WHITE KING/LUCKY LASS SUPERFUND SITE RECORD OF DECISION

FREMONT NATIONAL FOREST LAKEVIEW, OREGON

Prepared by

Office of Environmental Cleanup
EPA Region 10

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PART I: THE DECLARATION OF THE RECORD OF DECISION

SITE NAME AND LOCATION

The Fremont National Forest/White King and Lucky Lass Uranium Mines (USDA), referred to as the White King/Lucky Lass Uranium Site or AMines site@, is located in Lake County approximately 17 miles northwest of Lakeview, Oregon. The Mines site is in the Lakeview Ranger District of the Fremont National Forest and situated on both National Forest System Land and private property. The Mines site encompasses approximately 140 acres affected by uranium mining activities which occurred during the 1950s and 1960s.

The Environmental Protection Agency (EPA) Identification Number: OR7122307658.

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedy for the Mines site. This Record of Decision (ROD) has been developed in accordance with the requirements of the Comprehensive Environmental, Response, Compensation, and Liability Act (CERCLA) of 1980, 42 USC '9601 *et seq*. as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Oil and Hazardous Substance Pollution Contingency Plan (NCP), 40 CFR Part 300. This decision is based on the Administrative Record for the Mines site.

The remedy was selected by the U.S. Environmental Protection Agency. The U.S. Department of Agriculture Forest Service (AUSFS or Forest Service@), State of Oregon Department of Environmental Quality (ODEQ) and Oregon Office of Energy (OOE) concur with the selected remedy.

ASSESSMENT OF THE SITE

The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment. Such a release or threat of release may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

This ROD addresses contaminated soils, waste rock, and ground water at the White King and Lucky Lass Mines, and contaminated water and sediments at the water filled excavation pit (pond) located at the White King Mine. The selected remedy includes consolidating and covering of the most highly contaminated soils from both mines at the White King Mine area and continued neutralization of the acidity in the White King pond. Since the pond neutralization could impact the concentrations of contaminants in sediments, and sediment toxicity was not fully evaluated in the RI/FS, the White King pond will be further evaluated to better assess the risks and feasibility of environmental protection for the proposed beneficial uses (aquatic habitat).

The major components of the selected remedy for each area of the Mines site include:

White King Stockpiles

$ Recontour the protore[1] stockpile at the White King Mine so it is out of the Augur Creek floodplain. Approximately 138,000 cubic yards of the protore stockpile will be moved and regraded;

$ Excavate the overburden stockpile at the White King Mine and contaminated soils which are above background concentrations and exceed health based protective levels in the vicinity of the White King mine, including portions of Augur Creek adjacent to the stockpile, the haul road, and other areas referred to as Aoff-pile@, and consolidate with the recontoured protore stockpile described above. Approximately 465,000 cubic yards of overburden will be excavated;

$ Isolate the consolidated stockpile (also referred to as the mine waste repository) under recompacted clay and cap with a two-foot thick clean soil cover in order to support native vegetation;

$ Implement long term inspection and maintenance of the mine waste repository to ensure it remains protective;

$ Land use restrictions will be put in place to limit and manage human exposure to contaminated soils underneath the Mine waste repository cover and underlying groundwater, and any uses that could impact the integrity of the Mine waste cover.

$ Access will be restricted by constructing a fence or other physical barrier surrounding the mine waste repository in order to prevent exposure to and disruption or use of the stockpiles materials by human or medium-to-large animals.

[1] Protore is a mining term for low-grade mineralized materials surrounding an ore. This term was originally used to describe one of the stockpiles at the Mines site. The results of subsequent investigations indicated that both stockpiles consist of overburden (material removed to reach the ore), however, the original terminology was retained to be consistent with previous reports.

- Monitor upgradient and downgradient ground water at the mine waste repository and Augur Creek surface water and sediment to ensure that the proposed beneficial uses of ground water (aquatic life and livestock) are maintained and that the remedy is protective.

White King Pond

- Conduct maintenance on the pond in order to raise the pH in the pond water in order to be protective and meet state water quality standards for Goose Lake Basis (requires a pH range of 7-9).

- Monitor the pond (water and sediments) and ground water (including surface discharge or seeps along the highwall) to determine the effectiveness of pond neutralization, refine background levels, establish trends and further evaluate the risks associated with pond water, seeps, and sediments.

- Conduct an assessment of the toxicity and bioaccumulation potential of COCs in pond sediments to further assess the risks and feasibility of environmental protection for the proposed beneficial uses (aquatic habitat)[2]. If sediments are determined to pose an unacceptable risk to aquatic organisms at the population level which could impact higher trophic levels, action such as sediment capping or dredging may be required. This action will be documented in an Explanation of Significant Decision (ESD) or ROD amendment.

- Implement access restrictions such as fencing to prevent other beneficial uses of the pond which could pose an unacceptable exposure to sediments in the pond (e.g., recreational use, livestock watering).

- Land use restrictions will be put in place to limit and manage use of the pond such as for recreational, or agricultural purposes. Use of the pond water for fire suppression may be allowed in certain circumstances consistent with the Forest Plan Amendment.

Lucky Lass Stockpile

[2] Because the White King pond occurs in a mineralized zone it is uncertain if certain beneficial uses can be fully protected with respect to sediment exposure. This issue is discussed further in Section 12.2.2.

$ Excavate soils and waste rock, which are above background concentrations and exceed health based protective levels from the Lucky Lass stockpile and off-pile areas (approximately 3,000 cubic yards), and placement into the White King mine waste repository.

$ Regrade remaining soil and waste rock to prevent erosion and promote vegetation. The disturbed areas will be covered with 3 inches of soil.

$ Implement institutional controls to prevent removal or residential use of the remaining Lucky Lass stockpile soils and prohibit installation of drinking water wells within the stockpile.

STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable.

The remedy for the White King Pond, in-situ neutralization, satisfies the statutory preference for treatment as a principal element of the remedy. Neutralization of the pond water increases the pH and reduces the concentration of COCs in the surface water.

The contaminated soils at the Mines site are not principal threat wastes as that term is defined by EPA. Principle threat wastes are source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to human health or the environment should exposure occur. The stockpiles at the Mines site are considered to be relatively non-mobile with low toxicity which can be reliably contained. Section 11 of the Decision Summary provides the rationale for the determination that no principle threat wastes exist at the Mines site and Section 10.4.1 describes how treatment was considered during the comparative analysis of alternatives.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

ROD DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary section of this ROD. Additional information can be found in the Administrative Record for this Site.

- $ Chemicals of concern (COCs) and their respective concentrations. (See Section 5.3.1)

- $ Baseline risk represented by the COCs. (Section 7.1.6)

- $ Cleanup levels established for COCs and the basis for the levels. (See Section 12.6.1)

- $ Whether source materials constituting principal threats are found at the Mines site. (See Section 11)

- $ Current and future land and ground water use assumptions used in the baseline risk assessment and ROD. (See Section 6)

- $ Potential land and ground water use that will be available at the Mines site as a result of the Selected Remedy. (See Section 12.6)

- $ Estimated capital, operation and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected. (See Section 12.5)

- $ Key factor(s) that led to selecting the remedy. (See Section 12.1)

AUTHORIZING SIGNATURE

____________________________________ __________________

Michael F. Gearheard, Director
Environmental Cleanup Office, Region 10
U.S. Environmental Protection Agency

Date

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ABBREVIATIONS AND SYMBOLS

AEC	Atomic Energy Commission
AMW	Acid Mine Water
ARAR	Applicable or Relevant and Appropriate Requirement
AWQC	Federal Ambient Water Quality Criteria
BSAF	Biota-sediment accumulation factor
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Code of Federal Regulations
CRP	Community Relation Plan
COC	Chemical of Concern
COPC	Chemical of Potential Concern
CSF	Cancer Slope Factor
cy	Cubic Yards
DEIS - RI/FS	Draft Environmental Impact Statement - Remedial Investigation/Feasibility Study
DO	Dissolved Oxygen
EPA	U.S. Environmental Protection Agency
EECA	Engineering Evaluation Cost Assessment
EPC	Exposure Point Concentration
ESD	Explanation of Significant Difference
FS	Feasibility Study
FWQC	Federal Water Quality Criteria
gpm	gallons per minute
HEAST	Health Affects Summary Tables
HI	Hazard Index
HQ	Hazard Quotient
I&M	Inspection and Maintenance
IRIS	Integrated Risk Information System
MCL	Maximum Contaminant Level
MOA	Memorandum of Agreement
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
OAR	Oregon Administrative Rule
O&M	Operation and Maintenance
ODEQ	Oregon Department of Environmental Quality
OOE	Oregon Office of Energy
ORP	Oxygen Reduction Potential
ORS	Oregon Revised Statute
OU	Operable Unit
PRP	Potentially Responsible Party
PRG	Preliminary Remediation Goal

ABBREVIATIONS AND SYMBOLS (CONTINUED)

RAO	Remedial Action Objective
RfD	Reference Dose
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act of 1986
SF	Slope Factor
UCL	Upper Confidence Limit
UTL	Upper Tolerance Level
UMTRCA	Uranium Mill Tailings Radiation Control Act
USFS	United States Forest Service

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PART II: DECISION SUMMARY

INTRODUCTION

This Decision Summary provides a description of the site-specific factors and analysis that led to the selection of the remedy for the White King/Lucky Lass Superfund Site. It includes information about the Mines site Background, the nature and extent of contamination, the assessment of human health and environmental risks, and the identification and evaluation of remedial alternatives.

This Decision Summary also describes the involvement of the public throughout the process, along with the environmental programs and regulations that may relate to or affect the alternatives. The Decision Summary concludes with a description of the selected remedy in this Record of Decision (ROD) and a discussion of how the selected remedy meets the requirements of the Comprehensive Environmental, Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA).

Documents supporting this Decision Summary are included in the Administrative Record for the Mines site. Key documents include the Final Remedial Investigation Report, the Final Feasibility Study Report, the Human Health and Ecological Baseline Risk Assessment Report and the Proposed Plan for the Mines site.

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SECTION 1

SITE NAME, LOCATION, AND DESCRIPTION

The White King/Lucky Lass Mines site consists of two former uranium mining areas located in south-central Oregon, approximately 17 miles northwest of Lakeview (**See Figure 1-1**). The Mines site is in the mountains adjacent to the northern boundary of the Goose Lake Valley within the Lakeview Ranger District, Fremont National Forest, Lake County, Oregon. The two mines are located near the edge of upland meadows encompassing portions of Augur Creek at an elevation of approximately 6,000 feet. The White King Mine is situated on the Fremont National Forest, which is managed by the USFS, and also on private lands owned by Fremont Lumber Company, and a Trust. The Lucky Lass Mine is situated 1 mile northwest of the White King Mine above Tamarack Flat. The EPA National Superfund electronic database identification number is OR7122307658.

The Mines site is situated in a remote area. The closest permanent inhabitants to the Mines site live near the intersection of FS 8270 and County Road 16B, approximately 12 miles southeast of the Mines site. The area around the Mines site is used for recreational purposes, including hunting, and snowmobiling. Wood-cutting and cattle grazing also occur in the general area of the Mines site. The major features at the White King Mine include a water-filled excavation pit covering 13.4 acres (pond), a protore stockpile covering 17 acres, an overburden stockpile covering 24 acres, areas where overburden and ore were dumped or spilled during the mining operations including haul roads, and Augur Creek which flows adjacent to the two White King stockpiles (**See Figure 1-2**). The stockpiles contain soil and mineralized rock that were removed from the mine pit. The major features at the Lucky Lass Mine include a 5 acre water-filled excavation pit (pond), a 14 acre overburden stockpile, and an adjacent meadow.

Other features at the Mines site include several collapsed wood frame structures, metal debris, gravel and dirt roads from mining activities, and barbed wire fences currently maintained by the Forest Service. Forest Service Road 3780 is the main road in the area and joins paved county Road 16B approximately 12 miles to the southeast. There are no structures or buildings at the Mines site which are on or eligible to be listed on the National Register of Historic Places.

EPA is the lead regulatory agency for the Mines site and the Forest Service, Oregon Office of Energy (OOE) and Oregon Department of Environmental Quality (ODEQ) are the respective Federal and state support agencies.

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SECTION 2

SITE HISTORY AND ENFORCEMENT ACTIVITIES

2.1 HISTORICAL LAND USE

Both Mines have had several operators, mineral claims holders, leasers and property owners. Mining began at the Mines site in 1955. Initial mining at White King was underground via mine shafts developed up to 312 feet below the surface. In 1959 due to problems with infiltration of water, underground mining was abandoned for open-pit mining techniques which were used until active mining stopped around 1965. Open-pit mining techniques were used from 1956-58 and from 1961-64. An extensive exploratory drilling program was carried on at both Mines through 1979. Since then, little activity has taken place on these claims. Available records indicate the White King Mine produced about 138,146 tons of ore and Lucky Lass produced about 5,450 tons of ore during their period of operation. A total of 140 acres have been disturbed by mining, 120 acres at the White King Mine and 20 acres at the Lucky Lass Mine. Disturbance includes stockpiling of ore and overburden and creation of the water filled White King and Lucky Lass mine pits.

2.2 INVESTIGATION HISTORY

In 1989, the Forest Service began considering action on the mine pits and the stockpiles. In August 1991, the Forest Service issued a draft report titled, "*Draft Environmental Impact Statement Remedial Investigation & Feasibility Study for the Cleanup and Rehabilitation of the White King and Lucky Lass Uranium Mines*@ (DEIS-RI/FS)," which evaluates proposed remediation alternatives at the Mines site. This report was revised in 1994 to included expanded discussions, more detailed descriptions, and edits for clarification. It identified placement of all contaminated soils in an upland engineered disposal cell and backfilling the pits with clean material as the preferred cleanup alternatives. Upon review of the 1994 DEIS-RI/FS Report, EPA determined that further investigation and analysis of remedial alternatives were needed to support a remedial action decision under CERCLA.

2.3 ENFORCEMENT HISTORY

The Mines site was added to the National Priorities List (NPL) in April 1995. EPA is the lead regulatory agency for the Mines site and the USFS, Oregon Office of Energy (OOE), and Oregon Department of Environmental Quality (ODEQ) are the respective Federal and State support agencies.

Prior to EPA listing the Mines site on the NPL the USFS was the lead regulatory agency under CERCLA. As discussed in Section 1, The White King Mine is located on both National Forest System land and private property while the Lucky Lass Mine is located solely on National Forest System land. As part of its CERCLA enforcement activities, the USFS performed an investigation into the potentially responsible parties (PRPs) at the Mines site, including issuing requests for information under CERCLA to various individuals and companies in 1991.

The USFS and the State of Oregon entered into a Memorandum of Agreement (MOA) regarding the Mines site in April 1994. This MOA was superceded by a revised Agreement which included EPA as a party and was signed in October 1994. The revised Agreement called for early response actions at the Mines site, and the USFS agreed to perform an Engineering Evaluation/Cost Analysis (EECA) and an action memorandum for a non-time critical removal action at the Mines. The EECA was completed in September 1994 and the removal action was completed in 1995. The USFS initiated site security activities and the stabilization of the stockpiles to prevent erosion. These temporary actions, which were continued until 1995, will be superceded by remedial actions selected in this ROD.

Since the Mines site was included on the NPL in 1995, EPA has been the lead regulatory agency. In April 1995, EPA entered into an Administrative Order on Consent (AOC) with Kerr-McGee Corporation, under which KMC agreed to perform the RI/FS for the Mines site. The administrative order was also signed by the USFS, OOE, and ODEQ as support regulatory agencies. In May 1995, a Memorandum of Understanding was signed between EPA and the USFS to facilitate coordination between the two Federal agencies during the RI/FS. KMC COMPLETED ALL WORK UNDER THE AOC IN JUNE 2000.

EPA continues to work in its lead regulatory role at the Mines site. In July and October 2000, EPA issued follow-up requests for information under CERCLA to PRPs and expects to negotiate cleanup agreements with PRPs after the ROD is issued.

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SECTION 3

COMMUNITY PARTICIPATION

This section summarizes the community relations activities performed by EPA and the USFS during the remedy selection process. EPA and the USFS developed a Community Relations Plan (CRP) for the Mines site in October 1995. The CRP was designed to promote public awareness of cleanup activities and investigations and to promote public involvement in the decision-making process. The CRP summarizes the concerns of local citizens, interest groups, industries, and local government representatives. Community participation activities have included personal interviews, and distribution of fact sheets, newspaper notices, and public notices. During the RI/FS, the USFS and ODEQ were consulted on the anticipated future land uses and potential future ground water uses at the Mines site.

The RI/FS Report and Proposed Plan for the Mines site were made available to the public in September 1999. These documents, along with others that form the basis for the cleanup decisions for the Mines site, can be found in the Administrative Record located at the USFS Lakeview Ranger District Offices, the EPA Region 10 Superfund Records Center at 1200 Sixth Avenue in Seattle, and the Lake County Library at 513 Center Street in Lakeview. Notice of the availability of these two documents was published in the Lake County Examiner on September 29, 1999. On September 29, 1999, a fact sheet and a copy of the proposed plan were mailed to the 100 individuals on the Mines site mail list. A public comment period was held from October 1, 1999 to October 30, 1999. Several extensions to the public comment period were requested and granted until January 10, 2000. A public meeting was held on October 14, 1999 to present the Proposed Plan. Approximately 18 people attended this meeting. During the meeting, representatives from EPA, the USFS, OOE, and ODEQ answered questions about the Mines site, the remedial alternatives, and the preferred alternative. EPA=s response to the comments received during this period is included in the Responsiveness Summary, which is part of this ROD.

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SECTION 4

SCOPE AND ROLE OF RESPONSE ACTION

The White King/Lucky Lass ROD addresses the soils, ground water, sediment and surface water at the Mines site.

The remedy selected by EPA and documented in this ROD includes remedial actions necessary to protect human health and the environment. The risk assessment determined that exposures to contaminated soils and ground water pose the greatest risks to human health and the environment. The selected remedy is intended to mitigate or abate the risks posed by Mines site contamination. While contamination will remain on-site, its potential to adversely impact human health and the environment will be mitigated by isolating contaminated soils beneath a soil cover. This will reduce or eliminate any continued migration through erosion which could impact surface water. The soil cover in combination with institutional controls will prevent future human contact with the contaminated soils and the soil cover will reduce potential animal exposure to contamination. The institutional controls will prevent future human contact with shallow ground water beneath the stockpile.

The risk assessment also identified risks to human health and the environment from the White King pond sediments. The remedy selected in this ROD will restrict access to the pond to protect human health and will assess pond sediments to evaluate if action is warranted to address the potential ecological risks. Given the uncertainties associated with the potential ecological risks, the controls in place to restrict human exposure, and the limited aquatic life currently in the pond, sediment cleanup is not warranted at this time. A sediment cleanup action, if determined necessary, will be documented in a future ESD or ROD amendment.

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SECTION 5

SUMMARY OF SITE CHARACTERISTICS

This section summarizes information obtained through the RI/FS. It includes a description of the conceptual site model on which all investigations, the risk assessment, and response actions are based. The major characteristics of the Mines site and the nature and extent of contaminant releases are summarized below. More detailed information is contained in the RI/FS report, which is located in the Administrative Record for the Mines site. See Section 3 for further information on the Administrative Record.

5.1 CONCEPTUAL SITE MODEL

The Conceptual Site Models (Human Health and Ecological) are depicted in **Figures 5-1 and 5-2.** The primary sources of contamination are the soil stockpiles, surface soil, pond water, and pond sediments. The primary release mechanisms are erosion due to wind or water, infiltration, and direct contact. Potential human receptors include recreational users of the Mines site, workers, and potential future residents. Ecological receptors include a variety of plants and animals that are found in the area of the Mines site.

5.2 PHYSICAL CHARACTERISTICS OF THE SITE

5.2.1 Surface Features

The White King/Lucky Lass Mines site is situated in a mountain physiographic setting that forms the northern boundary of Goose Lake Valley. Elevations at the Mines site range from 5,930 to 6,200 feet above mean sea level, with the nearby basalt ridge reaching 6,500 feet above mean sea level. The White King Mine is located west of the northwest-trending Augur Creek; the Lucky Lass mine is located approximately one mile northwest and upgradient of the White King Mine. The Lucky Lass area drains to the Augur Creek valley, intercepting Augur Creek upstream from the White King Mine. The White King Mine also drains to the Augur Creek Valley and Augur Creek.

5.2.1.1 <u>White King Mine</u>

The major surface features at the White King Mine include a 13.4 acre water-filled excavation pit (White King pond), a 85-foot-high wall at the west end of the White King pond, adjacent protore and overburden stockpiles, and smaller areas including haul roads where overburden and ore were dumped or spilled during the mining operations. These features encompass an area of approximately 66 acres.

The White King pond has a teardrop shape, formed from past mining operations. The narrow part of the teardrop was the haul road used to bring material up from the open pit during mining operation. For further information on the water hydrology of the White King pond see Section 5.2.3.2.

The two White King stockpiles were created during mining operations when the former pit (now pond) was being excavated. The protore stockpile covers approximately 17 acres and ranges in thickness from 8 to 27 feet. This stockpile consists of gravel, silt and low permeable layers of clay with a thin layer of gravel at the surface. The protore stockpile contains approximately 542,000 cubic yards of material.

The overburden pile covers approximately 24 acres and ranges in thickness from 7 to 33 feet. Studies on the overburden stockpile indicate that it consists of gravel near the surface with sand and clay material below. The overall nature of the majority of the overburden stockpile is clay-like. The overburden stockpile contains approximately 408,000 cubic yards of material.

A grassy meadow and wetlands separates the two piles. In addition, meadows with wetlands are located just south of the overburden pile and just north of the protore pile. Augur Creek, originating in a spring several miles north of the White King Mine, flows to the southeast along the eastern edge of the piles.

5.2.1.2 Lucky Lass Mine

The Lucky Lass Mine also includes a water-filled excavation mine pit (Lucky Lass pond) and includes an approximate 90-foot-high wall at the south end of the pond, and an adjacent overburden stockpile to the west, east, and north. These features encompass an area of approximately 20 acres. The pond has a teardrop shape similar to the White King pond and is approximately 70 feet deep. For further information on the water hydrology of the Lucky Lass pond, see Section 5.2.3.3. The stockpile rises from about 10 to 40 feet above the natural ground surface with slopes on the edges down to the meadow and Lucky Lass pond. Local relief on the stockpile is about 20 feet. East of the overburden stockpile is a flat grassy meadow containing wetlands. Pond drainage flows into these wetlands. The road network in the area includes a Forest Service road entrance to the stockpile area from the south, and a primitive road entering the meadow from the east, trending north around the mine.

5.2.2 Climate

Since no meteorological data are available for the Mines site, the following discussion is based on conditions observed in Lakeview. Lakeview is located in the semiarid to sub-humid high desert country of the Goose Lake Valley. Overall, this region is characterized by moderate winds (less than 25 mph), cold winters, warm summers, and light precipitation. In Lake County, annual precipitation generally averages from 8 to 10 inches in lower basins, 12 to 16 inches in mountain valleys, and 16 to 25 inches in the forested uplands. The Mines site would be characterized as forested uplands. December and January are the wettest months, with an average precipitation of 2.33 and 2.52 inches respectively. Snowfall accumulation ranges from 20 inches per year in Lakeview to 70 inches per year in the mountains. Snow at the Mines site generally begins to accumulate on the ground in November and may persist until April or May.

5.2.3 Surface Water Hydrology

5.2.3.1 Augur Creek

Augur Creek serves as the major surface drainage in the vicinity of the White King/Lucky Lass Mines site. **Figure 5-3** depicts the Augur Creek watershed at and above the White King Mine. From its headwaters about 3 miles upstream from the White King Mine, Augur Creek is generally confined to a narrow channel. In the vicinity of the White King Mine, the character of the stream changes as the topography flattens. Before mining activities, Augur Creek may have branched into several small channels within the Augur Creek meadow. During the early stages of mining operations, a one-half mile section of Augur Creek near the White King Mine was relocated several hundred feet east to its present day location. Earthen dikes were constructed to maintain this new stream channel. Downstream of the overburden stockpile, Augur Creek generally regains its pre-mining character. Augur Creek stream flow is seasonal with the higher flows experienced during the spring snowmelt and gradually declining through the summer into fall. Flow rates measured near the Mines site during the RI range from a low of 140 gallons per minute (gpm) in October to 3,100 gpm during a June rain event. **Figure 5-4** depicts the modeled location of the 500-year Augur Creek floodplain in the absence of the protore and overburden stockpiles.

5.2.3.2 White King Mine Water Filled Excavation Pit (Pond)

The White King pond was created when surface mining extended below the water table. A significant amount of ground water flowed through fractures in the volcanic tuffs into the underground workings of the mine. In 1978 Western Nuclear dewatered the pond as part of their exploration program. During this dewatering effort the inflow rate was estimated at 200 to 240 gallons per minute. The pond covers an area of approximately 13.4 acres and contains approximately 90 million gallons of water. The deepest part of the pond is approximately 70 feet. The White King pond is fed by surface seeps and springs, and shallow bedrock ground water. The water quality of the White King pond has historically been characterized by a pH in the range of 3 to 4.5, particularly at depth. The low pH is caused by acid generation during oxidation of sulfide minerals exposed in the pond bottoms, walls, and underground mine workings. The pond discharges to a drainage ditch which runs parallel to the overburden stockpile and eventually reaches Augur Creek. Sampling conducted in the pond during the RI suggested that there was no apparent thermal stratification. However, post RI pond sampling indicates thermal stratification during the summer. This stratification results in a pocket of low pH water in the deepest part of the pond. Section 9.3.2 describes the actions taken to neutralize this acidity during 1998 and 1999.

5.2.3.3 Lucky Lass Mine Pond

Lucky Lass pond covers approximately 5 acres and was also created when mining activities extended below the water table. The pond is bounded on the east, west and south sides by a steep highwall of exposed rock. The volume of water in the pond is estimated to be about 5 million gallons. The pond has a continuous discharge that flows from the north end of the pond into the Lucky Lass meadow. The Lucky Lass pond typically has a pronounced thermocline and neutral pH. No remedial action is being taken on the Lucky Lass pond.

5.2.4 Geology

The Mines site is located within the northwest terminus of the Basin and Range province. This area is characterized by north-trending fault-block mountains and basins of internal drainage. Geologic units in the region are characterized by a thick sequence of volcanic flows and volcaniclastic rocks which have been extensively faulted and fractured. Seven geologic units were identified in the surface and subsurface of the White King Mine. They are, from oldest to youngest: older volcaniclastic rocks, rhyolite intrusive and associated tuff breccia, younger and older basaltic flows, younger volcaniclastic rocks and pyroclastics,   alluvium, and stockpile. Three geological units were identified in the vicinity of the Lucky Lass Mine. They are from oldest to youngest: volcaniclastic rocks, alluvium and stockpile.

The Lakeview Uranium District includes an area extending 22 miles to the north of Oregon Highway 140 and 17 miles west of Lakeview. This 400-square miles area is host to about 20 uranium occurrences, prospects and past-producing mines. Since the mid-1950s, uranium mineralization has been prospected for and found scattered throughout the district. As discussed in the RI report, numerous uranium-arsenic occurrences and prospects are concentrated within a 50-square-mile section of the Lakeview Mining District. The result of this natural phenomenon is that the entire 50-square-mile area has relatively high geochemical background values in these and other metallic elements relative to the surrounding region. Arsenic levels have been identified up to 1,570 mg/kg and radium-226 at levels up to 9.9 pCi/g in White King meadow soils. These values likely represent the upper end of naturally occurring soil background, based upon information collected during the RI, but were not incorporated into EPA=s background calculations for reasons discussed in Section 5.3.1.2.

The major soils in the vicinity of the Mines site are alluvial soils (formed from unconsolidated, detrital sediments) and soils formed from basalt or tuff parent materials, which are generally found on the valley side slopes. The soil that has been most impacted at the Mines site is the alluvial soil associated with Augur Creek fluvial deposits.

5.2.5 Hydrogeology

Ground water flow in the vicinity of the Mines site is primarily controlled by the local and regional topography and geology. The geologic units beneath the Mines site are subdivided into four hydrogeological units: pile or perched, alluvial, shallow bedrock, and deep bedrock. The protore and overburden piles are mineralized with uranium-and metal-bearing sulfide minerals. Perched ground water in the stockpiles is mounded on top of the underlying alluvial unit. Recharge to the stockpile unit is primarily from precipitation and infiltration is primarily downward into the underlying alluvial unit or horizontal out the sides of the stockpiles. The stockpiles are hydraulically connected to the underlying alluvial unit. The mean hydraulic conductivity for the White King stockpile is approximately 4.5 feet per day.

The alluvial unit is recharged directly by precipitation, seeps, and springs from bedrock and locally by Augur Creek. Ground water is lost from the alluvial unit by recharge to Augur Creek and shallow bedrock, and by evapotranspiration. Ground water in the alluvial unit is unconfined.

During the spring and early summer months, the alluvial unit can be completely saturated with water. The mean hydraulic conductivity of the White King alluvium is approximately 1.3 feet per day. The water table in the alluvial unit reflects the local topography, with ground water flowing down the valley.

The shallow bedrock unit extends from the ground surface to a depth of 100 feet bgs except where it is overlain by the alluvial unit. Ground water flow in this unit occurs as fracture flow. This unit is recharged by precipitation and the overlying alluvium where present. Ground water in the shallow bedrock unit is unconfined. The mean hydraulic conductivity for the shallow bedrock at the White King mine is approximately 4.8 feet per day. The depth to water in the shallow bedrock in the valleys tends to be shallow (<10 feet), whereas beneath the ridges it can be relatively deep (>50 feet).

The deep bedrock unit is 100 feet or greater below the ground surface. Ground water flow and storage in the deep bedrock unit occurs in fractures. The deep bedrock unit is hydraulically connected to shallow bedrock. Deep ground water probably occurs under semiconfined to confined conditions. The mean hydraulic conductivity of the deep bedrock is approximately 3.6 feet per day at the White King mine.

5.2.6 Natural Resources

The forested area surrounding the Mines site is characterized by mixed-conifer forest dominated by ponderosa pine and white fir, with additional alpine species such as aspen and lodgepole pine. The dominant herbaceous community within the wetlands consists of a combination of hairgrass-sedge moist meadows, sedge-wet meadows, and low sagebrush/bluegrass meadows. The meadow areas downgradient of the Mines site (both Lucky Lass and White King Mines) meet the requirements as wetlands based upon the 1987 Corps of Engineers Wetlands Delineation Manual. However, the exact boundaries of these wetlands have not been field-determined.

The aquatic habitats at the Mines include the White King pond, Lucky Lass pond, the outflow from these ponds, and Augur Creek. Although the historically low pH of the White King Mine pond, due to mining operations, has prevented the development of extensive aquatic life in the pond, the edges of the pond and the surrounding wetland areas contain a variety of aquatic organisms. Aquatic invertebrates (e.g., giant water bugs, ologochaete worms, stoneflies, true fly larvae) and frogs and toads have been identified in all aquatic and wetland habitats. Two species of fish, the redband trout and pit-klamath brook lamprey, have been identified 2 miles downstream of the Mines site and historically had been found in Augur Creek near the Mines site[3]. According to a USFS report (1991b - See references at the end of Section 7.2) a natural 400 foot drop-off downstream of the Mines site prevents migration of fish upstream. This report also identifies several non-mining related impacts (i.e., over-grazing, timber harvesting, road

[3] On October 4, 1966 representatives of the Oregon State Board of Health observed over 40 dead trout in Augur Creek downstream of the Mine. Analysis of the discharge from the White King Mine pond showed a pH level of 3.4 and several metallic ions in sufficient concentrations to be lethally toxic when associated with the low pH.

construction/maintenance) which make it unlikely that a cold-water fish population (i.e., salmonids) could live in the creek in the vicinity of the Mines site under current conditions. Also see Section 7.2.1 Risk Assessment - Ecological Setting- which further describes the ecological habitat at the Mines site**.**

5.3 SUMMARY OF REMEDIAL INVESTIGATION ACTIVITIES

5.3.1 Nature and Extent of Contaminants

As part of the RI, field investigations were conducted from early June to early November 1995 and from June to October 1996. Soil, air, ground water, sediment, and surface water samples were collected in areas upgradient of the Mines site, on and adjacent to the Mines site, and downgradient of the Mines site. Two and three rounds of data were collected in 1995 of ground water and surface water, and additional surface water and ground water samples from selected locations in 1996. (Also see Section 9.3.2 for a discussion of post-RI sampling at the White King pond.) In addition to this information, data obtained prior to the RI by the U.S. Forest Service was also used in development of the RI report. The nature and extent of soil, ground water, surface water, and sediment contamination is summarized below and discussed in detail in the RI report. The following discussion focuses on the primary constituents of concern at the Mines site.

5.3.1.1 <u>Air</u>

Two types of RI air monitoring were conducted at the Mines site. The first type was daily ambient air monitoring with a particulate monitor to ensure the safety of the field crew. The second type was a long-term (3-month) monitoring event for ambient radon activities. Action levels for particulates were derived from health risk factors for arsenic, an identified inorganic constituent at the Mines site. Radon levels were compared to the household advisory level of 4 pCi/L. The results indicated that both particulates and radon levels were below action or guidance levels and similar to locations upgradient of the stockpiles.

5.3.1.2 <u>Soils</u>

Several reports have shown that naturally occurring elevated concentrations of arsenic and radium-226 are present in alluvial soils in and around the Mines site. During the RI, several different approaches were used to take this fact into consideration and account for the naturally elevated Abackground@ concentrations found in the vicinity of Mine site. EPA selected preliminary local soil background levels using a 95th percent upper tolerance level of samples that were not adjacent to or under the stockpiles because these samples could have been impacted from mining activities. EPA selected local soil background levels of 6.8 pCi/g radium-226 and 442 mg/kg for arsenic at the White King mine. Local soil background levels also were calculated for the Lucky Lass mine because of different geochemical characteristics of the ore body. The Lucky Lass values for radium-226 and arsenic are 3.6 pCi/kg and 5.4 mg/kg, respectively. Local background was adopted as a Preliminary Remediation Goal (PRG) at both mines except for arsenic at the Lucky Lass mine where the PRG is the arsenic soil standard of 38 mg/kg. These values may need to be re-evaluated during remedial action as more information is collected on background levels underneath or adjacent to the stockpiles.

As part of the RI, individual constituents were evaluated during a preliminary screening to identify primary and secondary constituents of concern in soils and overburden materials. The screening process consisted of comparing the 90 percent upper confidence limit (UCL) concentrations of the detected constituents for various areas of the Mines site to the most stringent available regulatory standard or 5 times the background value if no standard existed. If the 90% UCL concentration was greater than the standard or 5 times the background value, the constituent was selected for evaluation as a contaminant of concern. **Tables 5-1 through 5-8** compare the stockpile materials to standards (if available) or background (native soil near or below the stockpiles and local background) for the various media at the Mines site. (EPA soil screening levels were not used because the Mines site is located in a naturally mineralized area, for which the EPA standards do not account). As a result of this process, 8 constituents were selected for detailed evaluation at the White King Mine: antimony, arsenic, mercury, thallium, uranium-234, uranium-238, radium-226, and thorium-230. Arsenic and Radium-226 were evaluated at the Lucky Lass Mine. **Table 5-1** compares the White King stockpile surface and subsurface soils to background and standards and **Table 5-2** provides this comparison for Lucky Lass stockpile soil.

White King Protore Stockpile

The average concentration profiles for arsenic and radium-226 in the White King protore stockpile are presented in **Table 5-3.** Elevated concentrations of arsenic correlated closely with activities of uranium-238 and radium-226. The highest concentration of arsenic in the surface soil was 4,140 mg/kg. The highest concentration in surface soil adjacent to the protore stockpile was 895 mg/kg. The highest concentration of arsenic in the subsurface soil in the stockpile was 13,794 mg/kg at a depth of 6 feet. For radium-226 the highest activity in surface soil (collected at 2.5 feet) was 64.6 pCi/g and subsurface soil was 87 pCi/g at approximately 8 feet below the surface.

White King Overburden Stockpile

The average concentration profiles for arsenic in the White King overburden stockpile are also presented in **Table 5-3**. Elevated concentrations of arsenic correlated with elevated activities of uranium-238 and radium-226. The highest concentration of arsenic in the overburden stockpile surface soil was 769 mg/kg. The highest concentration in surface soil adjacent to the stockpile was 822 mg/kg. The highest concentration of arsenic in the subsurface soil within the stockpile was 11,700 mg/kg at a depth of 2.5 feet. The average concentration of arsenic was the greatest in the 2.5 to 5 ft. interval. For radium-226 the highest activity in surface soil (collected at 2.5 feet) was 291 pCi/g. The highest activity in the subsurface was 166 pCi/g collected at approximately 15 feet below the surface.

Lucky Lass Overburden Stockpile

Average concentration profiles for arsenic are presented in **Table 5-3**. The concentration of arsenic at the Lucky Lass Mine is consistently lower than that found at the White King Mine. The highest concentration of arsenic in the surface soil was 11.9 mg/kg and the highest concentration in the subsurface soil within the stockpile was 7.6 mg/kg at a depth of 7.5 feet.

The highest concentration of arsenic in the native soil below the overburden stockpile was 17.7 mg/kg at a depth of 3 feet below the stockpile-native soil interface. The highest concentration of arsenic in the surface soil immediately adjacent to the overburden stockpile was 15.0 mg/kg indicating possible erosion of the stockpile material. For radium-226 the highest activity in surface soil was 4.85 pCi/g. The highest activity in subsurface soils was 8.3 pCi/g at a depth of approximately 20 feet below the surface. The highest activity of radium-226 in the surface soil adjacent and nearby the overburden stockpiles was 72.4 pCi/g in the Lucky Lass meadow.

Off-Stockpile Areas

The focus of the RI sampling was on the stockpiles and adjacent Aoff-pile@ areas. There are also other smaller areas where overburden or ore was spilled or dumped during mining operations including haul roads. These areas were characterized with radiation surveys as part of the DEIS-RI/FS. The radiation surveys were designed to map out the areas and depths of greatest radioactive contamination outside the waste piles. The results of these surveys are illustrated in **Figures 11-5 and 11-6** which show a number of areas that potentially exceed cleanup levels.

In summary, arsenic and the radionuclides in the uranium series are the constituents of concern in soils based on their frequency and magnitude of detection. Average arsenic concentrations and radionuclide activities in the White King protore and overburden stockpiles are similar. Arsenic concentrations and radionuclide activities in the Lucky Lass stockpile were significantly less than the White King stockpiles.

The highest activity/concentrations of radionuclides and inorganics are found in the stockpiles. Ground water and subsurface soil sampling data indicate that limited migration has occurred into the soils below the stockpiles. Radionuclide and inorganic activity/concentrations are significantly less in the Lucky Lass stockpile as compared to the White King stockpiles.

5.3.1.3 Surface Water

Augur Creek

During the course of the RI, surface water samples were collected from various locations along Augur Creek. All surface water samples were analyzed for dissolved and total metals, as well as several radium, thorium, and uranium isotopes. Surface water samples were collected from White King and Lucky Lass ponds during 1995-1996.

Table 5-4 provides a comparison of the Augur Creek, Seep, and Drainage Channel Surface Water to background and freshwater chronic EPA Ambient Water Quality Criteria (AWQC). Total arsenic was detected in three of the six surface water sampling stations on Augur Creek. The highest concentration of total arsenic measured in Augur Creek was 41.8ug/L during an August sampling event. None of the detected total arsenic concentration exceeded the AWQC screening criteria of 190 ug/L. No concentrations of total arsenic were detected in surface water from the Lucky Lass drainage channel.

Uranium -234/238 was detected in all samples collected from adjacent and downgradient stations of Augur Creek. The highest RI uranium-234/238 activity measured was 22.5 pCi/L. The highest activity at the farthest downstream sampling location (AC-06) was 6.09 pCi/L. There is no regulatory standard for uranium-234/238 in surface water; however, there is a combined ground water standard (MCL) for uranium-234/238, which is 30 pCi/L. This standard is based upon use of ground water for drinking by humans. None of the surface water samples exceed this ground water standard.

White King and Lucky Lass Ponds

Table 5-5 summarizes the White King and Lucky Lass surface water data and compares it to AWQC. Total arsenic detected in the Mine ponds surface water ranged from 13.9 to 128 ug/L at White King and 9.7 to 17.5ug/L at Lucky Lass. None of these concentrations exceeded the freshwater chronic AWQC established for this constituent (190 ug/L).

Uranium-234/238 was detected during all rounds of RI surface water sampling in the White King pond and ranged from 10.82 to 15.69 pCi/L. Uranium-234/238 also was detected in samples at the Lucky Lass pond. The highest activity detected was 0.83 pCi/L. None of these values exceeded the combined ground water MCL for uranium-234/238 of 30 pCi/L.

Total zinc was detected during all rounds of surface water sampling in the White King pond and ranged from 121 to 157 ug/L. Total zinc concentrations measured in all samples slightly exceeded the freshwater chronic AWQC of 110ug/L.

The White King pond pH has historically ranged from 3 to 4.5 due to acid generation during oxidation of sulfide minerals exposed in the pond bottom, walls, and underground mine workings. The Lucky Lass pond pH values range from 7 to 7.5. Natural surface waters typically have a pH of 7.0. The state water quality standard for the Goose Lake Basin is a pH range of 7-9.

5.3.1.4 Sediments

Augur Creek and Lucky Lass Drainage

Table 5-6 summarizes the Augur Creek and drainage channel sediment data and compares it to background (when no water quality criteria exists) and Ontario Ministry of the Environment (OME) Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario (Persaud et al., 1993) Lowest Effect Level. Canadian guidelines were used as invertebrate effect criteria because of the absence of readily available U.S. criteria for freshwater sediments. Arsenic was detected in five of the six sediment samples collected from the upgradient Augur Creek stations and ranged from 1.9 to 4.2 mg/kg, below the OME guidelines for arsenic (6mg/kg). Sediment samples collected adjacent to the stockpiles and downgradient detected arsenic at concentrations exceeding the screening guidelines. Samples collected adjacent to the Mines site show an increase in arsenic concentrations (25.4 and 159 mg/kg). Concentrations in Auger Creek declined with distance from the Mines site. Concentrations of arsenic in the Lucky Lass drainage channel (6.5 mg/kg) were only slightly above background and the screening criterion of 6 mg/kg.

Other constituents that were either above background or the screening standard were manganese, Uranium-234 and -238.

White King and Lucky Lass Ponds

Table 5-7 provides a summary of the White King and Lucky Lass pond sediment data and compares it to the OME guidelines. Arsenic was detected in all sediment samples collected from the White King pond. Concentrations ranged from 196 mg/kg to 55,600 mg/kg which exceed the Ontario Ministry screening criteria of 6 mg/kg. Arsenic concentrations in the Lucky Lass pond were much lower and ranged from 0.68 to 6.7 mg/kg, which is only slightly above the screening standard.

Radium-226 was detected in all sediment sample collected from the White King pond. Radium-226 ranged from 1.39 to 115 pCi/g. At Lucky Lass pond, the activity ranged from 4.55 to 18.3 pCi/g. Sediment quality criteria are not available for radionuclides and there were no sediment chemistry data from a background pond for comparison.

Other constituents detected above background or a screening standard were iron, lead, manganese, mercury, and nickel.

5.3.1.5 Ground water

Individual ground water sample results were compared to ground water maximum contaminant limits (MCLs) or to a screening concentration based on five-times background concentrations when no MCL existed. MCLs are appropriate for water that will be used for drinking. In the case of radium and uranium, these values were compared to the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) ground water standard which is also based on use of the water for drinking since no MCL existed for uranium at the time of the RI. In December 2000 an MCL for uranium was finalized at 30 Φg/L. As a result of this process, arsenic and three radionuclides were identified as primary constituents of concern based on their likelihood of detection at the Mines site. **Table 5-8** provides a comparison of stockpile and off-stockpile ground water results to MCLs and background. The following conclusions are based on the ground water data:

$ Radionuclide and inorganic ground water concentrations were highest in samples from monitoring wells in the perched water in the stockpiles and significantly lower in monitoring wells completed off pile and below the stockpiles. There was one exception to this trend in one shallow bedrock well located immediately below the White King protore stockpile which had a uranium concentration of 75 pCi/L which is above the UMTRA standard and 3 orders of magnitude greater than a bedrock well at the overburden stockpile.

$ The pH values in all bedrock wells were within the typical ground water pH range while the stockpile (or perched water wells) were significantly lower.

$ There were no exceedances of the MCL for uranium-234/238 in the off-pile alluvial, shallow bedrock, or deep bedrock wells, including the wells downgradient of the stockpiles.

$ There were no exceedances of the MCL for radium-226/228 in the stockpile, alluvial, and deep bedrock wells. There were two exceedances (5.03 and 15.37 pCi/L) of the standard (5 pCi/L) in the shallow bedrock wells.

$ Radon concentrations are elevated and exceed the proposed MCL at nearly all locations, including background wells and deep bedrock wells. This is a result of naturally occurring uranium mineralization in the area.

$ Ground water concentrations in the vicinity of the White King Mine are slightly higher than ground water concentrations in the vicinity of the Lucky Lass Mine.

The following provides a more detailed discussion on the primary Chemicals of Concern:

Arsenic

Arsenic concentrations in the protore stockpile wells ranged from 24.4 to 164 Φg/L. Arsenic concentrations in the shallow bedrock well below the protore stockpile ranged from 19,100 to 21,900 Φg/L. Arsenic concentrations in the overburden stockpile wells ranged from 392 to 36,500 Φg/L. Arsenic concentrations in the shallow bedrock wells below the overburden stockpile were much lower, ranging from 10.6 to 486 Φg/L. The highest concentrations in deep bedrock ground water samples at White King ranged from 10.8 to 37.6 Φg/L.

At Lucky Lass, shallow downgradient bedrock wells ranged from non-detect for arsenic to 3.1 Φg/L. Deep bedrock wells at Lucky Lass ranged from 9.7 to 19 Φg/L. The ground water standard for arsenic is 50 μg/L.

Uranium-234/238

At White King, the highest combined uranium-234/238 activities were detected in mounded ground water samples collected in the protore stockpile and ranged from 27,300 and 43,600 pCi/L, which is greater than the UMTRCA ground water protection standard of 30 pCi/L. Activities in the overburden stockpile were much less and ranged from 0.5 to 17.8 pCi/L. There were no exceedances of the combined ground water guidance for uranium 234/uranium-238 in the off-pile alluvial, shallow bedrock, or deep bedrock wells, including the wells downgradient of the stockpiles.

Of the five shallow wells at Lucky Lass, uranium-234/238 was only detected in one downgradient well at activities of 4.16 and 4.22 pCi/L. The ground water standard for uranium is 30 pCi/L.

Radium-226, Radium 228

At White King there were no exceedances of the combined ground water guidance value for radium-226/radium-228 in the stockpile, alluvial, and deep bedrock wells. There were two exceedances (5.03 and 15.37 pCi/L) of this standard (5 pCi/L) in the shallow bedrock wells.

At Lucky Lass, shallow bedrock well concentrations ranged from 1.28 to 5.03 pCi/L which are less than or at the 5 pCi/L standard.

Radon

The proposed Drinking Water Standard for radon in ground water is 300 pCi/L. At White King the highest radon concentrations observed in samples were collected from the mounded ground water in the protore and overburden stockpiles and ranged from 4,190 and 1,800 pCi/L, respectively. Radon activities were much greater in the shallow bedrock wells located beneath the stockpiles and ranged from a maximum of 21,300 pCi/L at the protore stockpile to a maximum of 678 pCi/L at the overburden stockpile. Activities upgradient and downgradient of the stockpiles were lower and ranged from 441 to 551 pCi/L indicating this level of radon is naturally present in the aquifer. At Lucky Lass shallow downgradient wells had radon activities ranging from 283 to 556 pCi/L.

5.3.2 Fate and Transport

As part of the RI, geochemical speciation modeling was performed to determine metal species most likely present in ground water and to evaluate potential changes in speciation with ground water transport. The modeling, which applied site-specific conditions, indicated that constituent movement through the ground water is slow. Many of the constituent species exist in relatively insoluble forms and there is evidence of significant attenuation with the subsurface materials. In the case of uranium, the results indicate that it is strongly adsorbed by aquifer material and is removed from ground water as it migrates downgradient. The general trend observed for arsenic mirrors that of uranium with higher concentrations of arsenic detected within the White King stockpiles and rapid attenuation beneath and downgradient of the stockpiles. Results of the sampling efforts confirm the geochemical modeling conclusions. Other conclusions from the modeling indicate that there is no co-located low pH acidic ground water at the Mines site indicating that either neutralization or acid buffering is occurring in the ground water. In addition, no corresponding radionuclide or inorganic plume (as illustrated by uranium-238 activity and arsenic concentrations) were detected suggesting that metals are strongly adsorbed or retarded by aquifer solids.

Other transport pathways are movement of solid mineral matter from the high wall above the White King pond and from the stockpiles via erosion and surface water transport of suspended particulates. Any material which is eroded in the area of the high wall would be deposited in the sediment at the bottom of the White King pond. Erosion and surface water runoff from the stockpiles during storm events may transport suspended solids containing metals of concern downgradient. Arsenic and uranium have been the only COCs detected with any regularity in Augur Creek downgradient of the Mines site.

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SECTION 6

CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

This section discusses the current and reasonably anticipated future land uses and current and potential beneficial ground water uses at the Mines site, and discusses the basis for future use assumptions. This information forms the basis for reasonable exposure assessment assumptions and risk characterization conclusions in Section 7.

6.1 LAND USES

The Mines site and surrounding area is currently uninhabited. A Forest Service key is required to gain vehicle access to the Mines site. The nearest city is Lakeview, located 17 miles to the southeast. Lakeview has a population of 2,785 and is the county seat and urban center of Lake County. The closest permanent residents to the Mines site live near the intersection of FS3780 and County Road 16B, approximately 12 miles southeast of the Mines site. Primitive campsites exist in Fremont National Forest in the general vicinity of the Mines site, with many used as hunting camps in the fall. Wood cutting and cattle grazing also occur in the general area of the Mines site.

Figure 6-1 shows the property boundaries of private and public land ownership at the White King Mine area. Lucky Lass Mine is located entirely on National Forest System lands. The boundaries of the privately-owned property are:

> Parcel 1, S1/2NE1/4, Section 30, T.37S., R.19E., W.M. This parcel is currently owned by the Coppin Trust (surface estate) and members of the Leehmann and Coppin families (mineral estate)
>
> Parcel 2, NW1/4SW1/4, Section 29 and NE1/4SE1/4, Section 30, T.37S., R.19E., W.M. This parcel is currently owned by Fremont Lumber Company (surface estate) and members of the Leehmann and Coppin families (mineral estate)

The intended future use of the Mines site and the immediate vicinity is for commercial production of timber and forage for domestic livestock as described in the current Forest Management Plan. Future on-site human receptors might include timber workers, USFS personnel, recreational users, and trespassers.

6.2 GROUND AND SURFACE WATER USES

The ground water associated with the Mines site is not currently used, nor will it likely be used for any purpose in the future due to the remote location of the Mines site and the limited quantity and quality of water in the shallower zones. The reasonable likely future use of ground water in the vicinity of the Mines site is for discharge to surface water. Surface water in this area is currently used by livestock and wildlife.

Water quality in the White King pond, Lucky Lass pond, and Augur Creek are required to meet the standards and beneficial uses under OAR 340-41 for the Goose Lake basin. The potential beneficial use for these areas is for aquatic life, livestock, and recreation. The remedy also incorporates the objective of protecting the reasonable likely future beneficial uses as defined under ORS 465.315 and the corresponding rule OAR 340-122-090 and -115. At the White King pond the potential future beneficial use is for aquatic life. Livestock watering and recreation are also reasonably likely, but will be restricted as part of the remedy.

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SECTION 7

SUMMARY OF SITE RISKS

Human health and ecological risk assessments were conducted to evaluate the potential for current and future impacts of Site-related contaminants on receptors inhabiting or visiting the White King/Lucky Lass Mines site. These evaluations are discussed in detail in Volume V of the RI/FS which is located in the Administrative Record for the Mines site. The baseline risk assessment estimates what risks the Mines site poses if no action was taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the baseline risk assessment for the Mines site.

7.1 HUMAN HEALTH RISK ASSESSMENT

7.1.1 Identification of Chemicals of Concern

Contaminants evaluated in the human health risk assessment include those chemicals that exceeded background levels representative of unmineralized areas, exceeded EPA risk-based screening concentrations (Region III risk based screening concentrations dated October 4, 1995), and were not Aessential nutrients@ for humans. Based on this evaluation, chemicals of potential concern (COPCs) identified for human and ecological receptors include inorganic constituents and certain uranium and thorium series radionuclides. Based on the findings of the human health risk assessment this list was narrowed down to Arsenic and Radium-226 as the primary chemicals of concern (COC).

7.1.2 Conceptual Site Model

The media, exposure pathways, and receptors considered in the risk assessment are identified in the human health conceptual model presented in **Figure 5-1**. The receptors chosen for evaluation are based on knowledge of current and projected future use scenarios for the Mines site. The media chosen for consideration are those potentially impacted by historical mining activities for which there is a potential for human exposure. Some of the pathways were excluded from quantitative evaluation based on qualitative and/or quantitative reasoning. A description of the receptors chosen for evaluation is presented below in Section 7.1.3.

7.1.3 Exposure Assessment

The objectives of the exposure assessment are to identify potential exposure scenarios by which contaminants of concern in Mines site media could contact humans and to quantify the intensity and extent of that exposure.

The intended future use of the Mines site and the immediate vicinity is for commercial production of timber, recreation, and forage for domestic livestock. Future on-site human receptors might include timber workers, USFS personnel, recreational users, and trespassers. There is no current residential use at the Mines site and the likelihood that the area would be used for residential use in the near future is small given the current land ownership and remote location of the Mines site. However, because of the long-lived radionuclides (decay rate from days to 1000s of years) at the Mines site, the baseline risk assessment evaluated potential risk under a residential use scenario which includes workers, recreational users (also used to represent potential exposure to a trespasser), and residents. A complete summary of all the scenarios and pathways considered in the risk assessment are set forth in the baseline risk assessment report which is located in the Administrative Record for the Mines site.

7.1.3.1 <u>Receptors Evaluated in the Risk Assessment</u>

Site Worker

A worker would potentially be exposed to site-related COCs through contact with surface and subsurface stockpile material, surface and subsurface soil, surface water and sediment in Augur Creek, ponded water and sediment in the mine pits, and airborne dust and vapors. It is assumed that exposure to subsurface soil could occur in the future if workers engaged in intrusive activities.

Although listed as possible routes of exposure, exposure pathways for mine pit water and sediment were not evaluated. It was assumed that a worker would be aware of the contamination at the Mines site through a Site safety and health plan and would not drink the mine pit water.

Recreational User

The recreational land user includes adults and children who spend a limited amount of time at or near the Mines site fishing, swimming, hunting, or engaging in other recreational activities. A recreational user could potentially be exposed to COCs through contact with stockpile material, surface soil, airborne dust and vapors, Augur Creek surface water and sediment, and mine pit ponded water and sediments. A recreational user may contact subsurface soil in the future if the activities of other receptors (i.e., workers or residents) resulted in the transport of subsurface soil to the surface. In addition, a recreational user may be exposed to site-related contamination from ingestion of game or fish caught on the Mines site.

Resident

A future resident could potentially be exposed to site-related COCs through contact with surface and subsurface stockpile materials, surface and subsurface soil, airborne dust and vapors, and ground water. Although ground water associated with the Mines site is not currently used as a source of potable water, it was considered a possible medium of exposure for potential future residents. In addition to these media, a resident may be exposed through ingestion of home-grown produce, ingestion of home-raised livestock, contact with Augur Creek surface water and sediment, and contact with mine pit ponded water and sediment.

7.1.3.2 <u>Exposure Pathways Excluded From Quantitative Evaluation</u>

Based on semi-quantitative and/or qualitative reasoning, certain exposure pathways were excluded from quantitative evaluation in the risk assessment A brief discussion of the reasons for the elimination of these pathways is presented below.

Inhalation of Gas (Radon) in Outdoor Air

In the screening process used to identify COPCs for the Mines site, it was determined that radon gas in the air was present at concentrations equivalent to background [See the Technical Memorandum: Constituents of Potential Concern]. For this reason, this constituent (and consequently this pathway) was eliminated from consideration.

Dermal Contact with Stockpile Materials, Soil, and Sediment

As indicated in the conceptual site model and risk assessment report, exposure via dermal contact with stockpile material and soil was not evaluated. As discussed in the *Dermal Exposure Assessment: Principles and Applications* (EPA, 1992b - the released guidance at the time of the risk assessment), there are only nine chemicals for which percutaneous absorption from a soil matrix has been studied: eight organic chemicals and cadmium. None of these eight organic chemicals were COPCs at the Mines site and cadmium was not included as a COPC. Therefore dermal contact with stockpile materials, soil, and sediment was not quantitatively evaluated.

Dermal Contact with Surface Water

As with dermal contact with stockpile materials, soil, and sediment, dermal contact with Augur Creek surface water and mine pit water was not evaluated due to a lack of available information on the percutaneous absorption of the COPCs. In addition review of EPA=s *Dermal Exposure Assessment: Principle and Applications* (EPA, 1992b) revealed that permeability coefficient for the COPCs identified for water were not available at the time.

In addition, this guidance states that the solubility of a compound (either in a lipid or aqueous solution) is a primary factor governing its dermal permeability. At the Mines site, the COPCs identified for surface water are all inorganic compounds which are most likely in the form of an insoluble metal or an inorganic salt which are in the group of compounds least able to penetrate the skin. Therefore, in addition to the lack of available chemical-specific information, dermal absorption of the COPCs in water was not evaluated due to their limited ability to penetrate the skin.

External Radiation from Surface Water

Based on professional judgement, it was assumed that the radiation exposure an individual would receive from being in contact with or in close proximity to surface water would be negligible compared to the radiation exposure received from ingesting surface water. Once surface water is ingested, the radiation remains until metabolic processes eliminated the contaminant, or until the radionuclide completes its decay series. Conversely, external radiation associated with being near surface water would end the moment a person left the water body. For this reason, external radiation from surface water (i.e., Augur Creek surface water and mine pit water) was not quantitatively evaluated.

Ingestion of Homegrown Produce

EPA Region 10 Supplemental Risk Assessment guidance for Superfund (EPA, 1996a) states that the site characteristics which would make consideration of food chain pathways (such as produce ingestion) important are current residential use of the site, the presence of large areas of contaminated soil in an agricultural area, and the presence of contaminants known to be taken up into plants at potentially significant levels (e.g., cadmium and PCBs). None of these factors apply to conditions present at the Mine site, which provides support for the decision to exclude this pathway from evaluation.

Ingestion of Livestock and Game

In order to estimate edible tissue concentrations in game/livestock it is necessary to model the following: plant concentrations from soil concentrations, animal tissue concentrations based on plant ingestion, animal tissue concentrations based on incidental soil ingestion while grazing, and animal tissue concentrations based on ingestion of surface water. There is limited information available to quantify these exposure pathways and studies that are available indicate that metal uptake into edible tissues is not a concern. These factors in combination with the limited amount of time an animal would graze in the vicinity of the Mines site provide the basis for exclusion of this pathway from evaluation.

Ingestion of Fish

During the RI, the only fish seen in Augur Creek in the vicinity of the Mines site were brook lampreys, which are not consumed by humans. Downstream of the Mines site, Augur Creek sustains a 400-foot drop over a distance of less than 0.6 miles. The steepness of the creek bed prevents trout or other species found in the lower stretches of Augur Creek from migrating to areas of the creek adjacent to the Mines site. Ingestion of fish was not quantitatively evaluated in the risk assessment due to the absence of edible fish in Augur Creek in the vicinity of the Mines site, and because physical conditions of the creek restrict new species.

During the Feasibility Study (FS), EPA requested Kerr McGee evaluate human health effects that may be associated with ingestion of fish containing inorganic arsenic in White King pond if the pond is to be used in the future as a sport fishing resource. Based on their report, Kerr McGee concluded that the fish in the White King Pond would not contain levels of inorganic arsenic that would pose a health concern. This conclusion is based on a number of factors, including: low potential for inorganic arsenic to bioconcentrate in freshwater finfish, metabolic processes that detoxify inorganic arsenic in fish, data from other sites showing low potential for inorganic arsenic to pose a risk, and a preliminary risk evaluation using the White King Pond water concentrations.

7.1.4 Exposure Point Concentrations

Exposure point concentrations were defined by identifying geographical areas that could be contacted by the receptors of concern. Five general geographic areas were defined for the Mines site. These areas are the following:

$ The protore stockpile at the White King Mine

$ The overburden stockpile at the White King Mine

$ Off-pile areas at the White King Mine

$ The overburden stockpile a the Lucky Lass Mine

$ Off-pile areas at the Lucky Lass Mine

Exposure point concentrations were calculated for a potential future resident, current and future Forest Service workers, and current and future recreational users. A current resident was not considered because there are currently no residents at the Mines site. Current and future exposure point concentrations were assumed to be the same for all media except soil. For soil, current exposure point concentrations were calculated incorporating soil analytical results from a depth of 0-6 inches; future exposure point concentrations were calculated incorporating soil analytical results from a depth of 0 to 6 feet (EPA, 1992c). Exposure point concentrations for the receptors of concern were calculated for soil, air, surface water, sediment, and ground water. A summary of Chemicals of Concern and Medium-Specific Exposure Point Concentrations are presented in **Tables 7-1 to 7-7.**

The summary of the exposure parameter values (e.g. exposure frequency (days/year), exposure duration (years) for the reasonable maximum exposure are presented in **Table 7-8**.

7.1.5 Toxicity Assessment

The human health toxicity assessment quantified the relationship between estimated exposure (dose) to a contaminant of concern and the increased likelihood of adverse effects. Risks of contracting cancer due to a site exposure are evaluated based on toxicity factors (cancer slope factors or CSFs) published by EPA. Quantification of non-cancer injuries relies on published reference doses (RfDs).

CSFs are used to estimate the probability that a person would develop cancer given exposure to site-specific contaminants. This site-specific risk is in addition to the risk of developing cancer due to other causes over a lifetime. Consequently, the risk estimates generated in risk assessment are frequently referred to as Aincremental@ or Aexcess lifetime@ cancer risks.

RfDs represent a daily contaminant intake below which no adverse human health effects are expected to occur. To evaluate noncarcinogenic health effects, the human health impact of contaminants is approximated using a hazard quotient (HQ). Hazard quotients are calculated by comparing the estimates to site-specific human exposure doses with RfDs. Values greater than 1.0 are considered to represent a potential risk.

The following hierarchical approach was used to determine toxicity values:

The Integrated Risk Information System (IRIS) computer database (EPA, 1996b)

The Health Effects Assessment Summary Tables (HEAST) (EPA, 1995b)

EPA Region 10 was consulted for toxicity values when toxicity values were not available from the above sources.

With the exception of lead (there are currently no EPA-derived slope factors for lead), all COPCs evaluated in the assessment that have evidence of carcinogenicity in animals or humans and are classified as carcinogens by EPA (Groups A, B, or C) were evaluated for potential carcinogenic risk. Certain inorganic COPCs (cadmium, chromium VI, and nickel) are only considered carcinogenic through the inhalation route. Therefore, cancer risk through oral ingestion exposure routes was not evaluated for these COPCs.

7.1.6 Risk Characterization

For carcinogens, risks are generally expressed as the incremental probability of an individual=s developing cancer over a lifetime as a result of exposure to the carcinogen. This Aexcess lifetime cancer risk@ is calculated from the following equation:

Risk = CDI x SF

where: risk = a unitless probability (e.g., 2 x 10^{-5} or 2E-5) of an individuals=s developing cancer

CDI = chronic daily intake averaged over 70 years (mg/kg-day)

SF = slope factor, expressed as (mg/kg-day)-1

(See **Table 7-8** for a summary of the input parameters used in the risk calculations)

Risks are probabilities that usually are expressed in scientific notation (*e.g.,* 1 x 10^{-6} or 1E-6). An excess lifetime cancer risk of 1 x 10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an Aexcess lifetime cancer risk@ because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual=s developing cancer from all other causes has been estimated to be as high as one in three. EPA=s generally accepted risk range for site-related exposures is 1 x 10^{-4} to 1 x 10^{-6}. Oregon cleanup rules defined at OAR 340-122-115 establish acceptable risk for carcinogens at or below 1 x 10^{-6} for individual carcinogens and 1 x 10^{-5} for cumulative carcinogens.

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (*e.g.,* life-time) with the RfD derived for a similar exposure period. An RfD represents a level that an individual may be exposed to a given chemical that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ < 1 indicates that a receptor=s dose of a single contaminant is less than the RfD, and that toxic noncarcinogenic effects from that chemical are unlikely. The Hazard Index (HI) is generated by adding the HQs for all chemical(s) of concern that affect the same target organ (*e.g.,* liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. A HI < 1 indicates that, based on the sum of all HQ=s from different contaminants and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI > 1 indicates that site-related exposures may present a risk to human health.

The HQ is calculated as follows:

Non-Cancer HQ = CDI/RfD

where: CDI=Chronic daily intake

RfD = reference dose

CDI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term).

7.1.6.1 Cancer Risk Summary

A summary of the Mines site cancer risks for each scenario/receptor is presented in **Tables 7-11 to 7-18.** The results of the human health risk characterization indicated that the following exposure scenarios had elevated risks:

A White King Mine current adult worker had a total risk of 6 x 10^{-5} due to ingestion of arsenic in soil and exposure to external radiation from radium-226/228 in soil. In a future scenario the risk to workers were slightly greater with a total risk of 2 x 10^{-4}. These risks were also associated with ingestion of arsenic in soil and exposure to radiation from radium-226 in soil.

For the future recreational user (child) at the White King Mine total cancer risks were 4 x $10^{-4.}$ This is due to exposure to arsenic in soil, exposure to external radiation from radium-226/228 in soil, and ingestion of arsenic in Augur creek and White King pond sediment and surface water. These risks are primarily associated with incidental ingestion of arsenic in surface soils (3.9 x 10^{-4}). Total risks to the current recreational user (child) were slightly lower at 2 x 10^{-4}.

For the potential future resident (adult) at the White King mine, the total chemical and radionuclide cancer risks were 3 x 10^{-1}. The chemical and radionuclide cancer risks are associated with ingestion of arsenic in soil (5 x 10^{-2}) and exposure to external radiation from radium-226/228 (5 x 10^{-2}), ingestion of arsenic in shallow bedrock ground water[4] (3 x 10^{-1}), inhalation of radon in shallow ground water (1 x 10^{-2}), and exposure to arsenic in White King Pond surface water and sediment (10 x 10^{-6}). The total risks to the future child resident were 2 x 10^{-1} from the same exposure points and chemicals of concern.

For the potential future resident at the Lucky Lass mine, the total chemical and radionuclide cancer risks were 1 x 10^{-3}. The highest chemical cancer risks are associated with ingestion of arsenic in shallow ground water (6 x 10^{-4}), inhalation of radon from shallow ground water (6 x 10^{-4}), ingestion of arsenic in surface soil (2 x 10^{-6}), and exposure to external radiation from

[4] Deep bedrock ground water throughout the Mines site, which is not impacted by historical mining activities, contains levels of naturally occurring arsenic, radon, and minerals that are likely to preclude its use as a residential drinking water source. Risks associated with exposure to shallow bedrock ground water at the White King protore stockpile are dominated by a single well. For a variety of reasons, use of the shallow aquifer for drinking water purposes in the vicinity of the Mines site seems unlikely. Therefore, this exposure pathway very likely overestimates the potential risks.

radium-226/228 in soil (2×10^{-4}). The total risk to the future child resident were slightly lower at 5×10^{-4}. from the same exposure points and chemicals of concern.

7.1.6.2 Noncancer Health Effects

A summary of the non-carcinogenic risks are shown in **Tables 7-19 to 7-24.**

The estimated hazard index for current workers was 0.4 due to exposure to arsenic in soil which is below the benchmark value of 1. The estimated hazard index for both the current and future adult recreational users exposure to overburden soils throughout the Mines site were also below the benchmark value of 1.

Estimates for both current and future child recreational users (hazard index of 4 and 11 respectively) were above the hazard index of 1, indicating that there is a potential for adverse health effects. The potential for current and future adverse noncancer health effects to a child are primarily associated with incidental ingestion of arsenic in overburden soil (1×10^{1} to 3×10^{0}).

There is a potential for adverse noncarcinogenic effects to potential future residents residing at the White King Mine with a total risk of 2×10^{3}. This risk is associated with ingestion of arsenic and manganese in shallow bedrock ground water (2×10^{3}) and ingestion of arsenic in soil (30).

There is also a potential for adverse noncarcinogenic effects to potential future resident residing at Lucky Lass Mine that is associated primarily with the ingestion of arsenic in deep bedrock ground water (4). All estimated hazard indices associated with exposure to surface water and sediment in White King pond, Lucky Lass pond, and Augur creek were below the benchmark value of 1 indicating that there is little potential for adverse noncarcinogenic effects for all receptors from these pathways.

7.1.6.3 Uncertainties

Uncertainties associated with the human health risk assessment includes exposure assumptions (e.g., pathways, frequency, and duration), the applicability of experimental animal study data on humans, potential differences in toxicity and absorption efficiency between humans and laboratory animals, derivation of dermal toxicity values from oral toxicity values, and the validity of adding risks or hazard quotients for multiple chemicals or pathways. Because several factors used in the risk assessment are uncertain, a conservative (risk aversive) approach was used to select variables for use in risk calculations.

The key uncertainties that may impact the estimate of risk for the Mines site are presented below:

Uncertainty Associated with Background Concentrations

The ability of the selected soil and sediment background locations to accurately depict area background concentrations is another source of uncertainty. Within mining areas there are often localized areas of high mineral deposits, and it is possible that the chosen background locations either missed or over represented these areas of high natural deposits. This could have the effect of eliminating COPCs through the screening process that should have been included or retaining COPCs that should have been screened out based on background. This indirectly is a source of uncertainty in the risk assessment which could lead to an underestimation or overestimation of total potential risks associated with the Mines site.

Another source of uncertainty associated with background concentrations is the absence of sufficient background characterization for shallow and deep bedrock ground water. Because the primary COCs associated with risk due to exposure to ground water (i.e., arsenic and radon) are known to be naturally occurring in the area, it is likely that the lack of adequate background screening resulted in retaining these as COPCs and using these values in the risk assessment. Inclusion of these COCs may have overestimated the risk due to ground water exposure.

Uncertainties in Analytical Data

Analytical results are variable due to the sample matrix, analytical method, and the laboratory performing the analysis. At the Mines site where a COPC was detected in a least one sample, nondetected samples were assigned estimated concentrations of one-half the detection limit. This may either over or underestimate the actual concentrations. Another uncertainty associated with the analytical data was the use of subsurface soil radionuclide concentrations to represent surface soil radionuclide concentrations. Surface soil radionuclide concentrations may be higher, lower, or similar to subsurface concentrations. Therefore risk to receptors may be underestimated, overestimated, or unaffected.

Uncertainties with Exposure Estimates

The choice of receptors evaluated in the risk assessment was based on knowledge of current site use and predictions of plausible future site use. Because current Site use (i.e., worker and recreations use) is documented, there is little uncertainty associated with the choice of these receptors. Conversely, the assumption that a resident would live at the Mines site is very uncertain and may overestimate risks.

7.2 ECOLOGICAL RISK ASSESSMENT

This section summarizes the results of the baseline ecological risk assessment for the Mines site. The objectives of the assessment were to assess qualitatively and quantitatively potential adverse effects to ecological receptors from contaminants detected at the Mines site.

The ecological risk assessment was conducted under a tiered or phased approach. The first phase (Tier I) involved conducting a screening level risk assessment where potential habitats, receptors, and exposures were identified, refined, and compared to site-specific COPC data to identify potential ecological risks. **Figure 7-1** shows the receptor and community feeding relationships and **Figure 5-2** depicts the ecological conceptual site model. The results from this assessment either identified a need for a more specific Tier II assessment or indicated that no remedial action was warranted.

Based on the findings of the Tier I assessment, a Tier II assessment was conducted to evaluate uncertainties associated with the risk estimates that were elevated in the screening ecological risk assessment for the Mines site. Specifically risk estimates that were based on terrestrial risk models or sediment guidelines were reassessed if the hazard quotient exceeded a value of 10. Risk estimates that were based on water quality criteria (ODEQ, 1994; EPA, 1986, 1992) were reassessed if the hazard quotient exceeded a value of 1.0. The following locations and media were considered in this reassessment of uncertainties: White King sediments, Lucky Lass pond sediments and surface water, and Augur Creek sediments and surface water.

7.2.1 Ecological Setting

The general vicinity of the Mines site contains a diverse assortment of habitat types as well as diverse wildlife communities (See **Figure 7-2** - Habitat Characterization Map). Vegetation associated with the Mines site can be characterized as forested and non-forested plant communities. Dominant plant communities found at the Mines site include mixed conifer forests comprised of ponderosa pine and lodgepole pine, wet-meadows, and shrub-steppe areas. Wet-meadow areas north of White King pond, south of the White King overburden pile, and north of the Lucky Lass overburden pile are dominated by sedge, meadow foxtail, Kentucky bluegrass, rushes, and tufted hairgrass. No Federally or State listed, threatened, or endangered plants have been identified within the boundaries of the Mines site.

The primary types of terrestrial mammals, amphibians and reptiles, and birds observed within the Mines site are species typically found in shrub-steppe, wet meadows, mixed conifer forested habitats in this region of southern Oregon. Both resident and migratory wildlife are present in the area. The most common mammals in the region are the least chipmunk, mule deer, pronghorn, black bear, and coyote. Birds commonly found in the region include the red-tailed hawk, northern harrier, common flicker, hairy woodpecker, common raven, green-tailed towhee, and dark-eyed junco. In addition, numerous sightings of the greater sandhill crane were made at the Mines site during field investigations.

In the aquatic environment, redband trout and pit-klamath brook lamprey utilize a portion of Augur Creek approximately 2 miles downstream from the White King Mine. However, for a number of reasons (see Section 5.2.6) they do not inhabit the portions of the creek adjacent to the Mines site. Aquatic invertebrates observed during field investigations at the White King pond include giant water bugs, aquatic worms, stoneflies, and true-fly larvae.

<u>Species of Special Status</u>

<u>Federally Listed</u>

The bald eagle, listed as threatened by the Federal Government under the Endangered Species Act of 1973, was identified as potentially utilizing areas associated with the Mines site. At the time of the risk assessment no observations of bald eagles either foraging or nesting in the study area had been documented. In 1990 and in 2001 a Biological Evaluation conducted by the Forest Service did not identify any eagles inhabiting the Mines site.

State of Oregon Listed Species

The Oregon Fish and Wildlife Commission (OFWC) also maintains a list of threatened and endangered species under OAR 635-100-125. No species on this list inhabit the Mines site. The State also maintains a list of sensitive species of vertebrates for the State of Oregon under OAR 635-100-040. The only Oregon-listed sensitive species observed at the Mines site was the greater sandhill crane, which is classified as vulnerable. Sensitive species listed as vulnerable are species that are not in imminent threat of becoming threatened or endangered and can avoid becoming listed as endangered through continued and/or expanded use of adequate protection measures and monitoring as defined by the Oregon Natural Heritage Program (ONHP, 1993).

Sensitive or Critical Habitat

Wetlands

Palustrine emergent wetlands (i.e., wet-meadows) situated on and downgradient of the Mines site were identified during field investigations. Based on field observations, these meadow areas displayed characteristics (i.e., hydrophytic vegetation, hydric soils, and hydrology) satisfying the criteria for identification of a wetland as outlined in the 1987 Corps of Engineers Wetland Delineation Manual (ACE, 1987). The exact boundaries of these wetland areas have not been delineated nor has a wetland assessment been conducted at the Mines site. The critical and unique status of wetlands and the associated flood plains downgradient of the Mines site may need to be determined prior to the commencement of any remedial action.

7.2.2 Identification of Chemicals of Concern

Similar to the human health risk assessment approach, contaminants evaluated in the ecological risk assessment included those chemicals that exceeded background. The risk-based screening step was not conducted for ecological receptors; therefore, all constituents that were determined to be present above background concentrations were included as COPCs for the ecological risk assessment.

Based on the findings of the ecological risk assessment this list was narrowed down to the following COCs as shown in **Tables 7-25 to 7-28:**

White King Pond Surface Water

$ Aluminum
$ Arsenic

Auger Creek and White King Pond Sediment

$ Arsenic
$ Manganese
$ Mercury

White King and Lucky Lass Soil

- $ Arsenic
- $ Antimony
- $ Mercury
- $ Selenium

7.2.3 Exposure Assessment

As previously stated, screening was performed before the ecological risk assessment. Therefore, the receptors and exposure pathways were initially identified on a broad trophic-level scale (**Table 7-29** summarizes the ecological exposure pathways of concern). Identifying receptors at the Mines site involves identifying primary routes of exposure through an understanding of the potential migration of COPCs (i.e., fate and transport). How groups of receptors are likely to be exposed and which media are likely to be involved in the primary routes of exposure was determined by identifying potential migration of COPCs.

7.2.4 Identification of Receptors

Individual receptor species, as defined by their trophic level (e.g., decomposer, producer, primary consumer) and group (e.g., plants, birds, mammals), were selected to represent all exposed receptors with comparable habitat requirements, feeding preferences, and life histories, as well as critical or "key" species identified by the following characteristics:

- _ Receptors that are vital to the structure and function of the food web such as principle prey or primary food sources of principle prey.
- _ Receptors that exhibit increased sensitivities to the COPCs.
- _ Receptors that have unique life histories or feeding behaviors whose loss may result in the elimination of a unique ecological niche or unpredictable results on the overall ecosystem.

An effort was made to select receptor species that most closely reflect these "critical" characteristics as well as species that are expected to inhabit the Mines site. Two bird species and one mammal species were selected as potential receptors for the Mines site because of their ability to feed and nest in areas of affected soil, sediment, and/or surface water. A plant and seed-eating bird (i.e., herbivore/granivore), represented by the blue grouse (*Dendragapus obscurus*), and an invertebrate-eating mammal (i.e., carnivore), represented by the vagrant shrew (*Sorer vagrans*), were selected to assess potential ecological impact from COPCs in White King and Lucky Lass mining area soil. The blue grouse was chosen as a receptor that is expected to be representative of other species of herbivorous/granivorous birds occupying a similar habitat at the Mines site. Similarly, the vagrant shrew was chosen as a receptor that is expected to be representative of other carnivorous species of small mammals occupying similar habitat at the Mines site. An Oregon-listed sensitive species of bird, the greater sandhill crane (*Grus canadensis tabida*), which feeds on aquatic organisms, was selected to assess potential ecological impact from COPCs in White King and Lucky Lass Mine pit water and sediment and Augur Creek surface water and sediment. The greater sandhill crane was chosen as a receptor that is expected to be representative of species of fish-eating birds occupying similar habitat at the Mines site.

Plants, aquatic invertebrates, and aquatic biota (including herpetiles and fishes) were also selected as receptors based on the potential for transport of COPCs to the soil, ponds, and creek associated with the Mines site. Plants were selected as receptors because of their close association with soil. Exposure of plants to COPCs in soil is expected through direct contact and uptake as the primary exposure routes. Aquatic invertebrates were selected as receptors because of their close association with benthic (i.e., sediment) environments. Aquatic biota were selected as receptors because of the close association of this community with surface water and wetland environments.

The incidental ingestion of COPCs in soil or sediment and the indirect ingestion of COPCs through dietary intake were selected as the primary routes of exposure for the receptor species (i.e., blue grouse, vagrant shrew, and sandhill crane). The primary exposure routes for aquatic invertebrates are diet and incidental ingestion and dermal contact with sediment. The primary exposure routes for aquatic biota to COPCs in surface water are diet and ingestion and dermal contact with surface water.

Exposure to COPCs in surface and subsurface soil at White King and Lucky Lass Mines was assessed by evaluating direct contact and uptake by plants, and ingestion of food (i.e., plants and soil invertebrates) and soil by the blue grouse and vagrant shrew. Exposure to COPCs in sediment from the White King Mine pond, Lucky Lass Mine pond, and Augur Creek was assessed by evaluating ingestion and dermal contact by aquatic invertebrates, and ingestion of aquatic organisms and sediment by the sandhill crane. Similarly, exposure to COPCs in surface water of White King and Lucky Lass ponds and Augur Creek was assessed by evaluating ingestion and dermal contact by aquatic biota, ingestion of aquatic organisms by the sandhill crane, and ingestion of surface water by the blue grouse, vagrant shrew, and sandhill crane. This simplified approach incorporated the conservatism needed to encompass all potential ecological effects that may be occurring at the Mines site.

7.2.5 Exposure Point Concentrations

Exposure point concentrations were derived for sediment, surface water, and soil and are presented in **Tables 7-25 to 7-28.** Maximum values were used as exposure point concentrations for all media at the Mines site. To estimate the environmental receptors exposure to radionuclides the absorbed doses (in Gy/day) were calculated for each receptor following the methodology described in *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards* (IAEA, 1992). Radionuclide-specific factors were based on those for radium-226 (Ra-226) as well as uranium-238 (U-238).

7.2.6 Ecological Effects Assessment

The focus of the effects assessment was to identify appropriate radionuclide and non-radionuclide effect doses for bird and mammal receptors and to identify available radionuclide effect doses and non-radionuclide effect criteria for communities of terrestrial plants, aquatic invertebrates, and aquatic biota. Defining the ecological effects (i.e., eco-toxicity) that may be associated with the receptors and the COPCs at the Mines site involved establishing potential effect doses from current literature and selecting effect criteria from appropriate regulatory guidance and literature sources.

Radionuclide effect doses were selected for birds, mammals, terrestrial plants, aquatic invertebrates, and aquatic biota from list of studies summarized in Eisler, 1994. Non-radionuclide effect doses for species of birds and mammals were obtained from peer reviewed primary research articles. Primary factors considered in the selection of suitable studies include study species, study duration, effect dose, and effect endpoint. Aquatic invertebrate effect criteria for non-radionuclides COPCs were obtained from the Ontario Ministry of the Environment (OME) *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario* (Persaud et al., 1993). Aquatic biota effect criteria for non-radionuclide COPCs were obtained from the Oregon State-Wide Water Quality Management Plan; Beneficial Uses, Policies, Standards and Treatment Criteria (ODEQ, 1994). At the time of the RI/FS the Oregon State-Wide Water Quality Management Plan had adopted EPA Ambient Water Quality Criteria (AWQC) [EPA, 1992] for regulating freshwater within the State of Oregon (ODEQ, 1994). The AWQC have been updated periodically. At the time of this ROD, the most recent version was published in December 10, 1998 with two corrections issued in April 1999.

7.2.7 Risk Characterization

The results of the ecological risk assessment are summarized in **Table 7-29.** The assessment showed some adverse impact, based on screening level assessment only, for the blue grouse, vagrant shrew, and terrestrial plants exposed to non-radionuclides (hazard index ranging from 38 to 94,000[5]) primarily from arsenic, selenium, antimony, lead, and mercury in surface and subsurface soil at the White King Mine. At Lucky Lass only slightly elevated risks (hazard index ranging from 1 to 3) were predicted for the vagrant shrew and terrestrial plants exposed to arsenic and silver in surface soil.

The risk assessment also predicted adverse impact, based on screening level assessment only, for aquatic invertebrates exposed to non-radionuclide COPCs in the sediments of the White King pond, Lucky Lass pond, and Augur Creek. The greatest risks were associated with arsenic in sediments at White King (HI of 33) and Augur Creek (HI of 27). There were additional elevated risks to aquatic invertebrates from manganese in Augur Creek (HI of 13). Adverse impact was also predicted for the sandhill crane exposed to non-radionuclide COPCs in White King pond and Lucky Lass pond sediment, but these impacts may also occur at levels below background concentrations.

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[5] Numerically large hazard quotients are associated with exposure to lead at the Mines site. Lead was detected at a maximum concentration of 515 mg/kg and an average of 28 mg/kg for all soil samples collected at the Mines site. The average value is very similar to the background lead levels that ranged from 11.3 to 16.7 mg/kg. The ecological assessment assumes all receptors are continuously exposed to the maximum detected concentration of lead (and all other COPCs) so these values may overestimate the true risk to ecological receptors.

A Tier 2 analysis was conducted to reassess in further detail the uncertainties associated with the risk estimates that were elevated in the screening ecological risk assessment for the Mines site. This reassessment of uncertainties indicated that no adverse impact is predicted for the sandhill crane due primarily to the highly conservative Biota-sediment accumulation factors (BSAF) used to estimate fish tissue concentrations in the screening level assessment. In addition, no adverse impacts to aquatic biota are expected in the Lucky Lass pond and Augur Creek surface water, since dissolved concentrations do not exceed water quality standards.

Since the bio-availability of arsenic and manganese affects whether benthic organisms will be impacted by these metals, further evaluation of the bioavailability of these metals in White King pond sediment (arsenic only) and Augur Creek sediment (arsenic and manganese) may be warranted.

There were no adverse impacts to ecological receptors predicted for the radionuclide and nonradionuclide COPCs in water of the White King pond, Lucky Lass pond, or Augur Creek. Little aquatic life has been observed to inhabit White King pond, and is presumed to be due to historically low pH water prior to pond neutralization in 1998. EPA established PRGs for aluminum and pH for White King pond surface water.

7.2.8 Uncertainties

Significant uncertainties in the screening level ecological risk assessment can be found with chemistry and sampling analysis, fate and transport parameters, exposure assumptions, and toxicological data. The largest sources of uncertainty are found in the use of very conservative exposure assumptions and the use of potentially weak toxicological data from laboratory studies rather than site-specific toxicity data.

7.2.8.1 <u>Environmental Chemistry and Sample Analysis</u>

As previously stated maximum values were used as exposure point concentrations for all metals at the Mines site. This is likely to result in overestimation of risk to receptors who may inhabit a greater area than the area represented by just one or a few samples.

COPCs in White King pond and Lucky Lass pond sediment and surface water were not completely evaluated in the background screening process because of lack of background data at the pond. This is likely to result in an overestimation of risk since constituents with a least one detected value were evaluated as COCs instead of only those constituents that were significantly above background levels. This is especially important since the pond bottoms represent naturally mineralized zones. The potential for overestimation of risk for naturally occurring elements is also true for aluminum, calcium, magnesium, potassium and sodium, which are primary soil components and, with the exception of aluminum, are considered to be essential elements.

7.2.8.2 <u>Fate and Transport Parameters</u>

The bioavailability of COPCs in the environmental media and diet of the receptors was estimated at 100 percent. This is likely to overestimate risk since constituents in the environment are quite frequently bound as complexes that reduce their bioavailability.

Bioaccumulation was assumed to be 100 percent in the absence of site-specific bioaccumulation data. This results in an overestimation of risk for those constituents that are not expected to bioaccumulate but may result in underestimation of risk for those COPCs that have the potential to bioaccumulate in plant and animal tissues above 100 percent. Bioaccumulation factors of 0.04 for arsenic, 0.045 for lead, and 0.025 for selenium have been reported in the literature. Thus risks to a blue grouse at the Mines site may be overestimated for these metals by more than an order of magnitude. Risk to the vagrant shrew and sandhill crane may also be overestimated based on bioaccumulation of COPCs in their prey (earthworms and fish respectively),

7.2.8.3 <u>Exposure Assumptions</u>

Exposure parameters for all receptors were selected based on literature information and professional judgement. In addition, the amount of time spent exposed to site-related media is assumed to be the highest possible value. The conservative assumptions used are likely to overestimate the potential risk estimates

The inhalation of radon gas by active and dormant near-surface wildlife, such as the vagrant shrew, presents a potential exposure pathway that was not evaluated during this assessment. Although subsurface exposure to radon gas at the Mines site may or may not be greater than that of ambient air, exclusion of this pathway from the assessment may underestimate the potential for risk from this contaminant.

Food and water ingestion rates for all bird and mammal receptors were based on allometric models from the scientific literature. These models generally result in an overestimation of actual intake rates for ecological receptors.

For all radionuclide COPCs, exposure was estimated using human toxicokinetic data and associated dose conversion factors. Applying human toxicokinetic data to predict radionuclide fate in animals is another source of uncertainty. The effect of this uncertainty cannot be quantified.

For the radionuclide COPCs, exposure was estimated using exposure parameters specific to radium-226 (for radium isotopes) and uranium-238 (for uranium isotopes.) This adds uncertainty in calculating total radionuclide exposures, particularly for thorium, although it is unclear if potential risks are over or underestimated.

7.2.8.4 <u>Toxicological Data</u>

Both radionuclide and non-radionuclides effects data were obtained from literature sources that were not specific to the receptors at the Mines site. This could lead to uncertainty in estimation of risks.

Radionuclide effects data presented as acute or chronic effects values were not extrapolated to acute or chronic no-effects values. For non-radionuclide effects data, a factor of 5 was used to extrapolate from effects levels to non-effects levels. Thus, no-effected data may be underestimated by about an order of magnitude.

Avian effects data were unavailable for several non-radionuclide COPCs (i.e, antimony, barium, beryllium, and potassium), which results in uncertainty as to whether these COCs contribute to the overall risk to receptors.

The majority of available non-radionuclide effects data were determined using laboratory animals studies under laboratory conditions. These data as well as toxicological interpretations based on blood biochemistry or body weight changes may not represent adverse health effects or cannot be precisely extrapolated to a free-ranging wildlife population.

Suitable phytotoxicity (toxicity to plant) data was very limited. In instances where data were available, the lowest reported concentration of a COPC that elicited an adverse effects was selected as the effective criterion.

7.3 BASIS FOR RESPONSE ACTION

Contaminated soil stockpiles at the Mines site represent a threat to ecological and human receptors. The chance of an individual developing cancer or non-carcinogenic effects related to exposure to Site stockpiles exceed the acceptable risk range identified in the NCP and DEQ acceptable limits. Terrestrial and aquatic ecological receptors may also be harmed by exposure to surface soils, surface water, sediments, and stockpile soil.

The response action selected in the this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

7.4 REFERENCES FOR SECTION 7

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SECTION 8

REMEDIATION OBJECTIVES

Remedial action objectives (RAOs) consist of medium-specific or location-specific goals for protecting human health and the environment. This section presents the RAOs for soil, surface water, sediment, and ground water at the Mine site. It outlines the risks identified in Section 7 and provides the basis for evaluating the cleanup options presented in Section 9. Additionally, a description of the major applicable or relevant and appropriate requirements (ARARs) for components of the remedial alternatives is provided.

8.1 NEED FOR REMEDIAL ACTION

The uranium mining operations at the Mines site have resulted in widespread distribution of contaminated soils and waste rock at the White King and Lucky Lass Mines, contaminated water and sediments in the White King Pond, and contaminated sediments in Augur Creek. Key COCs at the Mines site identified in the human health and ecological risk assessment include radium-226 and arsenic. The cleanup goals were driven by either background, or ARARs, in particular the Oregon Environmental Cleanup regulations. Normally, under the NCP, EPA strives to achieve an excess human health cancer risk, for the current or reasonably anticipated future land use, of between 1×10^{-4} and 1×10^{-6}. The Oregon Cleanup regulations, which are ARARs for the selection of response actions, require that the excess cancer risk be no greater than 1×10^{-6} for each individual carcinogen, and therefore are more stringent than the NCP. The following sections outline the remediation objective for each area of the Mines site. Specific cleanup goals are discussed in Section 12.6.

8.2 REMEDIAL ACTION OBJECTIVES

8.2.1 White King Mine

At the White King Mine, the potential cancer risks to workers, recreational users, and potential future residents exceeded 1×10^{-6} from exposure to external radiation, ingestion of arsenic in soils and ingestion of contaminants in pond water, pond sediment, shallow bedrock and perched ground water. Non-carcinogenic potential risks were also elevated above 1 for the current and future recreational user and potential future resident. These risks are associated with the incidental ingestion of arsenic in overburden soil and ingestion of arsenic in pond water and sediment and arsenic and manganese in shallow bedrock and perched ground water directly beneath the stockpiles.

Ecological risks were elevated above 1 for plants and animals exposed to surface and subsurface soils These risks are primarily associated with exposure to arsenic, selenium, antimony, lead, and mercury in soils. Ecological risks were also elevated for aquatic invertebrates exposed to pond sediments. These risks are primarily associated with arsenic.

8.2.1.1 <u>White King Soils</u>

The RAOs for the White King soils under current and future use scenarios are as follows:

$ Reduce exposure to stockpiles and contaminated off-pile soil by humans (ingestion and external exposure) and ecological receptors (ingestion). Demonstrate protectiveness to an excess risk level of 1×10^{-6} for carcinogenic risk (or a non-cancer HQ of 1) based on reasonable maximum exposure for an individual, or background concentration whichever is higher.

$ Reduce and eliminate the release and migration of contaminants from soils to ground water or surface water via erosion, oxidation, or leaching to protect for beneficial uses (recreational, agricultural, and aquatic habitat).

$ Prevent the removal or use of stockpile soils for any purpose.

8.2.1.2 <u>White King Pond</u>

The Human Health Risk Assessment for the White King pond concluded that the pond posed a slight carcinogenic risk to current and future recreational users and potential future residents from ingestion of arsenic in surface water (4×10^{-6}) and sediment (1×10^{-5}). Based upon a limited number of samples the ecological risk assessment predicted potential risks to aquatic invertebrates exposed to non-radionuclide contaminants in the sediment at the White King pond. The greatest risks were associated with arsenic and manganese in sediments. Additionally, limited aquatic life has been observed to inhabit White King pond presumably due to historical low pH and dissolved concentrations of metals. The reasonable likely future beneficial use as defined under ORS 465.315 is expected to be an aquatic habitat. Potential livestock watering and recreation are also reasonably likely, but can be restricted as part of the remedy. The remedial action goals are as follows:

$ Protect the potential beneficial use(s) (aquatic life) of the White King pond from exposure to COCs above applicable standards (Oregon=s State water quality standards (OAR 340-41-925), or background concentrations (if background concentrations are higher than the applicable standard).

$ Maintain a neutral pH in the White King pond water in order to reduce the toxicity of the acidic water and lower the concentrations of dissolved metals in the water.

8.2.1.3 <u>Augur Creek</u>

The risk assessment predicted potential adverse impact to aquatic invertebrates exposed to non-radionuclide contaminants in the sediments of Augur Creek. The greatest risks were associated with arsenic with a hazard index of 26.5. There were additional elevated risks to aquatic invertebrates from manganese in Augur Creek (HI of 13.2). There was also a slightly elevated carcinogenic risk to current and future recreational users from exposure to arsenic in Augur Creek sediment and surface water (9×10^{-6}). No adverse impact was predicted for surface water since dissolved concentrations did not exceed Federal ambient water quality standards. The RAOs for Augur Creek are:

- $ Reduce exposure to aquatic invertebrates and recreational users from COC=s in Augur Creek surface water and sediments above protective risk-based levels for recreational users, applicable standards (Oregon=s State water quality standards (OAR 340-41-925), or background concentrations (if background concentrations are higher than the applicable standard or protective level).
- $ Monitor surface water to ensure that the potential beneficial uses of surface water (discussed in the next section) are maintained and/or to establish a trend toward background concentrations.

8.2.1.4 White King Mine Ground water

Although future human use of ground water was determined to be unlikely, the risk assessment included human exposure to ground water. It indicated theoretical cancer risks exceeding 10^{-4} and non-cancer HQ exceeding 1 for future residential use of ground water for the bedrock aquifer. The primary risk drivers were arsenic and radon. For the shallow aquifer, the risk drivers are arsenic and radon (and beryllium and manganese at one location) directly below the protore and overburden stockpiles. The concentrations of arsenic in all of the downgradient monitoring wells in this aquifer are below MCLs. See Section 5.3.2 for a discussion of the sources and fates of contamination in ground water. The RAOs for White King Mine ground water are:

- $ Prevent any human exposure and future use of ground water beneath the stockpile with contaminant concentrations in excess of Federal and State drinking water standards or protective levels.
- $ Monitor ground water upgradient and downgradient of the stockpile to ensure that the potential beneficial uses of ground water (discharge to surface water) meet applicable standards (Oregon=s State water quality standards (OAR 340-41-925) at the boundary of the waste management area with Augur Creek and/or to establish a trend toward background concentrations.

Beneficial Use Determination

Since an RAO has been established to monitor the ground water to ensure that the potential beneficial uses of the ground water are maintained, the following paragraphs describe the determination of beneficial ground water use for the Mines site.

A beneficial water use determination is required in accordance with OAR Chapter 340, Division 122. General categories of water use include drinking water, irrigation, livestock, industry, engineering, aquatic life (aquatic habitat), recreation, and aesthetic quality. The RI has documented that the Mines site is located in a remote area of Lake County, Oregon, approximately 17 miles from the nearest city (Lakeview). Water uses such as industrial process or engineering purposes are highly unlikely. The land in the vicinity of the Mines site is typically used for timber production or cattle grazing, not for food crop production. Thus, the use of ground water or surface water for irrigation of crops is highly unlikely. The natural background levels of radon, arsenic, and other constituents present within the ground water make it a poor drinking water source. (Under the NCP ground water at the site would likely be designated as Class II (Subclass IIB - a potential source of drinking water) where remediation goals are typically set at drinking water standards (MCLs))[6]. Ground water may discharge to surface water at a point down the Augur Creek valley. Therefore, the discharge of such ground water to surface water use is considered by the state as the potential beneficial use of ground water.

The only surface water body in the vicinity of the Mines site is Augur Creek. There are no current recreational uses (fishing, swimming, boating) of Augur Creek in the vicinity of the Mines site and future such uses are extremely unlikely due to the small size and intermittent flow of the creek. Augur Creek is hydraulically connected to the ground water as determined in the RI, but, as discussed above, there is no beneficial use of the ground water other than discharge to surface water. A likely beneficial surface water use for the Mines site would include Augur Creek as an aquatic habitat for macroinvertebrates and benthic organisms. Thus, to protect the aquatic habitat of Augur Creek, the discharge from ground water to surface water should meet Oregon=s State water quality standards (OAR 340-41-925). Since the land use in the vicinity of the Mines site includes timber production and cattle grazing, water for livestock from either Augur Creek or a livestock watering well is also a potential water use.

8.2.2 Lucky Lass Mine

At the Lucky Lass Mine, the potential risks to a future resident exceed 1×10^{-6} due to exposure to arsenic and radionuclides in soil and arsenic and radon in ground water (as previously stated in section 7.1.3 residential exposure is not a reasonably likely future use although it was included in the risk assessment). The majority of the risks are associated with off-stockpile soils and shallow ground water below the stockpile. With the exception of specific surface soils, the overall levels of contamination in the Lucky Lass soils is much lower than that found at White King.

8.2.2.1 Lucky Lass Soils

The RAOs are as follows:

$ Prevent direct contact with the contaminated soils to reduce potential risks from incidental soil ingestion and threat from external radiation exposure.

$ Prevent any future use of stockpile soils with contaminant concentrations in excess of protective levels.

[6] EPA=s Superfund program uses EPA=s Ground Water Protection Strategy as guidance when determining the appropriate remediation for contaminated ground water at CERCLA sites. This strategy establishes different degrees of protection for ground waters based on their vulnerability, use, and value. EPA=s goal is to return usable ground water to their beneficial uses within a time frame that is reasonable given the circumstances of the site.

8.2.2.2 Lucky Lass Mine Ground water

Results of the human health BRA indicated cancer risks exceeding 1×10^{-6} and non-cancer hazard quotients exceeding 1 for future residential use of ground water from the shallow and deep aquifers. Radon was the only constituent of concern in shallow ground water. Arsenic and radon were the risk drivers in the deep (bedrock) aquifer. The concentrations of arsenic in ground water did not exceed the MCL at any location. The radon levels were similar to those detected in background samples. None of the radionuclides associated with mining activity were constituents of concern. As at the White King mine the state has determined that the potential beneficial use of the Lucky Lass ground water is discharge to surface water. EPA would classify this ground water as Class II (subclass IIB - a potential source of drinking water) where remediation goals are typically set at drinking water standards (MCLs). The RAOs for Lucky Lass Mine Ground water are:

$ Monitor ground water upgradient and downgradient of the stockpile to ensure that the potential beneficial uses of ground water (discharge to surface water) meet applicable standards (Oregon=s State water quality standards (OAR 340-41-925) at the boundary of the waste management area with Augur Creek and/or to establish a trend toward background concentrations.

$ Prevent any human exposure and future use of ground water beneath the stockpile with contaminant concentrations in excess of Federal and State drinking water standards or protective levels.

8.3 ESTIMATED AREAS AND VOLUMES OF STOCKPILE MATERIAL AND POND WATER

Table 8-1 presents an estimate of the areas and volumes of media of concern including the White King Stockpiles, White King Mine pond, and the Lucky Lass Mine Stockpiles that was developed for the FS. The assumptions and data used in estimating the areas and volumes are also indicated in the table.

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SECTION 9

DESCRIPTION OF ALTERNATIVES

Many technologies were considered to clean up the Mines site. Appropriate technologies were identified and screened for applicability to site conditions. The potential technologies were then assembled into alternatives. Potential remedial alternatives for the Mines site were identified, screened, and evaluated in the FS. The range of alternatives developed included no action, institutional controls, containment, treatment, and disposal. The alternatives are identified by numbers used in the FS.

9.1 COMMON ELEMENTS OF EACH ALTERNATIVE

With the exception of the No Action Alternative, the remedial alternatives developed for the Mines site share certain components, such as institutional controls and monitoring requirements. Several of the alternatives require institutional controls (e.g., deed restrictions such as an easement or covenant) to limit or restrict certain uses of the Mines site and to ensure the integrity of the stockpile soil cover. These institutional controls and monitoring requirements are discussed in each alternative as appropriate and outlined in detail in the selected remedy (Section 12).

9.2 DESCRIPTION OF ALTERNATIVES

9.2.1 White King Stockpile Alternatives

9.2.1.1 Alternative SP-1: No Action

Estimated Capital Cost: $0

Estimated Annual O&M Cost: $0

Estimated Present Worth Cost: $0

Estimated Construction Time frame: None

CERCLA requires evaluation of a no-action alternative as a baseline reflecting current conditions without any cleanup effort. This alternative is used for comparison to each of the other alternatives.

9.2.1.2 Alternative SP-2: Institutional Controls and Monitoring

Estimated Capital Cost: $509,000

Estimated Annual O&M Cost: $36,000

Estimated Present Worth Cost: $956,000 (7% discount rate for 30 years)

Estimated Construction Time frame: None

This alternative consists of access restrictions, institutional controls, inspection and maintenance, and monitoring.

Access Restrictions

Access would be restricted by constructing a fence or barrier surrounding the stockpiles to prevent exposure to and disruption or use of the stockpile materials. In order to prevent disturbance of the stockpiled material from humans and cattle or medium-to-large animals, a barbed-wire fence, boulder barrier, or chain-link fence would be constructed around the stockpiles. For costing purposes, the chain-link fence option was used for the above cost estimate.

Institutional Controls

Land use restrictions would be put in place to prevent removal or residential use of stockpile material and installation of ground water wells. Because the White King stockpiles are located on both National Forest System Lands and private property, different mechanisms for land use restrictions will be required:

For private property land use restrictions would include proprietary controls such as an equitable servitude and easement (consistent with ODEQ=s AFinal Guidance for Use of Institutional Controls@ (ODEQ, 1998). This is a legal instrument placed in the chain of title that provides access rights to a property for inspection and maintenance and monitoring and restrictions preventing residential use and installation of drinking water wells. This type of control shall be set forth in an EPA and ODEQ-approved form running with the land and enforceable by EPA and DEQ against present and future owners of the property. As an informational device the Mines site would be maintained on DEQ=s Environmental Cleanup Site Information Database as long as the institutional controls remain in effect. One additional informational device is a deed notice to inform the public that contamination remains on private property.

On National Forest System Land an amendment to the Forest Plan would be made by the Forest Service to prohibit residential use and installation of drinking water wells at the Mines site. The area of the Mines site was withdrawn from mining by the Bureau of Land Management (BLM) on August 9, 1993 to protect the rehabilitation work to be done on the White King and Lucky Lass mine. This withdrawal will expire on August 9, 2013 (20 years) unless the withdrawal is extended (withdrawals can be extended for 20 years at one time) . The USFS will request that the BLM continue to maintain a withdrawal of the area of the stockpiles from mineral entry.

Inspection and Maintenance

Two inspections would be performed each year to confirm that land use restrictions have been effectively implemented on private parcels and National Forest System lands. During the site inspections an evaluation of whether the land use restrictions have been violated (e.g., material moved from the stockpiles, construction of housing etc.) on the private parcels and National Forest System lands within and adjacent to the Mines site would be performed. In addition, the private property owners would be contacted once per year to discuss the land use restrictions and potential future uses or property transactions that could affect the land with the stockpiled material.

Site maintenance would be conducted during two site inspections per year (spring and fall). The maintenance would address damages to the perimeter fence, gates, locks, warning signs, and the monitoring wells caused by inclement weather or vandalism.

Monitoring

Monitoring of various environmental media would be conducted to determine if constituents of concern are migrating and to ensure that there would be no unacceptable long-term risk. Post-remedial monitoring would be used to refine background levels, establish trends, and determine the need for additional action, if necessary. Sediment and surface water samples would be collected from Augur Creek. These samples would be collected upgradient of the protore stockpile, between the protore and overburden stockpiles, and downgradient of the overburden stockpile. The samples would be collected and analyzed annually and analyzed, at a minimum, for arsenic and total uranium.

Ground water samples also would be collected from alluvium and shallow bedrock wells upgradient and downgradient of the protore and overburden stockpiles. These depths are based on concentrations of radionuclides and inorganic constituents detected in the existing alluvium and shallow bedrock wells. The samples would be collected and analyzed annually and include analyses, at a minimum, for arsenic, total uranium and sulfate. Monitoring of ground water would ensure that the beneficial uses of ground water (aquatic life and livestock) are maintained and/or to establish trends.

9.2.1.3 Alternative SP-3a: In-Place Containment

Estimated Capital Cost: $4,316,000

Estimated Annual O&M Cost: $68,000

Estimated Present Worth Cost: $5,160,000 *(7% discount rate for 30 years)*

Estimated Construction Time frame: 5.5 months

The objective of this alternative is to regrade the two White King stockpiles and place a separate 12- inch soil cover over each stockpile. The access restrictions and monitoring components would be the same as those described in Alternative SP-2. Additional institutional control and inspection and maintenance requirements are added under this alternative to ensure the integrity of the two stockpile covers and prevent further erosion. This alternative would be performed in conjunction with a White King pond alternative that does not involve filling the pit with the stockpiled material (i.e., WKPW-1, WKPW-2, or WKPW-3).

Stockpile Regrading

The White King stockpiles would be regraded to provide slope stability, promote drainage, control erosion, minimize the area that requires final cover, and move the stockpile materials away from Augur Creek. For the protore stockpile, approximately 93,000 cubic yards of material would be regraded. This includes 68,000 cubic yards of stockpile material and 25,000 cubic yards of off-pile and haul road material that would be excavated and placed on the protore stockpile. As part of the regrading the sideslopes of the protore stockpile located adjacent to Augur Creek would be moved 20 feet away from the creek to reduce erosion during storm events. This would require the movement of approximately 8,000 cubic yards of material, which is included in the 68,000 cubic yards of material noted above. The final slopes of the protore stockpile would be approximately 8 percent on the top and 4:1 on the sideslopes.

At the overburden stockpile, approximately 157,000 cubic yards of material would be regraded. This includes 132,000 cubic yards of stockpile material and 25,000 cubic yards of off-pile and haul road material that would be excavated and placed on the overburden stockpile. As with the protore stockpile, the sideslopes of the overburden stockpile located adjacent to Augur Creek would be moved 20 feet away from the creek to reduce erosion during storm events. This would require the movement of approximately 19,000 cubic yards of material which is included in the 132,000 cubic yards of material noted above. The final slopes of the overburden stockpile would be approximately 2 percent on the top and 13 percent on the sideslopes.

Augur Creek Erosion Control

In addition to the 20-foot setback from Augur Creek, the sideslopes of the stockpiles would be protected from the erosional forces of Augur Creek. The maximum bank velocities along the protore and overburden stockpiles based on a 500-year flood are 3.01 and 1.88 feet per second (ft/sec), respectively. Because the slopes of the stockpiles that border Augur Creek would be potentially exposed to the erosional forces of Augur Creek, a 1-foot layer of 3 to 4-inch rip-rap to control erosion of stockpiles into Augur Creek would be constructed. This size rip-rap would typically be appropriate to control erosion up to 5.5 ft/sec.

Cover

The final area to be covered is estimated to be 18 acres at each stockpile. During the regrading operation, materials of sand/gravel composition would be covered with regraded clay-like material from the stockpiles. AClay-like material@ is a term used to describe stockpile materials that consist of mixtures of clay and larger sized particles that exhibit significant plasticity in the field and low permeability in laboratory tests. This clay-like material would be placed in an estimated 9-inch layer (24,000 cubic yards) on the protore stockpile and an estimated 15-inch layer (37,000 cubic yards) on the overburden stockpile. The estimated thickness of clay- like material is dependent on the volume of clay-like material that is regraded at each stockpile. Based on volume estimates, 24,000 cubic yards and 37,000 cubic yards of clay-like material would be excavated and placed on the protore and overburden stockpiles, respectively, along with the sand/gravel like material. The compacted clay layer would further reduce the amount of precipitation that could infiltrate the stockpiles. After regrading and compacting, each stockpile would be covered with 9 inches of cover soil (24,000 cubic yards per stockpile) overlain by 3 inches of top soil (8,000 cubic yards per stockpile) and vegetation (18 acres per stockpile). The vegetation would likely consist of local climax vegetation (i.e., cool season grasses that are dormant in the summer and do not require long-term irrigation or other shallow rooted plants).

The appropriate vegetation would be determined during the design phase. Cover soil could be borrowed from numerous sources including the Lucky Lass mine (1.5 miles from White King mine), National Forest System lands between the White King mine and Lucky Lass mine (1 mile from White King mine), as well as private sources located 3, 6, and 15 miles from the Mines site.

Access Restrictions

Access would be restricted by constructing a fence or barrier surrounding the stockpiles to prevent exposure to and disruption or use of the stockpile as described under Alternative SP-2.

Institutional Controls

Institutional controls would include the mechanisms described for Alternatives SP-2. In addition this alternative would also add restrictions to ensure the integrity of the two covers. No uses would be allowed which could penetrate the surface covers or impact their functional integrity. Placement of a deed notice can be made by EPA.

Inspection and Maintenance

Inspection and maintenance would include the land use assessment and maintenance activities described under Alternative SP-2. In addition, Alternative SP-3a would include inspection and maintenance requirements for the 12-inch soil covers and vegetation as well as the stormwater management system. As indicated under Alternative SP-2, two site inspections would be conducted each year. The first inspection in the spring would include assessment of the cover system and stormwater management system.

The cover system would be inspected for areas of significant erosion. Erosion would primarily occur in the form of gullies along the steeper sideslopes. Significant erosion could be defined as one deep gully, or loss of vegetation and multiple shallow gullies. Design guidelines will be developed to prevent run-on to the stockpiles via perimeter diversion swales and reducing/preventing gully propagation on the cover surface through the use of berms/swales located on the top slopes and sideslopes. These berms and swales will be sized to accommodate a 500-year 24-hour storm event. The eroded areas will be backfilled with cover soil and topsoil, and reseeded/mulched. The cover system will also be inspected for signs of settlement and subsidence. Areas showing signs of potential ponding or continued settlement would be backfilled and repaired as described for erosion gullies.

With respect to the stormwater management system, the drainage channels would be inspected for excessive erosion damage or lack of suitable vegetation. Erosion gullies would be backfilled, seeded, and mulched. Additional straw bale barriers may be required to protect the repaired area until vegetation is reestablished. Regrading and backfilling may be required to correct the slope or erosion along the channel lengths. Areas that continually erode would be evaluated to determine the need for permanent riprap structures in these areas. Erosion control devices such as silt fences, hay bales, and/or jute or straw mats would be inspected during the first year following construction completion. Silt fence posts that are no longer secure or vertical would be reinstalled. Damaged fabric would be repaired or replaced with new fabric. Hay bales that are no longer intact or secured to the subgrade would be replaced. If there is evidence that runoff is passing around the hay bales, then the hay bales would be replaced or repositioned, or additional hay bales would be added. Damaged jute or straw mats that are no longer secure would be reinstalled, if necessary, in the event vegetation has not been established.

Monitoring

Monitoring of various environmental media would be conducted as described under Alternative SP-2.

9.2.1.4 Alternative SP-3b:Containment and Consolidation at Protore Stockpile Location

As a result of input from the State agencies, and additional technical evaluation by EPA, Alternative SP-3b has been modified in two ways from its description in the FS. First, under this alternative the protore stockpile will be recontoured to insure that it is out of the Augur Creek Floodplain and in compliance with the floodplain and erosion standards of OAR 340-050-0060 and ORS 469.375. This will require excavation of approximately 138,000 cubic yards of the protore stockpile. (Alternative SP-3b in the FS included removal of 33,000 cubic yards of the Protore stockpile in order to set it back 20 feet from Augur Creek. This modification adds 105,000 cubic yards of material to the volume of material to be moved as estimated in the FS). The second change is the addition of 12 inches of soil to the consolidated stockpile (also referred to as the mine waste repository), resulting in a total soil cover thickness of 24 inches. This is a variation of cover Aoption B@ presented in the FS which had a 12-inch soil and 6-inch rock cover. For the remainder of this ROD references to alternative SP-3b will include these two changes.

Estimated Capital Cost: $6,249,000

Estimated Annual O&M Cost: $54,000

Estimated Present Worth Cost: $6,919,000 (7% discount rate for 30 years)

Estimated Construction Timeframe: two 5.5-month construction seasons

The objective of this alternative is to excavate and place the overburden stockpile at the White King mine onto the protore stockpile at White King.

Stockpile Regrading

The Protore Stockpile will be reconfigured in order to remove stockpile material from the Augur Creek floodplain. It is estimated that approximately 138,000 cubic yards of material will need to be moved. **Figure 11-1** shows a conceptual design of the reconfigured protore stockpile, with the overburden stockpile on top, in relation to the Augur Creek floodplain and other major features at the Mines site.

The overburden stockpile (430,000 cubic yards) and off-pile, including portions of Augur Creek (35,000 cubic yards) and haul road material (15,000 cubic yards) will be excavated and relocated on top of the reconfigured protore stockpile. This material will be subsequently covered with regraded Aclay-like material@. AClay-like material@ is a term used to describe stockpile materials that consist of mixtures of clay and larger sized particles that exhibit significant plasticity in the field and low permeability in laboratory tests. Excavation of the 480,000 cubic yards of overburden stockpile and off-pile and haul road material will occur during the first construction season. Cover construction and planting of native grasses will occur during the second construction season. In addition, the second construction season will allow time for any additional regrading that might not have been completed during the first construction season.

Cover

A two-foot soil cover will be placed over the Mine waste repository. The total area that will require cover material is approximately 25 acres. The remedial design for the consolidated stockpiles shall include the following features: a low permeability lower layer utilizing the maximum thickness of regraded clay-like material over the top of the stockpile, use of natural features or drainage swales and french drains to divert surface water away from the consolidated stockpile, and to the extent practicable the final stockpile configuration shall fit into the natural topography. **Figure 11-2** shows a more detailed view of the proposed design features of the consolidated stockpiles. **Figure 11-3** depicts a cross section of the consolidated stockpile and **Figure 11-4** illustrates several potential design features of the consolidated stockpile. The final slopes of the stockpile will be approximately 4 percent on the top and 5:1 on the sides. The vegetation will consist of local climax vegetation (i.e., cool season grasses that are dormant in the summer and do not require long-term irrigation). The appropriate vegetation will be determined during the design phase. General cover soil can be borrowed from numerous sources including the Lucky Lass mine (1.5 miles from White King mine), National Forest System lands between the White King mine and Lucky Lass mine (1 mile from White King mine), as well as private sources located 3, 6, and 15 miles from the Mines site. The soil cover shall also include a storm water collection system to reduce the potential for erosion from or pooling of surface water. Final details on the soil cover and stockpile configurations will be developed during the design.

Reclamation

After excavation of the overburden stockpile, portions of the protore stockpile and off-pile and haul road areas, the disturbed areas will be reclaimed/revegetated with 3 inches of soil. The vegetation will consist of local climax vegetation (i.e., cool season grasses that are dormant in the summer and do not require long-term irrigation). The total area requiring reclamation/ revegetation is estimated to be 36 acres. Based on field observations during the RI, meadow areas situated on and downgradient of the stockpiles displayed characteristics (i.e., hydrophylic vegetation, hydric soils, and hydrology) satisfying the criteria for identification of a wetland area as outlined in the 1987 Corps of Engineers Wetland Delineation Manual (ACE, 1987). If there are any potential impacts on the wetlands due to the implementation of the final remedy, the remedial design will need to address these impacts.

Access Restrictions

Access would be restricted by constructing a fence or barrier surrounding the stockpile as described under SP-2 with the exception that the linear footage of fence would be less than fencing two stockpiles.

Institutional Controls

Land use restrictions will be put in place to prevent removal or residential use of stockpile material, installation of ground water wells, and to protect the integrity of the stockpile cover as described for Alternatives SP-2 and SP-3a.

Inspection and Maintenance

The White King waste repository cover will be inspected at a minimum of two times per year. The first site inspection will be conducted as soon as the Mines site is accessible in the spring (i.e., mid-May) and the second inspection will be conducted in late summer/early fall. The inspections will focus on the soil cover, sideslopes, perimeter fence, gates, locks, warning signs, and monitoring wells that could have been damaged by inclement weather or vandalism. Repairs will be conducted as necessary to correct the effects of settling, subsidence, erosion, vandalism, or other events to insure the integrity and effectiveness of the stockpile remedy. Visual indicators such as stressed vegetation, pooling of surface water indicating subsidence, also will be used to monitor effectiveness and integrity of the soil cover. The specific details for the stockpile monitoring and maintenance plan will be developed in design. (Additional details on maintenance of the stockpile is discussed later in this Section).

Confirmation that land use restrictions are effectively implemented will be assessed during site inspections. During the Mines site inspections, the private property and National Forest System lands within and adjacent to the Mines site will be assessed as to whether the land use restrictions have been violated (e.g., material removed from the stockpiles, construction of housing etc.).

Maintenance of the consolidated stockpile will include inspection and repair of the fences/physical barrier, gates, locks, warning signs, monitoring wells.

Monitoring

Monitoring of various environmental media would be conducted as described under Alternative SP-2.

9.2.1.5 <u>Alternative SP-4a: Consolidation & Containment of the White King Stockpiles within the White King Mine Pit.</u>

Estimated Capital Cost: $10,828,000

Estimated Annual O&M Cost: $55,000

Estimated Present Worth Cost: $11,510,000 (7% discount rate for 30 years)

Estimated Construction Timeframe: two 5.5-month construction seasons

The objective of this alternative is to excavate the White King stockpiles, dewater the White King pond, place the stockpile material within the empty pond, and provide a cover. Implementation of this alternative would include maintenance and monitoring to ensure the integrity of the cover. Institutional controls, access restrictions, monitoring components, and inspection and maintenance are the same as described in Alternatives SP-2 and SP-3a. This alternative would be implemented in coordination with a selected alternative for the White King pond that required dewatering of the pit.

White King Mine Pit Dewatering

The dewatering process would be determined by the alternative for the White King pond. Depending on the alternative selected for the White King pond, water may or may not be further treated prior to dewatering and may be discharged either to surface waters or applied to the land

Consolidation and Containment of the White King Stockpiles Within the White King Mine Pit

The excavation, transport, and placement of soil materials contained in the overburden and protore stockpiles would likely occur over the period of two construction seasons, which are assumed to last from 15 May through 31 October. During the first season, the White King Mine pit would be dewatered and backfilled with soil from both the protore and overburden stockpile to an elevation a few feet above the current pond's normal water elevation, and graded to prevent ponding and promote surface water drainage. This also would include limited excavation to remove off-pile areas (35,000 cubic yards. Erosion control measures (silt fence and/or hay bales) would be established around the overburden and protore stockpiles and the material within the White King Pond to reduce the transport of material off-site during storm events. During the second season, the remaining soil (based on visual observations of meadow) from both the protore and overburden stockpiles would be excavated and transported to the mine pit. The haul road (15,000 cubic yards) would also be excavated. The material would be placed in a manner that joins the high wall to the west of the mine pit with the north, south, and east portions of the Mines site and regrades the area to the approximate surrounding topography.

It is estimated that approximately 930,000 cubic yards of stockpile material and 50,000 cubic yards of off-pile and haul road material would be placed within and above the White King Mine pit. It takes approximately 391,000 cubic yards of material to fill the pit to the current pond water elevation. Clay-like material would be placed first into the White King Mine pit to form a 20-foot layer of low permeability material. This would require approximately 240,000 cubic yards of the clay-like material. The sand/gravel stockpile material (151,000 cubic yards) would be placed in the remainder of the volume below the water table. A 15- to 20-foot low permeability layer would be constructed along the highwall with the clay- like material. The remainder of the sand/gravel material (223,000 cubic yards) would be placed above the current pond water elevation and encapsulated with the clay-like stockpile material along the highwall and by the 5-foot clay cover. The total volume of clay-like material above the water table is approximately 317,000 cubic yards. During the alter design phase, the most efficient method for material handling (i.e., scrapers, dump trucks, and/or conveyor belts) would be determined. The soil would be placed in loose lifts of 12 inches and compacted.

Backfill placement would occur in a manner that allows the displacement of water toward the mine shaft. Pumping operations from the mine shaft area would continue as the shaft was surrounded with soil. At this point, soil would be pushed directly into the mine shaft. Pumping operations would continue as soil in the mine shaft displaced water. If determined necessary in the field (i.e., high ground water flow or AMW), the mine shaft would be filled with soil material. With the mine shaft filled, the pumping platform would be removed from the shaft area and placed into a sump area, which is below the mine shaft. The mine shaft would then be grouted with a cement-based grout mixture. Grout holes would be drilled into the soil placed in the mine shaft area at approximate 5-foot intervals. The grout hole would be filled with grout through an injection pipe placed at the base of the mine. The grout mixture would seal mine voids and further stabilize soil within the mine shaft. Soil placement activities in the mine pit would continue as mine grouting progressed. Soil would be placed, graded, and compacted in a manner that provides drainage to the sump area. Soil backfilling and placement would continue until the mine pit was backfilled to an elevation a few feet above the existing pond water elevation.

During the second construction season excavation would begin at the protore stockpile. The soil excavation, transport, and placement processes; the engineering controls; would be similar to those used during the first construction season. The remaining soil from the stockpiles would be placed to join the high wall to the west of the mine pit with the adjacent topography. It is estimated that the remaining 480,000 cubic yards of material in the stockpiles would be relocated in approximately four consecutive months.

Temporary and Final Reclamation

The areas requiring temporary and final reclamation include the overburden stockpile, the protore stockpile, the White King pit, and the off-pile areas. Following the excavation of material from the stockpiles during the first construction season, the stockpile areas would be graded to provide for positive drainage. The stockpiles, the mine pit area, and the off-pile areas would be regraded and surrounded with a silt fence and/or hay bales until the second construction season. Once the soil from the both of the stockpiles has been placed into the mine pit area, both the overburden and protore stockpile areas and the mine pit area would be graded to promote positive drainage; these areas would then be revegetated. Additionally, silt fencing would be installed or existing fencing would be repaired to control the erosion and the migration of sediment until the seed established a suitable cover over these areas. Augur Creek would be relocated to its original meandering pattern. The final configuration of the creek would be determined during the design phase. As discussed for Alternative SP-3a, if there are any impacts on the wetlands due to the implementation of the final remedy, the remedial design would address these impacts.

Cover

The cover for this alternative would consist of 9-inch cover soil layer (28,000 cubic yards) overlain by 3 inches of topsoil (9,500 cubic yards) and vegetation (23 acres). Five feet of clay-like material would underlay the 12-inch cover. The cover soil and topsoil would be obtained from similar sources as identified for Alternative SP-3a. Inspection and Maintenance of the cover system would be similar to Alternative SP- 3a..

9.2.1.6 Alternative SP-4d: Consolidation & Containment of the White King Stockpiles within the White King Mine Pit using a Permeable Treatment Wall.

Estimated Capital Cost: $11,314,000

Estimated Annual O&M Cost: $55,000

Estimated Present Worth Cost: $11,996.000 (7% discount rate for 30 years)

Estimated Construction Timeframe: two 5.5-month construction seasons

The objectives of this alternative are the same as Alternative SP-4a, except that a permeable limestone wall would also be used in the pit in the direction of ground water flow in order to provide further protection from generation of acid mine drainage. The purpose of the treatment wall is to neutralize any acid rock drainage that potentially could be generated from either the stockpile material or the pit walls and impact ground water. The amount of limestone needed to neutralize the potential acidity is estimated to be 4,500 tons. The limestone layer would be placed such that the stockpile material can be placed on the limestone layer. Other neutralizing agents like quicklime or hydrated lime may also be considered instead of limestone in the construction of a permeable treatment wall.

9.2.1.7 Alternative SP-5: Excavation of Stockpiles and Disposal in a new "Off-Mine" Disposal Cell.

Estimated Capital Cost: $26,116,000

Estimated Annual O&M Cost: $61,300

Estimated Present Worth Cost: $26,840,000 (7% discount rate for 30 years)

Estimated Construction Timeframe: three 5.5-month construction seasons

The objective of this alternative is to dewater the White King pond, construct an engineered disposal cell located away from the mined area, place the excavated material from construction of the cell into the White King Mine pit, excavate and place the stockpiles into the disposal cell, and restore the stockpile areas with topsoil. The below-surface disposal cell would be constructed in a location above any influences of ground water. A compacted clay layer would be placed on the bottom of the cell and the cover would be a 12- inch soil as described in SP-3a.

The tentative location of the new cell would be northwest of the Mines site on National Forest System Lands.

Institutional controls, access restrictions, monitoring components, and inspection and maintenance are the same as described in Alternative SP-3b.

AOff-Mine@ Location

The area for construction of the disposal cell that met the screening guidelines in the FS was Alternate site A, located northwest of the White King Mine on National Forest System lands. This site sits on a basalt flow. According to the DEIS, the thickness of the basalt flow extends beyond 160 feet in depth. The site ranges from about 100 to 160 feet in elevation above Augur Creek. It was proposed that the disposal cell be placed into the hillside on the south-facing slope. Excavation into the hillside would allow for disposal of about 90 percent of the material below natural grade. For the purposes of evaluating the feasibility of an "off-mine" disposal alternative, Alternate site A was considered representative for an Aoff-mine@ location.

White King Mine Pit Dewatering

The dewatering process would be determined by the alternative for the White King pond. Depending on the alternative selected for the White King pond, water may or may not be further treated prior to dewatering and may be discharged either to surface waters or applied to the land. These alternatives are discussed in Section 9.3.2.

Consolidation/Containment of the Stockpiles Within the Cell and Backfill White King Mine Pit with Basalt Material

During the first season, the White King Mine pit would be dewatered and backfilled with excavated disposal cell material to an elevation approximately 5 feet above the current pond's normal water elevation, and graded to prevent ponding and promote surface water drainage. Construction and placement of stockpile material within the disposal cell would occur over three construction seasons. This would also include limited excavation to move off-pile areas at the Mine to the disposal cell. Clearing and grubbing of Alate seral@ timber (18 acres) on land subject to Forest Service management requirements would also be needed at the cell location. Erosion control measures would be established around the overburden and protore stockpiles and the material within the White King Pond to reduce the erosion of material off-site during storm events. The selection of stockpile materials to be placed in the cell could vary based on the physical, chemical and radiological properties. During the second and third season, the remaining soil from both the protore and overburden stockpiles would be excavated and transported to the cell.

It is estimated that approximately 930,000 cubic yards of stockpile material and 50,000 cubic yards of off-pile and haul road material would be placed within the cell. Approximately 18 acres of area would require clearing and grubbing to prepare the area for disposal cell construction. Late Seral trees and shrubs would be removed and disposed off-site. The cell would consist of regraded compacted clay-like material at the bottom. The cell would be constructed with clay-like stockpile material encapsulating the sand/gravel stockpile material with the higher arsenic and radium-226 containing material at the base of the cell. The cover would consist of a 9-inch cover soil layer (18,500 cubic yards) overlain by 3 inches of topsoil (6,000 cubic yards) and vegetation (15 acres).

Temporary and Final Reclamation

The areas requiring temporary and final restoration include the overburden stockpile, the protore stockpile, the White King Mine Pit, the off-pile areas, and the cell area. Following the excavation of material from the stockpiles during the first and second construction season, the stockpile areas, the mine pit and the cell would be graded to provide for positive drainage and surrounded with a silt fence and/or hay bales. Once the soil from both the stockpiles has been placed into the cell and the mine pit backfilled with the basalt material during the third construction season, both the overburden and protore stockpile areas and the mine pit would be graded to promote positive drainage; these areas would then be revegetated. Additionally, silt fencing would be installed or existing fencing would be repaired to control the erosion and the migration of sediment until the seed establishes a suitable cover over these areas. Augur Creek would be relocated to a meandering pattern similar to the original meandering pattern. The final configuration of the creek would be determined during the design phase. As discussed for Alternative SP-3a, if there are any impacts on the wetlands due to the implementation of the final remedy, the remedial design would address these impacts.

9.2.1.8 <u>Consolidation/Containment of the Stockpiles Within the Cell and Backfill White King Mine Pit with Basalt Material</u>

During the first season, the White King Mine pit would be dewatered and backfilled with excavated disposal cell material to an elevation approximately 5 feet above the current pond's normal water elevation, and graded to prevent ponding and promote surface water drainage. Construction and placement of stockpile material within the disposal cell would occur over three construction seasons. This would also include limited excavation to move off-pile areas at the Mine to the disposal cell. Clearing and grubbing of Alate seral@ timber (18 acres) on land subject to Forest Service management requirements would also be needed at the cell location. Erosion control measures would be established around the overburden and protore stockpiles and the material within the White King Pond to reduce the erosion of material off-site during storm events. During the second and third season, the remaining soil from both the protore and overburden stockpiles would be excavated and transported to the cell.

It is estimated that approximately 930,000 cubic yards of stockpile material and 50,000 cubic yards of off-pile and haul road material would be placed within the cell. Approximately 18 acres of area would require clearing and grubbing to prepare the area for disposal cell construction. Late seral trees and shrubs would be removed and disposed off-site. The cell would consist of regraded compacted clay-like material at the bottom. The cell would be constructed with clay-like stockpile material encapsulating the sand/gravel stockpile material. The cover would consist of a 9-inch cover soil layer (18,500 cubic yards) overlain by 3 inches of topsoil (6,000 cubic yards) and vegetation (15 acres).

Temporary and Final Reclamation

The areas requiring temporary and final restoration include the overburden stockpile, the protore stockpile, the White King Mine Pit, the off-pile areas, and the cell area. Following the excavation of material from the stockpiles during the first and second construction season, the stockpile areas, the mine pit and the cell would be graded to provide for positive drainage and surrounded with a silt fence and/or hay bales. Once the soil from both the stockpiles has been placed into the cell and the mine pit backfilled with the basalt material during the third construction season, both the overburden and protore stockpile areas and the mine pit would be graded to promote positive drainage; these areas would then be revegetated. Additionally, silt fencing would be installed or existing fencing would be repaired to control the erosion and the migration of sediment until the seed establishes a suitable cover over these areas. Augur Creek would be relocated to a meandering pattern similar to the original meandering pattern. The final configuration of the creek would be determined during the design phase. As discussed for Alternative SP-3a, if there are any impacts on the wetlands due to the implementation of the final remedy, the remedial design would address these impacts.

9.2.2 White King Pond Water Alternatives

The alternatives considered for the water-filled excavation pit located in the White King Mine area include leaving the pond water in place, or pumping and discharging the pond water. The alternatives considered in-situ treatment, ex-situ treatment, or no treatment of the water to raise the pH level. Selection of an alternative for the pond water is interrelated to the selected alternative for addressing the White King stockpiles.

Summary of White King Pond Neutralization

During the period of preparation and review of the FS report, KMC proposed and EPA agreed to test neutralization of the White King pond. Prior to the neutralization effort, the pH level in the pond ranged from 3 to 4.5. Natural surface water typically has a pH level around 7 which is considered neutral. The neutralization effort consisted of adding lime to the White King pond during two events in 1998. The primary application was conducted on August 18, 1998, when approximately 9,000 lbs. (dry weight) of hydrated lime was applied in a slurry. A second application of lime occurred on September 13, 1998, and consisted of 200 lbs of hydrated lime apportioned in four paper sacks. Each sack was allowed to sink into the deepest location of the pond in order to target the more acidic pond water observed below the 40-foot depth. Monitoring of the pond occurred on a weekly or bi-weekly basis until November 19, 1998 (See **Table 9-1**). The results indicated that the vast majority of the pond water had a pH range from 6-7. An exception was found at the deepest portion of the pond where the pH level remained around 4. Analytical results for the neutralized pond water also showed substantially decreased levels (i.e., were precipitated by the lime application) of aluminum, beryllium, iron, zinc, and arsenic meeting all Oregon water quality criteria except for pH.

Monitoring of the pond in the spring and summer of 1999 showed that the pH level was beginning to decrease in the deepest portions of the pond. In October 1999 additional limestone rock was added to the deepest part of the pond to address ongoing acid generation and provide a more uniform and consistent buffering capacity. No further pond monitoring has been conducted since October 1999.

Table 9-1 compares the White King pond water quality, after the 1998 Pond Water Neutralization Study, with the PRGs (based on 1 x 10^{-6} protection level for a recreational user) and Summer and Goose Lake Basin Ambient Water Quality Standards. As shown in **Table 9-1**, with the exception of pH all PRGs and measured water quality criteria were met following the 1998 pond neutralization.

Results of the test neutralization indicate the pond can be neutralized. However, maintaining neutrality may require ongoing addition of neutralizing agents.

9.2.2.1 <u>Alternative WKPW-1. No Action</u>

Estimated Capital Cost: $0

Estimated Annual O&M Cost: $0

Estimated Present Worth Cost: $0

Estimated Construction Time frame: None

This alternative is used for comparison to other alternatives and does not include any type of action. No additional cost would be associated with this alternative. This alternative addresses the pond after the neutralization tests conducted in October 1999.

9.2.2.2 <u>Alternative WKPW-2. Storm Water Management and Pond Monitoring</u>

Estimated Capital Cost: $237,000

Estimated Annual O&M Cost: $24,000

Estimated Present Worth Cost: $535,000 (7% discount rate for 30 years)

Estimated Construction Time frame: none

This alternative consists of stormwater management and monitoring. Under this alternative no additional actions would be taken to maintain a neutral pH level in the pond.

Stormwater Management

Under this alternatives a diversion ditch would be constructed around the top of the highwall to collect and direct stormwater and minimize further erosion of the highwall.

Monitoring

Monitoring of ground water and pond water would be conducted twice per year to determine if constituents of concern are migrating and to ensure that there is no unacceptable risk from constituent migration through transport pathways. Post-remedial monitoring would be used to refine background levels, establish baseline trends, and determine the need for additional action, if necessary.

Ground water samples would be collected from alluvium and shallow bedrock wells upgradient and downgradient of the White King pond and analyzed, at a minimum, for total uranium, arsenic, and sulfate which act as indicator parameters. Monitoring of ground water would establish trends to ensure that the beneficial uses of ground water, are maintained.

White King pond water samples also would be collected and analyzed twice per year, at a minimum, for arsenic, aluminum, and pH.

9.2.2.3 Alternative WKPW-3: Management of Pond Water Using In-Situ Neutralization

Estimated Capital Cost: $237,000

Estimated Annual O&M Cost: $61,000

Estimated Present Worth Cost: $994,000 (7% discount rate for 30 years)

Estimated Construction Time frame: ongoing

Alternative WKPW-3, as described in the FS, was modified to address State and community input. These modifications include: the addition of controls to limit access and use of the pond while the neutralization is being evaluated; and, an expanded monitoring program to evaluate the effectiveness of neutralization and risks associated with arsenic in pond water and sediments. The following description of Alternative WKPW-3 incorporates these changes.

Stormwater Management

As in Alternative WKPW-2 a diversion ditch would be constructed around the top of the highwall to collect and direct stormwater and minimize further erosion of the highwall.

In Situ Neutralization

The pond water would be maintained at a neutral pH through periodic addition of pulverized limestone, limestone rock, hydrated lime or other neutralizing agents like soda ash. The limestone application rate and frequency is a function of factors such as existing water quality, source of acidification, volume of water, residence time of pond water, limestone application method, and limestone type, purity and particle size. The frequency and rate of liming would be determined during the design.

Post-Neutralization Pond Management

In addition to the liming, fertilizer may be added to the pond to stimulate primary biological activity. The biomass that would be produced from the biological activity would settle to the bottom of the pond and begin to develop a cover over the existing sediments. Any additional application volume and frequency of the fertilizer would be determined during the design and remedial action phase and will depend on the monitoring results.

Access Restrictions

Physical restrictions, such as fencing, would be required to control access to the pond while neutralization efforts and sediment risks are being evaluated. In order to prevent access by humans, livestock or medium-to-large animals, a barbed-wire fence or chain-link fence could be constructed around the pond. These restrictions may be eliminated in the future depending on the success of neutralization and the results of the sediment toxicity evaluation.

Institutional Controls

Land use restrictions would be put in place to prevent any use of the pond, such as for residential, recreational, or agriculture purposes and to prevent installation of ground water wells around the pond. Because the White King pond is located on both National Forest System Lands and private property, different mechanisms for land use restrictions would be required:

For private property land use restrictions would include proprietary controls such as an equitable servitude and easement (consistent with ODEQ=s AFinal Guidance for Use of Institutional Controls@ (ODEQ, 1998). This is a legal instrument placed in the chain of title that provides access rights to a property for inspection and maintenance and monitoring to prevent use of the pond and installation of drinking water wells. This type of control shall be set forth in an EPA and ODEQ-approved form running with the land and enforceable by EPA and DEQ against present and future owners of the property. As an informational device the Mines site would be maintained on DEQ=s Environmental Cleanup Site Information Database as long as the institutional controls remain in effect. One additional informational device is a deed notice to inform property owners of the existence of contamination in the White King pond. Placement of a deed notice can be made by EPA.

For National Forest Systems Land, an amendment to the Forest Plan (attached to this ROD) was made by the Forest Service to prohibit various uses of the Mines site including the White King pond. The uses restricted for the pond include residential, recreational use, and agricultural use. (See Section 12.2.1 for a complete discussion of these prohibitions). The area of the Mines site was also withdrawn from mining by the Bureau of Land Management (BLM) on August 9, 1993 to protect the rehabilitation work to be done on the White King and Lucky Lass mine. This withdrawal will expire on August 9, 2013 (20 years) unless the withdrawal is extended. The USFS would request that the BLM continue to maintain a withdrawal of the area of the stockpiles from mineral entry.

Inspection and Maintenance

Site inspections would be conducted twice per year. The inspection and maintenance activities would include inspection and repair of fences, gates, locks, warning signs, and monitoring wells caused by inclement weather or vandalism.

Monitoring

The monitoring of ground water and pond water are similar to that described for Alternative WKPW-2. Additional monitoring is added under this alternative to address the pond sediments and effectiveness of neutralization.

The monitoring/sampling of the pond (water and sediments) and ground water (including any surface discharge) will occur at a minimum of two times per year. A monitoring plan including a quality assurance program plan and a sampling plan would be submitted for EPA approval during the remedial design. The overall purpose of the monitoring is to determine the effectiveness of pond neutralization, to refine background levels, establish trends and further evaluate the risk associated with pond water and sediments. Specific objectives include: Improve the conceptual site model for the pond; describe the geochemical processes affecting pond chemistry and aquatic life; identify the sources, nature and extent of COCs in sediments; and, evaluate toxicity, bioavailability, and species exposure to pond sediments.

The results of each seasons sampling and monitoring data would by reviewed annually by the EPA. The information will be evaluated to determine if the pond neutralization is effective and what risks are associated with pond sediments. Based on limited sampling data risks have already been associated with pond sediments. Further evaluation of risks should utilize site-specific factors such as chemical bioavailability and toxicity using specific organisms of concern that typically inhabit similar environments. At a minimum the following factors shall be considered during this evaluation:

$ As specified in OAR 340-122-0115 acceptable risk level for populations of ecological receptors@ means a 10 percent chance, or less, that no more than 20 percent of the total local population will be exposed to an exposure point value greater than the ecological benchmark value for each contaminant of concern and no other observed significant adverse health effects on the health or viability of the local population.

$ AEcological benchmark value@ means the no-observed-adverse-effect level (NOAEL) for individual ecological receptors considering effects on reproductive success or the medial lethal dose or concentration (LD50 or LC50) for populations of ecological receptors.

9.2.2.4 Alternative WKPW-4: Land Application of Pond Water without additional In-situ Treatment

Estimated Capital Cost: $1,624,000

Estimated Annual O&M Cost: $0

Estimated Present Worth Cost: $1,624,000 (7% discount rate for 30 years)

Estimated Construction Time frame: 60 days

The objective of this alternative is to pump the White King pond and dispose of the water on the land within the immediate vicinity of the Mines site. The area needed for land application is estimated to be approximately 300 acres. This alternative would be implemented in coordination with a selected alternative for the White King stockpiles addressing consolidation/containment of stockpiles within the mine pit. No additional treatment of water would occur prior to land application.

White King Mine Pit Dewatering

The dewatering process for the mine pit would be accomplished using pumps mounted on a floating platform. To empty the pond in a one-month period, a pump or a combination of pumps capable of removing approximately 3,400 gpm would be required. Using a 30 percent safety factor, it is estimated that the pond would be dewatered at a pumping rate of 4,500 gpm for 30 days. Based on existing meteorological data, approximately 0.7 inch of rainfall could be expected during the dewatering process. The additional volume of water generated from rainfall is not expected to delay the dewatering process. Pumping operations would be monitored and maintained by operators 24 hours per day. Water removed from the pond would be managed in accordance with the selected alternative for the White King pond water.

Land Application

As discussed above, the dewatering rate needed to dewater the pond in 30 days is estimated to be 4,500 gpm. The recommended system in the FS for land application was a pressurized overhead sprinkler system with a manifold to allow water to be diverted to various areas during the dewatering period. The final selection of the type of land application system and locations would occur during the design phase. Based on the EPA slow rate design method, it was recommended that the maximum land application rate should be 1-inch per day. Based on the design dewatering rate of 4,500 gpm and a design land application rate of 1-inch per day, the area needed for land application is estimated to be 238 acres. Using a safety factor of 1.25, the maximum area needed for land application is estimated to be 300 acres.

9.2.2.5 <u>Alternative WKPW-5a: Land Application of Pond Water after Additional In-Situ Treatment.</u>

Estimated Capital Cost: $1,664,000

Estimated Annual O&M Cost: $0

Estimated Present Worth Cost: $1,664,000 (7% discount rate for 30 years)

Estimated Construction Time frame: 60 days

This alternative is the same as the Alternative WKPW-4, except that the pond water would be treated, if necessary, before being applied to the land in order to meet any applicable land application requirements. The in situ neutralization of the White King pond water is the same as described for Alternative WKPW-3. This alternative would be implemented in coordination with a selected alternative for the White King stockpiles addressing consolidation/containment of stockpiles within the mine pit.

9.2.2.6 Alternative WKPW-5b: Surface Water Discharge of Pond Water after Additional In-Situ Treatment

Estimated Capital Cost: $891,000

Estimated Annual O&M Cost: $0

Estimated Present Worth Cost: $891,000 (7% discount rate for 30 years)

Estimated Construction Time frame: 60 days

Alternative WKPW-5b is the same as Alternative WKPW-4 except that the treated water would be discharged to Augur Creek. This alternative would be implemented in coordination with a selected alternative for the White King stockpiles addressing consolidation/containment of stockpiles within the mine pit. The dewatering component would be the same as discussed for Alternative WKPW-4. The treatment and discharge components are described below.

Surface Water Discharge

Under this alternative, the treated pond water would be discharged to Augur Creek at a rate of approximately 4,500 gallons per minute or 10 cubic feet/second. A riprap outfall structure would be constructed to prevent erosion of the Augur Creek which has normal flows ranging from 3 to 150 cfs depending on the time of year. Thus, only limited erosion control may be necessary to protect Augur Creek during discharge from the pond. Following the completion of the mine pit dewatering, the outfall structure would be removed.

9.2.2.7 Alternative WKPW-6a: Land Application of Ex-situ Treated Pond Water.

Estimated Capital Cost: $1,731,000

Estimated Annual O&M Cost: $0

Estimated Present Worth Cost: $1,731,000 (7% discount rate for 30 years)

Estimated Construction Time frame: 60 days

The objective of this alternative is to pump the White King pond water, conduct ex-situ treatment, and then land apply the water over a large on-site area. This alternative is the same as the Alternative WKPW-4, except that the pond water would be neutralized ex-situ before the land application. The neutralized water would also go through portable sand media filters prior to land application. The details of ex-situ treatment are presented below.

Ex-situ Treatment

The ex-situ treatment would consist of raising the pH of the pond water to between 7 and 8. Based upon estimates in the FS a total of approximately 21 tons of 50% sodium hydroxide (using a safety factor of 1.5 to account for uncertainties associated with the initial pH, volume of water, and effectiveness during application) would be required to neutralize the acidity of the pond.

The ex-situ pH adjustment can be performed either in-line or in a tank. For purposes of the FS in line pH adjustment is discussed. For in-line pH adjustment, it is estimated that an analyzer, sensor probes, a 12-inch carbon steel static mixer, and an injection assembly can be mounted directly on the main line of the land application system. Sodium hydroxide would be fed directly into the pipeline and the pH adjustment would take place inside the pipeline. A control system would be used to ensure appropriate chemical addition rates. A chemical feed system would be needed. The chemical feed system would consist of a 5,000-gallon polyethylene tank (chemical storage tank), a 100-gallon polyethylene tank (day tank), a chemical feed pump, and an agitator. The selection of the appropriate pH adjustment equipment would take place in the remedial design process. The neutralized water would go through portable sand media filters to remove any precipitates prior to land application.

9.2.2.8. Alternative WKPW-6b: Surface Water Discharge of Ex-Situ Treated Pond Water

Estimated Capital Cost: $1,011,000

Estimated Annual O&M Cost: $0

Estimated Present Worth Cost: $1,011,000 (7% discount rate for 30 years)

Estimated Construction Time frame: 60 days

This alternative is the same as WKPW-5b except that the treatment of pond water would take place ex-situ.

Alternative WKPW-6b involves pumping the White King pond water, performing ex-situ treatment, and then discharging the water to Augur Creek. This alternative is the same as the Alternative WKPW-5b except that the treatment of pond water would take place ex-situ. The ex- situ pH adjustment would be the same as discussed in the Alternative WKPW-6a.

9.2.3 Lucky Lass Stockpile Alternatives

9.2.3.1 Alternative LL-1: No Action.

Estimated Capital Cost: $0

Estimated Annual O&M Cost: $0

Estimated Present Worth Cost: $0

Estimated Construction Time frame: None

CERCLA requires evaluation of a no-action alternatives as a baseline reflecting current conditions without any cleanup effort. This alternative is used for comparison to each of the other alternatives.

9.2.3.2 Alternative LL-2: Institutional Controls

Estimated Capital Cost: $169,000

Estimated Annual O&M Cost: $15,000

Estimated Present Worth Cost: $355,000 (7% discount rate for 30 years)

Estimated Construction Time frame: one month

This alternative consists of institutional controls, access restrictions, and inspection and maintenance similar to Alternative SP-2. No monitoring of environmental media is included.

Access Restrictions

Physical restrictions to reduce access to human and animals include a fence that would encompass the areas estimated to exceed protective cleanup goals for radium-226 and arsenic. The signs, fence, and inspection and maintenance activities would be the same as that described for Alternative SP-2.

Institutional Controls

Because the Lucky Lass mine area is situated entirely on National Forest System land, institutional controls would be implemented through Forest Service mechanisms only. Land use restrictions will be put in place to prevent residential or recreational use at the mine, installation of ground water wells, and removal of stockpile material. An amendment to the Forest Plan (attached to this ROD) has been made by the Forest Service to prohibit these uses. Various private individuals have asserted unpatented mining claims that confer ownership status to the Lucky Lass mine. However, the area of the Mines site was withdrawn from mining by the Bureau of Land Management (BLM) on August 9, 1993 to protect the rehabilitation work to be done on the White King and Lucky Lass mine. This withdrawal will expire on August 9, 2013 (20 years) unless the withdrawal is extended. The USFS will request that the BLM continue to maintain a withdrawal of the area of the stockpile from mineral entry. As an informational device the Mines site will be maintained on DEQ=s Environmental Cleanup Site Information Database as long as the institutional controls remain in effect.

9.2.3.3 <u>Alternative LL-3: Removal and Containment of Material Exceeding PRGs with the White King Stockpile</u>

Estimated Capital Cost: $349,000

Estimated Annual O&M Cost: $15,000

Estimated Present Worth Cost: $535,000 (7% discount rate for 30 years)

Estimated Construction Time frame: one month

This alternative involves excavating soils from the Lucky Lass stockpile and adjacent areas that exceed the EPA cleanup goals for arsenic and radium-226 and restoring the excavated area with topsoil.

Soil Excavation

All surface soils that exceed the cleanup level for arsenic and radium-226 (See **Table 8-1**) will be excavated and placed within the consolidated White King Stockpile. Most of these soils have been identified in the Lucky Lass meadow, downhill from the overburden pile and Lucky Lass pit, with the highest uranium activities occurring in the upper 1 to 2 feet of soil. Other soils with elevated radium-226 activity occur on top of the Lucky Lass stockpile as a reddish-black rock, which contrasts with the lower activity chalk-colored overburden. It is estimated that approximately 3,000 cubic yards of soil exceed a cleanup level of 3.6 pCi/g for radium-226 and 38 mg/l for arsenic. A field screening methodology for identification of these soils, similar to the approach at White King, will be developed during the design. The excavated areas will be restored to existing grade including 3 inches of topsoil. The Lucky Lass stockpile material that has been impacted by drainage from the Lucky Lass pond will also be excavated and moved so that there is no erosion impact of Lucky Lass pond drainage on the Lucky Lass stockpiles. The excavated material will be regraded with the Lucky Lass stockpiles and the excavated area will be restored with riprap to reduce erosion. Recontouring of the Lucky Lass Mine overburden stockpile may be necessary if portions of the stockpile are used as a borrow source for the White King consolidated stockpile soil cover. Such activities may include, but are not limited to, regrading the stockpiles to provide slope stability, promote drainage, and control erosion; placement of topsoil; and establishment of vegetation on the stockpile. No future monitoring or inspection and maintenance of the Lucky Lass stockpile will be required.

Access Restrictions

Short-term access restrictions will include physical restrictions (e.g., fencing), warning signs, and safety measures until completion of the remedial action.

Institutional Controls

Institutional controls would be required to prevent removal or residential use of the remaining Lucky Lass stockpile and prohibit installation of ground water wells within the stockpile. These controls would be the same as discussed under LL-2.

9.2.3.4 Alternative LL-4: Removal and Containment of Stockpile and Disposal in "Off-Mine" Disposal Cell

Estimated Capital Cost: $2,656,000

Estimated Annual O&M Cost: $9,000

Estimated Present Worth Cost: $2,768,000 (7% discount rate for 30 years)

Estimated Construction Time frame: 5.5 months

Alternative LL-4 involves excavating all the Lucky Lass Mine stockpiles (260,000 cubic yards) and the off-pile areas that exceed PRGs (3,000 cubic yards) and placing them in the proposed Aoff-mine@ disposal cell. This alternative would be implemented in conjunction with the alternatives for the White King Mine stockpiles that provide for excavation and disposal into an Aoff-mine@ cell (Alternative SP-5) and backfill of the White King pit with clean or treated material (Alternatives SP-4b and SP-4c). The excavated areas would then be restored with 3 inches of topsoil. The institutional controls, access restrictions, and inspection and maintenance for the Lucky Lass stockpiles and adjacent areas would be similar to the provisions in LL-2.

9.2.3.5 Alternative LL-4: "Off-Mine" Disposal

Estimated Capital Cost: $2,656,000

Estimated Annual O&M Cost: $9,000

Estimated Present Worth Cost: $2,768,000 (7% discount rate for 30 years)

Estimated Construction Time frame: 5.5 months

Alternative LL-4 involves excavating the Lucky Lass Mine stockpiles (260,000 cubic yards) and the off-pile areas that exceed PRGs (3,000 cubic yards) and placing them in the proposed Aoff-mine@ disposal cell. This alternative would be in conjunction with the alternatives for the White King Mine stockpiles that provide for excavation and disposal into an Aoff-mine@ cell (Alternative SP-5) and backfill of the White King pit with clean or treated material (Alternatives SP-4b or SP-4c). Institutional controls and monitoring components for the off-mine disposal cell are set for in Alternative SP-5. The excavated areas at the Lucky Lass Mine would then be restored with 3 inches of topsoil.

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SECTION 10

COMPARATIVE ANALYSIS OF ALTERNATIVES

The NCP requires that each remedial alternative analyzed in detail in the FS be evaluated according to specific criteria. The purpose of this evaluation is to promote consistent identification of the relative advantages and disadvantages of each alternative, thereby guiding selection of remedies offering the most effective and efficient means of achieving site cleanup goals. There are nine criteria by which feasible remedial alternatives are evaluated. While all nine criteria are important, they are weighed differently in the decision-making process depending on whether they describe protection of human health and the environment or compliance with Federal or State statutes and regulations, such as the State of Oregon rules for disposal of radioactive material (ORS 469.375) (threshold criteria), a consideration of technical or socioeconomic merits (primary balancing criteria), or involve the evaluation of non-EPA reviewers that may influence an EPA decision (modifying criteria).

10.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

This criterion evaluates whether an alternative achieves and maintains adequate protection of human health and the environment.

10.1.1 White King Mine Stockpile Alternatives

All the alternatives, except the no-action alternative (SP-1), would be protective of human health and the environment, by eliminating, reducing, or controlling the risks posed by the stockpile material. Because the Ano-action@ alternatives (SP-1) is not protective of human health and the environment it was eliminated from further consideration under the remaining eight criteria. Alternative SP-5 provides the greatest level of protection against potential risk by placing the stockpile material in an engineered disposal cell above any influences of ground or surface water. Alternatives SP-3a, SP-3b, SP-4a and SP-4d would be equally protective of the environment in reducing migration of COCs to ground water, surface water or surface soils. Although Alternatives SP-3a and SP-3b reduce runoff or erosion, Alternatives SP-4a and SP-4d would nearly eliminate the potential for surface erosion as most of the material would be placed below grade in the White King Mine Pit. The addition of a permeable limestone wall in Alternative SP-4d would neutralize any potential acidic water generated in the pit and prevent any impacts to ground water. Alternative SP-2 provides a fence (or barrier) to prevent access by medium-to-large mammals, domestic cattle, and humans; however, it does not provide protection for small mammals or prevent erosion and the protectiveness depends on the effectiveness of physical and land-use restrictions.

10.1.2 White King Pond Alternatives

Alternatives WKPW-4 through WKPW-6b achieve complete protection by treating the water, either in-situ or ex-situ, and discharging the water to land or surface water. The White King Pond is then eliminated and filled depending on which stockpile alternative is selected. Under alternative WKPW-3 human and ecological risks from the low pH pond water would be eliminated through neutralization. However, risks associated with pond sediments would not necessarily be addressed through neutralization alone and further action such as sediment capping or dredging may be required. The protectiveness of WKPW-2 depends on the effectiveness of continuation of land use and physical restrictions.

Because the Ano-action@ alternative (WKPW-1) is not protective of human health and the environment it was eliminated from further consideration under the remaining eight criteria.

10.1.3 Lucky Lass Mine Stockpile Alternatives

All the Lucky Lass Stockpile Alternatives, except the no-action alternative (LL-1) would be protective of human health and the environment. Alternative LL-4 provides the greatest level of protectiveness by placing all the stockpile material into an engineered Aoff-mine@ disposal cell. Alternative LL-3 provides protection by excavating and containing the material (within the White King Stockpiles) that exceed the radium-226 PRG. The protectiveness of Alternative LL-2 relies on the effectiveness of physical controls (fencing) and land use restrictions to prevent exposure and/or use of stockpile materials at the Mines site.

Because the Ano-action@ alternative (LL-1) is not protective of human health and the environment it was eliminated from further consideration under the remaining eight criteria.

10.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Section 121(d) of CERCLA and 40 CFR 300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites attain legally applicable or relevant and appropriate requirements AARARs,@ unless such ARARs are waived under CERCLA section 121(d)(4).

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, or contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those State standards that are identified by a State in a timely manner and that are more stringent than Federal requirements may be applicable. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that, while not Aapplicable@ to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. Only those State standards that are identified in a timely manner and are more stringent than Federal requirements may be relevant and appropriate.

10.2.1 White King Mine Stockpile Alternatives

As discussed in Sections 9.2.1.4 one significant requirement for the Mines site is the State of Oregon rules for disposal of radioactive material. ORS 469.375 prohibits siting of a waste disposal facility for uranium mine overburden and other radioactive material in Oregon unless the disposal site meets a number of criteria to assure protection of the health and safety of the public and of the environment. Among other criteria, ORS 469.375 and OAR 345-050-0060 provide that the site for disposal of radioactive material must not be located in or adjacent to an area that is subject to river or creek erosion within the lifetime of the facility or is within the 500-year floodplain of a river, creek, or stream. The OOE has determined that Alternative SP-3b (as modified in this ROD) would comply with these requirements. Similarly, Alternative SP-5 would also meet these requirements in that the disposal cell would be well above the Augur Creek floodplain. OOE has determined that all other stockpile Alternatives would not meet these requirements since all or part of the stockpile materials would remain within the floodplain of Augur Creek.

10.2.2 White King Pond Alternatives

White King pond water alternatives 4 through 6b would meet all ARARs through treatment of pond water or land application. The No Action (WKPW-1) and Institutional Controls (WKPW-2) Alternatives would not meet all ARARs. With respect to WKPW-2 , the NCP requires that institutional controls shall not substitute for active response measures as the sole remedy unless active measures are determined not to be practicable based on the balancing of trade-offs among alternatives. As demonstrated in this section, active measures beyond institutional controls are practicable. It is expected that WKPW-2 will meet all ARARs however, further monitoring and evaluation of the pond will evaluate the ability to achieve Oregon=s State water quality standards (OAR 340-41-925).

10.2.3 Lucky Lass Mine Stockpile Alternatives

At Lucky Lass Alternative LL-2 would not comply with State requirements for mining reclamation under OAR 632-35 or OAR 345-95-118. This alternative would also not comply with ARARs for material exceeding remediation goals. LL-3 and LL-4 would meet these and all other ARARs.

10.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

This criterion evaluated the ability of an alternative to maintain protection of human health and the environment over time. The following factors were considered in the evaluation of long-term effectiveness:

$ Magnitude of the residual risks remaining at the completion of remedial activities.

$ Adequacy and long-term reliability of management and technical controls for providing continued protection from the residual risks.

10.3.1 White King Mine Stockpile Alternatives

Alternatives SP-3a, SP-3b, SP-4a, and SP-4d would all be reliable and require similar degrees of monitoring and maintenance. Alternatives SP-3b, SP-4a, SP-4d, SP-5 would consolidate the two stockpiles either at the protore stockpile, in the White King pit, or in a new disposal cell. These alternatives would have a slight advantage over SP-3a with respect to a reduction in the area that would be subject to surface runoff and erosion and require continued maintenance. In addition, during consolidation of the stockpiles, natural clay like material would be placed on top of the stockpiles which would further reduce infiltration, radon emanation, gamma emissions and isolate the most contaminated material from erosion and direct contact. These alternatives would tend to be more reliable and require somewhat less monitoring and maintenance than leaving the stockpiles in place as in Alternative SP-3a. Alternatives SP-3b (as modified), and SP-5 are outside the floodplain of Augur Creek. This makes them less susceptible to creek erosion and more reliable than the other stockpile alternatives. Alternative SP-2 requires physical and land use restrictions, the long-term effectiveness is dependent upon the implementation, maintenance, and monitoring of the institutional controls. The fence would prevent biointrusion by medium to large mammals, but would not completely prevent biointrusion for smaller mammals. In addition institutional controls do not address infiltration and percolation that results from leaving the stockpiles uncovered.

10.3.2 White King Pond Alternatives

Alternatives WKPW-4, WKPW-5a, WKPW-5b, WKPW-6a and WKPW-6b require dewatering of the pond and are effective in the long-term but to varying degrees. All these alternatives will be completed in approximately 60 days and there will be minimal residual risk, no potential for future exposure from the pond water, no need for long-term replacement, and no concerns for long-term reliability. Alternative WKPW-3 provides less long-term effectiveness and permanence due to the potential need for continued neutralization in order to maintain stable pH conditions and improved water quality. If neutralization is effective in the long-term, ecological risks from exposure to acid pond conditions may be eliminated. However, it is unclear whether ecological risks from the pond sediments would be eliminated. The long-term effectiveness of Alternative WKPW-2 is dependent upon the effective implementation and monitoring of institutional controls which may be less effective due to the remote location of the pond. In addition the residual risks to aquatic organisms from the pond water and sediments would not be addressed by Alternative WKPW-2.

10.3.3 Lucky Lass Mine Stockpile Alternatives

Alternatives LL-3 and LL-4 provide the greatest degree of assurance of long-term effectiveness for materials exceeding PRG levels by either containment or removal. Both alternatives have low residual risk since they eliminate the future exposure to material containing COCs by humans and ecological receptors. Alternative LL-2 is dependent upon the effective implementation and monitoring of the institutional controls and fencing.

10.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

CERCLA states a preference for selecting remedial actions that principally employ treatment technologies to permanently and significantly reduce toxicity, mobility or volume of the hazardous substances at the site. There is also a preference for treatment of Aprincipal threats@ at a site through destruction of toxic COCs, reduction of the total mass of toxic COCs, irreversible reduction in constituent mobility, or reduction of total volume of media containing COCs. See Section 11 for a discussion on principal threats at the site.

In determining an appropriate range of alternatives for sites with high volume/low risk waste, EPA has stated its position in the regulations as well as guidance documents. Specifically, EPA expects to use engineering controls, such as containment, for waste that poses a relatively low long-term threat or where treatment is impracticable.@ <u>40 CFR 300.430(a)(iii)(B)</u>. In addition EPA <u>Guidance for Conducting RI/FS under CERCLA, Interim Final (EPA, 1988)</u> states ADevelopment of a complete range of treatment alternatives will not be practical in some situations. For example, for sites with large volumes of low concentrated wastes such as some municipal landfills and mining sites, an alternative that eliminates the need for long-term management may not be reasonable given site conditions, the limitations of technologies, and extreme costs that may be involved.@

Thus, given the large volume (980,000 cubic yards which included stockpiles, haul roads, and off-pile material) of overburden material present at the Mines site, limitations of treatment technologies potentially implementable for the stockpile material, extreme costs, and the low risk nature of the majority of the material, treatment was not considered in the FS to be practical. However, because CERCLA sets forth a statutory preference for remedial actions in which treatment permanently and significantly reduces the volume, toxicity, or mobility of hazardous substances, the FS evaluated treatment alternatives for the stockpiled material. Treatment technologies that were retained for assembly into alternatives include chemical stabilization/solidification, permeable treatment walls, and physical segregation. Chemical stabilization/solidification may be appropriate for a small volume of the highly contaminated material (Ahot spot@). A permeable treatment wall may potentially be used to prevent leaching of AMW from the stockpile material following placement into the White King pond. Physical separation of the material by physical or chemical properties may potentially be used as a component of the stockpile alternatives.

The following considerations were applied to each alternative:

$ The treatment processes the remedy will employ, and the materials they will treat.

$ The amount of hazardous materials that will be destroyed or treated, including how the principal threat(s) will be addressed.

$ The degree of expected reduction in toxicity, mobility, or volume measured as a percentage of reduction (or order of magnitude).

$ The degree to which the treatment will be reversible.

$ The type and quantity of treatment residuals that will remain following treatment.

$ Whether the alternative would satisfy the statutory preference for treatment as a principal element.

It should be noted that there is <u>no</u> treatment technology known to reduce or prevent radioactive decay. Volume reduction of radioactive material could be performed in certain circumstances. However, volume reduction would not be appropriate at the overburden stockpiles since the larger particles (sand/gravel) have the high activity as opposed to fine particles having high activity which could be separated from large particles with low activity. In addition, given the large volume (980,000 cubic yards) of overburden material present, limitations of treatment technologies potentially implementable for the stockpile material, extreme costs, and the low risk nature of the majority of the materials, treatment is not practical. In fact, due to the large volume of material, solidification and stabilization, an effective and reliable treatment technology, was not cost-effective and was screened out in the FS.

10.4.1 White King Mine Stockpile Alternatives

Alternative SP-2 does not use any treatment process and there is no reduction in toxicity, mobility, or volume.

There is no active chemical or biological treatment of the stockpile material using Alternatives SP-3a, or SP-3b, but to the extent reduction of potential for acid generation leaching from the piles is seen as beneficial, these alternatives would reduce mobility. Specifically, the grading and recontouring will compact stockpile soils, utilize clay-like soils to minimize percolation and provide a secure cover. Modeling conducted during the FS predicted that Alternatives SP-3a, and SP-3b would reduce the total volume of percolation through the stockpile material by 53 percent and 65 percent as compared to Alternative SP-2, thereby reducing the mobility of COCs. Although containment is not a treatment process, it also reduces the mobility of radon, gamma emissions and transport of stockpile COCs via wind and water erosion. The 12-inch cover in Alternative SP-3a decreases gamma emissions by 98 percent and radon emissions by 26 percent. The benefits of containment would be reduced if the cover thickness is not maintained. Annual maintenance would help eliminate this concern.

Alternatives SP-3b provides the same level of reduction in mobility as Alternative SP-3a. However, the 7.5-foot compacted clay-like material layer over the higher activity gravel/sand material would further reduce radon and gamma emission.

For Alternative SP-4a, acid mine water generation is prevented by inhibiting oxygen transport. Physical handling of the stockpile materials to deposit them in the pit would result in reduced mobility of COCs using clay-like materials for the bottom of the pit. Modeling conducted during the FS predicted that, using Alternatives SP-4a and SP-4d, the total volume of percolation through the stockpile material would be reduced by 98 percent as compared to Alternative SP-2, thereby potentially reducing mobility of COCs. It should be noted that the model cannot account for lateral ground water flow through backfilled stockpile material that would ultimately be below the water table. Alternative SP-4d provides treatment by neutralizing any AMW generated that could migrate away from the pit. Both Alternatives SP-4a and SP-4d would reduce the radon and gamma emission to negligible levels via a 5-foot compacted clay-like material layer beneath the 12-inch soil cover similar to Alternative SP-3b. The 12-inch soil cover would lose 25% of its thickness without annual maintenance due to wind and water erosion over 1,000 years.

Alternative SP-5 would result in similar reductions in mobility of COCs as the physical handling operations and reduction in radon and gamma emissions discussed for Alternatives SP-4a and SP-4d. The modeling predicts that Alternative SP-5 would reduce the total volume of percolation through the stockpile material by 97 percent when compared to Alternative SP-2. Alternative SP-5 offers the same treatment for AMW as Alternative SP-4a, but the treatment may not be as successful for inhibiting generation of AMW as other alternatives because the clean material (basalt) used in backfilling may not be as effective in inhibition of oxygen transport as clay-like stockpile material.

10.4.2 White King Pond Alternatives

Alternatives WKPW-2 and WKPW-4 do not use any active treatment process as a principal element. WKPW-4 relies on natural attenuation to reduce the toxicity and mobility of COCs following land application.

Alternatives WKPW-3, WKPW-5a and WKPW-5b involve in-situ neutralization with hydrated lime or other materials as the principal element for treating pond water. The 1998 Neutralization Treatability Study preliminary results indicated that, in addition to stabilization of the pH, COCs in surface water were reduced to concentrations below both PRGs and surface water discharge standards. Because of the increase in pH of pond water, some of the calcium, magnesium, aluminum, and iron salts precipitated along with the COCs. This results in decreased concentrations in the water column but an increase in concentrations of COCs in pond sediments.

Alternatives WKPW-6a and WKPW-6b involve ex-situ neutralization with sodium hydroxide and sand filtration as the principal element for treating pond water to reduce toxicity and volume of COCs.

10.4.3 Lucky Lass Mine Stockpile Alternatives

None of the Lucky Lass alternatives include active chemical or biological treatment as a principal element. Although Alternatives LL-3 and LL-4 do not include treatment, both of these alternatives reduce the potential for mobility of COCs via suspended solids transport at the Lucky Lass mine by excavating and removing the soil that is above PRGs. In addition, both these alternatives excavate the material that is subject to the minimal erosive forces of discharge from the Lucky Lass pond. In both alternatives (LL-3 and LL-4), the material would be contained beneath an engineered cover system as part of the selected White King stockpile alternative.

10.5 SHORT-TERM EFFECTIVENESS

The short-term impacts of alternatives were assessed by considering the following: (1) Short-term risks that might be posed to the community during implementation of an alternative; (2) Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures; (3) Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation; and (4) Time until protection is achieved.

10.5.1 White King Mine Stockpile Alternatives

Alternative SP-2 has the greatest short-term effectiveness because there is minimal adverse impact to the community, workers and the environment during implementation. Alternative SP-2 also requires the shortest time (one month) to implement. All other alternatives have less short-term effectiveness than Alternative SP-2 because they require cover material to be transported from off-site and would take more time to implement. Alternative SP-3a requires one 5.5-month construction season to implement while Alternatives SP-3b, SP-4a and SP-4c require two 5.5-month construction seasons to implement. Alternative SP-3b requires 62,000 cubic yards (5,200 trucks) of off-site cover material as compared to 86,000 cubic yards (7,200 trucks) of off-site cover material required by Alternative SP-3a. Alternative SP-3b involves the additional excavation and placement of 230,000 cubic yards of material. These alternatives would pose the greatest potential risk to workers during regrading and hauling and have a potential for run-off to impact Augur Creek during construction. Short term risks and impacts, if any, from these alternatives can be mitigated or prevented through monitoring and protective measures. Alternatives SP-4a and SP-4d would require more time to implement because they require excavation of 980,000 cubic yards of stockpile material and placement within the White King Mine pit. Alternative SP-5 offers the least short-term effectiveness because it involves the most potential risk to workers. It would also result in a greater impact to the environment as approximately 20 acres of timber would be removed at the new disposal location. Approximately 980,000 cubic yards of stockpile material would have to be excavated and moved up the hillside to the new disposal cell location. Blasting (640,000 cubic yards) and excavation (340,000 cubic yards) of basalt would likely be needed to construct the cell and then the 980,000 cubic yards of basalt would have to be moved and placed in the White King Mine pit. Approximately 35,000 cubic yards (2,900 trucks) of off-site material would be needed. This alternative would require three 5.5 month construction seasons, which is the longest of all the stockpile alternatives.

10.5.2 White King Pond Alternatives

WKPW-2 has minimal impacts because it involves institutional controls only. Alternative WKPW-3 has some short-term impacts compared to WKPW-2 due to the risk to workers from handling and applying hydrated lime and the implementation time is slightly longer. Alternatives WKPW-4, WKPW-5a, and WKPW-6a have more potential short-term impacts on workers and the environment than Alternatives WKPW-3, WKPW-5b, and WKPW-6b because of potential risk to workers during construction and operation of a 300-acre land application system as compared to a surface water discharge system.

10.5.3 Lucky Lass Mine Stockpile Alternatives

Alternative LL-2 would provide the greatest degree of short-term effectiveness and would have no impacts on the community, no health effects to workers, no impacts to the environment, and will require the shortest time period to implement. Alternatives LL-3 and LL-4 would provide the least degree of short-term effectiveness. Although there would be no impacts to the community, Alternative LL-4 would have the greatest impact to the environment and to workers during construction because it would require excavation and moving approximately 260,000 cubic yards of stockpile material to the Aoff-mine@ location. Erosion control measures, dust control, and proper health and safety protocols can mitigate these impacts. In addition, LL-4 requires the longest time period to implement, which is due to the time it would take to construct a new disposal cell.

10.6 IMPLEMENTABILITY

The implementability of the alternatives was assessed by considering, as appropriate, the following factors: (1) Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy; (2) Administrative feasibility, including activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies (for off-site actions); (3) Availability of services and materials, including the availability of adequate off-site treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources; the availability of services and materials; and availability of prospective technologies.

10.6.1 White King Mine Stockpile Alternatives

Alternatives SP-3a and SP-3b do not pose significant difficulties to implement. Both alternatives require regrading and hauling of stockpile material, and placement of a cover. Alternative SP-3b involves the movement of a larger volume of overburden material within the Mines site; however, Alternative SP-3a would require the transport of an extra 24,000 cubic yards of off-site cover material and an extra 200 truck trips. The regrading of stockpiles is implementable with conventional construction equipment. Coordination and approval from the USFS would be required to construct haul roads or for access control. The fence (or barrier) building component of Alternative SP-2 is easy to implement based on availability of services; however, the land use restrictions pose more difficulty in terms of coordination and implementation. Coordination with USFS and private land owners will be required for land use and physical restrictions but are not expected to pose any difficulties. Alternatives SP-4a, and SP-4d would be more difficult to implement than Alternatives SP-3a, and SP-3b. Alternatives SP-4a and SP-4d require excavation and removal of the stockpiles (980,000 cubic yards) to the pit and placement of a soil cover. Placement of material in the pit would pose some difficulties in implementation because of muddy conditions in the pond after dewatering. Alternative SP-4a is slightly easier to implement than Alternative SP-4d because Alternative SP-4d requires additional construction of a permeable limestone treatment.

Alternative SP-5 is the most difficult to implement because it requires excavation of 980,000 cubic yards of stockpile material and moving the stockpiles up the hill to a new disposal location. Blasting and excavation of basalt would likely be needed. The blasted/excavated basalt would have to be moved and placed in the White King Mine pit. This alternative would also require implementing the selected WKPW alternative. Implementing this alternative is expected to be the most difficult in terms of administrative feasibility. Coordination and approval from USFS would be needed to construct a new disposal cell, clear timber resources and construct haul roads or obtain approval for access control. It is expected that there would be more administrative requirements in constructing a new disposal cell in an Aoff-mine@ location as compared to consolidating the stockpiles at the protore pile or within the White King pit.

10.6.2 White King Pond Alternatives

Alternative WKPW-2 can be implemented to limit use of the White King pond water. The ability to monitor the effectiveness may be hindered by the remote location of the Mines site and because the Mines site is not accessible during the winter months. The services and materials required to construct the monitoring wells should be available. The administrative feasibility of implementing the land use restrictions may be difficult. This may require coordination within the Forest Service and with local government offices to ensure that the restrictions are effectively implemented, maintained and monitored.

Alternative WKPW-3 can be easily implemented (and has been already demonstrated) to neutralize the White King pond water. The neutralization process is technically feasible because the liming process is a well-established practice and liming materials and equipment are available and can be transported to the Mines site. Periodic neutralization may be needed. However, preliminary results of the 1998 Neutralization Treatability Study confirmed that neutralization of the pond is relatively easy to implement. The administration feasibility of implementing this alternative would not be difficult.

Alternatives WKPW-4, 5a, and 6a can each be implemented to dewater the White King pond and apply the water to the land. Appropriate equipment to handle the high pump discharge pressures and potentially high suspended solids at the bottom of the pit should be available. Additionally, the irrigation system, including the booster pumps for differences in terrain elevation, should also be available. Land application of the water is administratively feasible given that a land application permit from ODEQ is not required under CERCLA. Substantive requirements of the permit would be handled as ARARs. Alternatives WKPW-5b/WKPW-6b are technically feasible regarding ex-situ treatment and surface water discharge structures. Materials and services for the ex-situ treatment system are readily available.

Alternatives WKPW-5b and 6b can each be implemented to dewater the White King pond and discharge the water to Augur Creek. Surface water discharge is administratively feasible given that a permit from ODEQ is not required under CERCLA. Substantive requirements of the permit would be handled as ARARs. If additional treatment is deemed necessary, a treatability study would be needed or a variance from the standard may be necessary. Preliminary results from the 1998 Neutralization Treatability Study indicate that surface water discharge standards can be met.

10.6.3 Lucky Lass Mine Stockpile Alternatives

Alternative LL-2 can be implemented to prevent access to the Lucky Lass Mine stockpiles and to limit land use. Preventing access by constructing a barrier, posting warning signs, etc., should be technically feasible. However, the ability to monitor the effectiveness may be hindered by the remote location of the Mines site and because the Mines site is not accessible during the winter months. The services and materials required to construct the fence, etc., should be available. The administrative feasibility of implementing the land use restrictions may be difficult. This may require coordination within the Forest Service and with local government offices to ensure that the restrictions are effectively implemented, maintained, and monitored. However, these restrictions are not unusual.

Alternative LL-3 involves relatively small excavation and placement of material (3,000 cubic yards) with the White King stockpile materials and would be relatively easy to implement. The services and materials are readily available. The administrative feasibility of implementing the land use restrictions may be difficult as described under Alternative LL-2.

Alternative LL-4 is technically feasible, and materials and services are available for the excavation and movement of the stockpile material (263,000 cu. yd.). Under Alternative LL-4, the material would be placed in an Aoff-mine@ location which could have significant administrative difficulties associated with permitting and approvals by the USFS. Administrative feasibility would be difficult for the same reasons as Alternative SP-5.

10.7 COST

This criterion includes estimated capital and operation and maintenance costs as well as present worth costs. Cost estimates are expected to be accurate within a range of +50 to -30 percent.

Table 10-1 presents a comparative summary of the total capital costs, the present worth of O&M cost, and the total present worth costs for all the alternatives as presented in the FS.

A remedy shall be cost-effective if its costs are proportional to its overall effectiveness.@ (CFR '300.430(f)(1)(ii)(D)). This is accomplished by evaluating the Aoverall effectiveness@of those alternatives that satisfied the threshold criteria (*i.e.*, were both protective of human health and the environment and ARAR-compliant).

10.7.1 White King Mine Stockpile Alternatives

Alternative SP-2 has the lowest cost (at a total present worth cost of $956,000). Alternative SP-5 has the greatest cost at a total present worth of $26,840,000. Alternatives SP-3a and SP-3b fall within a $5,000,000 to $8,000,000 range while Alternatives SP-4a and SP-4d fall within an $11,000,000 to 12,000,000 range. Compared to all other alternatives, Alternative SP-5 is the least cost effective when comparing costs proportionate to overall effectiveness

Under ODEQ=s State statutes, remedies must also demonstrate costs are reasonable by showing costs are proportioned to benefits. Alternative 3b would cost approximately $1.8 million more than Alternative 3a. Alternatives 4 and 5 would cost up to several times the costs of Alternative 3a or 3b.

With regards to the Stockpile Alternatives only SP-3b and SP-5 met the threshold criteria to remove overburden from the flood plain and allow compliance with State regulations. Between these two alternatives SP-3b had the lowest cost at approximately $6,625,000. Alternative SP-5 has the greatest cost at a total present worth of $26,840,000. Alternative SP-5 is the least cost effective when comparing costs in proportion to overall effectiveness.

10.7.2 White King Pond Alternatives

Alternative WKPW-2 has the lowest cost at a total present worth cost of $281,000, while Alternative WKPW-6a has the greatest cost at a total present worth cost of $1,731,000. As discussed in Section 9 of this ROD, implementation of White King pond Alternatives WKPW-4, WKPW-5a, WKPW-5b, WKPW-6a, and WKPW-6b are linked to various stockpile alternatives. Depending on which stockpile alternative is selected, the cost of the White King pond alternatives must be added to the cost of the stockpile remedy to evaluate cost-effectiveness. Because Alternatives SP-4a, SP-4d and SP-5 are less cost effective than the other alternatives, White King Pond Alternatives WKPW-4, WKPW-5a, WKPW-5b, WKPW-6a, and WKPW-6b would not be as cost effective as WKPW-3.

10.7.3 Lucky Lass Mine Stockpile Alternatives

Alternative LL-2 has the lowest cost at a total present worth cost of $355,000. Alternative LL-3 has the next lowest cost with a total present worth cost of $535,000. Alternative LL-4 is the most expensive with a total present worth cost of $2,768,000.

The cost effectiveness of Alternative LL-4 is also dependent upon selection of a remedy involving offsite disposal of White King stockpiles. The addition of costs attributable to those White King options along with costs for Alternative LL-4 make it even less cost effective than the other alternatives.

10.8 STATE ACCEPTANCE/SUPPORT AGENCY ACCEPTANCE

The USFS, DEQ, and OOE have been involved with the development and review of the RI, FS, proposed plan and ROD. These agencies concur with the selected remedy in this ROD. The State does not support selection of Alternatives SP-3a and SP-4a for the reasons outlined in Section 12.1.1.

10.9 COMMUNITY ACCEPTANCE.

This criterion evaluates whether the local community agrees with EPA=s analyses and preferred alternative. Community members expressed support for Alternatives SP-3b, WKPW-3, and LL-3.

EPA, with input from the State of Oregon, and USFS have carefully considered all comments submitted during the public comment period and taken them into account during the selection of the remedy for the Mines site. EPA=s response to comments received during the public comment period are included in the attached Responsiveness Summary (Appendix A).

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SECTION 11

PRINCIPAL THREAT WASTE

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by a site wherever practical. A principal threat concept is applied to the characterization of Asource material@ at a Superfund site. A source material is material that includes or contains hazardous substances, pollutants or contaminants that act a reservoir for migration of contaminant to ground water, surface water or air, or acts as a source for direct exposure. EPA has defined a principal threat wastes as those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur.

The stockpiles at the Mines site are considered to be relatively non-mobile with low toxicity which can be reliably contained. A treatability study for the leachability of stockpiled material was conducted during the RI/FS. The results indicated that the stockpile soils exhibited little tendency, if any, to release toxic constituents in toxic amounts or at levels which could impact water quality. (See Section 5.3.1.5 for a discussion of the groundwater results adjacent to and beneath the stockpiles.)

ODEQ has a Ahotspot@ provision under OAR 340-122-085 (implementing rules of ORS 465.200-900) that is similar to EPA=s Aprincipal threat@ concept. For purposes of this requirement, a Ahot spot@ is defined as: 1) for ground or surface water, hazardous substances having a significant adverse effect on existing or reasonably likely future beneficial uses of water or waters to which the hazardous substances would be reasonably likely to migrate and for which treatment is reasonably likely to restore or protect such beneficial uses within a reasonable time, and 2) for other media, the extent to which hazardous substances exceeding background concentrations present an excess risk of cancer of 1×10^{-4}, a hazard quotient of 10 for human exposure, or a toxicity quotient of 10 for ecological receptors (OAR 340-122-115(35)).

ODEQ cleanup rules (OAR 340-122) require that all remedies treat Ahot spots@ of contamination to the extent feasible. The feasibility evaluation under the ODEQ cleanup rules is based on the five remedy selection factors which include cost reasonableness. The FS did consider treatment of Ahot-spots@ in soil (there are no hot spots in other media). It was estimated that approximately 330,000 cubic yards of stockpile material would exceed the ODEQ arsenic or radium-226 1×10^{-4} cancer risk level and background concentrations. This Ahot-spot@ material consists of both sand and gravel material and clay-like material. Solidification/stabilization of this material was considered but would not be effective on the clay-like material. The sand-gravel portion (230,000 cubic yards) was evaluated for treatment but there did not appear to be an incremental advantage in treating the Ahot-spots@ and it is not certain that solidification/stabilization would be able to provide the additional benefit of reducing the leaching potential for these materials. Therefore, for these reasons, treatment of this Ahot spot@ soil was not retained because of effectiveness and implementability concerns, and very high incremental cost over other alternatives which offered similar effectiveness and protection of human health and the environment. Finally, it was determined that after completion of any of the other options retained through the detailed evaluation in the FS, there would be no potential exposure to Ahot spot@ materials which would be covered or restricted.

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SECTION 12

THE SELECTED REMEDY

The selected remedy is Alternative SP-3b for the White King Stockpiles, Alternative LL-3 for the Lucky Lass stockpile, and WKPW-3 for the White King pond. These alternatives are discussed more fully below. The selected remedy meets the requirements of the two mandatory threshold criteria: protection of human health and the environment, and compliance with ARARs, while providing the best balance of benefits and tradeoffs among the five balancing criteria: long-term effectiveness, short-term effectiveness, implementability, reduction in toxicity, mobility and volume through treatment, and cost. The selected remedy also provides for meeting the remedial action objectives and remediation goals presented in Section 8.

12.1 SUMMARY OF THE RATIONALE FOR THE SELECTED REMEDY

The key factors upon which the remedy decision is based are presented below along with a description of how the selected remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria.

12.1.1 White King Stockpiles

The selected remedy for the White King Stockpiles is consolidation of the two stockpiles, including portions of Augur Creek impacted by erosion from the stockpiles, and Aoff-pile@ and haul road material, at the location of the mine waste repository (Alternative SP-3b). (As discussed separately in Section 12.2.3 soils from the Lucky Lass stockpile will also be consolidated into the White King stockpile.)

Alternative SP-3b will be protective of human health and the environment and meet all ARARs. Compliance with the State of Oregon=s rules for the disposal of radioactive material was one of the main factors upon which the remedy decision is based. Moving the protore stockpile out of the Augur Creek floodplain will insure that the remedy meets the State floodplain and erosion standards. Several other factors that led to selecting this alternative are as follows:

$ Alternative SP-3b will have high long-term effectiveness and permanence. The 7.5 feet of recompacted clay and 2 feet of soil on the cover will provide an additional effective thickness not found in Alternative SP-3a. The clay/soil cover will reduce infiltration, contaminant migration from erosion, and provide adequate freeze thaw protection for the underlying stockpile material. The 2 feet of soil cover will also help promote native vegetation. Because the consolidated stockpile is isolated below the 7.5 foot clay/2 foot soil cover, the potential for direct exposure and inadvertent human or animal contact is also reduced.

$ Consolidation of the two stockpiles will reduce the total area to be covered as compared to Alternative SP-3a. A single cover in one location with a smaller surface area will be somewhat easier to maintain and monitor than two separate stockpiles and covers as found in Alternative SP-3a.

$ There was little additional long-term effectiveness for the in-pit and off-mine disposal alternatives that would justify the significantly greater costs. In addition, there were a number of technical uncertainties on the potential ground water impacts from the in-pit disposal option, which could not be easily resolved.

$ Consolidation will restore a greater portion of Augur Creek/Meadow wetland habitat to pre-mining conditions than covering the two White King stockpiles in-place. This was a potential benefit supported by community members, the State, and Forest Service during the public comment period.

12.1.2 White King Pond

The selected remedy for the White King pond is continued in-situ neutralization (WKPW-3).

Selection of Alternative WKPW-3 was a logical outgrowth from the 1998 neutralization study and selection of SP-3a as the preferred stockpile alternative. WKPW-4 through WKPW-6b involved land application or surface discharge of the pond water. These alternatives would have been implemented in coordination with a selected alternative for the White King stockpiles addressing consolidation/containment of stockpiles or clean or treated fill within the mine pit. As discussed previously, filling in the pond with stockpile material would not meet State of Oregon requirements for disposal of radioactive material and was associated with a number of technical uncertainties which could not be easily resolved. Because SP-5, the only alternative that used clean material to fill the pond, was less cost effective than the other alternatives, White King Pond Alternatives WKPW-4, WKPW-5a, WKPW-5b, WKPW-6a, and WKPW-6b would not be as cost effective as WKPW-3. In addition, the community and USFS expressed a desire to retain the pond as a potential aquatic habitat. The 1998 neutralization study demonstrated that it was possible to raise the pH in the pond through treatment which could allow eventual establishment of a diverse aquatic habitat.

12.1.3 Lucky Lass Stockpile

The selected remedy for the Lucky Lass stockpile is excavation of soils from the stockpile that exceed cleanup goals for arsenic and radium-226 restoring the excavated area with topsoil (LL-3).

LL-3 was selected because it provided the greatest degree of assurance of long-term effectiveness at a reasonable cost. It also is relatively easy to implement, results in lower residual risk, and it provides for reclamation of the Lucky Lass Mine stockpiles. The remaining stockpile material, presents a much lower level of risk which can be easily managed through institutional controls. Excavation of the entire stockpile, as in LL-4, is not necessary in order to achieve protectiveness.

12.2 DESCRIPTION OF THE SELECTED REMEDY

This section expands on the description of the Selected Remedy for each area at the Mines site from that which was provided in the Description of Alternatives (Section 9). The remedy may change somewhat as a result of the remedial design and construction processes. Any significant changes to the remedy described in the ROD will be documented using a technical memorandum, an ESD, or ROD amendment which would be included in the Administrative Record.

12.2.1 White King Stockpiles

The Selected Remedy for the White King Stockpiles is as follows:

$ **Reconfiguration of the Protore Stockpile**

The protore stockpile will be reconfigured in order to remove stockpile material from the Augur Creek floodplain. It is estimated that approximately 138,000 cubic yards of material will need to be moved. **Figure 12-1** shows a conceptual design of the reconfigured protore stockpile, with the overburden stockpile on top, in relation to the Augur Creek floodplain and other major features at the White King mine. The exact dimensions and elevation of the reconfigured stockpile will be determined during the remedial design and will take into consideration natural features present at the Mines site, the volume of the overburden stockpile, and the location of the Augur Creek floodplain.

$ **Consolidation of the Stockpiles**

The White King overburden stockpile (430,000 cubic yards), off-pile (35,000 cubic yards)(including portions of Augur Creek impacted by erosion from the stockpiles), and haul road material (15,000 cubic yards) will be excavated and relocated on top of the reconfigured protore stockpile. This material will be subsequently covered with regraded Aclay-like material@ present within the existing stockpiles. AClay-like material@ is a term used to describe stockpile materials that consist of mixtures of clay and larger sized particles that exhibit significant plasticity in the field and low permeability in laboratory tests. Excavation of the overburden stockpile, off-pile, and haul road material will occur during the first construction season. Additional details on the cleanup approach for the excavation of soils is presented below. The remedial design for the consolidated stockpiles (also referred to as the mine waste repository) shall include features to control surface infiltration, surface water runon and runoff and any impacts from upgradient shallow ground water. These features may include but are not limited to the following: a low permeability layer utilizing the maximum thickness of regraded clay-like material over the top of the stockpile; use of natural features or drainage swales to divert surface water and french drains to divert shallow ground water away from the consolidated stockpile; and, to the extent practicable, the final stockpile configuration shall fit into the natural topography. The design shall be developed to accommodate a 500-year 24-hour storm event. **Figure 12-2** shows a conceptual view of proposed design features of the consolidated stockpile. **Figure 12-3** depicts a conceptual cross section of the consolidated stockpile and **Figure 12-4** illustrates several conceptual design features of the consolidated stockpile. The final slopes of the stockpile will be approximately 4 percent on the top and 5:1 on the sides. The final dimensions and elevations of the stockpile will be determined during design.

Cleanup Approach for Stockpiles, AOff-Pile@, and Haul Road Areas

The low-grade ore and minespoil piles have been sitting at the Mines site for over 40 years and have been subject to wind erosion, oxidation, and leaching. Thus, radioactive materials, and other contaminants may have been spread around the two mines. **Figure 11-5** from the Draft EIS provides the approximate areas and depths of contaminated soil at the White King Mine based on gamma surveys. (**Figure 11-6** provides a similar figure for the Lucky Lass mine). Information obtained in the RI indicates that in most cases the stockpiles and disturbed areas can be readily identified from the native surface material by their color, texture, and gamma radiation. In order to prevent excavation into naturally occurring mineralized subsurface soil the following approach has been developed:

$ The initial cleanup approach for stockpiles, off-pile, Augur Creek, and haul road areas is to remove the chalk-like (referring to color and not consistency) material down to the original organic soil (or sediment in the case of Augur Creek) layer using a Avisual approach@.

$ After Avisual@ cleanup is completed, confirmatory sampling including gamma screening[7] will be conducted in such a manner as to confirm completeness of visual removal and achievement of the soil excavation levels (See **Table 12-1 page 12-14)**, at the level of the organic soil layer. An alternative approach would be to remove the upper six inches of meadow surface, wherever it is in contact with the radioactive materials in the stockpile, off-pile, and haul road areas. In either case clean fill will be added to the surface after soil removal, in order to meet background surface soil concentrations.

The specific clean-up approach will be determined during the Remedial Design and Remedial Action Workplan with consideration being given to localized background for the Mines site. Among the factors which may be considered by EPA in determining the additional amount of material to excavate will be the following: satisfying surface exposure or background requirements, the type of material which is found and whether the material in question is leachable (or has leached) posing a potential source to ground water or surface water, whether the surface readings result in finding subsurface naturally occurring radioactive material, potential damage to meadow soils that further excavation may cause, and State acceptance. A

[7] Evidence collected during the RI indicates that radioactive contaminants are co-located with other contaminants such as arsenic. An approach to identify and cleanup radiological contaminants, such as radium-226, to background should assure that arsenic and other uranium decay-series radionulcides will also be removed. Gamma surveys may be sufficient for initial verification of cleanup. However, there also may be a need for some representative analytical sampling to confirm the removal of arsenic to background.

similar approach will be applied to Augur Creek sediment removal. Factors to be considered by EPA in determining sediment removal will be the toxicity of the sediments to aquatic organisms using available sediment criteria, risk to recreational users, and the potential ecological impacts, such as habitat loss or disruption, associated with removal of contaminated sediments. Following excavation of soils and sediments, residual risk will be evaluated in accordance with ODEQ=s cleanup law (ORS 465.315, OAR 340-122-040).

$ **Stockpile Cover**

In addition to the recompacted clay layer mentioned above a two-foot soil cover will be placed over the mine waste repository. The total area that will require cover material is approximately 25 acres. General cover soil can be borrowed from numerous sources including areas at the Lucky Lass mine (1.5 miles from White King mine), National Forest System lands between the White King mine and Lucky Lass mine (1 mile from White King mine), as well as private sources located 3, 6, and 15 miles from the Mines site. The soil cover shall also include a storm water collection system to reduce the potential for erosion from or pooling of surface water. Final details on the soil cover and stockpile configurations will be developed during the design. Vegetation will be established on the top of the cover consisting of local climax vegetation (i.e., cool season grasses that are dormant in the summer and do not require long-term irrigation). The appropriate vegetation will be determined during the design phase.

$ **Inspection & Maintenance**

Inspection and Maintenance (I&M) of the mine waste repository will include inspection and repair of the fences/physical barrier, gates, locks, warning signs, monitoring wells, and maintenance of the 24-inch soil/vegetation cover, and stormwater management system. A minimum of two site inspections will be conducted each year during the late spring and fall. It is conservatively assumed that 5 percent of the total acreage of vegetation and 5 percent of the topsoil volume would be replaced each year.

A draft I&M plan that will be prepared as part of the design which will outline the above activities and quantitatively define how the inspector should identify a Asatisfactory area of vegetation.@ Areas that show signs of erosion or sparse vegetation will be repaired. The surface will be graded and/or filled to match the surrounding grade with topsoil material. The area will be reseeded, mulched, and sufficiently watered to restore the vegetation. Woody shrubs or trees will be identified and removed before deep roots are established.

The cover system will be inspected for areas of significant erosion. To further control erosion in the long term and prevent gully propagation, certain guidelines will be developed during the design. The eroded areas will be backfilled with cover soil and topsoil, and reseeded/mulched. The cover system will also be inspected for signs of settlement and subsidence. Areas showing signs of potential ponding or continued settlement will be backfilled and repaired as described for erosion gullies.

Erosion control devices such as silt fences, hay bales, and/or jute or straw mats will be inspected during the first year following construction completion. Silt fences, hay bales, and/or jute or straw mats will be maintained for a minimum of one year or until a full vegetative layer has been established. Silt fence posts that are no longer secure or vertical will be reinstalled. Damaged fabric will be repaired or replaced with new fabric. Hay bales that are no longer intact or secured to the subgrade will be replaced. If there is evidence that runoff is passing around the hay bales, then the hay bales will be replaced or repositioned, or additional hay bales will be added. Damaged jute or straw mats that are no longer secure will be reinstalled, if necessary, in the event vegetation has not been established.

In addition to the above actions EPA can and will require additional actions if necessary to maintain the protectiveness of the stockpile remedy.

$ **Reclamation**

After excavation of the overburden stockpile, portions of the protore stockpile and off-pile and haul road areas, the disturbed areas will be reclaimed/revegetated using a minimum of 3 inches of soil. A significantly thicker layer of soil may be required in certain areas to meet surface soil background levels as previously discussed in the Acleanup approach@. The vegetation will consist of local climax vegetation (i.e., cool season grasses that are dormant in the summer and do not require long-term irrigation). The total area requiring reclamation/ revegetation is estimated to be 36 acres. Based on field observations during the RI, meadow areas situated on and downgradient of the stockpiles displayed characteristics (i.e., hydrophylic vegetation, hydric soils, and hydrology) satisfying the criteria for identification of a wetland area as outlined in the 1987 Corps of Engineers Wetland Delineation Manual (ACE, 1987). If there are any potential impacts on the wetlands due to the implementation of the final remedy, the remedial design will need to address these impacts.

$ **Monitoring**

Ground water, surface water, and sediment monitoring and evaluation will be conducted as part of the stockpile remedy to: (1) determine the effectiveness of the source control measures in preventing erosion and infiltration, (2) insure that contaminants are not migrating into Augur Creek (via surface runoff or ground water discharge to surface water), (3) further refine background levels and/or establish ground water, surface water, and sediment trends, and (4) insure the remedy remains protective of the potential beneficial use (aquatic habitat and livestock) and meets applicable standards. A monitoring plan shall be submitted, including a quality assurance program plan and a sampling plan, for EPA approval during the remedial design. The monitoring program will be assessed periodically to determine if it should be supplemented or modified in any way. Additional remedial actions may be required in the event the evaluation of monitoring data show contaminant levels have increased and/or pose a threat to the environment. The following are specific monitoring requirements for Augur Creek and ground water upgradient and downgradient of the mine waste repository.

Augur Creek Sediment and Surface Water Monitoring

Surface water and sediment samples will be collected in Augur Creek both upgradient and downgradient of the consolidated stockpile at a minimum of one time per year. As previously discussed in Section 8.2 surface water in Augur Creek is expected to meet Oregon=s State water quality standards (OAR 340-41-925) for the Goose Lake Basin (See Table 8-1) and beneficial uses for the Goose Lake basin. Monitoring shall be conducted in surface water to insure that these standards are being met. Sediment monitoring shall be conducted to establish trends and insure the remedy is protective.

Ground water Monitoring

As with surface water, the discharge of ground water to surface water is expected to meet Oregon=s State water quality standards. At a minimum, the monitoring plan shall outline sampling for alluvium and shallow bedrock wells upgradient and downgradient of the mine waste repository[8]. The goal of monitoring is to ensure that the potential beneficial uses of ground water (discharge to surface water) meet Oregon=s State water quality standards (OAR 340-41-925) for the Goose Lake Basin (See Table 12-6 page) at the boundary of the waste management area with Augur Creek and/or to establish a trend toward background concentrations.

$ **Institutional Controls**

Land use restrictions will be put in place to limit and manage human exposure to contaminated soil underneath the Mine waste repository cover and underlying groundwater, and any uses that could impact the integrity of the Mine waste cover. **Figure 6-1** shows the boundaries of public and private property at the Mines site. The private property that requires institutional controls is:

Parcel 1, S1/2NE1/4, Section 30, T.37S., R.19E., W.M. This parcel is currently owned by the Coppin Trust (surface estate) and members of the Leehmann and Coppin families (mineral estate)

Because the mine waste repository will be located on both National Forest System Lands and private property, different mechanisms for land use restrictions will be required:

For private property land use restrictions will include proprietary controls such as an equitable servitude and easement (consistent with ODEQ=s AFinal Guidance for Use of Institutional Controls@ (ODEQ, 1998). This is a legal instrument placed in the chain of title that provides access rights to a property for inspection and maintenance and monitoring and restrictions preventing residential use and

[8] As discussed in section 5.3.1.5 the perched ground water beneath the protore stockpile had elevated levels of inorganics and radionuclides which pose a human health risk. This remedy employs institutional controls to prohibit use of this ground water for drinking purposes and therefore remediation levels or monitoring are not required for the ground water beneath the consolidated stockpile.

installation of drinking water wells. This type of control shall be set forth in an EPA and DEQ-approved form running with the land and enforceable by EPA and DEQ against present and future owners of the property. As an informational device the Mines site will be maintained on DEQ=s Environmental Cleanup Site Information Database as long as the institutional controls remain in effect. One additional informational device is a deed notice to inform property owners that contamination remains on site. Placement of a deed notice can be made by EPA.

On National Forest System Land, an amendment to the Forest Plan (attached to this ROD) has been made by the Forest Service that prohibits the following uses on 240 acres at the Mines site. These prohibitions apply to most of the Mine Waste repository, all of the Lucky Lass stockpile and a small portion of the White King pond:

Prohibitions

$ Residential structures or use

$ Drinking water well drilling

$ Any permanent structures

$ Permanent recreation sites (e.g., campgrounds) and uses (e.g. swimming in White King pond)

$ Removal of stockpiled material

$ Agricultural Activities

$ Any other use that would impact the integrity of the Mine waste repository and Lucky Lass stockpile, including grazing on stockpiles and off-road vehicle use

The area of the Mines site was also withdrawn from mining by the Bureau of Land Management (BLM) on August 9, 1993 to protect the rehabilitation work to be done on the White King and Lucky Lass mine. This withdrawal will expire on August 9, 2013 (20 years) unless the withdrawal is extended. The USFS will request that the BLM continue to maintain a withdrawal of the area of the mine waste repository from mineral entry since this activity could damage the soil cover and the effectiveness of the remedy.

Confirmation that land use restrictions are obeyed whether on private property or National Forest System lands will be monitored visually during the site inspections. During the site inspections, the private property and National Forest System lands within and adjacent to the Mines site will be assessed as to whether the land use restrictions have been violated (e.g., material removed from the repository, construction of housing etc.).

$ **Physical Access Restrictions**

Access will be restricted by constructing a fence or other physical barrier surrounding the mine waste repository in order to prevent exposure to and disruption or use of the stockpiles materials. This fence/barrier will also prevent disturbance of the mine waste repository from humans and cattle or medium-to-large animals, which could expose the material to the effects of wind and water erosion. The specific type and size of the fence/barrier will be determined in design. If a fence is selected in design the foundations for the fence posts will extend below the maximum frost penetration depth to prevent damage to the fence from the freeze/thaw cycle during the winter months. A fence should have gates that can be locked at all times. Warning signs will be posted every 200 feet along the fence/barrier stating the hazards, who to contact, and advising people not to remove or disturb any of the stockpiled material. Efforts will be made to reduce the visual impact of the fence/barrier.

12.2.2 White King Pond

The Selected Remedy for the White King Pond is as follows:

$ **Stormwater Management**

A diversion ditch will be constructed around the top of the highwall to collect and direct stormwater and minimize further erosion of the highwall. A stormwater management plan shall be developed during the design which will address surface water runoff and highwall slope/stability in order to adequately address continued erosion into the pond.

$ **Maintenance of the White King pond**

The pH in the pond water will be increased through periodic addition of pulverized limestone, limestone rock, hydrated lime or other neutralizing agents like soda ash. The state water quality standards for Goose Lake Basis requires a pH range of 7-9. The limestone application rate and frequency is a function of factors such as existing water quality, source of acidification, volume of water, residence time of pond water, limestone application method, and limestone type, purity and particle size. The frequency and rate of liming will be determined during the design.

In addition to the liming, fertilizer may be added to the pond to stimulate primary biological activity. The biomass that would be produced from the biological activity would settle to the bottom of the pond and begin to develop a cover over the existing sediments. Any additional application volume and frequency of the fertilizer would be determined during the design and remedial action phase and will depend on the monitoring results discussed below.

$ **Monitoring/Assessment**

Monitoring of the pond (water and sediments) and ground water (including surface discharge or seeps along the highwall) will occur at a minimum of one time per year. A monitoring plan including a quality assurance program plan and a sampling plan will be submitted for EPA approval during the remedial design. The overall purpose of the monitoring is to collect information to evaluate the effectiveness of pond neutralization, establish trends, and enable further evaluation of the spatial distribution of contaminants and the risks associated with pond water, seeps, and sediments. Specific objectives include the following: Improve the conceptual site model for the pond; further describe the geochemical processes affecting pond chemistry and aquatic life; further characterize the sources, nature and extent of COCs in sediments, surface water, and seeps, and evaluate the ability to achieve Oregon=s State water quality standards (OAR 340-41-925) for the Goose Lake Basin, particularly for pH.

In addition to the above monitoring, an assessment of the toxicity, bioavailability and bioaccumulation potential, and species exposure to contaminants in pond sediments shall be conducted. This assessment, in conjunction with the above pond monitoring, will provide information on the ecological risks associated with the pond and the feasibility of environmental protection for the proposed beneficial uses (primarily aquatic habitat). Further evaluation of risks should utilize site-specific factors such as chemical bioavailability and toxicity to benthic and aquatic organisms using tests acceptable to EPA.

The results of each seasons sampling and monitoring data will by reviewed annually by the EPA. The information will be evaluated to determine if the pond neutralization is effective and what risks are associated with pond sediments. If the data verifies the toxicity of pond sediments to benthic or aquatic organisms at the population level, additional action such as sediment capping or dredging may be required. This action will be documented in an ESD or ROD amendment.

$ **Institutional Controls**

Land use restrictions will be put in place to prevent residential, recreational, or agriculture uses of the pond. Because the White King pond is located on both National Forest System Lands and private property, different mechanisms for land use restrictions will be required as described above for the White King Stockpiles. The majority of the pond is on private land therefore the predominant mechanism for implementation of these controls will be through proprietary controls such as an equitable servitude and easement (consistent with ODEQ=s AFinal Guidance for Use of Institutional Controls@ (ODEQ, 1998).

$ **Access Restrictions**

Physical restrictions, such as fencing, will be required to prevent exposure to the pond water and sediments. These restrictions may be eliminated in the future depending on the success of neutralization and any actions to address the risks associated with the pond sediments. Warning signs will be posted every 200 feet along the fence stating the hazards, who to contact, and advising people not to swim in the pond.

$ **Inspection and Maintenance**

Site inspections will be conducted at a minimum of twice per year. The inspection and maintenance activities will include inspection and repair of fences, gates, locks, warning signs, and monitoring wells caused by inclement weather or vandalism.

12.2.3 Lucky Lass Stockpile

The Selected Remedy for the Lucky Lass Stockpile is:

$ **Soil Excavation**

All surface soils that exceed the levels shown in **Table 12-5 page 12-16** shall be excavated and placed within the White King mine waste repository:

Most of these soils have been identified in the Lucky Lass meadow, downhill from the overburden pile and Lucky Lass pit, with the highest uranium activities occurring in the upper 1 to 2 feet of soil. Other soils with elevated radium-226 activity occur on top of the Lucky Lass stockpile as a reddish-black rock, which contrasts with the lower activity chalk-colored overburden. It is estimated that approximately 3,000 cubic yards of soil exceed a cleanup level of 3.6 pCi/g for radium-226 and 38 mg/kg for arsenic. A field screening methodology for identification of these soils, similar to the approach outlined above for the White King soils, will be developed during the design. The excavated areas will be restored to existing grade including 3 inches of topsoil. The Lucky Lass stockpile material that has been impacted by drainage from the Lucky Lass pond will also be excavated and moved so that there is no further erosion impact from the Lucky Lass pond drainage. The excavated material will be regraded with the Lucky Lass stockpiles and the excavated area will be restored with riprap to reduce erosion. Recontouring of the Lucky Lass Mine overburden stockpile may also be necessary if portions of the stockpile are used as a borrow source for the White King mine waste repository cover. Such activities may include, but are not limited to, regrading the stockpiles to provide slope stability, promote drainage, and control erosion; placement of topsoil; and establishment of vegetation on the stockpile. No future monitoring or inspection and maintenance of the Lucky Lass stockpile will be required.

$ **Institutional Controls**

Because the Lucky Lass mine area is situated entirely on National Forest System land, institutional controls must be implemented through Forest Service mechanisms only. Land use restrictions are required to prevent residential/recreational use at the mine, installation of drinking water wells within the stockpile, and removal of stockpile material. As discussed for the White King stockpile an amendment to the Forest Plan has been made by the Forest Service to prohibit these and other uses. In addition the area of the Lucky Lass Mine has been withdrawn from mining as described for the White King Stockpile remedy. As an informational device the Mines site will be maintained on DEQ=s Environmental Cleanup Site Information Database as long as the institutional controls are required.

$ **Access Restrictions**

Short-term access restrictions will include physical restrictions (e.g., fencing), warning signs, and safety measures until completion of the remedial action.

12.4 PERMITS

CERCLA Section 121(e)(1) states that no Federal, State or local permit shall be required for the portion of any removal or remedial action conducted entirely "on-site" where such remedial action is selected and carried out in compliance with Section 121. The term "on-site" is clarified in the NCP, 40 CFR 300.400(e), which states that on-site means the aerial extent of contamination and all suitable areas in very close proximity necessary for implementation of the response action. EPA has determined that the land areas adjacent to the White King and Lucky Lass Stockpiles to be used for consolidation and/or recontouring of the stockpiled material are necessary for implementation of the remedy and considered on-site for purposes of CERCLA Section 121(e)(1).

12.5 SUMMARY OF THE ESTIMATED REMEDY COSTS

The Total Present Worth Cost of the Selected Remedy is approximately $7,900,376[9] based on a present worth discount rate of 7% and 30-year O&M. This value is for the combined costs for the White King Stockpile Alternative SP-3b, White King Pond Alternative WKPW-3, and Lucky Lass Stockpile Alternative LL-3. These costs are summarized in **Tables 11-1 through 11-3**.

Due to changes made in Alternative SP-3b during the remedy selection process the cost estimate in the FS (and presented in Section 10 of this ROD) has been modified to include the additional costs for excavation of portions of the protore stockpile and the costs for an additional 12-inch soil cover. In addition to these changes, EPA reduced the contingency costs for this alternative in the FS estimates from 25% to 10%. This decision was based on input from Jacobs Engineering under contract to the Forest Service and the Corps of Engineers who felt that a 25% contingency was too high given the relatively few unknowns associated with this project. This resulted in a significant reduction in the cost estimate that was shown in the FS for a similar alternative. On the other hand the cost associated with the sediment monitoring was not estimated in the FS and has not been included in the total remedy cost. Given the significant unknowns surrounding the nature and extent of this monitoring no attempt was made to estimate these costs at this time.

The cost summary provided is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file, and ESD, or a ROD amendment. This is

[9] This number is based on a combination of revised costs for Alternatives SP-3b as discussed in section 12.7, Cost for WKPW-3, and Costs for Lucky Lass LL-3.

an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

12.6 EXPECTED OUTCOMES OF THE SELECTED REMEDY

The purpose of this response action is to control risks posed by direct contact with contaminated soil, ground water, and sediments and to minimize migration of contaminants to ground water and surface water. The results of the baseline risk assessment indicate that existing conditions at the Mines site pose an excess lifetime cancer risk of 3×10^{-4} to a current worker exposed to radionuclides in soil. Risks to workers from arsenic in soils was 6×10^{-5} . Non-cancer risks were also elevated (hazard index of 4) for current child recreational users primarily from ingestion of arsenic in soils. For potential future residents the chemical and radionuclide cancer and non-cancer risks were much higher (cancer risks up to 5×10^{-1} and non-cancer hazard indexes up to 5,000) due to exposure to soil and shallow ground water.

The source control measures of consolidation and cover of the White King stockpiles, off-pile areas, and haul road and portions of the Lucky Lass stockpile will reduce the pathway of exposure for human and ecological receptors which will reduce the potential risks to correspond with an excess lifetime cancer risk of 1×10^{-6} or a hazard index of 1. It will also reduce the potential migration of contaminants into Augur Creek surface water, sediments and ground water. Monitoring of surface water, sediment, and ground water will be conducted to ensure the beneficial use of these resources. Implementation of the remedy should be completed within 3 years and allow return of the Mine site (with the exception of the mine waste repository and pond) to the anticipated future use of recreation, grazing, and timber production. Riparian habitat in the meadow will also be restored. Short-term impacts during the period of implementation are minimal and do not persist throughout the entire year due to snowfall and limited access to the Mines site.

The baseline ecological risk assessment predicted adverse impact to aquatic invertebrates exposed to non-radionuclide contaminants in the White King pond sediments. The greatest risks were associated with the arsenic in sediments (HI of 33). Historically very little aquatic life has inhabited the White King pond. This is probably due to a number of factors including low pH and elevated sediment arsenic levels. Neutralization of the White King pond and further evaluation of the sediments will help to determine what future beneficial uses of the pond are achievable. If the data verifies that sediments pose an unacceptable risk to aquatic organisms at the population level, additional action such as sediment capping or dredging may be required. This action would be documented in an ESD or ROD amendment.

12.6.1 Remediation Levels

Numerical cleanup levels are based upon risk, background concentrations, or chemical specific ARARs, whichever are higher. The rationale for the cleanup levels presented in Section 12.2 is discussed below.

White King Stockpile

For the Mines site stockpiles and soils EPA used ODEQ=s cleanup law (ORS 465.315 and implementing regulations at OAR 340-122), which establishes standards for cleanup based on acceptable risk levels or background concentration, whichever is higher. At the White King Mine, background levels are higher than the protective levels, due to the natural mineralization in the area, and therefore were used to establish excavation levels. EPA and DEQ policy is to remediate to background, regardless of the risk from exposure to background concentration. Based upon EPA=s determined subsurface background at White King the remediation levels shown in Table 12-1 apply to excavation into the surface and subsurface. Clean fill will be added to the surface or excavation after removal of the stockpiles, in order to meet surface soil background concentrations. Surface soil background levels will be established during the remedial design.

Table 12-1 White King Soil Remediation Levels

Area of Site	Chemical	Remediation Level	Basis for Remediation Level
White King Soils	Arsenic	442 mg/kg	Background (95% UTL lognormal subsurface soils - under and near pile locations omitted)
	Radium-226	6.8 pCi/g	Background (95% UTL normal subsurface soils - under and near pile locations omitted)

Because arsenic is an intrinsic component of mineralization at the White King mine, cleanup for radium-226 to background will assure that arsenic, thorium-230 and uranium-234 and -238 also will be removed.

White King Pond Water

The remediation levels for arsenic, the primary COC in the pond water is shown below in Table 12-2. Remediation levels would typically be based on surface water quality standards or pond surface water background values, whichever is less stringent. Since the pond was created by mining activities, a background value, as that term is used by EPA, is not available for the pond. Therefore, the value shown below is based on the Augur Creek surface water background levels. Further monitoring and evaluation of the pond will evaluate the ability to achieve Oregon=s State water quality standards (OAR 340-41-925).

Table 12-2 White King Pond Water Remediation Levels

Area of Site	Chemical or Parameter	Remediation Goal	Basis for Remediation Goal
White King Pond	Arsenic	0.033mg/l	95% UTL Background[a]

[a] 95% UTL normal distribution upgradient of White King pond (value may be elevated due to an outlier)

White King Pond Sediment

As a result of limited information on the arsenic concentrations in sediment, and the unknowns associated with long term pond neutralization, numerical cleanup goals for sediment have not yet been established. After a period of investigation and evaluation described in Section 12.2 remediation goals will be selected that will be protective of the beneficial use.

Augur Creek Surface Water

Active remediation of surface water is not required in Augur Creek in order to achieve protection of human health. Monitoring of surface water will be conducted to ensure the stockpile remedy remains protective and meets state water quality standards. The remediation levels for arsenic water quality are based on an Augur Creek background concentration evaluated during the remedial investigation. By selecting a background level as a goal it is in compliance with the state water quality standards and the state environmental cleanup law. Background is provided for under 340-041-925 (3) of the state water quality rule and under OAR 340-122-040 the state cleanup rules.

Table 12-3 Augur Creek Surface Water Remediation Levels

Area of Site	Chemical or Parameter	Remediation Level	Basis for Remediation Level
Augur Creek Surface Water	Arsenic	**0.033mg/l**	95% UTL Background[a]

[a] 95% UTL normal distribution upgradient of White King pond (value may be elevated due to an outlier)

Augur Creek Sediment

Some portions of Augur Creek, particularly those adjacent to the White King stockpiles, contain elevated levels of arsenic in sediment from stockpile erosion. As shown in **Table 12-1** a cleanup level of 4.2 mg/kg was established for these areas. This value is based on the maximum observed background concentration upstream from the White King mine. A visual cleanup approach as described above for the stockpile soils will be utilized to the maximum extent practicable, followed by verification sampling.

Table 12-4 Augur Creek Sediment Remediation Levels

Area of Site	Chemical or Parameter	Remediation Level	Basis for Remediation Level
Augur Creek Sediment	Arsenic	**6 mg/kg (dry weight)**	Lowest Effect Level Ontario Sediment Quality Guidelines
	Manganese	**1610 mg/kg**	Background Highest Upgradient Concentration

Ground water (White King & Lucky Lass)

Active remediation of ground water is not required at the Mines site in order to achieve protection of human health. Discharge of groundwater to surface water is the State designated beneficial use. (Under the NCP ground water would be designated as Class II(b). Eventually ground water at the edge of the waste management area should be returned to drinking water standards (MCL for Arsenic is currently 50Φg/l)). In order to protect the aquatic habitat of Augur Creek, the discharge from ground water to surface water should meet background concentrations since background is higher than the applicable standard or protective level. Monitoring of ground water will be conducted to insure that these goals are being met and to insure protectiveness of the designated beneficial use of ground water.

Table 12-5 White King/Lucky Lass Mine Ground water			
Area of Site	**Chemical or Parameter**	**Remediation Level**	**Basis for Remediation Level**
Ground water at Edge of Waste Management Area	**Arsenic**	**.033mg/l**	**95% UTL Background[a] for Surface Water**
[a] 95% UTL normal distribution upgradient of White King pond (value may be elevated due to an outlier)			

Lucky Lass Stockpile

As with the White King soils EPA used ODEQ=s cleanup law (ORS 465.315 and implementing regulations at OAR 430-122), for establishing standards for cleanup based on acceptable risk levels or background concentration. At the Lucky Lass Mine, the cleanup goals are lower that at the White King Mine due to differences in local background levels. The remediation goal for arsenic is 38 mg/kg based on recreational use (the most likely exposure scenario). The radium-226 cleanup level is 3.6 pCi/g, again based on background levels. The soil cleanup process will begin with gamma screening to identify areas with elevated Radionuclides followed by excavation using a visual criteria as described for the White King stockpile soils. Following soil excavation confirmation sampling and gamma screening will be conducted to verify cleanup.

Table 12-6 Lucky Lass Soil Remediation Levels			
Area of Site	**Chemical**	**Remediation Level**	**Basis for Remediation Level**
Lucky Lass Soils	Arsenic	38 mg/kg	$1x10^{-6}$ Protection for Recreational User ORS 465.315
	Radium-226	3.6 pCi/g	Background - 95% UTL normal distribution subsurface soils (without meadow locations)

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SECTION 13

STATUTORY DETERMINATIONS

Under CERCLA '121 and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with applicable or relevant and appropriate requirements (unless a statutory waiver is justified), are cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes. The following sections discuss how the selected remedy meets these statutory requirements.

13.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedy, Containment and Consolidation of the White King Stockpiles (SP-3b), Pond Water Neutralization (WKPW-3), and removal of soils exceeding remediation goals at Lucky Lass (LL-3), will protect human health and the environment by:

$ Preventing direct contact, including ingestion, dermal contact and inhalation of soils containing COCs above health-based levels

$ Restricting access to the contaminated soils through physical and institutional controls

$ Neutralizing the acidic water in the White King pond and restricting access to the pond until the risks from pond sediments are more fully evaluated

$ Consolidating and covering of contaminated soils to reduce infiltration of COCs into ground water

There are no short-term threats associated with the selected remedy that cannot be readily controlled. In addition, no adverse cross-media impacts are expected from the selected remedy.

Implementation of the selected remedy is not expected to pose unacceptable short-term risks or significant cross-media impacts.

13.2 Compliance with Applicable or Relevant and Appropriate Requirements

The selected remedy for the Mines site will comply with Federal and State ARARs that have been identified. No waiver of any ARAR is being sought or involved for the selected remedy. Where a State ARAR is equivalent or more stringent that a corresponding Federal ARAR, only the State ARAR is identified. The ARARs for the Mines site are identified below.

Applicable or Relevant and Appropriate Requirements (ARARs)

CERCLA remedial action is required to comply with applicable or relevant and appropriate requirements (ARARs), unless an ARAR is waived. ARARs for cleanup of the Mines site include statutory and regulatory requirements promulgated by the State of Oregon that address the disposal of radioactive material including uranium mine overburden. Also see Section 10.2.1 for a discussion of this ARAR. These rules require that radioactive material not be located in: certain specified locations which affect some of the stockpiles and the placement of the mine waste repository at the Mines site. The rules include a pathway exemption set forth in OAR 345-050-0035, which exempts certain material from the rules. The Oregon Office of Energy, the agency charged with administering these laws, determined that the floodplain and erosion standards apply to the overburden piles because the gamma pathway set forth in OAR 3450-50-0035 is exceeded. OOE has determined that concentrations of radioactive material in the overburden and protore stockpiles at the Mines site exceed the pathway exemption and therefore are subject to the requirements of this rule. For such disposal, a site is not suitable if it is located in: an area subject to surface water erosion over the projected life of the facility considering historical erosion, ancient shorelines, stream beds and cutting due to floods; a 500-year floodplain of a river, stream or creek considering potential erosion effects; an active fault zone; an area of ancient, recent or active mass movement; an area subject to volcanic damage.

The selected remedy will also comply with the following ARARs:

Federal Endangered Species Act of 1973 (16 USC 1531 et seq., 50 CFR Part 200, 402). This regulation is applicable to any action authorized, funded, or carried out by any Federal agency that could jeopardize the continued existence of any listed species or result in the destruction or adverse modification of habitat of such species. The listed and proposed endangered and threatened species that may occur within the area of the Mines site is the bald eagle, Canada Lynx, and Modoc Sucker. A biological evaluation completed by the Forest Service on 6/15/01 determined no impact or environmental effects from the project on habitat, individuals, a population, or listed or sensitive Therefore EPA has determined the implementation of the selected remedy is not likely to affect the listed species or their designated critical habitat.

Oregon Revised Statute (ORS) Chapter 469.375. (Required Findings for Radioactive Waste Disposal Facility). Under this statutory provision, the Oregon Energy Facility Siting Council (EFSC) shall not issue a site certificate for a waste disposal facility for uranium mine overburden unless certain findings are made. Although a site certificate issued by the EFSC is not required at this site pursuant to CERCLA Section 121(e)(1), portions of this requirement are relevant and appropriate. The remedial action will comply with this requirement by not locating the mine waste repository in an area determined to be potentially subject to river or creek erosion within the lifetime of the facility.

Oregon Administrative Rules (OAR) Chapter 345, Division 50 (Radioactive Waste Materials), Section 60 (Site Suitability). These rules are applicable and govern disposal of radioactive material, including uranium mine overburden. For such disposal, a site is not suitable if it is located in: an area subject to surface water erosion over the projected life of the facility considering historical erosion, ancient shorelines, stream beds and cutting due to floods; a 500-year floodplain of a river, stream or creek considering potential erosion effects; an active fault zone; an area of ancient, recent or active mass movement; an area subject to volcanic damage. The remedial action will satisfy this requirement because the mine waste repository will not be located in any of these areas. The rules also include a pathway exemption set forth in OAR 345-050-0035, which exempts certain material from the rules however, the Oregon Office of Energy, the agency charged with administering these laws, determined that the concentrations of radioactive material in the stockpiles at the White King mine exceed the gamma pathway set forth in OAR 3450-50-0035. OOE made this determination based on radium-226 concentrations sampled in the stockpiles (OOE=s June 21, 2000 letter sets forth the reports of sampling data). OOE compared these concentrations to levels seen at other sites, and concluded that gamma radiation at the White King overburden and protore stockpiles would result in exposures exceeding 500 millirem per year. Because the exemption does not apply, the remedy will comply with these requirements.

Water Pollution Control Laws (ORS Chapter 468B) and Oregon Stormwater Standards (ORS Chapter 468B.025). Although the administrative permitting requirements of this provision are not applicable to the Mines site, the substantive stormwater protection requirements are relevant and appropriate. The 468 requirements address effluent standards, substantive permit requirements for discharges to U.S. waters, and minimum Federal water quality criteria. The remedy will meet these requirements by consolidating the stockpiles with a cover and native vegetation, and treatment of the White King pond water. Monitoring will be conducted on surface water to ensure the remedy meets these requirements. The 468B requirements address any construction activity that disturbs more than 5 acres. Although a permit is not required at the Mines site pursuant to CERCLA Section 121(e)(1), the substantive provisions of Oregon=s NPDES general permit 122-E will apply. The remedial action will meet these requirements through preparation of an erosion and sediment control plan during the design. This plan will use best management practices to prevent discharge of significant amounts of sediment to surface waters in order to comply with water quality standards in OAR 340-41.

Clean Air Act, 42 U.S.C. ' ' 7401 et seq., (CAA), National Ambient Air Quality Standards (NAAQS) 40 CFR. Part 50; Oregon implements the Federal Clean Air Act requirements and ambient air standards. These regulations are applicable for control of dust particles emitted into the air during remediation construction activities. The selected remedy will meet these requirements by using dust control measures while excavating the stockpiles.

Oregon Environmental Cleanup Law, Oregon Revised Statute (ORS) Chapter 465.315; OAR Chapter 340 Division 122 (Hazardous Substance Remedial Action Rules) . These rules are applicable for the establishment of cleanup levels and selection of remedial actions. OAR 340-122-040(2) requires that hazardous substance remedial actions achieve one of four standards: a)acceptable risk levels, b) generic soil numeric cleanup levels, c) remedy-specific cleanup levels provided by ODEQ as part of an approved generic remedy, or d) background levels in areas where hazardous substances occur naturally. The risk based and background levels are applicable to the Mines site.

OAR 340-122-115 defines the following maximum acceptable risk levels:

- $\quad 1 \times 10^{-6}$ for individual carcinogens
- $\quad 1 \times 10^{-5}$ for multiple carcinogens, and
- $\quad$ a Hazard Index of 1.0 for noncarcinogens

These acceptable risk levels were used as a basis to establish soil remedial goals for the Mines site, taking into account the current and reasonably likely future land use, as presented in Section 6. These remedial goals are applicable to soil at the Mines site where COC concentrations in soil exceed the remedial goals and background and will be achieved through a combination of soil hot spot removal, consolidation and covering, and institutional controls.

OAR 340-122-085(7) requires that, for hot spots of contamination in media other than ground water or surface water, the feasibility of treatment be evaluated. This evaluation is discussed further in Section 11.

Further assessment of the White King pond will determine the effects of arsenic on aquatic invertebrates. Additional action, if determined to be necessary, to address unacceptable risk levels in the aquatic environment will be documented in an ESD or ROD amendment.

OAR Chapter 345, Division 92 (Standards for the Siting of Uranium Mills), Section 31(1) (Standards Relating to Public Health and Safety of Uranium Mill Operation, Decommissioning and Waste Disposal). This regulation establishes standards that applicants must meet to obtain a site certificate for uranium mills and related and supporting facilities, which includes any site for the permanent disposal of mine overburden. This regulation is not applicable to the remedial action because it applies to an application to prospectively construct and operate a uranium mill and supporting facilities. However, this regulation is relevant and appropriate because it establishes allowable radiation equivalent criteria for any member of the public, criteria for release of airborne effluents and protection criteria for population doses. The remedy will meet these requirements by covering the stockpiles and reducing radiation exposures to below the levels established under these requirements (25 millirems to whole body, 75 millirems to thyroid, etc).

OAR Chapter 345, Division 95 (Construction, Operation and Decommissioning Rules for Uranium Mills), Section 90 (Public Health Impacts). This regulation applies to uranium mills and related and supporting facilities operated pursuant to a site certificate agreement. It is relevant and appropriate because it establishes allowable radiation equivalent criteria for any member of the public, criteria for release of airborne effluents and protection criteria for population doses. The remedy will meet these requirements by covering the stockpiles and reducing overall radiation exposures.

36 CFR Part 228 (Minerals), Section 8. These regulations are intended to minimize adverse environmental impacts on National Forest Service System surface resources in connection with operations authorized by Federal mining. In addition to requiring compliance with applicable air quality, water quality, and solid waste standards, this section requires that operators, to the extent practicable, harmonize operations with scenic values through construction of structures which blend with the landscape, take all practicable measures to maintain and protect fisheries and wildlife habitat that may be affected by operations, construct and maintain all roads to assure adequate drainage and minimize damage to soil, water and other resource values, and reclaim the surface disturbed in operations by controlling erosion, landslides, and water runoff, isolating, removing or controlling toxic materials, reshaping and revegetation of disturbed areas where reasonably practicable, and rehabilitating fisheries and wildlife habitat. This section is relevant and appropriate to the remedial action at the Mines site. The selected remedy will meet these requirements by excavating and consolidating stockpiles to blend with the natural contours at the Mines site. Placement of a soil cover and establishment of vegetation on the stockpiles will also prevent erosion and reduce infiltration which will protect Augur Creek and its associated wetland habitat. Neutralization of the White King pond may allow the establishment of a diverse aquatic community which will enhance and protect this habitat.

Oregon Administrative Rules, Chapter 345, Division 95 (Oregon Construction, Operation and Decommissioning Rules for Uranium Mills) Section 118 (Mine Reclamation). Because this regulation applies to uranium mills and related and supporting facilities operated pursuant to a site certificate agreement, it is not applicable to the remedial action. However, it is relevant and appropriate because it requires that a mine site be reclaimed by modifying overburden and waste dump slopes to grades favorable to reclamation, implementing surface water management measures to prevent water collection or erosion in the area and to aid in revegetation of the site.

Oregon Administrative Rules, Chapter 632, Division 30 (Oregon Mined Land Reclamation Action) Section 27 (Minimum Standards for a Reclamation Plan). These rules prescribe procedures for obtaining an operating permit and complying with other requirements of the Oregon Mined Land Reclamation Act. Although a permit is not required at the Mines site pursuant to CERCLA 121(e)(1), portions of the substantive requirements are relevant and appropriate. A reclamation plan is not required to be submitted, although the remedial design will address certain minimum standards of a reclamation plan.

Migratory Bird Treaty Act (16 USC 703 et seq.). The Migratory Bird Treaty Act makes it unlawful to Ahunt, take, capture, kill@ or take various other actions adversely affecting a broad range of migratory birds, including mallards, ravens, juncos, nuthatchs, chickadees, and sandhill cranes (see 50 CFR 10.13) for a list of protected migratory birds) without prior approval by the Department of the Interior. This statute and implementing regulations are relevant and appropriate for protecting migratory bird species identified at the Mines site. The selected remedies will be carried out in a manner that avoids taking or killing of protected migratory bird species, including individual birds or their nests.

Other Criteria, Advisories, or Guidance To-Be-Considered (TBCs) for this remedial action

Additional policies, guidance, and other laws and regulations considered in the selection of the remedy, or which impact the remedy include the following:

Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, 40 C.F.R '192, Authority: Sec. 275 of the Atomic Energy Act of 1954, 42 U.S.C. '2022, as added by the Uranium Mill Tailings Radiation Control Act of 1978, Pub. L. 95-604, as amended.). This rule provides general design standards for cleanup and disposal of uranium tailings from inactive uranium processing sites as well as regulations to correct and prevent contamination of ground water from these sites. Because mine wastes are radiologically and geochemically similar to tailings, this standard is Ato be considered@ in design of the mine waste repository and soil cover.

International Atomic Energy Agency (IAEA) Guidelines (Technical Report Series No. 335). This document provides current practices used in design, siting, construction, and closeout of impoundment facilities for uranium mill tailings. Because the Mines site does not contain mill tailings, these guidelines are not directly applicable to the selected remedy. However, given the similarity between the wastes at the Mines site and those discussed in these guidelines and the similar goals they are Ato be considered@ in the design of the mine waste repository and soil cover.

The EPA action level of 4.0 pCi/l of indoor radon is commonly recognized by Federal (and ODEQ) agencies as an upper limit on radon exposure in the home. This is equivalent to 0.02 WL (Lung Cancer Risk from Indoor Exposures to Radon Daughters, Internal Commission on Radiological Protection (ICRP) Publication 50, 1987, Pergamon Press, Oxford). The selected remedy will meet these levels by covering the stockpiles and preventing future residential use of the Mines site. Post construction monitoring of the mine waste repository will be conducted to confirm compliance with these levels.

U.S. Water Quality Criteria, 1986

The water quality criteria are standards for ambient surface water quality. These criteria present guidance on the environmental effects of pollutants that can be a useful reference in environmental monitoring. These criteria are Ato be considered@ in monitoring surface water at the Mines site and evaluating remediation levels.

13.3 COST-EFFECTIVENESS

The selected remedy is determined to be cost-effective. In making this determination, the following definition set forth in the NCP was used: AA remedy shall be cost-effective if its costs are proportional to its overall effectiveness.@ (40 CFR '300.430(f)(1)(ii)(D)). This was accomplished by evaluating the Aoverall effectiveness@ of those alternatives that satisfied the threshold criteria (*i.e.*, were both protective of human health and the environment and ARAR-compliant). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness). Overall effectiveness was then compared to costs to determine cost-effectiveness. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs and hence this alternative represents a reasonable value for the money to be spent.

The estimated present worth cost of the selected remedy is as follows:

Alternative SP-3b (stockpiles): $6, 625,376
Alternative LL-3 (Lucky Lass): $535,000
Alternative WKPW-3 (White King Pond): $740,000

13.4 UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES (OR RESOURCE RECOVERY TECHNOLOGIES) TO THE MAXIMUM EXTENT PRACTICABLE

The selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the Mines site. Of those alternatives that are protective of human health and the environment and comply with ARARs, the selected remedy provides the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element and bias against off-site treatment and disposal and considering State and community acceptance.

13.5 PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

The selected remedy utilizes alternative treatment (or resource recovery) technologies to the maximum extent practicable for this site. The remedy for the White King Pond, in-situ neutralization, satisfies the statutory preference for treatment as a principal element of the remedy. Neutralization of the pond water increases the pH and reduces the concentration of COCs in the surface water. Treatment of the remaining threats, stockpile soils, was not found to be practicable due to the large volume.

13.6 FIVE-YEAR REVIEW REQUIREMENTS

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

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SECTION 14

DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plan was released for public comment in October 1999. It identified Alternative SP-3b as the preferred alternative for the White King stockpiles which included recontouring of the protore stockpile, consolidation with the overburden stockpile, a 24-inch rock/soil cover, and a 20-foot setback from Augur Creek (excavation of 33,000 cubic yards). Comment was received from OOE indicating that Alternative SP-3b would not comply with State of Oregon requirements because the mine waste repository would still be within the Augur Creek floodplain.

In order to meet the State requirements Alternative SP-3b was modified as discussed in Section 9.3.1.3. This change requires movement of approximately 138,000 cubic yards of the protore stockpile from the Augur Creek floodplain. While this is a larger volume of material than was originally described in the FS for this alternative, this action serves the same purpose, to prevent erosion, and therefore could have been reasonably anticipated based on the information in the Proposed Plan.

The preferred alternative also identified a 12-inch rock bio-barrier covered by a 12-inch soil cover for the White King mine waste repository. After the public comment period, EPA sought additional input on the cover design from the U.S. Army Corps of Engineers (COE) and other technical experts within EPA. The COE and others commented that the 12-inch soil layer, underlain by a 6 or 12-inch bio-barrier (cobbles) may not perform as intended and may effectively prevent plant root penetration and the establishment of vegetation on the soil cover. The 12-inch rock layer would also cause the cover soil to dry out very quickly (from above and below) leaving inadequate moisture for good vegetation. A poor stand of vegetation could lead to a higher long-term erosion rates of the 12-inch soil cover. In addition it was felt that 12 inches of soil alone is too thin to provide protection against large rainfall events and that 24 inches of soil would provide additional protection from long-term erosion. Based upon this input, EPA changed the soil cover design from 24 inches of rock/soil to 24 inches of soil. While this design does not eliminate potential biointrusion of the burrowing animal species present at the Mines site (mice and shrews), it will allow for establishment of vegetation and protection from erosion. EPA felt that establishment of vegetation outweighed the potential impact from burrowing animals, which can be easily addressed through annual maintenance. This change also could have been reasonably anticipated based on the information in the Proposed Plan.

Cost Calculations

The cost estimates presented in the FS and the Proposed Plan included a 25% allowance for contingencies. After the public comment period EPA re-evaluated the FS cost estimates. Typically the contingency percentage is included to cover costs for unforseen construction conditions as well as costs for incomplete designs during construction. While it is possible for total percentage contingencies to reach 35% on some projects, this usually happens at projects with complex treatment trains utilizing a number of treatment technologies. At the Mines site EPA believes that there are few unknowns that would complicate the implementation of the stockpile remedy. The material to be excavated is easily identified and the volumes are known. There are no complex treatment processes or specific difficulty in handling the material. Therefore, EPA believes that it is more appropriate to use a 10% figure for contingency to estimate the costs of the stockpile alternative SP-3b which is reflected in **Table 11-1.** While it was also felt that the construction management costs were higher than what is typically used, these values were not changed. There have been no changes made in the costs associated with the selected alternative for the White King pond or Lucky Lass stockpile.

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