	1,589
Kellogg	2,228
Smelterville	598
Wardner	197
Osburn	1,389
Wallace	861
Mullan	748

Source: U.S. Census Bureau, 2008 Population Estimates.

Note:
Populations for communities within the Upper Basin such as Kingston and Silverton could not be determined because they are unincorporated.

TABLE B7-1
Preliminary Remediation Goals for Surface Water for Protection of Human Health and Aquatic Organisms in the Upper Coeur d'Alene Basin
Site Information Package for National Remedy Review Board

	Federal Ambient Water Quality Criteria[a]						**Idaho Water Quality Standards[a]**						**Site-Specific Criteria, South Fork Coeur d'Alene River (HUC 17010302)[b]**					
Metal	**Acute**			**Chronic**			**Acute**			**Chronic**			**Acute**			**Chronic**		
Hardness																		
Hardness[c]	30	50	100	30	50	100	30	50	100	30	50	100	30	50	100	30	50	100
Metals																		
Arsenic	340	340	340	150	150	150	340	340	340	150	150	150	N/A	N/A	N/A	N/A	N/A	N/A
Cadmium[d]	0.62	1.03	2.01	0.11	0.15	0.25	0.49	0.73	2	0.28	0.38	1	0.61	1.03	2.08	0.42	0.62	1.03
Copper	4.3	7.0	13	3.2	5.0	9.0	5.5	8.9	17	4.06	6.3	11	N/A	N/A	N/A	N/A	N/A	N/A
Lead	17	30	65	0.66	1.2	2.5	17.0	30.1	65	0.66	1.2	2.5	80	129	248	9.1	14.7	28.3
Mercury[e]	1.4	1.4	1.4	0.77	0.77	0.77	2.1	2.1	2.1	0.012	0.012	0.012	N/A	N/A	N/A	N/A	N/A	N/A
Zinc	42	65	120	43	66	120	42	65	120	43	66	120	88	123	195	88	123	195

Notes:

[a]Criteria and standards in micrograms per liter (µg/L) from Idaho Administrative Procedures Act (IDAPA) 58.01.01.
[b] Criteria in micrograms per liter (µg/L) from IDAPA 58.0102.284. HUC = Hydrologic Unit Code.
[c] Hardness in milligrams of calcium per liter (mg $CaCO_3$/L).
[d] In 2006, Idaho adopted statewide site-specific aquatic life criteria for cadmium, revising the hardness-dependent criteria equations for cadmium in Section 210.02 of the rules. Until the U.S. Environmental Protection Agency (USEPA) acts on this change to state water quality standards, the effective water column criteria for dissolved cadmium at 100 mg/L hardness are as summarized in the table above (IDAPA 58.01.02.210.01, 2005).
[e] In 2005, Idaho adopted USEPA's methylmercury fish tissue criterion for protection of human health. The decision was made to remove the old aquatic life criteria and rely on the fish tissue criterion to provide protection for aquatic life. Thus, current Idaho water quality standards do not have mercury water column criteria for the protection of aquatic life. While USEPA approved of Idaho's adoption of the fish tissue criterion, it has not yet acted on the removal of the water column criteria. Until USEPA acts on this change to state water quality standards, the effective water column criteria for total recoverable mercury are as summarized in the table above (IDAPA 58.01.02.210.01, 2004).

N/A = not applicable

TABLE B8-1
Descriptions of Typical Conceptual Designs
Site Information Package for National Remedy Review Board

TCD Code	Name	Description	Retained or New/ Revised[a]
Source Control TCDs			
C01	Excavation (dry)	Physically remove solid waste material using equipment including backhoes, hydraulic excavators (trackhoes), draglines, bulldozers, and scrapers.	R
C01b	Excavation (60% dry/40% wet)	Same as C01 except C01b assumes that 40% of the excavation would be conducted below the water table. Therefore, this option includes dewatering.	R
C02a-c	Regrade/Consolidate/Re vegetate	Reduce the potential for erosion and leaching of metals by regrading waste material and placing a vegetative cover.	R
C03	Low-Permeability Cap	Significantly reduce metals loads by substantially reducing infiltration through waste materials. Includes a GCL liner as part of the cap.	R
C04	Low-Permeability Cap with Seepage Collection	Same as C03 for the low-permeability cap with addition of water collection upgradient of the waste pile to minimize leaching of the waste and seepage at the downgradient toe of the waste pile so that it could be treated.	R
C05	Low-Permeability Cap with Erosion Protection	Same as C03 for the low-permeability cap with erosion protection to minimize the erosion of waste below the nominal 100-year flood level.	R
C06	Waste Consolidation Area with Erosion Protection	Onsite consolidation of waste material in an area that includes a high-performance GCL cap. Geotextile and low-permeability native soil are beneath the waste.	R
C07	Waste Consolidation Area Above Flood Level	Same as C06 except this waste consolidation area is above the 100-yr flood level.	R
C08a	Repository	This includes a flexible membrane liner (FML) cap and an FML bottom liner that would provide a high level of performance. The capacity is 1 million cubic yards.	N
C09	Impoundment Closure	Address the closure of existing abandoned tailings impoundments or cells by capping the impoundment with a GCL and regrading.	R
HAUL-2	Haul to Repository	Transport the waste materials to a repository.	R
Water Collection, Conveyance, and Management TCDs			
C10	Adit Drainage Collection	Collect adit drainage for conveyance to a water treatment facility by constructing a partial bulkhead at the base of the adit.	R
C11a-j	Hydraulic Isolation Using Slurry Wall	Minimize the discharge of contaminated groundwater to the surface water system, thereby reducing the dissolved metals loading to the surface water system. Installation of slurry walls ranging in depths from 15-50 feet. Only includes slurry wall on one side of the river. TCDs 11h - 11j include a drain.	N
C14a-c	Stream Lining	Reduce dissolved metals loading from groundwater to the stream and reduce surface water recharge of the aquifer with installation of PVC liner and a geotextile layer keyed into the anchor trench. Lining ranges in width from 10-100 feet.	N
C15a-d	French Drain	Intercept contaminated groundwater that would otherwise discharge to the natural drain by installing French drain in trench and piping collected water to a water treatment system for treatment and subsequent discharge. Depths range from 10-25 feet below ground surface (bgs).	N
C17a-e	Groundwater Extraction Well	Intercept metals-laden groundwater prior to discharge into a surface water body using extraction wells ranging from 20-70 feet deep.	N
C18	SFCDR Diversion	Temporarily divert the SFCDR for cutoff wall installation which transverses the SFCDR valley floor. The SFCDR diversion is assumed to include a cofferdam with a series of pumps and a conveyance pipeline to transport the SFCDR water to a downstream location.	N
C19	I-90 Crossing	Removal of I-90 at select locations is required for cutoff wall installation which transverses the SFCDR valley floor. Removal and replacement of I-90 is assumed to occur in phases.	N
C-20	Check Dam	Prevent the flow of Bunker Hill Mine water into the Reed and Russell tunnels and out of the adit openings using check dams at tunnel entrances.	N

TABLE B8-1
Descriptions of Typical Conceptual Designs
Site Information Package for National Remedy Review Board

TCD Code	Name	Description	Retained or New/ Revised[a]
PIPE-1-4	Gravity Pipeline	Convey water to the treatment plant by gravity flow to the extent possible. Pipeline is assumed to be below-grade HDPE pipe ranging from 6-36 inches in diameter.	R (PIPE-1-3) N (PIPE-4)
PRESSURE-PIPE-1-4	Pressurized Pipeline	Convey water to the treatment plant by pumping. Pipeline is assumed to be below-grade HDPE pipe ranging from less than 6 inches to greater than 14 inches in diameter.	N
PUMP-1-5	Pump Station	Contain and pump the collected water designated for active treatment at the CTP. The pump station is assumed to include a wet well and stainless steel pumps with pump capacities ranging from 0.14 to 6.5 MGD.	N
Water Treatment TCDs			
WT01	Centralized High-Density Sludge (HDS) Treatment at Central Treatment Plant (CTP)	Treat mining-impacted waters responsible for high metals loading to the South Fork Coeur d'Alene River (SFCDR), which are collected at Operable Unit (OU) 2/OU 3 sites and conveyed to the CTP in Kellogg, Idaho, for treatment. Combines HDS metals precipitation with granular media filtration, and includes necessary upgrades to the CTP.	N
WT02	Onsite Semi-Passive Water Treatment Using Lime Addition and Settling Pond(s)	Treat water onsite with modest operations and maintenance (O&M) requirements. Especially applicable for high-strength waters that are collected in a pipe or channel but not conveyed to the CTP for centralized treatment. Uses mechanical (non-electrical) addition of dry lime based on flow and sedimentation of metal hydroxide solids in settling ponds.	N
WT03	Onsite Semi-Passive Water Treatment Using Sulfate-Reducing Bioreactor (SRB) System	Treat water onsite with low O&M requirements. Especially applicable for low- to moderate-strength waters that are collected in a pipe or channel but not conveyed to the CTP for centralized treatment. Consists of SRB vessels for precipitation of metal-sulfide solids, and a passive aeration channel, an aerobic polishing pond, and a wetland for removal of byproducts and polishing.	N
WT04a-b	*In Situ* Groundwater Treatment Using Sulfate-Reducing Permeable Reactive Barrier (SR-PRB)	Treat groundwater emanating from a metals-contaminated site prior to discharging to surface water. Permeable reactive barrier, consisting of a trench filled with organic media, constructed perpendicular to groundwater flow to intercept and treat groundwater. Treatment is effected by biological sulfate reduction and precipitation of metal-sulfide solids. This is designed for a either 10 foot (WT04a) or 40 foot (WT04b) deep barrier.	N
Human Health TCDs			
HH-2	Upland Waste Pile Soil Cover	Decrease human exposure to mining-related waste materials at waste piles using cover similar to C02.	R
HH-3	Millsite Decontamination	Decrease human exposure to mining-related waste materials at millsites. Hazardous substances would be disposed of in accordance with applicable regulations. Access restrictions would be provided.	R
HH-4	Millsite Demolition/Disposal	Decrease human exposure to mining-related waste materials at millsites. Buildings, structures, foundations, and underlying contaminated soil would be removed. Nonhazardous construction materials would be capped onsite, disposed of in a repository with other mining-related waste, or disposed of in a landfill. The hazardous substances would be disposed of in accordance with applicable regulations.	R
Stream and Riparian Improvement TCDs			
CD-AVG	Current Deflectors	Alter stream flows, directing stream energy away from erodible areas, or to prevent channel migration from outflanking shoreline stabilization structures. Current deflectors include several different types of structures constructed of wood, rock, or other materials attached to a bank or in midchannel which redirect stream energy away from erodible areas.	R
CD-SED	Current Deflectors, Sediment Traps	Same as CD-AVG with sediment traps added to reduce sediment in areas where it impinges on the ecosystem.	R

TABLE B8-1
Descriptions of Typical Conceptual Designs
Site Information Package for National Remedy Review Board

TCD Code	Name	Description	Retained or New/ Revised[a]
VBS-AVG	Vegetative Bank Stabilization	Introduce a self-maintaining mechanism for improving bank stability by planting native species adapted to stream banks. Bank stabilization using vegetative techniques that include the placement/planting of living and organic materials on actively eroding stream banks. These materials may include seeded ground cover, live cuttings, or rooted plant stock, and bundles or mats of live native plant species well adapted to riparian and streambank conditions.	R
BSBR-AVG	Bioengineered Revetments	Create a durable form of bank protection that provides riparian and instream habitat features. Bioengineered revetments integrate several bank stabilization materials, including traditional riprap, large woody debris (LWD, e.g., large logs and rootwads), and live plantings.	R
FP/RP-AVG	Floodplain and Riparian Replanting	Provide site stabilization. Bioengineering techniques for riparian zone rehabilitation will generally include replanting of riparian vegetation where possible and additional structural elements (e.g., nurse logs, snags) to provide additional site stabilization.	R
OFFCH-AVG	Off-Channel Hydrologic Features	Help to moderate and stabilize the hydrology of degraded stream systems using surface water-fed side channels, groundwater-fed side channels, and off-channel ponds and wetlands.	R
CH REAL-1	Channel Realignment	Reshape the stream channel to a more naturally stable condition and to recreate in-channel hydrologic features, particularly increased pool density and volume.	R

Notes:

[a] R = Retained virtually intact from 2001 Feasibility Study (USEPA, 2001d); N = New or substantially revised.

TABLE B8-2

Summary of Alternatives 3+ and 4+ for Operable Unit 3 by Remedial Action Type

Site Information Package for National Remedy Review Board

Remedial Action Type	Waste Type	Alternative 3+		Alternative 4+	
Excavation/Disposal in Repository	Floodplain (Artificial Fill)	5,700	CY	250,000	CY
	Floodplain Sediments	2,100,000	CY	3,600,000	CY
	Tailings, Impounded in Inactive Facilities		CY	3,700,000	CY
	Tailings, Unimpounded	370,000	CY	820,000	CY
	Waste Rock with Loading Potential	400	CY	4,300,000	CY
	Waste Rock, Upland (with Little Loading Potential)		CY	110,000	CY
	Total	**2,500,000**	**CY**	**13,000,000**	**CY**
Excavation/Disposal in Waste Consolidation Area	Floodplain (Artificial Fill)		CY		CY
	Floodplain Sediments	95,000	CY		CY
	Tailings, Impounded in Inactive Facilities	13,000	CY		CY
	Tailings, Unimpounded	410,000	CY		CY
	Waste Rock with Loading Potential	1,600,000	CY	1,800,000	CY
	Waste Rock, Upland (with Little Loading Potential)	7,900	CY	28,000	CY
	Total	**2,100,000**	**CY**	**1,800,000**	**CY**
Hydraulic Isolation	Tailings, Impounded in Active Facilities		CY		CY
	Tailings, Impounded in Inactive Facilities	1,800,000	CY		CY
	Total	**1,800,000**	**CY**	**0**	**CY**
Hydraulic Isolation at Discrete Facilities	Floodplain Sediments	1,400,000	CY	920,000	CY
Hydraulic Isolation of Stream Reaches	Floodplain Sediments	2,300,000	CY	2,000,000	CY
Cap	Tailings, Impounded in Active Facilities	4,000,000	CY	4,700,000	CY
	Tailings, Impounded in Inactive Facilities	1,300,000	CY		CY
	Tailings, Unimpounded	21,000	CY		CY
	Waste Rock with Loading Potential	4,000,000	CY	20,000	CY
	Waste Rock, Upland (with Little Loading Potential)	81,000	CY		CY
	Total	**9,400,000**	**CY**	**4,700,000**	**CY**
Regrade/Consolidate/Revegetate	Floodplain (Artificial Fill)	46,000	CY		CY
	Waste Rock with Loading Potential	770,000	CY	290,000	CY
	Waste Rock, Upland (Human Health)	15	AC		AC
	Waste Rock, Upland (with Little Loading Potential)	540,000	CY	3,500,000	CY
	Total	**1,400,000**	**CY**	**3,800,000**	**CY**
Passive Treatment	Adit Drainage	43	LB/DAY	45	LB/DAY
	Groundwater		LB/DAY	0	LB/DAY
	Seep	4	LB/DAY	4	LB/DAY
	Total	**47**	**LB/DAY**	**49**	**LB/DAY**
Active Treatment	Adit Drainage	88	LB/DAY	88	LB/DAY
	Groundwater	550	LB/DAY	95	LB/DAY
	Total	**690**	**LB/DAY**	**180**	**LB/DAY**
Stream and Riparian Improvements	Bioengineered Revetments	110,000	LF	130,000	LF
	Current Deflectors	1,800	EA	2,200	EA
	Floodplain/Riparian Planting	310	AC	540	AC
	Off-Channel Hydrologic Features	100	AC	210	AC
	Sediment Traps	190	EA	0	EA
	Vegetative Bank Stabilization	140,000	LF	160,000	LF

Notes:

AC = acres; CY = cubic yards; LB/DAY - pounds of zinc per day; LF = lineal feet; EA = each

TABLE B8-3
Technologies and Process Options for Remedy Protection
Site Information Package for National Remedy Review Board

Technology	Process Option	Description
Creek Channel Modifications		
	Channel Hydraulic Capacity Improvements	Enlargement of cross-sectional area (widening, deepening, increasing bank height, and/or removal of material)
	New Channel	Reroute of creek to new channel; development of new channel
	Channel Stabilization - Vegetation	Bank stabilization (vegetation, other)
	Channel Stabilization - Riprap	Bank stabilization (riprap)
	Channel Stabilization - Concrete	Bank stabilization (concrete channel)
	Channel Realignment	Change in channel alignment to remove sharp bend and improve hydraulic capacity of the channel
	Creek Culvert - Box	Concrete box/bridge (new or replacement) for roadways and/or driveway stream crossings
	Creek Culvert - Pipe	Installation of new pipe culverts or replace existing culverts with larger sizes
Inlet and Diversion Structures		
	Diversion Structure	Diversion structure for high-flow bypass
	Inlet Structure	New or improved existing inlet structure to collect creek flows
General Drainage Improvements		
	Stormwater Drainage Network	Network of inlets, catch basins, pipes, and vaults for conveyance of local precipitation runoff; either new discharge location or tie into existing system
	High-Flow Bypass Drainage Network	Network pipes and manholes/vaults for conveyance of creek high-flow bypass; either new discharge location or tie into existing system
	Drainage Network Maintenance Improvements to Existing Drainage System	Installation of manhole or cleanout in existing drainage system to allow for more effective cleaning and maintenance of existing infrastructure
	High-Capacity Stormwater Inlet	Cattle guard or oversized Department of Transportation-type inlet structure to collect runoff; tie into drainage system
	Rolling Dip	Rolling dip on roadway surface to channel water
Road Shoulder Drainage Improvements		
	Road Shoulder - Pavement	Pavement of roadway shoulder
	Road Shoulder - Gravel	Replacement of contaminated road shoulder gravel with clean materials
	Road Shoulder - Armoring	Placement of larger rock along road shoulder to limit scouring
	Paved Roadside Ditches	Paved roadside ditches (asphalt); either add new ditches and/or line existing ditches with asphalt
	Rock-Lined Roadside Ditches	Rock-lined roadside ditches with rock sized for estimated flow velocities and with check dams if necessary
	Curb and Gutter	Curb and gutter network
	Rolled Curb	Rolled concrete curb across driveway approaches
Inspection		
	Visual Observation and Documentation	Observation and documentation of the condition of watersheds and drainage systems

TABLE B9-1a

Comparative Analysis of the No Action Alternative and Alternatives 3+(a) through 3+(e)

Site Information Package for National Remedy Review Board

		OU 3 Component				
		Alternative 3+: More Extensive Removal, Disposal, and Treatment				
		OU 2 Component				
		OU 2 Alternative (a) **Minimal Stream Lining**	**OU 2 Alternative (b)** **Extensive Stream Lining**	**OU 2 Alternative (c)** **French Drains**	**OU 2 Alternative (d)** **Stream Lining/French Drain Combination**	**OU 2 Alternative (e)** **Extensive Stream Lining/French Drain Combination**
		Combined Upper Basin Alternative				
Criteria	**No Action**	**Alternative 3+(a)**	**Alternative 3+(b)**	**Alternative 3+(c)**	**Alternative 3+(d)**	**Alternative 3+(e)**
Overall Protection of Human Health and the Environment						
Controls used to reduce risks	No actions to reduce risks. Existing unacceptable risks to ecological receptors would remain unabated. Potential human health risks would remain unchanged.	Under Alternative 3+(a), environmental risks would be reduced by removing tailings-impacted alluvium and waste rock from the 100-year floodplain, containing/stabilizing other high-level wastes in-place, treatment of most adit drainage, and hydraulic isolation and groundwater treatment at tailings impoundments and river reaches. Intensive stream and riparian improvements and creation of off-channel hydrologic units would improve stream stability. Dredging of sediment traps would reduce bedload transport. Potential human health risks would be addressed by the above actions and additional access restrictions. Decontamination of structures would further address potential human health risks. The OU 2 stream liners would reduce the infiltration of relatively clean surface water into contaminated subsurface materials beneath OU 2, and thereby reduce metals loading from groundwater to surface water in the downstream gaining reaches.	See Alternative 3+(a). In addition, this alternative would provide more extensive stream lining throughout the Bunker Hill "Box". Extraction wells and slurry walls would also be included in some Box tributaries to collect clean groundwater for discharge to the lined stream.	See Alternative 3+(a). Alternative differences include no stream lining and the addition of French drains in the Box. Direct piping of the CTP effluent to the SFCDR is also included.	See Alternative 3+(c). The only difference between this alternative and Alternative 3+(c) is that this alternative also has a stream liner in Government Gulch, with a slurry wall and extraction wells at the upstream end for discharge of clean groundwater to the lined stream channel. Direct piping of the CTP effluent to the SFCDR is also included.	See Alternative 3+(a). In addition, this alternative includes extensive stream lining with slurry walls and extraction wells for groundwater collection, as well as French drains along the SFCDR. The extensive actions included in this alternative would effectively decouple the groundwater and surface water systems through the Box.
Effectiveness summary	Contaminants would limit recovery of habitat structure and ecosystem function.	Would effectively contain media with high to intermediate loading potential, and improve recovery of ecosystem function.	Would effectively contain media with high to intermediate loading potential, and improve recovery of ecosystem function.	Would effectively contain media with high to intermediate loading potential, and improve recovery of ecosystem function.	Would effectively contain media with high to intermediate loading potential, and improve recovery of ecosystem function. Would provide slightly higher effectiveness than Alternative 3+(c) by providing additional benefits to the water quality in Government Creek.	Would effectively contain media with high to intermediate loading potential, and improve recovery of ecosystem function. In addition, significantly more aggressive actions would be implemented in the Box.
		Overall moderate load reduction (42 percent at Pinehurst). Natural source depletion processes would further reduce residual risk.	Overall moderate load reduction (41 percent at Pinehurst). Natural source depletion processes would further reduce residual risk.	Overall large load reduction (60 percent at Pinehurst). Natural source depletion processes would further reduce residual risk.	Overall large load reduction (62 percent at Pinehurst). Natural source depletion processes would further reduce residual risk.	Overall large load reduction (66 percent at Pinehurst). Natural source depletion processes would further reduce residual risk.
ARARs summary	No actions would be conducted to reduce AWQC ratios, which are estimated to be 5.5 at Elizabeth Park and 4.3 at Pinehurst.	Overall moderate AWQC-ratio reduction (2.8 compared to 4.3) for Pinehurst. Attainment of ARARs for surface water would require a period of natural source depletion	Overall moderate AWQC-ratio reduction (2.8 compared to 4.3) for Pinehurst. Attainment of ARARs for surface water would require a period of natural source depletion	Overall large AWQC-ratio reduction (1.5 compared to 4.3) for Pinehurst. Attainment of ARARs for surface water would require a period of natural source depletion	Overall large AWQC-ratio reduction (1.5 compared to 4.3) for Pinehurst. Attainment of ARARs for surface water would require a period of natural source depletion	Overall large AWQC-ratio reduction (1.3 compared to 4.3) for Pinehurst. Attainment of ARARs for surface water would require a period of natural source depletion

TABLE B9-1a
Comparative Analysis of the No Action Alternative and Alternatives 3+(a) through 3+(e)
Site Information Package for National Remedy Review Board

		OU 3 Component				
		Alternative 3+: More Extensive Removal, Disposal, and Treatment				
		OU 2 Component				
		OU 2 Alternative (a) **Minimal Stream Lining**	**OU 2 Alternative (b)** **Extensive Stream Lining**	**OU 2 Alternative (c)** **French Drains**	**OU 2 Alternative (d)** **Stream Lining/French Drain Combination**	**OU 2 Alternative (e)** **Extensive Stream Lining/French Drain Combination**
		Combined Upper Basin Alternative				
Criteria	**No Action**	**Alternative 3+(a)**	**Alternative 3+(b)**	**Alternative 3+(c)**	**Alternative 3+(d)**	**Alternative 3+(e)**
Compliance with ARARs						
Chemical-specific ARARs	Would not comply with chemical-specific ARARs (AWQC) for surface water until natural decay processes reduced loading to below AWQC levels (see ARARs summary above).	Would significantly reduce metals concentrations in surface water, but would not meet surface water ARARs following remediation (see ARARs summary above).	Would significantly reduce metals concentrations in surface water, but would not meet surface water ARARs following remediation (see ARARs summary above).	Would significantly reduce metals concentrations in surface water, but would not meet surface water ARARs following remediation (see ARARs summary above).	Would significantly reduce metals concentrations in surface water, but would not meet surface water ARARs following remediation (see ARARs summary above).	Would significantly reduce metals concentrations in surface water, but would not meet surface water ARARs following remediation (see ARARs summary above).
Location- and action-specific ARARs	Not applicable	Would comply with all action-specific and location-specific ARARs, including substantive requirements of CWA Section 404, Rivers and Harbors Act Section 10, and Endangered Species Act.	See Alternative 3+(a).	See Alternative 3+(a).	See Alternative 3+(a).	See Alternative 3+(a).
Long-Term Effectiveness and Permanence						
Magnitude of residual risk	Magnitude of existing ecological risk may decrease slightly or remain essentially unchanged for several decades or centuries. Potential for ecosystem recovery is limited by contaminants.	Moderate reduction in expected post-remediation mass loadings (estimated 42% reduction). Some smaller loading sources would receive no action or limited containment. Low potential for mobilization (through erosion) of contaminated alluvium left in place. Natural source depletion processes would further reduce residual risks.	See Alternative 3+(a). Additional benefits would be achieved through this alternative by significantly improving water quality in several OU 2 tributaries (Government, Magnet, and Deadwood Creeks).	Large reduction in expected post-remediation mass loadings (estimated 60% reduction). Some smaller loading sources would receive no action or limited containment. Low potential for mobilization (through erosion) of contaminated alluvium left in place. Natural source depletion processes would further reduce residual risks.	Large reduction in expected post-remediation mass loadings (estimated 62% reduction). Load reduction estimates provided are for the SFCDR. Additional benefits would be achieved through this alternative by significantly improving water quality in Government Creek. Some smaller loading sources would receive no action or limited containment. Low potential for mobilization (through erosion) of contaminated alluvium left in place. Natural source depletion processes would further reduce residual risks.	Large reduction in expected post-remediation mass loadings (estimated 66% reduction). Additional benefits would be achieved through this alternative by significantly improving water quality in many OU 2 tributaries. Some smaller loading sources would receive no action or limited containment. Low potential for mobilization (through erosion) of contaminated alluvium left in place. Natural source depletion processes would further reduce residual risks.
	Potentially significant residual risks to humans.	Low residual risk to humans. Decontamination of structures and access restrictions would be effective.	Low residual risk to humans. Decontamination of structures and access restrictions would be effective.	Low residual risk to humans. Decontamination of structures and access restrictions would be effective.	Low residual risk to humans. Decontamination of structures and access restrictions would be effective.	Low residual risk to humans. Decontamination of structures and access restrictions would be effective.
Adequacy and reliability of controls	No controls would be implemented to control residual risks.	Remedy could effectively be maintained through monitoring, maintenance, and institutional controls. Moderate maintenance requirements for caps, stream and riparian improvements, sediment traps, French drains, and stream liners. High maintenance requirements for passive and active treatment.	See Alternative 3+(a).	See Alternative 3+(a). More linear feet of French drain are included in this alternative, although less stream lining.	See Alternative 3+(a). More linear feet of French drain and slightly less stream lining would be included in this alternative.	See Alternative 3+(a). Significantly more stream lining and French drains would be included in the alternative, as well as slurry walls and groundwater extraction wells.

TABLE B9-1a
Comparative Analysis of the No Action Alternative and Alternatives 3+(a) through 3+(e)
Site Information Package for National Remedy Review Board

		OU 3 Component				
		Alternative 3+: More Extensive Removal, Disposal, and Treatment				
		OU 2 Component				
		OU 2 Alternative (a) **Minimal Stream Lining**	**OU 2 Alternative (b)** **Extensive Stream Lining**	**OU 2 Alternative (c)** **French Drains**	**OU 2 Alternative (d)** **Stream Lining/French Drain Combination**	**OU 2 Alternative (e)** **Extensive Stream Lining/French Drain Combination**
		Combined Upper Basin Alternative				
Criteria	**No Action**	**Alternative 3+(a)**	**Alternative 3+(b)**	**Alternative 3+(c)**	**Alternative 3+(d)**	**Alternative 3+(e)**
Reduction of Toxicity, Mobility, or Volume through Treatment						
Treatment processes used	None	Active treatment of adit drainages, and groundwater from impoundment closures and hydraulic isolation, and repository drainage areas using hydroxide precipitation. Estimated average flow rate from all sources to the CTP is approximately 11,600 gpm (670 lb/day). All of this flow is from OU 3. No water from OU 2 would be treated. Semi-passive treatment of 802 gpm (47 lb/day) would occur at 27 additional adits using either SRB or lime addition/precipitation.	Treatment processes and semi-passive treatment scheme are the same as for Alternative 3+(a). Estimated average flow rate from all sources to the CTP is approximately 11,800 gpm (716 lb/day). All of this flow is from OU 3 with the exception of about 189 gpm (46 lb/day) from the under-liner drains associated with the stream liners in OU 2.	Treatment processes and semi-passive treatment scheme are the same as for Alternative 3+(a). Estimated average flow rate from all sources to the CTP is approximately 15,500 gpm (1,830 lb/day). The majority of this flow is from OU 3 with the exception of approximately 3,930 gpm (1,160 lb/day) from the under-liner drains and French drains in OU 2.	Treatment processes and semi-passive treatment scheme are the same as for Alternative 3+(a). Estimated average flow rate from all sources to the CTP is approximately 15,600 gpm (1,860 lb/day). The majority of this flow is from OU 3 with the exception of approximately 4,000 gpm (1,190 lb/day) from the under-liner drains, French drains, and extraction wells in OU 2.	Treatment processes and semi-passive treatment scheme are the same as for Alternative 3+(a). Estimated average flow rate from all sources to the CTP is approximately 14,100 gpm (1,250 lb/day) . The majority of this flow is from OU 3 with the exception of approximately 2,540 gpm (575 lb/day) from the under-liner drains, French drains, and extraction wells in OU 2.
Amount treated or destroyed	None	Total estimated dissolved zinc load removed from water through treatment is approximately 700 lb/day (99% of 670 + 80% of 47).	Total estimated dissolved zinc load removed from water through treatment is approximately 750 lb/day (99% of 716 + 80% of 47).	Total estimated dissolved zinc load removed from water through treatment is approximately 1,850 lb/day (99% of 1,830 + 80% of 47).	Total estimated dissolved zinc load removed from water is approximately 1,880 lb/day (99% of 1,860 + 80% of 47).	Total estimated dissolved zinc load removed from water is approximately 1,280 lb/day (99% of 1,250 + 80% of 47).
Reduction in toxicity, mobility, or volume	None	Water treatment would reduce the mobility and toxicity of metals by hydroxide precipitation and adsorption/precipitation into media. Volume of contaminated water would be reduced.	Same as Alternative 3+(a).	See Alternative 3+(a). More load is removed through treatment with this alternative; therefore, a higher reduction in toxicity, mobility, and volume through treatment would be achieved than for Alternatives 3+(a) and (b).	Reduction in toxicity, mobility, or volume is similar for Alternative 3+(d) and 3+(c).	Reduction in toxicity, mobility, or volume is lower than that for Alternatives 3+(d) and 3+(c) but higher than that for Alternatives 3+(a) and (b).
Irreversible treatment	None	Treatment is irreversible for the water stream treated for both active and semi-passive processes. Treatment residuals (Spent SRB media and hydroxide sludge) would require proper disposal to ensure that leaching of metals into the environment would not occur.	Same as Alternative 3+(a).	Same as Alternative 3+(a).	Same as Alternative 3+(a).	Same as Alternative 3+(a).
Type and quantity of residuals	None	Spent SRB substrate and hydroxide sludge require disposal. It is assumed that these wastes would be disposed of onsite. Total volume requiring disposal is estimated to be 9,100 cy/y.	Same as Alternative 3+(a).	Same waste types as for Alternative 3+(a). Total volume requiring disposal is greater, and estimated to be 14,000 cy/y.	Same as Alternative 3+(c).	Same waste types as for Alternative 3+(a). Total volume requiring disposal is greater than Alternative 3+(a) and (b) but less than Alternatives 3+(c) and (d), and is estimated to be 12,100 cy/y.
Statutory preference for treatment	Does not satisfy.	Satisfies.	Satisfies.	Satisfies.	Satisfies.	Satisfies.

TABLE B9-1a
Comparative Analysis of the No Action Alternative and Alternatives 3+(a) through 3+(e)
Site Information Package for National Remedy Review Board

		OU 3 Component				
		Alternative 3+: More Extensive Removal, Disposal, and Treatment				
		OU 2 Component				
		OU 2 Alternative (a) **Minimal Stream Lining**	**OU 2 Alternative (b)** **Extensive Stream Lining**	**OU 2 Alternative (c)** **French Drains**	**OU 2 Alternative (d)** **Stream Lining/French Drain Combination**	**OU 2 Alternative (e)** **Extensive Stream Lining/French Drain Combination**
		Combined Upper Basin Alternative				
Criteria	**No Action**	**Alternative 3+(a)**	**Alternative 3+(b)**	**Alternative 3+(c)**	**Alternative 3+(d)**	**Alternative 3+(e)**
Short-Term Effectiveness						
Community protection	No additional short-term risks to the community.	Short-term risks to the community from construction traffic. Risks would be minimized by traffic control plans and selective repository siting.	See Alternative 3+(a). Slightly higher volume of truck trips would be associated with the longer stream liner lengths in Alternative 3+(b).	See Alternative 3+(a). Slightly higher volume of truck trips would be associated with more extensive floodplain work to install French drains.	See Alternative 3+(c). Slightly higher volume of truck trips would be associated with stream lining and associated work in Government Gulch.	See Alternative 3+(d). Significant increase in highway and local traffic logistics (because of the upstream and downstream cutoff walls on the SFCDR that would need to be constructed through I-90).
Worker protection	No additional short-term risks to workers.	Limited risks to workers from remedial actions. Risks would be minimized with standard health and safety measures.	Limited risks to workers from remedial actions. Risks would be minimized with standard health and safety measures.	Limited risks to workers from remedial actions. Risks would be minimized with standard health and safety measures.	Limited risks to workers from remedial actions. Risks would be minimized with standard health and safety measures. Risks may be slightly higher than for Alternative 3+(c) due to the additional actions in Government Gulch.	Limited risks to workers from remedial. Risks would be minimized with standard health and safety measures. Relative to other alternatives, Alternative 3+(e) would present the greatest short-term risks to workers.
Environmental impacts	No additional short-term risks to the environment.	Short-term environmental impacts could result from construction. These impacts would be minimized and mitigated through engineering controls and revegetation. In the context of current water quality in the SFCDR, these potential risks would be minimal. The impacts would be associated with: - 240,000 LF stream and riparian - Extensive excavation - Construction within floodplains - Repository requirements - Potential stream flow reduction	See Alternative 3+(a). In addition, more extensive floodplain construction would be required in the Box, adding to the short-term risks, although in the context of current water quality in the SFCDR, these potential risks would be minimal.	Slightly less floodplain construction would be required in the Box relative to Alternative 3+(b); therefore, short-term risks would be slightly lower. In the context of current water quality in the SFCDR, these potential risks would be minimal.	Short-term risks would be roughly comparable to Alternative 3+(b). In the context of current water quality in the SFCDR, these potential risks would be minimal.	Short-term risks would be higher than for Alternatives 3+(a) through 3+(d) due to extensive floodplain construction in the Box. In the context of current water quality in the SFCDR, these potential risks would be minimal.
Time until action is complete[c]	No actions would be conducted.	Approximately 50 to 90 years to implement actions. Additional time would be required for natural source depletion to attain ARARs. See the discussion of overall protection of human health and the environment above.	Approximately 50 to 90 years to implement actions. Additional time would be required for natural source depletion to attain ARARs. See the discussion of overall protection of human health and the environment above.	Approximately 50 to 90 years to implement actions. Additional time would be required for natural source depletion to attain ARARs; however, it is expected this time would be shorter than Alternatives 3+(a) and 3+(b), given the lower predicted AWQC ratios at remedy completion. See the discussion of overall protection of human health and the environment above.	Approximately 50 to 90 years to implement actions. Additional time would be required for natural source depletion to attain ARARs; however, it is expected this time would be shorter than Alternatives 3+(a) and 3+(b), given the lower predicted AWQC ratios at remedy completion. See the discussion of overall protection of human health and the environment above.	Approximately 60 to 100 years to implement actions. Less time would be required for natural source depletion to attain ARARs given the lower predicted AWQC ratios at remedy completion. See the discussion of overall protection of human health and the environment above.

TABLE B9-1a
Comparative Analysis of the No Action Alternative and Alternatives 3+(a) through 3+(e)
Site Information Package for National Remedy Review Board

		OU 3 Component				
		Alternative 3+: More Extensive Removal, Disposal, and Treatment				
		OU 2 Component				
		OU 2 Alternative (a) **Minimal Stream Lining**	**OU 2 Alternative (b)** **Extensive Stream Lining**	**OU 2 Alternative (c)** **French Drains**	**OU 2 Alternative (d)** **Stream Lining/French Drain Combination**	**OU 2 Alternative (e)** **Extensive Stream Lining/French Drain Combination**
		Combined Upper Basin Alternative				
Criteria	**No Action**	**Alternative 3+(a)**	**Alternative 3+(b)**	**Alternative 3+(c)**	**Alternative 3+(d)**	**Alternative 3+(e)**
Implementability						
Technical feasibility	The No Action Alternative is technically feasible.	No significant technical feasibility concerns. Significant uncertainties in construction volumes – these could be handled in design/construction phases. Major cost and logistical considerations for obtaining borrow materials and excavating in floodplains. Potential construction difficulties for hydraulic isolation. The reach of the SFCDR to be lined in the Box would be located within the developed areas of the City of Kellogg. Access for large equipment along with space for SFCDR diversion would pose significant logistical issues. Treatability testing would be required for semi-passive treatment design. Monitoring could assess effectiveness and need for additional action.	See Alternative 3+(a). Longer stream lining included in Alternative 3+(b) would add to the logistical issues noted, although there is no SFCDR liner in this alternative which would have many logistical challenges. See Alternative 3+(a).	See Alternative 3+(a). In addition, the extensive French drains included in this alternative would add to the logistical issues noted. See Alternative 3+(a).	See Alternative 3+(c). In addition, work in Government Gulch would add to the logistical issues noted. See Alternative 3+(a).	See Alternative 3+(c). In addition, extensive work in the Box would add to the logistical issues noted. Excavation of sediments from below the water table would pose significant logistical issues and result in higher costs. These implementability concerns are great under this alternative because the French drain and pump station depth may range from 10 to 40 feet below ground surface. Deeper excavations, if required, would increase the dewatering difficulties. See Alternative 3+(a).
Administrative feasibility	Not applicable	Significant difficulties would be encountered in acquiring land and obtaining approvals for repositories and active treatment conveyance pipelines, and for obtaining borrow materials. Coordination with other agencies would be required, potentially including completion of a biological assessment.	See Alternative 3+(a).	See Alternative 3+(a).	See Alternative 3+(a). More linear feet of French drains and slightly less stream lining would be included in this alternative.	See Alternative 3+(a). Extensive actions in the Box would add to the difficulties in acquiring land and obtaining approvals.
Availability of services and materials	Not applicable	Services, equipment, and technologies are all available, at least on a regional level.	See Alternative 3+(a).	See Alternative 3+(a).	See Alternative 3+(a).	See Alternative 3+(a).

TABLE B9-1a

Comparative Analysis of the No Action Alternative and Alternatives 3+(a) through 3+(e)

Site Information Package for National Remedy Review Board

		OU 3 Component				
		Alternative 3+: More Extensive Removal, Disposal, and Treatment				
		OU 2 Component				
		OU 2 Alternative (a) Minimal Stream Lining	OU 2 Alternative (b) Extensive Stream Lining	OU 2 Alternative (c) French Drains	OU 2 Alternative (d) Stream Lining/French Drain Combination	OU 2 Alternative (e) Extensive Stream Lining/French Drain Combination
		Combined Upper Basin Alternative				
Criteria	**No Action**	**Alternative 3+(a)**	**Alternative 3+(b)**	**Alternative 3+(c)**	**Alternative 3+(d)**	**Alternative 3+(e)**
Cost						
Total Capital Cost	$0	$1,140,000,000	$1,110,000,000	$1,100,000,000	$1,100,000,000	$1,330,000,000
O&M Cost (30-Year NPV) [a]	$0	$87,700,000	$87,500,000	$88,400,000	$89,100,000	$94,200,000
Total Cost (30-Year NPV) [b]	$0	$1,320,000,000	$1,290,000,000	$1,280,000,000	$1,290,000,000	$1,520,000,000
	No cost alternative.	Costs for Alternatives 3+(a) through 3+(d) are very similar and within the accuracy of the estimate (-30/+50%). Costs for alternatives based on Alternative 3+ are lower than corresponding alternatives based on Alternative 4+.	Costs for Alternatives 3+(a) through 3+(d) are very similar and within the accuracy of the estimate (-30/+50%). Costs for alternatives based on Alternative 3+ are lower than corresponding alternatives based on Alternative 4+.	Costs for Alternatives 3+(a) through 3+(d) are very similar and within the accuracy of the estimate (-30/+50%). Costs for alternatives based on Alternative 3+ are lower than corresponding alternatives based on Alternative 4+.	Costs for Alternatives 3+(a) through 3+(d) are very similar and within the accuracy of the estimate (-30/+50%).Costs for alternatives based on Alternative 3+ are lower than corresponding alternatives based on Alternative 4+.	This alternative has a relatively high cost. Costs for alternatives based on Alternative 3+ are lower than corresponding alternatives based on Alternative 4+.

Notes:

[a] O&M costs over 30 years in current dollars, assuming a 7% discount factor.

[b] Total NPV cost equals the total equivalent cost of the alternative over 30 years in current dollars, assuming a 7% discount factor.

[c] This assumes a rough estimated range of $15M/yr to $25M/yr of available annual funding to cover capital costs.

ARARs = applicable or relevant and appropriate requirements
AWQC = ambient water quality criteria
CTP = Central Treatment Plant
CWA = Clean Water Act
cy = cubic yards
gpm = gallons per minute
LF = lineal feet
NPV = net present value
O&M = operation and maintenance
OU = Operable Unit
RAO = Remedial Action Objective
SFCDR = South Fork Coeur d'Alene River
SRB = sulfate-reducing bioreactor
cy/y = cubic yards per year

NOTE: The above costs are presented rounded to three significant figures.
NOTE: The above cost opinion is a Feasibility Study-level estimate with a nominal accuracy of –30 percent to +50 percent (–30/+50%).
NOTE: The above cost opinion is in 2009 dollars and does not include future escalation. The order-of-magnitude cost opinion shown has been prepared for guidance in project evaluation from the information available at the time of preparation. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, the final project scope, the final project schedule, and other variable factors. As a result, the final project costs will vary from those presented above. Because of these factors, funding needs must be carefully reviewed prior to making specific financial decisions or establishing final budgets.

TABLE B9-1b
Comparative Analysis of Alternatives 4+(a) through 4+(e)
Site Information Package for National Remedy Review Board

	OU 3 Component				
	Alternative 4+: Maximum Removal, Disposal, and Treatment				
	OU 2 Component				
	OU 2 Alternative (a) **Minimal Stream Lining**	**OU 2 Alternative (b)** **Extensive Stream Lining**	**OU 2 Alternative (c)** **French Drains**	**OU 2 Alternative (d)** **Stream Lining/French Drain Combination**	**OU 2 Alternative (e)** **Extensive Stream Lining/French Drain Combination**
	Combined Upper Basin Alternative				
Criteria	**Alternative 4+(a)**	**Alternative 4+(b)**	**Alternative 4+(c)**	**Alternative 4+(d)**	**Alternative 4+(e)**
Overall Protection of Human Health and the Environment					
Controls used to reduce risks	Would reduce environmental risks with extensive removal and containment to address all media above PRGs. Highest-performance containment using regional repositories. Expanded treatment would address all adit drainages of concern and remaining contaminated groundwater. More off-channel hydrologic units would be created. Demolition and cleanup of any structures would further address potential human health risks.	See Alternative 4+(a). In addition, this alternative would provide more extensive stream lining throughout the Box. Extraction wells and slurry walls would also be included in some Box tributaries to collect clean groundwater for discharge to the lined stream.	See Alternative 4+(a). Alternative differences include no stream lining and the addition of French drains in the Box. Direct piping of the CTP effluent to the SFCDR is also included.	See Alternative 4+(c). The only difference between this alternative and Alternative 4+(c) is that this alternative also has stream lining in Government Gulch with a slurry wall and extraction wells at the upstream end for discharge of clean groundwater to the lined stream channel. Direct piping of the CTP effluent to the SFCDR is also included.	See Alternative 4+(a). In addition, this alternative includes extensive stream lining with slurry walls and extraction wells for groundwater collection, as well as French drains along the SFCDR.
Effectiveness summary	Would provide high effectiveness in containing all media with significant loading potential, and in recovery of ecosystem function. Extensive hauling would pose significant short-term risks to the community and to workers.	See Alternative 4+(a).	See Alternative 4+(a).	See Alternative 4+(a). Would also provide slightly higher effectiveness than Alternative 3+(c) by providing additional benefits to the water quality in Government Creek.	See Alternative 4+(a). In addition, significantly more aggressive actions would be implemented in the Box.
	Overall moderate load reduction (47 percent at Pinehurst). Natural recovery processes would further reduce residual risk.	Overall moderate load reduction (46 percent at Pinehurst). Natural recovery processes would further reduce residual risk.	Overall large load reduction (65 percent at Pinehurst). Natural recovery processes would further reduce residual risk.	Overall large load reduction (67 percent at Pinehurst). Natural recovery processes would further reduce residual risk.	Overall large load reduction (70 percent at Pinehurst). Natural recovery processes would further reduce residual risk.
ARARs summary	Overall moderate AWQC-ratio reduction (2.7 compared to 4.3) for Pinehurst. Attainment of ARARs for surface water would require a period of natural source depletion	Overall moderate AWQC-ratio reduction (2.7 compared to 4.3) for Pinehurst. Attainment of ARARs for surface water would require a period of natural source depletion	Overall large AWQC-ratio reduction (1.4 compared to 4.3) for Pinehurst. Attainment of ARARs for surface water would require a period of natural source depletion	Overall large AWQC-ratio reduction (1.3 compared to 4.3) for Pinehurst. Attainment of ARARs for surface water would require a period of natural source depletion	Overall large AWQC-ratio reduction (1.1 compared to 4.3) for Pinehurst. Attainment of ARARs for surface water would require a period of natural source depletion
Compliance with ARARs					
Chemical-specific ARARs	Would significantly reduce metals concentrations in surface water, but would not meet surface water ARARs following remediation (see ARARs summary above).	Would significantly reduce metals concentrations in surface water, but would not meet surface water ARARs following remediation (see ARARs summary above).	Would significantly reduce metals concentrations in surface water, but would not meet surface water ARARs following remediation (see ARARs summary above).	Would significantly reduce metals concentrations in surface water, but would not meet surface water ARARs following remediation (see ARARs summary above).	Would significantly reduce metals concentrations in surface water, but would not meet surface water ARARs following remediation (see ARARs summary above).
Location- and action-specific ARARs	Would comply with all action-specific and location-specific ARARs, including substantive requirements of CWA Section 404, Rivers and Harbors Act Section 10, and Endangered Species Act. Potential difficulties in meeting requirements for repository siting and obtaining borrow materials.	See Alternative 4+(a)	See Alternative 4+(a)	See Alternative 4+(a)	See Alternative 4+(a)

TABLE B9-1b
Comparative Analysis of Alternatives 4+(a) through 4+(e)
Site Information Package for National Remedy Review Board

	OU 3 Component				
	Alternative 4+: Maximum Removal, Disposal, and Treatment				
	OU 2 Component				
	OU 2 Alternative (a) **Minimal Stream Lining**	**OU 2 Alternative (b)** **Extensive Stream Lining**	**OU 2 Alternative (c)** **French Drains**	**OU 2 Alternative (d)** **Stream Lining/French Drain Combination**	**OU 2 Alternative (e)** **Extensive Stream Lining/French Drain Combination**
	Combined Upper Basin Alternative				
Criteria	**Alternative 4+(a)**	**Alternative 4+(b)**	**Alternative 4+(c)**	**Alternative 4+(d)**	**Alternative 4+(e)**
Long-Term Effectiveness and Permanence					
Magnitude of residual risk	Moderate reduction in expected post-remediation mass loadings (estimated 47% reduction). All significant loading sources in OU 3 would receive action. Low potential for mobilization (through erosion) of contaminated alluvium left in place. Natural recovery processes would further reduce residual risks.	See Alternative 4+(a). Moderate reduction in expected post-remediation mass loadings (estimated 46% reduction).	Large reduction in expected post-remediation mass loadings (estimated 65% reduction). Some smaller loading sources would receive no action or limited containment. Low potential for mobilization (through erosion) of contaminated alluvium left in place. Natural recovery processes would further reduce residual risks.	Large reduction in expected post-remediation mass loadings (estimated 67% reduction). Some smaller loading sources would receive no action or limited containment. Low potential for mobilization (through erosion) of contaminated alluvium left in place. Natural recovery processes would further reduce residual risks.	Large reduction in expected post-remediation mass loadings (estimated 70% reduction). Some smaller loading sources would receive no action or limited containment. Low potential for mobilization (through erosion) of contaminated alluvium left in place. Surface water ARARs would be achieved at the time of remedy completion.
	Low residual risk to humans. All areas posing significant risk would be cleaned up or contained.	Low residual risk to humans. All areas posing significant risk would be cleaned up or contained.	Low residual risk to humans. All areas posing significant risk would be cleaned up or contained.	Low residual risk to humans. All areas posing significant risk would be cleaned up or contained.	Low residual risk to humans. All areas posing significant risk would be cleaned up or contained.
Adequacy and reliability of controls	Remedy could effectively be maintained through monitoring, maintenance, and institutional controls. Moderate maintenance requirements for caps; low maintenance requirements for stream and riparian improvements; high maintenance requirements for passive and active treatment.	See Alternative 4+(a).	See Alternative 4+(a). More linear feet of French drain are included in this alternative, although less stream lining.	See Alternative 4+(a). More linear feet of French drain and slightly less stream lining would be included in this alternative.	See Alternative 4+(a). Significantly more stream lining and French drains would be included in this alternative, as well as slurry walls and groundwater extraction wells.
Reduction of Toxicity, Mobility, or Volume through Treatment					
Treatment processes used	Active treatment of adit drainages, and groundwater from impoundment closures and hydraulic isolation, and repository drainage areas using hydroxide precipitation. Estimated average flow rate from all sources to the CTP is approximately 14,200 gpm (569 lb/day). All of this flow is from OU 3. No water from OU 2 would be treated. Semi-passive treatment of 1,490 gpm (49 lb/day) would occur at 54 additional adits using either SRB or lime addition/precipitation.	Treatment processes and semi-passive treatment scheme are the same as for Alternative 4+(a). Estimated average flow rate from all sources to the CTP is approximately 14,400 gpm (615 lb/day). All of this flow is from OU 3 with the exception of about 189 gpm (46 lb/day) from the under-liner drains associated with the stream liners in OU 2.	Treatment processes and semi-passive treatment scheme are the same as for Alternative 4+(a). Estimated average flow rate from all sources to the CTP is approximately 18,100 gpm (1,730 lb/day). The majority of this flow is from OU 3 with the exception of approximately 3,930 gpm (1,160 lb/day) from the under-liner drains and French drains in OU 2.	Treatment processes and semi-passive treatment scheme are the same as for Alternative 4+(a). Estimated average flow rate from all sources to the CTP is approximately 18,200 gpm (1,760 lb/day). The majority of this flow is from OU 3 with the exception of approximately 4,000 gpm (1,190 lb/day) from the under-liner drains, French drains, and extraction wells in OU 2.	Treatment processes and semi-passive treatment scheme are the same as for Alternative 4+(a). Estimated average flow rate from all sources to the CTP is approximately 16,700 gpm (1,140 lb/day) . The majority of this flow is from OU 3 with the exception of approximately 2,540 gpm (575 lb/day) from the under-liner drains, French drains, and extraction wells in OU 2.
Amount treated or destroyed	Total estimated dissolved zinc load removed from water through treatment is approximately 600 lb/day (99% of 569 + 80% of 49).	Total estimated dissolved zinc load removed from water through treatment is approximately 650 lb/day (99% of 615 + 80% of 49).	Total estimated dissolved zinc load removed from water through treatment is approximately 1,750 lb/day (99% of 1,730 + 80% of 49).	Total estimated dissolved zinc load removed from water is approximately 1,780 lb/day (99% of 1,760 + 80% of 49).	Total estimated dissolved zinc load removed from water is approximately 1,060 lb/day (99% of 1,140 + 80% of 49).
Reduction in toxicity, mobility, or volume	Water treatment would reduce the mobility and toxicity of metals by hydroxide precipitation and adsorption/precipitation into media. Volume of contaminated water would be reduced.	Same as Alternative 4+(a).	See Alternative 4+(a). More load is removed through treatment with this alternative; therefore, a higher reduction in toxicity, mobility, and volume through treatment would be achieved than for Alternatives 4+(a) and (b).	Reduction in toxicity, mobility, or volume is similar for Alternative 4+(d) and 4+(c).	Reduction in toxicity, mobility, or volume is lower than that for Alternatives 4+(d) and 4+(c) but higher than that for Alternatives 4+(a) and (b).

TABLE B9-1b
Comparative Analysis of Alternatives 4+(a) through 4+(e)
Site Information Package for National Remedy Review Board

	OU 3 Component				
	Alternative 4+: Maximum Removal, Disposal, and Treatment				
	OU 2 Component				
	OU 2 Alternative (a) **Minimal Stream Lining**	**OU 2 Alternative (b)** **Extensive Stream Lining**	**OU 2 Alternative (c)** **French Drains**	**OU 2 Alternative (d)** **Stream Lining/French Drain Combination**	**OU 2 Alternative (e)** **Extensive Stream Lining/French Drain Combination**
	Combined Upper Basin Alternative				
Criteria	**Alternative 4+(a)**	**Alternative 4+(b)**	**Alternative 4+(c)**	**Alternative 4+(d)**	**Alternative 4+(e)**
Irreversible treatment	Treatment is irreversible for the water stream treated for both active and semi-passive processes. Treatment residuals (Spent SRB media and hydroxide sludge) would require proper disposal to ensure that leaching of metals into the environment would not occur.	Same as Alternative 4+(a).	Same as Alternative 4+(a).	Same as Alternative 4+(a).	Same as Alternative 4+(a).
Type and quantity of residuals	Spent SRB substrate and hydroxide sludge require disposal. It is assumed that these wastes would be disposed of onsite. Total volume requiring disposal is estimated to be 10,300 cy/y.	Same as Alternative 4+(a).	Same waste types as for Alternative 4+(a). Total volume requiring disposal is greater, and estimated to be 15,300 cy/y.	Same as Alternative 4+(c).	Same waste types as for Alternative 4+(a). Total volume requiring disposal is greater than Alternative 4+(a) and (b) but less than Alternatives 4+(c) and (d), and is estimated to be 13,300 cy/y.
Statutory preference for treatment	Satisfies.	Satisfies.	Satisfies.	Satisfies.	Satisfies.
Short-Term Effectiveness					
Community protection	Potentially significant short-term risks to the community from construction traffic. Risks would be minimized by traffic control plans and selective repository siting.	See Alternative 4+(a). Slightly higher volume of truck trips would be associated with the longer stream liner lengths in Alternative 4+(b).	See Alternative 4+(a). Slightly higher volume of truck trips would be associated with more extensive floodplain work to install French drains.	See Alternative 4+(c). Slightly higher volume of truck trips would be associated with stream lining and associated work in Government Gulch.	See Alternative 4+(d). Slightly higher volume of truck trips would be associated with additional construction work in the Box.
Worker protection	Limited risks to workers from remediation actions. Risks would be minimized with standard health and safety measures. The massive scope of actions under Alternative 4+ would increase the risk of work injury relative to Alternative 3+.	See Alternative 4+(a).	See Alternative 4+(a).	See Alternative 4+(a). Risks may be slightly higher than for Alternative 4+(c) due to the additional actions in Government Gulch.	See Alternative 4+(a). Relative to other alternatives, Alternative 4+(e) would present the greatest short-term risks to workers.
Environmental impacts	Significant and ongoing impacts to environment during several decades of construction. In the context of current water quality in the SFCDR, these potential risks would be minimal. Impacts associated with: - 300,000 LF stream and riparian improvements - Very extensive excavation - Extensive repository requirements - Potential stream flow reduction (hydraulic isolation)	See Alternative 4+(a). In addition, more extensive floodplain construction would be required in the Box, adding to the short-term risks. In the context of current water quality in the SFCDR, these potential risks would be minimal.	Slightly less floodplain construction would be required in the Box relative to Alternative 4+(b); therefore, short-term risks would be slightly lower. In the context of current water quality in the SFCDR, these potential risks would be minimal.	Short-term risks would be roughly comparable to Alternative 4+(b). In the context of current water quality in the SFCDR, these potential risks would be minimal.	Short-term risks would be higher than for Alternatives 4+(a) through 4+(d) due to extensive floodplain construction in the Box. In the context of current water quality in the SFCDR, these potential risks would be minimal.
Time until action is complete[c]	Approximately 80 to 130 years to implement actions. Additional time would be required for natural source depletion to attain ARARs. See the discussion of overall protection of human health and the environment above.	Approximately 80 to 130 years to implement actions. Additional time would be required for natural source depletion to attain ARARs. See the discussion of overall protection of human health and the environment above.	Approximately 80 to 130 years to implement actions. Additional time would be required for natural source depletion to attain ARARs; however, it is expected this time would be shorter than Alternatives 3+(a) and 3+(b) and Alternatives 4+(a) and (b), given the lower predicted AWQC ratios at remedy completion. See the discussion of overall protection of human health and the environment above.	Approximately 80 to 130 years to implement actions. Additional time would be required for natural source depletion to attain ARARs; however, it is expected this time would be shorter than Alternatives 3+(a) and 3+(b) and Alternatives 4+(a) and (b), given the lower predicted AWQC ratios at remedy completion. See the discussion of overall protection of human health and the environment above.	Approximately 90 to 140 years to implement actions. Less time would be required for natural source depletion to attain ARARs given the lower predicted AWQC ratios at remedy completion. See the discussion of overall protection of human health and the environment above.

TABLE B9-1b
Comparative Analysis of Alternatives 4+(a) through 4+(e)
Site Information Package for National Remedy Review Board

	OU 3 Component				
	Alternative 4+: Maximum Removal, Disposal, and Treatment				
	OU 2 Component				
	OU 2 Alternative (a) **Minimal Stream Lining**	**OU 2 Alternative (b)** **Extensive Stream Lining**	**OU 2 Alternative (c)** **French Drains**	**OU 2 Alternative (d)** **Stream Lining/French Drain Combination**	**OU 2 Alternative (e)** **Extensive Stream Lining/French Drain Combination**
	Combined Upper Basin Alternative				
Criteria	**Alternative 4+(a)**	**Alternative 4+(b)**	**Alternative 4+(c)**	**Alternative 4+(d)**	**Alternative 4+(e)**
Implementability					
Technical feasibility	Technically feasible, but major logistical constraints on truck traffic. Large uncertainty in construction volumes – these could further increase construction difficulties and administrative difficulties. Major cost and logistical considerations for obtaining borrow materials and excavating in floodplains. Potential construction difficulties for hydraulic isolation.	See Alternative 4+(a). Longer stream lining included in Alternative 4+(b) would add to the logistical issues noted, although there is no SFCDR liner in this alternative which would have many logistical challenges.	See Alternative 4+(a). In addition, the extensive French drains included in this alternative would add to the logistical issues noted.	See Alternative 4+(c). In addition, work in Government Gulch would add to the logistical issues noted.	See Alternative 4+(c). In addition, extensive work in the Box would add to the logistical issues noted. Excavation of sediments from below the water table would pose significant logistical issues and result in higher costs. These implementability concerns are great under this Alternative because the French drain and pump station depth may range from 10 to 40 feet below ground surface. Deeper excavations, if required, would increase the dewatering difficulties.
	Treatability testing would be required as with Alternatives 3+(a) through 3+(e). Monitoring could assess effectiveness and the need for additional action.	Treatability testing would be required as with Alternatives 3+(a) through 3+(e). Monitoring could assess effectiveness and the need for additional action.	Treatability testing would be required as with Alternatives 3+(a) through 3+(e). Monitoring could assess effectiveness and need for additional action.	Treatability testing would be required as with Alternatives 3+(a) through 3+(e). Monitoring could assess effectiveness and the need for additional action.	Treatability testing would be required as with Alternative 3+(a) through 3+(e). Monitoring could assess effectiveness and need for additional action.
Administrative feasibility	Major difficulties in acquiring land and obtaining approvals for repositories and active treatment pipelines, obtaining borrow materials, and coordinating truck traffic. Coordination with other agencies would be required, potentially including completion of a biological assessment.	See Alternative 4+(a).	See Alternative 4+(a).	See Alternative 4+(a).	See Alternative 4+(a). Extensive actions in the Box would add to the difficulties in acquiring land and obtaining approvals.
Availability of services and materials	Services, equipment, and technologies are all available, at least on a regional level.	See Alternative 4+(a).	See Alternative 4+(a).	See Alternative 4+(a).	See Alternative 4+(a).
Cost					
Total Capital Cost	$1,690,000,000	$1,650,000,000	$1,650,000,000	$1,660,000,000	$1,870,000,000
O&M Cost (30-Year NPV) [a]	$137,900,000	$137,700,000	$138,600,000	$139,300,000	$144,400,000
Total Cost (30-Year NPV) [b]	$1,970,000,000	$1,930,000,000	$1,930,000,000	$1,940,000,000	$2,160,000,000
	Costs for Alternatives 4+(a) through 4+(d) are very similar and within the accuracy of the estimate (-40/+50%).Costs for alternatives based on Alternative 4+ are lower than corresponding alternatives based on Alternative 3+.	Costs for Alternatives 4+(a) through 4+(d) are very similar and within the accuracy of the estimate (-40/+50%). Costs for alternatives based on Alternative 4+ are lower than corresponding alternatives based on Alternative 3+.	Costs for Alternatives 4+(a) through 4+(d) are very similar and within the accuracy of the estimate (-40/+50%). Costs for alternatives based on Alternative 4+ are lower than corresponding alternatives based on Alternative 3+.	Costs for Alternatives 4+(a) through 4+(d) are very similar and within the accuracy of the estimate (-40/+50%). Costs for alternatives based on Alternative 4+ are lower than corresponding alternatives based on Alternative 3+.	This alternative has a relatively high cost. Costs for alternatives based on Alternative 4+ are lower than corresponding alternatives based on Alternative 3+.

TABLE B9-1b
Comparative Analysis of Alternatives 4+(a) through 4+(e)
Site Information Package for National Remedy Review Board

	OU 3 Component				
	Alternative 4+: Maximum Removal, Disposal, and Treatment				
	OU 2 Component				
	OU 2 Alternative (a) Minimal Stream Lining	OU 2 Alternative (b) Extensive Stream Lining	OU 2 Alternative (c) French Drains	OU 2 Alternative (d) Stream Lining/French Drain Combination	OU 2 Alternative (e) Extensive Stream Lining/French Drain Combination
	Combined Upper Basin Alternative				
Criteria	**Alternative 4+(a)**	**Alternative 4+(b)**	**Alternative 4+(c)**	**Alternative 4+(d)**	**Alternative 4+(e)**

Notes:

[a] O&M costs over 30 years in current dollars, assuming a 7% discount factor.
[b] Total NPV cost equals the total equivalent cost of the alternative over 30 years in current dollars, assuming a 7% discount factor.
[c] This assumes a rough estimated range of $15M/yr to $25M/yr of available annual funding to cover capital costs.

ARARs = applicable or relevant and appropriate requirements
CTP = Central Treatment Plant
CWA = Clean Water Act
cy = cubic yards
gpm = gallons per minute
LF = linear feet
NPV = net present value
O&M = operation and maintenance
OU = Operable Unit
PRG = preliminary remediation goal
RAO = Remedial Action Objective
SFCDR = South Fork Coeur d'Alene River
SRB = sulfate-reducing bioreactor

NOTE: The above costs are presented rounded to three significant figures.
NOTE: The above cost opinion is a Feasibility Study-level estimate with a nominal accuracy of –30 percent to +50 percent (–30/+50%).
NOTE: The above cost opinion is in 2009 dollars and does not include future escalation. The order-of-magnitude cost opinion shown has been prepared for guidance in project evaluation from the information available at the time of preparation. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, the final project scope, the final project schedule, and other variable factors. As a result, the final project costs will vary from those presented above. Because of these factors, funding needs must be carefully reviewed prior to making specific financial decisions or establishing final budgets.

TABLE B9-2
Comparative Analysis of Remedy Protection Alternatives
Site Information Package for National Remedy Review Board

Feasibility Criterion	Description of Criterion	ALTERNATIVE RP-1 No Further Action (Post-Event Response)	ALTERNATIVE RP-2 Modifications to Selected Remedies to Enhance Protectiveness (Remedy Protection Projects)
Threshold Criteria			
Overall Protection of Human Health and the Environment	Ability of alternative to achieve and maintain protection of human health and the environment	Alternative RP-1 would be protective of human health and the environment because the existing Selected Human Health Remedies are currently protective. The risk of exposure to contaminated material for Alternative RP-1 could temporarily increase following a storm event from the time the Selected Remedies were damaged until the post-event response was completed.	Alternative RP-2 would be protective of human health and the environment because the existing Selected Human Health Remedies are currently protective. Additionally, Alternative RP-2 would be more protective of human health and the environment than Alternative RP-1 because it would enhance the long-term effectiveness and permanence of the Selected Remedies by reducing the potential for floods or surface water flow to damage the existing Selected Remedies.
Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)	Ability of alternative to meet location- and action-specific ARARs	Alternative RP-1 could potentially be implemented in compliance with location- and action-specific ARARs. Chemical-specific ARARs were not included as part of this evaluation because the remedy protection alternatives only enhance the existing Selected Remedies.	Alternative RP-2 could potentially be implemented in compliance with location- and action-specific ARARs. Chemical-specific ARARs were not included as part of this evaluation because the remedy protection alternatives only enhance the existing Selected Remedies.
Primary Balancing Criteria			
Long-Term Effectiveness and Permanence	Ability of technology to be protective of human health and the environment without upset over the long-term	Alternative RP-1 would provide relatively less long-term effectiveness and permanence. Based on hydrologic and hydraulic models, there are areas of the existing Selected Remedies which are at risk to recontamination due to flooding and uncontrolled surface water flow. Alternative RP-1 would not address this issue of permanence of the existing Selected Remedies, but instead would rely on post-event response to repair the Selected Remedies when damaged.	Alternative RP-2 would enhance the long-term effectiveness and permanence of the Selected Remedies. This alternative would be expected to provide protectiveness to the communities from storm events smaller than the 50-year event.
Reduction of Toxicity, Mobility or Volume through Treatment	Ability of alternative to reduce mobility, toxicity, or volume of contaminants	Alternative RP-1 would not reduce the toxicity, mobility, or volume of metals contamination through treatment.	Alternative RP-2 would not reduce the toxicity, mobility, or volume of metals contamination through treatment.
Short-Term Effectiveness	Ability of alternative to protect human health and the environment during the short-term time frame.	In general, Alternative RP-1 would be effective in the short term because the existing Selected Remedies are currently protective of human health and the environment. Much of the existing infrastructure within communities is under-capacity. Therefore, Alternative RP-1 would allow a relatively higher risk of contaminant mobility within residential areas during and immediately following storm events. Additionally, the risk of exposure could temporarily increase following a storm event until the post-event response is completed.	Alternative RP-2 would be effective in the short term because the existing Selected Remedies are currently protective of human health and the environment. Additionally, Alternative RP-2 reduces the risk of exposure to contaminated material by protecting the Selected Remedies up to the 50-year storm event. This alternative would effectively convey stormwater and floodwater for storm events smaller than the 50-year event and reduce the risk of exposure and mobility of contaminants within residential areas.
Implementability	Ability of alternative to meet technical, administrative, and logistical challenges associated with implementation	Alternative RP-1 would not be expected to have any technical feasibility issues. There would be administrative issues regarding the availability of federal funds to repair the Selected Remedies following a storm event. Additionally, in some cases, the repair of the protective barriers could be time-sensitive in order to maintain protectiveness and limit a resident's risk of exposure.	Alternative RP-2 would not be expected to have any technical implementability issues. The list of technologies and process options applied for Alternative RP-2 are standard engineering practices. There could be administrative issues that arise in regard to determining which state or local entity would be responsible for O&M of the Alternative RP-2 projects. Additionally, there could be logistical challenges to implementing Alternative RP-2 on private properties, where access and easement agreements would be needed prior to construction.
Cost	Total Capital Cost for Upper Basin Communities [a]	NA	$13,700,000
	O&M Cost (30-Year NPV) for Upper Basin Communities [a]	NA	$4,980,000
	Total Cost (30-Year NPV) for Upper Basin Communities [a]	$33,800,000	$18,800,000
	Total Capital Cost for Side Gulches [b]	NA	$10,900,000
	O&M Cost (30-Year NPV) for Side Gulches [b]	NA	$4,180,000
	Total Cost (30-Year NPV) for Side Gulches [b]	$16,300,000	$15,100,000
	Total Cost (30-Year NPV)	**$50,100,000**	**$33,900,000**

Notes:

NPV = net present value; ARARs = applicable or relevant and appropriate requirements; NA = nor applicable

[a] The costs for Alternatives RP-1 and RP-2 in the eight Upper Basin communities include Pinehurst, Smelterville, Kellogg, Wardner, Osburn, Silverton, Wallace and Mullan

[b] Side gulch costs for Alternatives RP-1 and RP-2 are approximate based on assumptions discussed in the FFS Report (see Appendix D, which is provided in File B14-1 on the Supplemental CD provided with this Site Information Package).

NOTE: The above costs are presented rounded to three significant figures

NOTE: The above cost opinion is a Feasibility Study-level estimate with a nominal accuracy of –30 percent to +50 percent (–30/+50%).

NOTE: The above cost opinion is in 2009 dollars and does not include future escalation. The order-of-magnitude cost opinion shown has been prepared for guidance in project evaluation from the information available at the time of preparation. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, the final project scope, the final project schedule, and other variable factors. As a result, the final project costs will vary from those presented above. Because of these factors, funding needs must be carefully reviewed prior to making specific financial decisions or establishing final budgets.

TABLE B11-1
Legend of Bureau of Land Management Site Names
Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

Big Creek	
KLE025	Sunshine Tailings Pond: No.2
KLE026	Silver Syndicate
KLE027	North American Mine
KLE047	Big Ck Impacted Riparian: No.1
KLE053	North American/Silver Syndicate Mine
KLE054	Crescent/Hooper Tunnel
KLE071	Big Ck Impacted Riparian: No.3
KLE073	Big Ck Impacted Riparian: No.2
POL001	Sunshine Consolidated Rockford Group
POL002	Silver Dale And Big Hill Mine
POL008	Globe Mine
POL010	Western Star Mine
POL011	Wolfson Mine
POL022	First National Mine
POL044	Unnamed Prospect
POL052	Lucky Boy Mine
POL066,067,068	Unnamed Adits
Canyon Creek	
BUR066	Moonlight Mine
BUR067	Tamarack No.7 (1200 Level)
BUR068	Headlight Mine
BUR072	Standard-Mammoth No.4
BUR073	Standard-Mammoth Campbell Adit
BUR075	Sherman 1000 Level (Oreano Adit)
BUR087	Hercules No.3
BUR088	Ajax No.2
BUR089	Idaho And Eastern Mine
BUR090	Hercules No.4
BUR094	Sherman 600 Level
BUR096	Anchor Mine
BUR097	Hidden Treasure Mine
BUR098	Hercules No.5
BUR099	Benton Mine
BUR105	Oom Paul No.2
BUR107	Ajax No.3
BUR109	Oom Paul No.1
BUR112	Gem No.2
BUR117	Frisco Millsite
BUR118	Frisco No.2 & No.1
BUR119	Black Bear No.4
BUR120	Silver Moon Mine
BUR121	Black Bear Fraction
BUR122	Flynn Mine
BUR124	Omaha Mine
BUR125	Midway Summit Mine
BUR128	Hecla-Star Mine & Millsite Complex
BUR129	Tiger-Poorman Mine
BUR130	Marsh Mine
BUR132	Gertie Mine
BUR133	Russel Mine
BUR134	Alcides Prospect & Imperial Mine
BUR135	Sonora Mine
BUR141	Canyon Ck Impacted Floodplain
BUR142	Gem Millsite
BUR143	Canyon Ck Impacted Riparian
BUR144	Standard-Mammoth Loading Area
BUR145	O'Neill Gulch Unnamed Rock Dump
BUR146	Gorge Gulch Impacted Riparian
BUR149	Ajax No.2 Adjacent Rock Dump
BUR150	Canyon Ck Garbage Dump
BUR153	Canyon Ck Impacted Floodplain (CCSEG02 & CCSEG04)
BUR166 & 176	Unnamed Adits
BUR177	Joe Matt Mine
BUR178	West Hecla Mine
BUR180	Stanley Mine
BUR185	West Mammoth Mine
BUR187	Unnamed Adit
BUR189	Duluth Mine Canyon Ck
BUR190	Gem No.3
BUR191	Frisco No.3
BUR192	Black Bear Millsite
BUR204	Unnamed Rock Dump
THO023	Unnamed Adit
Canyon Creek – Woodland Park	
OSB047	Canyon Ck Formosa Reach SVNRT Rehab
WAL007	Canyon Ck Gravel Pit
WAL008	Sisters Mine
WAL009	Hecla-Star Tailings Ponds
WAL010	Canyon Ck Pond Reach SVNRT Rehab
WAL011	Canyon Silver (Formosa) Mine
WAL012	Verde May Mine
WAL039	Standard-Mammoth Millsite
WAL040	Canyon Ck Impacted Floodplain
WAL041	Canyon Ck Repository Reach SVNRT Rehab
WAL042	Canyon Ck Tailings Repository SVNRT
WAL081	Wallace Old Private Landfill
WP-OPTIONC	Woodland Park Option C
Mainstem SFCDR	
KLE011	Silver Crescent Tailings (KLE011 source area is actually Silver Summit Tailings Pond. It is believed that the names were mistakenly switched within the BLM GIS database. For consistency, we have not revised the BLM naming convention.)
KLE016	Syndicate Mining & Exploration Co.
KLE020	New Hilarity Mine
KLE021	Alhambra Mine

TABLE B11-1
Legend of Bureau of Land Management Site Names
Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

KLE023	Pioneer Mines Inc. Property
KLE033	Polaris Mine
KLE034	Silver Dollar Mine
KLE035	Silver Summit Mine
KLE040	SFCDR Impacted Floodplain: No.5
KLE042	Moon Ck Pond at Mouth
KLE048	SFCDR SVNRT Rehab
KLE049	SFCDR Impacted Riparian (MIDGRADSEG01 & MIDGRADSEG02)
KLE051	Florence Mine
KLE062	Osburn Flats Bureau Of Mines Testplots
KLE066	Rhode Island No.1 & No.2 & Assoc. Adits
KLE067	St. Joe No.4
KLE068	Unnamed Adit (St. Joe No.2)
KLE069	St. Joe No.3
KLE070	Unnamed Adit
KLE074	Coeur D'Alene Millsite
KLE075	Silver Summit Millsite (Polaris)
KLW061	BH No.2
KLW062	Bluebird Mine & Guy Cave Area
KLW070	Milo Ck Impacted Riparian: No.1
KLW095	Phil Sheridan Mine
MUL085	Vienna International Mine
MUL086	Wibberding-Golden Slipper Mines
OSB025	Capitol Silver-Lead: No.3
OSB030	Silverton Prospect Upper Adit
OSB065	SFCDR Impacted Floodplain: No.3
OSB070	Silverore-Inspiration Mine
OSB072	Western Union Upper Adit
OSB073	Silverton Prospect Lower Adit
OSB074	St. Joe No.1
OSB075	Unnamed Adit
OSB076	Unnamed Adit (May Claim)
OSB078	Unnamed Adit (Hardscrabble Claim)
OSB117	Osburn Zanetti Stockpiled Tailings
OSB118	Osburn North Tailings Area
OSB119	Osburn Zanetti Gravel Operation
OSB120	SFCDR Impacted Floodplain: No.4
POL018	Merger Mine
POL019	Coeur D'Alene Mine
POL021	Eclipse Mine
POL064	Unnamed Adit
WAL001	Osburn Tailings Ponds
WAL002	Western Union Lower Adit
WAL004	SFCDR Railroad Yards & Impacted Floodplain
WAL014	St. Elmo Mine
WAL016	Argentine Mine
WAL020	Caladay Mine
WAL024	War Eagle Mine
WAL034	Shields Gulch Impacted Riparian
WAL035	Osburn Rockpit along I-90: No.2
WAL036	Lake Ck Impacted Riparian
WAL037	Hercules Millsite
WAL046	Day Mines Claims
WAL055	Unnamed Adit
WAL056	Peerless Group (Osceola)
WAL057	Peerless Group
WAL058, 062, 064, 072, 073	Unnamed Adits
Moon Creek	
KLE008	Maine-Standard Mine
KLE014	Royal Anne Mine
KLE041	Moon Ck Impacted Riparian
KLE061	Unnamed Tunnel
KLE063, 064, 065	Unnamed Adits
Nine Mile Creek	
BUR051	Sunset Mine
BUR052	Little Sunset Mine
BUR053	Interstate-Callahan Mine/Rock Dumps
BUR054	Rex No.2/Sixteen-To-One Mine
BUR055	Interstate Millsite
BUR056	Tamarack Rock Dumps
BUR058	Tamarack No.3
BUR139	Rex No.1
BUR140	Ninemile Creek Impacted Floodplain
BUR160	Interstate-Callahan Lower Rock Dumps
BUR170	Tamarack 400 Level
BUR171	Tamarack No.5
BUR172	Tamarack Unnamed Adit
BUR173	Tamarack Millsite
OSB032	Duluth Mine Blackcloud Ck
OSB033	Ruth Mine
OSB038	California No.4
OSB039	Dayrock Mine
OSB040	East Fprl Ninemile Ck Hecla Rehab
OSB044	Success Mine Rock Dump
OSB048	American Mine
OSB052	Dayrock Mine Tailings Pile/SVNRT Repository
OSB056	East Fork Ninemile Ck Impacted Riparian
OSB057	East Fork Ninemile Ck Impacted Riparian
OSB058	East Fork Ninemile Ck SVNRT Rehab
OSB059	Ninemile Ck below Dayrock Mine
OSB060	Ninemile Ck SVNRT Rehab Near Blackcloud
OSB061	Blackcloud Ck Millsite
OSB082	Monarch Mine Blackcloud Ck
OSB084	Blackcloud Ck Impacted Riparian
OSB085	Blackcloud Ck Impacted Riparian

TABLE B11-1
Legend of Bureau of Land Management Site Names
Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

OSB088	Alameda Mine
OSB089	Success No.3
OSB115	Option Mine
WAL006	Northside Mine
WAL033	Ninemile Ck Potential Tailings Deposit
Pine Creek	
KLW075	Matchless Mine
KLW077	General Mine
KLW079	Gold Eagle Mining Co.
KLW082	Carbonate Mine: No.2
KLW083	Liberal King Part of Tunnel: No.2
KLW085	Carbonate Mine: No.1
MAS003	Liberal King Mine & Millsite
MAS006	Nabob Tailings Pond
MAS007	Nabob 1300 Level
MAS008	Nabob 600 Level (Crystalite)
MAS009	Shetland Mining Co-Nabob Silver-Lead
MAS011	Idaho Prospect: No.2
MAS012	Lynch-Pine Creek Mine
MAS013	Nabob 600 Level (300 Level)
MAS014	Hilarity Mine
MAS015	Little Pittsburg Mine: No.2
MAS016	Little Pittsburg Mine: No.1
MAS017	Sidney (Denver) 500 Level
MAS018	Denver Mine (Nabob Adit)
MAS019	Star Antimony Lower Adit
MAS020	Sidney (Red Cloud) Mine/Millsite
MAS021	Nevada-Stewart Mine
MAS022	Surprise Mine & Upper Rock Dump
MAS023	Blue Eagle Mine
MAS027	Constitution Lower Mine & Rock Dump
MAS028	Lon Chaney Group
MAS029	Big It Mine
MAS030	Trapper Creek Silver
MAS031	Trapper Mining & Smelting Company Ltd.
MAS032	L And J Prospect
MAS033	Coeur D'Alene Premier
MAS035	Nabob 600 Level Shaft
MAS036	Denver Ck Tailings Pile
MAS040	Denver Ck Impacted Riparian: No.2
MAS041	Denver Ck Impacted Riparian: No.3
MAS042	Denver Ck Impacted Riparian: No.4
MAS043	Denver Ck Impacted Riparian: No.1
MAS045	Highland Ck Impacted Riparian
MAS046	Highland & Red Cloud Ck Impacted Riparian
MAS048	Constitution Lower Millsite & Tailings
MAS049	Constitution Upper Tailings (Non-BLM land)
MAS050	Constitution Upper Tunnel & Rock Dump
MAS052	Owl/Fred Mine
MAS053	Unnamed Adits
MAS054	Marmion or South Fork Fraction
MAS055, 057	Unnamed Adit
MAS065	Unnamed Prospect
MAS068, 072	Unnamed Adit
MAS078	Highland-Surprise Mine & Millsite
MAS079	Highland-Surprise Lower Rock Dump
MAS083	Nabob Millsite
MAS084	Douglas Minesite Tailings Repository
TWI002	Palisade Mine Lower Workings
TWI006	Manhattan Mine
TWI008	West Pine Creek Deposit
TWI009	Equitable Prospect
TWI011	Unnamed Adit
TWI012	KC Prospect
TWI013	Bluebird Prospect (Hannibal)
TWI014	Great Dunkard Mine
TWI018	Unnamed Prospect
TWI020	Unnamed Adit
TWI027	Unnamed Prospect
TWI029, 030	Unnamed Adits
Upper SFCDR	
LOK001	Lucky Calumet No.1
LOK002	Lucky Calumet No.2
LOK004	Snowshoe No.2
LOK005	Lucky Boy No.2
LOK006	Lucky Boy No.1
LOK007	Butte & Coeur D'Alene (Idaho Silver)
LOK008	Idaho Silver No.2
LOK009	Snowstorm No.4
LOK010	Hash House Mine
LOK011	Snowstorm No.3
LOK017	Beacon Light
LOK024	Silver Cable Mine
LOK048	Snowstorm Apex
LOK050	Daisy Gulch Tailings Pond
LOK051	Daisy Gulch Old Landfill
LOK053	Unnamed Adit
MUL001	Golconda Minesite
MUL002	Golconda Millsite
MUL004	United Lead Zinc Mine
MUL006	Square Deal Mine
MUL007	Wonder Mine
MUL008	Alice Mine
MUL009	Silver Shaft
MUL012	Star 1200 Level
MUL013	We Like Mine
MUL014	Grouse Mine
MUL015	West Star Mine
MUL018	Mullan Metals Mine

TABLE B11-1
Legend of Bureau of Land Management Site Names
Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

MUL019	Morning No.6
MUL020	Lucky Friday Tailings Pond No.3
MUL021	Independence Mine
MUL022	Sunshine Premier Mine
MUL023	Fanny Gremm Mine
MUL027	Morning No.4
MUL028	Morning No.5
MUL029	North Franklin Mine
MUL030	Wall Street Mine
MUL031	Cincinnati Mine
MUL033	American Commander No.2
MUL037	Lucky Friday Tailings Pond No.2
MUL038	Gold Hunter No.6
MUL042	Gold Hunter No.5
MUL043	Silver Reef Mine
MUL045	Homestake Mine
MUL047	Lottie L. Mine
MUL048	Alma Mine
MUL049	Copper Plate Mine
MUL051	Pilot Mine
MUL052	Copper King Mine
MUL053	National Mine
MUL054	Unnamed Adit
MUL056	Coughlin Mine
MUL057	Butte And Coeur D'Alene Mine
MUL058	Lucky Friday Tailings Pond No.1
MUL059	Rock Creek Mine Rock Dump

MUL060	Rock Creek Mine
MUL063	Gem State Mine
MUL065	Moe Mine
MUL071	Atlas Mine
MUL073	Atlas Mine (Carbonate Hill)
MUL081	Reindeer Queen Mine
MUL083	Copper Queen Mine
MUL103	Missoula Mine
MUL119	Unnamed Adit
MUL120	Banner Mine No.02
MUL129	Atlas Mine Rock Dump
MUL131	National Millsite
MUL132	National Millsite Adjacent Tailings
MUL135, 136, 139	Unnamed Adits
MUL141	Mill Ck Impacted Riparian No.3
MUL142	Grouse Gulch Impacted Riparian
MUL145	Mill Ck Impacted Riparian No.2
MUL146	Morning No.3
MUL149	Mill Ck Impacted Riparian No.1
MUL150	Deadman Gulch Impacted Riparian
MUL153	Deadman Gulch Impacted Riparian
THO020	Bull Frog Mine
WAL013	Granada Mine
WAL038	SFCDR Impacted Floodplain: No.1
WAL076	Mary D Claim Workings
WAL077	Golconda Tailings

TABLE B11-2

Summary of Estimated Post-Remediation Water Quality at Elizabeth Park and Pinehurst

Site Information Package for National Remedy Review Board

	Current Conditions		At Remedy Completion					
	Dissolved Zinc Load (lb/day)	**AWQC Ratio**	**Post-Remediation Dissolved Zinc Load (lb/day)**	**80% Probability Interval on Load Estimates**		**Post-Remediation Dissolved Zinc Load Reduction**		
	Best Estimate	*Best Estimate*	*Best Estimate*	*Lower*	*Upper*	*lb/day*	*Percent*	**AWQC Ratio**
Elizabeth Park (Station SF-268)	1,260	5.5						
Alternative 3+ (OU 3 Only)	**--**	**--**	**441**	**88**	**939**	**816**	**65**	**1.7**
Alternative 4+ (OU 3 Only)	--	--	353	85	726	904	72	1.5
Pinehurst (Station SF-271)	2,120	4.3						
Alternative 3+(a)	--	--	1,240	234	2,660	884	42	2.8
Alternative 3+(b)	--	--	1,240	239	2,670	877	41	2.8
Alternative 3+(c)	--	--	840	84	1,910	1280	60	1.5
Alternative 3+(d)	**--**	**--**	**812**	**77**	**1,840**	**1310**	**62**	**1.5**
Alternative 3+(e)	--	--	738	58	1,680	1380	65	1.3
Alternative 4+(a)	--	--	1,130	247	2,370	990	47	2.7
Alternative 4+(b)	--	--	1,140	253	2,380	983	46	2.7
Alternative 4+(c)	--	--	734	80	1,660	1390	65	1.4
Alternative 4+(d)	--	--	706	72	1,600	1410	67	1.3
Alternative 4+(e)	--	--	632	52	1,440	1490	70	1.1

Notes:

AWQC = ambient water quality criterion
lb/day = pounds per day
OU = Operable Unit

TABLE B11-3
Fishery Tier Definitions and Ranking System
Site Information Package for National Remedy Review Board

Fishery Tier	Definition	COPC Concentration Range
Tier 0	No fish present	> 20x the chronic AWQC
Tier 1	No resident fish are present. Adult and juvenile salmonids (trout species) transit occasionally to reach spawning and rearing areas.	10x to 20x the chronic AWQC
Tier 2	Native or introduced salmonids (trout) are present, but with less than three year classes and generally low densities (less than 0.05 fish/m^2). Sculpins are generally absent, or present at very low densities.	7x to 10x the chronic AWQC
Tier 3	Three or more year classes of native or introduced salmonids are present. Trout densities are moderate to high (>0.05 fish/m^2) and young of the year fish that are representative of spawning and rearing are present. Sculpin are generally absent or present at very low densities.	3x to 7x the chronic AWQC
Tier 4	Three or more year classes of native or introduced salmonids are present. Salmonid densities are generally high (>0.10 fish/m^2) and young of the year are present, which indicates successful spawning and rearing. Sculpin are present at moderate to high densities.	1x to 3x the chronic AWQC
Tier 5	Three or more year classes of native or introduced salmonids are present at high densities (>0.10 fish/m^2), and young of the year and adult fish. A full range of native species predominate and are present at high densities.	Below the chronic AWQC

Notes:

From *Technical Memorandum: Interim Fishery Benchmarks for the Initial Increment of Remediation in the Coeur d'Alene River Basin* (URS Greiner, 2001).

AWQC = ambient water quality criterion
COPC = contaminant of potential concern
m^2 = square meter

TABLE B11-4
Summary of Remedy Protection Projects for Alternative RP-2
Site Information Package for National Remedy Review Board

Community	Drainage	Brief Description of Project
Pinehurst		
	Little Pine Creek	Channel hydraulic capacity improvements and culvert replacement
Smelterville		
	Grouse Creek	Channel hydraulic capacity improvements (including concrete walls)
Kellogg		
	Jackass Creek	Channel hydraulic capacity improvements and stabilization with riprap
	Italian Gulch[a]	Visual observation and documentation
	Portland Road	Asphalt-lined ditches and pipe culvert installation
	Localized Drainages[a]	Visual observation and documentation
Wardner		
	Milo Creek	High-capacity stormwater inlets and associated below-grade piping
Osburn		
	Shields Gulch	Channel hydraulic capacity improvements, culvert replacement, and new channel alignment
	Rosebud Gulch	Channel hydraulic capacity improvements and culvert replacement
	Meyer Creek	Below-grade bypass drainage network
	McFarren Gulch[a]	Visual observation and documentation
Silverton		
	Revenue Gulch	High-flow bypass drainage network and stormwater drainage network
	Unnamed Creek	Channel hydraulic capacity improvements and culvert replacement
Wallace		
	Printer's Creek	New inlet structure and drainage system maintenance improvements
	Placer Creek[a]	Visual observation and documentation
Mullan		
	Mill Creek	Rolling dip, channel hydraulic capacity improvements, concrete-lined channel, and culvert replacement
	Tiger Creek	Diversion structure, channel stabilization, culvert replacement, and asphalt-lined ditch
	Neighborhood Surface Flow Issues[b]	Asphalt-lined ditches, pipe culvert installation, and stormwater catch basins
TOTAL		

Notes:

[a] Only process option is visual observation and documentation. No capital cost. These costs are accounted for in community operation and maintenance (O&M) costs.

[b] Alternative RP-2 includes remedy protection for neighborhood surface flow issues in the following Mullan neighborhoods: 3rd Street, Mill Street, Dewey Street Area, Copper Street, and the south end of 2nd Street.

TABLE B12-1
Potential Chemical-Specific ARARs for Protection of Aquatic Life and Human Health in Surface Water in the Upper Coeur d'Alene Basin
Site Information Package for National Remedy Review Board

	Federal Ambient Water Quality Criteria[a]						**Idaho Water Quality Standards[a]**						**Site-Specific Criteria, South Fork Coeur d'Alene River (HUC 17010302)[b]**					
	Acute			**Chronic**			**Acute**			**Chronic**			**Acute**			**Chronic**		
Hardness																		
Hardness[c]	30	50	100	30	50	100	30	50	100	30	50	100	30	50	100	30	50	100
Metals																		
Arsenic	340	340	340	150	150	150	340	340	340	150	150	150	N/A	N/A	N/A	N/A	N/A	N/A
Cadmium[d]	0.62	1.03	2.01	0.11	0.15	0.25	0.49	0.73	2	0.28	0.38	1	0.61	1.03	2.08	0.42	0.62	1.03
Copper	4.3	7.0	13	3.2	5.0	9.0	5.5	8.9	17	4.06	6.3	11	N/A	N/A	N/A	N/A	N/A	N/A
Lead	17	30	65	0.66	1.2	2.5	17.0	30.1	65	0.66	1.2	2.5	80	129	248	9.1	14.7	28.3
Mercury[e]	1.4	1.4	1.4	0.77	0.77	0.77	2.1	2.1	2.1	0.012	0.012	0.012	N/A	N/A	N/A	N/A	N/A	N/A
Zinc	42	65	120	43	66	120	42	65	120	43	66	120	88	123	195	88	123	195

Notes:
[a]Criteria and standards in micrograms per liter (µg/L) from Idaho Administrative Procedures Act (IDAPA) 58.01.01.
[b] Criteria in micrograms per liter (µg/L) from IDAPA 58.0102.284. HUC = Hydrologic Unit Code.
[c] Hardness in milligrams of calcium per liter (mg $CaCO_3$/L).
[d] In 2006, the State of Idaho adopted statewide site-specific aquatic life criteria for cadmium, revising the hardness dependent criteria equations for cadmium in section 210.02 of the rules. Until the U.S. Environmental Protection Agency (USEPA) acts on this change to state water quality standards, the effective water column criteria for dissolved cadmium at 100 mg/L hardness are as summarized in the table above (IDAPA 58.01.02.210.01, 2005).
[e] In 2005, the State of Idaho adopted USEPA's methylmercury fish tissue criterion for protection of human health. The decision was made to remove the old aquatic life criteria and rely on the fish tissue criterion to provide protection for aquatic life. Thus, current Idaho water quality standards do not have mercury water column criteria for the protection of aquatic life. While USEPA approved of Idaho's adoption of the fish tissue criterion, it has not yet acted on the removal of the water column criteria. Until USEPA acts on this change to state water quality standards, the effective water column criteria for total recoverable mercury are as summarized in the table above (IDAPA 58.01.02.210.01, 2004).

N/A = not applicable

TABLE B14-1

Estimated Costs Summarized by Alternative

Site Information Package for National Remedy Review Board

Alternative	Description	Total Capital Cost	O&M Cost (30-Year NPV)	O&M Cost (Annual Average)	Total Cost (30-Year NPV)
Alternative 3+ (a)	More Extensive Removal, Disposal, and Treatment w/ Minimal Stream Lining	$ 1,140,000,000	$ 87,700,000	$ 7,080,000	$ 1,320,000,000
Alternative 3+ (b)	More Extensive Removal, Disposal, and Treatment w/ Extensive Stream Lining	$ 1,110,000,000	$ 87,500,000	$ 7,060,000	$ 1,290,000,000
Alternative 3+ (c)	More Extensive Removal, Disposal, and Treatment w/ French Drains	$ 1,100,000,000	$ 88,400,000	$ 7,140,000	$ 1,280,000,000
Alternative 3+ (d)	More Extensive Removal, Disposal, and Treatment w/ Stream Lining and French Drain Combination	$ 1,110,000,000	$ 89,100,000	$ 7,190,000	$ 1,290,000,000
Alternative 3+ (e)	More Extensive Removal, Disposal, and Treatment w/ Extensive Stream Lining and French Drain Combination	$ 1,330,000,000	$ 94,200,000	$ 7,600,000	$ 1,520,000,000
Alternative 4+ (a)	Maximum Removal, Disposal, and Treatment w/ Minimal Stream Lining	$ 1,690,000,000	$ 137,900,000	$ 11,130,000	$ 1,970,000,000
Alternative 4+ (b)	Maximum Removal, Disposal, and Treatment w/ Extensive Stream Lining	$ 1,650,000,000	$ 137,700,000	$ 11,110,000	$ 1,930,000,000
Alternative 4+ (c)	Maximum Removal, Disposal, and Treatment w/ French Drains	$ 1,650,000,000	$ 138,600,000	$ 11,190,000	$ 1,930,000,000
Alternative 4+ (d)	Maximum Removal, Disposal, and Treatment w/ Stream Lining and French Drain Combination	$ 1,660,000,000	$ 139,300,000	$ 11,240,000	$ 1,940,000,000
Alternative 4+ (e)	Maximum Removal, Disposal, and Treatment w/ Extensive Stream Lining and French Drain Combination	$ 1,870,000,000	$ 144,400,000	$ 11,660,000	$ 2,160,000,000
Alternative RP-1	No Further Action (Post-Event Response) [a]	--	--	--	$50,100,000
Alternative RP-2	Remedy Protection Projects	$ 24,600,000	$ 9,160,000	$ 401,000	$33,900,000

Notes:

O&M = operation and maintenance; NPV = net present value

[a] Costs for RP-1 include expected post-event response costs based on methodology described in *Memorandum: Methodology for Estimating Expected Loss from Damage to Remedies* (CH2M HILL, 2009e).

NOTE: The above costs are presented rounded to three significant figures.
NOTE: The above cost opinion is a Feasibility Study-level estimate with a nominal accuracy of –30 percent to +50 percent (–30/+50%).

NOTE: The above cost opinion is in 2009 dollars and does not include future escalation. The order-of-magnitude cost opinion shown has been prepared for guidance in project costs, actual site conditions, productivity, competitive market conditions, the final project scope, the final project schedule, and other variable factors. As a result, the final project costs will vary from those presented above. Because of these factors, funding needs must be carefully reviewed prior to making specific financial decisions or establishing final budgets.

NOTE: Active treatment is not included in OU 2 Alternatives (a) and (b); therefore, total flows for Alternatives 3+(a) and 3+(b) and Alternatives 4+(a) and 4+(b) will be identical.

NOTE: The O&M Cost (Annual Average) is calculated by dividing the O&M Cost (30-Year NPV) by a factor of 12.409 to account for the 30 years at 7%.

TABLE B14-2
Summary of Estimated Costs for Typical Conceptual Designs
Site Information Package for National Remedy Review Board

TCD Code	Name	Unit	2009 Direct Capital Unit Cost[a]($)	2009 Indirect Capital Unit Cost[b] (%)	Present Value of 30 Years of Operations and Maintenance Costs[b] (%)
Source Control TCDs					
C01	Excavation (dry)	CY	$4.20	70	0
C01b	Excavation (60% dry/40% wet)	CY	$13.20	70	0
C02a	Regrade/Consolidate/Revegetate Cover: Lower Part of Pile in 100-Year Floodplain	AC	$84,300.00	70	13
C02b	Regrade/Consolidate/Revegetate Cover: Waste Rock Pile in Stream Valley	AC	$167,000.00	70	13
C02c	Regrade/Consolidate/Revegetate Cover: Stabilize Using Erosion Protection	AC	$14,900.00	70	23
C03	Low-Permeability Cap	AC	$225,000.00	70	12
C04	Low-Permeability Cap with Seepage Collection and Treatment	AC	$254,000.00	70	23
C05	Low-Permeability Cap with Erosion Protection	AC	$252,000.00	70	23
C06	Waste Consolidation Area with Erosion Protection	CY	$15.70	70	23
C07	Waste Consolidation Area Above Flood Level	CY	$14.70	70	22
C08a	Repository, 1 million cy	CY	$17.70	70	14
C09	Impoundment Closure	AC	$246,000.00	70	20
HAUL-2	Haul to Repository	CY-MI	$1.10	70	0
Water Collection, Conveyance, and Management TCDs					
C10	Adit Drainage Collection	LS	$9,680.00	70	18
C11a	Hydraulic Isolation Using Slurry Wall (no drain): 15 ft deep	LF	$196.00	70	0
C11b	Hydraulic Isolation Using Slurry Wall (no drain): 20 ft deep	LF	$261.00	70	0
C11c	Hydraulic Isolation Using Slurry Wall (no drain): 30 ft deep	LF	$391.00	70	0
C11d	Hydraulic Isolation Using Slurry Wall (no drain): 40 ft deep	LF	$522.00	70	0

TABLE B14-2
Summary of Estimated Costs for Typical Conceptual Designs
Site Information Package for National Remedy Review Board

TCD Code	Name	Unit	2009 Direct Capital Unit Cost[a]($)	2009 Indirect Capital Unit Cost[b] (%)	Present Value of 30 Years of Operations and Maintenance Costs[b] (%)
C11e	Hydraulic Isolation Using Slurry Wall (no drain): 45 ft deep	LF	$595.00	70	0
C11f	Hydraulic Isolation Using Slurry Wall (no drain): 50 ft deep	LF	$652.00	70	0
C11g	Hydraulic Isolation Using Slurry Wall (no drain, soil cement): 50 ft deep	LF	$4,170.00	70	0
C11h	Hydraulic Isolation Using Slurry Wall (w/drain): 15 ft deep	LF	$1,120.00	70	2
C11i	Hydraulic Isolation Using Slurry Wall (w/drain): 20 ft deep	LF	$1,210.00	70	2
C11j	Hydraulic Isolation Using Slurry Wall (w/drain): 30 ft deep	LF	$1,590.00	70	2
C14a	Stream Lining (10 feet wide)	LF	$318.00	70	4
C14b	Stream Lining (20 feet wide)	LF	$505.00	70	4
C14c	Stream Lining (100 feet wide)	LF	$2,970.00	70	3
C15a	French Drain (10 feet below ground surface [bgs])	LF	$545.00	70	2
C15b	French Drain (15 feet bgs)	LF	$907.00	70	2
C15c	French Drain (20 feet bgs)	LF	$949.00	70	2
C15d	French Drain (25 feet bgs)	LF	$1,210.00	70	2
C17a	Groundwater Extraction Well - 20 ft deep, 6” diameter pipe	EA	$65,700.00	70	100
C17b	Groundwater Extraction Well - 40 ft deep, 6” diameter pipe	EA	$68,600.00	70	100
C17c	Groundwater Extraction Well - 50 ft deep, 6” diameter pipe	EA	$72,900.00	70	100
C17d	Groundwater Extraction Well - 50 ft deep, 10” diameter pipe	EA	$80,400.00	70	100
C17e	Groundwater Extraction Well - 70 ft deep, 10” diameter pipe	EA	$83,300.00	70	100
C18	SFCDR Diversion	EA	$882,000.00	70	0
C-19	I-90 Crossing	EA	$276,000.00	70	0
C-20	Check Dam	LS	$47,900.00	70	0

TABLE B14-2
Summary of Estimated Costs for Typical Conceptual Designs
Site Information Package for National Remedy Review Board

TCD Code	Name	Unit	2009 Direct Capital Unit Cost[a]($)	2009 Indirect Capital Unit Cost[b] (%)	Present Value of 30 Years of Operations and Maintenance Costs[b] (%)
PIPE-1	Gravity Pipeline (6-inch)	LF	$58.70	70	8
PIPE-2	Gravity Pipeline (12-inch)	LF	$86.20	70	8
PIPE-3	Gravity Pipeline (24-inch)	LF	$139.00	70	8
PIPE-4	Gravity Pipeline (36-inch)	LF	$180.00	70	8
PRESSURE-PIPE-1	Pressurized Pipeline - <6" diameter	LF	$44.10	70	20
PRESSURE-PIPE-2	Pressurized Pipeline - 6"-14" diameter	LF	$91.40	70	20
PRESSURE-PIPE-3	Pressurized Pipeline - >14" diameter	LF	$180.00	70	20
PRESSURE-PIPE-4	Pressurized Pipeline – 3" diameter, Cherry Raise	LF	$155.00	70	20
PUMP-1	Pump Station - 0.14 MGD	EA	$29,300.00	70	100
PUMP-2	Pump Station - 1.4 MGD	EA	$959,000.00	70	100
PUMP-3	Pump Station - 3.9 MGD	EA	$1,025,000.00	70	100
PUMP-4	Pump Station - 6.3 MGD	EA	$1,188,000.00	70	100
PUMP-5	Pump Station - 6.5 MGD	EA	$1,208,000.00	70	100
Water Treatment TCDs					
WT01[c]	Centralized High-Density Sludge (HDS) Treatment at Central Treatment Plant (CTP)	GPM	y = 672x + 1,612,565	107	y = (82.11x + 1,004,308.16)/ (672x + 1,612,565)
WT02[d]	Onsite Semi-Passive Water Treatment Using Lime Addition and Settling Pond(s)	GPM	y = 2,613x + 258,722	70	y = (4,254.9x + 997,357) / (2,613x + 258,722)
WT03[d]	Onsite Semi-Passive Water Treatment Using Sulfate-Reducing Bioreactor (SRB) System	GPM	y = 6,482.4x + 132,414	70	y = (3,012.9x + 526,116) / (6,482.4x + 132,414)
WT04a	In Situ Groundwater Treatment Using Sulfate-Reducing Permeable Reactive Barrier (SR-PRB) (10 feet deep, 100 feet long, 7.5 feet wide)	EA	$19,500.00	70	1,993
WT04b	In Situ Groundwater Treatment Using Sulfate-Reducing Permeable Reactive Barrier (SR-PRB) (40' deep, 100 feet long, 7.5 feet wide)	EA	$118,000.00	70	480

TABLE B14-2
Summary of Estimated Costs for Typical Conceptual Designs
Site Information Package for National Remedy Review Board

TCD Code	Name	Unit	2009 Direct Capital Unit Cost[a]($)	2009 Indirect Capital Unit Cost[b] (%)	Present Value of 30 Years of Operations and Maintenance Costs[b] (%)
Human Health TCDs					
HH-2	Upland Waste Pile Soil Cover	AC	$58,400.00	70	13
HH-3	Millsite Decontamination	LF	$136,000.00	70	13
HH-4	Millsite Demolition/Disposal	CY	$169.00	70	13
Stream and Riparian Improvement TCDs					
CD-AVG	Current Deflectors	EA	$2,060.00	70	30
CD-SED	Current Deflectors, Sediment Traps	EA	$1,870.00	70	600
VBS-AVG	Vegetative Bank Stabilization	LF	$52.00	70	30
BSBR-AVG	Bioengineered Revetments	LF	$122.00	70	30
FP/RP-AVG	Floodplain and Riparian Replanting	SF	$1.34	70	18
OFFCH-AVG	Off-Channel Hydrologic Features	SY	$42.70	70	18
CH REAL-1	Channel Realignment	SY	$42.20	70	17

Notes:

[a] Detailed information about the TCD unit costs is provided in File B14-1 on the Supplemental CD to this Site Information Package (Appendix D of the FFS Report).

[b] As a percentage of the 2009 Direct Capital Unit Cost.

[c] Cost equations valid for flow rates between 2,000 and 20,000 GPM.

[d] Cost equations valid for flow rates between 5 and 1,000 GPM.

AC = acre; CY = cubic yard; CY-MI = cubic yard–mile; EA = each; GPM = gallons per minute; LF = linear foot; LS = lump sum; SF = square foot; SY = square yard; TCD = typical conceptual design.

NOTE: The above costs are presented rounded to three significant figures.

NOTE: The above cost opinion is a Feasibility-Study-level estimate with a nominal accuracy of –30 percent to +50 percent (–30/+50%).

NOTE: The above cost opinion is in 2009 dollars and does not include future escalation. The order-of-magnitude cost opinion shown has been prepared for guidance in project evaluation from the information available at the time of preparation. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, the final project scope, the final project schedule, and other variable factors. As a result, the final project costs will vary from those presented above. Because of these factors, funding needs must be carefully reviewed prior to making specific financial decisions or establishing final budgets.