Proposed Plan

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

United States
Environmental Protection
Agency Region 10

July 12, 2010

This Proposed Plan includes a summary of all of the cleanup alternatives that were evaluated and a description of the U.S. Environmental Protection Agency's (USEPA's) Preferred Alternative for the Upper Basin of the Coeur d'Alene River. In response to the high level of public interest, USEPA has set a comment period of 45 days instead of the usual 30 days. USEPA is accepting written comments on this Proposed Plan from July 12, 2010 through August 25, 2010.

Where to Send Comments

Written comments on the Proposed Plan should be directed to:

cdabasin@epa.gov *or*

Coeur d'Alene Basin Team
U.S. Environmental Protection Agency
1200 6th Avenue, Suite 900
MS ECL-113
Seattle, Washington 98101

Comments are due by August 25, 2010.
In addition, you may provide oral or written comments on the Proposed Plan at the Public Meeting and Open House described below.

Public Meeting and Open House

August 4, 2010
Shoshone Medical Center,
Health and Education Center,
858 Commerce Drive, Smelterville, Idaho 83868
Open House: 5:00 p.m. to 6:30 p.m.
Public Meeting: 7:00 p.m. to 8:30 p.m.

The Public Meeting will include a formal EPA presentation followed by recorded oral public comments. People wishing to provide oral comments for the record will be called upon in the order in which they have signed in. Comment cards will also be available for those who would like to submit written comments at the Public Meeting.

All members of the public are also invited to the informal Open House, to be held before the Public Meeting at the same location. The Open House will offer a chance to view displays, talk with project managers, and learn about the cleanup. Drop in any time. There will be no formal presentations or recording of oral public comments at the Open House, but written comments on the Proposed Plan may be submitted.

Where to Review the Proposed Plan and Administrative Record

You can review the Proposed Plan and supporting documents at the following locations.

Kellogg Public Library
16 West Market Avenue
Kellogg, Idaho 83837
208-786-7231

Wallace Public Library
415 River Street
Wallace, Idaho 83873
208-752-4571

Molstead Library (North Idaho College)
(Contains the Administrative Record)
1000 Garden Avenue
Coeur d'Alene, Idaho 83814
208-769-3355

St. Maries Library
822 W. College Avenue
St. Maries, Idaho 83861
208-245-3732

Spokane Public Library
906 West Main Avenue
Spokane, Washington 99201-0976
509-444-5336

USEPA, Coeur d'Alene Field Office
1910 Northwest Boulevard, Suite 208
Coeur d'Alene, Idaho 83814
208-664-4588

USEPA Seattle Office, Superfund Records Center
(Contains the Administrative Record)
1200 6th Avenue
Seattle, Washington 98101
206-553-4494 or 800-424-4372

USEPA'S Website:
http://yosemite.epa.gov/r10/cleanup.nsf/sites/bh+rod+amendment
(or, http://go.usa.gov/igD)

Summary

This Proposed Plan presents the recommended approach for the cleanup of historical mining-related contamination in the Upper Basin of the Coeur d'Alene River ("the Upper Basin") in Northern Idaho. For the purposes of this Proposed Plan, the Upper Basin includes areas of mining-related contamination along the South Fork of the Coeur d'Alene River (SFCDR), its tributaries downstream to one mile west of the confluence of the South and North Forks of the river, and the Bunker Hill "Box", a rectangular 21-square-mile area surrounding the former smelter complex. The Upper Basin is part of the Bunker Hill Mining and Metallurgical Complex Superfund Site ("the Bunker Hill Superfund Site" or "the Site"). The changes to the cleanup plan will result in a more complete cleanup of the Basin, will protect human health for the long-term, and will also ensure better protection for water quality, wildlife, and habitat. This is an important next step in cleanup of historical mining-related waste in the Coeur d'Alene Basin and the Bunker Hill Superfund Site.

The U.S. Environmental Protection Agency (USEPA) is the lead agency for the Bunker Hill Superfund Site and has issued several Record of Decision (ROD) documents for the Site. These RODs mostly focused on remedies to protect human health in the communities, residential areas, and recreational areas of the Site, as well as the environment in the Coeur d'Alene Basin. The most recent ROD was issued in 2002 for the Upper Basin watershed (comprising areas surrounding the South and North Forks of the Coeur d'Alene River), the Lower Basin watershed (which comprises the area around the main stem of the river down to Coeur d'Alene Lake), and a portion of the Spokane River where Coeur d'Alene Lake drains into Washington State. This ROD (USEPA, 2002) included a human health remedy for the communities, residential areas, and identified recreational areas, as well as an interim remedy for ecological protection. Over the last 8 years, USEPA has learned much more about the nature and extent of mining-related contamination in the Upper Basin, which is the main area of historical mining and industrial activities and the primary source of downstream metals contamination. This Proposed Plan identifies USEPA's Preferred Alternative for the Upper Basin cleanup, building upon the remedies identified in the previous RODs and the additional information obtained since 2002.

At this time, USEPA is seeking public comments on the Proposed Plan for the Upper Basin and supporting information in the Administrative Record, including the Draft Final Focused Feasibility Study Report for the Upper Basin (FFS Report; USEPA, 2010). After careful consideration of all comments received, USEPA will select the cleanup remedy for the Upper Basin. The selected remedy will be documented in a **ROD Amendment**. The Upper Basin ROD Amendment will also include a Responsiveness Summary containing responses to comments received during the public comment period.

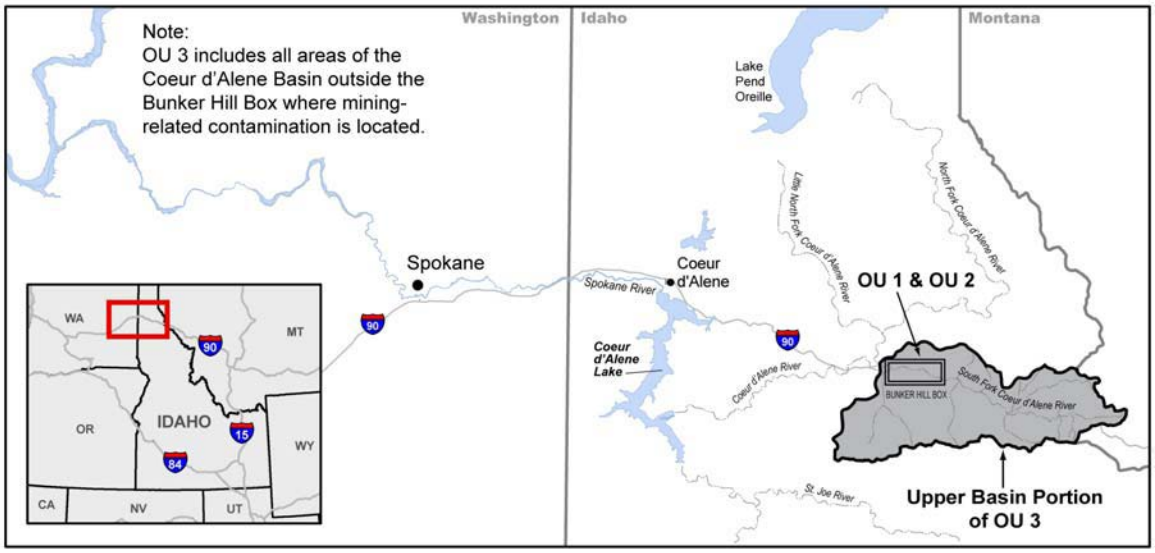
This Proposed Plan was developed in consultation with the Idaho Department of Environmental Quality, the Coeur d'Alene Tribe, the federal Natural Resource Trustees (the U.S. Fish and Wildlife Service, the Bureau of Land Management, and the U.S. Forest Service), the Spokane Tribe, the Washington Department of Ecology, local communities, and other interested parties. Because of the complexity of the Bunker Hill Superfund Site and the extensive cleanup required, USEPA has made many efforts to ensure community participation

including presentations to the Basin Environmental Project Improvement Commission ("the Basin Commission"), regular Project Focus Team meetings as well as meetings with local officials and community groups. USEPA has also distributed fact sheets, held public workshops, and sought public reviews of draft documents. USEPA is committed to meaningful public involvement and will continue these efforts throughout the duration of remaining cleanup work at the Site.

The Bunker Hill Superfund Site

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. As a result of past practices, substantial portions of the Basin contain elevated concentrations of lead, zinc, cadmium, arsenic, and other metals. The Bunker Hill Superfund Site was placed on the National Priorities List in 1983. Contaminated media in the Upper Basin include surface water, groundwater, soil, and sediments.

USEPA has identified three Operable Units (OUs) at the Bunker Hill Superfund Site. OU 1 (Populated Areas) and OU 2 (Non-Populated Areas) are located in the Upper Basin within the Bunker Hill "Box", a rectangular 21-square-mile area surrounding the former smelter complex. OU 3 includes all areas of the Coeur d'Alene Basin outside the Bunker Hill Box where mining-related contamination is located. OU 3 extends from near the Idaho-Montana border into the State of Washington, and includes floodplains, communities, lakes, rivers, and tributaries. As noted above, the Upper Basin is the focus of this Proposed Plan. It includes areas of mining-related contamination along the SFCDR and tributaries downstream to one mile west of the confluence with the North Fork. This Proposed Plan includes actions that will update and add to the previous cleanup plans for the Upper Basin described in the RODs for OUs 1, 2, and 3 and related decision documents.



OU = Operable Unit

Vicinity Map
Upper Basin Proposed Plan

382081.FI.06.01.03_BunkerHill_ES042009003SEA . Study Area Map for Summary.ai

Why a ROD Amendment is Needed

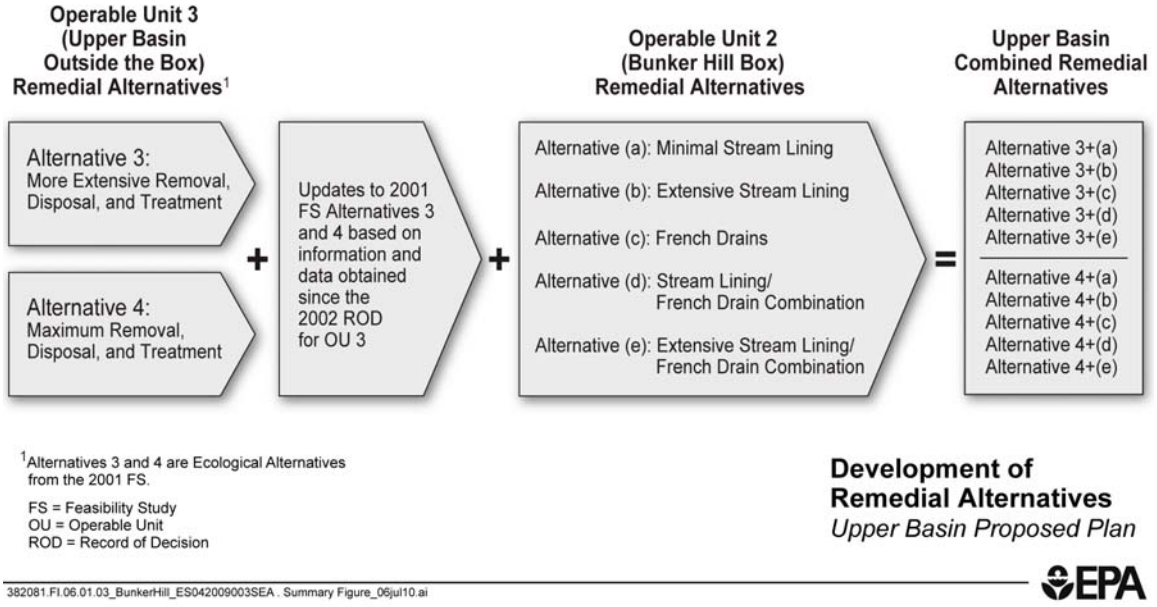
A ROD Amendment is needed now to document the decision for a final remedy for surface water and for soil, sediments, and source materials where remedial actions are taken in the Upper Basin to protect human health and the environment. This ROD Amendment also includes actions to protect portions of the human health remedy selected in the 2002 ROD. Considerably more knowledge about the Upper Basin has been gained over the last 8 years from site investigations, groundwater modeling, research into groundwater-surface water interactions, and ecological studies. A holistic approach can now be taken to address contamination in the Upper Basin. This effort is also intended in part to address recommendations from the National Academy of Sciences on the 2002 ROD. The ROD Amendment will present a comprehensive remedy for the Upper Basin that:

- Aggressively addresses contaminant sources (such as mine tailings, waste rock, and contaminated floodplain sediments),
- Improves surface water quality in the SFCDR and its tributaries, and
- Protects existing human health remedies that are vulnerable to erosion and recontamination.

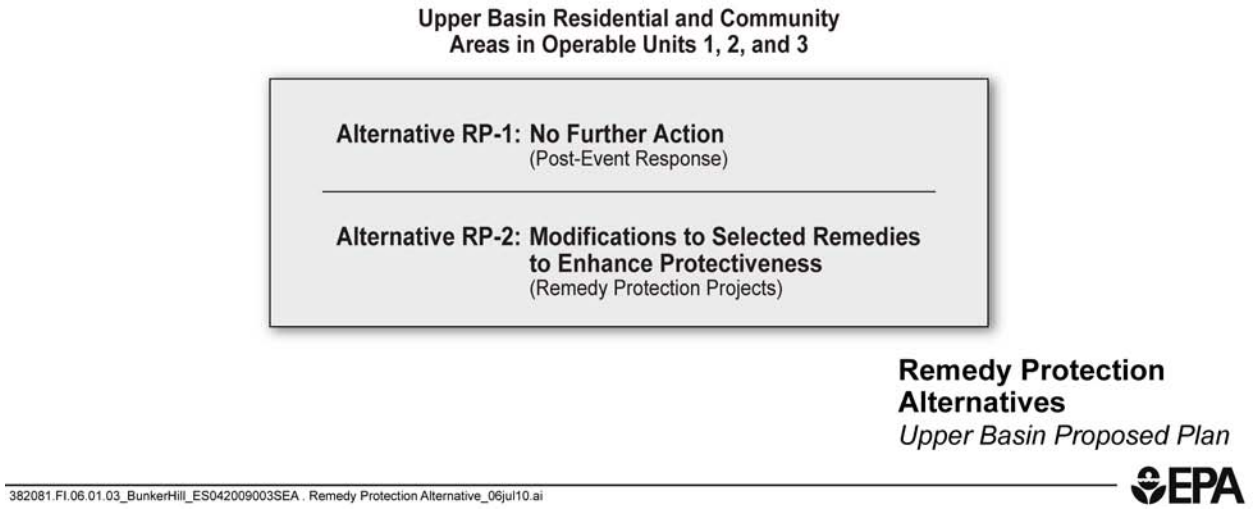
Alternatives Developed and Evaluated

The FFS Report (USEPA, 2010) describes and evaluates two types of alternatives that were developed with the goal of protecting human health and the environment in the Upper Basin:

- **Remedial Alternatives**. These alternatives address the widespread contamination that impacts surface water and other media in the Upper Basin. As shown below, the remedial alternatives build upon two alternatives addressing contamination in OU 3 and five alternatives addressing contaminant sources in OU 2. Therefore, a total of 10 remedial alternatives are evaluated in the FFS Report.



- **Remedy Protection Alternatives**. Two remedy protection alternatives are evaluated in the FFS Report. The alternatives focus on preventing, limiting, and/or repairing erosion and contamination of clean barriers caused by localized tributary flooding and precipitation events.



Preferred Alternative

The Preferred Alternative for the Upper Basin includes one remedial alternative [Alternative 3+(d)] and one remedy protection alternative (Alternative RP-2). 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 materials at locations where remedial actions are taken.

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

Preferred Remedial Alternative

The Preferred Remedial Alternative for the Upper Basin, Alternative 3+(d), includes extensive remedial actions within the Bunker Hill Box and elsewhere along the SFCDR and its primary tributaries (Canyon Creek, Ninemile Creek, Big Creek, Moon Creek, and Pine Creek).

Highlights of the remedial actions included in the Preferred Remedial Alternative outside the Box are:

- Extensive excavation of waste rock, tailings, and floodplain sediments.

- Remedial actions along stream reaches to reduce the flow of contaminated groundwater into the SFCDR and its tributaries.
- Capping, regrading, and revegetation of tailings and waste rock areas.
- Collection and treatment of contaminated adit discharges, seeps, and groundwater.
- Stream and riparian cleanup actions in every major Upper Basin watershed.

Highlights of remedial actions included in the Preferred Remedial Alternative in the Box are:

- Remedial actions to reduce the flow of contaminated groundwater entering the SFCDR.
- Collection and treatment of groundwater and water management actions to reduce the flow of contaminated adit discharges near the Reed and Russell Mines.

Key benefits of the Preferred Remedial Alternative include:

- Greater protection of human health and wildlife by reducing the risk of exposure through direct contact with contaminated soil and sediments and potential contact with contaminated surface water.
- Significant reduction of the transport of dissolved metals contamination into the Coeur d'Alene River system from the Upper Basin.
- Reduction of the downstream transport of lead-containing sediments as the result of cleanup actions at upstream contaminant source areas. This will reduce downstream exposures and the potential for recontamination.

The Preferred Alternative is also 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 additional actions are needed or would be effective in meeting drinking water standards. If further actions would not be effective, a Technical Impracticability waiver may be warranted at specific locations where groundwater does not achieve drinking water standards.[1]

Preferred Remedy Protection Alternative

The Preferred Remedy Protection Alternative for the Upper Basin, Alternative RP-2, combines stormwater control actions to protect the existing human health remedies for OUs 1 and 2 and the Upper Basin portion of OU 3 against tributary flooding and high-precipitation events. Highlights of the remedial actions included in the Preferred Remedy Protection Alternative are:

- Actions to reduce the potential for erosion and contamination of the existing clean barriers installed within residential and community areas in the Upper Basin.
- Stormwater control actions such as culvert replacements, channel improvements, and installation of asphalt ditches.

[1] Specific ARARs can be waived if appropriately justified [40 *Code of Federal Regulations* (CFR) 300.430(f)(1)(ii)(C)].

Key benefits of the Preferred Remedy Protection Alternative include:

- Greater long-term protection of human health and the environment in residential and community areas in the Upper Basin, achieved through improvements to existing water conveyance systems (i.e., culvert replacements, asphalt ditches, etc.).
- A proactive approach to addressing recontamination issues associated with the potential erosion and/or contamination of existing clean barriers.

Implementing the Selected Remedy

The large number of cleanup actions identified in the Preferred Alternative will need to be planned carefully. Working with Basin stakeholders, USEPA has already begun the critical process of planning and prioritizing actions for implementation of the remedy that is selected in the ROD Amendment, whether it is the Preferred Alternative or another remedy. The outcome of this effort will be an Implementation Plan, a separate document from the Upper Basin ROD Amendment, that will act as a "living document" to identify priority projects and guide the actions selected in the ROD Amendment.

USEPA, consistent with its guidance, considered reasonably foreseeable future land uses in the Upper Basin during development of this Proposed Plan. During the implementation planning process and the design of remedial actions, USEPA will consider a wide range of site-specific issues that will affect the implementation of the cleanup. These include (but are not limited to) current and future use, access, impacts to local residences, and impacts to ongoing or future site development such as mining activity. In addition, such things as timing of the action, staging, coordination with other work in the area, and coordination with the entity that would perform the work will be considered.

USEPA recognizes that mining and mineral processing have played an important role in the development of the Silver Valley. USEPA also recognizes that mining and mineral activities are likely to continue for the foreseeable future. USEPA intends to manage its Superfund responsibilities in the Upper Basin in a manner that will allow for responsible mining and mineral processing activities as well as exploration and development. Provided that environmental conditions are not exacerbated and that USEPA's ability to implement cleanup is not impeded, USEPA expects that future mining-related activities can be conducted in a manner that will not impair or interfere with the implementation of cleanup actions or the protectiveness of any implemented cleanup actions. USEPA intends to work with entities interested in conducting mining and mineral processing activities to ensure that these activities and cleanup are responsibly implemented.

USEPA will involve stakeholders and community members in the development of the Implementation Plan and during the implementation of cleanup actions. (Note: USEPA is seeking input during the Proposed Plan comment period on the type and frequency of input for the Implementation Plan). As currently envisioned, this will involve working through the Basin Commission process and with the respective Project Focus Teams to revise the Implementation Plan on a regular basis, review the sites identified in that process, and seek input from stakeholders and community representatives on the sites selected. These activities will be documented in the Basin Commission work plans. USEPA expects that its efforts to involve the public will continue as new phases of remedial actions are prioritized. There may be situations

in the future when new phases of an action for a particular area differ significantly from the remedial action selected in a ROD. In such instances, USEPA will provide opportunities for public participation consistent with the requirements of Section 113(k) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and 40 *Code of Federal Regulations* (CFR) Section 300.435(c) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). Depending on the significance of changes in the remedial approach, this may result in additional opportunities for public comment.

Because these actions will take years to implement and conditions will change over time, USEPA will use an adaptive management process to prioritize actions "along the way" as more information becomes available on the effectiveness of initial cleanup actions. Stated more simply, this is learning by doing. The Implementation Plan will be updated on a regular basis to guide future decisionmaking and to document adjustments to project priorities based on new information such as monitoring data. Cleanup actions will be prioritized based on such factors as:

- The potential for people and wildlife to be exposed to contaminated materials;
- The potential for recontamination of cleaned-up areas;
- The need for repository space and restoration work;
- Construction staging; and
- Design needs.

USEPA will develop and modify the Implementation Plan in close cooperation with state agencies, other federal agencies, Tribal representatives, and other involved parties including the Basin Commission, community representatives, and the Coeur d'Alene Basin Natural Resource Trustees. As it has in the past, USEPA will continue to work with property owners and affected businesses in the area as it moves forward with cleanup on specific properties, and with mining companies that plan to conduct work at existing mining sites identified in the cleanup plan or at new mining sites in the area of the cleanup.

Community Participation

Because of the complexity of the Bunker Hill Superfund Site and the extensive cleanup required, USEPA has made many efforts to ensure community participation. USEPA is committed to meaningful public involvement in this process. To that end, the agency has held public workshops and briefings, issued fact sheets and news articles, met with local officials and organizations, requested public review of draft documents, launched a webpage, worked with the media, and coordinated closely with the Basin Commission and its subgroups. USEPA will continue to involve the public throughout the duration of remaining cleanup work at the Site.

USEPA is issuing this Proposed Plan as part of its public participation process under Section 300.420(f)(2) of the NCP. This Proposed Plan summarizes information that can be found in the FFS Report for the Upper Basin (USEPA, 2010) and other documents contained in the Administrative Record file that supports the upcoming ROD Amendment. The public is encouraged to review these documents to gain a more comprehensive understanding of the Site and USEPA's recommended cleanup plan for

the Upper Basin. Technical reports and memoranda, meeting presentations, and community involvement documents related to development of the FFS and this Proposed Plan are available at: http://yosemite.epa.gov/r10/cleanup.nsf /sites/bh+rod+amendment.

The Proposed Plan and supporting documentation are available for review at the locations listed on page i of this Proposed Plan. The Administrative Record is available for review at the Molstead Library (North Idaho College) and the USEPA Seattle Office, Superfund Records Center.

In consultation with the other government agencies, USEPA will select the remedy for the Upper Basin after reviewing and considering all information submitted during the 45-day comment period for this Proposed Plan, including state agency, Tribal, and public comments, as required by the Superfund process. The selected remedy documented in the ROD Amendment may be a modification of the Preferred Alternative or another remedy, based on new information or comments received from the state, Tribes, or the public. Therefore, the public is encouraged to review and comment on the information presented in this Proposed Plan and alternative proposals considered, and to attend the Public Meeting and Open House described on page i.

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1.0 Introduction

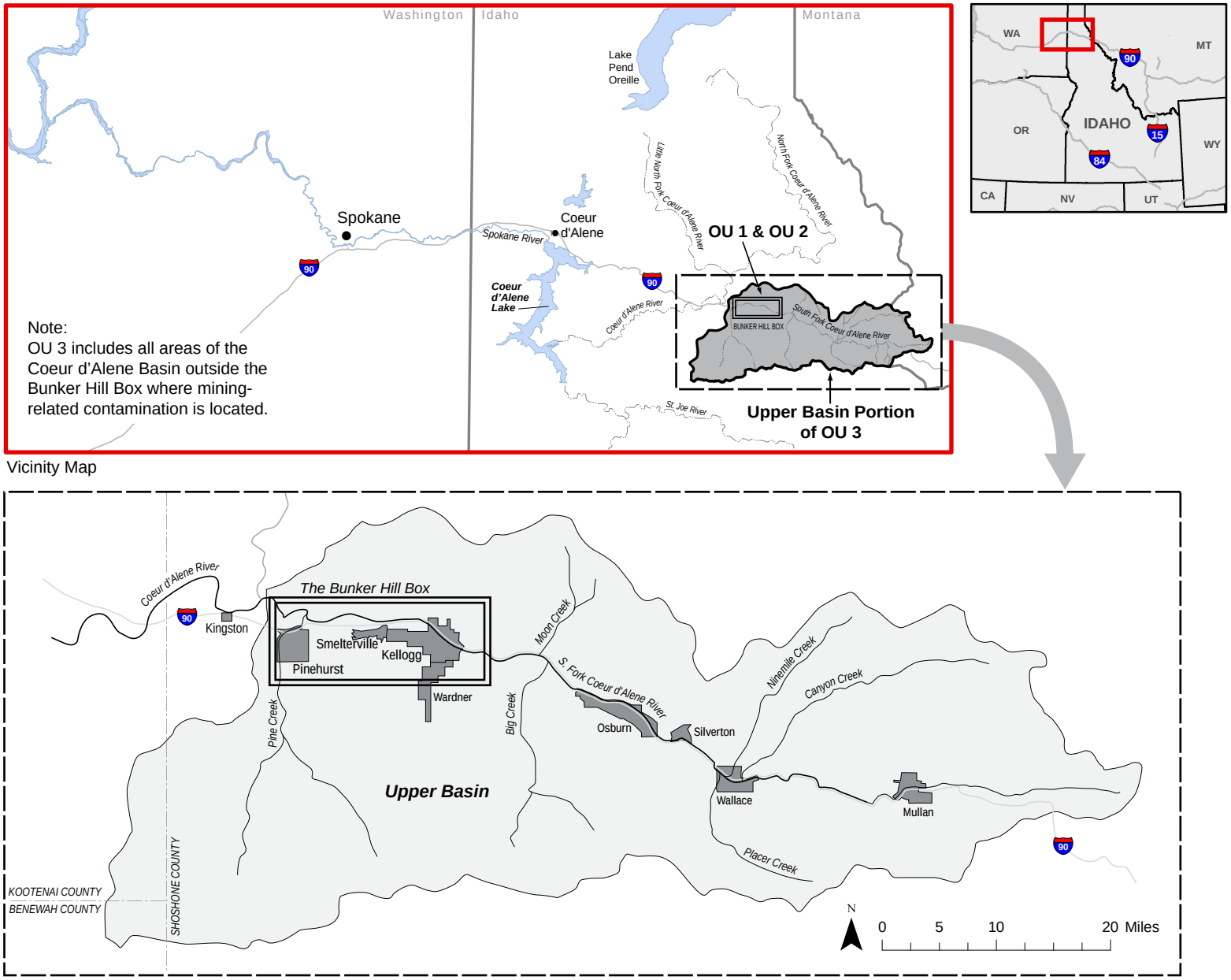
This Proposed Plan presents the U.S. Environmental Protection Agency's (USEPA's) Preferred Alternative for cleaning up historical mining-related contamination in the Upper Basin of the Coeur d'Alene River in Northern Idaho, part of the Bunker Hill Mining and Metallurgical Complex Superfund Site ("the Bunker Hill Superfund Site", or "the Site"). The Site includes mining-contaminated areas of the Coeur d'Alene River corridor, adjacent floodplains, downstream water bodies, tributaries, and fill areas, as well as the 21-mile square mile Bunker Hill "Box" that is located in the area surrounding historical smelting operations.

USEPA is the lead agency for the Bunker Hill Superfund Site and has identified three Operable Units (OUs) at the Site: the populated areas of the Bunker Hill Box (OU 1); the non-populated areas of the Box (OU 2); and mining-related contamination in the broader Coeur d'Alene Basin exclusive of the Box (OU 3). The Coeur d'Alene River Basin includes the Upper Basin watershed (which comprises areas surrounding the South and North Forks of the Coeur d'Alene River), the Lower Basin watershed (which comprises the area around the main stem of the river), Coeur d'Alene Lake, and a portion of the Spokane River where Coeur d'Alene Lake drains into Washington State (Figure 1).

This Proposed Plan addresses the Upper Basin of the Coeur d'Alene River (referred to in this Proposed Plan as "the Upper Basin"), which includes the areas of mining-related contamination along the South Fork Coeur d'Alene River (SFCDR), its tributaries downstream to one mile west of the confluence of the South and North Forks of the river, and the Box (Figure 1). The SFCDR portion of the Upper Basin watershed is the area of historical mining and industrial activities and the primary source of downstream metals contamination. The North Fork portion, although part of the Upper Basin watershed, is not included in this Proposed Plan because it has been affected by mining activities to a much lesser degree and is being addressed by other (non-USEPA) agencies, primarily the U.S. Forest Service (USFS).

The purpose of this Proposed Plan is to provide background information, describe USEPA's Preferred Alternative and the reasons why it has been chosen, and summarize the other cleanup alternatives considered for the Upper Basin. The public is encouraged to review and comment on the Preferred Alternative and on all the cleanup alternatives described in this Plan and associated documents. Details of where to review the documents in the Administrative Record, send comments, and attend the upcoming Public Meeting and Open House to discuss this Proposed Plan are provided on page i.

Following public review of the Proposed Plan, USEPA will prepare a Record of Decision (ROD) Amendment for the Upper Basin. USEPA has issued several decision documents for the Bunker Hill Superfund Site, mostly focused on remedies to protect human health in the communities, residential areas, and recreational areas, as well as the environment in the Coeur d'Alene Basin. The most recent ROD was issued for OU 3 in 2002. It included a final remedy for protection of human health and an interim remedy for protection of the environment. Over the last 8 years, considerably more knowledge has been gained about the nature and extent of mining-related contamination in the Upper Basin. The Proposed Plan also addresses recommendations from the National Academy of Sciences' evaluation of the ROD for OU 3 (NAS, 2005).



OU = Operable Unit

Figure 1
Study Area Map
Upper Basin Proposed Plan

This Proposed Plan describes a recommended remedy for the Upper Basin, building upon the remedies identified in the previous RODs and the additional information and data obtained since 2002.

USEPA's Preferred Alternative for the Upper Basin consists of long-term cleanup actions to address risks that are still posed to humans and the environment. The Preferred Alternative 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 materials at locations where remedial actions are taken.

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

The Preferred Alternative includes extensive remedial actions along the SFCDR and its tributaries that range from excavation of waste rock, tailings, and sediments to capping and revegetation of waste rock areas, measures to reduce the flow of contaminated groundwater, and collection and treatment of contaminated adit discharges, seeps, and groundwater. Within the Bunker Hill Box, the Preferred Alternative includes various remedial actions to reduce the flow of contaminated groundwater entering the SFCDR. In addition, the Preferred Alternative includes stormwater control actions in residential and community areas in the Upper Basin to protect the existing human health remedies for OUs 1, 2, and 3 and to protect against future tributary flooding and precipitation events.

Following consideration of state agency, Tribal, and public comments, USEPA, in consultation with other government agencies, will select the remedy for the Upper Basin. The remedy will be documented in a ROD Amendment for the Upper Basin. The ROD Amendment will also include a Responsiveness Summary containing responses to comments received during the public comment period for this Proposed Plan.

The Preferred Alternative includes a large number of cleanup actions, and USEPA will develop an Implementation Plan (separately from the ROD Amendment) with input from stakeholders and the community to prioritize these actions. Because the actions will take years to implement and conditions will change over time, USEPA will also use a process called adaptive management to make decisions on prioritization and to update the Implementation Plan as more information becomes available on the effectiveness of initial cleanup actions. USEPA is the lead agency for the Upper Basin cleanup and has developed this Proposed Plan in consultation with the many active stakeholders in the Site. These include (but are not limited to) 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 Idaho Department of Environmental Quality (IDEQ); the Coeur d'Alene and Spokane Tribes; the Washington Department of Ecology; the federal Natural Resource Trustees (the U.S. Fish and Wildlife Service [USFWS], the Bureau of Land Management [BLM], and the USFS); and other interested parties. By issuing this Proposed Plan and holding a public meeting, USEPA is fulfilling the public participation requirements set forth in Section 117(a) of the Comprehensive

Environmental Response, Compensation, and Liability Act (CERCLA) and Section 300.430(f)(2) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

The Proposed Plan summarizes information that can be found in greater detail in the *Draft Final Focused Feasibility Study Report for the Upper Basin of the Coeur d'Alene River, Bunker Hill Mining and Metallurgical Complex Superfund Site* (FFS Report; USEPA, 2010) and other documents contained in the Administrative Record for the upcoming ROD Amendment.

2.0 Site Background

Mining 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. Mining activities were concentrated in the Upper Basin, where BLM, USFS, and others including USEPA and their contractors have identified more than 1,000 mining or milling-related features. As a result of past mining, milling, and smelting practices, substantial portions of the Basin contain elevated concentrations of lead, zinc, cadmium, arsenic, and other metals that are potentially hazardous to human health and the environment.

Within the Upper Basin, elevated concentrations of metals resulted primarily from the discharge or erosion of mill tailings and other mine-generated wastes 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. Tailings were also frequently used as fill materials to build communities upon and for commercial and infrastructure construction projects, while particulates released to the air from smelting operations contained high concentrations of metals and were transported as airborne dust and deposited over a large area.

Because of these historical factors, high concentrations of metals are pervasive in the soil, sediments, surface water, and groundwater in the Upper Basin, posing risks to people, plants, and animals. High blood lead levels in children living in the Basin have been documented for more than 20 years. Migratory birds and mammals have died due to ingestion of lead-contaminated soil and sediments, while contaminated surface water, soil, and sediments have increased mortality and decreased growth and reproduction of various plants and animals, especially fish and waterfowl.

The Bunker Hill Superfund Site was placed on the National Priorities List (NPL) in 1983. Following initial investigation of the Site, cleanup actions began in the late 1980s and have continued to the present time. These actions have been conducted by the mining companies, various state and federal agencies, the Coeur d'Alene and Spokane Tribes, and other entities including the Coeur d'Alene Basin Natural Resource Trustees, in cooperation with other stakeholders and the public.

The three OUs at the Bunker Hill Superfund Site are summarized on page 2-3. As indicated in Figure 2 on the next page, previous Remedial Investigations (RIs) and Feasibility Studies (FSs) have been conducted and RODs issued for all three OUs.

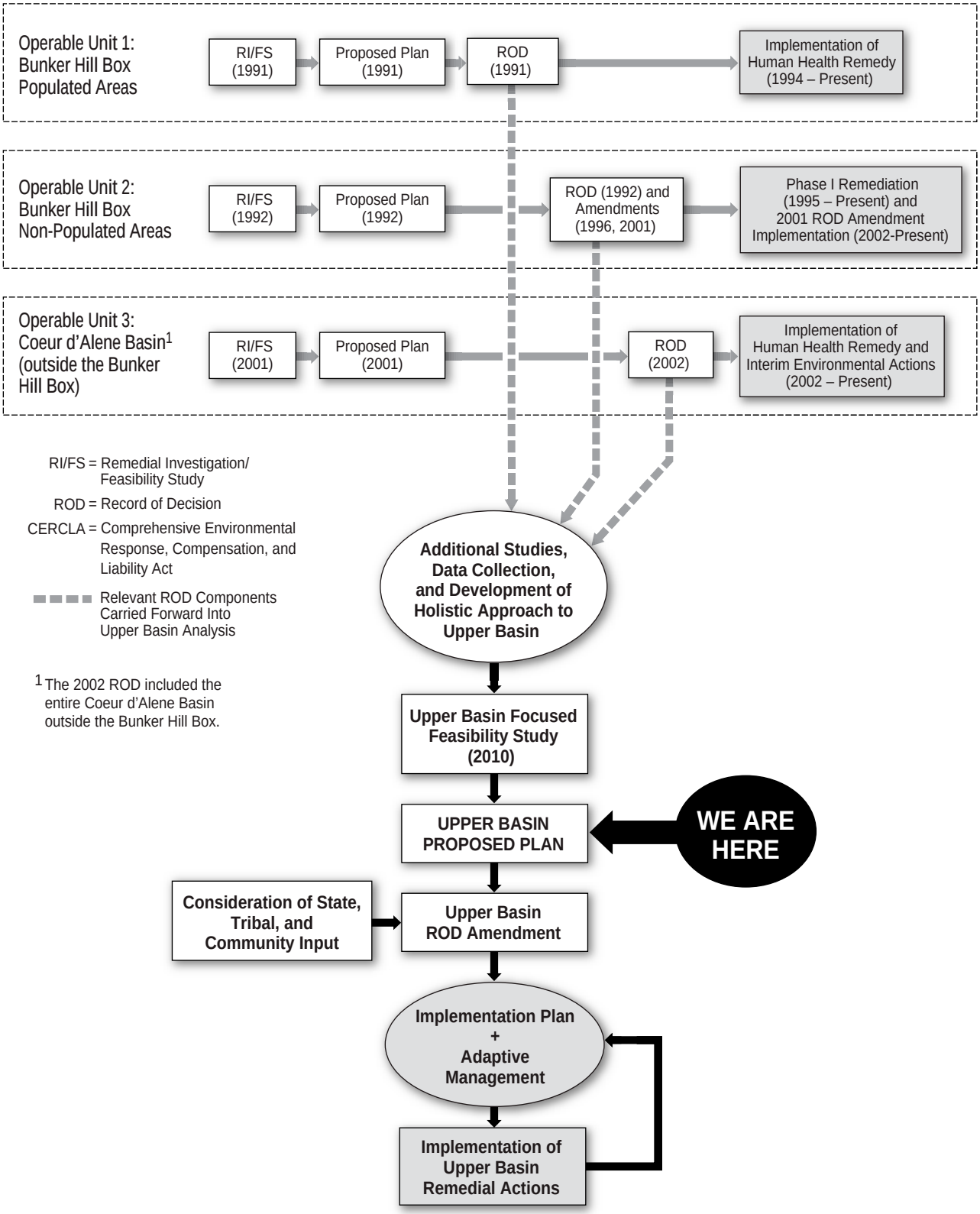


Figure 2
CERCLA Process
Upper Basin Proposed Plan

Bunker Hill Superfund Site Operable Units (OUs)	
OU 1	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. Residences also extend up side gulches and adjacent hillside areas. Populated-area issues of concern include residential yards, house dust, commercial properties, public use areas, and street rights of way.
OU 2	OU 2 includes the *non-populated areas* of the Bunker Hill Box. These 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 the Bunker Hill Box); hillsides, creeks, and gulches; the Central Impoundment Area (CIA) in Kellogg; the Central Treatment Plant (CTP), a water treatment facility in Kellogg for acid mine drainage (AMD) and other metals-contaminated water; and the Bunker Hill Mine with its associated AMD.
OU 3	OU 3 includes all areas of the Coeur d'Alene Basin outside the Bunker Hill Box where mining-related contamination is located. OU 3 extends from near the Idaho-Montana border into the State of Washington, and includes floodplains, communities, lakes, rivers, and tributaries. Pine Creek and the portion of the SFCDR within the Bunker Hill Box are considered part of OU 3.

Substantial progress has been made in implementing the remedies selected in previous decision documents and actions for the OUs, primarily those focused on reducing the risks posed to human health by exposure to mining-related contamination:

- **OU 1:** 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. The ROD for OU 1 (USEPA, 1991a) focused on remediation of lead-contaminated soil in residential areas primarily through removals and partial removals and the installation of protective soil/vegetation barriers. The human health remedy installed by the potentially responsible parties (PRPs) for OU 1 was certified complete in 2008.
- **OU 2:** Phased cleanup activities in OU 2 began in the early 1990s. The ROD for OU 2 (USEPA, 1992) included actions to protect human health in the non-populated areas, commercial areas, and other common-use areas through removals, source control, capping, and other measures. Phase I source control actions for OU 2 are largely complete. Phase I has included removal, containment, and consolidation of extensive contamination from various areas, capping of source areas, demolition of structures, and corresponding public health response actions. This ROD also addressed some OU 1 remedial activities such as rights of way, commercial properties, and house dust.
- **OU 3:** Cleanup activities since the ROD for OU 3 (USEPA, 2002) have primarily focused on implementation of the human health remedy in community and residential areas. Prior to the 2002 ROD, limited removal actions in OU 3 were conducted by EPA and other entities such as the Silver Valley Natural Resource Trustees (SVNRT, now referred to as the Coeur d'Alene Natural Resource Trustees), USFS, IDEQ, and BLM. Implementation of the selected human health remedy for community, residential, and recreational areas in the Coeur d'Alene Basin outside the Box, presented in the ROD for OU 3, is ongoing and nearing completion. USEPA recently received additional funding through the American Recovery and Reinvestment Act of 2009 to accelerate the implementation of remaining human health cleanup activities in OU 3.

The selected human health remedies for OUs 1, 2, and 3 have functioned as designed and are protective of human health. In particular, the cleanup actions have resulted in significant and well-documented declines in children's blood lead levels. An Institutional Controls Program (ICP), administered by the Panhandle Health District, provides a locally enforced set of rules and regulations established to maintain the integrity of installed barriers[2] and to ensure that new barriers are installed during redevelopment that may occur within the administrative boundary of the ICP (described in Section 7.1.4). In OU 2, where a phased program of remedial actions is being conducted, Phase I remedial work is largely complete as noted above. An evaluation of the effectiveness of the Phase I actions has been conducted along with studies to provide the basis for selecting appropriate Phase II actions to address long-term water quality issues.

In addition to selecting a human health remedy for community, residential, and recreational areas within OU 3, the 2002 ROD for OU 3 also selected an interim remedy for protection of the environment that focused on improving water quality, minimizing downstream migration of metal contaminants, and improving conditions for fish and wildlife populations. Because a conscious decision to prioritize human health actions was made, most of the actions to protect the environment have not yet been implemented. However, USEPA has conducted some actions at mine and mill sites that addressed recreational human health as well as ecological exposures.

Remedy implementation in the three OUs has included continued studies, information gathering, monitoring, and assessment of the performance of remedial actions that have provided a greater understanding of conditions and risks in the Upper Basin. The resulting information indicates that it is necessary to augment the established remedies to ensure continued protection of human health and the environment in the Upper Basin.

[2] Barriers are used as components of the human health remedies selected for OUs 1, 2, and 3 to prevent human contact with contaminated materials.

3.0 Site Characteristics

The Upper Basin occupies approximately 300 square miles of land surface in the Panhandle of Northern Idaho. For the purposes of the Proposed Plan, the area includes the SFCDR and tributaries downstream to one mile west of the confluence of the South and North Forks of the river. The Upper Basin is 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 wastes 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 Interstate 90 (I-90).

This section discusses the current and future land uses and resource uses, the nature and extent of contamination, contaminant fate and transport, and principal threat materials in the Upper Basin. Information provided in this section is based on the work documented in the 2001 RI and FS Reports (USEPA, 2001a, 2001b) and the ROD for OU 3 (USEPA, 2002), and incorporates additional study information and monitoring data obtained from 2002 through 2009. Specific sources of data used in the analysis of nature and extent of contamination include the Basin Environmental Monitoring Program (BEMP) for OU 3, the Environmental Monitoring Program (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.

3.1 Land and Resource Uses

The following sections describe current and anticipated future land uses in the Upper Basin and groundwater and surface water use.

3.1.1 Current and Anticipated Future Land Uses

The Upper Basin of the Coeur d'Alene River is located primarily in Shoshone County in the Panhandle of Northern Idaho (Figure 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, 2009]). The majority of these residents live in communities located along the SFCDR, including Kingston, Pinehurst, Smelterville, Kellogg, Wardner, Osburn, Silverton, Wallace, and Mullan.

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, 2001a, 2001b), but its numerous streams still provide abundant recreational opportunities. In 2002, a project to convert a contaminated 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.

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 home sites, 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.

3.1.2 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, approximately 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.)

3.2 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.

3.2.1 Sources and Locations of Mining Wastes

Contaminant sources, as identified by BLM and others are widespread in the Upper Basin, extending up nearly every drainage area (USEPA, 2001a, 2001b). Many 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, 2001b), 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.

- Primary sources:
  - Tailings: 11 million cubic yards

  - Waste rock: 11.7 million cubic yards
  - Adit drainage: 101 pounds of zinc per day
- Secondary sources:
  - Contaminated floodplain sediments: 7.1 million cubic yards
  - Deeper floodplain sediments, road and railroad fill and embankments: 4 to 20 million cubic yards

A significant amount of remediation work has been conducted in the Bunker Hill Box since OU 2 Phase I remedial actions began in 1995. Over 3.3 million cubic yards of contaminated wastes have been removed from the Box and consolidated onsite in engineered closure areas (the Smelter Closure Area [SCA] and Central Impoundment Area [CIA]). The use of geomembrane cover systems on these closure areas effectively prevents exposure to 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, because of USEPA's commitment not to displace the communities, a significant amount of contamination still remains beneath the Bunker Hill Box that is not accessible for removal and capping.

Known source areas and approximate volumes of mining-related contamination within different areas of the Upper Basin are summarized in Table 1. In addition to these known sources, significant contamination is also present beneath developed areas outside the Box, including beneath the town of Wallace. Similar to developed areas within the Box, this material is not accessible for removal.

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 the early 1900s 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. 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 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.

TABLE 1
Known Source Areas and Approximate Volumes of Mining-Related Contamination in the Upper Basin

Watershed	Number of Source Areas	Number of Historical Producing Mines	Number of Historical Mills	Ore Produced (tons)	Tailings Produced [a] (tons)
Upper SFCDR (upstream of Wallace, Idaho)	181	11	7	25,000,000	20,000,000
Canyon Creek	127	21	13	35,000,000	27,000,000
Ninemile Creek	70	8	7	5,000,000	4,100,000
Big Creek	68	4	2	12,000,000	11,000,000
Moon Creek	14	2	1	5,600	4,000
Pine Creek	131	14	10	3,200,000	2,500,000
Mainstem SFCDR (not including the Bunker Hill Box)	174	25	4	9,800,000	9,400,000
Bunker Hill Box	NA	NA	15	48,000,000	No estimate
Total	**765**	**85**	**59**	**167,000,000**	**74,000,000**

Source: RI and FS Reports for the Coeur d'Alene Basin (USEPA, 2001a and 2001b respectively).

[a] Estimated tailings generated from ore produced in each watershed were not necessarily disposed of within the watershed where the ore was mined. An estimated 62 million tons of tailings have been discharged to the Basin since mining began.

SFCDR = South Fork Coeur d'Alene River
USEPA = U.S. Environmental Protection Agency

NA = not available

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). Direct discharge of tailings to the Basin did not cease until 1968.

3.2.2 Types of Contamination and Affected Media

The contaminants of concern (COCs) for the Upper Basin include arsenic, cadmium, lead, mercury, and zinc, with cadmium, lead, and zinc affecting all of the environmental media in the Basin (soil, sediments, surface water, and groundwater). Contaminant releases within the Upper Basin are controlled primarily by the movement of surface water and groundwater within the environmental system. Dissolved zinc in surface water and groundwater and total (or particulate) lead in surface water are used as indicators to identify potential sources resulting in negative effects on SFCDR water quality; other COCs have been discussed in detail in other documents (USEPA, 2001a, 2001b).

Dissolved zinc is considered an appropriate indicator for dissolved metals in surface water and groundwater because it is the most ubiquitous of the metals; it occurs at the highest concentrations; it is relatively mobile compared to other metals; and dissolved metals (particularly cadmium) appear well correlated with dissolved zinc throughout the Upper Basin (USEPA, 2001b). Zinc is widely distributed in the environment, and SFCDR site-specific ambient water quality criteria (AWQC) for zinc (see below) are exceeded throughout the Upper Basin, generally at levels toxic to aquatic organisms. The sulfide mineral sphalerite is the primary mineral form of zinc. As one of the most mobile of the heavy metals, zinc is readily transported in most natural waters and can occur in both suspended and dissolved forms in surface water.

Lead is used as an indicator for total metals because it is the primary COC for the Upper Basin (described later in Section 5.2.1) and because it is found in nature as a component of various minerals (for example, galena, cerussite, and anglesite). Lead is a stable metal in most environments and generally shows a very limited solubility; therefore, a significant fraction of lead that is present in the SFCDR and its tributaries is expected to be in an undissolved form, as particulate lead. Total lead is considered representative of suspended metals in surface water.

3.3 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 RI/FS for the Coeur d'Alene Basin (USEPA, 2001a, 2001b) and the 2002 ROD for OU 3 (USEPA, 2002). 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; and
- Sources and mechanisms for releases of contaminants to surface water and groundwater

This section includes discussions of surface water quality 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 the Bunker Hill Box).

3.3.1 Surface Water Quality

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 3.

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 OUs 1 and 2 (in the Bunker Hill Box) and OU 3. Additional monitoring data have been collected as part of the OU 2 EMP and the OU 3 BEMP (focused on evaluating long-term trends), the Coeur d'Alene Basin Remedial Action Monitoring Program (assessing the effects of remedial actions in specific areas), and site-specific studies (such as evaluating water quality during high-flow and low-flow conditions, groundwater-surface water interactions, and daily changes in stream chemistry).

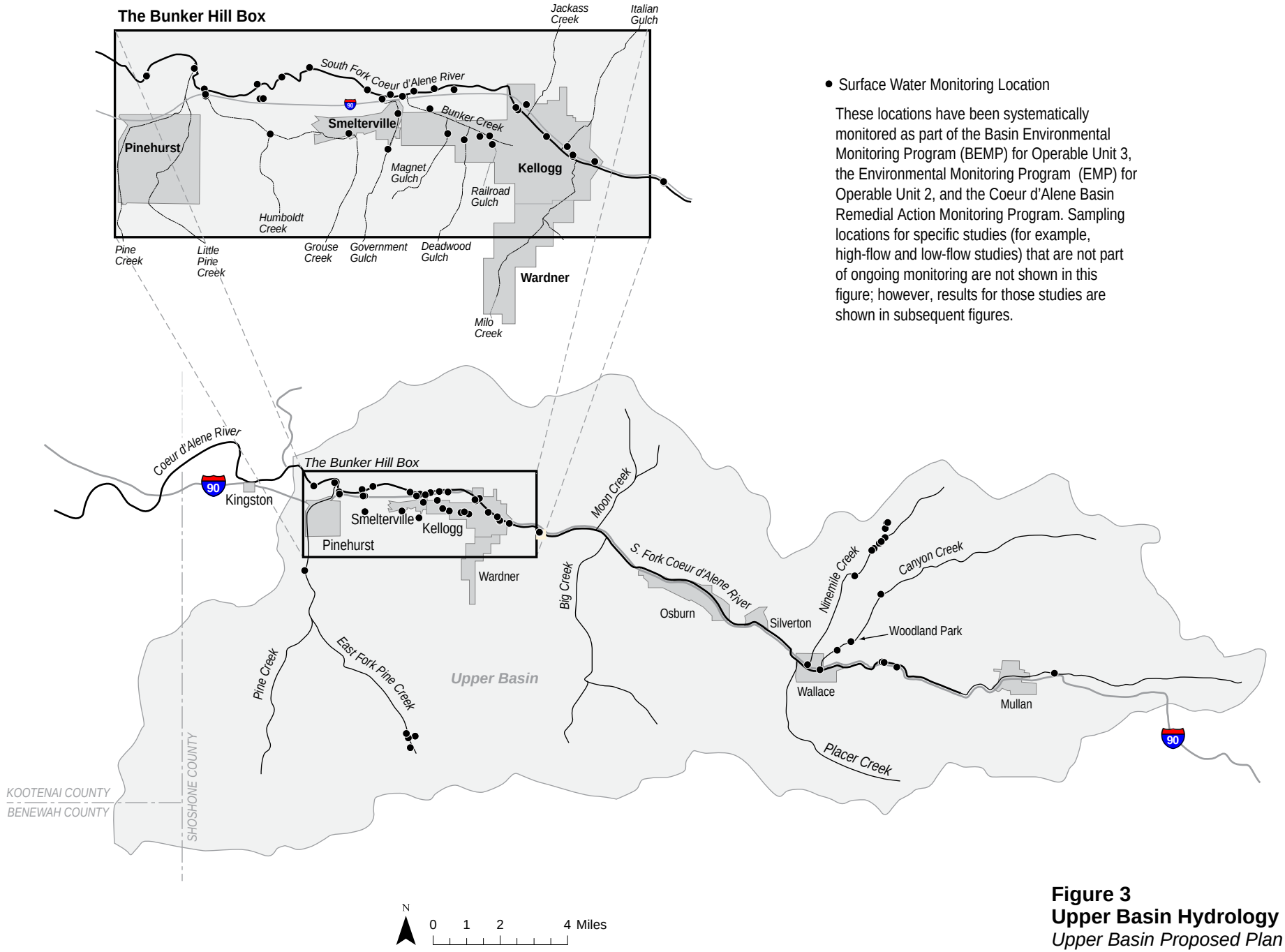
For evaluating dissolved zinc as an indicator of surface water quality, site monitoring data were used to calculate site-specific AWQC ratios. Site-specific AWQC for cadmium, lead, and zinc for ecological protection of the SFCDR basin were developed by the State of Idaho and have been adopted by USEPA (IDAPA 58.01.02.284). Reference to AWQC in this Proposed Plan refers to these standards.

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 discharges (USEPA, 2004). AWQC are based on measured or calculated hardness, which varies by location and sampling event.[3] Because hardness varies by sampling location and the conditions during sampling, calculated AWQC values for dissolved zinc are sample-specific.[4]

Figure 4 shows the distribution of AWQC ratios at selected locations for different key time periods. The locations were selected because they enable a focused analysis of Basin conditions and provide 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 4 uses box plots (in the upper portion of the figure) to group the data by each time period for each location, and scatter plots

[3] The site-specific AWQC for zinc is a function of water hardness and is calculated using the following formula: $AWQC = e^{(0.6624 * \ln(hardness) + 2.2235)}$.

[4] For evaluating AWQC and AWQC ratios, surface water grab samples that have been analyzed for dissolved metals, including calcium and magnesium, are used to calculate sample-specific hardness values.



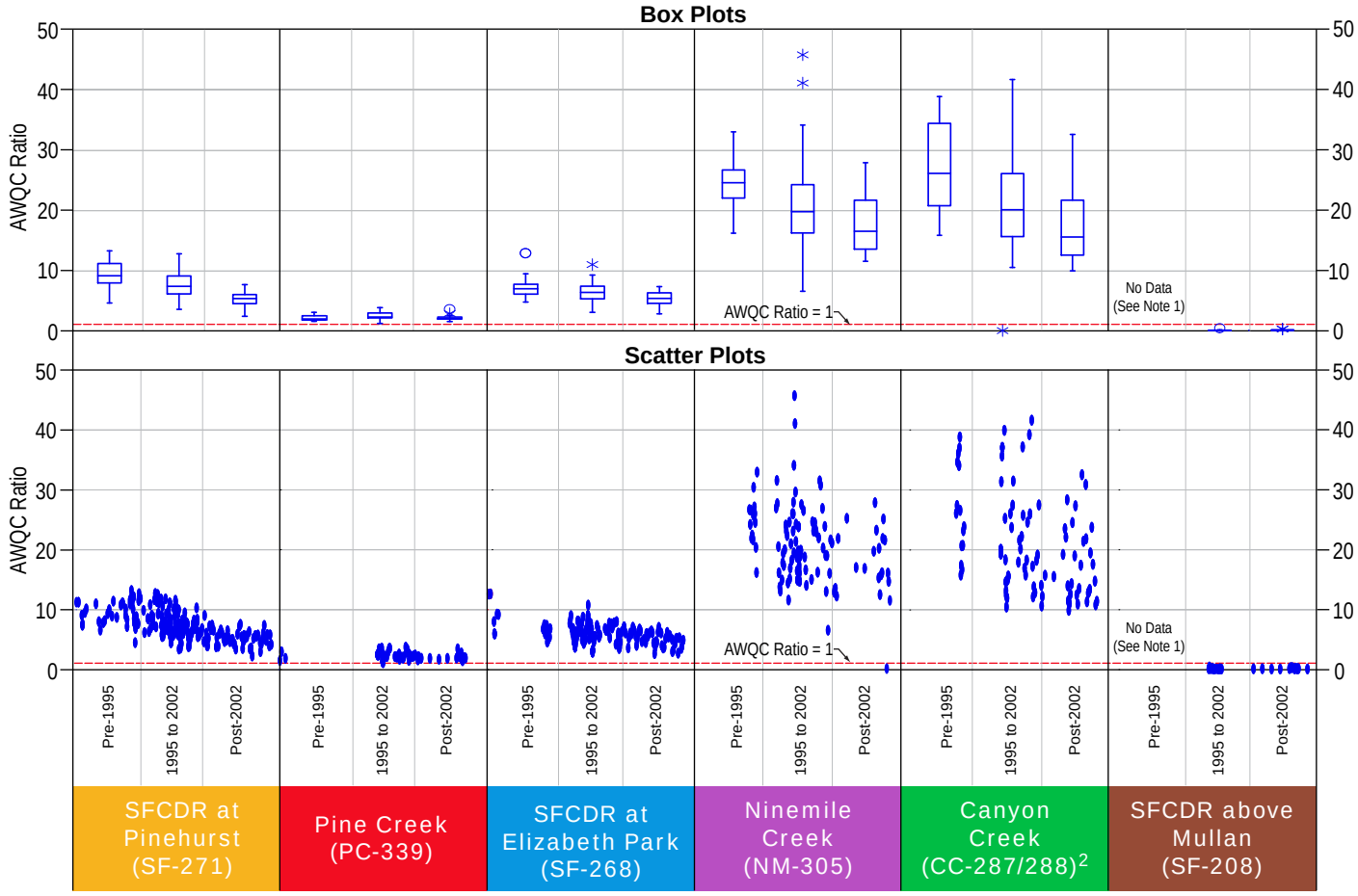
- Surface Water Monitoring Location

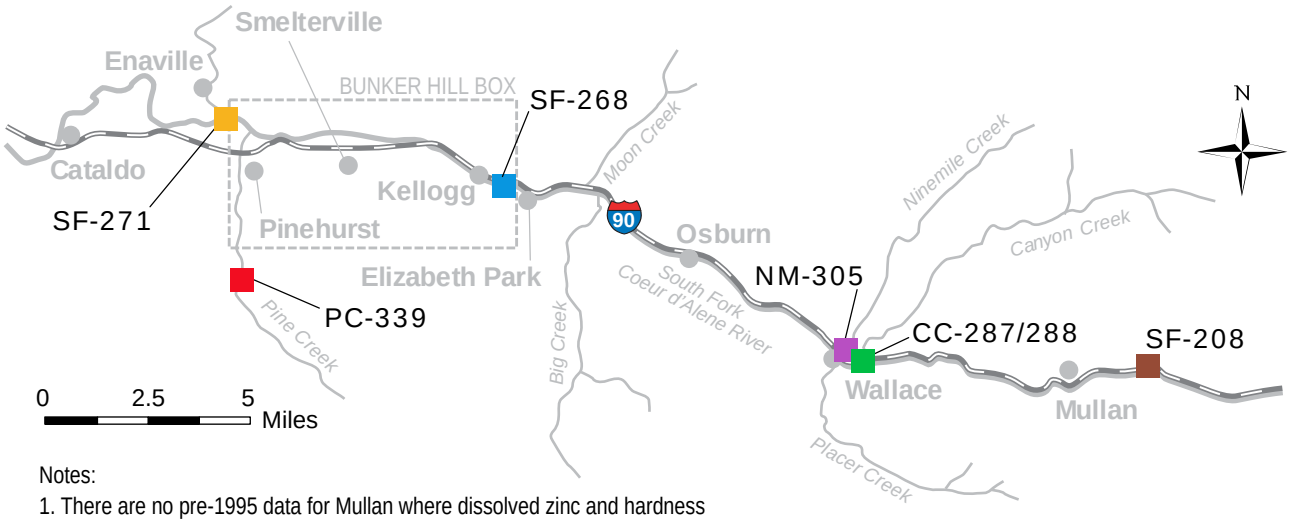
These locations have been systematically monitored as part of the Basin Environmental Monitoring Program (BEMP) for Operable Unit 3, the Environmental Monitoring Program (EMP) for Operable Unit 2, and the Coeur d'Alene Basin Remedial Action Monitoring Program. Sampling locations for specific studies (for example, high-flow and low-flow studies) that are not part of ongoing monitoring are not shown in this figure; however, results for those studies are shown in subsequent figures.

Figure 3
Upper Basin Hydrology
Upper Basin Proposed Plan

How to Read the Box Plots

The box plot shows the median or 50th percentile (the line in the middle of the box), along with the 25th and 75th percentiles (the top and bottom of the box), and the range (the 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.

AWQC = Ambient Water Quality Criteria
SFCDR = South Fork Coeur d'Alene River
Pre-1995 = 9/15/1987 to 9/15/1995
Post-2002 = 10/2002 to present

Figure 4
Zinc AWQC Ratio Distribution in Surface Water at Selected Sites
Upper Basin Proposed Plan

(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 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), cessation of direct discharge of mine water and mine tailings to the river, and some degree of natural source depletion.

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 5 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 6 shows the same data specifically for the Bunker Hill Box. Figure 5 also displays the discrete source areas located within the Upper Basin.

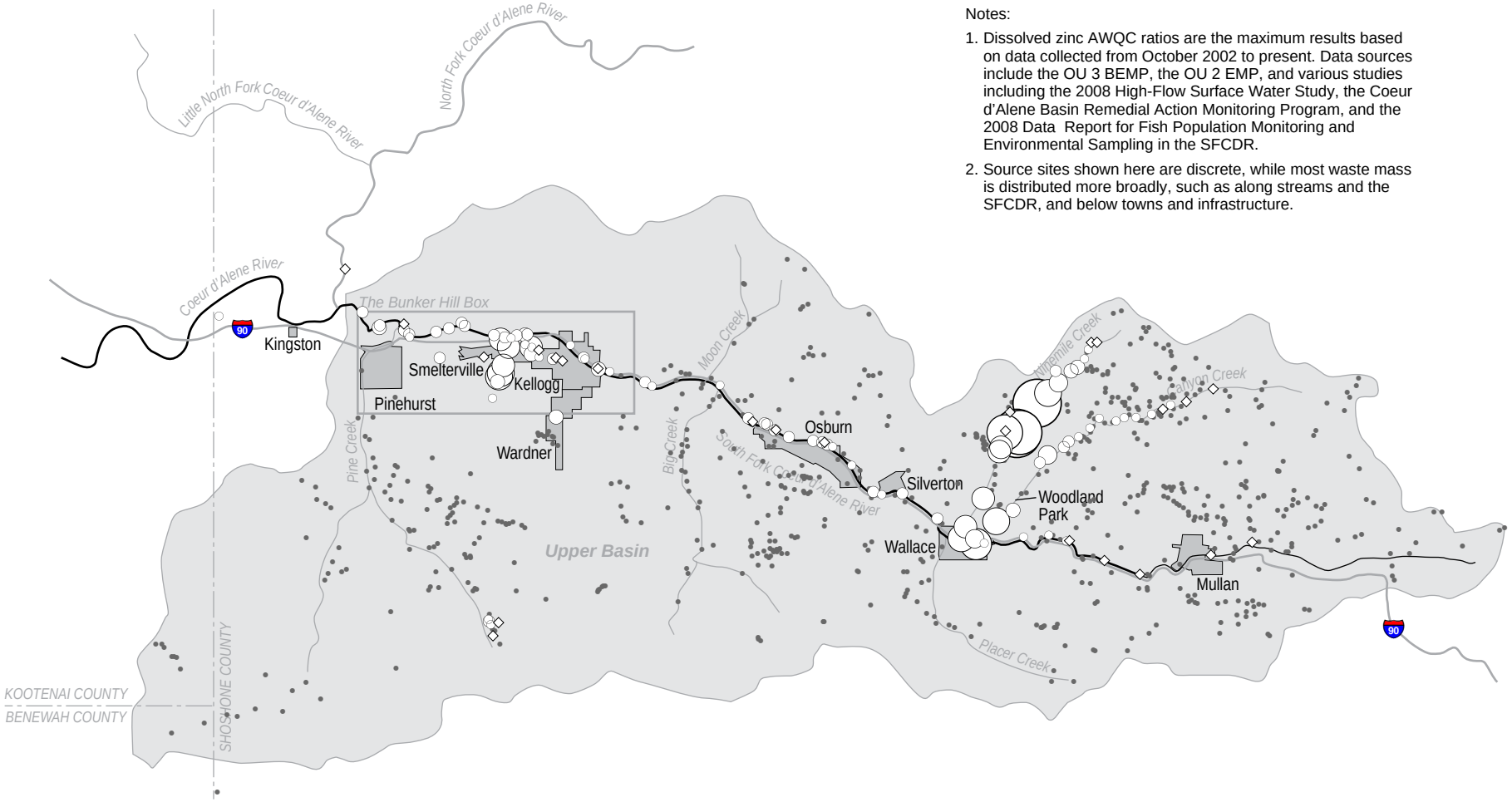
The most contaminated areas upstream of the Box include Canyon Creek, Ninemile Creek, and the mainstem SFCDR downstream of Mullan. AWQC ratios have historically been, and continue to be lowest in the SFCDR upstream of Mullan, above significant past mining activities. The most contaminated streams within the Bunker Hill Box 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 because the Bunker Hill Mine owner is not in compliance with an order from USEPA to capture and treat all discharges from the mine. Milo Creek is the only surface water body in the Box where surface water quality was worse following OU 2 Phase I remedial actions because the AMD release began after Phase I remedial actions were implemented.

As indicated in Figure 5, 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 (e.g., Big Creek and Pine Creek) as compared to the most contaminated areas noted above. 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 these sources, 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

Notes:

1. Dissolved zinc AWQC ratios are the maximum results based on data collected from October 2002 to present. Data sources include the OU 3 BEMP, the OU 2 EMP, and various studies including the 2008 High-Flow Surface Water Study, the Coeur d'Alene Basin Remedial Action Monitoring Program, and the 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.



AWQC Ratios

◇	< 1
○	5
◯	20
◯	50
◯	75

Representative Values

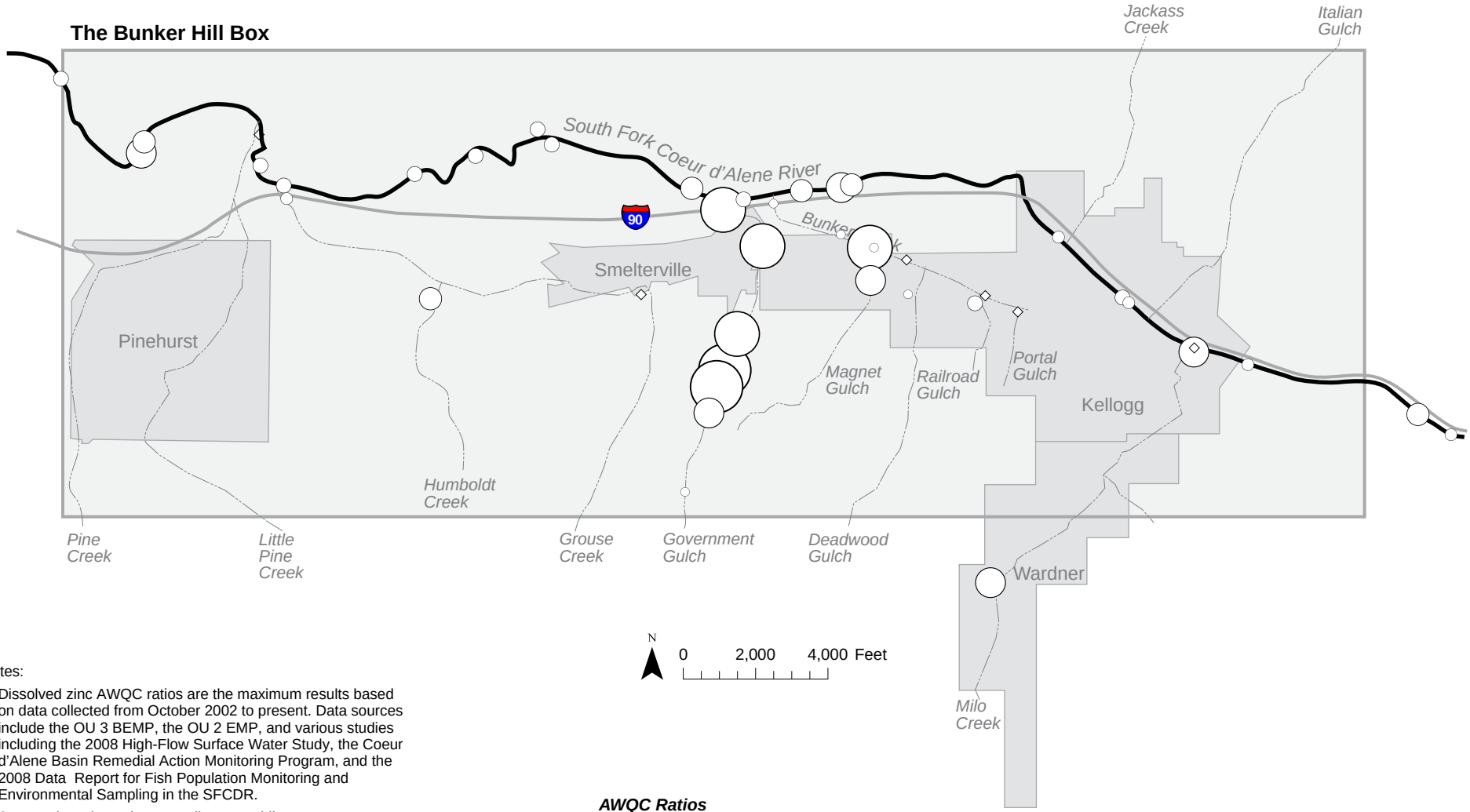
AWQC = Ambient Water Quality Criteria
BEMP = Basin Environmental Monitoring Program
EMP = Environmental Monitoring Program
OU = Operable Unit
SFCDR = South Fork Coeur d'Alene River

• Source Site

N

0 1 2 4 Miles

Figure 5
Maximum Upper Basin Zinc AWQC Ratios in Surface Water, Post-2002
Upper Basin Proposed Plan



Notes:

1. Dissolved zinc AWQC ratios are the maximum results based on data collected from October 2002 to present. Data sources include the OU 3 BEMP, the OU 2 EMP, and various studies including the 2008 High-Flow Surface Water Study, the Coeur d'Alene Basin Remedial Action Monitoring Program, and the 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.

AWQC = Ambient Water Quality Criteria
BEMP = Basin Environmental Monitoring Program
EMP = Environmental Monitoring Program
OU = Operable Unit
SFCDR = South Fork Coeur d'Alene River

AWQC Ratios

◇	<1
○	2
○	8
○	16
○	25

Representative Values

Figure 6
Maximum Bunker Hill Box Zinc AWQC Ratios in Surface Water, Post-2002
Upper Basin Proposed Plan

uncertainty than those collected under low-energy, low-flow conditions when fewer lead-bearing particulates are typically transported. Figure 7 shows data from Station SF-271 at Pinehurst (near the confluence of the North and South Forks of the Coeur d'Alene River) from 2000 to 2009. 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 to Upper Basin surface water.

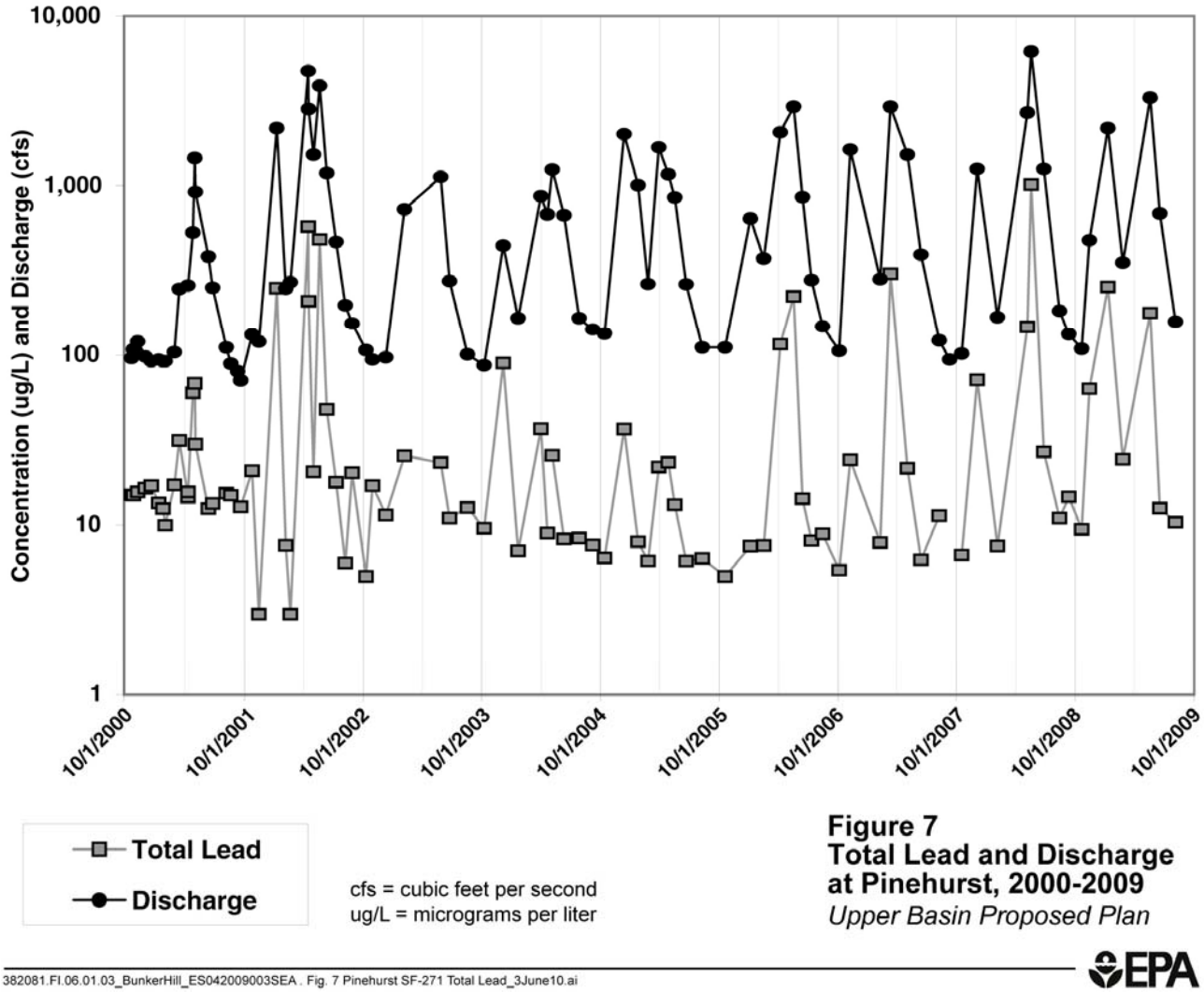
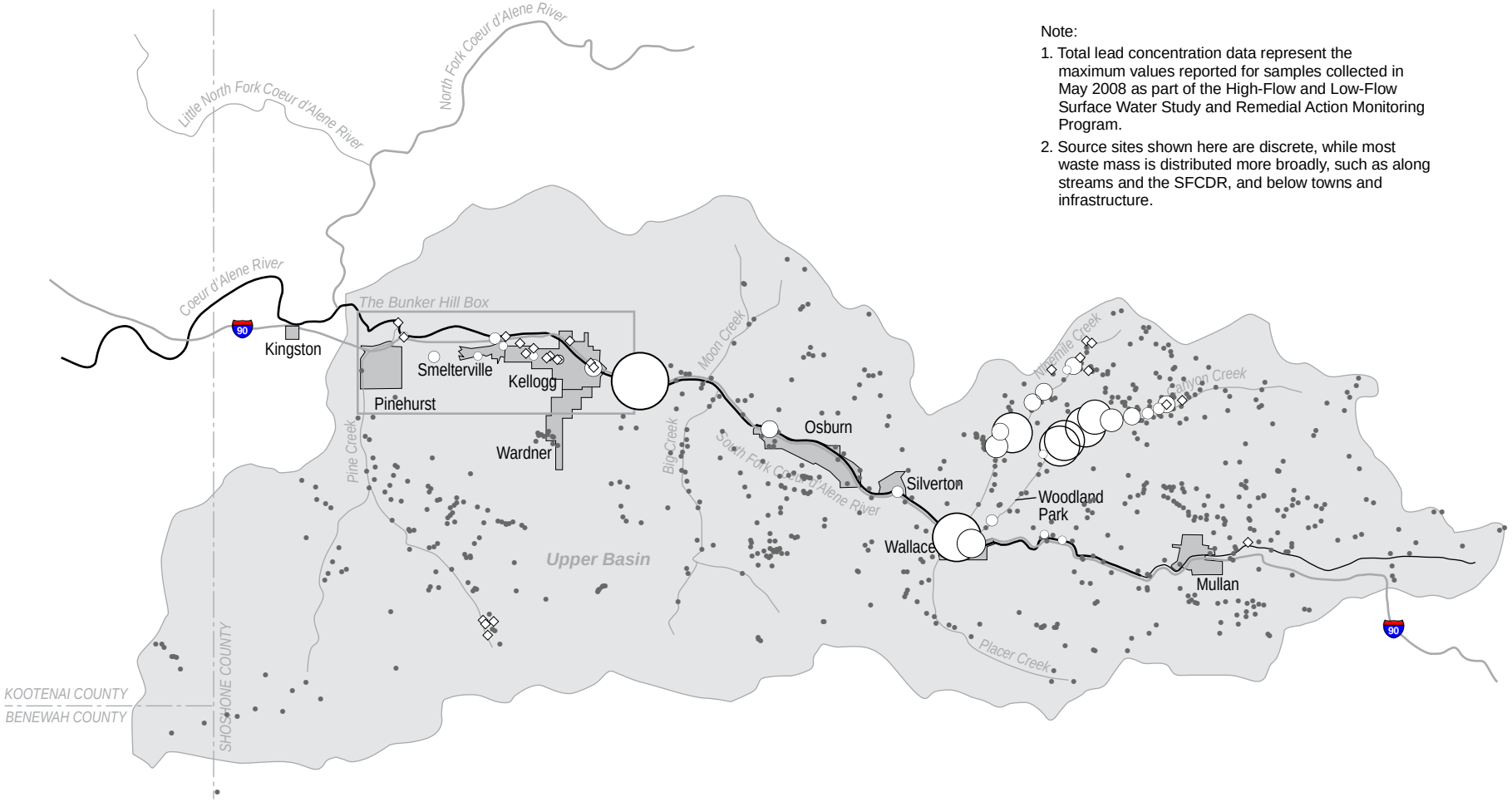


Figure 7
Total Lead and Discharge at Pinehurst, 2000-2009
Upper Basin Proposed Plan

382081.FI.06.01.03_BunkerHill_ES042009003SEA . Fig. 7 Pinehurst SF-271 Total Lead_3June10.ai

Figure 8 shows a map view of total lead in surface water during high-flow conditions in May 2008.[5] Total lead concentrations upstream of OU 2 are highest in Canyon Creek and Ninemile

[5] 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, 2009c) and the Coeur d'Alene Basin Remedial Action Monitoring Program.



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.

Total Lead Concentration

Representative Values (ug/L)

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

SFCDR = South Fork Coeur d'Alene River
ug/L = micrograms per liter

• Source Site

N

0 1 2 4 Miles

Figure 8
Upper Basin Total Lead Concentrations in Surface Water, May 2008
Upper Basin Proposed Plan

EPA

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.

3.3.2 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.

The City of Kingston maintains a municipal production well in the lower aquifer downstream from the confluence of the SFCDR and the North Fork, and the City of Pinehurst maintains a municipal production well in the lower portion of the Pinehurst aquifer. Water quality in these areas has historically been of high quality and free of contamination and, while these areas are technically hydraulically connected to the lower aquifer in the Bunker Hill Box, they are not considered threatened by conditions within the Box. There are no municipal supply wells in the Bunker Hill Box. With the exception of the area immediately surrounding Pinehurst in the Pine Creek Watershed, groundwater quality in the shallow (or upper) aquifer of the Upper Basin has been affected to the point that it is not suitable for domestic or municipal use in many areas.

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.
- 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 the Bunker Hill Box. 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 3). Dissolved zinc concentrations in groundwater during October 2008 in the Woodland Park aquifer are shown in Figure 9. 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

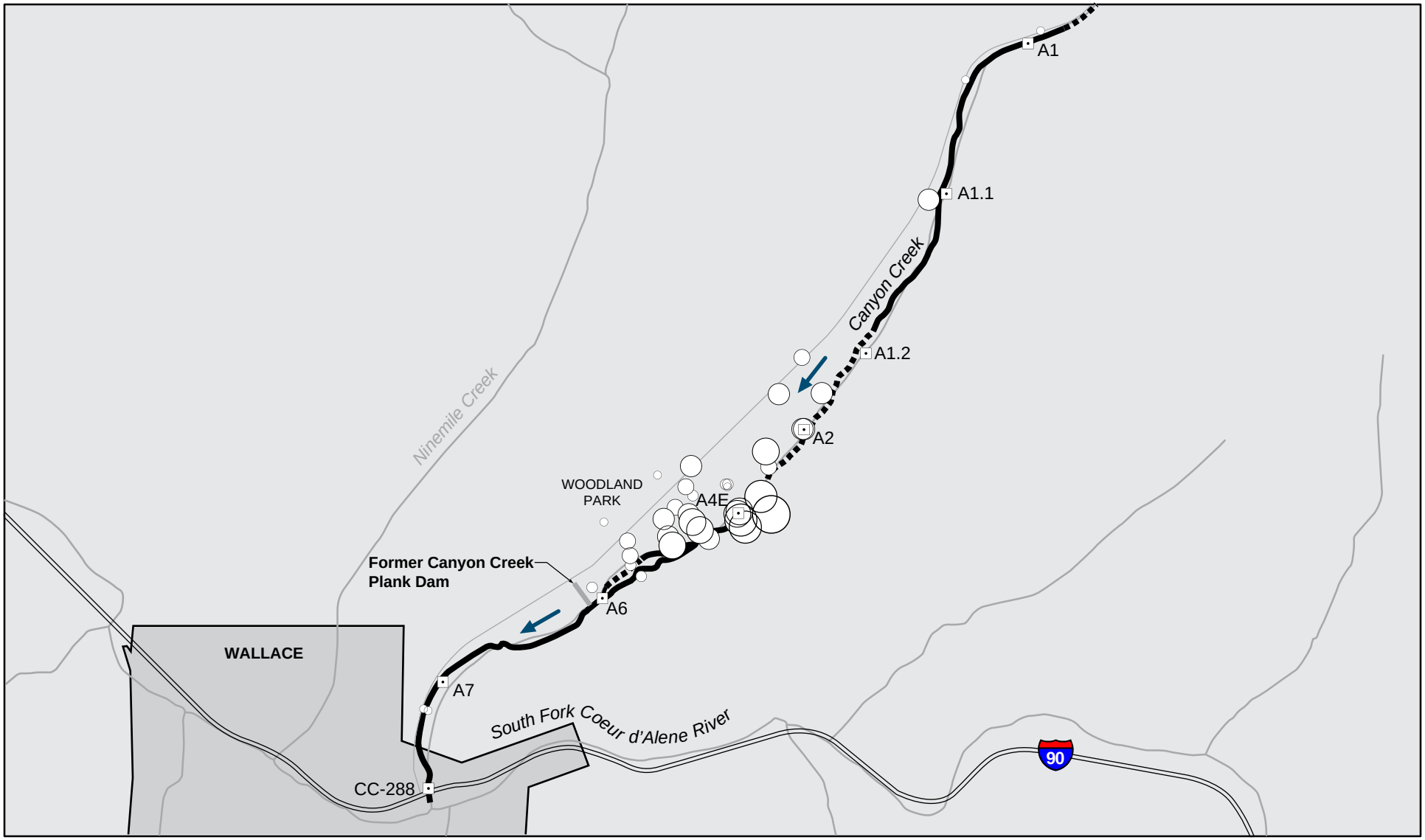
Osburn Flats is located along the SFCDR in Osburn. Concentrations of dissolved zinc in Osburn Flats groundwater in October 2008 are shown in Figure 10. In general, higher dissolved zinc concentrations were found in the area upstream (or east) of McFarren Gulch, which is near the historical location of 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.

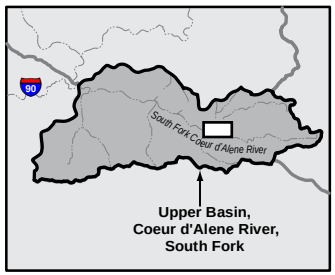
A study of metals loading to the SFCDR in Osburn Flats under low-flow conditions in September 2008 determined that the surface water load of dissolved zinc increased due to groundwater discharge from the area under the former Osburn Plank Dam, resulting in an increase in dissolved zinc concentrations in the SFCDR (CH2M HILL, 2009d). 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, 2009b). The largest increases in dissolved zinc concentrations in surface water occurred in the primarily gaining reach from Station B3 to Station B5-ALT.

Bunker Hill Box

In most of the Upper Basin there is a single aquifer, but in the Bunker Hill Box and downstream there are both upper and lower alluvial aquifers. The upper aquifer exists in alluvial materials in the SFCDR valley and a lower, confined aquifer exists throughout most of the Box. The shallow upper aquifer in the Box has more contamination than the lower aquifer because of the surface water and groundwater interaction with the SFCDR.

Concentrations of dissolved zinc in the upper aquifer of the Bunker Hill Box groundwater under low-flow conditions in October 2008 are presented in Figure 11. In general, the highest concentrations of dissolved zinc in groundwater in the Bunker Hill Box 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.





Dissolved Zinc Concentrations October 2008 (mg/L)

Representative Values

- 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 Groundwater Flow Direction, Base-Flow Conditions

mg/L = milligrams per liter

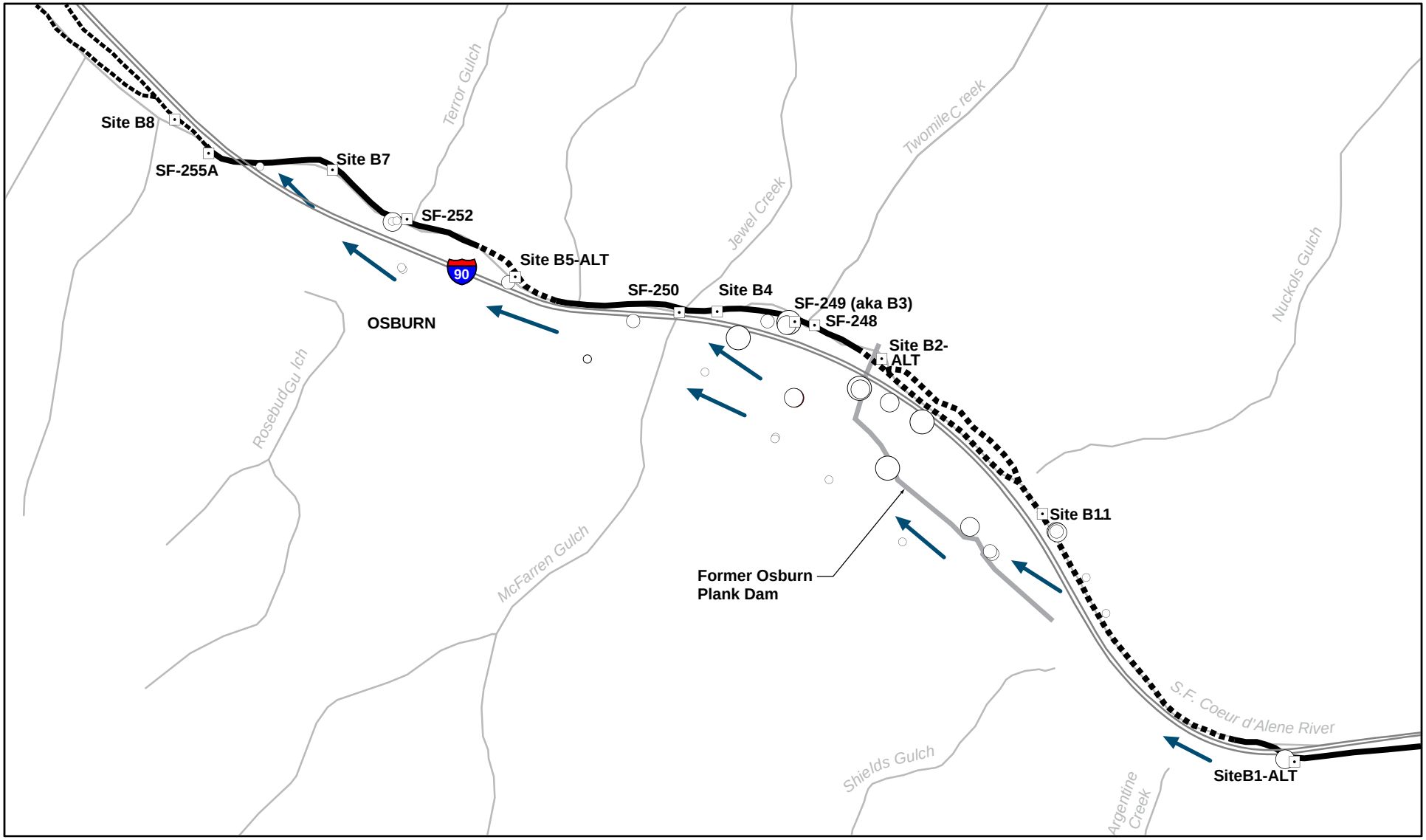
Note:
Gaining and losing reaches were determined from low-flow numerical simulation results, and are presented as approximate conditions during low-flow conditions.

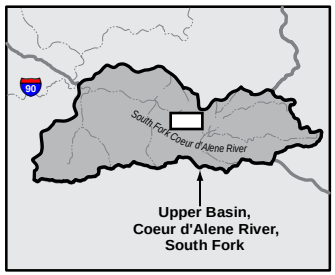
N

0 1,000 2,000 Feet

Figure 9
Dissolved Zinc Concentrations in Groundwater and Hydrogeology at Woodland Park
Upper Basin Proposed Plan

EPA





Dissolved Zinc Concentrations October 2008 (mg/L)

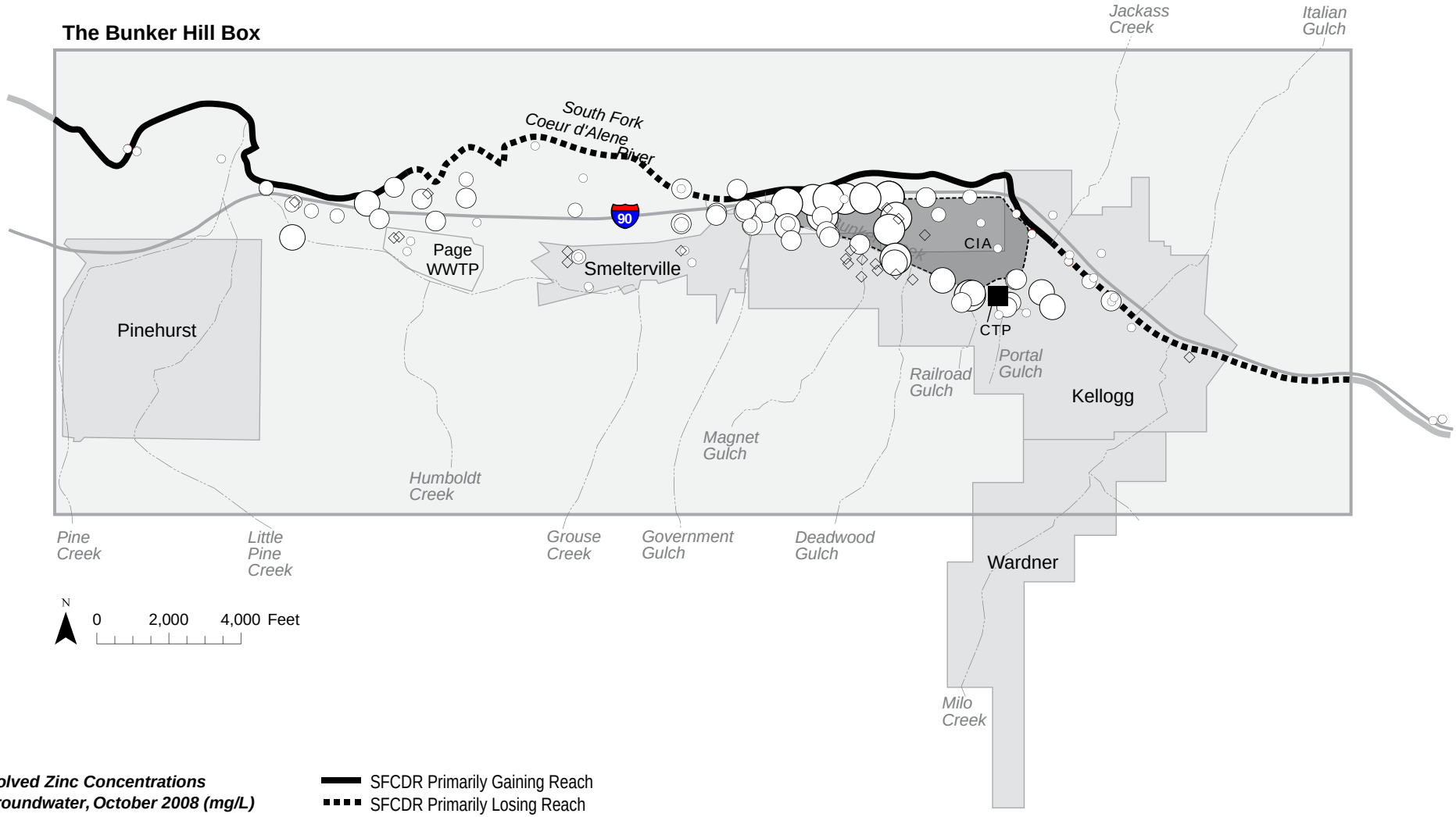
0.5
1
2
3
Representative Values

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

mg/L = milligrams per liter
SFCDR = South Fork Coeur d'Alene River

N
0 1,000 2,000 Feet

Figure 10
Dissolved Zinc Concentrations in Groundwater and Hydrogeology at Osburn Flats
Upper Basin Proposed Plan



Dissolved Zinc Concentrations in Groundwater, October 2008 (mg/L)

- ◇ Nondetect
- 1
- 4
- 8
- 15
- 25

SFCDR Primarily Gaining Reach
SFCDR Primarily Losing Reach

Notes:

CIA = Central Impoundment Area
CTP = Central Treatment Plant
SFCDR = South Fork Coeur d'Alene River
WWTP = Wastewater Treatment Plant
mg/L = milligrams per liter

Figure 11
Dissolved Zinc Concentrations in Groundwater in the Bunker Hill Box
Upper Basin Proposed Plan

The groundwater-surface water interaction within the Bunker Hill Box is significant in terms of the volume exchanged and its water quality impact on the SFCDR. The eastern (upstream) gaining reach in the Box (see Figure 11) is located near the CIA which 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 the Box, dissolved zinc loads in surface water increase (Figure 11). This increase is driven by the large volumes of contaminated groundwater discharging to surface water, and not by greatly elevated dissolved zinc concentrations measured in the SFCDR. As noted earlier, dissolved zinc concentrations in the western portion of the Bunker Hill Box are considerably lower than those in the eastern portion of the Box.

3.4 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 *Code of Federal Regulations* (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 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

USEPA developed the PTM concentrations based upon an evaluation of the acute toxicity of contaminants of concern at the Bunker Hill Superfund Site (USEPA. 1991c).

The 1996 ROD Amendment for OU 2 (USEPA, 1996) 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.

3.5 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, actions that EPA has committed not to take. Contaminant contributions from groundwater to the SFCDR within OU 2 remain relatively large and have a large negative impact on SFCDR water quality.

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 relatively extensive 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 Site media include arsenic, cadmium, lead, mercury, and zinc.
- Surface water meets, or is close to, AWQC upgradient from mine waste 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 the Bunker Hill Box), 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 is severely affected and contributes to surface water contamination.
- PTM are not expected to be encountered during cleanup conducted in the Upper Basin; however, if additional materials that meet the definition of PTM are found, these materials would be managed in a manner that is protective of human health and the environment and consistent with the NCP.

4.0 Scope and Role of Response Actions

USEPA will prepare a ROD Amendment to document the selection of the amended remedy for the Upper Basin, after consideration of agency and public comments on this Proposed Plan. As previously noted, USEPA developed the Proposed Plan and its supporting documents in consultation with many stakeholders, including the Basin Commission Project Focus Teams and other community meetings. This Plan identifies USEPA's Preferred Alternative based on the evaluations conducted during the FFS. The Upper Basin ROD Amendment will update and add to previous cleanup plans described in the RODs for OUs 1, 2, and 3 and related decision documents. In particular, the Upper Basin ROD Amendment will select 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 materials at locations where remedial actions are taken.

The remedy selected in the Upper Basin 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 selected in the Upper Basin 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 additional actions are needed or would be effective in meeting drinking water standards. If further actions would not be effective, a Technical Impracticability waiver may be warranted at specific locations where groundwater does not achieve drinking water standards.[6]

USEPA believes that the Preferred Alternative identified in this Proposed Plan is necessary to protect public health and the environment from actual or threatened releases of hazardous substances into the environment.

4.1 Geographic Scope of Response Actions

Figure 12 shows the relationship of actions to be included in the Upper Basin ROD Amendment to complete Coeur d'Alene Basin-wide remedy implementation. As indicated in the figure, mine wastes and waste-impacted media in several areas of the Coeur d'Alene Basin will not be addressed at this time, including the Lower Basin, although water quality improvements resulting from Upper Basin cleanup actions will improve surface water quality in these areas. Because of the significant recontamination potential in the Lower Basin due to flooding and other issues, USEPA is conducting studies to evaluate Lower Basin contaminated sediment transport issues. USEPA will consider recontamination potential and other site-specific

[6] Specific ARARs can be waived if appropriately justified [40 CFR 300.430(f)(1)(ii)(C)].

Area	Operable Unit(s)	Included in Past Decision Documents?	Included in Forthcoming Upper Basin ROD Amendment?
Bunker Hill Box	1 & 2	☑ Human health remedies in residential and community areas, selected in the 1991 ROD, have been implemented.	☑ Additional actions to protect the existing human health remedies.
		☑ Phase I remedial actions have been implemented since the 1992 ROD.	☑ Phase II remedial actions to reduce metals loading to the SFCDR to protect human health and the environment.
Upper Basin (outside the Bunker Hill Box)	3	☑ Human health remedies in residential and community areas, selected in the 2002 ROD, are being implemented.	☑ Additional actions to protect and enhance the existing human health remedies.
		☑ Relatively few interim ecological actions have been implemented since the 2002 ROD.	☑ Final actions to protect human health and the environment by achieving surface water quality standards and providing a final remedy for soil and sediments where actions are taken.
Lower Basin	3	☑ Human health remedies for recreational areas, selected in the 2002 ROD, have been implemented.	Will not be included in the Upper Basin ROD Amendment.
		☑ Pilot-scale actions have been implemented since the 2002 ROD. An Enhanced Conceptual Site Model is being developed, which will be used to inform the selection, design, and implementation of remedial actions.	
Spokane River	3	☑ Human health remedies for recreational areas, selected in the 2002 ROD, have been implemented.	
Coeur d'Alene Lake	3	Coeur d'Alene Lake is being managed by state, tribal, federal, and local governments outside the Superfund process through the Lake Management Plan.	

ROD = Record of Decision
SFCDR = South Fork Coeur d'Alene River

Figure 12
Relationship of Preferred Alternative to Complete Remedy Implementation
Upper Basin Proposed Plan

information prior to making or implementing remedy decisions on projects in the Lower Basin that may be significantly impacted by future flooding events. The primary focus of remedial actions implemented to date in the Lower Basin has been human-health-focused cleanup actions (in residences, recreational areas, and other common use areas) and a clean waterfowl feeding area project. 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. This improved understanding of Lower Basin sediment transport processes is essential to the evaluation of the complex remedial actions necessary to address contaminated sediments. USEPA is continuing to support data collection and analysis efforts in the Lower Basin to provide an improved understanding of sediment transport and deposition in the Lower Basin and to support the evaluation of specific remedial alternatives.

In the near term, the focus of continued work in the Lower Basin will be to fill data gaps and to finalize and refine an Enhanced Conceptual Site Model (ESCM), including sediment transport modeling that will help guide effective decisionmaking regarding future remedial actions in the Lower Basin. The ESCM represents an updated working hypothesis of the Lower Basin based upon computational modeling, data collection, and studies that have been performed since the 2001 FS Report for the Coeur d'Alene Basin was issued (USEPA, 2001b). The intent of this work is to develop a better understanding of the physical processes that drive the mobilization and transport of sediments, especially those processes related to river hydraulics, sediment transport, and geomorphology. These processes play key roles in the movement of sediment and lead contamination into, within, and from the Lower Basin. A better understanding of these processes will enable USEPA to examine appropriate remedies for ecological protection in the Lower Basin. As with the Upper Basin, the Lower Basin work will likely include review of the remedial actions identified in Ecological Alternatives 3 and 4 in the 2001 FS Report with a view to USEPA's anticipated issuance of a future ROD Amendment for the Lower Basin.

In addition to the Lower Basin, other areas not within the geographic scope of the FFS are:

- the North Fork Coeur d'Alene River watershed, which is not included because it has been less seriously impacted by mining activities and is being addressed under CERCLA by other (non-USEPA) agencies, primarily USFS;
- Coeur d'Alene Lake, which is being addressed outside the Superfund process by state, Tribal, federal, and local governments through revision of the *Coeur d'Alene Lake Management Plan* (IDEQ and Coeur d'Alene Tribe, 2009). The Tribe and the State of Idaho have adopted the revised plan and are now beginning to conduct the "core elements" of the Lake Management Plan. These include monitoring, conducting a nutrient inventory, and assessing the need for a public outreach program; and
- dispersed recreational areas along the Spokane River, where the State of Washington is implementing remedial actions under the ROD for OU 3 (USEPA, 2002).

The scope of the upcoming ROD Amendment is defined not only in geographic terms but also in terms of its technical scope, including the types of risks addressed and associated design objectives of the alternatives. The technical scope of the study is discussed in the following section.

4.2 Technical Scope of Response Actions

The technical scope of the ROD Amendment will be focused on remedial actions that reduce risks to human health and the environment that are present in the Upper Basin as a result of mining related contamination. Many complex and interwoven factors contribute to the overall risks in the Upper Basin, and not all of these factors are directly addressed by the alternatives described and evaluated in the FFS Report (USEPA, 2010). Factors that are not within the technical scope of the alternatives developed include SFCDR and Pine Creek flooding, contaminated materials beneath paved roadways, and infiltration and inflow (I&I) of contaminated groundwater into sanitary sewer lines. Each of these factors is discussed in further detail below.

USEPA acknowledges that the Upper Basin communities are justifiably concerned about potential SFCDR or Pine Creek flood damage in the communities as well as a number of other issues, such as potential future exposure to contaminated materials that are beneath existing paved roadways; actions to upgrade sanitary sewer lines to prevent infiltration of contaminated ground water into local sanitary sewer treatment systems; and actions to address contamination in the Lower Basin. Included in this Proposed Plan are remedy protection actions identified for specific locations that are intended to enhance the long-term protectiveness of the cleanup. "Remedy protection" as used in this Proposed Plan is focused on keeping clean areas clean by addressing uncontrolled overland water flow from tributary flooding, rain storms, and rapid snowmelt runoff that can erode clean barriers or leave behind contaminated sediments. This approach is consistent with one of the primary goals of the human health cleanup, which is to create barriers that are durable and protective of human health. The remedy protection measures included in this Proposed Plan are in direct response to the types of barrier damage observed in communities from frequent high precipitation events and certain recommendations included in a National Academy of Sciences report (NAS, 2005). These measures will enhance the long-term protectiveness of the implemented human health remedies. USEPA and IDEQ have incorporated local drainage control in remedial activities in the past on a site-by-site basis to ensure that the remedy remains viable, but potential damage to a large portion of the remedies from major flooding has not been addressed at this time.

During site characterization and remedial design of remedy protection, source control, and water quality projects, USEPA will coordinate with local communities and the Basin Commission to ensure that associated flooding concerns along the SFCDR and Pine Creek are addressed by the appropriate entity or entities. Where planning and logical work sequencing allow, USEPA will work collaboratively with other entities performing flood control projects to coordinate implementation of cleanup projects in a manner that provides joint benefits. In addition, USEPA will ensure that implementation of the selected remedy will comply with applicable or relevant and appropriate requirements (ARARs) and will refer to information "to be considered" (TBCs) including those official documents that address flooding, such as Executive Order 11988, Protection of Floodplains. Among other things, Executive Order 11988 requires federal agencies undertaking actions within a floodplain to minimize potential harm to or within floodplains and to avoid long- and short-term adverse impacts with modifications to floodplains. Thus, as remedial actions are implemented within the floodplains of Pine Creek and the SFCDR, efforts will be undertaken to comply with the mandate of this Executive Order.

Flooding of the SFCDR and Pine Creek that inundates the communities with fast-moving water would likely result in damage that affects the protectiveness of remedial barriers. This type of flooding would likely also damage private and public property and create a safety hazard to residents. The locally-developed Shoshone County Multi-Jurisdictional Hazards Mitigation Plan ("the Plan") can be used to illustrate the potential damage in terms of value to property and remediation work in the 100-year floodplain. The Plan shows that, in the City of Kellogg and associated rural areas, public and private property in the 100-year floodplain has an estimated value of $108.2 million. The Plan shows estimated re-remediation costs to be $19.7 million. In Pinehurst and associated rural areas, the estimated value of at-risk property is $56.8 million and re-remediation is estimated to cost $11.3 million. Even though flooding of this magnitude has not occurred since the Bunker Hill Superfund Site was listed on the NPL, the history of extensive flooding indicates that flood control is an issue that is important to the cleanup program and local communities.

During its Five-Year Reviews of the completed portions of the Superfund cleanup, USEPA evaluated risks of flooding and related threats to the remedies and recommended follow-up actions, resulting in the identification of the remedy protection projects described in this Proposed Plan. USEPA 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 USEPA's and IDEQ's cleanup programs, and the capabilities of local communities. Therefore, the Basin Commission, consistent with its authority, agreed in November 2009 to take a leadership role in evaluating flooding issues associated with the SFCDR 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 Basin Commission has engaged a range of entities with the combined required expertise and regulatory jurisdiction. These entities include the U.S. Army Corps of Engineers, the Federal Emergency Management Agency, the Idaho Bureau of Homeland Security, USEPA, and IDEQ. USEPA and IDEQ are committed to assisting the Commission-led activities to evaluate and plan actions relative to dealing with SFCDR and Pine Creek flooding issues. A funding source for the Commission-led activities will need to be established. If these efforts identify actions that would meet Superfund remedy requirements, USEPA could define and select these activities in future decision documents.

The RODs for OUs 1, 2, and 3 address cleanup of rights of way (ROWs)[7] in the Bunker Hill Box and the Coeur d'Alene Basin, as appropriate to respond to risks to human health. The RODs allow ROWs to be cleaned up such that they provide barriers to underlying metals contamination. Many ROWs have been cleaned up as residential and commercial properties have been remediated in Box and Basin communities. However, USEPA and IDEQ recognize that some pre-existing paved roadways may not provide adequate long-term barriers to underlying contaminated material, and that local and state entities are responsible for the long-term road development and maintenance efforts. Additionally, USEPA and IDEQ acknowledge that the operation of trucks associated with the human health cleanup activities have impacted some roads within the Site. As a result, the agencies are developing an approach under the current RODs to address this issue collaboratively with local, county, and state entities responsible for providing and maintaining roadways in their communities. The objective of this

[7] Rights of way (ROWs) are defined in the current RODs as all state, county, local, and private roads.

effort is to develop and implement a strategy that ensures the long-term effectiveness of barriers installed in ROWs, and also aligns with the transportation and maintenance needs of Box and Basin communities.

USEPA and IDEQ evaluated whether infiltration and inflow (I&I) of contaminated groundwater into sanitary sewer lines results in increased metal loadings to surface water bodies within the Upper Basin. I&I poses problems meeting metals discharge requirements at the Page and Smelterville municipal treatment plants, but it is a lesser source of metals to surface waters than other source areas under consideration for cleanup actions. As a result, cleanup actions relative to sanitary sewers were not evaluated in the FFS and are not included in this Proposed Plan.

5.0 Summary of Site 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) (Science Applications International Corporation [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). 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 Ecological Risk Assessment (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, 2006).

As reported in CERCLA Five-Year Review Reports prepared for the Bunker Hill Superfund Site (USEPA, 2000a, 2000b, 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 groundwater 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.

The following sections provide an overview of the human health risks (Section 5.1) and ecological risks (Section 5.2).

5.1 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.

5.1.1 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). As noted above, 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.

5.1.2 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 Mine Operations Area (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 (1998), 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. The number of children participating in the surveys has varied from year to year, with generally fewer participants in recent years. 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.

Based on the last Five-Year Review Report (USEPA, 2005) results from these surveys indicated that the selected human health remedies have likely contributed 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. 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.

5.1.3 Non-Lead Metals Risk Summary

Health risks for the COCs other than lead are described as either non-carcinogenic (not cancer-causing) or carcinogenic (potentially cancer-causing) and the risks are calculated differently. For non-carcinogenic risks, the risk measure is a hazard quotient, which is the exposure dose from the site divided by a dose equal to a threshold where no adverse effects are expected. The sum of hazard quotients for all chemicals assessed within a specific exposure scenario is the hazard index. If the hazard index for non-carcinogenic chemicals is near 1, then no adverse effects are anticipated. Cancer risks are calculated assuming that carcinogens, at any non-zero dose, contribute to cancer risk. Cancer risks are presented as the incremental increase in the likelihood of developing cancer. A cancer risk level of 1×10^{-6} describes an incremental increased risk of one case in one million exposed individuals. USEPA uses the general excess order of magnitude risk range of (10^{-6} to 10^{-4}) (1/1,000,000 to 1/10,000) as a "target range" within which risks are managed as part of a Superfund cleanup.

The RADER for the populated areas (USEPA, 1990) identified the following unacceptable 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. The results of the RI/FS risk characterization for non-lead metals (2001 HHRA; USEPA, 2001a, 2001b) 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.[8] 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).

The 2001 HHRA also concluded that arsenic concentrations in some Basin yard soil may need to be addressed, independently of lead, to reduce both non-cancer hazards and cancer risks. Arsenic is a carcinogen that also has non-cancer adverse effects. Non-cancer hazards are greatest for children up to 7 years of age, as hazard indices exceeded 1 for exposure to yard soil and homegrown vegetables. 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 the exposure scenarios evaluated for the Upper Basin (residential, recreational, modern subsistence) under the RME condition. Residential cancer risks ranged from 3×10^{-5} to 3×10^{-4}, recreational cancer risks ranged from 6×10^{-6} to 4×10^{-5} (for Kingston, Silverton, and Wallace), and modern subsistence cancer risk were estimated at 7×10^{-4}. 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. 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, ranging from at 2×10^{-5} to 3×10^{-5}.

5.2 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

[8] The RME is defined as the highest exposure that is reasonably expected to occur at a site (USEPA, 1998).

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.

5.2.1 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

5.2.2 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 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 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, 2006) 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.

5.3 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.

6.0 Remedial Action Objectives

Remedial action objectives (RAOs) are general descriptions of what a cleanup under CERCLA is expected to accomplish in order to achieve compliance with potential ARARs or an intended level of risk protection. The RAOs for the Upper Basin are listed in Table 2. These are RAOs for the upcoming ROD Amendment only, and additional RAOs are as specified in previous RODs.

TABLE 2
Remedial Action Objectives for the Upper Basin of the Coeur d'Alene River

Human Health	**Remedial Action Objective(s)**
Soil/Sediments/Source Materials	Reduce human exposure to soil, sediments, and source materials, including residential yard soil, that have concentrations of contaminants of concern (COCs) greater than selected risk-based levels for soil.
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.
Aquatic Food Sources	Prevent human exposure to unacceptable levels of COCs via ingestion of aquatic foods (e.g., fish and waterfowl)
Ecological Receptors	**Remedial Action Objective(s)**
Ecosystem Physical Structure and Function	Remediate soil, sediments, and surface water to mitigate mining-related 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 aquatic biota that are protected under the Endangered Species Act, the Fish and Wildlife Conservation Act, and the Migratory Bird Treaty Act.
Soil/Sediments/Source Materials	Prevent ingestion or uptake of and dermal (skin) contact with arsenic, cadmium, copper, lead, mercury, silver, and zinc by ecological receptors at concentrations that result in unacceptable risk.
	Prevent transport and deposition of arsenic, cadmium, copper, lead, mercury, silver, and zinc from soil and sediments into surface water and groundwater at concentrations above applicable or relevant and appropriate requirements (ARARs).
Surface Water	Prevent ingestion of surface water containing COCs at concentrations that may cause adverse impacts to bull trout.
	Prevent ingestion or uptake of arsenic, cadmium, copper, lead, mercury, and zinc by 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.

Ecological Receptors (continued)	Remedial Action Objective(s)
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.
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.

Achievement of the RAOs will reduce short- and long-term risks posed to human health and ecological receptors by reducing exposure to and contact with contaminated soil, sediments, and surface water.

Preliminary remediation goals (PRGs) are standards by which aspects of a cleanup under CERCLA may be measured with a view toward achieving the RAOs. PRGs are initial points of focus using readily available toxicity and exposure factor information, frequently used standards (e.g., ARARs), and reasonable exposure assumptions.

PRGs established in the FFS for the environmental media in the Upper Basin are provided in Appendix A. PRGs for soil are provided in Tables A-1 and A-2 for the protection of terrestrial biota, and for the protection of aquatic birds and mammals, respectively. PRGs for sediment for the protection of aquatic organisms are provided in Table A-3. For soil and sediment, the site-specific lead cleanup goal of 530 mg/kg, is proposed by USEPA, is the principal PRG for protection of songbirds and is consistent with human health protection.

PRGs for surface water for the protection of human health and aquatic organisms are provided in Table A-4 in Appendix A. For surface water, AWQC are the principal PRGs for protection of the aquatic environment. AWQC, adjusted for hardness for specific metals, were identified as the PRGs for surface water in the 2001 EcoRA and have been updated based on current regulations and guidance. The 2001 EcoRA also presented a water-borne concentration that represents the lowest chronic effects level of metals that may affect aquatic plants. However, this effects level for plants is a screening-level benchmark that is not as robust as the AWQC, which also take into account the protection of aquatic plants. Therefore, the AWQC are considered adequately protective for aquatic organisms. Table A-5 includes PRGs for surface water used as drinking water, which include maximum contaminant levels (MCLs), MCL goals (MCLGs), and State of Idaho criteria for public water systems using surface water resources. Final site-specific action or cleanup levels developed for the Upper Basin will be established in the forthcoming ROD Amendment and may or may not differ from the PRGs presented in these tables. Potential ARARs for CERCLA response actions in the Upper Basin include federal and state requirements. As previously noted, USEPA has selected remedial actions and identified ARARs for OUs 2 and 3. Many of the actions included in the alternatives evaluated in the FFS Report are similar to previously selected remedial actions. It is likely that many ARARs identified for OUs 2 and 3 will be used for the remedies that are selected in the ROD Amendment. USEPA is working closely with IDEQ, the Basin Commission, the Coeur d'Alene Tribe, other federal, state, and local agencies, and local community members on this complex cleanup effort.

7.0 Summary of Alternatives

The FFS Report (USEPA, 2010) developed and evaluated two kinds of alternatives for the Upper Basin:

- Remedial alternatives that address the widespread mining-related contamination in the Upper Basin (OUs 2 and 3); and
- Remedy protection alternatives that would enhance the protectiveness of the existing human health remedies for OUs 1, 2, and 3.

7.1 Remedial Alternatives

Remedial alternatives were first developed separately for the Upper Basin portion of OU 3 and for OU 2 (Figure 13). These separate alternatives were then combined to produce 10 combined remedial alternatives that address all of the Upper Basin.

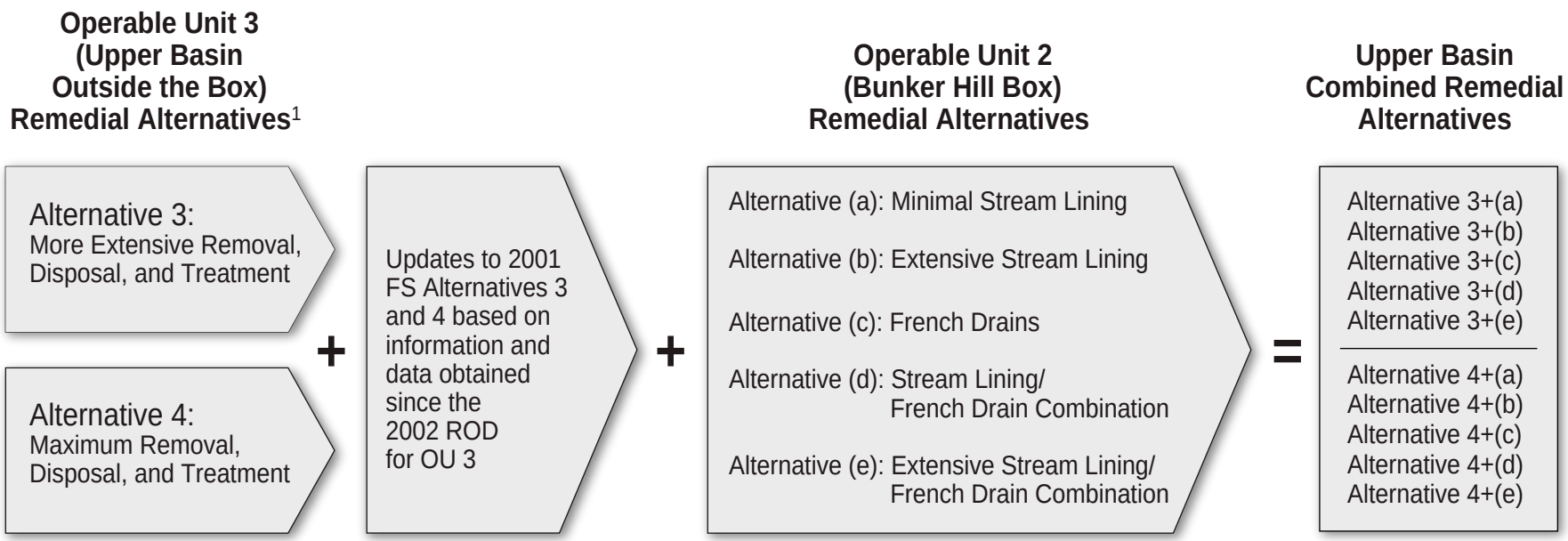
7.1.1 Remedial Alternatives for OU 3 (the Upper Basin Outside the Bunker Hill Box)

The remedial alternatives presented in the FFS Report for OU 3 were developed based on ecological remedial alternatives included in the 2001 FS Report (USEPA, 2001b). The approach used to develop these alternatives in the 2001 FS Report is summarized below, as it laid the groundwork for how the remedial alternatives for the Upper Basin portion of OU 3 were developed in the 2010 FFS Report.

2001 FS Approach (for OU 3)

Due to the size and complexity of the Upper Basin, a typical conceptual design (TCD) approach was applied to specific source sites to develop the Ecological Alternatives in the 2001 FS Report that were used as the basis for the remedial alternatives for OU 3 developed in the 2010 FFS Report. The source sites are discrete areas located throughout the Upper Basin that have been identified as potential sources of metals contamination to surface water. A source site is often comprised of multiple waste types such as tailings, contaminated floodplain sediments, waste rock, and adit discharges. A TCD is a conceptual design for an element of remedial action such as excavation, capping, or active water treatment, that can be applied based on the waste type present at a given source site. Table B-1 in Appendix B presents the complete list of TCDs used for developing the remedial alternatives in the 2010 FFS Report. TCDs were applied to various waste types described under the following three broad categories:

- **Tailings and tailings-impacted floodplain sediments**. Tailings are present within impoundments, in unimpounded piles, and intermixed with floodplain sediments or waste rock. They typically contain high concentrations of metals and are potentially significant sources of metals loading to surface water and groundwater. They are present throughout the Upper Basin both in floodplain areas and upland areas. TCDs applied to these sources include Impoundment Closure, Hydraulic Isolation Using Slurry Wall, Stream Lining, French Drains, Water Treatment, and Excavation to a Waste Consolidation Area or Repository.



[1]Alternatives 3 and 4 are Ecological Alternatives from the 2001 FS.

FS = Feasibility Study
OU = Operable Unit
ROD = Record of Decision

Figure 13
Development of Remedial Alternatives
Upper Basin Proposed Plan

- **Waste rock.** Waste rock typically contains lower concentrations of metals than tailings, and as such the TCDs identified are not as aggressive as the more costly TCDs used for tailings. Actions for waste rock are applied based on the potential for erosion or leaching during flooding events. TCDs applied to these sources include Regrade/Consolidate/Revegetate, Low-Permeability Caps, and Excavation to a Waste Consolidation Area or Repository.
- **Adit drainages, seeps, and groundwater.** These are all water sources that have the potential to contribute metals loading to surface water depending on the discharge rate, concentration of metals, and proximity. The water treatment approach comprised the following two steps: (1) determine whether a water source will be treated under a given alternative based on discharge rate, concentration, and proximity to conveyance pipeline or the CTP, and (2) identify the most appropriate water treatment approach (i.e., TCD) for each water source based on cost, effectiveness, and implementability.

The development of alternatives consists of applying specific TCDs to a source site based on the waste material type and the overall goal of the alternative. As such, each alternative considers all the source sites in the Upper Basin (but remedial actions are not included for each site in each alternative). The 2001 FS Report (USEPA, 2001b) developed and evaluated six alternatives using this TCD approach. The six alternatives listed below provided a range of protectiveness from no action to maximum removal.

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

Based on information gathered as part of the 2001 RI/FS, an inventory of estimated quantities for the various waste types at each source site were then linked to the TCDs identified for the source site for each alternative. Unit costs were also developed for each TCD and costs were calculated on a source-site basis. The quantities and costs were then compiled for all the sites to create an aggregate estimate of the actions to be completed under each alternative, along with associated cost.[9]

2010 FFS Approach (for the Upper Basin portion of OU 3)

Of the six alternatives evaluated in the 2001 FS Report, only Ecological Alternatives 3 and 4 were determined to be compliant with the NCP. Therefore, USEPA decided to carry forward the Upper Basin components of Ecological Alternatives 3 and 4 as the basis for remedial alternatives to be considered in the FFS for the Upper Basin.

[9] It is important to note that the TCDs are only conceptual designs, and the constructed remedies may differ from the TCDs based on site- and waste-specific characterization assessments and other pre-design activities.

USEPA used new data and study results obtained since the 2002 ROD for OU 3 to update the TCDs and expand Ecological Alternatives 3 and 4 in the FFS Report. The new data and study results include the following:

- Development of a numerical groundwater model for the SFCDR Watershed (CH2M HILL, 2009b) 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 to be acted upon based on remedial work conducted since the 2002 ROD for OU 3; and
- 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. 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 in Table 3, a total of 761 sites were considered.

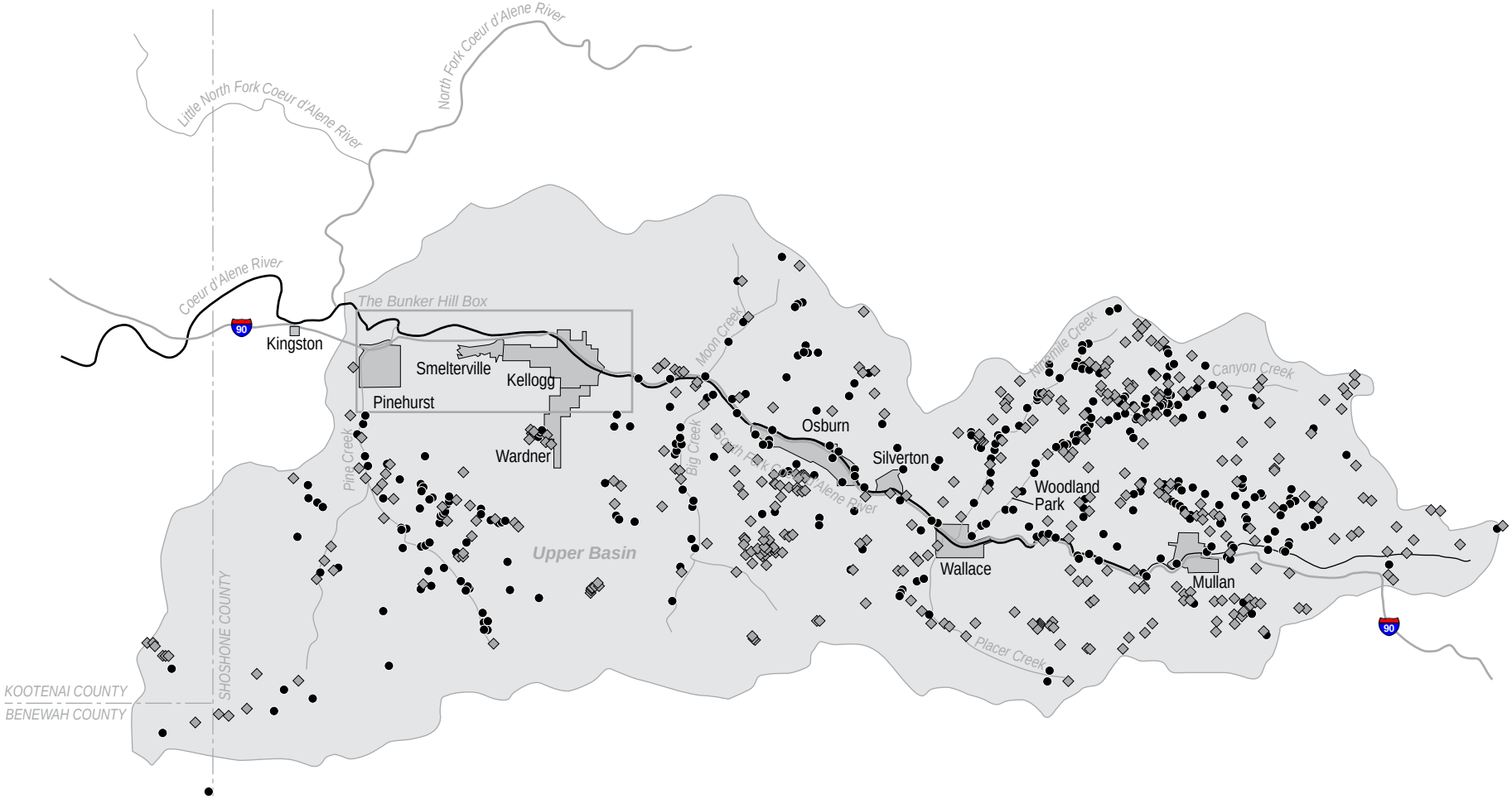
TABLE 3
Sites Addressed in Alternatives 3+ and 4+

Sites	Alternative 3	Alternative 3+	Alternative 4	Alternative 4+
Sites with Proposed Action(s)	332	348	699	704
Sites with No Proposed Actions	429	413	62	57
Total	**761**	**761**	**761**	**761**

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). Figure 14 shows the difference in the number of source sites addressed by Alternatives 3+ and 4+.

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 (additional details comparing Alternatives 3, 3+, 4 and 4+ are included in the FFS Report):

- **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, and four were not included in Ecological Alternative 4 in the 2001 FS Report.



● Source site with remedial action(s) included in both Alternatives 3+ and 4+

◇ Additional source site with remedial action(s) included in Alternative 4+ only (i.e., not included in Alternative 3+)

N

0 1 2 4 Miles

Figure 14
Remedial Alternatives 3+ and 4+
Upper Basin Proposed Plan

EPA

- **Formerly and currently operating 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.
- **Sites with a water treatment component.** A total of 59 sites in Alternative 3+ and 96 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[10], the method of treatment for specific sites (active to semi-passive and vice versa), and the manner of providing semi-passive treatment.
- **Sites within the Pine Creek Watershed.** Based on discussions with BLM, the remedial actions identified for the Pine Creek Watershed have been modified to account for remedial work that has been completed and new data that have been collected since the 2001 FS Report was issued. In addition, several sites have been added to the list for remedial action based on recommendations provided by BLM.
- **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 it is a significant source of dissolved metals loading to surface water in the Upper Basin. It is also 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.

[10] The 2001 FS Report proposed constructing a new high-density sludge plant for water treatment in Pinehurst. The FFS remedial alternatives include expanding and upgrading the existing CTP in Kellogg.

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 1,400 gpm would be treated by onsite semi-passive systems.

Section 6.0 of the FFS includes additional text and tables detailing the differences between Alternatives 3 and 3+ and Alternatives 4 and 4+, as well as the waste material quantities at each source site. The quantities of materials to be addressed as well as the associated cost estimates for these TCD-based alternatives are considered a reasonable approximation for feasibility-level evaluations. The actual constructed remedies at each source site may vary from the approximations based on pre-design work including site- and waste-characterization assessments.

7.1.2 Remedial Alternatives for OU 2 (within the Bunker Hill Box)

The OU 2 remedial alternatives were developed by taking into consideration the effectiveness of the source removal, containment, and surface capping completed as part of Phase I remedial actions completed in OU 2 by USEPA and IDEQ from 1994 to 2002, the effectiveness of those actions, and EPA's commitment not to displace the communities. Given these considerations, 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, 2007b) 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, USEPA's commitment to not displace the community, 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, 2009b) was developed, 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).

In order to achieve Bunker Hill Mine AMD compliance with the order from USEPA to capture all discharges, phased water collection and management actions for the Reed and Russell Adit Tunnel discharge (part of the Bunker Hill Mine) would be addressed with the same action in each of the five defined OU 2 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 are not achieved in the residual Reed and Russell Adit Tunnel 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 Adit Tunnel actions discussed above. No additional 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 Adit Tunnel actions discussed above. No additional water treatment would occur under this alternative.
- **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 or in a pipe along Bunker Creek (instead of discharging to Bunker Creek as is currently done); and phased implementation of the Reed and Russell Adit Tunnel actions discussed above. An estimated average flow of 3,900 gpm of contaminated groundwater would be treated at the CTP (in addition to current flows of AMD from the Bunker Hill Mine and waters to be added from OU 3).
- **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 installed on the

east side of the CIA or in a pipe along Bunker Creek; and phased implementation of the Reed and Russell Adit Tunnel actions discussed above. An estimated average flow of 3,900 gpm of contaminated groundwater would be treated at the CTP (in addition to current flows of AMD from the Bunker Hill Mine and waters to be added from OU 3).

- **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 Adit Tunnel actions discussed above. An estimated average flow of 2,400 gpm of contaminated groundwater would be treated at the CTP (in addition to current flows of AMD from the Bunker Hill Mine and waters to be added from OU 3).

7.1.3 Combined Remedial Alternatives for the Upper Basin

Each combined remedial alternative for the Upper Basin consists of components for the Upper Basin portion of OU 3 and for OU 2. There are significantly more remedial actions included in OU 3 Alternatives 3+ and 4+ compared to the OU 2 alternatives; therefore the majority of the estimated cost, approximately 80 to 99 percent of the total for each alternative, comprises OU 3 actions. Together with the No Action Alternative, which is presented for comparative purposes, the 10 combined remedial alternatives are summarized in Table 4 along with the estimated capital costs, operation and maintenance (O&M) costs, and total costs.

7.1.4 Institutional Controls Program

An existing ICP provides a locally enforced set of rules and regulations established to maintain the integrity of installed barriers and to ensure that new barriers are installed during redevelopment that may occur within the administrative boundary of the ICP. The ICP was adopted by the Idaho State Legislature and is administered by the Panhandle Health District. The ICP applies to all waste left in place within the Bunker Hill Superfund site ICP boundary, including the preferred alternative source area actions. Among other things, the ICP issues permits for work that may encounter mine waste contaminated material, stipulates mine waste contaminated material handling procedures and disposal, and trains and certifies contractors prior to working with potentially contaminated materials. Institutional controls may be necessary to protect the integrity of the remedy, ensure agency access, or prevent human exposures after remedial actions are implemented. USEPA will evaluate whether the existing ICP administered by the Panhandle Health District is adequate or whether additional institutional controls are needed to ensure the protectiveness of the implemented remedy.

TABLE 4
Summary of Combined Remedial Alternatives and Cost Estimates

Remedial Alternative	Description	Cost ($ Million)[1]	
No Action Alternative	No Action	Capital:	$0.0
		O&M:	$0.0
		Total Cost:	$0.0
Alternative 3+(a)	OU 3 Alternative 3+ (More Extensive Removal, Disposal, and Treatment) and OU 2 Alternative (a): Minimal Stream Lining	Capital:	$1,240
		O&M:	$95
		Total Cost:	$1,340
Alternative 3+(b)	OU 3 Alternative 3+ and OU 2 Alternative (b): Extensive Stream Lining	Capital:	$1,200
		O&M:	$94.9
		Total Cost:	$1,290
Alternative 3+(c)	OU 3 Alternative 3+ and OU 2 Alternative (c): French Drains	Capital:	$1,200
		O&M:	$99.8
		Total Cost:	$1,300
Alternative 3+(d)	OU 3 Alternative 3+ and OU 2 Alternative (d): Stream Lining/French Drain Combination	Capital:	$1,210
		O&M:	$101
		Total Cost:	$1,310
`Alternative 3+(e)	OU 3 Alternative 3+ and OU 2 Alternative (e): Extensive Stream Lining/French Drain Combination	Capital:	$1,430
		O&M:	$104
		Total Cost:	$1,530
Alternative 4+(a)	OU 3 Alternative 4+ (Maximum Removal, Disposal, and Treatment) and OU 2 Alternative (a): Minimal Stream Lining	Capital:	$1,840
		O&M:	$145
		Total Cost:	$1,990
Alternative 4+(b)	OU 3 Alternative 4+ and OU 2 Alternative (b): Extensive Stream Lining	Capital:	$1,800
		O&M:	$145
		Total Cost:	$1,950
Alternative 4+(c)	OU 3 Alternative 4+ and OU 2 Alternative (c): French Drains	Capital:	$1,800
		O&M:	$150
		Total Cost:	$1,950
Alternative 4+(d)	OU 3 Alternative 4+ and OU 2 Alternative (d): Stream Lining/French Drain Combination	Capital:	$1,810
		O&M:	$151
		Total Cost:	$1,960
Alternative 4+(e)	OU 3 Alternative 4+ and OU 2 Alternative (e): Extensive Stream Lining/French Drain Combination	Capital:	$2,030
		O&M:	$154
		Total Cost:	$2,180

[1]The operation and maintenance (O&M) and total costs are presented as net present value (NPV) costs. NPV costs are based on a 30-year planning period and a discount rate of 7%. For standardizing cost estimates, consistent with USEPA guidance, they assume that all construction occurs in year 1. The above cost estimates are Feasibility-Study-level estimates with a nominal accuracy of –30 percent to +50 percent (–30/+50%). Cost estimates are in 2009 dollars and do not include future escalation.

7.2 Remedy Protection Alternatives

The remedy protection alternatives for the Upper Basin focus on protecting the human health remedies selected in the RODs for OUs 1, 2, and 3. These existing 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 and exposure to mining-related contaminants. Long-term maintenance of these barriers is a key component of the success of these remedies. To date, the remedies that have been implemented are functioning as designed and are protective of human health. However, USEPA is aware of certain limited circumstances where the potential for adverse impacts from erosion and/or recontamination has already threatened or could threaten the long-term effectiveness and permanence of these remedies.

Before developing alternatives to enhance the protectiveness of the existing remedies in the Upper Basin, the potential threat of damage posed to the remedies by localized storm events was assessed. The assessment focused on eight of the most densely populated communities in the 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 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 tributary flooding and 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 to humans and ecological receptors. Hydrologic and hydraulic models analyzed 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 and in Table 5, including the estimated capital, O&M, and total costs.

- **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 remedies selected in previous decision documents. If the existing 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 approaches 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 remedies are expected to be damaged during storm events, based on hydrologic and hydraulic analyses conducted during the FFS, Alternative RP-1 includes the estimated costs for repair of the existing remedies in the Upper Basin communities. Although detailed

analyses were not conducted for the side gulches (i.e., drainages within the Upper Basin but outside the eight primary 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 comprises combinations of various actions to protect the existing remedies selected in previous decision documents against tributary flooding and high precipitation events up to the 50-year storm. Each community has different water conveyance infrastructure-related issues that pose risks to the remedies. Actions that could be applicable to remedy protection projects were developed from common engineering practice for stormwater conveyance projects. The actions identified to mitigate the risks posed to the existing remedies in Alternative RP-2 were determined based on current conditions in each community area, and on 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. Easements and O&M agreements may be necessary components of Alternative RP-2 to ensure long-term access and the functionality of the remedy protection projects. If necessary to ensure long-term maintenance of the remedy protection projects, USEPA, IDEQ, and the Work Trust[11] will also rely on local governments to ensure continued O&M as property uses change.

TABLE 5
Summary of Remedy Protection Alternatives and Cost Estimates

Remedy Protection Alternative	Description	Cost ($ Million)[1]	
Alternative RP-1	No Further Action (Post-Event Response) [2]	Capital:	$ -
		O&M:	$ -
		Total Cost:	$50.1
Alternative RP-2	Modifications to Selected Remedies to Enhance Protectiveness (Remedy Protection Projects)	Capital:	$24.6
		O&M[3]:	$9.16
		Total Cost:	$33.9

[1]The operation and maintenance (O&M) and total costs are presented as net present value (NPV) costs. NPV costs are based on a 30-year planning period and a discount rate of 7%. They assume that all construction occurs in year 1. The above cost estimates are Feasibility-Study-level estimates with a nominal accuracy of –30 percent to +50 percent (–30/+50%). Cost estimates are in 2009 dollars and do not include future escalation.

[2]There are no capital or O&M costs associated with Alternative RP-1.

[3] RP-2 O&M costs were calculated assuming that 2 percent of capital costs would be spent annually on repairs and maintenance to the remedy protection projects.

[11] See Section 13.0, Glossary, for a definition of the Work Trust.

8.0 Evaluation of Alternatives

The NCP (Section 300.430 (e)(9)(iii)) requires that the alternatives be compared with one another using nine CERCLA evaluation criteria. The purpose of the comparison is to identify the relative advantages and disadvantages of the alternatives in terms of these CERCLA criteria. These nine criteria are divided into subcategories: Threshold Criteria, Primary Balancing Criteria, and Modifying Criteria.

The CERCLA Threshold Criteria include:

- **Overall Protectiveness of Human Health and the Environment.** Evaluates the overall protectiveness of the alternatives and describes how risks posed are eliminated, reduced, or controlled through treatment, engineering, or institutional controls.
- **Compliance with Applicable or Relevant and Appropriate Requirements (ARARs).** Evaluates whether an alternative meets federal, state, and Tribal environmental statutes, regulations, and other requirements that pertain to the site, and/or whether a waiver is justified.

The CERCLA Primary Balancing Criteria include:

- **Long-Term Effectiveness and Permanence.** Considers an alternative's ability to protect human health and the environment over time.
- **Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment.** Evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present.
- **Short-Term Effectiveness.** Considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation.
- **Implementability.** Considers the technical and administrative feasibility of implementing an alternative, including factors such as the availability of goods and services.
- **Cost.** Includes estimated present worth capital and operation and maintenance (O&M) costs. O&M costs are estimated for a 30-year period using a discount rate of 7 percent.

The CERCLA Modifying Criteria include:

- **State/Tribal Acceptance.** Considers whether the States and Tribes agree with USEPA's analyses and recommendations.
- **Community Acceptance.** Considers whether the local community agrees with USEPA's analyses and the selected remedy. Comments received on the Proposed Plan during the public comment period are an important indicator of community acceptance.

The three criteria categories are based on the role of each criterion during the evaluation and remedy selection process. The two Threshold Criteria relate directly to statutory requirements

that must be satisfied by a selected alternative, as ultimately documented in the ROD Amendment. The five Primary Balancing Criteria represent the primary technical, cost, institutional, and risk factors that form the basis of the evaluation. The two Modifying Criteria will be evaluated in the ROD Amendment following the receipt of state agency, Tribal, and public comments on the FFS Report and the Proposed Plan.

Because the two Modifying Criteria will not be evaluated until after comments are received from the state, Tribes, and the public, seven CERCLA criteria (i.e., the Threshold and Primary Balancing Criteria) guide the evaluation presented in this Proposed Plan. The basis for the evaluation of these seven criteria is discussed in the following sections. A more detailed comparative analysis is provided in the FFS Report (USEPA, 2010), which also presents an individual evaluation of each alternative in terms of the seven CERCLA criteria.

8.1 Remedial Alternatives

A summary of the comparative analysis for the remedial alternatives is presented in Figure 15. A more detailed comparative analysis is provided in Tables C-1 and C-2 in Appendix C. 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, communities, 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.
- **Estimates of post-remediation AWQC ratios.** The Predictive Analysis in the FFS was used to estimate post-remediation AWQC ratios to aid in the evaluation of effectiveness for the remedial alternatives. All of the remedial alternatives will eventually achieve AWQC (the principal chemical-specific ARAR) ratios of 1 after differing periods of natural source depletion, depending on the magnitude of the actions taken. The Predictive Analysis also includes a component that can be used to estimate the effects of natural source depletion on AWQC ratios over time as a function of a decay rate. However, the natural source depletion component was not used in the FFS analysis because the prediction of long-term water quality trends and specific water quality in the SFCDR Watershed in the distant future is subject to considerable uncertainty. These uncertainties include complex weathering rates and the changes in these rates for the numerous mine waste types and source areas in the watershed. Site-specific exposure to seasonal wetting and water flux, as well as variations in particle surface area, iron sulfide content, trace metal content, air diffusion, and other factors, control the release of contaminants from mine wastes. The effect of cleanup actions further complicates these predictions. Therefore, the evaluation relies on the post-remediation AWQC estimates for comparison among 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.

Criterion	Alternative 3+(a)	Alternative 3+(b)	Alternative 3+(c)	Alternative 3+(d)	Alternative 3+(e)	Alternative 4+(a)	Alternative 4+(b)	Alternative 4+(c)	Alternative 4+(d)	Alternative 4+(e)
Threshold Criteria										
Overall Protectiveness of Human Health and the Environment evaluates the overall protectiveness of the alternatives and describes how risks posed are eliminated, reduced, or controlled through treatment, engineering, or institutional controls.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Compliance with Applicable or Relevant and Appropriate Requirements (ARARs) evaluates whether an alternative meets federal, state, and tribal environmental statutes, regulations, and other requirements that pertain to the site, and/or whether a waiver is justified.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Primary Balancing Criteria										
Long-Term Effectiveness and Permanence considers an alternative's ability to protect human health and the environment over time.	●	●	●	●	●	●	●	●	●	●
Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present.	•	●	●	●	•	•	•	●	●	●
Short-Term Effectiveness considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation.	●	●	●	●	●	●	●	●	●	•
Implementability considers the technical and administrative feasibility of implementing an alternative, including factors such as the availability of goods and services.	●	●	●	●	•	•	•	•	•	○
Cost includes estimated present worth capital and operation and maintenance (O&M) costs. O&M costs are estimated for a 30-year period using a discount rate of 7 percent.	●	●	●	●	●	○	○	○	○	○
Modifying Criteria										
State/Tribal Acceptance considers whether the States and Tribes agree with USEPA's analyses and recommendations, as described in the Focused Feasibility Study Report and the Proposed Plan.	**To be evaluated after comments are received on the Proposed Plan.**									
Community Acceptance considers whether the local community agrees with USEPA's analyses and the Selected Remedy. Comments received on the Proposed Plan during the public comment period are an important indicator of community acceptance.										

✓ Alternative meets this Threshold Criterion.

Comparative Ranking Symbols:

● **Highest** – The alternative is either the most favorable, compared to the other alternatives, or is equally favorable among the alternatives ranked highest.

● **High** – The alternative is highly favorable in regard to this criterion, but at least one other alternative is ranked higher.

● **Medium** – The alternative is moderately favorable (i.e., other alternatives are more or less favorable for this criterion).

• **Low** – The alternative is somewhat favorable for this criterion, but at least one alternative is ranked lower.

○ **Lowest** – The alternative is either the least favorable, compared to other alternatives, or does not meet the criterion.

Figure 15
Overview of Comparative Analysis of Remedial Alternatives
Upper Basin Proposed Plan

- **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. Note that the repository siting process is ongoing and being led by IDEQ. Public meetings and workshops will continue to provide citizens with the opportunity to provide comments on both the siting process and specific sites being considered.
- **Long-term management and associated costs.** Overall 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 and Primary Balancing Criteria.

8.1.1 Overall Protection of Human Health and the Environment

Protection of human health and the environment is one of two threshold requirements that each alternative must meet in order to be eligible for selection as a remedy (the other being compliance with ARARs). All of the alternatives, except the No Action Alternative, would achieve the criterion of overall protection of human health and the environment.

Although this criterion is evaluated as either "meets" or "does not meet", it can be helpful to also look at the different approaches to protectiveness, in that some alternatives may be more favorable than others. For example, all of the alternatives based on Alternative 3+ may provide benefits different from Alternative 4+, regardless of which OU 2 alternative is included. This is because 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 much larger extent of long-term construction and hauling involved, which are risks that are considered to outweigh the additional long-term benefits of the proposed actions compared to Alternative 3+. 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.

8.1.2 Compliance with ARARs

Compliance with ARARs is the second threshold requirement that each alternative must meet in order to be eligible for selection as a remedy. All of the alternatives would achieve the criterion of compliance with ARARs. PRGs for soil and sediments would be met upon completion of remedial actions in all locations where remedial actions are taken under each alternative, while ARARs for surface water would be met for all the alternatives through implementation of the remedial actions and different periods of natural source reduction (described more below). As with the overall protectiveness criterion, although this

criterion is evaluated as either "meets" or "does not meet", it can be helpful to also look at the differences between the initial effectiveness of each alternative in the progress towards meeting surface water quality standards (i.e., AWQC).[12]

An analysis was conducted during the FFS to estimate relative post-remediation AWQC ratios and dissolved zinc load reduction in the SFCDR at Elizabeth Park and Pinehurst for each alternative. Pinehurst was selected as a location for this analysis because it is located at the downstream end of the Bunker Hill Box, which coincides relatively closely with the downstream end of the Upper Basin. However, there are differences between the initial relative effectiveness of each alternative in reducing AWQC ratios, as shown in Table 6.

TABLE 6
Estimated Post-Remediation Dissolved Zinc AWQC Ratios and Load Reduction at Pinehurst

Alternative	Estimated Post-Remediation AWQC Ratio for Dissolved Zinc at Pinehurst	Estimated Post-Remediation Dissolved Zinc Load Reduction at Pinehurst
Alternative 3+(a)	2.9	940 lb/day (41%)
Alternative 3+(b)	3.0	930 lb/day (41%)
Alternative 3+(c)	1.8	1,340 lb/day (59%)
Alternative 3+(d)	1.7	1,380 lb/day (60%)
Alternative 3+(e)	1.5	1,450 lb/day (63%)
Alternative 4+(a)	2.8	1,040 lb/day (45%)
Alternative 4+(b)	2.8	1,030 lb/day (45%)
Alternative 4+(c)	1.6	1,440 lb/day (63%)
Alternative 4+(d)	1.5	1,480 lb/day (65%)
Alternative 4+(e)	1.3	1,550 lb/day (68%)
No Action Alternative	5.2	N/A

AWQC = ambient water quality criteria
lb/day = pounds per day
N/A = not applicable
Note: For reference the estimated current average annual dissolved zinc load at Pinehurst is 2,290 lb/day.

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 relative period of time required between alternatives is expected to be related to the water quality improvement achieved upon the completion of remedial actions. It is important to note that this analysis was only conducted at two key locations on the SFCDR: Pinehurst and Elizabeth Park. These two locations provide an estimate of overall cleanup progress in the Upper Basin, as Elizabeth Park is located on the SFCDR upstream of the Box and the Pinehurst location is on the SFCDR near the confluence with the North Fork. It is expected that dramatic localized improvements in surface water

[12] Note that MCLs for drinking water are also ARARs for surface water as a drinking water source in the Upper Basin. However, the AWQC are used as an indication of compliance with surface water ARARs because, in general, the AWQC are lower than the MCLs for the site contaminants of concern.

quality would be observed throughout areas of the Upper Basin resulting from remedial actions in various watershed and tributaries to the SFCDR.

Because the No Action Alternative was only included for baseline comparison purposes and does not meet either of the Threshold Criteria (overall protection of human health and the environment, and compliance with ARARs), it is not discussed further in the following sections that evaluate the remaining evaluation criteria (the Primary Balancing Criteria).

8.1.3 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+ would achieve 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, 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.

8.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

All the 10 combined remedial alternatives are considered to satisfy the statutory preference for treatment. Although the treated water flow rates are relatively similar for all the alternatives, the estimated mass of dissolved zinc removed through treatment ranges from 230 to 1,500 lb/day. Surface water treatment would occur through both active treatment at the CTP in Kellogg and semi-passive treatment near the source sites.

OU 2 Alternatives (a) and (b) do not include treatment and, therefore, rank lower under this criterion. OU 2 Alternative (c) would treat the greatest dissolved zinc load, followed by Alternative (d) and then (e). Alternative 4+ includes greater volumes of water treated at the CTP than Alternative 3+. However, Alternative 3+ is expected to remove more contaminant mass through treatment than Alternative 4+; therefore, Alternative 3+ ranks higher than Alternative 4+ (330 lb/day versus 230 lb/day, respectively). 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.

8.1.5 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 more extensive nature of the remedial actions that would be conducted under Alternative 4+, which would require a much longer time period to complete (up to 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.

8.1.6 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).

8.1.7 Cost

Estimated costs for each remedial alternative are presented in Table 4. As shown, costs for alternatives based on Alternative 4+ are consistently higher than those based on Alternative 3+, regardless of which OU 2 alternative it is coupled with. The OU 2 costs are relatively small, ranging from 1 to 20 percent of the total alternative cost. The ranking of the OU 2 alternatives based on lowest 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 lining, (a) includes a liner on the SFCDR that carries a significantly higher cost. In addition, Figure 16 depicts the relationship between the total cost (30-year net present value [NPV]) and the predicted post-remediation AWQC ratios at the Pinehurst monitoring location for each alternative.

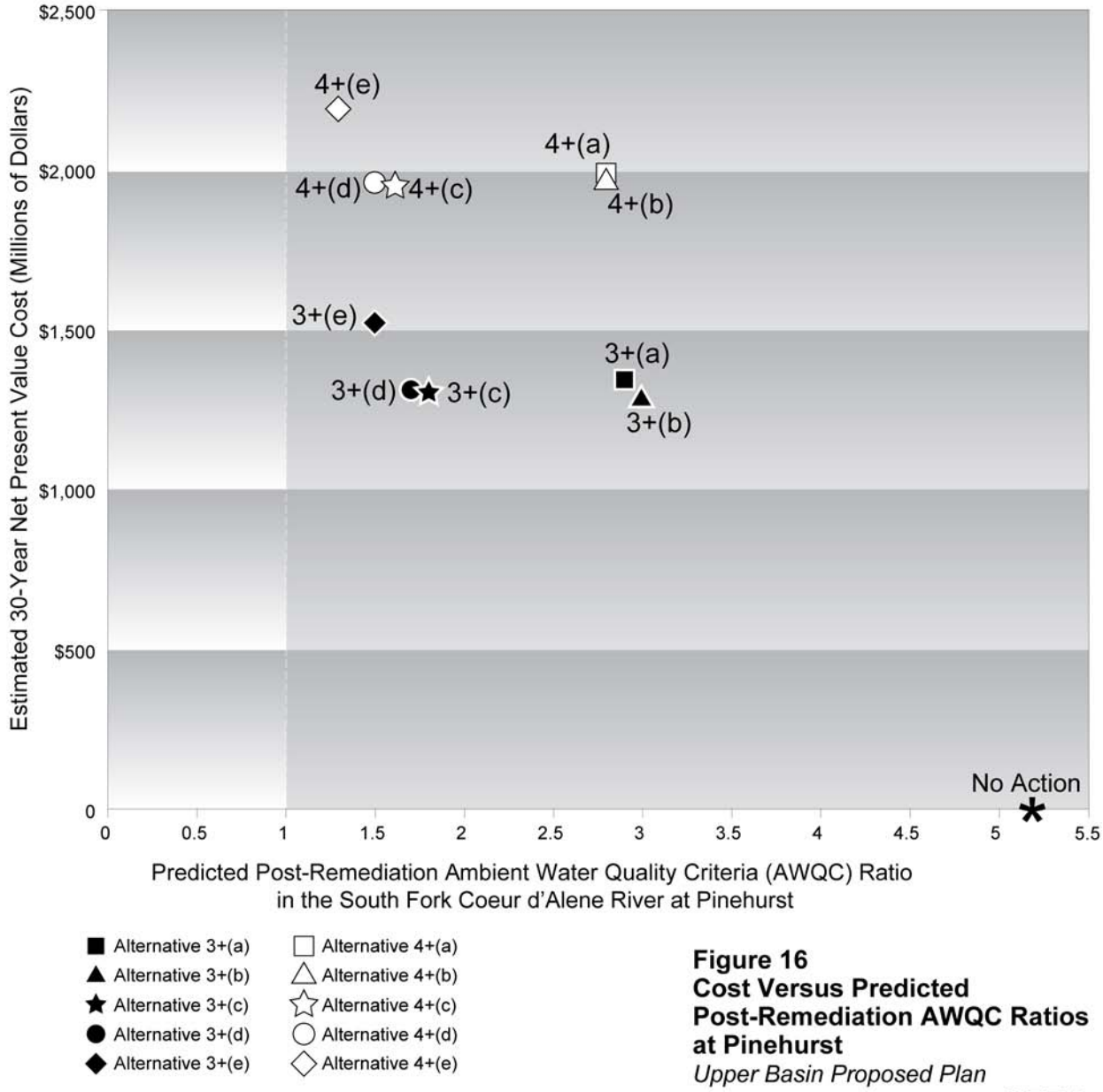


Figure 16
Cost Versus Predicted Post-Remediation AWQC Ratios at Pinehurst
Upper Basin Proposed Plan

382081.FI.06.01.03_BunkerHill_ES042009003SEA . Fig. 16 Present Value vs AWQC Ratios_22June10.ai

8.2 Remedy Protection Alternatives

The remedy protection alternatives aim to enhance the protectiveness of existing human health remedies that were selected in the RODs for OUs 1, 2, and 3, consistent with USEPA's adaptive management of the Bunker Hill Superfund Site. In order to identify the best ways to ensure the continued protectiveness of these remedies, the alternatives were compared using the CERCLA Threshold and Primary Balancing Criteria. The comparative analysis of the remedy protection alternatives is summarized below and in Figure 17. Table C-3 in Appendix C includes detailed comparative analysis of remedy protection alternatives.

Criterion	Alternative RP-1	Alternative RP-2
Threshold Criteria		
Overall Protectiveness of Human Health and the Environment evaluates the overall protectiveness of the alternatives and describes how risks posed are eliminated, reduced, or controlled through treatment, engineering, or institutional controls.	✓	✓
Compliance with Applicable or Relevant and Appropriate Requirements (ARARs) evaluates whether an alternative meets federal, state, and tribal environmental statutes, regulations, and other requirements that pertain to the site, and/or whether a waiver is justified.	✓	✓
Primary Balancing Criteria		
Long-Term Effectiveness and Permanence considers an alternative's ability to protect human health and the environment over time.	●	⬤
Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present.	○	○
Short-Term Effectiveness considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation.	●	⬤
Implementability considers the technical and administrative feasibility of implementing an alternative, including factors such as the availability of goods and services.	●	⬤
Cost includes estimated present worth capital and operation and maintenance (O&M) costs. O&M costs are estimated for a 30-year period using a discount rate of 7 percent.	●	⬤
Modifying Criteria		
State/Tribal Acceptance considers whether the States and Tribes agree with USEPA's analyses and recommendations, as described in the Focused Feasibility Study Report and the Proposed Plan.	**To be evaluated after comments are received on the Proposed Plan.**	
Community Acceptance considers whether the local community agrees with USEPA's analyses and the Selected Remedy. Comments received on the Proposed Plan during the public comment period are an important indicator of community acceptance.		

✓ Alternative meets this Threshold Criterion.

Comparative Ranking Symbols:

⬤ **Highest** – The alternative is either the most favorable, compared to the other alternatives, or is equally favorable among the alternatives ranked highest.

● **High** – The alternative is highly favorable in regard to this criterion, but at least one other alternative is ranked higher.

● **Medium** – The alternative is moderately favorable (i.e., other alternatives are more or less favorable for this criterion).

● **Low** – The alternative is somewhat favorable for this criterion, but at least one alternative is ranked lower.

○ **Lowest** – The alternative is either the least favorable, compared to other alternatives, or does not meet the criterion.

Figure 17
Overview of Comparative Analysis of Remedy Protection Alternatives
Upper Basin Proposed Plan

- Both Alternative RP-1 and Alternative RP-2 would be protective of human health and the environment because the existing 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 remedies by decreasing the risk of recontamination due to flooding and uncontrolled surface water flows.
- 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 only enhance the protectiveness of existing remedies and would not directly address metals contamination.)
- Alternative RP-2 would increase the long-term effectiveness and permanence of the existing remedies by increasing tributary flooding controls and localized surface water controls, thereby decreasing the risk of recontamination and damage to the existing remedies due to flooding and uncontrolled surface water flows. Alternative RP-1 would only maintain and repair the existing 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 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 tributary 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 existing remedies. The effective implementation of Alternative RP-1 would require a coordinated overall response within the communities and among response agencies. Administrative implementability issues would exist for Alternative RP-1 with respect to the repair and replacement of the existing remedies following storm events. These storm events cannot be predicted, and the availability of funds to repair the 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, except 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, agreements will have to be completed regarding which state or local entity will perform O&M tasks associated with Alternative RP-2 and ensure that sufficient resources are available, or a determination will be made that a local regulatory scheme ensures performance of O&M. 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 5 presents a side-by-side comparison of the total estimated costs (30-year NPV) for Alternatives RP-1 and Alternative RP-2. The total cost for Alternative RP-1 includes the expected cost to repair and re-remediate the existing remedies based on model outputs and flood event probabilities. For Alternative RP-2, the total cost includes direct and indirect capital costs and O&M costs for construction of the remedy protection projects. Total costs for both alternatives include estimated costs for the side gulches. Detailed analyses were not conducted for the side gulches, but approximate costs were developed for both alternatives based on trends observed in the Upper Basin communities.

9.0 Description of the Preferred Alternative

The Preferred Alternative for the Upper Basin would represent 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 materials at 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. 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 additional actions are needed or would be effective in meeting drinking water standards. If further actions would not be effective a Technical Impracticability waiver may be warranted at specific locations where groundwater does not achieve drinking water standards.[13]

Remedial Alternative 3+(d) and Remedy Protection Alternative RP-2 are the two components of the Preferred Alternative. The two components have been identified following evaluation of the remedial alternatives and remedy protection alternatives; therefore, Remedial Alternative 3+(d) is also referred to as "the Preferred Remedial Alternative", and Remedy Protection Alternative RP-2 is also referred to as "the Preferred Remedy Protection Alternative". The selected remedy documented in the ROD Amendment may be the Preferred Alternative, a modification of the Preferred Alternative or another remedy, based on new information or public comments.

9.1 Preferred Remedial Alternative

Alternative 3+(d), the Preferred Remedial Alternative, would provide a number of improvements over the interim environmental remedy for OU 3 that was documented in the ROD for that OU (USEPA, 2002). The Preferred Remedial Alternative constitutes a comprehensive approach to remedial actions within the entire Upper Basin, and includes actions both in the Upper Basin portion of OU 3 and in OU 2 (within the Bunker Hill Box). It is important to note that USEPA proposes to implement Alternative 3+(d) in a prioritized manner using the adaptive management process and an Implementation Plan, as discussed in Section 10.0.

For OU 3, the Preferred Remedial Alternative component is Alternative 3+ and is illustrated in Figures 18 and 19. Figure 18 shows the general source control actions by watershed, including

[13] Specific ARARs can be waived if appropriately justified [40 CFR 300.430(f)(1)(ii)(C)].

WHAT THIS FIGURE SHOWS

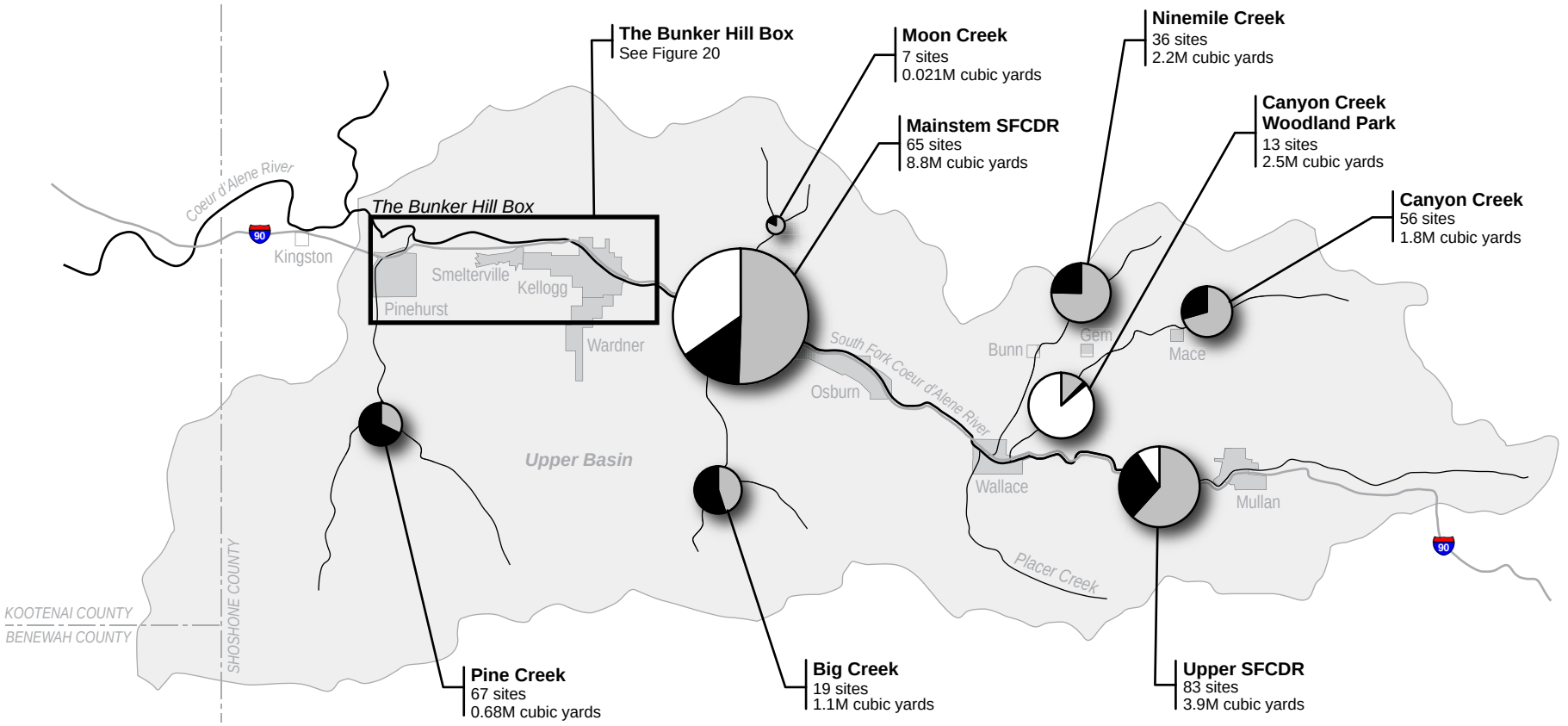
For the main and upper parts of the South Fork Coeur d'Alene River and major creeks, this figure shows the number of individual locations where remedial actions have been planned and the amount of material, such as contaminated tailings, waste rock, and floodplain sediments, that would be cleaned up. The "pie charts" for each portion of the river and creeks show the general breakdown of the proposed actions. The volume (cubic yards) listed for each watershed includes all material addressed by the Preferred Alternative.

The bigger the pie chart, the more contaminated materials are planned to be addressed.

Cap – Includes engineered or soil covers, or regrading and planting.

Excavation – Includes removing materials and either consolidating locally or transporting to a separate repository.

Hydraulic Isolation – Includes preventing contaminated water (seeps, adit drainage, or groundwater) from entering the river and creeks.



Key to Pie Charts

- Cap
- Excavation
- Hydraulic Isolation

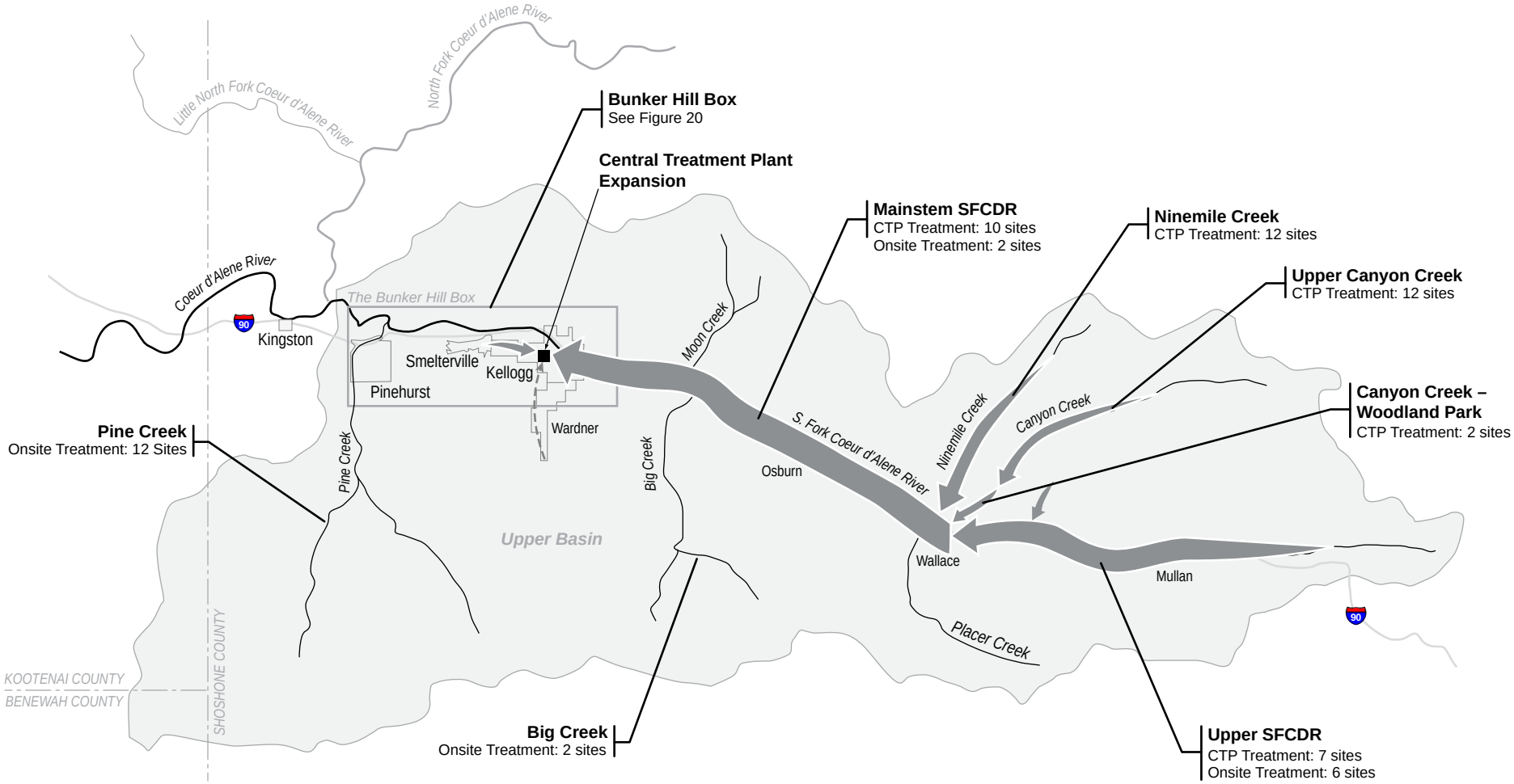
Note:

SFCDR = South Fork Coeur d'Alene River

N

0 1 2 4 Miles

Figure 18
Preferred Remedial Alternative: Source Control Actions by Watershed in the Upper Basin
Upper Basin Proposed Plan



Water Conveyance Pipeline to Central Treatment Plant

N

0 1 2 4 Miles

Notes:
CTP = Central Treatment Plant
SFCDR = South Fork Coeur d'Alene River

Figure 19
Preferred Remedial Alternative: Water Collection and Treatment in the Upper Basin
Upper Basin Proposed Plan

the number of source sites and an estimated total volume of contaminated materials to be addressed. These source control actions include:

- Extensive excavation of waste rock, tailings, and floodplain sediments. Excavated material would be placed in repositories and waste consolidation areas. Appropriate locations for repositories would be developed prior to the implementation of excavation activities with input from other agencies and the communities. Waste consolidation areas would provide a relatively high degree of protectiveness for tailings and tailings/waste rock mixtures via onsite capping of waste material. Source sites that are appropriate for waste consolidation areas would be determined prior to implementation.
- Capping, regrading, and revegetation in many waste rock areas.
- 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.

Figures that depict the detailed source control actions included in Alternative 3+ for each watershed are provided in Appendix D. Appendix D also includes examples of specific source sites with actions included in Alternative 3+ and illustrates how TCDs were applied to the sites.

Alternative 3+ also includes the various water treatment elements, as shown in Figure 19:

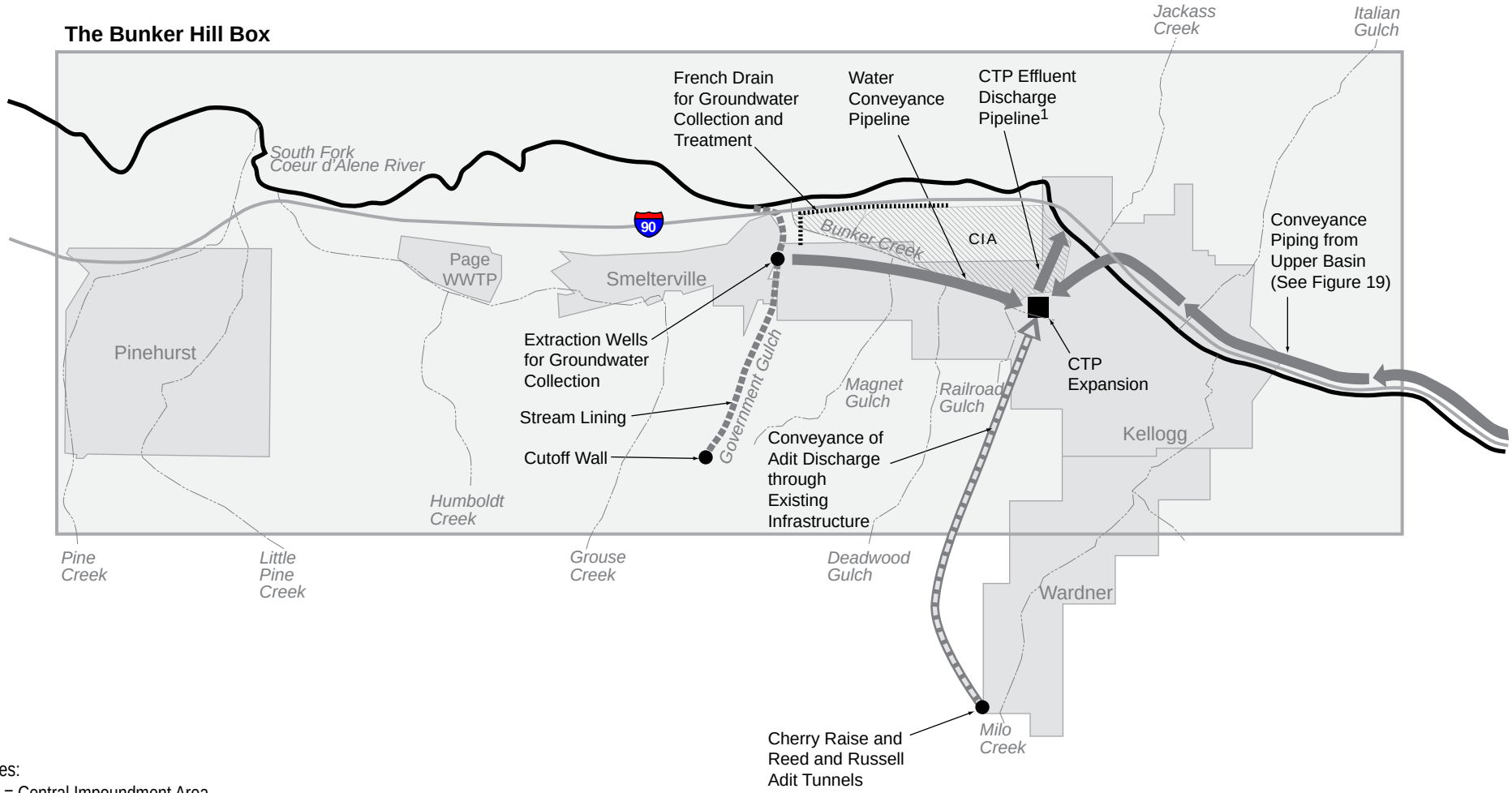
- Collection and treatment near individual sources using semi-passive treatment methods.
- Conveyance of contaminated adit discharges, seeps, and groundwater to the CTP for consolidated active treatment.

All active water treatment would take place at the CTP. Therefore, conveyance piping would be installed to transport contaminated water from each site to the CTP. To accommodate the additional water, the CTP would be expanded to treat greater volumes. A phased approach would be taken in the implementation of the conveyance pipelines and CTP expansion.

Stream and riparian cleanup actions in every major watershed within the Upper Basin are also included as part of Alternative 3+. The objective of the stream and riparian cleanup actions would be to improve bank and stream stability, thereby reducing erosion and sediment loading to the stream. This would include actions such as installation of current deflectors, vegetative bank stabilization, and sediment traps [additional details about stream and riparian cleanup actions can be found in the FFS Report (USEPA, 2010)]. Following the implementation of stream and riparian cleanup actions, the Natural Resource Trustees could then conduct restoration activities to further improve ecosystem function.

For OU 2, the Preferred Remedial Alternative component is Alternative (d) and is illustrated in Figure 20. OU 2 Alternative (d) consists of the following components:

- A phased approach to address adit drainage from the Reed and Russell Adit Tunnels within the Milo Gulch Watershed.



Notes:
CIA = Central Impoundment Area
CTP = Central Treatment Plant

[1]CTP effluent discharge pipeline my be conveyed to the SFCDR on the east side of the CIA (as pictured above) or along Bunker Creek.

N
0 2,000 4,000 Feet

Figure 20
Preferred Remedial Alternative: The Bunker Hill Box
Upper Basin Proposed Plan

- French drain installation between the CIA and the SFCDR and extending south to the eastern side of the mouth of Government Gulch, to reduce contaminated groundwater flow to the SFCDR.
- 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 lining and groundwater extraction wells on Government Creek. The stream lining would be accompanied by an upstream clean groundwater cutoff wall that would divert clean groundwater into the lined stream. Groundwater extraction wells at the mouth of Government Gulch and an associated conveyance system would intercept and transport contaminated groundwater to the CTP for treatment.

9.1.1 Benefits of the Preferred Remedial Alternative

The Preferred Remedial Alternative would provide greater protection of human health and the environment than is currently provided by the remedies for OUs 1, 2, and 3 identified in the RODs for the three OUs.

For OU 3, Alternative 3+ was identified as a component of 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. The key factors leading to the preference for Alternative 3+ over Alternative 4+ include:

- **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 (upstream of the Box) is 1.9. This estimated post-remediation AWQC ratio represents a substantial decrease from the current value of 5.5 and is similar to the estimated post-remediation AWQC ratio under Alternative 4+ (1.6). It is important to note this estimated decrease in AWQC ratio is for one location in the Upper Basin. Dramatic localized surface water quality improvements would be expected throughout the Upper Basin following remedial actions.
- **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 $1.27 billion, which is substantially ($640 million) less than the estimated cost for Alternative 4+ ($1.91 billion).

For OU 2, Alternative (d) was identified as a component of the Preferred Remedial Alternative because it would meet the CERCLA Threshold Criteria and provide the best balance of trade-offs based on the CERCLA Primary Balancing Criteria. The key factors leading to the preference for OU 2 Alternative (d) over the other remedial alternatives for OU 2 include:

- **Significant improvements in water quality.** OU 2 Alternative (d) would have the second best expected improvement of surface water quality of the OU 2 alternatives. OU 2 Alternative (d) is estimated to reduce the AWQC ratio for dissolved zinc in the SDCDR at Pinehurst from the current value of 5.2 to 1.7 (when coupled with Alternative 3+ actions in OU 3) at the completion of remedial actions. More dramatic localized improvements in the dissolved zinc AWQC ratio would likely be achieved in other areas of the Upper Basin where remedial actions occur. Additionally, Alternative (d) addresses surface water contamination in Government Gulch. Alternatives (a) and (b) are estimated to provide much smaller improvements in water quality than OU 2 Alternatives (c), (d), and (e), yet would incur nearly the same cost.
- **Fewer implementability concerns.** 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.
- **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 1,380 lb/day of zinc) from surface water through treatment than any other OU 2 alternative.
- **Relatively high long-term effectiveness.** There is relatively little difference between Alternatives (d) and (e) in terms of long-term 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 $39 million, which is substantially less (approximately $221 million) than the estimated cost for OU 2 Alternative (e).

The comprehensive remedial actions included in Alternative 3+(d) would provide substantial improvements in water quality, and would do so by incorporating groundwater-based approaches and providing treatment for lower-volume, higher-concentration waters. 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 overall benefits of the Preferred Remedial Alternative include the following:

- **Reduction of 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.

Following the implementation of Alternative 3+(d), the health of the Upper Basin fisheries is expected to improve dramatically.

- **Reduction of 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, to protect humans and wildlife from exposure and enable more Lower Basin cleanups to proceed.
- **Reduction of 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, 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.

Based on information currently available, USEPA believes that the Preferred Remedial Alternative meets the CERCLA Threshold Criteria and provides the best balance of tradeoffs among the alternatives evaluated with respect to the Primary Balancing Criteria. USEPA expects the Preferred Remedial Alternative to satisfy the following statutory requirements of CERCLA §121(b): (1) be protective of human health and the environment; (2) comply with ARARs; (3) be cost-effective; (4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and (5) satisfy the preference for treatment as a principal element.

9.2 Preferred Remedy Protection Alternative

As previously discussed, the purpose of the remedy protection component of the Preferred Alternative is to enhance the long-term effectiveness and permanence of the existing clean barriers installed as part of the human health remedies for OUs 1, 2, and 3. Analyses completed during the FFS found that portions of the existing remedies are vulnerable to damage resulting from relatively small storm events.

The Preferred Remedy Protection Alternative for the Upper Basin communities is Alternative RP-2. Alternative RP-2 is composed of combinations of various technology and process options, selected based on hydrologic and hydraulic analyses conducted for the eight primary Upper Basin communities, that would protect the existing human health remedies against stormwater and high SFCDR tributary flow events up to the 50-year storm event.

Figure 21 shows the eight Upper Basin communities where detailed analyses were conducted and specific Alternative RP-2 actions were identified in the FFS Report. Figure 21 also identifies areas outside the eight Upper Basin communities that are referred to as "side gulches".

Table 7 lists the actions included in the Preferred Remedy Protection Alternative for the eight primary Upper Basin communities that were identified during development of the FFS. During remedial design and implementation, these actions may be modified and/or augmented with

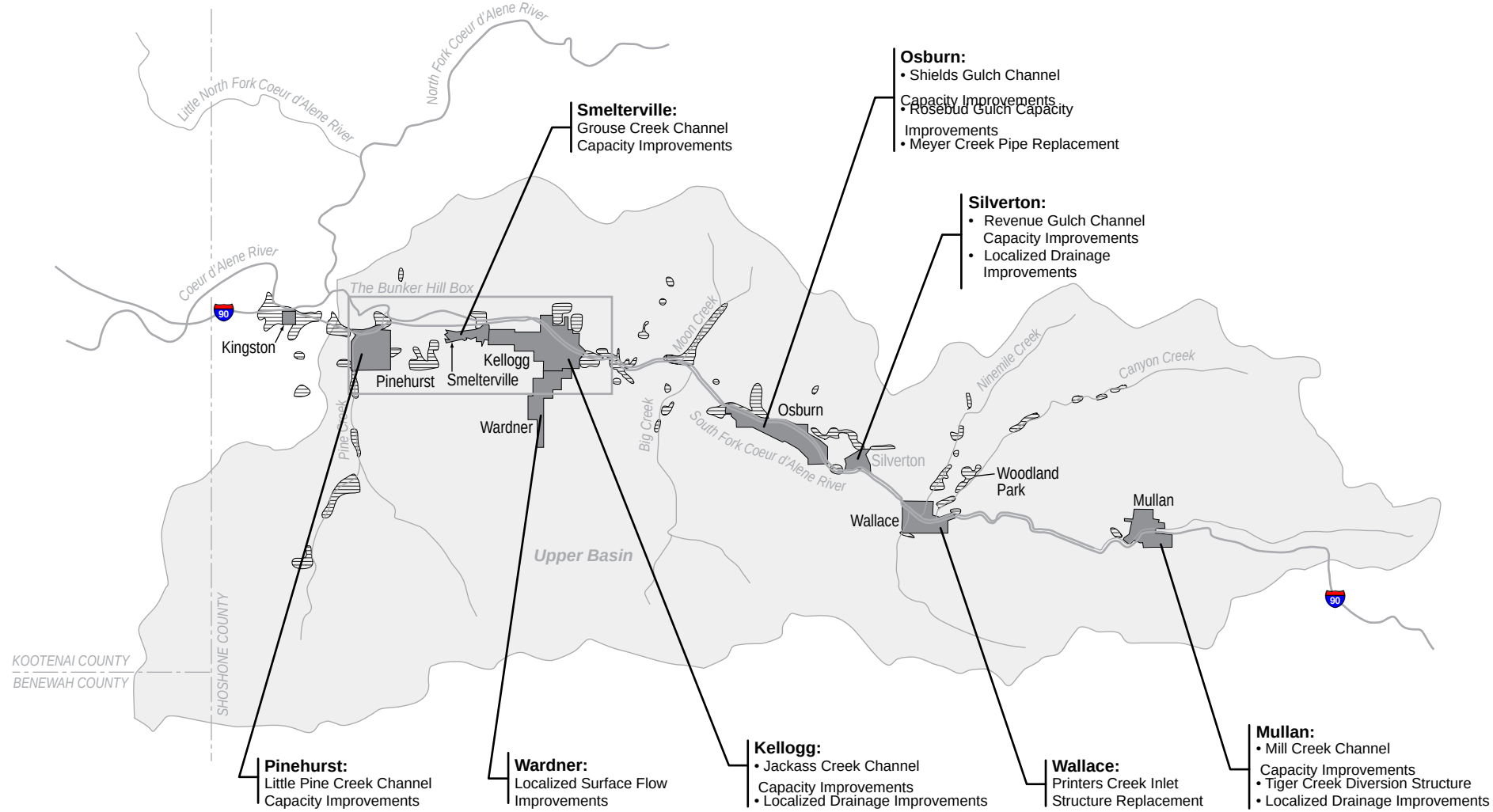


Figure 21
Remedy Protection Areas
Upper Basin Proposed Plan

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TABLE 7
Alternative RP-2 Actions in the Upper Basin Communities

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
	Portland Road	Asphalt-lined ditches and pipe culvert installation
	Italian Gulch[1]	Visual observation and documentation
	Localized Drainages[1]	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[1]	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[1]	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	Asphalt-lined ditches, pipe culvert installation, and stormwater catch basins

[1] Visual observation and documentation to be used for these locations to ensure existing stormwater systems continue to function.

other, similar actions to address issues encountered during the design phase, identified by stakeholder input, and/or other emergent considerations.

On-going maintenance of constructed Alternative RP-2 remedy protection projects will be essential to ensure remedy protection drainage improvements continue to function as designed. Easements and O&M agreements may be a necessary component of Alternative RP-2 to ensure long-term access and functionality of the remedy protection projects. If necessary to ensure long term maintenance of the remedy protection projects, USEPA, IDEQ, and the Work Trust will

also rely on local governments to ensure continued operation and maintenance as property use changes.

Potential remedy protection actions in the side gulches to the SFCDR would also be included as part of Alternative RP-2. During the FFS, detailed analyses were not conducted for the side gulches to determine the area of existing human health 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.

It should be noted that the side gulches and associated existing remedies generally have similar physical and topographical characteristics to the drainages that were analyzed in detail for the eight primary Upper Basin communities. The process for applying technologies and process options to the side gulches in the future will 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 existing 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. Selection of specific remedy protection process options for the side gulches will be accomplished through future Explanations of Significant Differences (ESD) or other decision documents.

9.2.1 Benefits of the Preferred Remedy Protection Alternative

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 remedies, which have been shown to be protective (USEPA, 2005), by decreasing the risk of recontamination due to tributary flooding and uncontrolled surface water flow. Alternative RP-2 would enhance the long-term effectiveness and permanence of the existing human health remedies, while Alternative RP-1 would only maintain and repair the existing remedies when they became damaged or recontaminated. By implementing technologies and process options to enhance the permanence of the existing 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 provide greater 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. This would reduce the potential routes of exposure to contamination by humans and ecological receptors and address concerns about the protectiveness of the existing remedies.

- **Fewer implementability issues.** Alternative RP-2 would have fewer implementability issues than 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, agreements will have to be completed regarding which state or local entity will perform O&M tasks associated with Alternative RP-2 and ensure that sufficient resources are available, or a determination will be made that a local regulatory scheme ensures performance of O&M. 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).

Based on information currently available, USEPA believes the Preferred Remedy Protection Alternative meets the CERCLA Threshold Criteria and provides the best balance of tradeoffs among the alternatives evaluated with respect to the Primary Balancing Criteria. USEPA expects the Preferred Remedial Alternative to satisfy the following statutory requirements of CERCLA §121(b): (1) be protective of human health and the environment; (2) comply with ARARs; (3) be cost-effective; and (4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.

10.0 Implementation of the Selected Remedy

The large number of cleanup actions identified in the Preferred Alternative for the Upper Basin would need to be planned carefully. Working through the Upper Basin Project Focus Team (PFT), USEPA has already begun the critical process of planning and prioritizing actions for implementation of the remedy that will be selected in the ROD Amendment for the Upper Basin, whether it is the Preferred Alternative or another remedy that is selected. The outcome of this effort will be an Implementation Plan, which will be developed as a separate document from the Upper Basin ROD Amendment.

This Implementation Plan will guide the actions selected in the ROD Amendment. The Implementation Plan will be a "living document", separate from the ROD Amendment, that will identify priority projects and guide cleanup actions into the future. The Implementation Plan will identify distinct phases of cleanup work from the ROD Amendment that will be conducted in the near term. These actions will then be evaluated to determine whether cleanup goals are being met. USEPA will develop and modify the Implementation Plan in close cooperation with state agencies, other federal agencies, Tribal representatives, and other involved parties, including the Coeur d'Alene Basin Natural Resource Trustees.

The Plan will use adaptive management to incorporate "lessons learned' and to guide future efforts to prioritize work. Adaptive management, illustrated in Figure 22, is a process wherein decisions are made as part of an ongoing science-based process or, as stated more simply, learning by doing. As noted in this section, the public will be involved in the development of the Implementation Plan. USEPA expects that its efforts to involve the public will continue as new phases of remedial actions are prioritized.

There may be situations in the future when new phases of an action for a particular area differ significantly from the remedial action selected in the ROD Amendment. In such instances, USEPA will provide opportunities for public participation consistent with the requirements of Section 113(k) of CERCLA and 40 CFR Section 300.435(c) of the NCP, and depending on the significance of change in the remedial approach, this may result in additional opportunities for public comment.

Adaptive management involves testing, monitoring, and evaluating applied strategies, and incorporating new knowledge, such as monitoring data, into management approaches that are based on scientific findings. Using adaptive management, the Implementation Plan will be a tool to help USEPA and others prioritize the implementation of actions selected in the ROD Amendment as more information becomes available on the effectiveness of initial cleanup actions. The Plan will be routinely updated as increments of work are completed and decisions are made for new phases of work to guide future decisionmaking and help document adjustments to project priorities based on new information.

An important consideration affecting the Implementation Plan will be the amount of funding available for remedial actions on an annual basis. USEPA recognizes the importance of securing and preserving sufficient resources to implement the forthcoming Upper Basin ROD Amendment and other cleanup actions throughout the Coeur d'Alene Basin. Therefore, the Implementation Plan will include assumptions about annual funding levels and information

about cleanup and restoration work conducted by other federal and state agencies, Natural Resource Trustees, and other parties in the Basin.

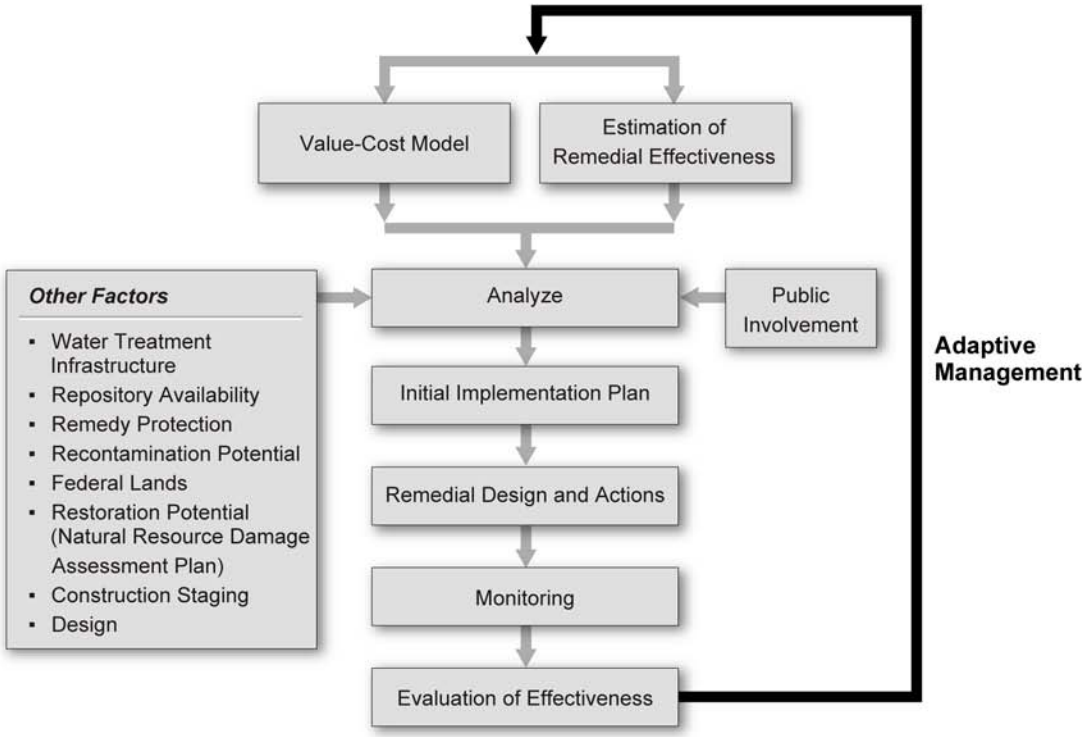

Figure 22
Adaptive Management Process
Upper Basin Proposed Plan

382081.FI.06.01.03_BunkerHill_ES042009003SEA . Fig. 22 Adaptive Management Chart_22June10.ai

EPA

10.1 Considerations for Implementation of the Remedial Alternative Selected in the ROD Amendment

Prior to and during implementation of the remedial alternative selected in the ROD Amendment, the following issues, at a minimum, will be considered for prioritization purposes:

- **Human health exposure to contaminated mine waste materials.** USEPA will place a higher priority on sites that present current exposure to individuals from contaminated mine wastes.
- **Metals loading to surface water.** USEPA will prioritize the implementation of remedial actions at sites based on each site's potential to add metals, such as lead and zinc to groundwater and surface water.
- **Potential for recontamination of cleaned areas.** USEPA will prioritize the implementation of remedial actions in order to reduce the potential for recontamination of previously

remediated areas. This typically means conducting work at sites that are topographically higher in a drainage area first in order to avoid recontamination from sites above them.

Additional factors that will be considered prior to the implementation of remedial actions include:

- **Water treatment.** Is water treatment necessary for the remedial action? What are the water flows and locations of the site? Can the water be treated with "passive" technology, or will it require piping the water to the CTP?
- **Repository space.** Is repository space needed, and is the space currently available?
- **Restoration work.** Is restoration work already planned by the Coeur d'Alene Basin Natural Resource Restoration Plan? Are there advantages of addressing relatively cleaner areas first in order to allow for restoration to proceed?
- **Construction staging.** How will construction be staged in order to minimize disruption in a community and make the cleanup of multiple sites in close proximity to each other the most efficient? How will work at a site be coordinated with property owners and/or allow for future development such as mining
- **Design needs.** What are the design needs for the remedial action (e.g., pre-design investigations and treatability studies)?
- **Stakeholder and community input.** USEPA will involve stakeholders and community members in the development of the Implementation Plan and during the implementation of cleanup actions. As currently envisioned, this will involve working through the Basin Commission process and the respective PFTs to revise the Implementation Plan on a regular basis, review the sites identified in that process, and seek input from stakeholders and community representatives on the sites selected. These activities will be documented in the Basin Commission work plans. (Note: USEPA is seeking input during the Proposed Plan comment period on the type and frequency of input for the Implementation Plan).

USEPA, consistent with its guidance, considered reasonably foreseeable future land uses in the Upper Basin during development of this Proposed Plan. During the implementation planning process and design of remedial actions, USEPA will consider a wide range of site-specific issues that will affect the implementation of the cleanup. These include (but are not limited to) current and future use, access, impacts to local residences, and impacts to ongoing or future site development such as mining activity. In addition, such things as timing of the action, staging, coordination with other work in the area, and coordination with the entity that would perform the work will be considered.

USEPA recognizes that mining and mineral processing have played an important role in the development of the Silver Valley. USEPA also recognizes that mining and mineral activities are likely to continue for the foreseeable future. USEPA intends to manage its Superfund responsibilities in the Upper Basin in a manner that will allow for responsible mining and mineral processing activities as well as exploration and development. Provided that environmental conditions are not exacerbated and that USEPA's ability to implement cleanup is not impeded, USEPA expects that future mining-related activities can be conducted in a manner that will not impair or interfere with the implementation of cleanup actions or the

protectiveness of any implemented cleanup actions. USEPA intends to work with entities interested in conducting mine and mineral processing activities to ensure that these activities and cleanup are responsibly implemented.

In addition to the specific work identified in the preferred alternative, post-ROD-Amendment pre-designs will be needed where there was insufficient information to fully evaluate the technology for a specific site. These will include evaluations of 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, and various stream and riparian cleanup actions. This approach is consistent with USEPA's adaptive management strategy for the site and will allow for the simultaneous implementation of small-scale remedial actions and pre-design studies.

Also, as noted earlier, USEPA and IDEQ have already solicited public input on repository siting, recognizing that repositories for containing waste materials should be sited in locations that meet the needs of the local residents as well as the needs of the overall cleanup. IDEQ has been leading the repository siting process for potential Basin repositories. This siting process has included many public meetings and workshops where citizens have been provided the opportunity to provide comment on both the siting process and the specific sites being considered. As additional repositories are needed to implement the selected remedy, a similar repository siting process will be conducted.

10.2 Considerations for Implementation of the Remedy Protection Alternative Selected in the ROD Amendment

Prior to implementation of the remedy protection alternative selected in the ROD Amendment, the following issues will be considered:

- **General prioritization of the remedy protection actions.** USEPA will work with local communities, IDEQ and other stakeholders to prioritize the remedy protection actions.
- **Coordination between source control actions and remedy protection actions**. Where possible, the implementation of source control actions that have potential to affect existing remedies and/or remedy protection actions will be coordinated. For example, there are some mine waste sites with potential for erosion located on hillsides above or adjacent to, existing human health barriers. These sites will be evaluated further and prioritized for cleanup if they are determined to pose significant recontamination potential to existing remedies.
- **O&M of remedy protection projects**. USEPA and IDEQ will coordinate with communities and other agencies and/or entities to ensure that proper O&M of remedy protection projects is conducted and ensure that sufficient resources are available, or determine that a local regulatory scheme ensures performance of O&M.

10.3 Focus Areas for the Implementation Plan

As discussed above, cleanup actions will be prioritized based on factors such as the potential for people and wildlife to be exposed to contaminated materials, how much contamination is expected to be removed or reduced as a result of the action, the potential

for recontamination of cleaned-up areas, the need for repository space, restoration needs, and construction staging and design needs. Given these considerations, working through the Upper Basin PFT, USEPA has to date identified the following activities that would likely be implemented as part of the initial phase of cleanup actions:

- Water treatment infrastructure projects to collect and convey contaminated groundwater to the CTP (In parallel with this effort, expansion of the CTP would occur in phases to provide capacity for the additional water.)
- Remedy protection projects
- Collection of additional information to refine the understanding of adit flows, location and identification of sites in side drainages that could compromise remedy protection work, and identification of potential locations for onsite consolidated waste areas
- Initiation of mine and mill site cleanups in the upper portions of drainages such as in Ninemile or Canyon Creek
- Identification of stream segments where water quality is closer to the cleanup goal, and limited actions completing the cleanup in these areas to allow for restoration work by the Natural Resource Trustees

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

11.0 Community Participation

Community involvement has played an essential part in developing the cleanup plan for the Upper Basin. The project spans a large geographic area that includes unique communities with diverse interests and points of view. Recognizing this, USEPA has presented a wide range of opportunities for people in the Basin to learn about and participate in the ROD Amendment process. Public interest regarding USEPA's activities has been high, and citizens have been actively involved in providing input. Some of USEPA's community involvement efforts are summarized here.

11.1 Involving the Community

Since 2008, USEPA Project Managers have been meeting with local organizations, community leaders, and local elected officials to discuss the forthcoming Upper Basin ROD Amendment. Their input has helped shape the process and the content of the technical documents. The agency has prepared fact sheets, news articles, responses to "Frequently Asked Questions", and other materials to help the public stay informed and involved. Materials have been provided by mail, email, paid newspaper advertisements, and via the Internet. USEPA maintains a webpage where people can find technical reports and memoranda, meeting presentations, community involvement documents, and other materials related to the ROD Amendment process (see page i.). USEPA has also worked with the media to share updates and involvement opportunities.

USEPA has collaborated with the Basin Commission, since its formation in 2001, to increase community participation. The public is welcome at meetings of the Basin Commission and its subgroups. USEPA has provided updates about the ROD Amendment process at each Basin Commission meeting since October 2008. Additionally, USEPA has worked with the Basin Commission's Technical Leadership Group and various Project Focus Teams (PFTs). The Upper Basin PFT was involved in creating the FFS Report (USEPA, 2010), participating with USEPA in more than a dozen technical meetings. Also, USEPA provided updates on this process to the Basin Commission's Citizen Coordinating Council at each of the council's meetings since February 2009.

Although it is not required by CERCLA, to respond to the high level of interest, USEPA is providing the public with the opportunity to review and comment on the Draft Final FFS Report and will address comments received on that draft final report. The Draft Final FFS Report is being made available to the public at the same time as this Proposed Plan.

11.2 Comment Period, Public Meeting, Open House

The public is encouraged to review and comment on USEPA's Preferred Alternative and on all the alternatives presented in the Proposed Plan, the Draft Final FFS Report, and documents available in the Administrative Record for the Upper Basin ROD Amendment.

Written comments on the Proposed Plan should be directed to:

cdabasin@epa.gov

or

Coeur d'Alene Basin Team
U.S. Environmental Protection Agency
1200 6th Avenue, Suite 900
MS ECL-113
Seattle, Washington 98101

Comments are due by August 25, 2010.

Following the comment period, USEPA will consider and respond to all comments and plans to issue the Upper Basin ROD Amendment in late 2010. The ROD Amendment will include a Responsiveness Summary with responses to comments received during the public comment period for this Proposed Plan. In response to the high level of public interest, USEPA has set a comment period of 45 days instead of the usual 30 days.

USEPA will hold a **Public Meeting** on August 4, 2010 at the Shoshone Medical Center, Health and Education Center, 858 Commerce Drive, in Smelterville, Idaho, from 7:00 p.m. to 8:30 p.m. Project Managers will give a presentation about the Proposed Plan. Members of the public are invited to present oral comments for the record. Written comments may also be submitted at the meeting. An **Open House** will take place before the Public Meeting, at the same location. The public can view displays, talk informally with agency representatives, learn about the cleanup, and submit written comments. Drop in any time between 5:00 p.m. to 6:30 p.m. There will be no formal presentations or recording of oral public comments at the Open House.

Once the ROD Amendment is issued, design and implementation of the cleanup actions will begin. Collaboration among the agencies, Tribes, local governments, and community members will be critical during this next phase of the cleanup effort.

12.0 Abbreviations and Acronyms

µg/dL	microgram(s) per deciliter
µg/L	microgram(s) per liter
ALAD	aminolevulinic acid dehydratase
AMD	acid mine drainage
ARAR	applicable or relevant and appropriate requirement
AWQC	ambient water quality criterion/criteria
BEMP	Basin Environmental Monitoring Program for Operable Unit 3
bgs	below ground surface
BLM	Bureau of Land Management, U.S. Department of the Interior
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CIA	Central Impoundment Area
COC	contaminant of concern
COPEC	contaminant of potential ecological concern
CTP	Central Treatment Plant
EcoRA	Ecological Risk Assessment
ED_{20}	effective dose—20 percent response
EMP	Environmental Monitoring Program for Operable Unit 2
ESCM	Enhanced Conceptual Site Model
ESD	Explanation of Significant Differences
ESRI	Environmental Systems Research Institute
FML	flexible membrane liner
FFS	Focused Feasibility Study
FS	Feasibility Study
GCL	geosynthetic clay liner
gpm	gallons per minute
HDPE	high-density polyethylene
HDS	high-density sludge

HHRA	Human Health Risk Assessment
IAC	Idaho Administrative Code
I&I	infiltration and inflow
ICP	Institutional Controls Program
IDAPA	Idaho Administrative Procedures Act
IDEQ	Idaho Department of Environmental Quality
IDHW	Idaho Department of Health and Welfare
IDTL	Initial Default Target Level
IDWR	Idaho Department of Water Resources
lb/day	pounds per day
LOAEL	lowest observed adverse effects level
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MOA	Mine Operations Area
NAS	National Academy of Sciences
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NHDPlus	National Hydrography Dataset Plus
NOAEL	no observed adverse effects level
NPL	National Priorities List
NPV	net present value
O&M	operation(s) and maintenance
OU	Operable Unit
PFT	Project Focus Team
PHD	Panhandle Health District
ppm	parts per million
PTM	principal threat materials
PRG	preliminary remediation goal
PRP	potentially responsible party

PVC	polyvinyl chloride
RADER	Risk Assessment Data Evaluation Report
RAO	remedial action objective
REM	Risk Evaluation Manual
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RME	reasonable maximum exposure
ROD	Record of Decision
ROW	right of way
SAIC	Science Applications International Corporation
SCA	Smelter Closure Area
SFCDR	South Fork of the Coeur d'Alene River
SRB	sulfate-reducing bioreactor
SR-PRB	sulfate-reducing permeable reactive barrier
TBC	to be considered
TCD	typical conceptual design
TI	Technical Impracticability
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USFS	U.S. Forest Service
USGS	U.S. Geological Survey

13.0 Glossary

acid mine drainage (AMD): The formation and movement of highly acidic water rich in heavy metals. This acidic water forms through the chemical reaction of surface water (rainwater, snowmelt, pond water) and shallow subsurface water with rocks that contain sulfur-bearing minerals, resulting in sulfuric acid. Heavy metals can be leached from rocks that come in contact with the acid, a process that may be substantially enhanced by bacterial action. The resulting fluids may be highly toxic and, when mixed with groundwater, surface water, and soil, may have harmful effects on humans, animals, and plants.

active water treatment: A treatment system that typically requires frequent or continuous operator attention and addition of treatment chemicals. Typically most appropriate for sites with good access and water with relatively high concentrations of metals.

adit: A horizontal or near-horizontal passage from a surface into a mine. Often called a tunnel, and sometimes referred to as a mine opening.

adaptive management: The act or process of adapting a management strategy to new or unforeseen conditions as they develop or are encountered.

Administrative Record: The complete body of documents that forms the basis for selecting Superfund response actions and making cleanup decisions, and is available for public review.

alluvium: Sediments transported and deposited by a flowing river.

ambient water quality criteria (AWQC): Federal regulatory criteria defining acceptable levels of contamination in surface water for protection of aquatic life. In the case of metals, AWQC vary with water hardness to account for increased toxicity at lower hardness levels. In 2002, the State of Idaho established site-specific AWQC values for the dissolved zinc and other metals in the SFCDR watershed. See also AWQC ratio.

applicable or relevant and appropriate requirements (ARARs): Those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental, state environmental, or facility siting laws that either (1) specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site (i.e., applicable standards), or (2) while not "applicable", address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site (i.e., relevant and appropriate standards). Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate.

AWQC ratio: 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. AWQC ratios are less variable than measured concentrations or calculated loads, and are not correlated with discharge except at very high discharges.

Basin: An area drained by the main stream and tributaries of a major river.

blood lead level: The amount of lead measured in human blood that can be used to decide whether a person may experience harmful health effects.

Bunker Hill Box: A 3-mile by 7-mile rectangular area adjacent to the lower South Fork of the Coeur d'Alene River. The Bunker Hill Box was the location of the lead smelter and other processing facilities and is the current location of the Central Impoundment Area (CIA) and the Central Treatment Plant (CTP).

Central Impoundment Area (CIA): Initially constructed in 1928 as a repository for tailings from the Bunker Hill mine. Over time has been developed into a managed Superfund repository for tailings, mine wastes, gypsum and other process wastes. The CIA covers about 260 acres and was closed in 2000 with an impermeable cap.

Central Treatment Plant (CTP): An active water treatment plant in Kellogg, Idaho that treats acid mine drainage (AMD) and metals-contaminated water. The CTP currently only treats contaminated water from the Kellogg Tunnel.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): The 1980 federal law, commonly known as Superfund, that authorized response actions for uncontrolled releases of hazardous substances to the environment. The law was updated and modified in 1986 by the Superfund Amendments and Reauthorization Act (SARA).

conveyance piping: Refers to piping used to direct water from the source of collection (e.g., adit drainage, French drain) to a water treatment system.

extraction well: A remedial action to intercept metals-laden groundwater prior to discharge into a surface water body.

floodplain: The flat or nearly flat land adjacent to a river or a stream that is covered by water during a flood.

Focused Feasibility Study (FFS): A Feasibility Study is an in-depth study designed to review the available information and data on the nature and extent of contamination at a Superfund site; establish the objectives for remedial action at the site; identify preliminary alternatives for remedial actions; evaluate the alternatives using criteria specified by CERCLA; and support the technical and cost analyses of the alternatives. In this case, USEPA has conducted an FFS because the complete Coeur d'Alene Basin was addressed by a Feasibility Study in 2001, and the focus of the current effort is on the Upper Basin. Otherwise the approach and methods used to conduct the study were similar.

French drain: A remedial action to intercept contaminated groundwater that would otherwise discharge to surface water. Collected water would be pumped to a water treatment system for treatment and subsequent discharge.

hydraulic isolation: The implementation of methods to control the movement of contaminated groundwater, including methods of preventing the discharge of contaminated groundwater into river systems.

Implementation Plan: A separate document from the ROD Amendment that will be used to prioritize remedial actions from the selected remedy. It will be a "living document" that will be modified as necessary based on pilot-scale tests and ongoing monitoring results.

institutional controls (ICs): Institutional controls are non-engineered instruments, such as administrative and legal controls, that help minimize the potential for human exposure to contamination and/or protect the integrity of the remedy.

Institutional Controls Program (ICP): There is an existing Institutional Controls Program (ICP) that provides a locally enforced set of rules and regulations established to maintain the integrity of installed barriers and to ensure that new barriers are installed during redevelopment that may occur within the administrative boundary of the ICP. The IC Program was adopted by the Idaho State Legislature and is administered by the Panhandle Health District.

Lower Basin. The Lower Basin includes the Coeur d'Alene River and its tributaries from the confluence of the North and South Forks downstream to the mouth of the Coeur d'Alene River at Coeur d'Alene Lake.

maximum contaminant level (MCL): The level of a contaminant in drinking water below which there is no known or expected risk to health.

National Oil and Hazardous Substances Pollution Contingency Plan (NCP): The federal regulation that guides determination of the sites to be investigated under the Superfund program.

Operable Unit (OU): An area (which can include multiple sites) that has been identified for investigation and/or cleanup under the Superfund program.

passive water treatment: A treatment system that is designed to function for extended periods of time with minimal operator attention or addition of treatment chemicals. Typically most appropriate for remote sites and/or water with relatively low concentrations of metals.

Record of Decision (ROD): A public document issued by USEPA that presents the selected remedy for cleanup of a site under Superfund. When the selected remedy is subsequently modified, a ROD Amendment is issued.

riparian: Occurring in or by the edge of a stream (including its floodplain).

risk assessment: An analysis of the available scientific information on existing and potential risks to human health and the environment. The analysis includes identifying contaminants of concern, calculating the amount of each contaminant that may have an unhealthy effect, and assessing the exposure that an individual (human or ecological) would receive in a particular setting.

stakeholder: An individual or an organization interested in the outcome of projects at the Bunker Hill Mining and Metallurgical Complex Superfund Site.

stream lining: A remedial action to reduce dissolved metals loading from groundwater to the stream. Includes the installation of a polyvinyl chloride (PVC) liner and a geotextile layer to act as a barrier.

tailings: By-products of ore processing that contain limited, but often significant, quantities of metals.

Upper Basin: In this Proposed Plan the Upper Basin is defined to include the South Fork of the Coeur d'Alene River, its tributaries downstream to the confluence of the South and North Forks

of the river, and the Bunker Hill "Box", a rectangular 21-square-mile area surrounding the former smelter complex.

waste rock: Rock derived from mining activities (not considered ore, but may be mineralized).

Work Trust: An entity created and funded pursuant to the Asarco, Inc. bankruptcy that operates as the Successor to Asarco solely for the purpose of performing, managing, and funding environmental response actions that have been selected and approved by USEPA as part of its comprehensive remedy for the Coeur d'Alene Basin.

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APPENDIX A

Preliminary Remediation Goals

Appendix A

Preliminary Remediation Goals

This appendix includes tables of preliminary remediation goals (PRGs) for environmental media in the Upper Basin. The tables include:

A-1 Preliminary Remediation Goals for Soil for Protection of Terrestrial Biota in the Upper Coeur d'Alene Basin

A-2 Preliminary Remediation Goals for Soil for Protection of Aquatic Birds and Mammals in the Upper Coeur d'Alene Basin

A-3 Preliminary Remediation Goals for Sediment for Protection of Human Health and Aquatic Organisms in the Upper Coeur d'Alene Basin

A-4 Preliminary Remediation Goals for Surface Water for Protection of Human Health and Aquatic Organisms in the Upper Coeur d'Alene Basin at Typical Hardness Values

A-5 Preliminary Remediation Goals for Surface Water as Drinking Water in the Upper Coeur d'Alene Basin

More detailed discussion of the PRGs for the Upper Basin and how they were selected is provided in the Focused Feasibility Study Report (U.S. Environmental Protection Agency, 2010).

Note that the final site-specific action or cleanup levels developed for the Upper Basin will be established in the forthcoming Record of Decision (ROD) Amendment and may differ from the PRGs presented in these tables.

TABLE A-1

Preliminary Remediation Goals for Soil (mg/kg) for Protection of Terrestrial Biota[a] in the Upper Coeur d'Alene Basin

Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

	Soil Biota[b]		Wildlife[b]			90th Percentile of Soil-Sediment Background	
Analyte	**Population/ Community**	**Individual/ NOAEL-based**	**Population/ LOAEL-based**	**Population/ ED_{20}-based**	**Site-specific PRG for Riparian Songbirds[b]**	**Upper Basin[c]**	**Idaho REM IDTLs[d]**
Arsenic	16.8	14	67	40	NA	22	0.391
Cadmium	10	9.8	105	386	NA	2.7	1.35
Copper	100	496	751	1021	NA	53	921
Lead	450	2.5	159	522	530	171	49.6
Mercury	None provided	None provided	None provided	None provided	NA	0.3e	.005
Zinc	106	27	434	261	NA	280	886

Notes:

[a] Birds and mammals occurring in upland, agricultural, and riparian habitats; terrestrial plants and invertebrates; and soil processes.

[b] See Attachment 4-1 in the Focused Feasibility Study Report for the Upper Basin of the Coeur d'Alene River (U.S. Environmental Protection Agency [USEPA], 2010). Based on analysis of site-specific data, various lines of evidence are available for evaluation (such as comparisons to single-chemical laboratory toxicity studies; toxicity testing using soil, sediments, or water from the Coeur d'Alene Basin; and field studies in the Basin) (Sources: Remedial Investigation/Feasibility Study Risk Assessment in USEPA, 2001a and 2001b; CH2M HILL, 2006; Hansen, 2007).

[c] Gott and Cathrall (1980), and selected by USEPA as background values in the Remedial Investigation for the Coeur d'Alene Basin (USEPA, 2001a).

[d] Idaho Risk Evaluation Manual (REM) (Idaho Department of Environmental Quality, 2004). IDTLs = Initial Default Target Levels. Arsenic based on surficial soil exposure pathway; all other metals based on groundwater protection pathway.

[e] USEPA, 2001a, *Final (Revision 2) Remedial Investigation Report, Coeur d'Alene Basin Remedial Investigation/Feasibility Study*, Volume 1, Part 7 (Summary), Table 3.2-1, "Selected Background Concentrations for Metals in the Basin".

ED_{20} = effective dose – 20 percent response
LOAEL = lowest observed adverse effects level
NOAEL = no observed adverse effects level
mg/kg = milligram(s) per kilogram
NA = not available

TABLE A-2

Preliminary Remediation Goals for Soil (mg/kg) for Protection of Aquatic Birds and Mammals[a] in the Upper Coeur d'Alene Basin

Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

	Wildlife[b]				
Analyte	**Individual/ NOAEL-based**	**Population/ LOAEL-based**	**Population/ ED_{20}-based**	**Site-specific Individual-level PRG for Waterfowl[b]**	**90th Percentile of Soil-Sediment Background, Upper Basin[c]**
Arsenic	54	222	138	NA	22
Cadmium	11.7	173	664	NA	2.7
Copper	1,606	2,157	2,209	NA	53
Mercury[d]	0.2	2.5	7	NA	0.3
Lead	3.65[e]	249[e]	718[e]	530	171
Zinc	5.3	519	390	NA	280

Notes:
[a] Birds and mammals occurring in palustrine, lacustrine, and riverine habitats.
[b] 10th percentile of individual-level sediment PRGs calculated for tundra swans, Canada geese, mallards, and wood ducks.
[c] Gott and Cathrall (1980).
[d] Mercury was not measured in Lower Basin sediment samples. Therefore, a background concentration could not be calculated.
[e] For the comparison used in the Ecological Risk Assessment (CH2M HILL and URS Greiner, 2001), analyses by Beyer et al. (2000) resulted in a waterfowl no-effect concentration of 24 mg/kg and a lowest-effect (reduced ALAD) activity concentration of 530 mg/kg. Using site-specific waterfowl mortality data, Beyer et al. further estimated that waterfowl mortality would begin to be observed at 1,800 mg/kg**.**

ALAD = aminolevulinic acid dehydratase
ED_{20} = effective dose – 20 percent response
LOAEL = lowest observed adverse effects level
NOAEL = no observed adverse effects level
mg/kg = milligram(s) per kilogram
NA = not available
PRG = preliminary remediation goal

TABLE A-3

Preliminary Remediation Goals for Sediment for Protection of Human Health and Aquatic Organisms in the Upper Coeur d'Alene Basin[a]

Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

	Preliminary Remedial Goals (PRGs) (mg/kg dry weight)	
Analyte	**Upper Basin [c]**	**NOAA SQuiRT[b]**
Arsenic	22	5.9 – 33
Cadmium	2.7	0.583 – 10
Copper	53	16 – 197
Lead	530	31 – 250
Mercury	0.3	0.174 – 2
Silver	1.1	0.5 – 4.5
Zinc	280	98 – 820

Notes:
[a] PRGs based on toxicity reference values; other PRGs default to background concentrations for those portions of the Basin.
[b] National Oceanic and Atmospheric Administration, 2008, Screening Quick Reference Tables (SQuiRT) -- Ranges for Freshwater Sediments.
[c] U.S. Environmental Protection Agency, 2008, *Ecological Soil Screening Levels (Eco-SSLs): freshwater sediment range for plants, soil biota, and avian and aquatic mammals.*

mg/kg = milligram(s) per kilogram

TABLE A-4

Preliminary Remediation Goals for Surface Water for Protection of Human Health and Aquatic Organisms in the Upper Coeur d'Alene Basin at Typical Hardness Values

Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

	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[c]	30	50	100	30	50	100	30	50	100	30	50	100	30	50	100	30	50	100
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	0.62	1.03	2.01	0.42	0.62	1.03	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. 1	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) 58.01.02.

[b] Criteria in micrograms per liter (µg/L) from IDAPA 58.0102.284. HUC = Hydrologic Unit Code.

[c] Hardness in milligrams of calcium carbonate 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 USEPA acts on a change to state water quality standards, the effective water column criteria for dissolved cadmium at 100 milligrams per liter (mg/L) hardness are summarized based on the 2005 version of IDAPA 58.01.02.210.01. A pending rule (Docket 58-0102-0801) before the 2010 Idaho Legislature will lower the cap on hardness for cadmium to 10 mg/L, which is expected to allow for USEPA approval and will change the cadmium aquatic life standards to 1.3 acute and 0.6 chronic accordingly.

[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 summarized in the table above (IDAPA 58.01.02.210.01, 2004).

N/A = not applicable

TABLE A-5

Preliminary Remediation Goals for Surface Water as Drinking Water in the Upper Coeur d'Alene Basin

Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

Metal	MCL[a] (μg/L)	MCLG (μg/L)	Public Water Systems Using Surface Water Sources[d] (μg/L)
Arsenic	10	None	10
Cadmium	5	5	5
Copper	1,300[b]	1,300	1,300
Lead	15 [b]	Zero	15
Mercury	2	2	2
Zinc[c]	5,000	5,000	5,000

Notes:

[a] Primary drinking water standards only (secondary standards are for protection of aesthetic qualities of water). U.S. Environmental Protection Agency, June 2003.
MCL = maximum contaminant level.

[b] Action level at the tap.

[c] Secondary drinking water standard.

[d] Idaho Administrative Procedures Act (IDAPA), Idaho Rules for Public Drinking Water Systems 58.01.08, Idaho Administrative Code (IAC) 2010.

MCLG = maximum contaminant level goal

μg/L = microgram(s) per liter

APPENDIX B

Typical Conceptual Designs

Appendix B

Typical Conceptual Designs

This appendix contains Table B-1, which lists summary descriptions of the typical conceptual designs (TCDs) used in the development of remedial alternatives for the Upper Basin. More detailed discussion of the TCDs for the Upper Basin and how they were developed and then selected for each source site is provided in the Focused Feasibility Study Report (U.S. Environmental Protection Agency, 2010).

TABLE B-1
Descriptions of Typical Conceptual Designs (TCDs)
Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

TCD Code	Name	Description
Source Control TCDs		
C01	Excavation (dry)	Physically remove solid waste material using equipment including backhoes, hydraulic excavators (trackhoes), draglines, bulldozers, and scrapers.
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.
02a through C02c	Regrade/Consolidate/ Revegetate	Reduce the potential for erosion and leaching of metals by regrading waste material and placing a vegetative cover.
C03	Low-Permeability Cap	Significantly reduce metals loads by substantially reducing infiltration through waste materials. Includes a geosynthetic clay liner (GCL) as part of the cap.
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.
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.
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.
C07	Waste Consolidation Area Above Flood Level	Same as C06 except this waste consolidation area is above the 100-year flood level.
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.
C09	Impoundment Closure	Address the closure of existing abandoned tailings impoundments or cells by capping the impoundment with a GCL and regrading.
HAUL-2	Haul to Repository	Transport the waste materials to a repository.
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.
C11a through C11j	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 to 50 feet. Only includes slurry wall on one side of the river. TCDs 11h through 11j include a drain.
C14a through C14c	Stream Lining	Reduce dissolved metals loading from groundwater to the stream and reduce surface water recharge of the aquifer with installation of polyvinyl chloride (PVC) liner and a geotextile layer keyed into the anchor trench. Lining ranges in width from 10 to 100 feet.
C15a through C15d	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 to 25 feet below ground surface (bgs).
C17a through C17e	Groundwater Extraction Well	Intercept metals-contaminated groundwater prior to discharge into a surface water body using extraction wells ranging from 20 to 70 feet deep.

TABLE B-1

Descriptions of Typical Conceptual Designs (TCDs)

Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

TCD Code	Name	Description
C18	SFCDR Diversion	Temporarily divert the South Fork Coeur d'Alene River (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.
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.
C-20	Check Dam	Prevent the flow of Bunker Hill Mine water into the Reed and Russell Adit Tunnels and out of the adit openings using check dams at tunnel entrances.
PIPE-1 through PIPE-4	Gravity Pipeline	Convey water to the treatment plant by gravity flow to the extent possible. Pipeline is assumed to be below-grade high-density polyethylene (HDPE) pipe ranging from 6 to 36 inches in diameter.
PRESSURE-PIPE-1 through -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.
PUMP-1 through PUMP-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 million gallons per day (MGD).
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 SFCDR. The waters 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.
WT02	Onsite Semi-Passive Water Treatment Using Lime Addition and Settling Pond(s)	Treat water onsite with modest operation 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.
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.
WT04a and WT04b	*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 either a 10-foot-deep (WT04a) or a 40-foot-deep (WT04b) barrier.
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.
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.

TABLE B-1
Descriptions of Typical Conceptual Designs (TCDs)
Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

TCD Code	Name	Description
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 wastes, or disposed of in a landfill. The hazardous substances would be disposed of in accordance with applicable regulations.
Stream and Riparian Cleanup Action 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.
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.
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.
BSBR-AVG	Bioengineered Revetments	Create a durable form of bank protection that provides riparian and in-stream 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.
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.
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.
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.

APPENDIX C

Comparative Analysis of Alternatives

Appendix C

Comparative Analysis of Alternatives

This appendix includes summary tables for the comparative analysis of the remedial action alternatives and remedy protection alternatives. The tables include:

C-1 Comparative Analysis of the No Action Alternative and Alternatives 3+(a) through 3+(e)

C-2 Comparative Analysis of Alternatives 4+(a) through 4+(e)

C-3 Comparative Analysis of Remedy Protection Alternatives

More detailed discussion of the comparative analysis of the alternatives for the Upper Basin is provided in the Focused Feasibility Study Report (U.S. Environmental Protection Agency, 2010).

TABLE C-1

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

Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

	OU 3 Component				
	Alternative 3+: More Extensive Removal, Disposal, and Treatment				
	OU 2 Component				
	OU 2 Alternative (a)	**OU 2 Alternative (b)**	**OU 2 Alternative (c)**	**OU 2 Alternative (d)**	**OU 2 Alternative (e)**
	Minimal Stream Lining	**Extensive Stream Lining**	**French Drains**	**Stream Lining/French Drain Combination**	**Extensive Stream Lining/French Drain Combination**
	Combined Upper Basin Alternative				
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					
No actions to reduce risks. Existing unacceptable risks to ecological receptors would remain unabated. Potential human health risks would remain unchanged. Contaminants would limit recovery of habitat structure and ecosystem function.	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 cleanup actions and creation of off-channel hydrologic units would improve stream stability and reduce sediment loading. Potential human health risks would be addressed by the above actions and additional access restrictions.	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. Under Alternative 3+(b), there would be no stream liner on the SFCDR as there is under Alternative 3+(a). Overall moderate AWQC-ratio reduction (3.0 compared to 5.2) for Pinehurst. Attainment of ARARs for surface water would require a period of natural source depletion.	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. Overall large AWQC-ratio reduction (1.8 compared to 5.2) for Pinehurst. Attainment of ARARs for surface water would require a period of natural source depletion.	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. Would provide slightly higher effectiveness than Alternative 3+(c) by providing additional benefits to the water quality in Government Creek. Overall large AWQC-ratio reduction (1.7 compared to 5.2) for Pinehurst.	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. Overall large AWQC-ratio reduction (1.5 compared to 5.2) for Pinehurst. Attainment of ARARs for surface water would require a period of natural source depletion.

TABLE C-1

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

Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

	OU 3 Component				
	Alternative 3+: More Extensive Removal, Disposal, and Treatment				
	OU 2 Component				
	OU 2 Alternative (a)	**OU 2 Alternative (b)**	**OU 2 Alternative (c)**	**OU 2 Alternative (d)**	**OU 2 Alternative (e)**
	Minimal Stream Lining	**Extensive Stream Lining**	**French Drains**	**Stream Lining/French Drain Combination**	**Extensive Stream Lining/French Drain Combination**
	Combined Upper Basin Alternative				
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 (continued)					
	Decontamination of structures would further address potential human health risks. Overall moderate AWQC-ratio reduction (2.9 compared to 5.2) for Pinehurst. Attainment of ARARs for surface water would require a period of natural source depletion.			Attainment of ARARs for surface water would require a period of natural source depletion.	
COMPLIANCE WITH ARARS					
Would not comply with chemical-specific ARARs for surface water until natural decay processes reduced loading to sufficient levels. Would not meet PRGs for soil and sediment. Location- and action-specific ARARs would not be applicable.	Would meet surface water ARARs after period of natural source depletion and would result in significantly reduce metals concentrations in surface water. Would meet PRGs for soil and sediment at locations where actions are taken. 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).

TABLE C-1

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

Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

	OU 3 Component				
	Alternative 3+: More Extensive Removal, Disposal, and Treatment				
	OU 2 Component				
	OU 2 Alternative (a)	**OU 2 Alternative (b)**	**OU 2 Alternative (c)**	**OU 2 Alternative (d)**	**OU 2 Alternative (e)**
	Minimal Stream Lining	**Extensive Stream Lining**	**French Drains**	**Stream Lining/French Drain Combination**	**Extensive Stream Lining/French Drain Combination**
	Combined Upper Basin Alternative				
No Action	**Alternative 3+(a)**	**Alternative 3+(b)**	**Alternative 3+(c)**	**Alternative 3+(d)**	**Alternative 3+(e)**
LONG-TERM EFFECTIVENESS AND PERMANENCE					
Does not meet either of the Threshold Criteria; therefore, Primary Balancing Criteria not evaluated.	Moderate reduction in expected post-remediation mass loadings in surface water (estimated 41% 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 from surface water. Risks from contaminated soil and sediment would be significantly reduced. Low residual risk to humans. Decontamination of structures and access restrictions would be effective. Remedy could effectively be maintained through monitoring, maintenance, and institutional controls. Moderate maintenance requirements for caps, stream and riparian cleanup	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). Low residual risk to humans. Decontamination of structures and access restrictions would be effective.	Large reduction in expected post-remediation mass loading in surface water (estimated 59% 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. Risks from contaminated soil and sediment would be significantly reduced. Low residual risk to humans. Decontamination of structures and access restrictions would be effective. See Alternative 3+(a). More linear feet of French drain are included in	Large reduction in expected post-remediation mass loading in surface water (estimated 60% 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. Risks from contaminated soil and sediment would be significantly reduced. Low residual risk to	Large reduction in expected post-remediation mass loadings (estimated 63% 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. Risks from contaminated soil and sediment would be significantly reduced. Low residual risk to humans. Decontamination of structures and access restrictions would be effective. See

TABLE C-1

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

Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

	OU 3 Component				
	Alternative 3+: More Extensive Removal, Disposal, and Treatment				
	OU 2 Component				
	OU 2 Alternative (a)	**OU 2 Alternative (b)**	**OU 2 Alternative (c)**	**OU 2 Alternative (d)**	**OU 2 Alternative (e)**
	Minimal Stream Lining	**Extensive Stream Lining**	**French Drains**	**Stream Lining/French Drain Combination**	**Extensive Stream Lining/French Drain Combination**
	Combined Upper Basin Alternative				
No Action	**Alternative 3+(a)**	**Alternative 3+(b)**	**Alternative 3+(c)**	**Alternative 3+(d)**	**Alternative 3+(e)**
LONG-TERM EFFECTIVENESS AND PERMANENCE (continued)					
	actions, sediment traps, French drains, and stream liners. High maintenance requirements for passive and active treatment.		this alternative, although less stream lining.	humans. Decontamination of structures and access restrictions would be effective. See Alternative 3+(a). More linear feet of French drain and slightly less stream lining would be included in this alternative.	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.
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT					
Does not meet either of the Threshold Criteria; therefore, Primary Balancing Criteria therefore not evaluated.	Satisfies the statutory preference for treatment. Estimated average flow rate from all sources to the CTP is approximately 11,500 gpm (290 lb/day). All of this flow is from OU 3. No water from OU 2 would be treated. Semi-passive treatment of 800 gpm (47 lb/day) would occur at 27 additional adits using either SRB or lime addition/precipitation. Volume of contaminated water would be reduced. Spent SRB substrate and hydroxide sludge require	Satisfies the statutory preference for treatment. See Alternative 3+(a).	Satisfies the statutory preference for treatment. 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 15,400 gpm (1,450 lb/day). The majority of this flow is from OU 3 with the exception of approximately 3,900 gpm (1,160 lb/day) from	Satisfies the statutory preference for treatment. Treatment processes and semi-passive treatment scheme are the same as for Alternative 3+(c).	Satisfies the statutory preference for treatment. 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 13,900 gpm (820 lb/day). The majority of this flow is from OU 3 with the exception of approximately 2,400 gpm (530 lb/day) from

TABLE C-1

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

Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

	OU 3 Component				
	Alternative 3+: More Extensive Removal, Disposal, and Treatment				
	OU 2 Component				
	OU 2 Alternative (a)	**OU 2 Alternative (b)**	**OU 2 Alternative (c)**	**OU 2 Alternative (d)**	**OU 2 Alternative (e)**
	Minimal Stream Lining	**Extensive Stream Lining**	**French Drains**	**Stream Lining/French Drain Combination**	**Extensive Stream Lining/French Drain Combination**
	Combined Upper Basin Alternative				
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 (continued)					
	disposal. It is assumed that these wastes would be disposed of onsite. Total volume requiring disposal is estimated to be 8,900 cy/y.		the French drains in OU 2. Total volume of treatment residuals requiring disposal is estimated to be 13,900 cy/y.		the French drains and extraction wells in OU 2. Total volume of treatment residuals requiring disposal is estimated to be 11,900 cy/y, less than that of Alternatives 3+(c) and 3+(d).
SHORT-TERM EFFECTIVENESS					
Does not meet either of the Threshold Criteria; therefore, Primary Balancing Criteria not evaluated.	Short-term risks to the community from construction traffic. Risks would be minimized by traffic control plans and selective repository siting. Limited risks to workers from remedial actions. Risks would be minimized with standard health and safety measures. Short-term environmental impacts could result from construction. These impacts would be minimized and mitigated through engineering controls and revegetation. through 3+(d).	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. 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.	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). Relative to other alternatives, Alternative 3+(e) would present the greatest short-term risks to workers. Implementation of this alternative may take approximately 60 to 100 years[c].

TABLE C-1

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

Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

	OU 3 Component				
	Alternative 3+: More Extensive Removal, Disposal, and Treatment				
	OU 2 Component				
	OU 2 Alternative (a)	**OU 2 Alternative (b)**	**OU 2 Alternative (c)**	**OU 2 Alternative (d)**	**OU 2 Alternative (e)**
	Minimal Stream Lining	**Extensive Stream Lining**	**French Drains**	**Stream Lining/French Drain Combination**	**Extensive Stream Lining/French Drain Combination**
	Combined Upper Basin Alternative				
No Action	**Alternative 3+(a)**	**Alternative 3+(b)**	**Alternative 3+(c)**	**Alternative 3+(d)**	**Alternative 3+(e)**
SHORT-TERM EFFECTIVENESS (continued)					
	In the context of current water quality in the SFCDR, these potential risks would be minimal. Implementation period would be approximately the same for Alternatives 3+(a) Based on estimated funding streams, this may be 50 to 90 years[c].				
IMPLEMENTABILITY					
Does not meet either of the Threshold Criteria; therefore, Primary Balancing Criteria therefore not evaluated.	No significant technical feasibility concerns. Significant uncertainties in construction volumes (OU 3) – 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.	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). In addition, the extensive French drains included in this alternative would add to the logistical issues noted.	See Alternative 3+(c). In addition, work in Government Gulch would add to the logistical issues noted.	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.

TABLE C-1

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

Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

	OU 3 Component				
	Alternative 3+: More Extensive Removal, Disposal, and Treatment				
	OU 2 Component				
	OU 2 Alternative (a)	**OU 2 Alternative (b)**	**OU 2 Alternative (c)**	**OU 2 Alternative (d)**	**OU 2 Alternative (e)**
	Minimal Stream Lining	**Extensive Stream Lining**	**French Drains**	**Stream Lining/French Drain Combination**	**Extensive Stream Lining/French Drain Combination**
	Combined Upper Basin Alternative				
No Action	**Alternative 3+(a)**	**Alternative 3+(b)**	**Alternative 3+(c)**	**Alternative 3+(d)**	**Alternative 3+(e)**
IMPLEMENTABILITY (continued)					
	Access for large equipment along with space for SFCDR diversion would pose significant logistical issues. Impacts of stream liners on river hydraulics would need to be evaluated. Treatability testing would be required for semi-passive treatment design. Significant difficulties would be encountered in acquiring land and obtaining approvals for repositories and active treatment conveyance pipelines and for obtaining borrow materials. Services, equipment, and technologies are all available, at least on a regional level.				Deeper excavations, if required, would increase the dewatering difficulties.
COST					
Total Capital Cost $0	**Total Capital Cost** $1,240,000,000	**Total Capital Cost** $1,200,000,000	**Total Capital Cost** $1,200,000,000	**Total Capital Cost** $1,210,000,000	**Total Capital Cost** $1,430,000,000
O&M Cost (30-Year NPV)[a] $0	**O&M Cost (30-Year NPV)[a]** $95,000,000	**O&M Cost (30-Year NPV)[a]** $94,900,000	**O&M Cost (30-Year NPV)[a]** $99,800,000	**O&M Cost (30-Year NPV)[a]** $101,000,000	**O&M Cost (30-Year NPV)[a]** $104,000,000

TABLE C-1

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

Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

	OU 3 Component				
	Alternative 3+: More Extensive Removal, Disposal, and Treatment				
	OU 2 Component				
	OU 2 Alternative (a)	**OU 2 Alternative (b)**	**OU 2 Alternative (c)**	**OU 2 Alternative (d)**	**OU 2 Alternative (e)**
	Minimal Stream Lining	**Extensive Stream Lining**	**French Drains**	**Stream Lining/French Drain Combination**	**Extensive Stream Lining/French Drain Combination**
	Combined Upper Basin Alternative				
No Action	**Alternative 3+(a)**	**Alternative 3+(b)**	**Alternative 3+(c)**	**Alternative 3+(d)**	**Alternative 3+(e)**
COST (continued)					
Total Cost (30-Year NPV)[b] $0	**Total Cost (30-Year NPV)[b]** $1,340,000,000	**Total Cost (30-Year NPV)[b]** $1,290,000,000	**Total Cost (30-Year NPV)[b]** $1,300,000,000	**Total Cost (30-Year NPV)[b]** $1,310,000,000	**Total Cost (30-Year NPV)[b]** $1,530,000,000
Does not meet either of the Threshold Criteria; therefore, Primary Balancing Criteria not evaluated.	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 although is still within the accuracy of the estimate relative to Alternatives 3+(a) through 3+(d). 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

Notes (continued):
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
cy/y = cubic yards per year

The above costs are presented rounded to three significant figures.

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

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 C-2
Comparative Analysis of Alternatives 4+(a) through 4+(e)
Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

OU 3 Component				
Alternative 4+: Maximum Removal, Disposal, and Treatment				
OU 2 Component				
OU 2 Alternative (a)	**OU 2 Alternative (b)**	**OU 2 Alternative (c)**	**OU 2 Alternative (d)**	**OU 2 Alternative (e)**
Minimal Stream Lining	**Extensive Stream Lining**	**French Drains**	**Stream Lining/French Drain Combination**	**Extensive Stream Lining/French Drain Combination**
Combined Upper Basin Alternative				
Alternative 4+(a)	**Alternative 4+(b)**	**Alternative 4+(c)**	**Alternative 4+(d)**	**Alternative 4+(e)**
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT				
Would reduce environmental risks with extensive removal and containment to address all known media above PRGs. Highest-performance containment using 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. 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. Overall moderate AWQC-ratio reduction (2.8 compared to 5.2) for Pinehurst.	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. Under Alternative 4+(b), there would be no stream liner on the SFCDR as there is under Alternative 4+(a). Overall moderate AWQC-ratio reduction (2.8 compared to 5.2) for Pinehurst. Attainment of ARARs for surface water would require a period of natural source depletion	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. Overall large AWQC-ratio reduction (1.6 compared to 5.2) for Pinehurst. Attainment of ARARs for surface water would require a period of natural source depletion.	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. Overall large AWQC-ratio reduction (1.5 compared to 5.2) for Pinehurst. Attainment of ARARs for surface water would require a period of natural source depletion.	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. Overall large AWQC-ratio reduction (1.3 compared to 5.2) for Pinehurst. Attainment of ARARs for surface water would require a period of natural source depletion.

TABLE C-2
Comparative Analysis of Alternatives 4+(a) through 4+(e)
Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

OU 3 Component				
Alternative 4+: Maximum Removal, Disposal, and Treatment				
OU 2 Component				
OU 2 Alternative (a)	**OU 2 Alternative (b)**	**OU 2 Alternative (c)**	**OU 2 Alternative (d)**	**OU 2 Alternative (e)**
Minimal Stream Lining	**Extensive Stream Lining**	**French Drains**	**Stream Lining/French Drain Combination**	**Extensive Stream Lining/French Drain Combination**
Combined Upper Basin Alternative				
Alternative 4+(a)	**Alternative 4+(b)**	**Alternative 4+(c)**	**Alternative 4+(d)**	**Alternative 4+(e)**
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT (continued)				
Attainment of ARARs for surface water would require a period of natural source depletion.				
COMPLIANCE WITH ARARS				
Would meet ARARs for surface water after a period of natural source reduction and would result in significantly reduce metals concentrations in surface water. Would meet PRGs for soil and sediment in locations where actions are taken. 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 C-2
Comparative Analysis of Alternatives 4+(a) through 4+(e)
Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

OU 3 Component				
Alternative 4+: Maximum Removal, Disposal, and Treatment				
OU 2 Component				
OU 2 Alternative (a)	**OU 2 Alternative (b)**	**OU 2 Alternative (c)**	**OU 2 Alternative (d)**	**OU 2 Alternative (e)**
Minimal Stream Lining	**Extensive Stream Lining**	**French Drains**	**Stream Lining/French Drain Combination**	**Extensive Stream Lining/French Drain Combination**
Combined Upper Basin Alternative				
Alternative 4+(a)	**Alternative 4+(b)**	**Alternative 4+(c)**	**Alternative 4+(d)**	**Alternative 4+(e)**
LONG-TERM EFFECTIVENESS AND PERMANENCE				
Moderate reduction in expected post-remediation mass loading in surface water (estimated 45% 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. Risks from contaminated soil and sediment would be significantly reduced. Low residual risk to humans. All areas posing significant risk would be cleaned up or contained. Remedy could effectively be maintained through monitoring, maintenance, and institutional controls. Moderate maintenance requirements for caps; low maintenance requirements for stream and riparian cleanup actions; high maintenance requirements for passive and active treatment.	See Alternative 4+(a).	See Alternative 4+(a). Large reduction in expected post-remediation mass loadings (estimated 63% 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. Risks from contaminated soil and sediment would be significantly reduced.	See Alternative 4+(a). 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. Risks from contaminated soil and sediment would be significantly reduced.	See Alternative 4+(a). Large reduction in expected post-remediation mass loadings (estimated 68% 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. Risks from contaminated soil and sediment would be significantly reduced.

TABLE C-2
Comparative Analysis of Alternatives 4+(a) through 4+(e)
Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

OU 3 Component				
Alternative 4+: Maximum Removal, Disposal, and Treatment				
OU 2 Component				
OU 2 Alternative (a)	**OU 2 Alternative (b)**	**OU 2 Alternative (c)**	**OU 2 Alternative (d)**	**OU 2 Alternative (e)**
Minimal Stream Lining	**Extensive Stream Lining**	**French Drains**	**Stream Lining/French Drain Combination**	**Extensive Stream Lining/French Drain Combination**
Combined Upper Basin Alternative				
Alternative 4+(a)	**Alternative 4+(b)**	**Alternative 4+(c)**	**Alternative 4+(d)**	**Alternative 4+(e)**
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT				
Satisfies the statutory preference for treatment. Estimated average flow rate from all sources to the CTP is approximately 14,000 gpm (184 lb/day). All of this flow is from OU 3. No water from OU 2 would be treated. Semi-passive treatment of 1,410 gpm (49 lb/day) would occur at 54 additional adits using either SRB or lime addition/precipitation. Volume of contaminated water would be reduced. Treatment residuals (Spent SRB media and hydroxide sludge) would require proper disposal to ensure that leaching of metals into the environment would not occur. It is assumed that these wastes would be disposed of onsite. Total volume requiring disposal is estimated to be 9,900 cy/y.	See Alternative 4+(a).	Treatment processes and semi-passive treatment scheme are the same as for Alternative 4+(a). Total volume of treatment residuals requiring disposal is greater, and estimated to be 14,900 cy/y. Estimated average flow rate from all sources to the CTP is approximately 17,900 gpm (1,350 lb/day). The majority of this flow is from OU 3 with the exception of approximately 3,900 gpm (1,160 lb/day) from the 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 17,900 gpm (1,330 lb/day). The majority of this flow is from OU 3 with the exception of approximately 3,900 gpm (1,150 lb/day) from the French drains and extraction wells in OU 2. Treatment residuals volumes are approximately the same as for Alternative 4+(c).	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 16,400 gpm (720 lb/day). The majority of this flow is from OU 3 with the exception of approximately 2,400 gpm (531 lb/day) from the French drains and extraction wells in OU 2. 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). Total volume of treatment residuals requiring disposal is greater than Alternative 4+(a) and (b) but less than Alternatives 4+(c) and (d), and is estimated to be 12,900 cy/y

TABLE C-2
Comparative Analysis of Alternatives 4+(a) through 4+(e)
Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

OU 3 Component				
Alternative 4+: Maximum Removal, Disposal, and Treatment				
OU 2 Component				
OU 2 Alternative (a)	**OU 2 Alternative (b)**	**OU 2 Alternative (c)**	**OU 2 Alternative (d)**	**OU 2 Alternative (e)**
Minimal Stream Lining	**Extensive Stream Lining**	**French Drains**	**Stream Lining/French Drain Combination**	**Extensive Stream Lining/French Drain Combination**
Combined Upper Basin Alternative				
Alternative 4+(a)	**Alternative 4+(b)**	**Alternative 4+(c)**	**Alternative 4+(d)**	**Alternative 4+(e)**
SHORT-TERM EFFECTIVENESS				
Potentially significant short-term risks to the community from construction traffic. Risks would be minimized by traffic control plans and selective repository siting. 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+. Significant and ongoing impacts to environment during several decades (or more) of construction. In the context of current water quality in the SFCDR, these potential risks would be minimal. Approx. 80 to 130 years[c] to implement actions for Alternatives 4+(a) through 4+(d). Additional time would be required for natural source depletion to attain ARARs in surface water. In addition, water treatment would need to continue beyond the	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. 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. Approx. 80 to 130 years[c] to implement actions. Additional time would be required for natural source depletion to attain ARARs for surface water; 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. In addition, water treatment would need to be continued beyond the Remedy Implementation	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. 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. Approximately 90 to 140 years to implement actions. Less time would be required for natural source depletion to attain ARARs for surface water given the lower predicted AWQC ratios at remedy completion. In addition, water treatment would need to be continued beyond the Remedy Implementation Phase for an unknown period of time.

TABLE C-2
Comparative Analysis of Alternatives 4+(a) through 4+(e)
Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

OU 3 Component				
Alternative 4+: Maximum Removal, Disposal, and Treatment				
OU 2 Component				
OU 2 Alternative (a)	**OU 2 Alternative (b)**	**OU 2 Alternative (c)**	**OU 2 Alternative (d)**	**OU 2 Alternative (e)**
Minimal Stream Lining	**Extensive Stream Lining**	**French Drains**	**Stream Lining/French Drain Combination**	**Extensive Stream Lining/French Drain Combination**
Combined Upper Basin Alternative				
Alternative 4+(a)	**Alternative 4+(b)**	**Alternative 4+(c)**	**Alternative 4+(d)**	**Alternative 4+(e)**
SHORT-TERM EFFECTIVENESS (continued)				
Remedy Implementation Phase for an unknown period of time.		Phase for an unknown period of time.		
IMPLEMENTABILITY				
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. Treatability testing would be required as with Alternatives 3+(a) through 3+(e). Major difficulties in acquiring land and obtaining approvals for repositories and active treatment pipelines, obtaining borrow materials, and coordinating truck traffic. Services, equipment, and technologies are all available, at least on a regional level.	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.

TABLE C-2
Comparative Analysis of Alternatives 4+(a) through 4+(e)
Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

OU 3 Component				
Alternative 4+: Maximum Removal, Disposal, and Treatment				
OU 2 Component				
OU 2 Alternative (a)	**OU 2 Alternative (b)**	**OU 2 Alternative (c)**	**OU 2 Alternative (d)**	**OU 2 Alternative (e)**
Minimal Stream Lining	**Extensive Stream Lining**	**French Drains**	**Stream Lining/French Drain Combination**	**Extensive Stream Lining/French Drain Combination**
Combined Upper Basin Alternative				
Alternative 4+(a)	**Alternative 4+(b)**	**Alternative 4+(c)**	**Alternative 4+(d)**	**Alternative 4+(e)**
COST				
Total Capital Cost $1,840,000,000	**Total Capital Cost** $1,800,000,000	**Total Capital Cost** $1,800,000,000	**Total Capital Cost** $1,810,000,000	**Total Capital Cost** $2,030,000,000
O&M Cost (30-Year NPV) [a] $145,000,000	**O&M Cost (30-Year NPV)** [a] $145,000,000	**O&M Cost (30-Year NPV)** [a] $150,000,000	**O&M Cost (30-Year NPV)** [a] $151,000,000	**O&M Cost (30-Year NPV)** [a] $154,000,000
Total Cost (30-Year NPV) [b] $1,990,000,000	**Total Cost (30-Year NPV)** [b] $1,950,000,000	**Total Cost (30-Year NPV)** [b] $1,950,000,000	**Total Cost (30-Year NPV)** [b] $1,960,000,000	**Total Cost (30-Year NPV)** [b] $2,180,000,000
Costs for Alternatives 4+(a) through 4+(d) are very similar and within the accuracy of the estimate (-30/+50%).Costs for alternatives based on Alternative 4+ are higher 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 (-30/+50%).Costs for alternatives based on Alternative 4+ are higher 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 (-30/+50%).Costs for alternatives based on Alternative 4+ are higher 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 (-30/+50%). Costs for alternatives based on Alternative 4+ are higher than corresponding alternatives based on Alternative 3+.	This alternative has a relatively high cost although is still within the accuracy of the estimate relative to Alternatives 4+(a) through 4+(d). Costs for alternatives based on Alternative 4+ are higher than corresponding alternatives based on Alternative 3+.

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

Notes (continued):
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

The above costs are presented rounded to three significant figures.

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

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 C-3

Comparative Analysis of Remedy Protection Alternatives

Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

	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 maintain 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 maintain 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 of 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	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 would

TABLE C-3

Comparative Analysis of Remedy Protection Alternatives

Proposed Plan, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

	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)
		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.	reduce 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 would 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 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 technologies and process options applied for Alternative RP-2 are standard engineering practices. There could be administrative issues that arise in regard to which state or local entity will perform and fund the O&M tasks associated with Alternative RP 2. Additionally, there could be logistical challenges to performing 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[1]	NA	$13,700,000
	O&M Cost (30-Year NPV) for Upper Basin Communities[1]	NA	$4,980,000
	Total Cost (30-Year NPV) for Upper Basin Communities[1]	$33,800,000	$18,800,000
	Total Capital Cost for Side Gulches[2]	NA	$10,900,000
	O&M Cost (30-Year NPV) for Side Gulches[2]	NA	$4,180,000
	Total Cost (30-Year NPV) for Side Gulches[2]	$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

Notes (continued):
NA = not applicable

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

[2] Side gulch costs for Alternatives RP-1 and RP-2 are approximate based on assumptions discussed in Appendix D of the FFS Report.

The above costs are presented rounded to three significant figures.

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

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.

APPENDIX D

Preferred Remedial Alternative Actions by Watershed

Appendix D

Preferred Remedial Alternative Actions by Watershed

This appendix includes figures depicting the proposed source control remedial actions for Alternative 3+ by watershed, water treatment actions in the Upper Basin for Alternative 3+(d), OU 2 Alternative (d), and an example of how specific actions, in terms of typical conceptual designs (TCDs), were selected at two of the source sites included in the Preferred Alternative. More detailed discussion of the specific actions and how they were selected is provided in the Focused Feasibility Study Report for the Upper Basin of the Coeur d'Alene River (U.S. Environmental Protection Agency, 2010).

The remedial action figures include:

D-1 Overview of Remedial Actions, Alternative 3+, Upper SFCDR Watershed
D-2 Overview of Remedial Actions, Alternative 3+, Canyon Creek Watershed
D-3 Overview of Remedial Actions, Alternative 3+, Ninemile Creek Watershed
D-4 Overview of Remedial Actions, Alternative 3+, Big Creek Watershed
D-5 Overview of Remedial Actions, Alternative 3+, Moon Creek Watershed
D-6 Overview of Remedial Actions, Alternative 3+, Pine Creek Watershed
D-7 Overview of Remedial Actions, Alternative 3+, Mainstem SFCDR Watershed
D-8 Water Treatment Approach, Alternative 3+(d)
D-9 OU 2 Alternative (d): Stream Lining/French Drain Combination

Table D-1 includes the legend of Bureau of Land Management (BLM) site names shown on the figures.

The general manner by which TCDs were selected is described in Section 7.0 of the Proposed Plan. By way of example, the following presents the general logic used to select TCDs for specific waste types at two source sites. A similar process was used for other source areas and is documented in the Focused Feasibility Study.

Success Mine and Mill Site (BLM Sites OSB044, OSB088, and OSB089)

The Success Mine and Mill Site includes three source sites in the Ninemile Creek Watershed (see Figures D-3 and D-8). It includes a large jig tailings pile and a waste rock pile (OSB044), and two discharging adits (Success No. 3 [OSB088] and Alameda [OSB089]). Of note:

- The site has been identified as the largest source of metals loading in the Ninemile Creek Watershed, contributing approximately 37 percent and 87 percent of the total cadmium, lead, and zinc load to the East Fork of Ninemile Creek at high and low discharge, respectively.
- The predominant source of metals loading is theorized to be groundwater that flows through the on-site jig tailings pile and ultimately discharges into the East Fork of Ninemile Creek. The Success No. 3 adit discharges water containing very high concentrations of zinc.

Remedial actions selected as part of the Preferred Alternative for these source sites based on source material type include:

- Tailings and floodplain sediments: The most protective actions are applied to the jig tailings and floodplain sediments, because these sources are the most significant sources of metals loading. The jig tailings and floodplain sediments would be removed by excavation to an offsite waste consolidation area.
- Waste rock: The waste rock pile is a less significant source of metals loading and therefore received a less protective action that includes regrading, consolidating, and revegetating the waste rock pile onsite.
- Adit drainages: The adit drainages contain high concentrations of zinc and are also considered a significant source of metals loading. As such, the most protective water treatment action, active treatment at the Central Treatment Plant, was applied to the adit drainages (see Figure D-8).

Hercules No. 5 (BLM Site BUR098)

The Hercules No. 5 site is located in the Canyon Creek watershed (see Figures D-2 and D-8). It includes an adit that seasonally discharges high loads of metals, a waste rock pile that is retained at a very steep angle by deteriorating wooden cribbing, and abandoned structures. Surface samples from the waste pile contain elevated levels of cadmium, lead, and zinc.

Remedial actions selected as part of the Preferred Alternative for this source site based on source material type include:

- Waste rock: Though waste rock piles are generally a less significant source of metals loading, at this site the elevated levels of metals found in surface samples combined with the deteriorating cribbing and structures holding the pile in place require a more protective action in Alternative 3+. This action includes removal by excavation of the waste rock pile to a nearby waste consolidation area.
- Adit drainage: The adit drainage at this site contains high loads of metals and is considered a significant source of metals loading. As such, the most protective water treatment action, active treatment at the Central Treatment Plant, was applied to the adit drainage (see Figure D-8).

TABLE D-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.

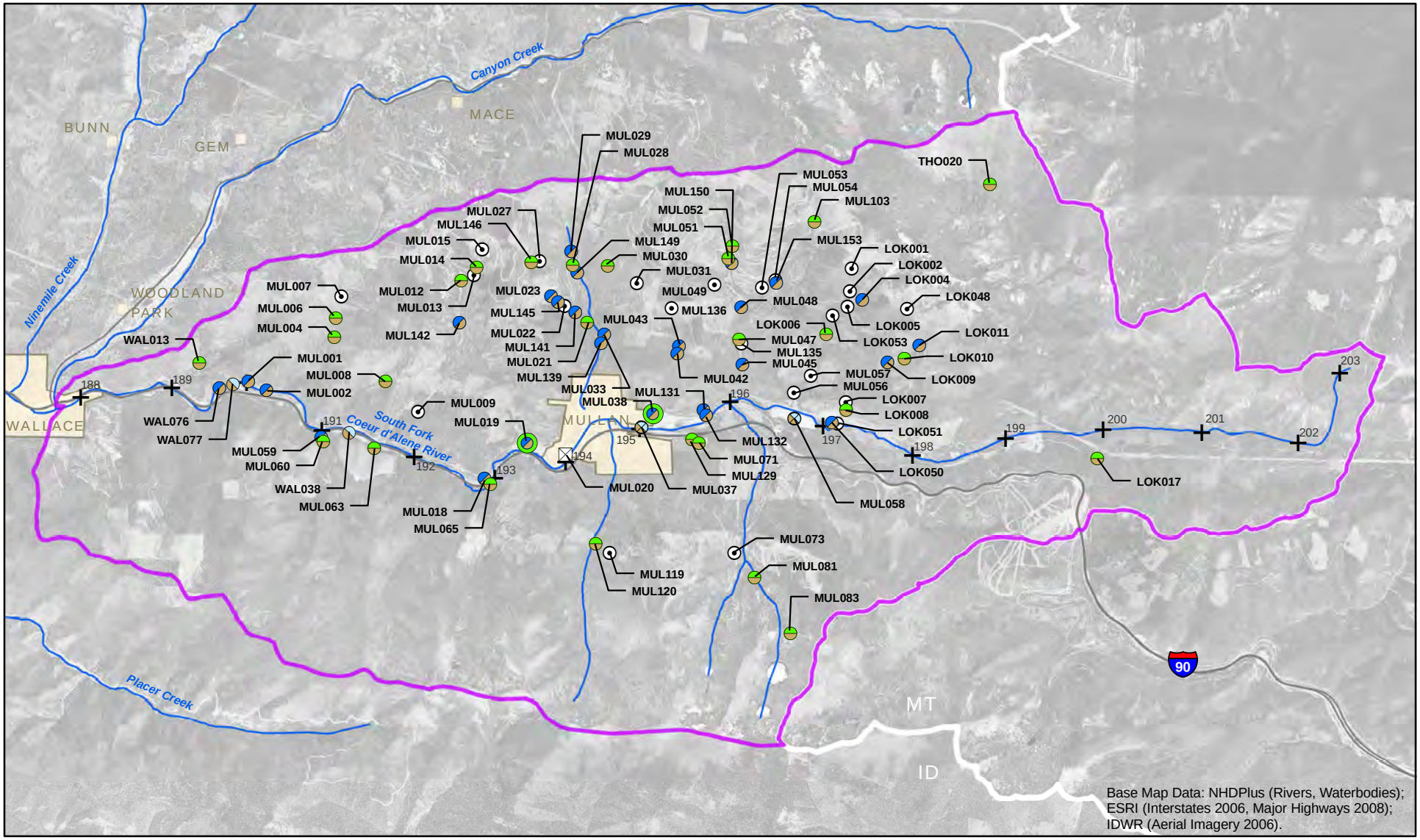
KLE020	New Hilarity Mine
KLE021	Alhambra Mine
KLE023	Pioneer Mines Inc. Property
KLE033	Polaris Mine
KLE034	Silver Dollar Mine
KLE035	Silver Summit Mine
KLE040	SFCDR Impacted Floodplain: No.5
KLE042	Moon Ck Pond at Mouth
KLE048	SFCDR SVNRT Rehab
KLE049	SFCDR Impacted Riparian (MIDGRADSEG01 & MIDGRADSEG02)
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

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

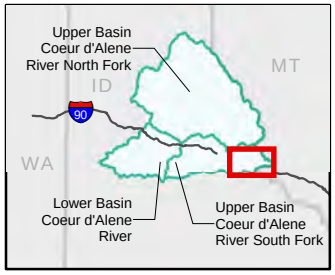
MAS053	Unnamed Adits
MAS054	Marmion or South Fork Fraction
MAS055, 057	Unnamed Adit
MAS065	Unnamed Prospect
MAS068, 072	Unnamed Adit
MAS078	Highland-Surprise Mine & Millsite
MAS079	Highland-Surprise Lower Rock Dump
MAS083	Nabob Millsite
MAS084	Douglas Minesite Tailings Repository
TWI002	Palisade Mine 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
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



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

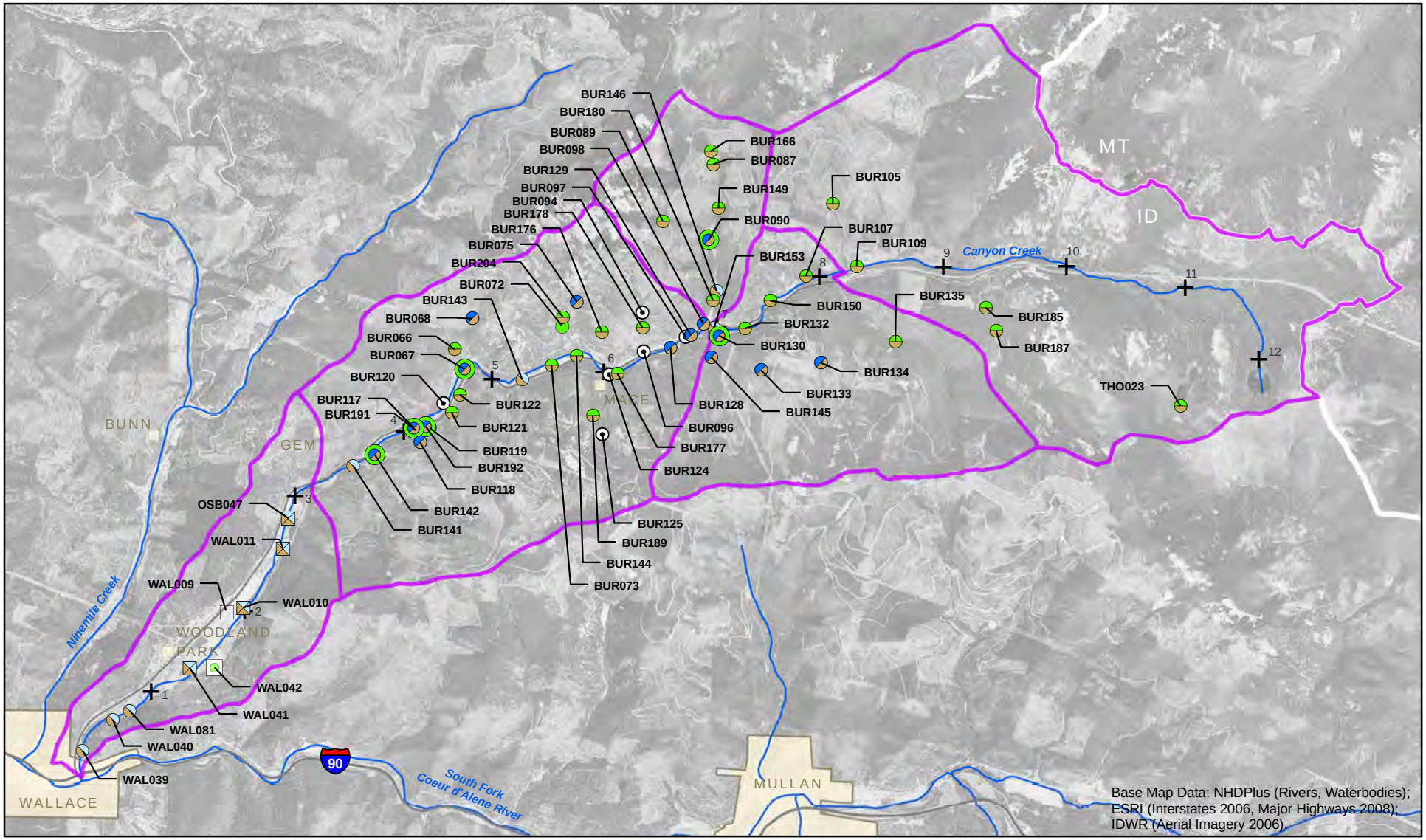
Note: See Table B11-1 for a list of site names.

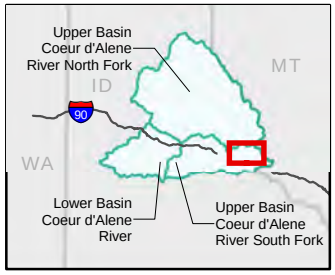
N

0 0.5 1 Miles

Figure D-1
Overview of Remedial Actions, Alternative 3+, Upper SFCDR Watershed
Upper Basin Proposed Plan

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)
- 4 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 D-2
Overview of Remedial Actions, Alternative 3+, Canyon Creek Watershed
Upper Basin Proposed Plan

EPA

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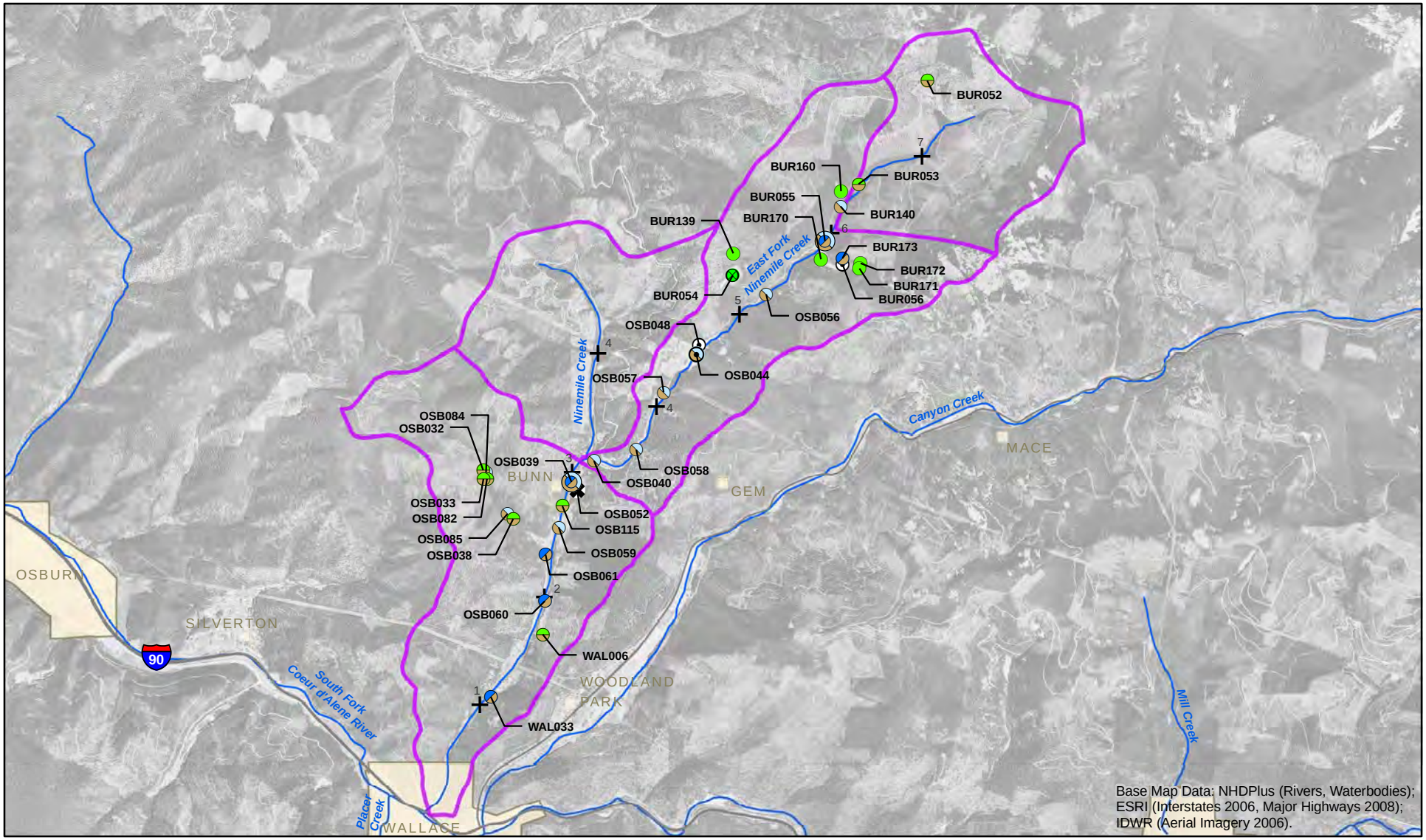
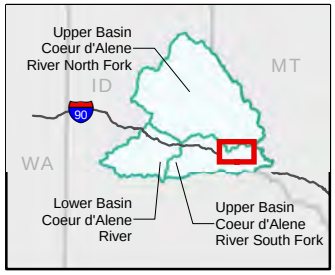


Base Map Data: NHDPlus (Rivers, Waterbodies); ESRI (Interstates 2006, Major Highways 2008); IDWR (Aerial Imagery 2006).



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 D-3
Overview of Remedial Actions, Alternative 3+, Ninemile Creek Watershed
Upper Basin Proposed Plan

EPA

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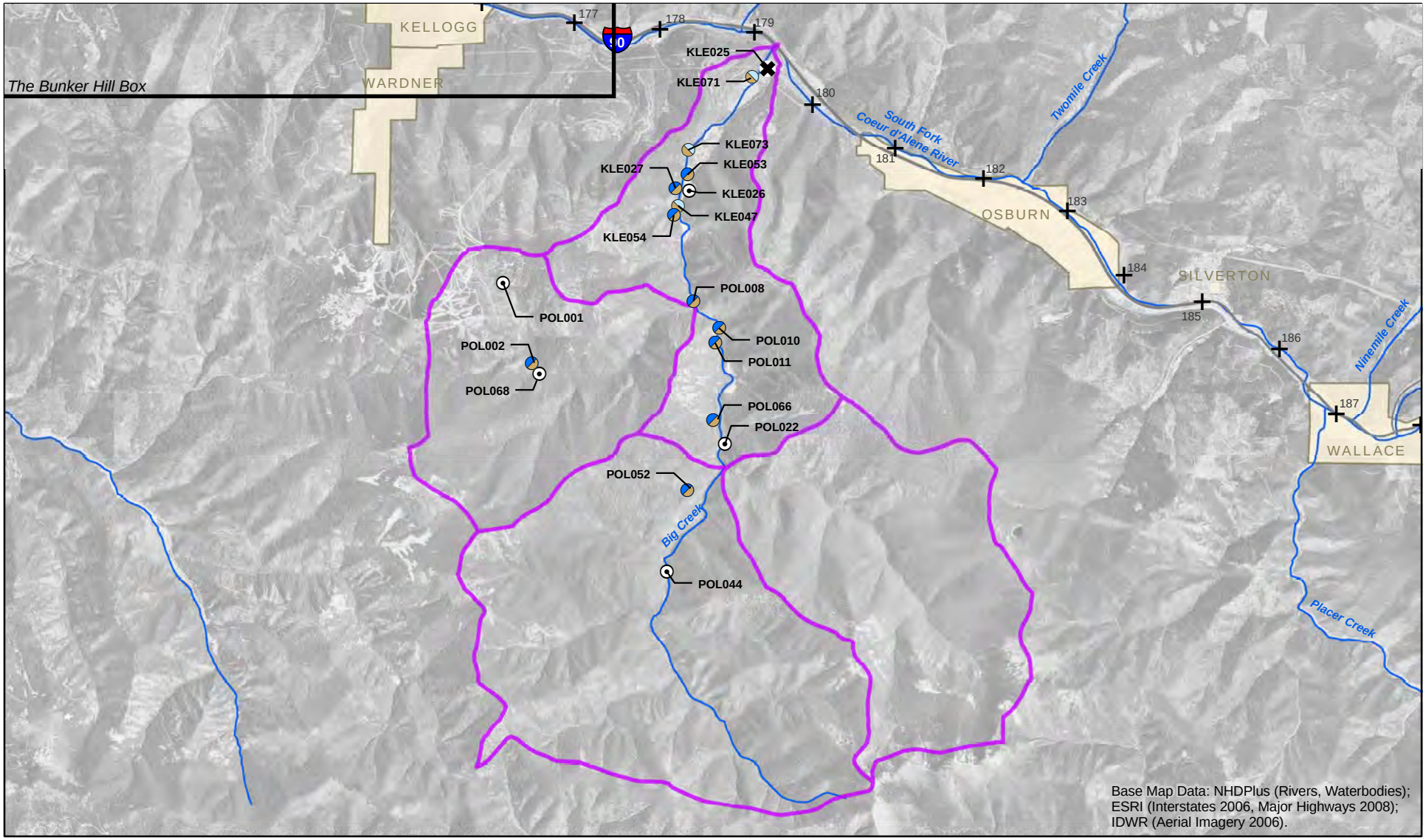
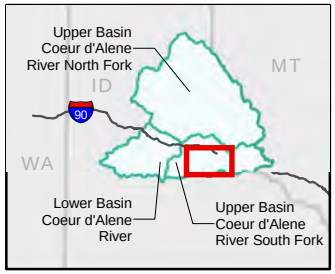




Remedial Action Types:

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

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

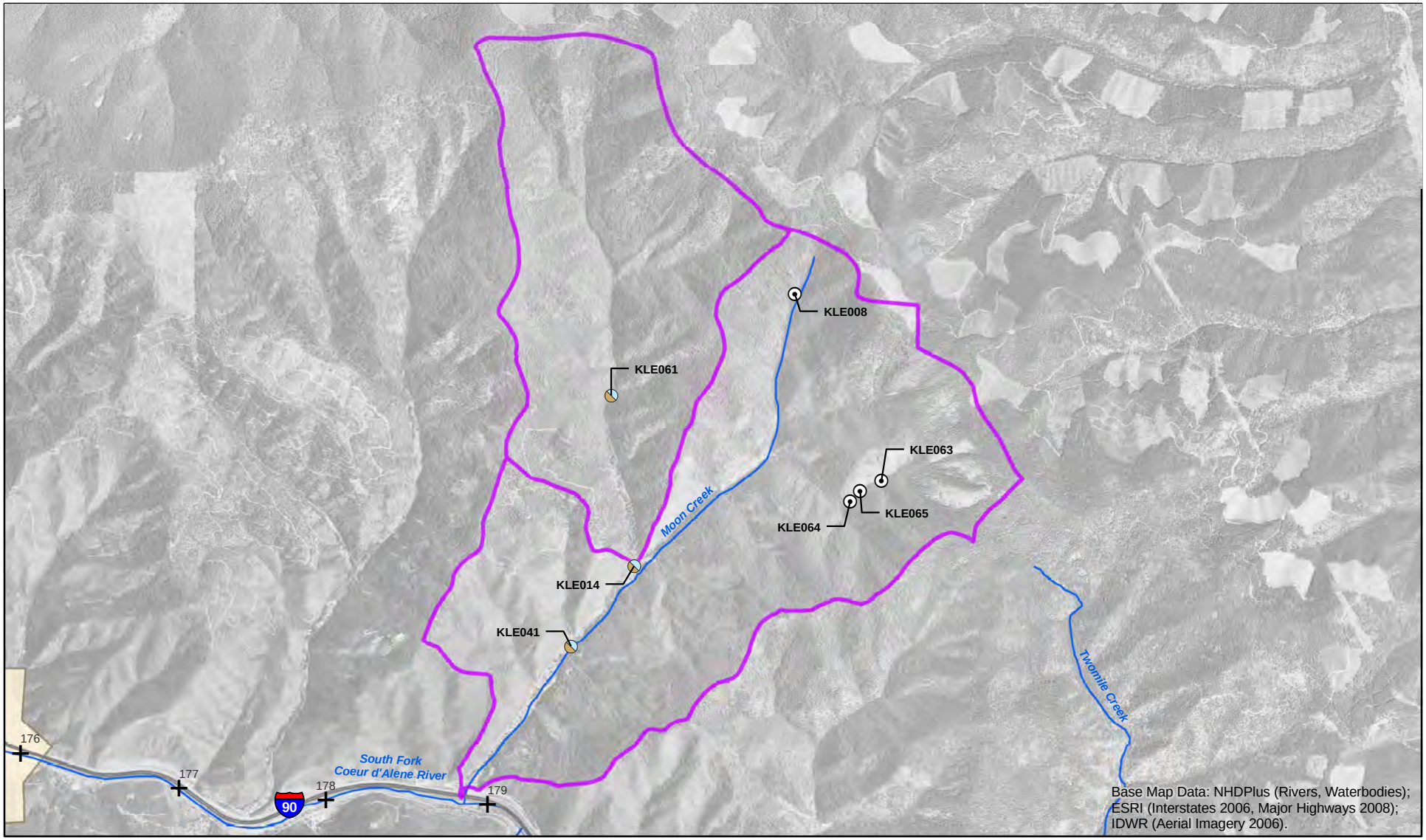
Note: See Table B11-1 for a list of site names.

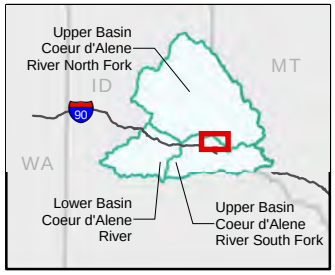
N

0 0.5 1 Miles

Figure D-4
Overview of Remedial Actions, Alternative 3+, Big Creek Watershed
Upper Basin Proposed Plan

EPA





Remedial Action Types:

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

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

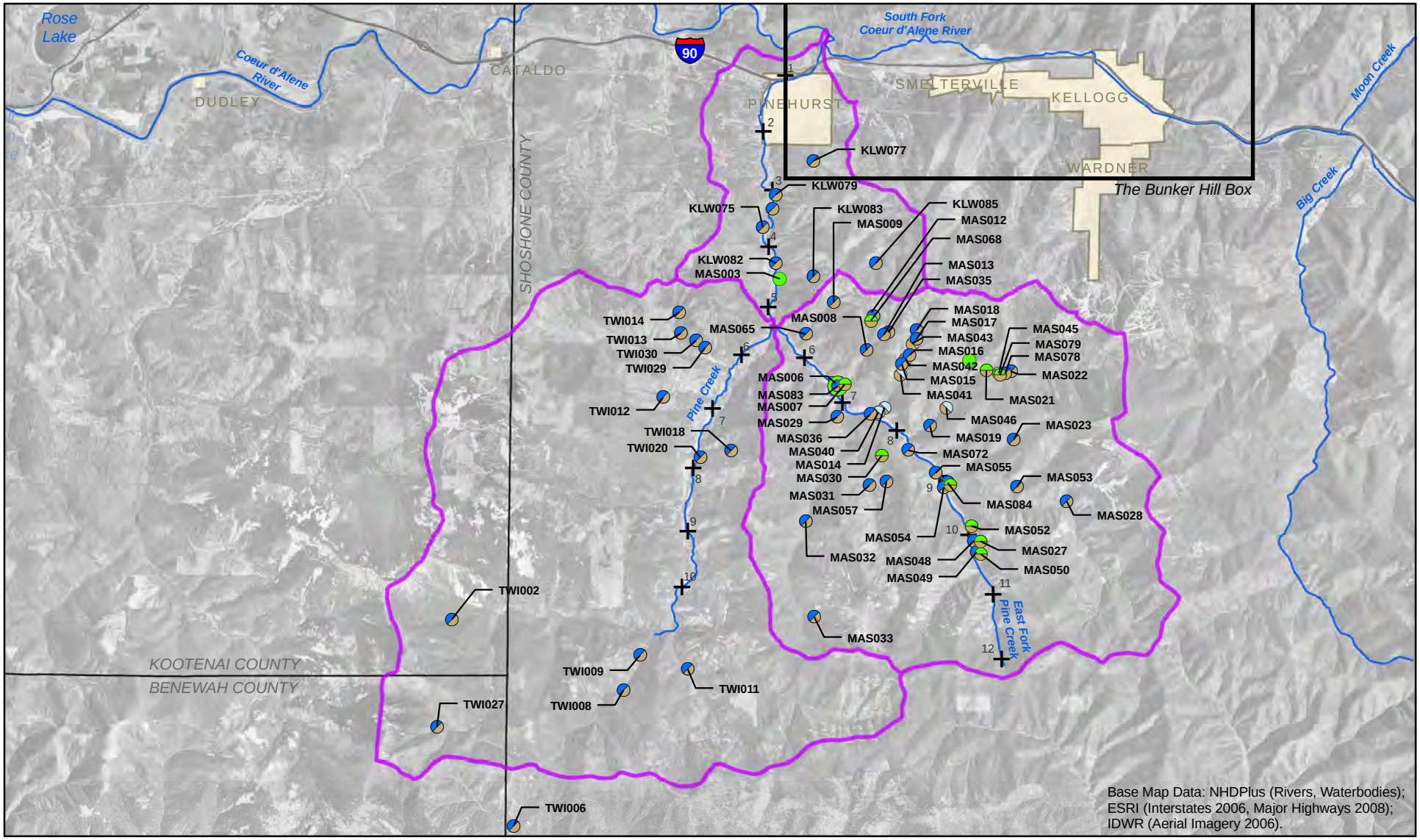
Note: See Table B11-1 for a list of site names.

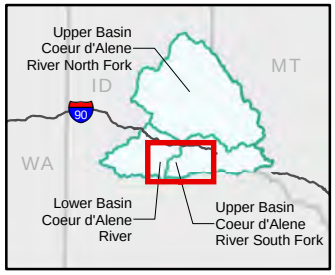
N

0 0.5 1 Miles

Figure D-5
Overview of Remedial Actions, Alternative 3+, Moon Creek Watershed
Upper Basin Proposed Plan

EPA





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

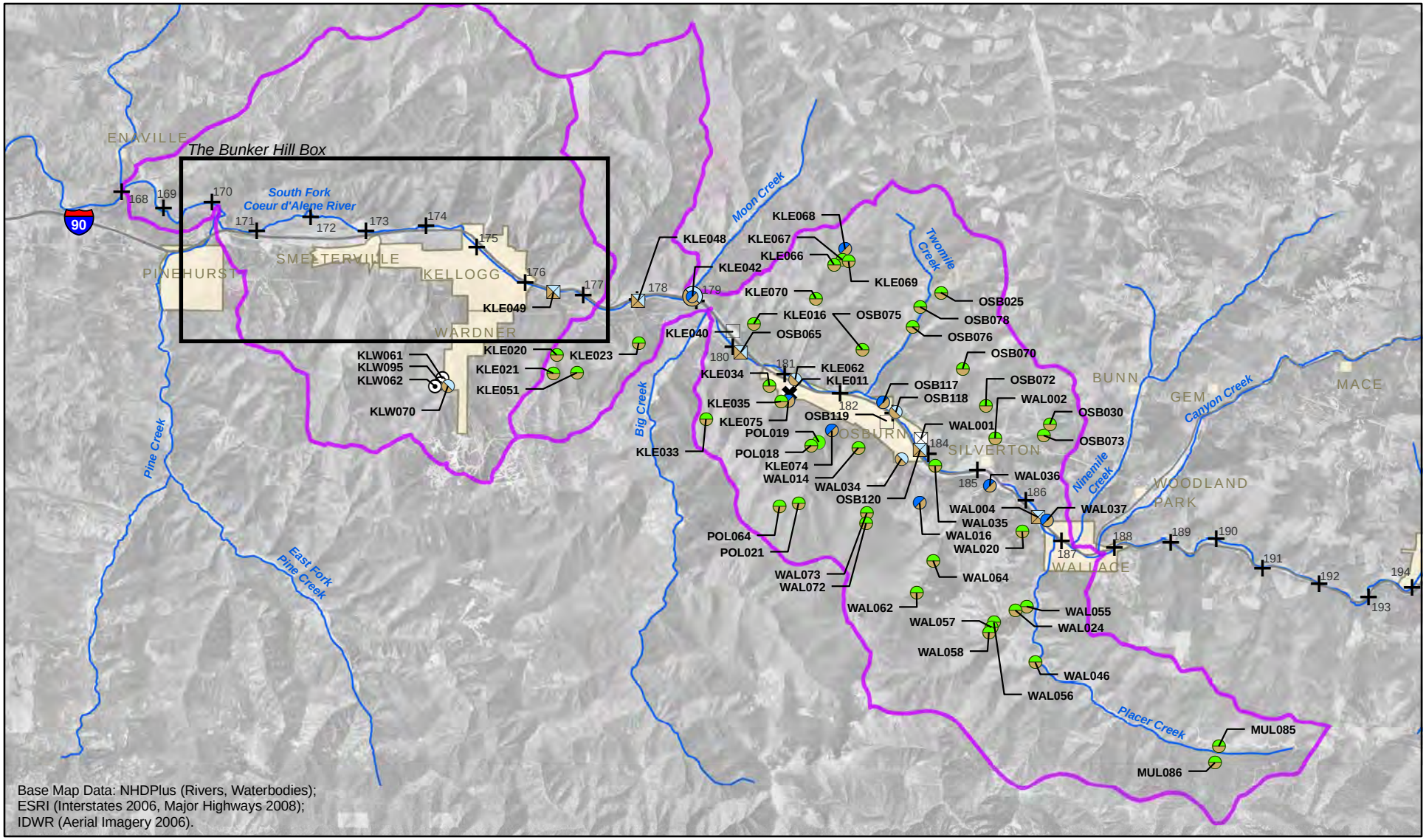
N

0 1 2 Miles

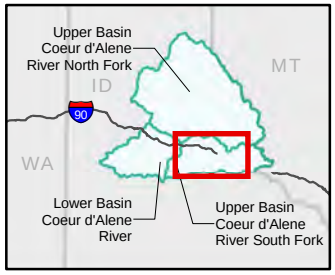
Note: See Table B11-1 for a list of site names.

Figure D-6
Overview of Remedial Actions, Alternative 3+, Pine Creek Watershed
Upper Basin Proposed Plan

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)

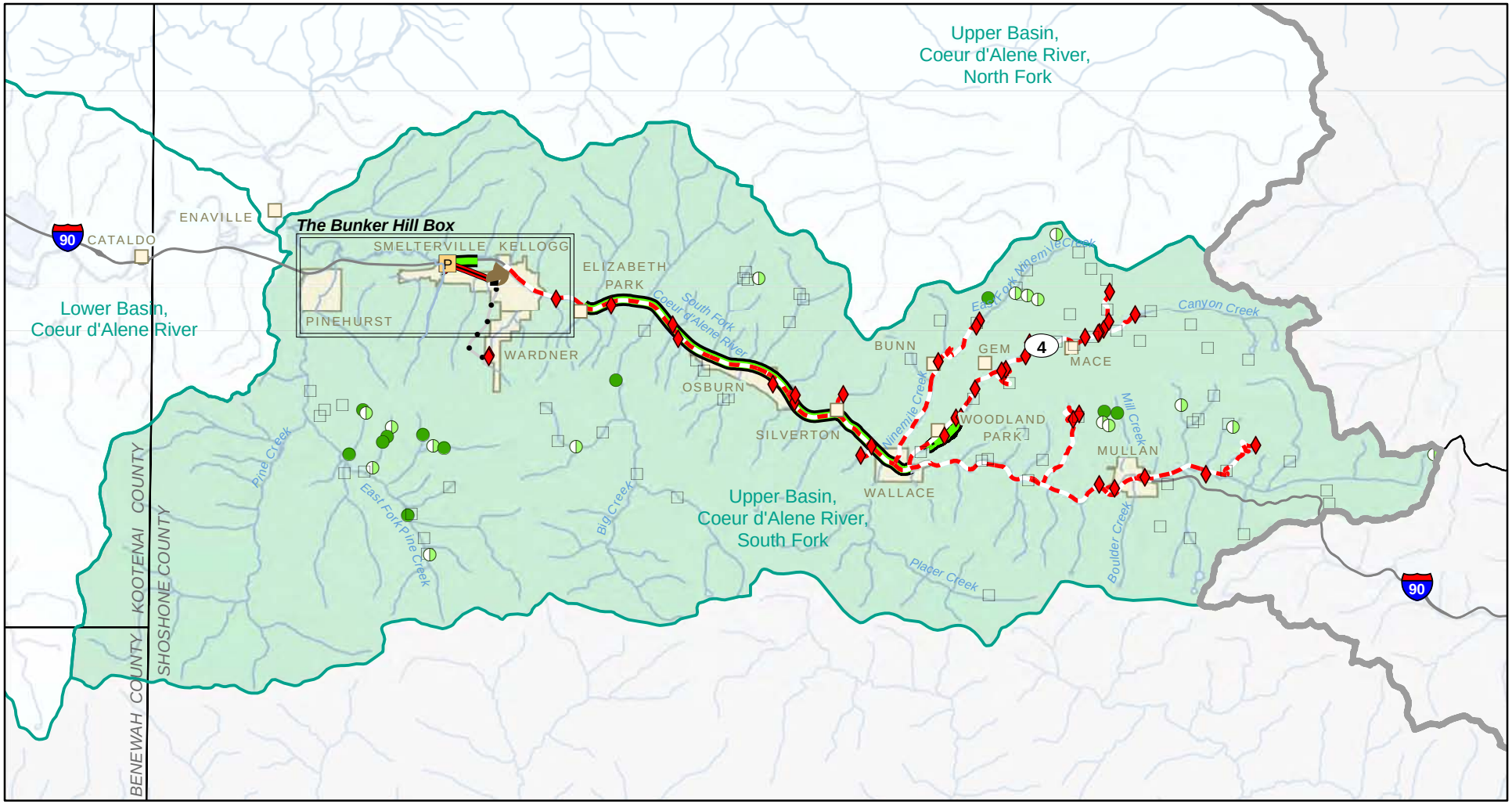
Note: See Table B11-1 for a list of site names.

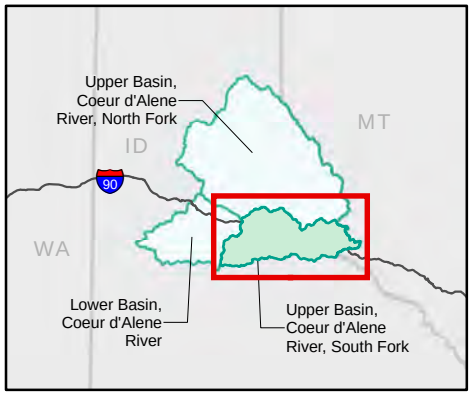
N

0 1 2 Miles

Figure D-7
Overview of Remedial Actions, Alternative 3+, Mainstem SFCDR Watershed
Upper Basin Proposed Plan

EPA





- Central Treatment Plant (CTP)
- Pump Station

Water Sources Considered for Treatment:

- Active Treatment (WT01)
- No Action
- Passive Treatment (WT02)
- Passive Treatment (WT03)
- Pressurized Pipeline to CTP
- Extraction Well
- 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
- Gravity Pipeline to CTP
- River/Creek
- Coeur d'Alene River Subbasin Boundary
- City Limit
- County Boundary
- State Boundary

N

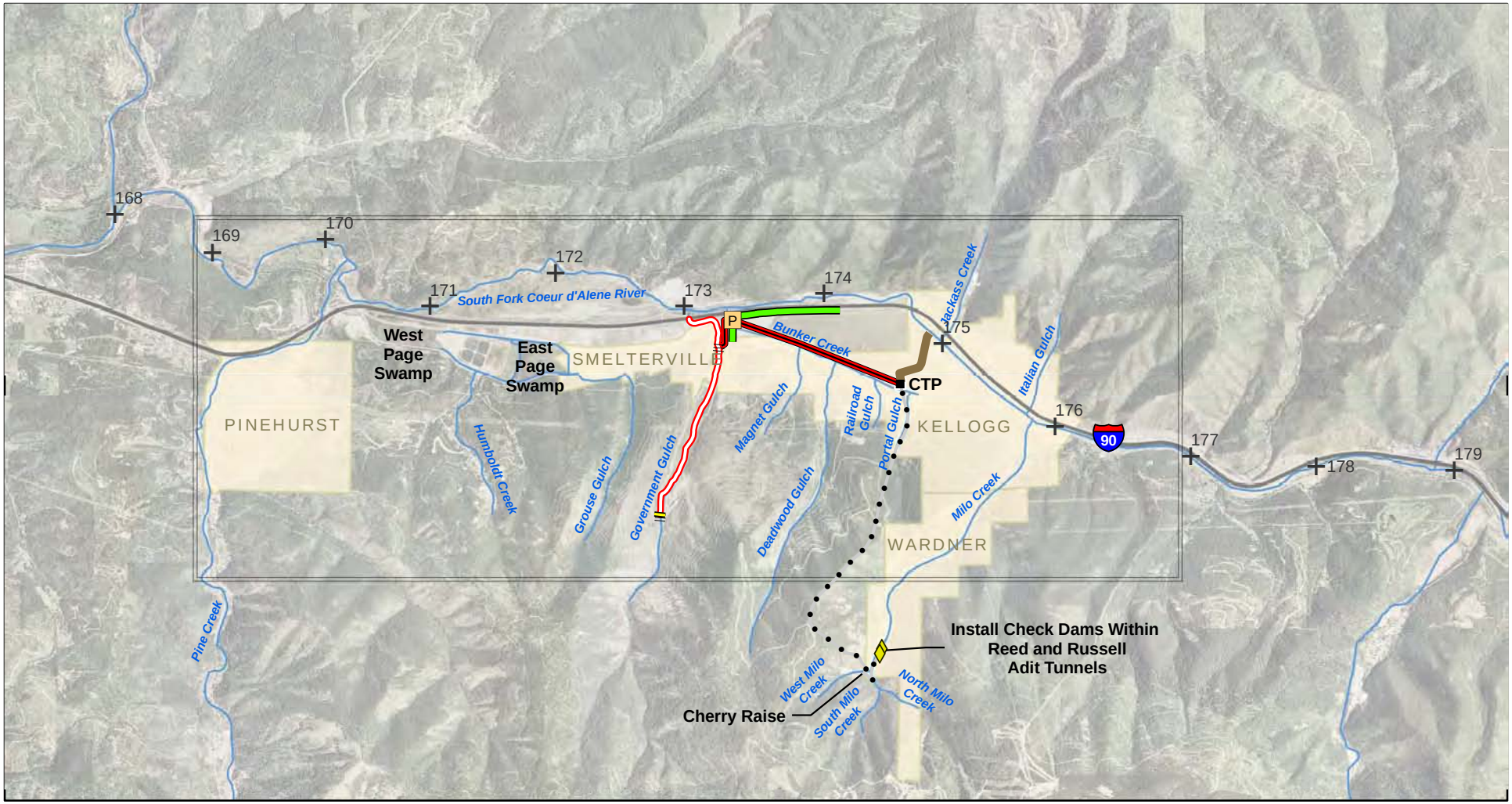
0 1 2 Miles

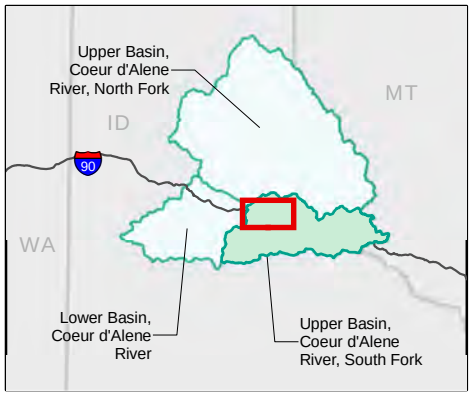
Base Map Data:
NHDPlus (Hydrography, 2005);
ESRI (Roads, Jurisdictional Boundaries, 2006)

Note: The location of the CTP Effluent Discharge Pipeline would be determined during the pre-design phase. The pipeline may be located as shown or may be piped parallel to Bunker Creek and discharged at the confluence of Bunker Creek and the SFCDR.

Figure D-8
Water Treatment Approach, Alternative 3+(d)
Upper Basin Proposed Plan

EPA





177 River Mile

Central Treatment Plant (CTP) in Kellogg, Idaho

Adit

P Pump Station

River/Creek

Conveyance of Reed and Russell adit discharge through the Bunker Hill Mine via the Cherry Raise and the Kellogg Tunnel to the CTP (see note below)

Pressurized Pipeline to CTP

Extraction Well

Slurry Wall

French Drain

Stream Liner

CTP Effluent Discharge Pipeline

The Bunker Hill "Box"

N

0 2,000 4,000 Feet

Base Map Data:
NHDPlus (Hydrography, 2005);
ESRI (Roads, Jurisdictional Boundaries, 2006);
IDWR (Aerial Imagery, 2006).

Note: The location of the CTP Effluent Discharge Pipeline would be determined during the pre-design phase. The pipeline may be located as shown or may be piped parallel to Bunker Creek and discharged at the confluence of Bunker Creek and the SFCDR.

Figure D-9
OU 2 Alternative (d):
Stream Lining/French Drain Combination
Upper Basin Proposed Plan