5.0 IDENTIFICATION OF REMOVAL ACTION ALTERNATIVES

This section identifies the removal action alternatives for each source area and summarizes the process by which the alternatives were developed.

Consistent with EECA guidance, selection of a limited number of practical alternatives is based on the RAGs (Section 2.0) and the environmental conditions to be addressed (Section 3.0). There is a large information base of technologies applied to control metals release from historical mining and milling sites under Superfund. Considerable information on specific options to control selenium releases to the environment has also been developed for the southeast Idaho phosphate mines. As described in Section 4.0 and Appendix B, a comprehensive menu of remedies related to typical mining features, literature on testing of treatment technologies, and phosphate mining district BMPs were considered during the identification of the removal action alternatives.

Section 5.1 provides a review of the technologies and approaches that have been further considered based on specific conditions at the Site. The technologies identified for consideration are assembled into removal action alternatives for each source area in Section 5.2.

5.1 Review of Technologies

This section uses the information provided in previous sections to identify and preliminarily evaluate primary technologies to be used in the development of the removal action alternatives. The discussion is structured by the technology types evaluated for specific conditions at the Site (e.g., water treatment). Fundamental considerations regarding the selection of remedial technologies for alternative development are presented. The implementability, effectiveness and cost of the remedial technologies are evaluated individually in Section 6.0 and in a comparative fashion in Section 7.0.

5.1.1 Source Removal

Removal of source materials is a general option for addressing the ongoing releases that can be associated with mining wastes. Two factors are key in the implementability and effectiveness of removals: the volume of source material; and suitable disposal locations.

Removal of source materials is a viable option for mining features at the Site that are of relatively small volume; such as sediments in stormwater detention basins or in ponds downgradient of seeps. These materials could be consolidated with other mining features. The implementability of disposal options would depend on the timing relative to active mining

operations. If active mining is occurring, then excavated materials could be used as backfill in pits, or included in external ODAs to be covered as required by the mine plan. Materials could also be placed in the tailings pond to be covered during reclamation, depending upon the schedule for closure.

Complete source removal is not a viable option for pit backfill and external ODAs. The material volume is large (millions to tens of millions of cubic yards) and no suitable location exists for disposal. Also, the resultant disposal area would have similar environmental conditions and issues as for the current pit backfill and ODAs. Pole Canyon ODA is in a unique physical setting because it fills a valley with an active creek. However , relocation of over 25 million cubic yards of material in the Pole Canyon ODA would not be feasible without great additional disturbance to the area and would have similar overall effectiveness to other, more straightforward source control actions (discussed below).

Source removal and relocation on-site is retained as an option for small-volume mine features (e.g., detention basin sediments and lower Pole Canyon Creek sediments).

5.1.2 Surface Water Management

Surface water management techniques are commonly used as a component of source control technologies for remediation of mining wastes. As discussed above, there is a comprehensive set of controls for the development of phosphate mining sites in southeast Idaho, including the management of water to reduce infiltration through overburden, thus reducing releases of selenium to the environment. Some of the surface water management controls that have been developed are described below.

Diversion Ditches – A diversion ditch is constructed to divert an influx of surface water (Montgomery Watson, 2000). It can be used to divert “clean water” from undisturbed areas around a mine disturbance area, or to route flow from a particular portion of the disturbance area around a particular facility or to a control structure. Diversions can also be used in conjunction with stream alterations to divert creeks away from mine areas. At the Site, diversion ditches would be effective upgradient of certain backfilled pits and external ODAs to reduce clean surface water run-on from the adjacent slopes by diverting it into existing creeks. This option is retained for the development of removal action alternatives.

Stream Alteration – Altering a stream refers to obstructing, diminishing, modifying, or otherwise relocating the natural existing shape or direction of flow of any stream channel within or below the mean high watermark. Stream alteration or diversion should be considered when natural flow needs to be diverted away from a mine pit, overburden pile, sedimentation pond, or other mine facility (Montgomery Watson, 2000).

At the Site, diversion of most of the Pole Canyon Creek flow around the Pole Canyon ODA, and infiltration of the remaining flow into the Wells Formation upstream of the ODA are potentially implementable stream alteration options. Because the elevation of the ODA surface is above the point where the creek enters the ODA, it is not possible to divert flow from the entire upgradient watershed around the ODA. Based on an evaluation of the existing topography and assuming a 1 percent slope on the diversion to maintain flow, it appears viable to divert the creek to either the south or the north along the side of the canyon wall (see Figure 5-5). This option is retained for the development of removal action alternatives.

Another stream alteration option is to convey Pole Canyon Creek through the ODA via a pipe. One technology that was evaluated initially was tunneling though the ODA from the point of creek entry to the toe, and installing a pipe or lined culvert to convey creek water through the ODA without contacting overburden material. Review with a company that develops tunneling designs and tunneling technologies indicated that this type of remedial option would be difficult to implement for the Pole Canyon ODA. The primary factor controlling implementability and effectiveness is the heterogeneous and relatively unconsolidated nature of the overburden (particularly the presence of large-size chert materials). Even if the pipe could be installed successfully, the potential for failure over the long term could be high, again due to the unconsolidated material and the differences in settling forces along the length of the pipe. In addition, external access for maintenance/repair would be precluded. Given the difficult implementation and uncertain effectiveness, this option is screened out from further consideration in the EECA.

5.1.3 Surface Modification/Capping and Cover

Surface modification refers to actions on source areas that either provide a physical barrier to prevent contact with materials of concern or modify surface conditions to address environmental concerns (such as reducing water infiltration). These actions are applicable to large surface areas such as the surface of the ODAs. These actions can be used alone or in conjunction with the surface water management technologies discussed above. Some of the surface modification actions that have been developed are described below.

Capping – There are a variety of capping techniques that are available for reclamation of overburden. Capping systems can be very simple or complex, consist of one or multiple layers, and can be designed with natural or synthetic materials (Montgomery Watson, 2000). Examples include soil cover, geomembrane, geosynthetic clay liner (GCL), or Site materials such as fragments of chert, Dinwoody, and/or Salt Lake formation. Capping technologies are retained for alternative development.

Vegetative Cover – Vegetation is a standard surface reclamation technique for backfilled pits and external ODAs. As well as stabilizing surface materials, having a well vegetated cover increases evapotranspiration at the surface and reduces water infiltration into overburden and subsequent release of selenium (see Appendix D). In addition, over time the vegetation will help build up the organic material at the surface which will help remove oxygen from infiltrating water, further reducing the potential for release of selenium from underlying overburden material. This option is retained for development of removal action alternatives with the use of native plant species that have low affinity for selenium uptake.

Covering – Covering can prevent direct contact in situations where source materials are present at the surface. Relevant situations at the Site include A Panel External ODA and Pole Canyon ODA where surface material is run-of-mine, and at stormwater detention ponds and ponds downgradient of seeps where water and sediments can have selenium above removal action levels. For ODAs, a soil cover could provide a physical barrier between the vegetation root zone and the shale, thus reducing selenium uptake by the plants. This option is retained for further consideration for ODAs.

Chert barriers are used as a BMP in current mining, but this is primarily feasible because sufficient chert is generated by active mining. For large historical mining features it may be possible to find sufficient chert from a separate Site borrow source, depending on the volume of material required. Simplot has recently implemented a pilot study at detention pond DP-10 and seep ES-5 to investigate the effectiveness of covering small areas that have surface water features posing exposure concerns with chert. The details of the pilot studies were provided in the respective work plans (NewFields, 2004a and 2004b). Covering with chert is expected to be an effective method of preventing direct contact with water, sediment, and associated vegetation in seep flow areas. It would be implemented in conjunction with source controls to reduce or eliminate seep flow. This action is applicable to other seep areas and associated detention basins at the Site and is retained for further consideration for relatively small mining features such as seeps or detention basins and for larger features such as covering of external ODAs, assuming a source can be found at the Site.

Treatment of water infiltrating into overburden has been tested at the Site and found to be effective in reducing selenium concentrations in pore water (see Section 4). Modification of surface chemistry conditions with zero-valent iron and organic materials to treat infiltrating waters that contribute to seepage within the overburden is retained for further consideration in conjunction with overburden cover options.

Soil Amendment and Fertilization – The use of soil amendments and fertilizers, when used in combination with proper seedbed preparation, topsoiling, planting methods, selection of species, and moisture, may greatly enhance the chance of revegetation success. Fertilizers add nutrients to the soil which encourage plant establishment, speed up plant growth, and maintain plant productivity. On overburden shales, fertilizer will speed up the production of biomass, which will provide long-term nutrients that enhance vegetative growth. Amendment with organic compost has been tested on tailings from the mine's tailings ponds and found to be effective in reducing plant uptake of selenium (NewFields and Redente, 2005). This option is retained for development of removal action alternatives.

Species Modification – Modifying the vegetation to reduce the proportion of selenium-accumulator species would help reduce the average selenium content in vegetation. Higher concentrations of selenium in forage samples collected from the Site may have been due to the presence of alfalfa and/or yellow sweetclover in the samples, species that are known to be secondary accumulators of selenium (Kabata-Pendias, 2001). Reducing or eliminating the presence of selenium-accumulator species and replacement with low level selenium-accumulator species is retained for development of removal action alternatives.

5.1.4 Institutional/Access Controls

Institutional and access controls can be an effective method of preventing contact with materials that pose a risk (for example, vegetated areas that have selenium concentrations above applicable guidelines or seep areas from external ODAs) and preserving the physical integrity of the response actions. Existing USFS institutional controls would limit vehicle traffic to designated roadways and trails at the time of mine closure. Some of the other institutional/action controls that have been successfully developed are described below:

Range Management – The USFS has grazing management plans in place for the grazing allotments in and around the Site (see Appendix A). These are tools used by the land managers to protect water quality, forage, and beneficial use. Traditionally, grazing control is the practice of managing forage harvest levels by cows, horses and sheep, so that the plant cover and community composition are maintained and erosion and sedimentation are not accelerated. Grazing controls must continue as a BMP at reclaimed mine facilities (Montgomery Watson, 2000). The practice can also be implemented to limit where, when, and for how long livestock graze reclaimed mine facilities. Controlling domestic livestock grazing would help to reduce the potential for unacceptable exposure and is retained for further consideration as an interim measure for the Site.

Fencing – Fencing can be used to prevent access to certain small features that pose a risk, such as seep areas, but is not applicable to large areas such as backfilled pits and ODAs. It is retained for further consideration as an interim measure while other actions become effective.

Alternative Water Supply – The purpose of this practice is to provide water sources to domestic livestock and wildlife that are impacted by mining activities. It could be appropriate for lower Pole Canyon Creek, if the removal action reduces or eliminates the flow into Sage Valley. In this event groundwater extraction could be implemented to provide an alternative source of irrigation water. This option is retained for further consideration.

Habitat Management – Like soil, water and vegetation, wildlife is a resource that must be protected from undue impacts of mining (Montgomery Watson, 2000). While wildlife control can be difficult, there are certain practices that can be applied to reduce the potential for exposure. In particular, modifying vegetation can change the species that will forage on reclaimed areas (see above). This option is retained for further consideration in the development of removal action alternatives.

Deed Restrictions, Covenants, Environmental Easements, Land Use Ordinances or Administrative Rule-Making – DEQ (2004) recommends precautionary measures to prohibit residential development of any phosphate mining waste units or impacted areas that may present potential public health risks in the future. This option is retained for further consideration.

5.1.5 Groundwater Capture/Control

Groundwater downgradient of some ODAs contains selenium above standards. Installation of groundwater extraction wells to intercept the groundwater for treatment (i.e., pump and treat) is not readily implementable or cost effective due to the complex hydrogeology and high flow rate of groundwater that would need to be captured. The source control options described above and surface water treatment options described below provide a more practical and long-term effective approach and therefore this option is not considered further.

5.1.6 Water Treatment

Beyond specific implementability and effectiveness issues associated with a treatment technology, the feasibility of treating impacted waters at the Site is primarily driven by the large volume of water that would potentially need to be treated (e.g., Pole Canyon Creek and Hoopes Spring), and the seasonal order of magnitude fluctuations in flow (e.g., Pole Canyon Creek and the Pole Canyon Creek shallow alluvial groundwater system). Given these fundamental feasibility concerns, as well as specific implementability concerns, water treatment is generally a less desirable alternative to source control measures to reduce the volume and concentration of impacted Site waters. However, large-scale water treatment is appropriate for consideration and is most suitable as a contingent measure if source control measures are not effective. As discussed in Section 4, there are some data available in the literature and results of Site-specific testing that support general concepts for removal of selenium. In particular, biological reduction

technologies, possibly with addition of zero-valent iron, appear to have the greatest promise. This technology could be implemented in a conventional-type facility to treat surface water, or as an in-situ treatment scheme for Pole Canyon creek flows exiting the overburden.

If large areas are available and winter temperature effects can be overcome, then it is possible that this technology could be implemented in a passive, wetlands-type system, although removal efficiencies may be reduced by low temperatures during winter months. COC concentrations in the effluent from the passive wetland system during the cold low flow winter months would be relatively higher than during the optimum spring/summer due to lower metabolic rates and dormant vegetation. There are additional factors that will influence effluent COC concentrations such as retention time, ice cover, concentrations of competing electron acceptors, etc. which are highly site specific and season specific. If the passive technology is unable to meet discharge standards, other technologies such as precipitation, extraction, and filtration may also be considered. In any event, detailed treatability testing would be required to evaluate the effectiveness of different technologies and process options on various Site waters in order to select the most cost-effective approach.

Creek water flowing from the toe of the Pole Canyon ODA has selenium levels above the water quality standard. A possible option that was initially evaluated was ex-situ treatment of all creek flow downgradient of the ODA. This would be difficult to implement for several reasons. The primary reason is that the flow varies significantly with season and treatment plants typically require relatively uniform flow rates and influent water quality. Operation of a conventional treatment plant to remove selenium down to the relatively low concentration to achieve the water quality standard in highly variable flows would not be feasible. There is no location to detain the water to reduce the flow variability. A treatment plant could not be implemented to treat large flows over short time frames, with extended periods of little or no flow. In addition, the setting at the toe of the ODA is remote; a treatment plant would require extensive infrastructure, including power and year-round access for workers and material transport. This option was therefore screened out from further consideration in favor of source control options. However, in-situ treatment of Pole Creek flow has been tested at the Site by infiltrating organic material (whey) and iron into the creek flow from a trench cut into the ODA near the toe (see Appendix B). This type of treatment system is retained for consideration in the development of removal action alternatives.

In-situ treatment of deep groundwater could not be implemented primarily due to the physical setting. The depth to groundwater and the large groundwater flow rates of the Wells Formation make installation of any kind of physical treatment infeasible. Introduction of treatment additives at the source area would be problematic because of the large size of the source areas, interference with surface reclamation activities and uncertainties concerning groundwater flow paths. Stand-alone actions (such as permeable barrier treatment) of alluvial groundwater downgradient of Pole Canyon ODA would be difficult during the spring runoff when water levels

and flows are high. Treatment of alluvial groundwater would be potentially viable if surface water control actions on the ODA reduce flow and moderate conditions in the aquifer.

Treatment of seep water has been shown to be effective (see Section 4) using organic substrate and iron filings. Testing performed at the Site indicated that infiltration through an organic substrate in a trench at the toe of Pole Canyon ODA reduced selenium concentrations in the creek water exiting the ODA (in-situ treatment). It may also be effective to add organic substrate to the inflow of Pole Canyon Creek to the ODA, although this has not been tested at the Site. These options are retained for further consideration.

5.2 Description of Removal Action Alternatives

This section provides a description of the source area removal action alternatives developed for evaluation in the EECA. The alternatives are logical combinations of the technologies that were discussed in the previous section to address the specific conditions identified at the Site. The alternatives are described for each source area in Sections 5.2.1 through 5.2.5. Specific assumptions regarding material types and quantities are provided for costing purposes. Final determinations would be made in the design phase.

5.2.1 A Panel Backfilled Pits and External ODA

This subsection provides a description of the removal action alternatives developed for the A Panel external ODA. Concerns to be addressed for the A Panel external ODA include infiltration and leaching of selenium. Seep AS-2 has a small seasonal flow with elevated selenium concentrations. The presence of selenium-accumulator species (e.g., alfalfa) on the A Panel external ODA results in selenium concentrations in vegetation above the BLM/USFS guidelines. No additional actions are considered for the surface of the backfilled pit, which is being closed and reclaimed per the mine plan. A summary of removal action alternatives for the A Panel is shown on Table 5-2.

5.2.1.1 Alternative 1 (No Action)

The A Panel pits are currently being backfilled with overburden from the B and C Panels and reclaimed (including the previously backfilled portion) under the current mine plan. The overburden will be covered with an eight-foot-thick layer of low selenium content run-of-mine (ROM) chert. The chert will then be covered with a two-foot-layer of revegetated topsoil. The cover also includes runoff recharge areas that will collect clean runoff from the surface for infiltration into the Wells formation. Under Alternative 1 it is anticipated that this work would be completed. No additional actions would be implemented for the A Panel pits or the A Panel external ODA under this alternative.

5.2.1.2 Alternative 2

Alternative 2 provides a range of actions to address A Panel conditions with a focus on reducing overburden infiltration and plant uptake of selenium (Table 5-2).

External ODA Soil Cover

Under Alternative 2, the A Panel external ODA (approximately 80 acres) would receive a 2 foot-thick topsoil cover. The topsoil would be applied over the entire area of the ODA and then fertilized and seeded using a seed mix that has a low potential for selenium uptake (Table 5-1).

Surface Water Run-on Controls

The A Panel external ODA has low potential for run-on. Only limited surface water from adjacent areas can currently run onto the north side of the A Panel external ODA. Minor regrading would be incorporated into the soil cover design to route run-on around this portion of the external ODA and to direct water off the surface (Figure 5-1). Haul roads with seleniferous shales at the surface would also be covered after they were no longer needed for mining activities.

Covering of Stormwater Detention Basin Sediments

There are seven stormwater detention basins located on or around the A Panel backfilled pits and the A Panel External ODA that have sediment COPC levels above the RAGs (AP-1, AP-3, AP-4, AP-5, AP-6, AP-7, and AP-9A; see Figure 5-2). Under this alternative, the basins, totaling approximately 1 acre in surface area, would be left in place until reclamation and removal actions on upgradient mine features are effective. Sediments would then be covered in place with a minimum of two feet of ROM chert fragments in the 4-inch to 2-foot size range.

Contingency Seep Treatment/Sediment Removal

Under Alternative 2, the current small seasonal flow at seep AS-2 would be expected to dry up due to the installation of a vegetated soil cover and run-on controls. In the event that the seep continues to flow, it would be treated. The treatment would consist of a subsurface bioreactor loaded with plastic media to support microbial growth and zero-valent iron (i.e., powdered iron metal) to sustain a reducing condition. The bioreactor would be routinely dosed with a carbon amendment for microbial growth. This technology has been tested at the Site and was found to be effective at a pilot scale (see Section 4). If treatment is necessary, the treated flows will be monitored quarterly for COPCs to assess treatment effectiveness and to identify whether additional treatment steps are needed.

Once the seep dried up, or seep treatment was implemented, sediment with COC concentrations above RAGs (approximately 100 cubic yards) would be removed from the downgradient seep collection pond AP-2. The sediment would be relocated on-Site, either into an area being actively backfilled as part of mining operations or on the tailings pond to be covered during final reclamation. The excavated sediments would not be placed in a lined repository. The volume of the sediments is considered to be too small to necessitate a liner as COPC levels in the excavated sediments are anticipated to be similar to COPC levels in tailings and overburden.

Interim Actions/Monitoring

Post-removal action construction monitoring would be performed under this alternative. The seep flow and water quality would be monitored after the soil cover was installed. A fence would be installed to prevent livestock gaining access to the seep flow area in the interim.

5.2.1.3 Alternative 3

Alternative 3 incorporates several actions to address A Panel conditions. The main focus is on reducing the quantity and modifying the chemistry of infiltration at the external ODA. The primary distinction between Alternative 2 and Alternative 3 is the inclusion of surface amendment instead of a soil cover (Table 5-2).

External ODA Surface Amendment/Revegetation

Under Alternative 3, an organic surface amendment (such as composted manure or biosolids) would be applied to the A Panel external ODA at a rate of 40 dry tons per acre. The amendment would be mixed to a depth of one foot using a chisel plow. Existing areas of selenium accumulators (e.g. alfalfa) would be sprayed with an herbicide prior to amendment. The external ODA would then be seeded using a reclamation seed mix that has a low potential for selenium uptake (Table 5-1). After re-seeding, additional efforts would be made, as needed, to minimize invasion of native selenium-accumulator species, such as aster and astragalus, until new vegetation is established.

Run-on Controls

Limited regrading may be necessary along the northern edge of the A Panel external ODA.

Removal of Stormwater Detention Basin Sediment

Under this alternative, stormwater detention basins AP-1, AP-3, AP-4, AP-5, AP-6, AP-7, and AP-9A would be left in place until reclamation of upgradient mine features is completed and

effective. At that time, sediment with COC concentrations above RAGs (approximately 1,800 cubic yards) would be excavated and relocated on-Site either into an area being actively backfilled as part of mining operations or on the tailings pond to be covered during final reclamation. The areas would then be seeded with a seed mix that has a low potential for selenium uptake.

Covering of Seep Flow Areas and Collection Ponds

For Alternative 3, any residual flow at seep AS-2 and its collection pond (AP-2) would be covered in place with a minimum of two feet of ROM chert. This is consistent with the pilot study work already completed at seep ES-5.

Interim Actions/Monitoring

Post-removal action construction monitoring would be performed under this alternative. Vegetation would initially be monitored and again at the time of 5-year review to verify that selenium levels in vegetation meet removal action goals. The seep flow would also be monitored as the cover vegetation matures. A fence would be installed to prevent livestock gaining access to the seep flow area in the interim. In addition, the AP-2 area would be visually monitored over the first few years after covering to confirm that the chert adequately covers the seep flow and the detention area is adequately covered.

5.2.1.4 Alternative 4

The primary distinction for Alternative 4 is the inclusion of a low-permeability cap (Table 5-2).

GCL Cap on External ODA

Under Alternative 4, the A Panel external ODA (approximately 80 acres) would be covered with a low-permeability engineered GCL cap. The cap would consist of four layers. The bottom layer would be a six-inch-thick cushion. The cushion layer would be comprised of a granular material free of large rocks or other debris that could damage the cap. The second layer would comprise the barrier. The barrier layer would be a Bentofix® GCL or equivalent. Overlying the GCL would be a one-foot-thick drainage layer. The drainage layer would be comprised of a high permeability material such as gravel. The top layer of the cap would be a 1.5-foot-thick vegetated soil cover (see Table 5-1 for seed mix). A 16-oz geotextile would be placed between the top vegetated layer and the underlying drainage layer (see Figure 5-3).

Run-on Controls

Limited regrading may be necessary along the northern edge of the A Panel external ODA to prevent potential erosion of the cover.

Removal of Stormwater Detention Basin Sediment

Sediments would be removed from stormwater detention basins AP-1, AP-3, AP-4, AP-5, AP-6, AP-7, and AP-9A consistent with the approach described under Alternative 3 (Section 5.2.1.3).

Interim Actions/Monitoring

It is anticipated that installation of the low-permeability cap under Alternative 4 would cause seep AS-2 to dry up. In the interim, a fence would be installed to prevent livestock gaining access to the seep flow area. Once the seep ceased to flow the sediment located in the former seep flow path and the seep detention basin AP-2 would be excavated and relocated on-Site (same as Alternative 2). The seep flow and water quality would be monitored after the cover was installed. A fence would be installed to prevent livestock gaining access to the seep flow area in the interim.

5.2.2 Pole Canyon ODA

The primary environmental issues to be addressed at the Pole Canyon ODA are the leaching of selenium to flow of Pole Canyon Creek through the base of the overburden backfill as well as infiltration originating as direct precipitation and run-on. A portion of the Pole Canyon Creek waters impacted by mixing with infiltration and direct contact with the overburden materials, recharge the shallow alluvial and Wells Formation aquifer. Resultant concentrations in Pole Canyon Creek and the underlying aquifers exceed their respective RAGs. In addition, the presence of selenium accumulator plant species (e.g., alfalfa) results in average plant tissue concentrations above the BLM/USFS guidelines. A summary of removal action alternatives for the Pole Canyon ODA is shown on Table 5-3.

5.2.2.1 Alternative 1 (No Action)

No action would be implemented under Alternative 1.

5.2.2.2 Alternative 2

Alternative 2 provides a range of actions to address Pole Canyon conditions with an emphasis on treatment and modification of overburden and infiltration chemistry (Table 5-3).

Cover/Surface Treatment System

Pole Canyon Creek would continue to flow into the ODA under Alternative 2. A cover/surface treatment would be installed on the surface of the Pole Canyon ODA (approximately 120 acres). The cover/surface treatment would be composed of three layers: a base layer approximately 1-inch-thick and comprised of zero-valent iron (e.g., granular iron or iron filings), overlain by three feet of ROM chert to provide a barrier to root penetration. A two-foot-layer of soil would be installed over the chert (see Figure 5-4). The cover/surface treatment would be seeded using a seed mix that has a low potential for selenium uptake (Table 5-1). Haul roads with seleniferous shales at the surface would also be covered after they were no longer needed for mining activities.

Stormwater Run-on Controls

A 4,800 foot run-on control ditch would be installed along the northern edge of the Pole Canyon ODA under this alternative to reduce run on from adjacent hillsides into the overburden (see Figure 5-1). This ditch would carry clean runoff along the edge of the ODA face, down to Pole Canyon Creek downstream of the ODA. In addition, a portion of the ODA just to the south of the point where the creek enters the ODA and a portion of the immediately adjacent D Panel backfilled area would be excavated and regraded to improve storm water runoff and reduce erosion (see Figure 5-1 for approximate area). Portions of the ODA surface may be regraded to promote controlled runoff and minimize the potential for ponding.

Covering of Stormwater Detention Basin Sediment

One stormwater detention basin (DP-14; see Figure 5-2), located near the toe of the Pole Canyon ODA, would be addressed under this alternative by covering with chert (less than 0.1 acre), as described above for A Panel (see Section 5.2.1.2).

In-Situ Treatment of Pole Canyon Creek Flow Prior to Exiting the ODA

Flow of lower Pole Canyon Creek would be treated prior to exiting the ODA. Two general options are available: addition of organics/iron at the inflow of the creek into the ODA or addition near the outflow using an infiltration trench. The latter option has been tested at the Site and found to be effective and is therefore used for evaluation in the EECA. However, if this alternative is ultimately selected, treatability/pilot testing of both options would be performed before implementation.

The treatment system evaluated in this EECA would consist of a trench cut into the overburden surface immediately above the creek flow path near the toe of the ODA (see Figure 5-4). The trench would be loaded with zero-valent iron (e.g., iron powder) and continuously dosed with a carbon amendment such as whey which would infiltrate through the overburden and into the

creek water to treat it prior to exiting the ODA. This system would be required to operate over the long term.

Lower Pole Canyon Creek Sediment Removal

Once the cover system for the Pole Canyon ODA and the treatment system for Lower Pole Canyon Creek have been effectively implemented, the sediments in lower Pole Canyon Creek with selenium concentrations above the RAG would be excavated and relocated on-Site.

Interim Actions/Monitoring

Post-removal action construction monitoring would be performed. Pole Canyon Creek flow and water quality would be monitored as part of the treatment system operation and alluvial and Wells Formation groundwater would be monitored downgradient of the ODA to assess the performance of the remedy. Vegetation would initially be monitored on the ODA and again at the 5-year review to verify that selenium levels in the vegetation meet removal action goals.

5.2.2.3 Alternative 3

Alternative 3 provides a range of actions with a focus on water management. A fundamental distinction from Alternative 2 is the management of Pole Canyon Creek flows and infiltration to minimize surface water movement and infiltration through the overburden (Table 5-3).

Infiltration/Diversion of Pole Canyon Creek

Under Alternative 3, Pole Canyon Creek flow into the ODA would be eliminated or significantly reduced by diverting creek flow around the ODA and by infiltrating flow into the Wells Formation upstream of the ODA. The amount of flow diverted around the ODA versus the amount infiltrated would depend on a number of factors including the achievable infiltration rate, the location of the diversion point, and water rights issues in Sage Valley. However, at a minimum, all flows in Pole Canyon Creek watershed downstream of the diversion point but above the ODA, would be infiltrated under most flow conditions. Supporting details are provided in Appendix C.

The diversion line would be a buried pipeline diverting the flow of Pole Canyon Creek far enough upstream of the ODA to allow it to gravity flow over the ODA. Assuming a 1 percent grade to maintain flow, review of existing topography indicates that the diversion point would be located approximately 5,500 feet upstream of the ODA crest. This is below the springs that provide perennial flow. A settling basin approximately 100 feet wide and 200 feet long with an interior berm (to lengthen the flow path) would be installed at the diversion point to remove sediment from the stream flow prior to entry into the diversion line. The pipeline could traverse

either the northern or southern slope of the canyon (see Figure 5-5). A 30-inch reinforced concrete pipe or corrugated (smooth interior wall) polyethylene pipe was selected to transport the conceptual design flow of 20 cfs. The total length of the diversion would be approximately 9,500 feet. The diversion would outfall to an energy dissipation structure in lower Pole Canyon Creek.

The infiltration basin would be located immediately upgradient of the ODA. A conceptual layout is shown in Figure 5-5. The creek surface flow would be infiltrated into the Wells Formation and pass under the ODA without contacting the overburden. The infiltration basin would be installed by strategically blasting down to the Grandeur Member of the Wells Formation with fracturing to increase infiltration rate. In order to capture creek flows downstream of the diversion, the infiltration basin would, at a minimum, need to infiltrate a flow of 2 cfs. The basin would have approximately 0.5 acres of contact area (i.e., pond bottom) with the Wells Formation, 2:1 side slopes, and a total depth of 20 feet. Upstream of the infiltration basin would be a settling basin approximately 200 feet long by 100 feet wide and 20 feet deep. This basin would remove sediment from the stream flow as well as provide additional storage during storm flows. Other water control features may be required within the watershed and creek to optimize the system operation. These would be identified during design.

Surface Amendment/Revegetation

After selective herbicide application, an organic surface amendment (such as composted manure or biosolids) would be applied to the Pole Canyon external ODA under Alternative 3. The amendment would be mixed to a depth of one foot using a chisel plow. The external ODA would then be seeded using a seed mix that has a low potential for selenium uptake (Table 5-1). After re-seeding, additional efforts would be made, as needed, to minimize invasion of native selenium-accumulator species, such as aster and astragalus, until new vegetation is established. Haul roads with seleniferous shales at the surface would also be covered after they were no longer needed for mining activities.

Stormwater Run-on Controls

Same as Alternative 2; see above.

Removal of Stormwater Detention Basin Sediment

Approximately 30 cubic yards of sediment with COC concentrations above RAGs from stormwater detention basin DP-14 (see Figure 5-2) would be addressed by sediment removal, as described above for A Panel. The sediment would be relocated on-Site.

Lower Pole Canyon Creek Sediment Removal

Once the water control actions have been effectively implemented, the sediments in lower Pole Canyon Creek with selenium concentrations above the RAG would be excavated and relocated on-Site.

Interim Actions/Monitoring

Post-removal action construction monitoring would be performed. Vegetation would be monitored on the ODA to verify that selenium levels in the vegetation meet the removal action goals. Pole Canyon Creek flow and water quality and alluvial and Wells Formation groundwater quality would also be monitored to assess performance of the remedy.

Potential Contingency Actions

Under this alternative, it is expected that Pole Canyon Creek flows emanating from the toe of the ODA would dry up once the water diversion and surface control actions become effective. If this is not the case, and the selenium concentration in the residual downstream creek flow is above the removal action goal, the seep flow area would be covered with chert, as described above. If monitoring indicates that the remedy is not meeting performance standards, a range of contingency actions could be implemented. Since the flow rate and water quality are unknown at this time, the actual contingency action would be selected based on future Site observations and monitoring data.

5.2.2.4 Alternative 4

Alternative 4 provides a range of actions, with the primary distinction from Alternative 3 being the addition of a low-permeability cap for the ODA (Table 5-3).

Infiltration/Diversion of Pole Canyon Creek

Under Alternative 4, Pole Canyon Creek flow into the ODA would be significantly reduced by diversion and/or infiltration, as described above for Alternative 3.

GCL Cap on Pole Canyon ODA

The ODA (including haul roads) would be covered with a low-permeability engineered GCL cap and revegetated (approximately 120 acres), as described above in Section 5.2.1.4 for the A Panel external ODA.

Stormwater Run-on Controls

A run-on control ditch would be installed along the northern edge of the Pole Canyon ODA to reduce flow of water from the adjacent hillsides into the overburden (same as Alternatives 2 and 3; see Figure 5-1).

Stormwater Detention Basin Sediment Removal

Sediments would be removed from stormwater detention basin DP-14, consistent with the approach described under Alternative 3 (Section 5.2.2.3). Sediments from Lower Pole Canyon Creek would be removed and relocated on-Site, as described in Section 5.2.2.2 for Alternative 2.

Monitoring

Pole Canyon Creek flow and water quality and alluvial and Wells Formation groundwater quality would be monitored to assess performance of the remedy.

5.2.3 D Panel Backfilled Pits and External ODA

The principal environmental condition to be addressed at the D Panel pit backfill and external ODA are a reduction in infiltration from run-on and direct precipitation and managing selenium concentrations in vegetation. A portion of the D Panel pit backfill is potentially subject to run-on from adjacent hillsides. Seeps DS-7 and DS-10 currently contain selenium concentrations above the RAG. Detention basin DP-10, which collects water in part from DS-10, has been covered with chert as a pilot study to reduce the exposure potential for wildlife and livestock. The presence of selenium-accumulator plant species on the north and east portions of the D Panel ODA result in the potential for livestock exposure to unacceptable selenium concentrations. The southernmost portion of the D Panel backfilled pit (approximately 100 acres) has already been reclaimed using a chert/topsoil cover (Figure 5-6). No additional action is proposed for this area in the removal action alternatives. Topsoil has also been applied to the northern portion of the backfilled pit and the external ODA. A summary of removal action alternatives for the D Panel is shown on Table 5-3.

5.2.3.1 Alternative 1 (No Action)

Under Alternative 1, reclamation actions performed under the mine plan would be allowed to mature. No additional action would be implemented.

5.2.3.2 Alternative 2

Alternative 2 provides a range of actions for the D Panel with a focus on reducing overburden infiltration and plant uptake. As with other action alternatives, it is assumed that reclamation required under the mine plan would be completed, as described above under Alternative 1 (Table 5-4).

ODA Soil Cover

Under Alternative 2, the northern portion of the backfilled pit (approximately 230 acres) and the external ODA (approximately 25 acres) would receive a 2 foot-thick topsoil cover (Figure 5-6). Topsoil has been placed in these areas. Additional soil would be added as necessary to achieve a 2 foot thick cover. The topsoil cover would be fertilized and seeded with a seed mix that has a low potential for selenium uptake (Table 5-1). Haul roads with seleniferous shales at the surface would also be covered after they were no longer needed for mining activities.

Stormwater Run-on Controls

A surface water run-on control ditch approximately 3,500 foot in length would be installed along the south side of the western edge of the backfilled pits under Alternative 2 (see Figure 5-7). A run-on control ditch already exists along the northern portion of the western side of the backfilled pits and would require no additional work. Only limited surface water from adjacent areas can currently run onto the north side of the D Panel external ODA. Limited regrading, including a small ditch, would be incorporated into the soil cover design for this portion of the external ODA. Runoff from a portion of the D Panel pit ODA may cross the haul road and enter the external ODA. The cover design and final grading will need to convey this water away from the external ODA. Therefore, some minor regrading/contouring may be necessary on the southeastern portion of the D Panel backfilled pits in conjunction with the soil cover.

Stormwater Detention Basin Covering

There are eleven stormwater detention basins, totaling approximately 1.1 acres, located on or around the D Panel backfilled pits and the D Panel external ODA that have sediment COPC concentrations above the RAGs (DP-1, DP-2, DP-3, DP-4, DP-5, DP-6, DP-8, DP-9, DP-11, DP-13 and DP-15; see Figure 5-8). These would remain in place until reclamation of upgradient mine features is completed and effective. At that time, the sediments would be covered in place with a minimum of two feet of ROM chert.

Contingency Seep Treatment/Sediment Removal

With time, flow at seeps DS-7 and DS-10 would be expected to be substantially reduced, due to the effect of improved water management and improved surface reclamation under Alternative

2. In the event that a seep continued to flow, it would be treated as described above for seep AS-2. Once the seep flow dissipated, or seep treatment was implemented, approximately 500 cubic yards of sediment would be removed from the downgradient seep collection pond (DP-7) and relocated on-Site.

Monitoring/Interim Actions

Post-removal action construction monitoring would entail flow and chemistry monitoring of the seeps. A fence would be installed to prevent livestock gaining access to the seep flow and pond area in the interim.

5.2.3.3 Alternative 3

Alternative 3 incorporates several actions to address D Panel conditions. The main focus is on reducing the quantity and modifying the chemistry of infiltration at the D Panel pit backfill and external ODA. The primary distinction between Alternative 2 and Alternative 3 is the inclusion of surface amendment instead of a soil cover (Table 5-4).

External ODA Surface Amendment/Revegetation

An organic surface amendment (such as composted manure or biosolids) would be applied at a rate of 40 dry tons per acre to the northern portion of the D Panel pit backfill (230 acres) and external ODA under Alternative 3. The amendment would be mixed to a depth of 12-inches using a chisel plow. The pit backfill and external ODA would then be seeded using a seed mix that has a low potential for selenium uptake (Table 5-1). After re-seeding, additional efforts would be made, as needed, to minimize invasion of native selenium-accumulator species, such as aster and astragalus, until new vegetation is established. Haul roads with seleniferous shales at the surface would also be covered and amended after they were no longer needed for mining activities.

Stormwater Run-on Controls

Same as for Alternative 2, see Section 5.2.3.2.

Stormwater Detention Basin Sediment Removal

Under Alternative 3, stormwater basins DP-1, DP-2, DP-3, DP-4, DP-5, DP-6, DP-8, DP-9, DP-11, DP-13 and DP-15 would be left in place until reclamation of upgradient mine features is completed and effective. At that time, the sediments (approximately 1,500 cy with COC concentrations above RAGs) would be excavated and relocated on-Site either into an area

being actively backfilled as part of mining operations or on the tailings pond to be covered by final reclamation.

Monitoring/Interim Actions

The seep flow and water quality would be monitored after the external ODA surface was amended and vegetation becomes established. A fence would be installed to prevent livestock gaining access to the seep flow area in the interim. If the seeps did not dry up after source controls became effective then, seep DS-7 and its collection pond (DP-7) and the flow area for seep DS-10 would be covered with chert (approximately 0.2 acres), as described above in Section 5.2.1.3 for seep AS-2. If the pond does not have sufficient storage capacity due to the addition of the chert, the berm would need to be enlarged to increase the storage capacity.

5.2.3.4 Alternative 4

The primary distinction for Alternative 4 is the inclusion of a low-permeability cap (Table 5-4).

GCL Cap on External ODA and Backfilled Pit

Under Alternative 4, the external ODA as well as the northern portion of the backfilled pit and haul roads with seleniferous shales at the surface would be covered with a low-permeability engineered GCL cap and revegetated, as described above in Section 5.2.1.4 for the A Panel external ODA.

Stormwater Run-on Controls

Same as Alternative 2 (Section 5.2.3.2).

Stormwater Detention Basin Sediment Removal

Sediments in stormwater detention basins DP-1, DP-2, DP-3, DP-4, DP-5, DP-6, DP-8, DP-9, DP-11, DP-13 and DP-15 would be removed and relocated on-Site, consistent with the approach described under Alternative 3 (Section 5.2.3.3).

Interim Actions/Monitoring

It is anticipated that installation of the low-permeability cap would cause seep DS-7 to dry up. A fence would be installed to prevent livestock gaining access to the seep flow area in the interim and the seep flow and water quality would be monitored after the cover was installed. Vegetation would initially be monitored on the D Panel backfilled pits (northern portion) and

external ODA and again at the time of 5-year review to verify that selenium levels in vegetation meet removal action goals.

5.2.4 E Panel External ODA

The primary environmental issues associated with the E Panel are related to seepage from the completed external ODA. Pit backfill had not occurred at the time of the SI and is now being conducted consistent with BMPs, which are expected to reduce the potential for plant uptake, leaching, and transport of selenium.

Seep ES-3 drains out of the north end of the E Panel external ODA and flows into detention basin EP-3. Seep ES-3 is associated with chert disposal and has not been found to contain substantially elevated selenium concentrations. The SI found that the selenium concentrations at ES-3 are below the selenium removal action levels for both extended and transient use (0.050 mg/L and 0.201 mg/L, respectively). The highest selenium concentration detected was 0.023 on 10/17/02. No additional actions are proposed for the chert area. Both seepage flows and concentrations are variable at the E Panel external ODA seeps ES-4 and ES-5. Observed high concentrations at these locations are thought to be reflective of the initial weathering of these recently placed materials. The surface expression of ES-5 has been covered with chert as part of a pilot study to reduce exposure potential for wildlife and livestock. More recent BMPs and reclamation practices, including a one- to two-foot soil cover over several feet of chert, have resulted in vegetation selenium concentrations below the relevant guidelines within the external ODA. A summary of removal action alternatives for the E Panel is shown on Table 5-5.

5.2.4.1 Alternative 1 (No Action)

Active mining is not yet completed in the E-0 pit and correspondingly, all of the E Panel has not yet been backfilled and reclaimed. Under Alternative 1, it is assumed that at the conclusion of mining operations in the E-0 pit, it will be backfilled and reclaimed under the current mine plan. The E-0 pit is anticipated to be backfilled using overburden from the proposed F Panel. The overburden would be covered with a layer of low selenium ROM chert also from the F Panel. Covering the chert would be a two-foot-layer of revegetated topsoil. No other action would be implemented.

5.2.4.2 Alternative 2

Alternative 2 provides a range of actions to address E Panel conditions with a focus on reducing overburden infiltration and plant uptake (Table 5-5).

External ODA Soil Cover

Under Alternative 2, the E Panel external ODA would receive no action since an adequate soil cover has already been installed (Table 5-5).

Stormwater Detention Basin Covering

There are five stormwater detention basins located on or around the E Panel backfilled pits and the E Panel external ODA (EP-1, EP-2, EP-6, EP-7, and EP-9; see Figure 5-7). The basin sediments (approximately 1000 cy) would be addressed by covering, as described in Section 5.2.1.2.

Contingency Seep Treatment

Under Alternative 2, post-removal action construction monitoring would entail flow and chemistry monitoring of the seeps ES-4 and ES-5. The existing chert cover on seep ES-5 would be modified to allow access for flow measurement and sampling. In the event that a seep continued to flow and contained COCs at concentrations above RAGs, it would be treated, as described above for A Panel seep AS-2. Once the seep dried up, or seep treatment was implemented, approximately 400 cubic yards of sediments would be removed from the downgradient seep collection pond and relocated on-Site.

A fence would be installed to prevent livestock gaining access to the ES-4 seep flow and pond area in the interim. The cover installed under the pilot study would remain in place at ES-5. A stand pipe could be installed for sampling.

5.2.4.3 Alternative 3

Alternative 3 incorporates several actions to address E Panel conditions. The main focus is on reducing the quantity and modifying the chemistry of infiltration at the external ODA. The primary distinction between Alternative 2 and Alternative 3 is the inclusion of surface amendment (Table 5-5).

External ODA Surface Amendment/Revegetation

Under Alternative 3, an organic surface amendment (such as composted manure or biosolids) would be applied to the non-chert portion of the E Panel external ODA. The amendment would be applied at a rate of 40 dry tons per acre and would be mixed to a depth of 12-inches using a chisel plow. The external ODA would then be seeded as necessary using a seed mix that has a low potential for selenium uptake. After re-seeding, additional efforts would be made, as

needed, to minimize invasion of native selenium-accumulator species, such as aster and astragalus.

Stormwater Detention Basin Sediment Removal

Under Alternative 3, approximately 700 cubic yards of sediments contained within stormwater basins EP-1, EP-2, EP-6, EP-7, and EP-9 would be removed and relocated on-Site.

Seep Covering

Seep ES-4 and its collection pond (EP-4) would be covered in place (approximately 0.2 acres) with chert as described above in Section 5.2.1.3 for seep AS-2. The area would be visually monitored over the first few years to confirm that the chert adequately covers the seep flow and detention area is adequately covered. If the pond does not have sufficient storage capacity due to the addition of the chert, the berm would need to be enlarged to provide increased storage capacity.

Monitoring/Interim Actions

A fence would be installed around seep flow areas to prevent livestock gaining access. If the seeps didn't dry up, then the flow areas would be covered with chert and visually monitored over the first few years to confirm that the chert covers the seep flow and that the detention areas are adequately covered.

5.2.4.4 Alternative 4

The primary distinction for Alternative 4 is the inclusion of a low-permeability cap (Table 5-5).

GCL Cap on External ODA

Under Alternative 4, the non-chert portion of the E Panel External ODA would be covered with a low-permeability engineered GCL cap. The cap would consist of four layers. The bottom layer would be a six-inch-thick cushion. The cushion layer would be comprised of a granular material free of large rocks or other debris that could damage the cap. The second layer would comprise the barrier. The barrier layer would be a Bentofix® GCL or equivalent. Overlying the GCL would be a one-foot-thick drainage layer. The drainage layer would be comprised of a high permeability material such as gravel. The top layer of the cap would be a 1.5-foot-thick vegetated soil cover. A 16-oz geotextile would be placed between the top vegetated layer and the underlying drainage layer (see Figure 5-3).

Stormwater Detention Basin Sediment Removal

Sediments contained within stormwater basins would be removed and relocated on-Site (same as Alternative 3).

Seeps

Seeps would be expected to dry up after the cap is installed. Sediments would then be removed and relocated on-Site. A fence would be installed in the interim to prevent livestock gaining access to seep flow areas.

5.2.5 Hoopes Spring

Hoopes Spring discharge contains selenium at concentrations above the RAG. A summary of removal action alternatives for Hoopes Spring is shown on Table 5-6. It is noted that since selenium is transported to Hoopes Spring from Site source areas, that monitoring at the source areas would also be performed to assess the effectiveness of any control actions. The results of this monitoring may provide an early indication of the likely effect on selenium concentrations in Hoopes Spring discharge.

5.2.5.1 Alternative 1 (No Action)

No action would be implemented on Hoopes Spring discharge.

5.2.5.2 Alternative 2

Implementation of source control actions on the backfilled mine pits and ODAs (described above for each source area) is expected to reduce selenium loading to the Wells Formation and subsequently to Hoopes Spring. Under Alternative 2, groundwater and surface water monitoring would be performed to assess the effectiveness of source control actions. Monitoring would also be performed during this period to develop a Site-specific standard for the Hoopes Spring drainage and downgradient Sage Creek (Table 5-6). Details of the approach are provided in Appendix E.

If the source control actions were found to be effective, and water quality standards were anticipated to be met at Hoopes Spring then no further action would be required. If the source control actions were not found to be effective over a period that was reasonable for Site conditions, then treatment of Hoopes Springs discharge would be implemented (see Section 5.1.2 for details of treatment options and approaches).

5.2.5.3 Alternative 3

Hoopes Spring discharge would be treated using an active biological water treatment plant under Alternative 3 (Table 5-6). The Hoopes Spring flow rate is about 5 cfs with seasonal fluctuations being approximately +/- 2.5 cfs) (+/- 50 percent). The biological water treatment plant would consist of a reactor tank, a filtration system, and a re-aeration system. This conceptual design is a scaled-up version of a working system. Selenium-impacted water would be collected below all of the dispersed springs and directed to the treatment plant where nutrients would be added. The water would then enter a closed reactor filled with activated carbon (the substrate to hold the bacteria) where the water would be retained for 6 – 12 hrs. For a flow rate of 7.5 cfs, the reactor tank(s) volume would need to be 1.2 – 2.4 million gallons. Within the reactor, the dissolved selenium is reduced to elemental selenium which precipitates from solution. The water plus elemental selenium exits the reactor and requires filtration to remove the elemental selenium. The water is treated to remove biological demanding material and ammonia (by products of the biological treatment) and discharged to the Hoopes Spring drainage. In addition, sludge generated by the treatment system would need to be disposed offsite. Information in the literature indicates that the sludge would likely be non-hazardous and could be disposed at a solid waste landfill. However, this would need to be verified by treatability testing. Additional supporting information on the treatment concept is provided in Section 4.3 and Appendix B.