CHAPTER 5 | EVALUATION OF ALTERNATIVES, INCLUDING ENVIRONMENTAL CONSEQUENCES

This chapter presents an evaluation of the restoration alternatives described in Chapter 4. As required under 43 CFR §11.82(c), factors considered by FWS in the evaluation of the alternatives include:

(1) The degree to which the project would provide the public with ecological services similar to those lost as a consequence of mining contamination;

(2) Technical feasibility (*i.e.*, whether it is possible to implement the alternative);

(3) The probability of project success (*i.e.*, the likelihood that implementing the alternative would produce the desired results);

(4) The anticipated relationship of costs to benefits;

(5) The relative cost-effectiveness of different alternatives (*i.e.*, if two alternatives are expected to produce similar benefits, the least costly one is preferred);

(6) The ability of the natural resources to recover with or without each alternative, and the time required for such recovery;

(7) The potential for collateral injury to the environment if the alternative is implemented;

(8) Potential effects on public health and safety;

(9) The results of actual or currently-planned response actions;

(10) Compliance with applicable Federal and state laws; and

(11) Consistency with relevant Federal and state policies.

Superior projects are those that provide ecological services similar to those lost, are technically feasible with a high probability of success, are cost-effective, are unlikely to cause collateral injury to natural resources, pose little if any risk to public health, and are compliant with applicable laws and policies.

The information presented about each alternative comes from the published literature, unpublished white papers and reports, personal communications with experts in the field, and other sources. Cost estimates are based on information from Federal, state, and other organizations, including the FWS Partners for Fish & Wildlife Program,[46] the Kansas Land Trust,[47] the Natural Resource Conservation Service (NRCS),[48] the Kansas Forest Service, as well as estimated costs from Tri-State EPA remediation efforts, costs of restoration efforts in Missouri and Oklahoma, costs of remediation and restoration efforts in similar mining-impacted sites (*i.e.*, Coeur d'Alene Basin (Idaho), Clark Fork River (Montana), and California Gulch/Arkansas River (Colorado) Superfund sites), local real estate data, and professional judgment. *All costs are presented in 2007 dollars (2007$).*

Costs are presented as unit costs (*i.e.*, per acre) because information available to determine the total likely size of any given alternative is not available—for instance, the extent to which certain alternatives could be applied will depend on landowner preferences. Cost estimates are approximations based on information available at the time of this report; many costs (*i.e.*, real estate costs) are expected to vary over time, and these variations may be substantial. Government agencies are required to pay fair market value for lands purchased. Fair market value would be determined through established appraisal procedures. The cost information developed in this report is intended to be of sufficient detail and reliability for purposes of general prioritization of restoration alternatives; additional costing evaluations would be required for detailed program design. Cost estimates therefore do not precisely represent the expected costs that would be incurred for each alternative. In addition, due to rounding, the presented cost totals may not exactly match the sum of their underlying cost elements.

The following paragraphs discuss each alternative in general terms, reflecting the evaluation factors listed above. Results are categorized as "benefits," "risks," or "costs" for each alternative.

5.1 TERRESTRIAL RESTORATION ALTERNATIVES

NO ACTION: ALTERNATIVE T1

The No Action alternative is essentially that of natural recovery. Because natural recovery is anticipated to be of extremely long duration (IEc 2004), this alternative is not anticipated to produce significant ecological or other environmental benefits in realistic timeframes. Current levels of ecological risk and associated environmental injuries are anticipated to continue indefinitely. Incremental costs are anticipated to be zero.

[46] The Partners for Wildlife Program provides technical and financial assistance to private landowners who are voluntarily seeking to restore native habitat and ecological communities on their property. For more information, see http://kansaspartners.fws.gov/ and http://partners.fws.gov/, viewed 4/21/08.

[47] The Kansas Land Trust is a nonprofit organization that protects property of ecological, scenic, historic, agricultural, or recreational importance in Kansas. The Kansas Land Trust offers landowners a variety of legal means to transfer permanent protection responsibilities to the Trust, such as conservation easements, land donations, and bargain sales. For more information, see http://www.klt.org/, viewed 4/21/08.

[48] The U.S. Department of Agriculture's NRSC assists private landowners to conserve their soil, water, and other natural resources. For more information, see http://www.nrcs.usda.gov/, viewed 4/21/08.

PRESERVE NATIVE PRAIRIES: ALTERNATIVE T2

Benefits

Native prairies, including native prairie hay meadows, provide a tremendous variety of ecological services and are of particular importance to the FWS. These areas are of value not only because they support native plants, including rare Midwest species, but also because of their exceptionally high floral biodiversity. Prairie soils also support many species of insects and fungi, which live in the ground in close association with prairie plants. Native prairies are one of the most endangered ecosystems in the world. The benefits of purchasing land or easements for purposes of preservation include the preservation of existing remnants of this type of ecosystem, including native flora, fauna, and the unique and valuable soil structure of the ecosystem. Such areas will also continue to provide habitat for non-resident species such as migratory birds. The preservation of this habitat type, which FWS regards as being in imminent danger of degradation or destruction, will help compensate for past and/or ongoing habitat services lost as a consequence of mining-related contamination.

Risks

Risks of native prairie preservation are few. Although a number of managerial and logistical issues have yet to be addressed, these are expected to be fully surmountable, and there are no technical feasibility concerns. The probability that these native prairie areas can be successfully maintained in their current state is high. Risks for adverse collateral impacts of this alternative are low. However, FWS notes that native prairie preservation will not have any effect on reducing the extent, bioavailability, or toxicity of residual metal contamination in the area.

Costs

Because no active remediation or restoration is required, the cost per acre of native prairie preservation is relatively low. The estimated cost for this option includes funds for: (a) purchasing land or purchasing an easement, (b) fencing, and (c) long-term management. FWS estimates that the approximate per-acre cost for purchasing native prairie areas is $2,500 per acre (2007$); this figure will of course vary over time, depending on local real estate conditions. FWS policy allows for the purchase of easements at a maximum cost of one-half the assessed value. The estimated cost for an easement is therefore $1,250 per acre (2007$). Fencing is also needed to exclude livestock at an estimated cost of $1.75 per linear foot (2007$).

Long-term management costs include the cost of labor for one permanent employee to manage the program, plus funds for contractor support, equipment use, and supplies. The cost of the permanent employee is fixed in the sense that it is independent of the area(s) of the native prairies to be managed. The contractor, equipment, and supply costs are variable in that they are a function of the numbers and sizes of the parcels under management.

FWS estimates that long-term management costs for native prairie preservation are approximately $150 per acre *per year* (2007$), which amounts to about $3,100 per acre in present-value terms over a 30-year time period (2007$).[49] Because management of these lands would continue indefinitely, FWS believes that the best way to arrange for funding in this situation is to create an endowment of sufficient size that will provide for the annual management costs of this program while also growing in proportion to inflation.[50] Total costs for this alternative are therefore about $4,300 to $5,600 per acre (2007$), plus fencing.

HIGH QUALITY PRAIRIE RESTORATION: ALTERNATIVE T3

Benefits

As noted above, prairies are both rare and valuable habitats, providing a wide variety of ecological services. FWS therefore believes that restoring prairies, to the extent possible, is desirable. While not likely to provide as fully rich and complex an ecosystem as existing native prairie areas, restored prairies nevertheless have the potential to be high quality habitats that provide many ecological benefits, including encouraging the growth of native flora, providing foraging opportunities for birds and mammals, and providing nesting habitat for prairie birds such as northern harrier (*Circus cyaneus*), the grasshopper sparrow (*Ammodramus savannarum*), the short-eared owl (*Asio flammeus*), horned lark (*Eremophilia elpestris*) and the bobolink (*Dolichonyx oryzivorus*) (Packard and Mutel 1997). The restoration of this habitat type will help compensate for past and/or ongoing terrestrial habitat services lost as a consequence of mining-related contamination.

In many cases, restoring degraded areas to a high quality state is possible, although it may take some time. Grass cover dense enough to be mowed will appear within the first few years, although grasses typically take about three years to establish themselves fully (Packard and Mutel 1997). Germination of certain native grass and forb species may take as long as five years; thus, flora acquired in the first few years may not be particularly diverse (Robertson 1996).

Risks

The primary risk of prairie restoration is project failure. In most cases this is unlikely: prairie restoration is a widely accepted means of enhancing ecosystem function in the Great Plains. However, it is possible that some sites are sufficiently degraded, and/or are so heavily contaminated by metals, that native species could not thrive. Restoring former mine waste areas is a particularly uncertain endeavor: no published studies are available investigating the technical feasibility of replanting high quality prairie mix at such sites.

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[49] We note that the per-acre cost will vary depending on how much land is managed: because of the fixed costs required—*i.e.,* hiring a person to oversee the management program—per acre management costs will be higher for smaller programs and lower for larger programs, as the cost of the manager's time is "spread out" over a larger total project size.

[50] This value is based on costs over a 30-year time period, assuming a 3 percent discount rate.

It is important to note that even a fully successful prairie restoration effort (*i.e.*, one in which the planted species thrive) will not produce a community that is identical to that present in a native prairie. In particular, the insect, small mammal and soil invertebrate communities may differ in restored prairies, compared to native prairies (Robertson 1996). Indeed, some restoration experts argue that the structure and diversity of the original ecosystem can never be completely replicated: Kindscher and Tieszen (1998), for example, state that restoration of the original, diverse complement of prairie plant species only occurs over very long time periods (*i.e.*, centuries) if at all.

Prairie restoration is not anticipated to have adverse collateral effects on the environment. However, FWS notes that prairie restoration will not have a substantial effect on reducing the extent, bioavailability, or toxicity of residual metal contamination in the area.

Costs

The estimated cost of this alternative includes funds for: (a) purchasing land or an easement, (b) seeding, (c) fencing, and (d) long-term management. As noted above, property values vary both over space and time, but FWS estimates that the approximate per-acre cost for purchasing land suitable for prairie restoration would be between $2,000 and $2,500 per acre (2007$). The price of easements is correspondingly estimated at $1,000 to $1,250 per acre (2007$), and as noted previously, long-term management-costs are estimated at $150 per acre per year, or $3,100 per acre in present-value terms ($2007). Seeding would likely cost approximately $2,000 per acre (including labor, equipment, and materials), although actual costs will depend in part on the initial condition of the property. Total per-acre costs (assuming land purchase) therefore range from approximately $7,000 to $7,500, plus fencing costs of roughly $1.75 per linear foot (2007$).[51] Using easements, costs would range from about $6,000 to $6,300 per acre (2007$) plus fencing costs.

CRP GRASSLAND RESTORATION: ALTERNATIVE T4

Benefits

Warm season grasses, such as those proposed for use in this alternative, provide wildlife with a wide variety of ecological services. As bunch grasses, the upright growth form of these grasses provides better habitat conditions for many upland species of wildlife such as ground-nesting birds and rabbits because stands have more bare ground under and between individual plants. Warm season grasses enhance plant community biodiversity: they are associated with a greater diversity of associated broadleaf forbs, legumes and insects than are cool-season grasses (Missouri Department of Conservation undated).

Warm season grasses provide forage of higher quality and quantity for herbivores than cool season grasses, especially in the hot months (Missouri Department of Conservation undated); they also require less fertilization and are more drought-tolerant because their

[51] For these and some of the other figures in this document, the presented totals may not exactly match the sum of their underlying elements due to rounding.

grass biomass is predominantly allocated to their extensive root systems. Root-based storage of biomass provides an additional advantage when the plants die: as the roots decay, they contribute a high amount of organic matter to the prairie soils (University of Minnesota 2003). Soils with high organic content can better resist erosion and compaction (University of Minnesota 2003).

While not likely to produce as rich and complex an ecosystem as a full prairie restoration effort, CRP grassland plantings nevertheless have the potential to be high quality habitats that provide many ecological benefits, including erosion control, support of native flora, enhanced foraging opportunities for birds and mammals, and nesting habitat for prairie birds. The restoration of this habitat type will help compensate for the past and/or ongoing mining contaminant-related losses of similar ecological services.

Over 83 percent of all CRP acres are in the Great Plains, where native grasslands historically supported some 260 species of breeding birds (Cunningham 1997). A comparison of densities of common species in CRP fields with densities in cropland revealed that most grassland species were more common in CRP fields than in cropland (Kantrud *et al.* 1993). Conversion of cropland to perennial cover thus adds suitable breeding habitat for these species and may enhance their populations. This change is especially important because during the last quarter-century, several grassland bird species suffered major population declines in the central United States (Kantrud *et al.* 1993).

Risks

CRP grassland restoration methods are not likely to have adverse collateral effects on the environment. If appropriate restoration procedures are followed, it appears that the risks of project failure are low: CRP grassland restoration has a long history of success in Kansas and elsewhere. The CRP program itself has been operational since 1985, and since that time has been instrumental in successfully encouraging the planting of over thirty million acres of CRP grasses nationwide (Cunningham 1997).

The primary risk of CRP restoration is project failure. In most cases this is unlikely: establishing CRP grasslands is a widely accepted means of enhancing ecosystem function in the Great Plains. However, it is possible that some sites are sufficiently degraded, and/or are so heavily contaminated by metals, that native species could not thrive. Restoring former mine waste areas is a particularly uncertain endeavor: no published studies are available investigating the technical feasibility of replanting high quality prairie mix at such sites.

As noted previously, even a fully successful restoration effort will not produce habitat that can provide the complete suite of ecological services provided by native prairie. Because forbs are not included in this alternative, the level of services provided is likely to be less than those provided under Alternative T3. FWS also notes that CRP grassland restoration will not have a substantial effect on reducing the extent, bioavailability, or toxicity of residual metal contamination in the area.

Costs

Costs are calculated similarly to those for high quality prairie restoration. That is, the estimated cost for this option include funds for: (a) purchasing land or purchasing an easement, (b) adding seed and potentially soil amendments, (c) fencing, and (d) long-term management. As above, property values likely vary between $2,000 and $2,500 per acre, and the price of easements is estimated at $1,000 to $1,250 per acre (2007$). Seed and soil amendments would likely cost about $2,700 per acre (including labor, equipment, and materials), depending on the initial condition of the property. Long-term management costs are about $3,100 per acre in present-value terms (2007$). Total per-acre costs (assuming land purchase) therefore range from approximately $7,700 to $8,200, plus fencing at roughly $1.75 per linear foot. Using easements, costs would range from about $6,700 to $7,000 per acre plus fencing costs.

COOL SEASON GRASSLAND RESTORATION: ALTERNATIVE T5

Benefits

Cool season grasses provide some habitat and forage value to local wildlife, although these benefits are significantly less than those provided by warm season grasses or prairies. Cool season grasses help reduce erosion, relative to conditions of sparse or no vegetation. They will likely establish reasonably well in virtually all terrestrial habitat types and conditions likely to be found in Cherokee County. Methods are even available for encouraging growth in former mine waste areas (MDNR 2003).

Cool season grasses establish relatively quickly, forming good cover within the first year, although cool season grassland restoration will not have a substantial effect on reducing the extent, bioavailability, or toxicity of residual metal contamination in the area. At some sites, restoration of cool season grasses would help compensate for the past and/or ongoing mining contaminant-related losses of similar ecological services, although as noted above, the ecological service gains are not anticipated to be as large as those provided by warm season grasses or prairies.

Risks

Cool season grassland growth over many years can reduce the quality of the underlying soils. Unlike warm season grasses, these grasses tend to leach nutrients out of soils, and fertilization is required for ongoing production (Redmon 1997). Soil must be carefully monitored on a regular basis, which is time-consuming, and the application of large amounts of fertilizer can be costly.

Costs

Costs are calculated similarly to those for other habitat restoration efforts. That is, the estimated cost for this option includes funds for: (a) purchasing land or purchasing an easement, (b) adding seed and potentially soil amendments, (c) fencing, and (d) long-term management. As above, property values likely vary between $2,000 and $2,500 per acre, and the price of easements is estimated at $1,000 to $1,250 per acre (2007$). Seed and soil amendments would likely cost approximately $2,700 per acre (including labor, equipment, and materials), depending on the initial condition of the property (2007$). Long-term management costs are about $3,100 per acre in present-value terms (2007$). Total per-acre costs (assuming land purchase) therefore range from $7,700 to $8,200, plus fencing costs of roughly $1.75 per linear foot (2007$). Using easements, costs would range from $6,700 to $7,000 per acre (2007$), plus fencing.

REMOVE AND DISPOSE OF TERRESTRIAL MINE WASTES:[52] ALTERNATIVE T6

Benefits

Removal and disposal of mine wastes in subsidences is technically feasible, at least up to a point. Andes (1988) found that “there is more than an adequate amount of space available at each subsite to dispose of the waste rock portion of the surface mine waste. In fact, enough space appears available at Waco, Lawton, Badger, and even Galena to dispose of all the surface mine waste if so desired.” Andes (1988) also noted that at Treece and Baxter Springs, “the large volumes of chat are significantly greater than the disposal volumes in existence”; however, this conclusion was reached prior to the EPA’s remediation of a substantial part of the Baxter Springs wastes. EPA’s 2006 ROD amendment for OU-3 and OU-4 of Cherokee County estimates a total subsidence pit volume of approximately 2 million cubic yards at the Baxter Springs and Treece subsites, which will be used to contain approximately 1.25 million cubic yards of excavated mine waste (EPA 2006). It may, therefore, be the case that sufficient subsidence space is available for subsurface disposal of remaining wastes. FWS has not evaluated in detail whether sufficient subsidence locations exist at acceptable locations (*i.e.*, non-floodplain locations) to accept all remaining mine wastes; nevertheless, FWS anticipates that the potential exists for a substantial portion of the remaining wastes to be disposed of in this manner.

Benefits from the removal of surficial mine wastes are anticipated include reductions in the loadings of metals to Cherokee County surface waters and possibly to the Boone aquifer. Because these mine waste areas support little or no vegetation, removal of the wastes (combined with some kind of vegetative restoration activity) will allow a healthier terrestrial community to thrive and would provide additional habitat for birds and other animals. Mine waste removal would help restore these areas to a state at which the ecological services provided would be closer to those that would have been provided, in the absence of mining-related contamination.

Risks

At this time, it is unclear as to exact extent of orphan mine waste that will eventually be addressed as part of EPA’s remedial activities – for example, EPA's plans rely on responsible chat sales before and during remedy implementation to reduce the volume of

[52] Mine wastes are the property of the landowners on whose property the wastes reside. FWS recognizes the need to obtain landowner approval before the removal of any mine wastes.

mine wastes. Implementation of this alternative would require close coordination with EPA and KDHE to address common issues such as liability, permitting, and design in a unified and cohesive manner.

In addition, many subsidences are flooded with ground water. Disposal of mine wastes in these areas therefore has the potential to increase metals loadings to ground water. To the extent that ground water discharges into streams and rivers resources, these may also become more contaminated.

The magnitude of this risk is difficult to evaluate with certainty; however, preliminary information suggests that the loadings from subsidence-disposed mine wastes may be low. Subaqueous disposal in a subsidence is, by design, intended to create anaerobic (oxygenless) conditions around the wastes. In the absence of oxygen, the chemical reactions that cause larger amounts of metal to leach out of the wastes, are greatly reduced (Newfields 2003).

Furthermore, EPA, the Missouri Department of Natural Resources, KDHE, and the Respondents (mining companies) have conducted a pilot test of subaqueous subsidence disposal of mine wastes. In this effort, about 58,000 cubic yards of tailings were transported and placed into a subsidence on the Kansas/Missouri border. No compaction was performed, although the tailings were mounded above the surrounding grade in anticipation of settlement. The tailings were capped with 18 inches of topsoil (Newfields 2003). Monitoring of zinc levels from nearby ponds and aquifer wells identified an initial increase in zinc concentrations after disposal, but these concentrations declined to near pre-disposal levels within approximately 18 months. After completing more tests and pilot studies, the EPA found the “underground or underwater (subaqueous) disposal of mining and milling wastes as a cost-effective and environmentally safe disposal method,” as prescribed in their selected remedy for OU-1 of the Jasper County/Oronogo-Duenweg Mining Belt Superfund Site in Missouri (EPA 2004b). Filling open subsidence pits would also address their physical hazards (*i.e.*, open pits, mine collapse) and should also improve groundwater conditions by reducing the oxidation of minerals.

Costs

The per-acre cost for this alternative does not include land purchase costs for mine waste areas but rather is based on the costs for waste removal and disposal. These costs depend not only on labor and equipment rates but also on how far the wastes need to be transported prior to disposal, and on the number of tons or cubic yards of mine wastes present on a given acre.

EPA estimates a cost of $7 per cubic yard (2007$) for removal and disposal of mine waste in nearby subsidences (EPA 2006). Using EPA’s estimates for the total volume and acreage of mine wastes in Cherokee County, this estimate translates to $86,900 per acre of mine wastes (2007$).[53]

Because the filled subsidences would be capped and revegetated, FWS estimates the cost per acre of subsidence cap to be $95,000 (in 2007$), based on the costs estimated in the Jasper County OU-1 ROD (EPA 2004b).[54] In addition, biosolids would be incorporated into the caps at a rate of 100 tons per acre, along with associated amendments (lime and carbon-rich matter) which is estimated to add approximately $10,100 (2007$) per acre of cap.[55] Assuming the subsidences are 30 feet deep, these costs estimated *on a per acre of subsidence cap basis* translate into a cost of approximately $26,200 *per acre of mine wastes removed* (2007$). Fencing is estimated to cost $1.75 per linear foot (2007$). Total estimated costs to remove, dispose, and cap and revegetate mine wastes in subsidences are therefore $113,100 (*i.e.*, $86,900 + $26,200) per acre of mine waste (in 2007$), plus fencing costs of roughly $1.75 per linear foot (2007$).

Estimated maintenance costs include those for vegetation maintenance (*i.e.*, $3,100 per acre in 2007$, as discussed in the above alternatives) plus ongoing monitoring and maintenance of the cap itself. The Jasper County OU-1 ROD estimated annual operating and maintenance costs for a cap at $250 per acre, in 2004 dollars (EPA 2004b).[56] In 2007 dollars, this translates to about $280 per acre per year, or about $5,500 per acre over a 30-year period, using a three percent discount rate (2007$). As a result, total long-term management costs are estimated at $430 per acre per year, or $8,500 per acre of cap (2007$). Assuming the subsidences are 30 feet deep, these costs are approximately equal to $2,100 per acre of mine wastes removed (2007$). The total costs for this alternative are therefore approximately $115,200 per acre of mine wastes (2007$), plus fencing.

Additional costs associated with this alternative include costs for restoration of the former mine waste areas and borrow areas. Once mine wastes have been removed, the remaining area will be revegetated in accordance with Alternatives T3 or T4. Borrow areas would be obtained either by direct purchase of the land or through the purchase of easements, and recontoured and revegetated following excavation. The former mine waste areas would be fenced and both the restored former mine waste areas and borrow areas would be subject to long-term monitoring and maintenance. The additional costs are approximately $8,600 to $8,900 per acre of mine wastes removed (2007$), including land purchase or easement costs (for borrow areas), plus fencing costs for the former mine

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[53] EPA's 2006 ROD amendment for OU-3 and OU-4 of Cherokee County estimates approximately 1.243 million cubic yards of chat occupying 103 acres, or about 12,000 cubic yards per acre (EPA 2006). Multiplying 12,000 cubic yards by the per-yard cost for removal and disposal of mine waster ($7) gives approximately $86.900 per acre.

[54] EPA (2004b) assumes a native, warm-season grass mix. Costs may be higher or lower for other vegetation approaches.

[55] See Alternative T9 for a discussion of biosolids costs.

[56] This estimate is based on the Jasper County OU-1 selected remedy cap size of 90 acres.

waste areas.[57] Altogether, the total cost for this alternative is approximately $124,000 per acre of mine wastes removed (2007$), plus fencing.

MINE WASTE RECONTOURING: ALTERNATIVE T7

Benefits

Recontouring mine wastes is technically feasible, as are adding nutrient amendments and planting seed. Recontouring will result in a more even profile of waste piles and may help reduce infiltration (which has the potential to increase ground water contamination) and erosion of contaminated materials. In particular, recontouring may eliminate closed basins and other areas where water can pool and then infiltrate into the ground (EPA 1989). Recontouring may also be used to redirect surface runoff to areas away from mineshafts or other permeable areas, and into drainageways, further reducing infiltration and controlling erosion (EPA 1989). If revegetation is successful, erosion from residual piles would be further reduced, and the vegetation would provide some habitat for wildlife. Mine waste recontouring might improve, to a degree, the level of ecological services provided by the restored area, which would partly offset past and/or ongoing ecological services losses at these sites. However, as discussed below, the increase in services provided by this alternative is not likely to be large.

Risks

At this time, it is unclear as to the exact extent of mine waste that will remain following EPA's remedy – for example, EPA's plans rely on responsible chat sales before and during remedy implementation (excavation and/or consolidation followed by encapsulation, or to the maximum extent practicable, disposal in subsidences or other mine workings in the area (EPA 2006)) to reduce the volume of mine wastes. Implementation of this alternative would require close coordination with EPA and KDHE to address common issues such as liability, permitting, and design in a unified and cohesive manner.

The probability of substantially reducing metals inputs to rivers and streams through this method is low. Ferrington (2002) has found no significant improvements in Short Creek since implementation of the Galena remedy, which consisted of mine waste recontouring. Further, the probability of mine wastes supporting a healthy stand of diverse, native vegetation over the long term is also low. EPA implemented its remedy for mine wastes in Galena between April 1993 and September 1995, planting a CRP mix of warm season grasses. Although initial growth appeared promising, today many areas support little if any vegetation, and the vegetation that survives bears little resemblance to the varied community of native grasses and forbs that is the goal of restoration activities.

[57] This estimate is based on the assumption that the depth of the material excavated from the borrow area is the same as the thickness of the cap material placed on the subsidences (18 inches). In other words, the estimated areas of filled subsidences and borrow areas are equivalent.

EXHIBIT 27 GALENA SUBSITE, JUNE 1993 (PRE-REMEDIATION)

Photos courtesy of Kansas Department of Health and Environment.

EXHIBIT 28 GALENA SUBSITE, NOVEMBER 2003 (POST-REMEDIATION)

Photo courtesy of John Miesner, U.S. Fish and Wildlife Service.

Exhibits 27 and 28 depict parts of the Galena subsite before remediation and in November of 2003. KDHE spends $50,000 to $100,000 in ongoing maintenance costs each year for the Galena subsite, renewing attempts to revegetate the wastes and prevent them from eroding into Short Creek. These efforts have unfortunately resulted in at most minimal improvements to the site.

Costs

The per-acre cost for this alternative does not include land purchase costs but rather is based on recontouring costs. The per-acre cost of mine waste recontouring depends not only on labor and equipment rates but also on how many tons of mine wastes are present on a given acre. At best, general approximations can be made.

Based on EPA's cost estimate in the Cherokee County OU-3 and OU-4 ROD amendment (EPA 2006), FWS estimates that mine waste recontouring and revegetation would cost at least $7,200 per acre (2007$), which could be higher depending on the selected revegetation regime. Fencing is estimated to cost $1.75 per linear foot (2007$). Annual maintenance costs are estimated to be at least as high as those for the revegetation alternatives (*i.e.*, $3,100 per acre in 2007$) and could be higher due to the additional need to monitor the area (*i.e.*, for water quality) and possibly maintain it. The total cost of this alternative is therefore roughly $10,300 per acre (2007$), plus fencing expenses.

MINE WASTE RECONTOURING AND ENCAPSULATION: ALTERNATIVE T8

Benefits

Recontouring with encapsulation is a technically feasible approach; as noted above, this was the alternative selected by EPA for the Baxter Springs subsite (EPA 1997) and remaining mine wastes in Cherokee County (EPA 2006). Caps of various types are routinely used in other contexts to reduce human and environmental exposure to wastes and/or hazardous substances beneath the cap.

This alternative has significant potential to reduce infiltration and erosion, thereby reducing inputs of metals to ground water as well as to local streams and rivers. Due to the cap, the potential for these reductions is greater than those provided by Alternative T6. Capping with a sufficiently thick quantity of local, good-quality topsoil should also allow the re-establishment of vegetation in areas that formerly could support little if any vegetation. Altogether, mine waste recontouring and encapsulation would help restore these areas to a state at which the ecological services provided would be closer to those that the area would have provided in the absence of mining-related contamination.

The Baxter Springs remedy was implemented in 2002**,** and the cap currently supports apparently healthy stands of warm season grasses and forbs (*i.e.*, Exhibits 30 to 33). Although only time will show how effective the Baxter Springs remedy will be in the long run, results to date are encouraging.

Risks

At this time, it is unclear as to the exact extent of mine waste that will eventually remain following EPA's remedy – for example, EPA's plans rely on responsible chat sales before and during remedy implementation (excavation and/or consolidation followed by encapsulation, or to the maximum extent practicable, disposal in subsidences or other mine workings in the area (EPA 2006)) to reduce the volume of mine wastes. Implementation of this alternative would require close coordination with EPA and KDHE to address common issues such as liability, permitting, and design in a unified and cohesive manner.

Additionally, the risks of this alternative include cap failure and/or reductions in the effectiveness of the cap. Specifically, over time the capped materials may consolidate and settle, disrupting the cap, causing the ponding of surface water on the cap, and causing other effects that may reduce the cap's effectiveness (EPA 2001). FWS believes that cap failure is possible but unlikely if the cap is well-designed, of sufficient thickness, and protected by fencing, and if the cap is monitored and maintained adequately.

EXHIBIT 29 SPRING BRANCH, IN BAXTER SPRINGS SUBSITE, DURING EXCAVATION OF CHAT (FEBRUARY 2002)

Photo courtesy of John Miesner, U.S. Fish and Wildlife Service.

EXHIBIT 30 SPRING BRANCH, BAXTER SPRINGS SUBSITE, AFTER ONE YEAR OF GROWTH (NOVEMBER 2003)

Photo courtesy of John Miesner, U.S. Fish and Wildlife Service.

EXHIBIT 31 SPRING BRANCH, IN BAXTER SPRINGS SUBSITE, WITH TWO YEARS OF GROWTH (JUNE 2004)

Note: Bare spots are attributed to cattle, which were allowed to graze the area before the plants had fully established.
Photo courtesy of John Miesner, U.S. Fish and Wildlife Service.

EXHIBIT 32 BAXTER SPRINGS SUBSITE, CAPPED AND SEEDED WITH GRASS (JUNE 2004)

Photo courtesy of John Miesner, U.S. Fish and Wildlife Service.

EXHIBIT 33 BAXTER SPRINGS SUBSITE, CAPPED AND SEEDED WITH GRASS AND FORBS (JUNE 2004)

Photo courtesy of John Miesner, U.S. Fish and Wildlife Service.

As part of its remedy for the Baxter Springs subsite (OU 3) in 2002**,** EPA regraded and capped mine wastes with six inches of topsoil on chat, and with 18 inches on the tailings pond. This area was then planted with a warm season CRP grass mix. To some areas, about two dozen forb species were planted in addition to the grasses.

Currently, the area is already covered with a significant vegetative cover. Exhibits 29 through 33 show a portion of the site at Spring Branch. Prior to remediation, Spring Branch ran underneath a large chat pile. The chat pile was excavated from above and around the creek (Exhibit 29); the surrounding area was regraded, capped, and planted. Some areas were planted a with warm season grass mix; other areas were planted with a combination of warm season grasses and forbs. Thus far, both the grasses and the forbs have thrived. FWS believes that evidence to date suggests that this remedy may be a viable restoration approach for areas where mine wastes remain, although FWS would enhance the approach taken by EPA by incorporating 100 tons of biosolids per acre into recontoured mine wastes prior to cap placement.

An additional risk of this alternative is the potential for injury to the borrow site. These risks will depend largely on how much soil is removed, and how well the area is restored afterwards. Because the quantity and locations of wastes potentially subject to recontouring and capping are currently unclear, the need for capping materials and the potential impacts of acquiring the needed quantity of these materials cannot be evaluated at this time. However, for a given volume of wastes, the need for such materials will likely be greater (and the associated impacts on the borrow site will likely be greater) than the waste removal/subsidence disposal alternative.

Costs

The per-acre cost for this alternative does not include land purchase costs for mine waste areas. As for the above alternatives that address primary restoration of terrestrial mine wastes, the per-acre cost of mine waste recontouring and capping are difficult to estimate with certainty because they depend in part on unknown factors such as how many tons or cubic yards of mine wastes are present on a given acre.

FWS estimates a cost of $50,500 per acre (2007$) to recontour, cap, and revegetate mine wastes, based on the costs estimated in the Cherokee County OU-3 and OU-4 ROD amendment (EPA 2006), although this figure will vary depending on the selected revegetation regime. Fencing is estimated to cost $1.75 per linear foot (2007$). In addition, application of biosolids at a rate of 100 tons per acre and associated amendments (lime and carbon-rich matter) to the cap is estimated to cost approximately $10,100 per acre.[58] Estimated long-term maintenance costs include expenses for both cap and vegetation maintenance, which total about $430 per acre per year (2007$), or $8,500 per acre in present-value terms over an estimated 30-year period, as discussed for the T6 alternative.

Additional costs associated with this alternative include costs for restoration of the borrow areas. Borrow areas will be obtained either by direct purchase of the land or through the purchase of easements, recontoured and revegetated following excavation, and subject to long-term monitoring and maintenance. The additional costs are approximately $11,300 to $12,800 per acre of mine wastes (2007$), including land purchase or easement costs.[59] Altogether, the total cost for this alternative is therefore roughly $81,000 per acre of mine wastes (2007$), plus fencing.

APPLY BIOSOLID AMENDMENTS BENEATH PLANNED EPA CAPS: ALTERNATIVE T9

Benefits

Although results of EPA's recontouring and encapsulation remedy (Alternative T8) for the Baxter Springs subsite (OU 3) are positive, more recent experience suggests that the incorporation of biosolid amendments into the cap would substantially encourage and sustain long-term growth of vegetation and recovery of the natural habitat. This technique has been widely applied to similar mining impacted soils in areas including Leadville (Colorado), Bunker Hill (Idaho), and Palmerton (Pennsylvania). Use of biosolid amendments is prescribed as part of the remedy for mine wastes in Jasper

[58] See Alternative T9 for a discussion of biosolids costs.

[59] This estimate is based on the assumptions that the depth of the material excavated from the borrow area is the same as the thickness of the cap material placed on the mine wastes (18 inches), and that the total area of borrow areas is equal to the total area of mine wastes capped. These assumptions overstate costs because consolidation of the mine wastes will likely reduce the area of the cap required.

County to “supplement the soil organic matter content and facilitate revegetation, which may also provide some treatment to any residual metals not excavated during subaqueous disposal” (EPA 2004b).

Biosolids have proven to be an effective amendment, binding metals into less bioavailable forms. Reductions in the phyto- and bio-availability of metals in plants have been attributed to biosolids applications, and biosolids applications may also have a treatment effect resulting in long-term reduction of risks to terrestrial vermivores by fixing and stabilizing metals in mine wastes (NewFields 2003b). Lime is added to keep the soil calcareous (pH of about 8), which prevents future zinc phytotoxicity, and minimizes cadmium bioaccumulation in plants. Carbon-rich matter, such as hay, yard wastes, wood chips, or sawdust, is also added to maintain the proper carbon-nitrogen ratio and reduce the potential for nitrogen leaching into underlying soils and groundwater or adjacent areas.

Risks

It may be difficult to coordinate and obtain approval and access from EPA and landowners for the addition of biosolid amendments with the EPA capping remedy. EPA’s efforts are primarily intended to reduce ecological and human health risk, but not necessarily to restore natural habitat and their associated injured services to their baseline condition. Furthermore, it may be difficult to coordinate both remedial and restorative activities at the same time – EPA has already issued a ROD amendment for remaining terrestrial mine wastes in Cherokee County (EPA 2006) and is expected to begin remediation shortly.

As described above, this alternative relies on a mix of amendments, including biosolids, to encourage and sustain long-term vegetation growth. These components have to be mixed in the correct ratios (*i.e.*, 100 tons of biosolids, 25 tons of lime, and 50 tons of carbon-rich amendment per acre); otherwise recovery could suffer and even be worse than restoration without biosolid amendments. In addition, nearby reliable sources of biosolids will have to be found and may be limited; they include municipal wastewater treatment plants (Springfield, Missouri and Tulsa, Oklahoma) and poultry farms (chicken litter).

Costs

FWS estimates a cost of $10,100 per acre (2007$) to incorporate biosolid and associated amendments into encapsulated mine wastes at a rate of 100 tons of biosolids per acre, based on the costs estimated in the Jasper County OU-1 ROD (EPA 2004b). This cost will vary depending on the selected application rate of the amendments; higher application rates may be necessary for mine wastes that have higher levels of contamination. In addition to costs for biosolids, lime, and carbon-rich matter, this cost includes costs for deep tilling the materials at sufficient depths to promote a fertile root zone. Fencing is estimated to cost $1.75 per linear foot (2007$).

These costs are incremental to the capping and revegetation costs that we assume would be borne by the EPA as part of the remedy. Finally, maintenance costs for both vegetation and cap monitoring and maintenance would be borne by the State (KDHE), and thus are not included in estimated costs for this alternative.

IMPROVE EPA MINE WASTE CAPS: ALTERNATIVE T10

The benefits and risks for this alternative are similar to those for Alternative T9. The alternative includes the addition of seed, soil amendments, and fencing to protect the area from grazers while the new vegetation becomes established. Because no biosolids are included and no deep tilling is required, the costs are lower than Alternative T9, at an estimated $2,700 per acre. Fencing costs are estimated at $1.75 per linear foot. No land acquisition costs are included in this alternative. Similarly, no operation and maintentance (O&M) costs for this alternative would be incurred by the Trustees, as the State would bear these costs.

5.2 AQUATIC RESTORATION ALTERNATIVES

NO ACTION: ALTERNATIVE A1

The No Action alternative is essentially that of natural recovery. Because natural recovery is anticipated to be of extremely long duration (IEc 2004), this alternative is not anticipated to produce significant ecological or other environmental benefits in realistic timeframes. Current levels of ecological risk and associated environmental injuries are anticipated to continue indefinitely. Incremental costs are anticipated to be zero.

PRESERVE HIGH QUALITY RIPARIAN CORRIDORS: ALTERNATIVE A2

Benefits

The benefits of purchasing land or easements for purposes of preservation include the maintenance of the protective buffering functions provided by these areas to the county's surface waters. Preservation will also ensure the availability of this ecologically valuable habitat for native flora and fauna. Without preservation, some of these areas may become over-harvested for timber (or overgrazed if grassland) or could be turned into agricultural land. Riparian corridor serves to capture and filter terrestrial runoff before it enters streams. Preservation of this habitat type will help compensate for past and/or ongoing aquatic habitat services lost as a consequence of mining-related contamination.

Risks

The risks of riparian corridor preservation are few. Although a number of managerial and logistical issues have yet to be addressed, these are expected to be fully surmountable, and there are no technical feasibility concerns. The probability that existing high quality riparian corridors can be successfully maintained in their current state is high. Risks for adverse collateral impacts of this alternative are low. However, FWS notes that riparian corridor preservation will not have any effect on reducing the extent, bioavailability, or toxicity of residual metal contamination in the area.

Costs

Because no active remediation or restoration is required, the cost per acre of riparian corridor preservation is relatively low. The estimated cost for this option includes funds for: (a) purchasing land or purchasing an easement, (b) water wells for livestock, and (c) vegetation management and fencing. Property values vary both over space and time, but FWS estimates that the approximate per-acre cost for purchasing these areas is $2,000 to $2,500 per acre and that an easement would therefore cost $1,000 to $1,250 per acre (2007$). FWS estimates two water wells per stream mile (one well on each bank) at a cost of $20,000 per well or $40,000 per stream mile, in 2007$, including installation, pumps, power, tankage, and maintenance.[60] Depending on whether the preserved corridor is 50 or 300 feet wide, well costs could range from approximately $550 to $3,300 per acre.[61] Long-term management and fencing costs are about $3,100 per acre (present-value over a 30-year time period), and $1.75 per linear foot (2007$), respectively. Total costs therefore range from $4,600 to $8,900 per acre, plus fencing at $1.75 per linear foot (2007$).

PRESERVE EMPIRE LAKE BUFFER: ALTERNATIVE A3

Benefits

The benefits of this alternative are similar to those for Alternative A2: *i.e.*, the maintenance of the protective buffering functions provided by these areas to the lake. Preservation will also ensure the availability of this ecologically valuable habitat for native flora and fauna. Without preservation, some these areas may become over-harvested for timber or could be turned into agricultural land. Preservation of this habitat type will help compensate for past and/or ongoing aquatic habitat services lost as a consequence of mining-related contamination.

Risks

As for Alternative A2, the risks of buffer preservation are few. However, FWS notes that preservation of the Empire Lake riparian corridor will not have any effect on reducing the extent, bioavailability, or toxicity of residual metal contamination in the area.

Costs

Because no active remediation or restoration is required, the cost per acre of buffer preservation is relatively low. The estimated cost for this option includes funds for: (a) purchasing land or purchasing an easement, and (b) vegetation management and fencing.

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[60] Well drilling and pump costs obtained from memorandum from F. Foshag, Jr., Kansas Department of Health and the Environment, Re: Memo Regarding Drilling Costs (May 3, 2007); and memorandum from W. Ray, Natural Resources Biologist, Oklahoma Department of Wildlife Conservation to E. Phillips, Assistant Attorney General, State of Oklahoma, Re: Pump/Well Costs (July 26, 2007), respectively.

[61] For example, one acre of preserved riparian corridor, if 50 feet in width for both banks, would extend for about 436 feet, or about 0.0825 miles, along a river (43,560 ft^2/acre divided by 100 feet). At a cost of $40,000 per mile for wells, this becomes about $3,300 per acre (i.e., $40,000 multiplied by 0.0825 miles).

Property values vary both over space and time, but for purposes of this RP/EA FWS estimates that the approximate per-acre cost for purchasing these areas is similar to that for high quality riparian buffer areas (*i.e.*, $2,000 to $2,500 per acre (2007$) to purchase, or an easement cost $1,000 to $1,250 of per acre). Vegetation management and fencing costs are approximately $3,100 per acre for a 30-year period and $1.75 per linear foot, respectively (2007$). Total restoration costs would therefore be $4,100 to $5,600 per acre, plus fencing.

IMPROVE RIPARIAN BUFFER: ALTERNATIVE A4

Benefits

The benefits of establishing buffers include enhancement of the protective buffering functions provided by these areas (described above) as well as the provision of valuable habitat for native flora and fauna. The restoration of this habitat type will, therefore, help compensate for past and/or ongoing aquatic habitat services lost as a consequence of mining-related contamination.

Risks

At most sites, establishing a good quality buffer area should be technically feasible. Riparian corridor restoration projects have been completed at many sites around the country. Risks for adverse collateral impacts of this alternative are low. However, FWS notes that riparian corridor preservation will not have any effect on reducing the extent, bioavailability, or toxicity of residual metal contamination in the area.

Costs

The estimated cost for this option includes funds for: (a) purchasing land or purchasing an easement, (b) riparian buffer improvements and fencing, (c) vegetation management, and if necessary, (d) water wells for livestock. Property values vary both over space and time, but FWS estimates that the approximate per-acre cost for purchasing these areas is $2,000 to $2,500 per acre and that an easement would therefore cost $1,000 to $1,250 per acre (2007$). FWS estimates riparian buffer improvement costs of $3,000 per acre (2007$), including site preparation, tree plantings, herbicide treatments, invasive plant and brush management, and fencing.[62] Vegetation management costs are approximately $3,100 per acre for a 30-year period (2007$). If necessary, FWS estimates two water wells per stream mile at a cost of $20,000 per well (or $40,000 per stream mile in 2007$), including installation, pumps, power, tankage, and maintenance. Depending on whether the preserved corridor is 50 or 300 feet wide on each side of the stream, well costs could range from approximately $550 to $3,300 per acre. Total restoration costs are therefore

[62] Vegetation management costs obtained from e-mail communication from R. Atchison, Rural Forestry Coordinator, Kansas Forest Service, Kansas State University to J. Hays, Kansas Department of Health and Environment (May 3, 2007) and 2007 Wildlife Habitat Incentive Program (WHIP) costs, available at http://www.ks.nrcs.usda.gov/programs/whip (last accessed July 24, 2007). These costs are coincidentally similar to the costs estimated for long-term management of vegetation, on a present value basis over 30 years.

approximately $7,600 to $11,900 per acre (2007$), including easement or land purchase costs, plus fencing at $1.75 per linear foot.

DREDGE WATERWAY(S): ALTERNATIVE A5

Benefits

Although other restoration alternatives can reduce ongoing inputs into streams and rivers, dredging is the only approach likely to substantially reduce existing in-stream contamination and thereby reduce metals-related risks to aquatic plants and animals. Dredging would help restore these areas to a state at which the ecological services provided would be closer to those that would have been provided, in the absence of mining-related contamination.

Risks

Although technically feasible, the scale of dredging needed to completely address the extent of current contamination would far outstrip currently available funding and has a significant potential to disturb the existing ecosystem. For this reason, FWS anticipates adopting one or more sediment removal techniques to remove the contaminated material in a way that minimizes disturbance of the remaining aquatic communities and their supporting habitat, reduces the quantity of contaminated material in the stream, and minimizes erosion and headcutting in streams. These techniques include sediment removal from tributaries, sediment removal from confluences in the Spring River with major tributaries, sediment removal behind dams, and gravel bar mining.

Finally, FWS notes that it has not been determined whether or to what extent contaminated sediments in mining impacted Missouri rivers and streams will be removed. In the absence of remedial actions in Missouri, the long-term efficacy of dredging of the Kansas portions of these waterways is uncertain.

Costs

FWS estimates sediment removal costs at approximately $275 per cubic yard (2007$), including installation of flow control structures, backfilling with clean sediment; reconstructing streambanks; dewatering, transportation, and disposal of removed sediments in repositories, subsidences, or other mine workings in the area; and encapsulation and revegetation of disposal areas. If removed sediments can be sieved or separated with the larger uncontaminated fraction returned to the stream instead of clean sediment or backfill (*i.e.*, as would likely be the case for sediment removal behind dams and gravel bar mining), then the cost of removal significantly decreases to approximately $25 per cubic yard[63] (2007$) (assuming 80 percent of the removed sediments represents the larger fraction and is returned to the stream).

[63] Significant cost savings are achieved by elimination of costs for flow control structures, clean sediment or backfill, and stream bank reconstruction; and reduced costs for sediment dewatering and disposal and encapsulation and revegetation of disposal areas.

These values may be converted into approximate per-mile costs assuming a particular dredging regime. For instance, if a waterway contains 11,700 cubic yards per stream mile (*i.e.*, sediments are dredged to a depth of 18 inches across a stream width of 40 feet), sediment removal costs range from $292,500 to $3,217,500 per river mile (in 2007$), depending on the quantity of dredged sediments that may be returned to the waterway. Dredging would likely necessitate buffer improvements (*i.e.*, to stabilize and restore shorelines impacted by dredging). As discussed for Alternative A4, FWS estimates these costs at $8,200 to $15,200 per acre, plus fencing at $1.75 per linear foot (2007$). The cost of buffer improvements per river mile depends on the width of the buffer that is restored.

In addition to the above costs, FWS estimates a cost of approximately $10 million (2007$) to design and construct a common system for treating water produced from all removal and dewatering operations (Alternatives A5 and A6) prior to discharge back to streams, if necessary.

DREDGE EMPIRE LAKE AND INSTALL UNDERWATER SEDIMENT RETENTION STRUCTURES ON SHORT CREEK: ALTERNATIVE A6

Benefits

Dredging the lake combined with the underwater dams on Short Creek would result in the removal of a large quantity of contaminated sediments from Cherokee County's aquatic ecosystem. In the long run, this alternative would result in a healthier biological ecosystem and would reduce the input of contaminated sediments to further downstream reaches of the Spring River. Given that the lake is severely impaired by sedimentation, dredging would also enhance its recreational value, especially for boating and fishing. In other words, dredging would help restore these areas to a state at which the ecological services provided would be closer to those that would have been provided, in the absence of mining-related contamination.

Risks

Dredging would result in the removal, to various depths, of virtually all the material that currently comprises the lake's bottom. Even if conducted in a phased fashion, with certain upstream areas being targeted for treatment prior to other areas, the short-term effects to the existing lake biota would likely be significant. Dredging on this scale would entail the use of large, potentially noisy, pieces of equipment both for actual dredging activities and for subsequent dewatering of sediments and transportation to their final site for disposal.

Costs

FWS estimates sediment removal costs of approximately $35 per cubic yard (2007$), including dewatering, transportation, and disposal of removed sediments in repositories, subsidences, or other mine workings in the area; and encapsulation and revegetation of disposal areas. This cost is higher than the $25 per cubic yard (2007$) cost described above for sediment removal behind dams and gravel bar mining because of the additional costs involved with sediment removal from barges staged within the lake. Juracek (2006) reports that the lake has approximately 4,260 cubic yards of sediment per acre.[64] Consequently, dredging the lake is estimated to cost roughly $149,000 per acre (2007$).

Construction of the three dams on Short Creek is estimated to cost about $1,300,000 (2007$). FWS also estimates that over a 30-year period, operation and maintenance of these structures, plus dredging behind these structures every five years, would cost approximately $350,000 in present-value terms (2007$).[65] A water treatment system (as discussed in Alternative A5) is also necessary.

AQUATIC BIOTA STOCKING OF RIVERS, STREAMS, AND/OR EMPIRE LAKE: ALTERNATIVE A9

Benefits

Once a species is extirpated from a specific waterway or water body, it can take many years for that species to return, if it ever does. Restocking these organisms is a means of jump-starting the ecological recovery process.

Restocking requires the ability to propagate the organisms in an appropriate facility and to grow them until the age of release. Fish propagation and restocking techniques are widely available, and FWS does not anticipate difficulties in developing suitable procedures for whatever fish species might be included in this program. Mussel restocking techniques are newer but have been successful in Missouri and Kansas (Barnhart 2002). Freshwater snail culture and propagation techniques would need to be developed. Aquatic biota restocking would enhance biodiversity and help restore the aquatic food web to a condition that is closer to what it would have been in the absence of mining-related contamination.

Risks

Native species restocking is not anticipated to have adverse collateral effects on the environment. The main risk is that of project failure, especially over the longer term. In Cherokee County, the rivers and streams most in need of restocking are those that have been adversely affected by human activities, especially mining. These waterways remain quite contaminated, and unless steps are taken to remove the contamination, it is possible that restocked biota will not be able to survive and/or reproduce.

Mussel restocking in particular presents some unique challenges. As one of the most imperiled groups of animals in North America (Obermeyer 2000), it is extremely desirable to reintroduce this group; however, mussels not only tend to be sensitive to

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[64] In particular, Table 6 in Juracek (2006) indicates that Empire Lake is about 16,840,000 square feet and contains 44,460,000 cubic feet of sediments. This amounts to approximately 4,260 cubic yards of sediment per acre.

[65] The cost of dredging will depend on the rate of sediment accumulation behind the underwater dams and on the proportion of removed sediments that are fines and must be disposed of rather than coarser particles that could potentially be returned to the river, among other factors.

metals levels but also depend on host fish for certain stages of their reproduction. In many cases, the host fish species associated with the mussel species is not known. Reintroducing a mussel species in the absence of its host fish may result in a temporary mussel population, but the population will not be able to maintain itself in the long term. Any mussel restocking program would have to carefully weigh the utility of restocking a particular species in light of not only the mussel's ability to survive the conditions present in a particular waterway but also that of its host fish. Mussel and snail restocking are also relatively new techniques; it is possible that unanticipated problems would hinder the success of these programs.

Costs

It is difficult to estimate precise costs for a restocking program as a number of the elements have not been decided; however, a rough approximation would be $113,000 (2007$) per fish species per stream mile, assuming that it will take 12 years or three generations to restore fish populations. The fish species likely to be propagated include those listed on the state and/or federal Threatened and Endangered species list such as the Neosho Madtom, Arkansas Darter, and Redspot Chub. For mussel species, FWS estimates approximately $5,000 (2007$) per mussel species per stream mile, assuming that it will take 10 years of propagation to restore mussel populations.[66] The mussel species likely to be propagated include those listed on the state and/or federal threatened and endangered species list such as the elktoe, butterfly, ellipse, flat floater, flutedshell, Neosho mucket, Ouachita kidneyshell, rabbitsfoot, and western fanshell. These figures do not include monitoring costs to evaluate program success in the years after which animals are released.

5.3 MISCELLANEOUS ALTERNATIVES

PILOT PROJECTS: ALTERNATIVE M1

Benefits

The benefits of pilot projects would vary, depending on the specific projects to be implemented. However, in general the projects would focus on developing methods and/or identifying hurdles to be overcome, to facilitate the long-term success and ensure maximum efficiency of implemented alternatives.

Risks

The risks of the pilot projects will be similar to the risks of the restoration alternative(s) addressed by each; however, the risks will be on a smaller scale, due to the more limited extent of the project relative to the full restoration effort.

[66] Costs estimated by Dick Neves, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Costs

The cost of the pilot project(s) will vary depending on the specific projects to be implemented. However, in keeping with the amount of money available from the bankruptcy proceedings, FWS generally expects that each pilot project would range in cost from about $30,000 to $100,000.

PUBLIC OUTREACH: ALTERNATIVE M2

Benefits

The benefits of public outreach include enhanced communication and understanding between FWS and the public, whose interests FWS is charged with serving. Better communication will make for more successful projects, and ones that better reflect the interests of the public as a whole.

Risks

FWS does not believe that this alternative includes significant risks. FWS notes that this alternative will not result in direct improvements in environmental conditions, although indirect improvements are likely.

Costs

Costs for this public outreach program will vary depending on the nature and extent of activities included in it. However, FWS estimates that producing a half-hour educational film would cost about $50,000. The production of brochures and similar educational materials is also expected to cost approximately $50,000. Public meetings are expected to cost between $1,000 and $3,000 each.

5.4 SUMMARY OF IMPACTS BY ALTERNATIVE

The evaluation of restoration alternatives can be framed in different ways. As noted previously, factors considered by FWS in the evaluation of alternatives include:

(1) The degree to which the project would provide the public with ecological services similar to those lost as a consequence of mining contamination;

(2) Technical feasibility (*i.e.*, whether it is possible to implement the alternative);

(3) The probability of project success (*i.e.*, the likelihood that implementing the alternative would produce the desired results);

(4) The anticipated relationship of costs to benefits;

(5) The relative cost-effectiveness of different alternatives (*i.e.*, if two alternatives are expected to produce similar benefits, the least costly one is preferred);

(6) The ability of the natural resources to recover with or without each alternative, and the time required for such recovery;

(7) The potential for collateral injury to the environment if the alternative is implemented;

(8) Potential effects on public health and safety;

(9) The results of actual or currently-planned response actions;

(10) Compliance with applicable Federal and state laws; and

(11) Consistency with relevant Federal and state policies.

Exhibits 34 through 36 provide an overview of the alternatives retained for consideration, highlighting the key benefits and risks of the types listed above.

NEPA guidance conceptualizes the evaluation of alternatives in terms of the potential to impact *biological*, *physical*, *social*, *cultural*, and *economic* conditions. Many of these impacts were touched on in the previous paragraphs, and Exhibits 37 through 39 summarizes the results, using the NEPA framework.

EXHIBIT 34 TERRESTRIAL RESTORATION ALTERNATIVES: BENEFITS AND RISKS

NAME	DESCRIPTION	BENEFITS	RISKS
T1	No action	• Lowest cost. • Technically feasible.	• No significant improvement in environmental conditions anticipated.
T2	Preserve native prairies	• Preserve rare, rich ecosystem remnants. • Technically feasible.	• No reduction in metals levels or associated injuries.
T3	High quality prairie restoration	• Increase quantity of high quality habitat. • Technically feasible in most if not all cases.	• No reduction in metals levels or associated injuries.
T4	CRP grassland restoration	• Increase quantity of good quality habitat. • Technically feasible in most if not all cases.	• No reduction in metals levels or associated injuries.
T5	Cool season grassland restoration	• Increase quantity of fair quality habitat. • Technically feasible in most if not all cases.	• No reduction in metals levels or associated injuries.
T6	Remove and dispose of terrestrial mine wastes in subsidences; cap subsidences	• Reduces exposure of terrestrial and aquatic biota to metals. • Technically feasible at least for some quantity of wastes.	• Potential risk of ground water contamination. • Unclear if sufficient subsidence space available to accommodate all wastes. • Potential injury to borrow area if poorly designed.
T7	Mine waste recontouring	• May reduce exposure of terrestrial and aquatic biota to metals by reducing erosion and runoff. • Technically feasible.	• Low probability of substantial reductions in metal inputs and sustained vegetation growth over the long-term.
T8	Mine waste recontouring and encapsulation	• Reduces exposure of terrestrial and aquatic biota to metals. • Technically feasible.	• Cap failure and re-exposure to contaminated materials, although these risks can be minimized with good cap design and a monitoring program. • Potential injury to borrow area if poorly designed.
T9	Apply biosolid amendments beneath planned EPA caps	• Improves long-term effectiveness and recovery of encapsulated mine wastes. • May also have a treatment effect by fixing and stabilizing metals in mine wastes. • Technically feasible.	• May be difficult to coordinate with EPA capping remedy. • Reliable supply of amendment materials may be limited.
T10	Improve EPA mine waste caps (through soil amendments and fencing)	• Improves long-term effectiveness and recovery of encapsulated mine wastes. • May also have a treatment effect by fixing and stabilizing metals in mine wastes. • Technically feasible.	• Reliable supply of amendment materials may be limited.

EXHIBIT 35 AQUATIC RESTORATION ALTERNATIVES: BENEFITS AND RISKS

NAME	DESCRIPTION	BENEFITS	RISKS
A1	No action	• Lowest cost. • Technically feasible.	• No substantial improvement in environmental conditions.
A2	Preserve high quality riparian corridor	• Preserve highly-valued ecosystem type. • Technically feasible.	• No reduction in metals levels or associated injuries.
A3	Preserve Empire Lake buffer	• Increase quantity of high quality habitat. • Technically feasible in most if not all cases.	• No reduction in metals levels or associated injuries.
A4	Improve riparian buffer	• Increase quantity of high quality habitat. • Technically feasible in most if not all cases.	• No reduction in metals levels or associated injuries.
A5	Dredge waterway(s)	• Reduces exposure of aquatic biota to metals. • Technically feasible.	• Ongoing input from Missouri may result in re-contamination of some areas. • Potential disturbance to existing ecosystem. • A comprehensive approach would be a large-scale effort and beyond available funding.
A6	Dredge Empire Lake; install underwater sediment retention structures on Short Creek	• Reduces exposure of aquatic biota to metals. • Enhances recreational value of lake. • Technically feasible.	• Scale of effort likely to be large and beyond available funding.
A9	Aquatic biota stocking	• Replaces species lost from certain river or stream reaches. • Technically feasible for at least some key species.	• No reduction in metals levels or associated injuries. • In the absence of reductions in current metals levels, some stocked biota might not be able to survive and/or reproduce. • Some methods development/preparatory research may be required.

EXHIBIT 36 MISCELLANEOUS ALTERNATIVES: BENEFITS AND RISKS

NAME	DESCRIPTION	BENEFITS	RISKS
M1	Pilot projects	• Enhances probability of success and/or efficiency in expenditures of full-scale efforts.	• Depend on specifics of the project(s).
M2	Public outreach	• Enhanced communication. • Better development and implementation of restoration alternatives.	• Little or no direct improvements in environmental conditions.

EXHIBIT 37 TERRESTRIAL RESTORATION ALTERNATIVES: HUMAN USE AND ECOLOGICAL IMPACTS

NAME	DESCRIPTION	HUMAN USE IMPACTS (SOCIAL, ECONOMIC, RECREATIONAL, AND/OR CULTURAL)	ECOLOGICAL IMPACTS (TO PHYSICAL AND BIOLOGICAL RESOURCES)
T1	No action	• No significant changes anticipated.	• No significant improvement in environmental conditions anticipated.
T2	Preserve native prairies	• Willing landowners will receive compensation in exchange for the sale of property and/or easements on property.	• Ecological services (*i.e.*, habitat provision, bird and wildlife forage opportunities) provided by these areas will be preserved. • No impacts to physical natural resources are anticipated. • No reductions in metals levels or associated injuries are anticipated.
T3	High quality prairie restoration	• Willing landowners will receive compensation in exchange for the sale of property and/or easements on property.	• Ecological services (*i.e.*, habitat provision, bird and wildlife forage opportunities, biodiversity) will be enhanced at project locations. • No reduction in metals levels or associated injuries anticipated.
T4	CRP grassland restoration	• Willing landowners will receive compensation in exchange for the sale of property and/or easements on property.	• Ecological services (*i.e.*, habitat provision, bird and wildlife forage opportunities, biodiversity) will be enhanced at project locations, although to a lesser degree than in T3. • No reduction in metals levels or associated injuries anticipated.
T5	Cool season grassland restoration	• Willing landowners will receive compensation in exchange for the sale of property and/or easements on property.	• Ecological services (*i.e.*, habitat provision, forage opportunities, biodiversity) will be enhanced at treated locations, although to a lesser degree than in T4. • No reduction in metals levels or associated injuries anticipated.
T6	Remove and dispose of terrestrial mine wastes in subsidences; cap subsidences	• Potential for positive impacts to local economy, depending on size of effort.	• Reduces exposure of terrestrial and aquatic biota to metals. • Potential risk of groundwater contamination • Potential injury to borrow area if poorly designed.
T7	Mine waste recontouring	• Potential for positive impacts to local economy, depending on size of effort.	• May reduce exposure of terrestrial and aquatic biota to metals by reducing erosion and runoff.

NAME	DESCRIPTION	HUMAN USE IMPACTS (SOCIAL, ECONOMIC, RECREATIONAL, AND/OR CULTURAL)	ECOLOGICAL IMPACTS (TO PHYSICAL AND BIOLOGICAL RESOURCES)
T8	Mine waste recontouring and encapsulation	• Potential for positive impacts to local economy, depending on size of effort.	• Reduces exposure of terrestrial and aquatic biota to metals. • Potential for cap failure and re-exposure to contaminated materials, although these risks can be minimized with good cap design and a monitoring program • Potential injury to borrow area if poorly designed.
T9	Apply biosolid amendments beneath planned EPA caps	• Potential for positive impacts to local economy, depending on size of effort.	• Reuses biosolids and carbon-rich matter. • Reduces exposure of terrestrial and aquatic biota to metals. • May have a treatment effect resulting in long-term risk reduction by fixing and stabilizing mine wastes.
T10	Improve EPA mine waste caps (through soil amendments and fencing)	• Potential for positive impacts to local economy, depending on size of effort.	• Reuses biosolids and carbon-rich matter. • Reduces exposure of terrestrial and aquatic biota to metals. • May have a treatment effect resulting in long-term risk reduction by fixing and stabilizing mine wastes.

EXHIBIT 38 AQUATIC RESTORATION ALTERNATIVES: HUMAN USE AND ECOLOGICAL IMPACTS

NAME	DESCRIPTION	HUMAN USE IMPACTS (SOCIAL, ECONOMIC, RECREATIONAL, AND/OR CULTURAL)	ECOLOGICAL IMPACTS (TO PHYSICAL AND BIOLOGICAL RESOURCES)
A1	No action	• No significant changes anticipated.	• No significant improvement in environmental conditions anticipated.
A2	Preserve high quality riparian corridors	• Willing landowners will receive compensation in exchange for the sale of property and/or easements on property.	• Ecological services (*i.e.*, buffering, habitat provision, bird and wildlife forage opportunities) provided by these areas will be preserved. • No reduction in metals levels or associated injuries anticipated.
A3	Preserve Empire Lake buffer	• Willing landowners will receive compensation in exchange for the sale of property and/or easements on property.	• Ecological services (*i.e.*, buffering, habitat provision, bird and wildlife forage opportunities, biodiversity) will be enhanced at project locations. • No reduction in metals levels or associated injuries anticipated.
A4	Improve riparian buffer	• Willing landowners will receive compensation in exchange for the sale of property and/or easements on property.	• Ecological services (*i.e.*, buffering, habitat provision, bird and wildlife forage opportunities, biodiversity) will be enhanced at project locations. • No reduction in metals levels or associated injuries anticipated.
A5	Dredge waterway(s)	• Potential for positive impacts to local economy, depending on size of effort.	• Long-term reduction in exposure of aquatic biota to metals anticipated. • Potential for short-term increase in metals exposure during dredging, which can be minimized with careful monitoring of dredging operations. • Risk of undesirable hydrologic and/or morphological impacts to waterways, which can be mitigated with careful program design and use of alternative sediment removal techniques (*i.e.*, gravel bar mining, removal of sediment from behind dams and depositional areas.
A6	Dredge Empire Lake; install underwater sediment retention structures on Short Creek	• Recreational value of lake enhanced. • Potential for positive impacts to local economy, depending on size of effort.	• Reduces exposure of aquatic biota to metals. • Potential impacts to hydrology of Short Creek.
A9	Aquatic biota stocking	• No significant changes anticipated.	• Replaces species lost from certain river or stream reaches, enhancing biodiversity and ecosystem integrity. • No reduction in metals levels or associated injuries anticipated.

EXHIBIT 39 MISCELLANEOUS ALTERNATIVES: HUMAN USE AND ECOLOGICAL IMPACTS

NAME	DESCRIPTION	HUMAN USE IMPACTS (SOCIAL, ECONOMIC, RECREATIONAL, AND/OR CULTURAL)	ECOLOGICAL IMPACTS (TO PHYSICAL AND BIOLOGICAL RESOURCES)
M1	Pilot projects	• No significant changes anticipated.	• Impacts depend on specifics of the pilot project(s) implemented but in general are anticipated to be smaller than the full-scale equivalent effort.
M2	Public outreach	• No significant changes anticipated.	• No direct significant improvement in environmental conditions anticipated; however, if outreach successfully encourages landowners to participate in restoration activities, indirect benefits may be realized.