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# CHEROKEE COUNTY

## Restoration Plan/ Environmental Assessment

December 2008

prepared for:

U.S. Department of the Interior

U.S. Fish and Wildlife Service


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## EXECUTIVE SUMMARY

Cherokee County, Kansas is part of the Tri-State Mining District, an approximately 2,500 square mile area that extends east and south to neighboring counties in Missouri and Oklahoma. The Tri-State Mining District has been extensively mined for lead and zinc for more than a century and was a major producer of these metals. During the period 1850-1950, the district produced 50 percent of the zinc and 10 percent of the lead in the United States (Brosius and Sawin 2001).

Past mining and related activities in the Tri-State Mining District have resulted in releases of metals such as cadmium, lead, and zinc to the local environment. Large piles of mining and milling wastes remain in the area, and metals have contaminated area soils, waters, ground water, and biota. Cadmium, lead, and zinc are toxic at sufficiently high concentrations, and contamination by these metals has resulted in a variety of injuries to natural resources (State of Kansas and DOI 2003). Although the full extent of these injuries has not yet been evaluated, there is a clear need to restore, rehabilitate, replace, and/or acquire the equivalent of the injured natural resources and the services they provide. This restoration plan applies only to Cherokee County, Kansas, and does not address restoration alternatives for the Missouri or Oklahoma portions of the Tri-State Mining District.

Many mining companies have operated in Cherokee County over the years, and only a fraction of these are still in business today. Recent years have seen a number of bankruptcy filings by companies that formerly owned and operated mines, and/or engaged in mining-related activities in Cherokee County. Two of these companies are Eagle-Picher Industries, Inc. (Eagle-Picher) and LTV Corporation (LTV). Eagle-Picher filed a petition under Chapter 11 of the United States Bankruptcy Code in 1991, re-organized, and in 2006 again filed under Chapter 11. LTV filed a petition under Chapter 11 in 1986, reorganized, and in 2000 again filed under Chapter 11.

During the companies' initial bankruptcy proceedings, the U.S. Fish and Wildlife Service (FWS) submitted a claim for damages in compensation for mining-related injuries to natural resources held under the trusteeship of the Department of the Interior (DOI). Negotiations ensued, and FWS eventually received approximately $2.6 million, including interest accrued to date, from the Eagle-Picher and LTV bankruptcy estates. FWS may also recover damages associated with injuries to natural resources in Cherokee County in conjunction with settlement negotiations with other current or former mining companies. FWS intends to use this restoration plan to focus possible restoration actions associated with future negotiations with other potentially responsible parties.

FWS is required to use the recovered funds to restore, rehabilitate, replace, and/or acquire the equivalent of the natural resources and those associated services that were injured as a consequence of these firms' mining activities in Cherokee County. This Restoration Plan/Environmental Assessment (RP/EA) describes FWS's broad priorities and general plans with respect to the use of these funds and any funds related to natural resource damages that may be acquired in the future. As an EA, this plan serves to facilitate public involvement in the plan and to comply with environmental decision-making requirements.

This RP/EA does not identify specific locations, scales, or other detailed information on potential restoration projects for a number of reasons. One of the most important reasons is the necessity of identifying landowners who are willing to work with FWS to pursue one or more of the specified alternatives: much of the land in question is privately held, and FWS may implement the alternatives described only with willing landowner cooperation. Therefore, instead of presenting specific locations or scales of activity, FWS identifies generally-preferred types of restoration projects. FWS intends to expend available funds in pursuit of cost-effective, environmentally beneficial projects. To best match restoration projects to associated injuries, FWS intends to implement its preferred restoration alternatives in areas impacted by the bankrupt firms' operations, namely within Cherokee County. However, FWS recognizes that adequate opportunities for restoration activities may be limited within these areas, and therefore will also consider restoration in surrounding areas (*i.e.*, Crawford, Montgomery, and Labette Counties).

Altogether, this RP/EA identifies and describes ten restoration alternatives for terrestrial habitats, nine restoration alternatives for aquatic habitats, and two non-habitat specific alternatives. It then evaluates these alternatives, taking into account a variety of factors including (43 CFR §11.82(c)):

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.

Based on these factors, FWS identifies and ranks the following groups of alternatives (Exhibit ES-1 through ES-3). Groups are ranked in order of priority. Within a rank group, alternatives are listed in FWS's order of preference, although differences in priority between rank groups are generally larger than differences in priority within a group. Two non-habitat specific alternatives are also included among the preferred alternatives.

### EXHIBIT ES-1 PRIORITIES FOR TERRESTRIAL ALTERNATIVES

| PRIORITY RANK GROUP | TERRESTRIAL | |
|---|---|---|
| | ALTERNATIVE NUMBER | DESCRIPTION |
| 1 | T2*✝ | Preserve native prairies |
| 2 | T3*✝ | High quality prairie restoration (no biosolids required) |
| | T4*✝ | CRP grassland restoration (no biosolids required) |
| | T10 | Improve EPA mine waste caps (through soil amendments and fencing) |
| | T5*✝ | Cool season grassland restoration (no biosolids required) |
| 3 | T3⁂ | High quality prairie restoration (biosolids required) |
| | T4⁂ | CRP grassland restoration (biosolids required) |
| | T5⁂ | Cool season grassland restoration (biosolids required) |
| | T6 (with T3, T4, or T5) | Remove and dispose of terrestrial mine wastes in subsidences; cap subsidences; replant |
| | T8 (with T3, T4, or T5) | Mine waste recontouring and encapsulation; replant |
| | T9 | Apply biosolid amendments beneath planned EPA caps |
| | T7 (with T3, T4, or T5) | Mine waste recontouring; replant |

Notes:
* Preferably in Cherokee County but potentially in neighboring Kansas counties.
✝ At non-mining related sites.
⁂ At mining-related sites.

**EXHIBIT ES-2 PRIORITIES FOR AQUATIC ALTERNATIVES**

| PRIORITY RANK GROUP | TERRESTRIAL | |
|---|---|---|
| | ALTERNATIVE NUMBER | DESCRIPTION |
| 1 | A2 | Preserve high quality riparian corridors |
| | A3 | Preserve Empire Lake buffer |
| 2 | A4 | Improve riparian buffer |
| 3 | A5 with A4 and A9 | Dredge waterways, restore buffer, restock |
| | A6 | Dredge Empire Lake; install and maintain underwater sediment retention structures on Short Creek |

**EXHIBIT ES-3 PRIORITIES FOR MISCELLANEOUS ALTERNATIVES**

| PRIORITY RANK GROUP | TERRESTRIAL | |
|---|---|---|
| | ALTERNATIVE NUMBER | DESCRIPTION |
| 1 | M1 | Pilot projects |
| | M2 | Public outreach |

FWS's first overall priority is the preservation of existing high quality habitat, including native prairies (usually in the form of native prairie hay meadows), high quality riparian corridors, and Empire Lake buffer. Preserving these areas would include purchasing land or easements from willing landowners, fencing the sites, and managing them over time. At this point, FWS has not determined who would hold the titles to any purchases or easements; options potentially include agencies within the State of Kansas or non-governmental organizations.

FWS anticipates that preservation of these areas will produce significant ecological benefits similar to the ecological services lost due to mining and related activities. For one, FWS believes that most if not all Cherokee County native prairie remnants can reasonably be considered to be in imminent danger: as one of the rarest types of ecosystems in the world, the habitat has been subject to extensive degradation and destruction throughout its range, including Cherokee County. High quality riparian areas are not very common within the county, and much of the shoreline of Empire Lake, the only lake within the county, has already been developed. Furthermore, almost all the areas to be preserved are in private hands, and in the absence of easements, current or future owners may use these areas as they see fit. It is therefore possible that degradation of these valuable habitats could occur at any time.

FWS's prioritization of the preservation of these habitat types is also based on the high ecological value provided by these areas, the lack of technical challenges in preserving these areas, and the relatively low cost, in that the main costs would be acquisition of land (or purchase of easements on the land) and management thereafter. Preservation of existing high quality habitat will not result in collateral injury to the environment, poses no risk to the public health, and can be accomplished in a manner that is consistent with state and Federal laws and policies[1]. In addition, habitat preservation will not delay EPA's remedial activities and will not be a detriment to the achievement of EPA's remedial goals.

For similar reasons, FWS's second overall priority for terrestrial and aquatic areas is to restore more degraded habitat types to a high quality state. This would entail purchasing property or easements from willing landowners, preparing the soil, controlling unwanted vegetation, and seeding the site, preferably with a native species mix. These alternatives also require funding to support the long-term management of the selected sites.

FWS notes that in selecting specific parcels for preservation or vegetative restoration, FWS generally favors those with one or more of the following characteristics:

- Those that fall within areas designated as critical habitat for threatened or endangered species;
- Those that are larger, as larger areas generally provide superior habitat than would smaller, fragmented areas even if equal in total size;
- Those that are contiguous with or close to other protected areas, as this helps to provide wildlife corridors and decreases habitat fragmentation;
- Those that are of higher habitat quality; and
- Those with greater proximity to mining-affected areas. All else equal, areas within Cherokee County are preferred over areas in adjacent counties.

Most of the alternatives described above are intended for sites where mine wastes are not present. FWS's third-ranked groups of alternatives address those areas where mine wastes still remain. At terrestrial sites, these alternatives entail applying biosolid amendments to mine waste areas and replanting. This group also includes other primary restoration measures such as waste removal and disposal in subsidences, encapsulation, and recontouring, among others. Replanting with a seed mix (preferably native) must be performed concomitant with such measures to restore the quality of the habitat.

At aquatic sites, the third priority group of alternatives also includes primary restoration activities such as the removal of contaminated sediments from depositional areas in rivers and creeks (*i.e.*, at confluence areas and behind dams), and the removal of contaminated sediments from Empire Lake. Appropriate measures to restore the quality of the habitat, such restocking aquatic species and restoring buffer areas are included.

[1] Applicable federal policies include DOI Environmental Quality Programs Part 518, Waste Management, Part 602, Land Acquisition, Exchange and Disposal, and Fish and Wildlife Service Manual 341 FW 3, Pre-Acquisition Environmental Site Assessment.

Addressing terrestrial or aquatic mine wastes in any reasonably effective fashion is expensive. Given the limited amount of funds currently available, a lower priority has been assigned to addressing mine waste in Cherokee County. However, the FWS recognizes there may be opportunities in the future to further reduce the bioavailability of metals in these wastes and thereby further reduce risks to terrestrial resources including migratory birds and endangered and threatened species. These opportunities may be pursued, dependent on the availability of additional funding.

To complement the terrestrial and aquatic preferred alternatives proposed above, FWS plans to implement both the M1 (pilot projects) and M2 (public outreach) alternatives. Adequate methods development and public outreach are key components to restoration project success, although they do not result in significant direct improvements in environmental conditions. Thus the M1 and M2 alternatives are not assigned a distinct priority relative to the other restoration projects but will be implemented as appropriate, regardless of the final terrestrial and aquatic alternatives selected.

FWS also notes that most of the proposed alternatives would require the cooperation of willing landowners, and that for various reasons, some landowners may prefer alternatives other than those preferred by FWS. FWS recognizes the need to identify restoration alternatives for specific parcels of land that are acceptable to landowners as well as to FWS.

When available, further information about Cherokee County restoration will be posted to the following website:

http://mountain-prairie.fws.gov/nrda/CherokeeCounty.htm.

# CHAPTER 1 | INTRODUCTION

Eagle-Picher Industries, Inc. (Eagle-Picher) and LTV Corporation (LTV) are two companies that formerly owned and operated mines, and engaged in mining-related activities within Cherokee County. Eagle-Picher filed a petition under Chapter 11 of the Bankruptcy Code in 1991, reorganized, and in 2006 again filed under Chapter 11. LTV filed a petition under Chapter 11 in 1986, reorganized, and in 2000 again filed under Chapter 11.

During the companies' initial bankruptcy proceedings, the U.S. Fish and Wildlife Service (FWS) claimed money in compensation for mining-related injuries to Cherokee County natural resources for which FWS has stewardship responsibilities. In particular, during the 1991 Eagle-Picher proceedings, FWS negotiated a $3 million allowed claim, of which approximately $1.2 million has been received. During the 1986 LTV proceedings, FWS negotiated a $2.5 million allowed claim, of which approximately $540,000 has been received.[2] FWS may also recover damages associated with injuries to natural resources in Cherokee County in conjunction with settlement negotiations with other current or former mining companies. FWS intends to use this restoration plan to focus possible restoration actions associated with future negotiations with other potentially responsible parties.

FWS is required to use recovered natural resource damages to restore, rehabilitate, replace, and/or acquire the equivalent of the natural resources and their associated services that were injured. This Restoration Plan/ Environmental Assessment (RP/EA) describes FWS's broad priorities and general plans with respect to the use of these funds. In particular, this document:

- Identifies the types of restoration projects that FWS proposes to undertake with any recovered natural resource damage funds;
- Describes FWS's rationale for the selection and prioritization of projects;
- Serves as an Environmental Assessment (EA) as required under the National Environmental Policy Act of 1969 (NEPA).[3]

This RP/EA does not identify specific locations, scales, or other detailed information on potential restoration projects. Instead, FWS identifies generally-preferred types of restoration projects, and will expend available funds in pursuit of cost-effective,

[2] These amounts do not include interest accrued since their receipt.

[3] Pub. L. No. 91-190, 42 U.S.C. 4321-4347, January 1, 1970, as amended by Pub. L. No. 94-52, July 3, 1975, Pub. L. No. 94-83, August 9, 1975, and Pub. L. No. 97-258, § 4(b), Sept. 13, 1982.

environmentally beneficial projects available at the time of implementation. FWS believes this approach is appropriate for several reasons:

1. Much of the land in question is privately held, and FWS may implement restoration activities in these areas only with landowner cooperation. Before specific sites and areas can be identified, FWS needs to identify those landowners who are willing to explore restoration options for their property.

2. The presentation of detailed plans at this time (*i.e.,* specifying particular pieces of property that would be a priority to FWS) could result in increased costs relating to those areas.

3. A general approach allows for increased flexibility, allowing FWS to take advantage of opportunities that may arise as ongoing information-gathering activities occur.

4. While mining-related injuries to natural resources throughout Cherokee County are in the process of being identified, documented, and quantified through other regulatory processes,[4] funds currently available for restoration are small compared to the likely scale of environmental injury at sites impacted in part by historical mining operations. Expenditure of bankruptcy funds will not result in over-compensation of the public for past and ongoing injuries to natural resources.

As an environmental assessment (EA), this document represents a critical stage in the NEPA-mandated process (Exhibit 1). Based on this EA, a determination will be made as to whether the Federal actions are likely to cause significant adverse effects to the environment. If significant effects are anticipated, an Environmental Impact Statement (EIS) must then be prepared, which evaluates potential effects in a great deal more detail, and only after which a determination may be made about whether to proceed with the project. If no significant adverse effects are anticipated, a Finding of No Significant Impact (FONSI) is issued, and the project may be implemented.

The remainder of this report contains the following chapters:

- Chapter 2 provides additional background information on topics such as the purpose and need for restoration, the history of mining in the Cherokee County area, Eagle-Picher's and LTV's contributions to mining contamination, and other information;

- Chapter 3 describes the affected environment;

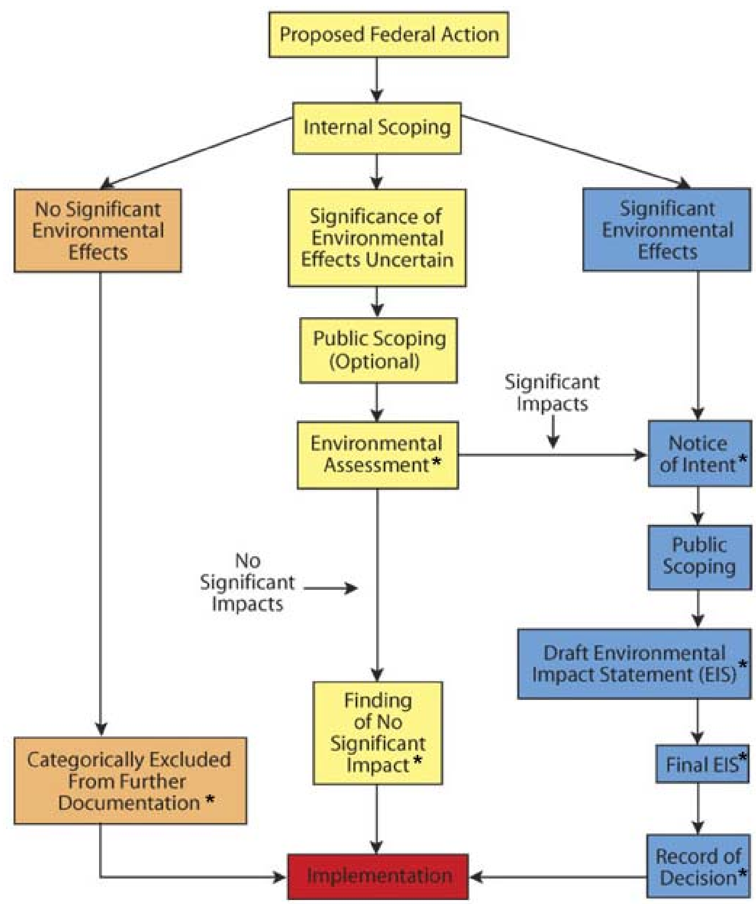
- Chapter 4 introduces the restoration alternatives;

- Chapter 5 evaluates the restoration alternatives according to a number of criteria, including the likely environmental consequences of each; and

- Chapter 6 presents FWS's preferred alternatives.

[4] In particular, a natural resource damage assessment (NRDA) for the Cherokee County site as a whole is ongoing. The NRDA process will be briefly described later in this document.

**EXHIBIT 1 NEPA DECISION-MAKING**




In addition to the public scoping steps indicated in this figure, opportunities for public review and comment occur at the stages indicated by an asterisk (*).

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# CHAPTER 2 | PURPOSE AND NEED: BACKGROUND

## 2.1 PURPOSE AND NEED FOR RESTORATION

Mining and mining-related activities contributed to cadmium (Cd), lead (Pb), and zinc (Zn) contamination at a variety of locations within Cherokee County. Cadmium, lead, and zinc are hazardous substances, and there is little doubt that many natural resources within the County–such as rivers, soils, plants, and animals–are, and/or have been injured by exposure to these metals (State of Kansas and DOI 2003). Although the full extent of these injuries has not yet been evaluated, there is a clear need to restore, rehabilitate, replace, and/or acquire the equivalent of the injured natural resources and the services they provide. Chapter 4 describes in more detail available information about the nature and extent of metals-related injuries to Cherokee County's natural resources.

The purpose of this RP/EA is to determine the best way(s) to use the funds available from the Eagle-Picher and LTV bankruptcy proceedings, and any other funds that may be similarly acquired in the future, to compensate the public for past and ongoing mining-related injuries to Cherokee County natural resources. The RP/EA considers a number of restoration alternatives and evaluates them according to a number of factors such as technical feasibility, cost effectiveness, and other considerations, and serves as a plan for implementing the selected alternative as required under the Department of Interior's Natural Resource Damage Assessment regulations as set forth at 43 CFR Part 11.

## 2.2 AUTHORITIES AND LEGAL REQUIREMENTS

This section briefly reviews a number of laws, executive orders, and DOI policies that provide the legal framework for this RP/EA. The discussion begins with Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) because it is the authorizing legislation behind the mining-related remedial actions that have taken place to date within Cherokee County. CERCLA is discussed both as the authorizing legislation for the Superfund program and for ongoing natural resource damage assessment activities in the area. The National Environmental Policy Act of 1969 (NEPA) is then discussed, followed by a number of additional relevant authorities.

### CERCLA AND SUPERFUND: CHEROKEE COUNTY SITE HISTORY

CERCLA is the authorizing legislation for the U.S. Environmental Protection Agency's (EPA) Superfund program. Under this authorization, and beginning over two decades ago, EPA started its evaluation of the Tri-State Mining District. EPA's evaluation focused on threats posed to human health and the environment by mining-related releases of hazardous substances, particularly metals. Based on the results of its evaluation, EPA placed each state's portion of the Tri-State Mining District on its National Priorities List (NPL), and each state's portion of the district became one or more distinct Superfund sites.[5] The resulting Superfund sites are: the Oronogo-Duenweg Mining Belt Superfund Site (Jasper County, MO), the Newton County Superfund Site (Newton County, MO), the Cherokee County Superfund Site (referred to hereafter as the Cherokee County Site), and the Tar Creek Superfund Site (Ottawa County, OK). The Cherokee County Site was added to the NPL in 1983.

EPA has divided the Cherokee County Site into a number of subsites, and into different operable units (OUs).[6] These divisions facilitate the identification, selection, and implementation of remedial activities at the sites. Exhibit 3 shows the seven subsites within the Cherokee County Site. EPA has conducted cleanups at some of the identified OUs, while cleanup actions for others are planned or are otherwise in progress. Exhibit 2 shows which OUs are associated with which subsites.

**EXHIBIT 2 CHEROKEE COUNTY OPERABLE UNIT - SUBSITE ASSOCIATIONS**

| OPERABLE UNIT | SUBSITE |
|---|---|
| 1 – Alternate water supply | Galena |
| 2 – Spring River | N/A |
| 3 – Mining and milling wastes | Baxter Springs |
| 4 – Mining and milling wastes | Treece |
| 5 – Ground water and surface water | Galena |
| 6 – Mining and milling wastes | Badger, Lawton, Waco, Crestline |
| 7 – Residential soils | Galena |

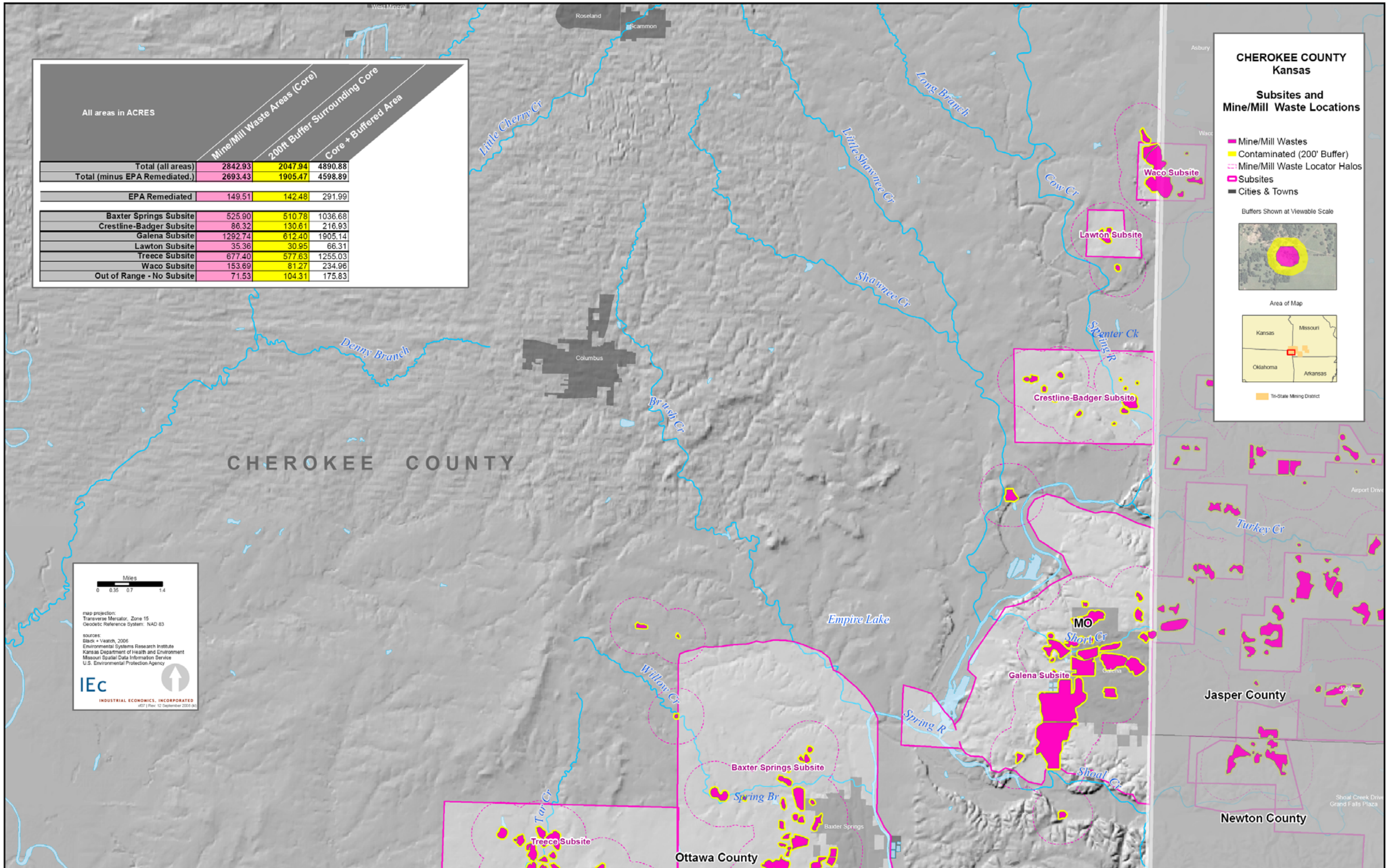
Restoration alternatives discussed in this RP/EA are not intended to replace or duplicate efforts undertaken by EPA or other organizations. They are intended to address areas of contamination for which no current EPA or other remediation plans exist, or residual resource injuries in areas where remedial actions have occurred or will occur. The restoration alternatives described here may also address interim losses[7] to natural resources.

[5] The NPL is a list of the worst hazardous waste sites that have been identified by EPA. The list is primarily an information resource that identifies sites that may warrant cleanup. The NPL is operated under the auspices of EPA's Superfund Program, the Federal government's CERCLA-authorized program to clean up the nation's uncontrolled hazardous waste sites.

[6] A subsite is a geographically distinct portion of a Superfund site. An operable unit is a term for each of a number of separate activities undertaken as part of a Superfund site cleanup. For example, the Galena subsite in Cherokee County has several operable units, including residential soils, ground water/surface water, and alternate water supply.

[7] Interim losses are measurable, adverse reductions in the quality or viability of a natural resource. Interim losses are those losses occur between the time of initial injury and the time at which the resource's condition is restored to baseline (*i.e.*, to the condition it would have had in the absence of the contaminant release). Within certain legal limits, Trustees are allowed to pursue compensation for interim losses to natural resources, even if the resources have fully recovered.

**EXHIBIT 3 CHEROKEE COUNTY SUPERFUND SITE: SUBSITES AND MINE/MILL WASTES**




| All areas in ACRES | Mine/Mill Waste Areas (Core) | 200ft Buffer Surrounding Core | Core + Buffered Area |
|---|---|---|---|
| Total (all areas) | 2842.93 | 2047.94 | 4890.88 |
| Total (minus EPA Remediated.) | 2693.43 | 1905.47 | 4598.89 |
| EPA Remediated | 149.51 | 142.48 | 291.99 |
| Baxter Springs Subsite | 525.90 | 510.78 | 1036.68 |
| Crestline-Badger Subsite | 86.32 | 130.61 | 216.93 |
| Galena Subsite | 1292.74 | 612.40 | 1905.14 |
| Lawton Subsite | 35.36 | 30.95 | 66.31 |
| Treece Subsite | 677.40 | 577.63 | 1255.03 |
| Waco Subsite | 153.69 | 81.27 | 234.96 |
| Out of Range - No Subsite | 71.53 | 104.31 | 175.83 |

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### CERCLA AND NATURAL RESOURCE DAMAGE ASSESSMENT (NRDA)

In addition to providing the legal framework for EPA's Superfund program, CERCLA (43 CFR Part II) authorizes designated Trustees of natural resources the authority to act on behalf of the public to recover damages for injuries to natural resources and to restore, rehabilitate, replace, or acquire the equivalent of the injured natural resources and their associated services. Under Section 107(F) of CERCLA and Section 311 of the Federal Water Pollution Control Act 33 USC §1251 *et seq.* (more commonly known as the Clean Water Act, CWA), and other applicable Federal and State laws, including subpart G of the National Contingency Plan (NCP) 40 CFR §§ 300.606-300.615 , the State of Kansas and the U.S. Department of the Interior (DOI) are the Trustees for the natural resources in Cherokee County (State of Kansas and DOI 2003). Natural resources include surface waters (rivers, lakes, streams, *etc.*), ground water, soils, air, plants, and wildlife. As Trustees, the State of Kansas and DOI serve as stewards for these resources within Cherokee County and have the authority to assess potential contaminant-related injuries to them.

The process through which the Trustees evaluate injuries associated with the release of hazardous substances and determine appropriate compensation for those injuries is called natural resource damage assessment (NRDA). NRDA complements EPA Superfund actions by providing a means to restore injured natural resources to the condition they would have been in but for unpermitted contaminant releases, and to compensate the public for interim lost services provided by those resources.

The Trustees are partway through the NRDA process. A damage assessment plan has been produced,[8] which describes the currently-planned activities for investigating and quantifying potential mining-related injuries to Cherokee County's natural resources. The investigation and quantification of these injuries is not complete, however, and no other plans or approaches for restoring, replacing, or acquiring the equivalent of the injured natural resources and their services, have yet been developed as part of the NRDA process.

### NATIONAL ENVIRONMENTAL PROTECTION ACT (NEPA) OF 1969

As noted previously, this restoration plan also serves as an environmental assessment under NEPA and as such has been prepared in accordance with NEPA (42 U.S.C. §§4371 *et seq.*) as amended, its implementing regulations (40 CFR §§1500 *et seq.*), and the Department of the Interior's Department Manual, Part 516.

### OTHER AUTHORITIES

As described below, FWS has taken (or will take) specific steps to comply with applicable laws, Executive Orders, and departmental policies.

[8] The assessment plan can be viewed at http://mountain-prairie.fws.gov/nrda/CherokeeCounty.htm.

**Clean Air Act of 1970, as amended.** Emissions anticipated from the implementation of any project alternative would be of short duration and designed to comply with the State of Kansas ambient air quality standards.

**Clean Water Act of 1972, as amended.** If one or more of the dredging alternatives[9] were to be pursued, it would be necessary to obtain a permit from the U.S. Army Corps of Engineers, which administers the permit program authorized under Section 401 of the Clean Water Act. However, currently available funding is insufficient for implementation of these alternatives. FWS therefore does not anticipate the need for a CWA permit at this time

**Endangered Species Act of 1973, as amended.** This act requires Federal agencies to determine whether their actions may adversely affect any federally listed or proposed threatened or endangered species. If so, formal consultation pursuant to Section 7 of the Endangered Species Act (ESA) must be initiated with the U.S. Fish and Wildlife Service. No irreversible or irretrievable commitment of resources may be made by the Federal agency prior to completion of formal consultation. As part of the public review and comment process, a copy of the draft RP/EA was provided to the U.S. Fish and Wildlife Service's Ecological Services Field Office to begin the consultation process pursuant to Section 7 of the ESA. In addition, the Trustees will consult on a project specific basis.

**Farmland Protection and Policy Act of 1981**. This act aims to protect farmland and reduce urban sprawl. No activities proposed under this RP/EA increase urban sprawl. Although some activities proposed in this document may remove lands from agricultural use, these areas will be preserved and/or returned to a more native-like, natural state. Furthermore, no active restoration actions would occur without landowner permission.

**Information Quality Act of 2001.** The information presented in this RP/EA meets the requirements of the IQA, including quality, utility, objectivity, and integrity.

**Migratory Bird Treaty Act of 1918, as amended.** No actions proposed in this RP/EA will result in the taking of migratory bird species. Rather, proposed projects are intended to reduce the risk of injury to a variety of species, including migratory birds, and to provide improved quantity and quality of habitat.

**National Historic Preservation Act of 1966, as amended**. FWS provided the State of Kansas Historic Preservation Officer with the draft RP/EA as part of the public review and comment process, requesting their input to ensure project compliance with Section 106 of the National Historic Preservation Act. There are no local tribes with whom to consult on the issues of threatened or sensitive tribal sites, or traditional heritage properties.

**National Wildlife Refuge System Administration Act of 1966, as amended.** No national wildlife refuges are present in Cherokee County. The project alternatives in this RP/EA will not have any significant adverse effects on refuges outside of the county.

[9] The dredging alternatives, as well as all other alternatives considered, are described in Chapter 3.

**Executive Order 11988, *Floodplain Management,*** directs all Federal agencies to take action to avoid, to the extent possible, the long- and short-term impacts associated with the occupancy and modification of floodplains. The project alternatives in this RP/EA will not have any significant adverse effects associated with modification and occupancy of floodplains.

**Executive Order 11990, *Protection of Wetlands*.** Implementation of any project alternative in this RP/EA is not anticipated to have or cause any significant adverse effects on wetlands.

**Executive Order 12898, *Environmental Justice*.** Implementation of any project alternative in this RP/EA is not anticipated to cause disproportionate adverse human health or environmental effects to minority or low-income populations. Implementation of any restoration actions in this plan requires the participation of willing landowners.

**Executive Order 12962, *Aquatic Systems and Recreational Fisheries.*** Executive Order 12962 directs Federal agencies to add additional public access to fisheries nationwide by conserving, restoring, and enhancing aquatic systems. Implementation of some project alternatives in this RP/EA may cause short-term adverse effects to aquatic systems but will be designed to minimize these effects and to maximize long-term benefits to aquatic systems.

**Executive Order 13007, *American Indian Sacred Sites*.** Executive Order 13007 directs Federal agencies to accommodate access to and ceremonial use of American Indian sacred sites by Indian religious practitioners and to avoid adversely affecting the physical integrity of such sacred sites. Implementation of any project alternative in this RP/EA will not affect access or ceremonial use of American Indian sacred sites.

**Executive Order 13045, *Protection of Children*.** Implementation of any project alternative in this RP/EA is not anticipated to cause disproportionate environmental health or safety effects to children.

**Executive Order 13112, *Invasive Species*.** Implementation of any alternative in this RP/EA will use existing integrated pest management strategies to prevent the introduction of invasive species, such as noxious weeds, and will not authorize or carry out actions that are likely to cause the introduction or spread of invasive species.

**Executive Order 13186, *Protection of Migratory Birds*.** Implementation of any alternative in this RP/EA is not anticipated to cause measurable negative effects on migratory bird populations.

**DOI Departmental Manual, Parts 517 and 609, *Pesticides and Weed Control*.** Consistent with DOI policy, implementation of any alternative in this RP/EA will use integrated pest management strategies. Pesticides will be used only after a full consideration of alternatives, and if used, the least hazardous material that will meet restoration objectives will be chosen.

**DOI Departmental Manual, Part 518, Waste Management**. Consistent with DOI policy, any alternative selected in this RP/EA will seek to prevent the generation and acquisition of hazardous wastes, but when waste generation or acquisition is unavoidable, sound waste management practices will be used. Wastes will be managed responsibly to protect resources and people who come in contact with the affected areas. Also consistent with DOI policy, aggressive measures will be used to clean up and restore these areas. Any restoration alternatives undertaken will comply with Federal, State, interstate and local waste management requirements, including payment of fees required for registrations and permits. Any required assessments, monitoring, pollution prevention, recordkeeping, reporting, response actions and training will take place on a timely basis.

**DOI Departmental Manual Part 602: Land Acquisition, Exchange and Disposal**. Consistent with DOI policy, any selected alternative that involves land acquisition will comply with appropriate pre-acquisition standards, particularly ASTM Standards on Environmental Site Assessments for Commercial Real Estate in effect at the time. Pre-acquisition assessments will be done by qualified individual(s) and will be done within 12 months of the date of acquisition. Any required approvals will be obtained, and acquisition conditions set out in Part 602 will be met.

**341 FW 3. Pre-Acquisition Environmental Site Assessments**. All conditions set forth in FW3, including environmental site assessment requirements, including pre- and post-acquisition requirements, Level I, II, or III assessment, assessment standards and conditions, retention of records, and time limits will be met.

## 2.3 PUBLIC PARTICIPATION

Public participation is required by NEPA (40 CFR §1506.6) and is a very important part of restoration plan development. Part 516 of DOI's Department Manual addresses NEPA compliance and specifies that DOI's policy is, "[t]o the fullest practicable extent, to encourage public involvement in the development of Departmental plans and programs through State, local, and tribal partnerships and cooperative agreements at the beginning of the NEPA process, and to provide timely information to the public to better assist in understanding such plans and programs affecting environmental quality" (DOI 2004). Procedures for public involvement, wherever appropriate, will include "provision for public meetings in order to obtain the views of interested parties, newsletters, and status reports of NEPA compliance activities" (DOI 2004).

As described in Appendix C, a draft RP/EA was released on July 24, 2008, and FWS engaged in a variety of public outreach activities associated with the release, including organization of a public meeting. FWS received several comments on the draft RP/EA during the subsequent pubic comment period. These comments have been addressed in this final RP/EA, and/or are specifically responded to in Appendix C.

When available, further information about Cherokee County restoration will be posted to the following website:

http://mountain-prairie.fws.gov/nrda/CherokeeCounty.htm.

## 2.4 MINING IN CHEROKEE COUNTY AND THE TRI-STATE MINING DISTRICT

The Tri-State Mining District is approximately 2,500-square miles in area and includes Cherokee County, which is located in the southeastern corner of Kansas (Exhibit 3). For over a century, portions of this county and neighboring counties in Missouri and Oklahoma were extensively mined for lead and zinc. Indeed, for the period 1850-1950, the district produced 50 percent of the zinc and 10 percent of t he lead in the United States. Altogether, the mines in the area produced 23 million tons of zinc concentrates and four million tons of lead concentrates (Brosius and Sawin 2001). The Tri-State Mining District ranks first in terms of past zinc production in the United States, and fourth in terms of past lead production (Long *et al.* 1998). Production in Cherokee County peaked in the 1920s and 1930s, then diminished until it ceased in the 1970s (Dames & Moore 1995; State of Kansas and DOI 2003).

### HISTORY OF MINING IN CHEROKEE COUNTY: OVERVIEW

Although shallow mining was used in some areas such as Galena (Brosius and Sawin 2001), most mining operations in the district used underground techniques (Dames & Moore 1993a). Room-and-pillar methods, in which rooms were mined for their ore while leaving pillars to support the roof, were common (Brosius and Sawin 2001). Some of the mined rock layers were aquifers–that is, they were saturated with ground water–such that constant pumping was required to keep the mines dry as mining operations continued (Dames & Moore 1993a).

Dames & Moore (1993a) indicates that "[e]arly mining was characterized by a multitude of small operators on 40-acre tracts with each operator conducting mining, drilling, and milling operations. This resulted in numerous shafts, waste piles, and mine structures." When higher grade ore deposits were depleted in the 1930s, larger companies could still profitably operate in the area due to central milling practices and improved technologies (Dames & Moore 1993a).

Once removed from the mines, ore was processed, and this processing produced a variety of wastes, including waste rock, chat, and tailings:

- Waste rock, known as bullrock (Exhibit 4), consists of cobble to boulder-sized rocks that were excavated but not milled. Bullrock includes rock that overlay an ore body, rock removed in the creation of air shafts, and mined rock containing little usable ore (Dames & Moore 1993a).
- Chat (Exhibits 5 and 6) consists of a mixture of gravel- to fine-sized mill waste, often mixed with sand-sized particles. Chat was produced as part of the initial milling of the mined rock. Chat piles are a dominant geographic feature in the Tri-State Mining District, although much of the gravel-sized chat in Cherokee County has been removed and sold as fill for roadbeds or for other uses (Dames & Moore 1993a).
- Tailings (Exhibit 7) are sand and silt-sized mine wastes, left over after the final milling of the ore and the flotation of metals from crushed rock, or created as a by-product of washing chat. Tailings were usually sluiced into a dammed pond in

a water slurry. Therefore, most tailings are located where the old ponds were located and some continue to contain ponded water (Dames & Moore 1993a).

**EXHIBIT 4 BULLROCK PILE IN LAWTON**

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

**EXHIBIT 5 CHAT IN CRESTLINE**

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

**EXHIBIT 6 CHAT PILE IN TREECE**

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

**EXHIBIT 7 TAILINGS IN CRESTLINE**

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

Mining wastes once covered 4,000 acres in southeastern Cherokee County (Brosius and Sawin 2001). Although large amounts of wastes have been removed, a considerable quantity still remains. As of 1993, the Treece and Baxter Springs subsites alone contained 3.2 million cubic yards of chat and 4.2 million cubic yards of other wastes such as tailings and bullrock, both of which covered about 1,250 acres (Dames & Moore 1993a). Remediation in Baxter Springs, completed in 2004, addressed some of these wastes. However, wastes, including piles subject to remedial action by the U.S. Environmental Protection Agency, are still present on over 2,000 acres in the county.

Smelting, the process of melting or fusing ore for the purpose of separating and refining the metal, also contributed to heavy metal contamination in Cherokee County. Initially, there may have been crude log smelters associated with each mine (Dames & Moore 1995). In addition, an Eagle-Picher smelter operated at Galena from about 1920 to 1970 (USACE 1995).

## HISTORY AND LOCATION OF EAGLE-PICHER MINING ACTIVITIES

Eagle-Picher Industries, Inc. has over 150 years of manufacturing experience with a current focus of supplying industry with machinery and parts (Pederson 1999). Established in 1842, the company was incorporated in 1867 as Eagle White Lead Company in Cincinnati, Ohio. Eagle White Lead Company consolidated with Picher Lead Company, a Missouri corporation, to form the Eagle-Picher Lead Company (EPLC) in 1916 (Pederson 1999, Knerr 1992). In 1930, EPLC formed a new mining subsidiary, incorporated in Delaware, Eagle Picher Mining & Smelting (EPM&S).[10] Due to a number of other corporate changes throughout the years, Eagle-Picher is a corporate successor to EPLC and EPM&S. Eagle-Picher filed a petition under Chapter 11 of the Bankruptcy Code on January 7, 1991.[11] A settlement agreement between Eagle-Picher and its creditors was entered into on March 27, 1995 and upheld on June 6, 1996.[12]

Eagle-Picher and its subsidiaries and predecessors owned and operated property in the Tri-State mining district, conducting mining operations in the Tri-State area from the 1840s to the 1950s.[13] In the early 20th century, Eagle-Picher was the leading zinc producer in the country and was also one of the largest lead producers (Pederson 1999). Among its operations were a lead smelter at Galena, Kansas, a zinc smelter in Henryetta, Oklahoma and a "central mill" at Picher, Oklahoma.[14] A number of sites were affected by Eagle-Picher's activities, including the Baxter Springs and Treece subsites in Cherokee County, Kansas and the Oronogo-Duenweg Superfund Site in Missouri, among others.[15] The company operated smelting operations in the Joplin area (Pederson 1999), and Eagle-Picher mined the Picher field along the Oklahoma-Kansas border for lead and zinc ores between 1904 and 1970[16]; this area was listed on the National Priorities list due to contamination of surface water at Tar Creek and area ground water.[17] Eagle-Picher facilities also contributed to contamination at Galena, Spring River, and Empire Lake, and may have also contributed to contamination at the OU6 site.

### HISTORY AND LOCATION OF LTV MINING ACTIVITIES

The LTV Corporation was a conglomerate whose business was concentrated in the steel, aerospace, and energy production industries. The company was first incorporated in 1956 as Ling Electronics, Inc. and in the late 1950s and early 1960s went through several mergers to become Ling-Temco-Vought (Pederson 1999). In 1971, after a series of acquisitions and divestments, this conglomerate became The LTV Corporation (Pederson 1999). At one point in time, LTV was the third largest steel producer in the United States (Pederson 1999).

The LTV Corporation and sixty-six of its affiliates filed for Chapter 11 bankruptcy protection on July 17, 1986.[18] This bankruptcy protection lasted for almost seven years, during which the company overhauled its steel operations, closing or selling many plants

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[10] Eagle-Picher Mining & Smelting Co. v. NLRB, 119 F.2d 903, 907 (8th Cir. 1941).

[11] In Re Eagle Picher Industries, Inc., 164 B.R. 265, 267 (S.D. Ohio, 1994).

[12] In Re Eagle Picher Industries, Inc., 197 B.R. 260, 262-271 (S.D. Ohio, 1996).

[13] In Re Eagle Picher Industries, Inc., 197 B.R. 260, 267 (S.D. Ohio, 1996).

[14] Eagle-Picher Mining & Smelting Co. v. NLRB, 119 F.2d 903, 907 (8th Cir. 1941).

[15] In Re Eagle Picher Industries, Inc. 197 B.R. 260, 263 (S.D. Ohio, 1996).

[16] The Oklahoma portion of this field was mined through 1958; the Swalley Mine at Baxter Springs in Kansas operated until 1970 (McCauley *et al.* 1983, Brady 2000).

[17] Eagle-Picher Industries, Inc. vs. United States EPA, 822 F.2d 132, 137 (D.C. Cir. 1987).

[18] In re Chateaugay Corporation, *et al.* 115 B.R. 760, 762 (S.D.N.Y. 1990).

and changing its focus, although it remained primarily a steel producer (Pederson 1999). On December 29, 2000, LTV, its parent company, and other related companies filed a voluntary petition for reorganization under Chapter 11 of the Bankruptcy Code in the Northern District of Ohio, Eastern Division.[19] As a corporate successor of the Vinegar Hill Zinc Company, LTV contributed to contamination at the Baxter Springs and Treece subsites in Cherokee County. LTV also contributed to contamination in Spring River, Willow Creek, and Tar Creek.

### MINING ACTIVITIES OF OTHER PARTIES

In addition to Eagle-Picher and LTV, other mining and mining-related companies have contributed to contamination in and injuries to Cherokee County's natural resources. In the future, FWS may recover damages associated with these injuries. FWS intends to use this restoration plan not only for damages it has received from Eagle-Picher and LTV but also to focus possible restoration actions associated with potential future recoveries from other potentially responsible parties.

### MINING AND METALS CONTAMINATION

Mining activities release metals into the environment through a variety of pathways. During periods of active mining, sources of metal contamination include dewatering operations and releases from the vast piles of mine wastes (bullrock, chat, and tailings) generated by mining activities. Mine wastes frequently contain elevated levels of metals, contaminating soils in and around the piles. This contamination can persist, not only for the period of active mining and not only in the mine wastes, but also in adjacent areas and for many years afterwards. In the Baxter Springs and Treece subsites, for example, researchers found that "average concentration of Cd, Fe [iron], Pb, Mn [manganese], and Zn are above baseline levels for non-agricultural soils in the immediate vicinity of surficial waste piles" (Dames & Moore 1993a).

In addition to contaminating adjacent soils, chat piles collect water, resulting in "perched water" within the piles (Dames & Moore 1993a). The porous, granular mill waste accumulations act as precipitation storage sites, slowly releasing contaminated water after a recharge event (Dames & Moore 1993a). Streams and ponds that receive drainage from perched water or water that filters through mine and mill waste deposits have elevated metals concentrations relative to upstream areas (Dames & Moore 1993a).

Waste piles on the surface also increase ground water recharge by impeding runoff, as water is both retained in pore spaces in the piles and physically impeded from becoming runoff (CH2M 1987). This puts highly oxygenated rain water into contact "with a much larger quantity (surface area) of metal-rich sulfide minerals than originally present in the premining condition," and may increase contaminant levels in ground water. Contaminated ground water in turn can contribute to metals loading in some streams. For instance, the Boone aquifer discharges to the streambeds of Spring River tributaries (Dames & Moore 1993a).

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[19] In re LTV Steel Co., Inc., 264 B.R. 455 (Bankr. N.D. Ohio, 2001).

When active mining ceased, pumping of the excavated areas stopped, and the remaining rooms and tunnels filled with water. This water became contaminated by contact with the ore remaining in the mine walls or left behind by the miners (Brosius and Sawin 2001), and some leached into surrounding areas of ground water and/or discharged to surface waters. These discharges can continue for long periods of time. For example, the Bruger shaft discharged into Willow Creek for decades after the cessation of mining operations. Even though the Bruger shaft area has been subject to remedial action (ESC 2003), water levels have at times been sufficiently high to overflow the Bruger holding pond and/or to discharge into culverts that lead to Willow Creek (Rykaczewski 2008).

Sometimes pillar-robbing occurred during the last stages of mining. In this practice, pillars that had previously been left intact to hold up the cavern's roof were removed. As a result, the roofs of underground workings collapse, resulting in the formation of subsidences, which may fill with water and become subsidence ponds (Brosius and Sawin 2001) (Exhibit 8). Weathering cycles and water movement also eroded roof materials, which contributed to the formation of collapses. Subsidence ponds and remaining chat/tailings ponds can release wastes into surface waters and/or ground water for many years. For instance, prior to remediation, the Spring Branch–an ephemeral creek that runs through the Baxter Springs subsite–was "entirely contained within an area impacted by mining and streamflow [was] supported, at least over the short term, by seepage from a large chat-wash pond (Ballard Pond)" such that it was believed that much of the dissolved cadmium present within the stream originate[ed] from this industrial pond" (Dames & Moore 1993b). The Spring Branch has been subject to remedial action (Environmental Strategies Corporation, 2003; also, see Exhibits 30 to 33); however, measurements of metals in Spring Branch waters in May and October of 2007 remained elevated (Rykaczewski 2008).

The result of all these activities is past and ongoing exposure of natural resources - land, water, and biota - to harmful substances, likely causing injuries to the natural resources and losses of associated services.

## 2.5 CONTAMINANTS OF CONCERN

Although mining and related activities can cause the release of a number of different potentially hazardous metals to the environment, most studies have focused on cadmium (Cd), lead (Pb), and zinc (Zn), contaminants that have significant potential for toxicity to many plants and animals. These metals are commonly found at elevated levels in soils, sediments, and surface waters throughout Cherokee County, and although NRDA activities are ongoing, substantial relevant data suggests that these metals may be adversely affecting Cherokee County natural resources. The following paragraphs provide some general information about the potential adverse effects of these metals on organisms.

**EXHIBIT 8 SUBSIDENCE POND AT SUNFLOWER MINE IN BAXTER SPRINGS**

### CADMIUM

Cadmium (Cd) is a soft metal that is found naturally in conjunction with zinc. Cadmium is used in electroplating, solder, nickel-cadmium batteries, and in rods to control atomic fission. Cadmium is not biologically essential or beneficial to any known living organism and is toxic to all known forms of life (Eisler 2000). Freshwater[20] animals tend to be most heavily impacted by cadmium contamination (WHO 1992). Impacts to freshwater animals include death, reduced growth, and inhibited reproduction (Eisler 2000). In freshwater systems, the lethal effects of cadmium can be reduced by limiting exposure time and increasing water hardness[21] (Eisler 2000). Sublethal effects of cadmium in freshwater organisms include decreases in plant standing crop, decreases in growth, inhibition of reproduction, immobilization, and population alterations (Eisler 2000). Mammals and birds are comparatively resistant to the toxic[22] effects of cadmium, though exposure to high levels can be fatal (Eisler 2000).

[20] Freshwater refers to waters that are not saline (salty).

[21] Water hardness is a measure of the content of certain naturally-occurring elements in water, especially calcium and magnesium.

[22] Toxins cause direct injury to an organism as a result of physiochemical interaction. Carcinogens cause cancer (for example, tumors, sarcomas, leukemias). Mutagens cause permanent genetic change. Teratogens cause abnormalities during embryonic growth and development.

Animals can be exposed to environmental cadmium through inhalation or ingestion. Cadmium is a known carcinogen, a known teratogen, and a probable mutagen (Eisler 2000; ATSDR 1999a). Studies investigating carcinogenicity have focused on mammals. Cadmium has been shown to cause tumors in the prostate, testes, and hematopoietic (blood-related) systems in rats (ATSDR 1999b). Based on studies in mice and bacteria, cadmium may be mutagenic (Ferm and Layton 1981 as cited in Eisler 2000). When present, cadmium is detected in particularly high concentrations in the leaves of plants and the livers and kidneys of vertebrates (ATSDR 1999b; Scheuhammer 1987 as cited in Eisler 2000).

### LEAD

Lead (Pb) is a soft metal whose past and/or current uses include the manufacture of batteries, ammunition, plumbing fixtures, paint, and as an additive for gasoline. Lead is not biologically essential or beneficial to any known living organism (Eisler 2000). It can be incorporated into the bodies of individual organisms by inhalation, ingestion, absorption through the skin, and (in mammals), placental transfer from the mother to the fetus (Eisler 2000). Toxic in most chemical forms, lead negatively affects survival, growth, reproduction, development, and metabolism of most animals under controlled conditions, but its effects are substantially modified by numerous physical, chemical, and biological variables. Younger, immature organisms tend to be more susceptible to lead toxicity (Eisler 2000). When absorbed in excessive amounts, lead has carcinogenic or co-carcinogenic properties (Eisler 2000). In large amounts, it is also a mutagen and a teratogen (Eisler 2000).

Aquatic animals have been demonstrated to experience adverse effects such as reduced survival, impaired reproduction, and reduced growth (Eisler 2000). As with cadmium, increased water hardness decreases lead bioavailability to aquatic animals (Wong *et al.* 1978 and NRCC 1973, both as cited in Eisler 2000). Early research suggested that birds are unlikely to show adverse effects from environmental lead (except when lead objects such as shot are directly ingested); however, there is now a growing body of evidence linking waterfowl poisoning with ingestion of lead-contaminated sediments, especially in the Coeur d'Alene area of Idaho (Chupp and Dalke 1964, Blus *et al.* 1991, Beyer *et al.* 1998, Heinz *et al.* 1999, all as cited in Eisler 2000). There are few data regarding the effect of environmental lead on mammalian wildlife (Eisler 2000).

Lead also can harm plants. Generally, large amounts must be present in soils before terrestrial plants are affected, although sensitivity varies widely between species (Demayo *et al.* 1982). Effects of lead toxicity in plants include reduced plant growth, photosynthesis, mitosis, and water absorption (Demayo *et al.* 1982).

### ZINC

Zinc (Zn) is used in a wide variety of products. In alloy form, it is used to make brass, nickel silver, and aluminum solder; it also is used to galvanize other metals and prevent them from rusting. Zinc is used in coins; it is also used to manufacture rubber, cosmetics, plastics, medicines, and many other items.

An essential trace element for all living organisms, zinc deficiency in animals can cause a variety of adverse effects (Eisler 2000; ATSDR 2005). Zinc is also toxic at high concentrations, although its toxicity depends on its chemical form and other environmental parameters (Eisler 2000). Zinc is not carcinogenic, although in certain chemical forms, zinc can be mutagenic (Thompson *et al.* 1989, as cited in Eisler 2000). Zinc is teratogenic to frog and fish embryos, but there is no conclusive evidence of teratogenicity in mammals (Dawson *et al.* 1988 and Fort *et al.* 1989, both as cited in Eisler 2000).

Environmental effects of zinc can occur at relatively low concentrations (Eisler 2000). Terrestrial plants can die from excess zinc in the soil (Eisler 2000). Freshwater animals can also experience adverse effects, including reduced growth, reproduction, and survival (Eisler 2000). Ducks experience pancreatic degeneration and death when fed diets containing high concentrations of zinc (Eisler 2000).

Recent studies have found evidence of zinc poisoning in birds collected from the Tri-State Mining District (Beyer *et al.* 2004, Carpenter *et al.* 2004, Sileo *et al.* 2003). Geese had zinc concentrations in their livers that the authors state are “comparable with those in waterfowl killed by Zn in laboratory studies or accidentally killed by ingesting zinc pennies in zoos” (Sileo *et al.* 2003). Liver and pancreas zinc levels in a Picher, Oklahoma trumpeter swan diagnosed with zinc poisoning were also elevated (Carpenter *et al. 2004*). Beyer *et al.* (2004) found significantly higher zinc levels in American robins (*Turdus migratorius*), northern cardinals (*Cardinalis cardinalis*), and waterfowl in the Cherokee County area, relative to reference site birds. Beyer *et al.* (2004) note that the increased environmental concentrations of zinc associated with mining in the area accounted for the pancreatitis previously observed in five waterfowl from the District, and that this is the first instance of free-flying birds found to be suffering severe effects of zinc poisoning.

Excess zinc can also adversely affect mammals. Mammals can generally tolerate greater than 100 times their minimum daily zinc requirement (NAS 1979, Wentink *et al.* 1985, Goyer 1986, Leonard and Gerber 1989, all as cited in Eisler 2000), but levels that are too high affect their survival, metabolism, and well-being (Eisler 2000).

# CHAPTER 3 | AFFECTED ENVIRONMENT

Cherokee County natural resources potentially affected by mining-related contamination include rivers and lakes, ground water, and geologic/terrestrial resources. The area also supports a wide variety of fish, birds, and other wildlife. Fifty-one species present in Cherokee County are included on state or Federal threatened and endangered (T&E) species lists or are otherwise of special concern.

The following paragraphs briefly summarize key features of the county's natural resources, including information about what makes the area unique, and also available information about the threat posed to these resources by mining-related and other contamination. These paragraphs describe those natural resources in or near areas impacted by mining activities. Given the locations of their facilities, FWS expects that the natural resources impacted by Eagle-Picher and LTV, as well as other responsible parties include: terrestrial parts of the Treece, Baxter Springs, Galena, Badger, Waco, Lawton, and Crestline subsites; the Boone aquifer; Empire Lake; and a number of rivers and streams, primarily Spring River, Short Creek, Shoal Creek, Willow Creek, Spring Branch, and Tar Creek.

## 3.1 SURFACE WATER RESOURCES: RIVERS, LAKES, STREAMS

### SPRING RIVER

The Spring River flows southwest into the state from Missouri, entering Cherokee County about ten miles north of Galena (Exhibit 3). It exits southward into Oklahoma, where it converges with the Neosho River to form the Grand River. In Kansas, the Spring River drains 500 square miles and flows through, near, or adjacent to areas heavily impacted by mining, including the Lawton, Badger, Galena, Baxter Springs, Waco, and Crestline Superfund subsites (KDHE 1980).

The Spring River is one of the state's most valued surface water resources. It ranks fifth in annual average flow and third-highest in critical low flow (United States Geological Survey (USGS) WATSTORE database). Upstream of the confluence with Center Creek, the river supports at least 74 fish and 23 mussel species, including the federally and state-threatened Neosho madtom (*Noturus placidus*). Ten other resident fish and shellfish species are listed as threatened or endangered in the State of Kansas, and 35 species are designated as in need of conservation (*i.e.*, SINC). As shown in Exhibit 9, some reaches support high-quality riparian corridors.[23]

The Spring River's importance as a natural resource has been recognized by a number of organizations. KDHE classifies the river as an exceptional state water and a special aquatic life use water (KDHE 2004a). The Kansas Department of Wildlife and Parks (KDWP) classifies the Spring River as "critical habitat for numerous threatened and endangered species" (for example, Neosho madtom) and as a highest-valued fishery resource (Moss and Brunson 1981). The National Park Service classifies the river as an outstandingly remarkable stream for scenic, recreational, fishing, and wildlife attributes (NPS 1982).

**EXHIBIT 9 SPRING RIVER RIPARIAN CORRIDOR**

Photo courtesy of Industrial Economics, Inc.

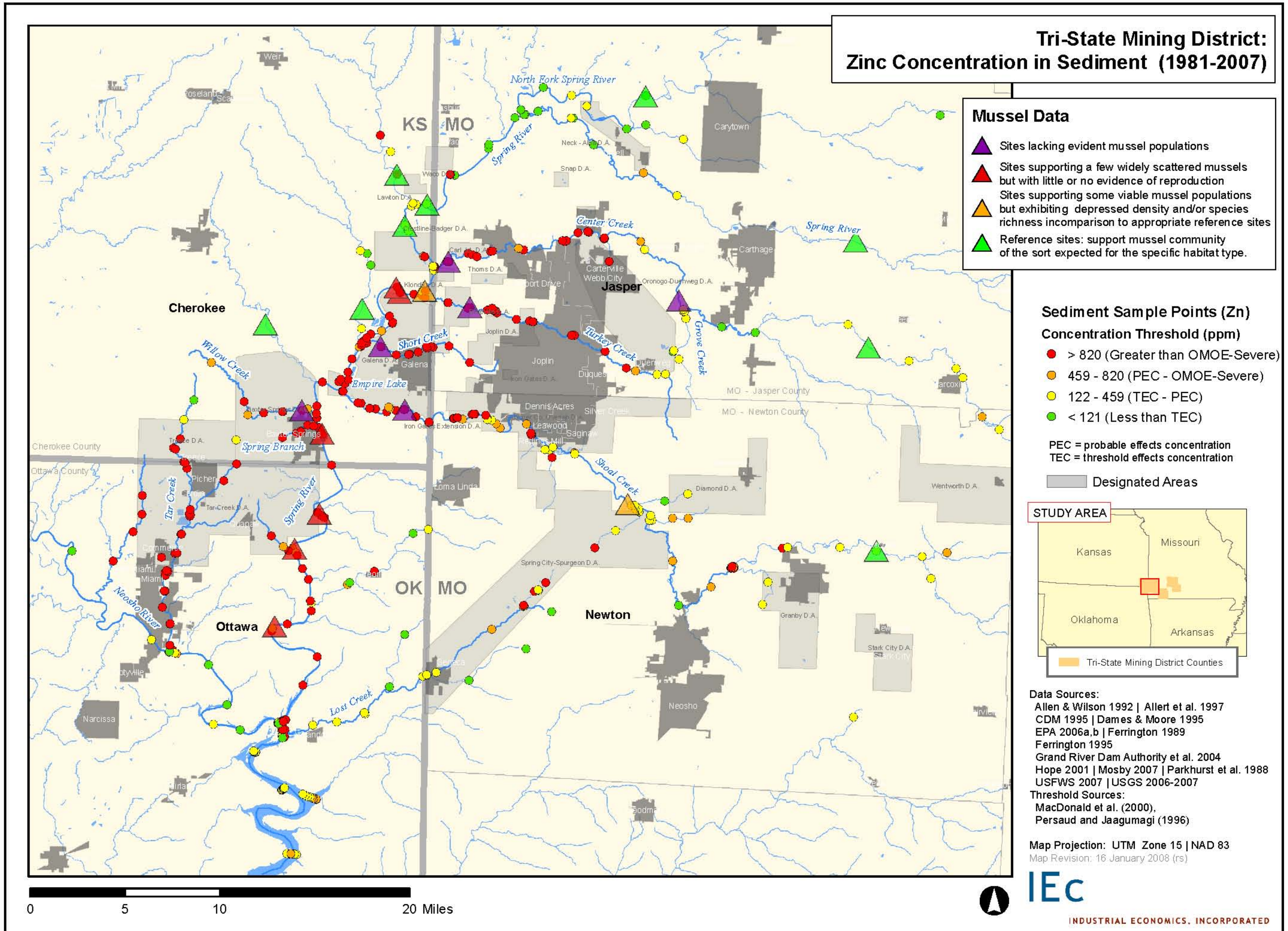
[23] Riparian corridors are low-lying natural lands within a certain distance of rivers or streams. Healthy riparian corridors are extremely important to the health of the surface waters they surround. They help reduce both erosion and nutrient pollution (for example, from fertilizer runoff), provide habitat for aquatic-associated animals (for example, nesting locations for birds and den locations for mink) and also provide continuous corridors of habitat that allow fauna to travel from one location to another. High-quality riparian corridors often support many different species of plants.

**EXHIBIT 10 TRI-STATE MINING DISTRICT: SEDIMENT ZINC CONCENTRATIONS AND MUSSEL COMMUNITY HEALTH**

Notes:
The Threshold Effects Concentration (TEC) is defined as the concentration below which adverse effects are not expected to occur. While samples below the TEC are unlikely to cause injury, samples above the TEC will exhibit toxicity in some cases, but not others (MacDonald et al. 2000).

The Probable Effects Concentration (PEC) is defined as the Concentration above which adverse effects are expected to occur "more likely than not" (ibid.).

The OMOE-Severe value is the concentration above which pronounced disturbance of the sediment-dwelling community is expected; detrimental to the majority of benthic species; 95th percentile of incidence of adverse effects, as defined by Persaud and Jaagumagi (1993).



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Spring River, especially in its more downstream reaches, has elevated metals levels (CH2M Hill 1987). KDHE's 2002 303(d) list (KDHE 2002) indicates that the lower river is impaired by lead, copper, and zinc.[24] As shown in Exhibit 10, zinc levels in sediments frequently exceed values associated in the literature with adverse impacts to benthic organisms. These benchmarks include the Threshold Effect Concentration (TEC), Probable Effects Concentration (PEC), and Ontario Ministry of the Environment (OMOE) Severe values (MacDonald *et al.* 2000; Persaud and Jaagumagi 1993).[25]

Field data confirm that elevated metals concentrations appear to be impacting the river's aquatic life. Wildhaber *et al.* (2000) investigated fish populations in the Spring River and concluded that these fish, especially Neosho madtoms, are limited in part by the presence of metals in the water. Mussel populations also appear to have been impacted: Obermeyer *et al.* (1995) reported that only the portion of the river upstream of Center Creek is rich with these organisms, and Angelo *et al.* (2007) confirms this finding (Exhibit 10). Cope (1985) states that "[d]rainage from mines and mine tailings along Center, Turkey, and Short creeks… probably contribute pollutants that are toxic to naiads [mussels]."

### SPRING RIVER TRIBUTARIES

As shown in Exhibit 3**,** key tributaries of the Spring River, ordered from north to south and entering on the east (E) or west (W) side, are as follows: Cow Creek (W), Center Creek (E), Turkey Creek (E), Shawnee Creek (W), Short Creek (E), Shoal Creek (E), Brush Creek (W), Willow Creek (W), and Spring Branch (W). Similar to the Spring River, some of these tributaries are habitat to valued aquatic animals including threatened and endangered species. Many of these tributaries flow through mining-affected lands and have sediment metal levels that exceed TEC, PEC, and OMOE-Severe thresholds (Exhibit 10). The following paragraphs briefly describe key characteristics of each.

<u>Cow Creek</u> is the major Kansas tributary to the Spring River in the northern region of the watershed (KDHE 1980). It originates in Crawford County and flows southeast before converging with the Spring River in Cherokee County (KDHE 1980). Cow Creek drains coal-mined and agricultural areas (Dames & Moore 1995), and receives treated sewage effluents and storm runoff from the City of Pittsburg, Kansas (City of Pittsburg 2003).

[24] Section 303(d) of the Federal Clean Water Act requires states to periodically prepare a list (referred to as a 303(d) list) of all surface waters in the state with pollutant concentrations that exceed water quality standards. These waters are considered to be impaired with respect to specific beneficial uses associated with the water quality standards, such as drinking, recreation, aquatic habitat, and/or industrial use. Kansas's 2004 303(d) list is available at http://www.kdheks.gov/tmdl/download/2004_303(d)_List_Pub.pdf (visited 11/14/08).

[25] Injuries to sediment-dwelling organisms begin to be observed when contaminant concentrations in sediment exceed the Threshold Effects Concentration (TEC). More specifically, the TEC is defined as the concentration below which adverse effects are not expected to occur. While samples below the TEC are unlikely to cause injury (i.e., the TEC correctly predicts the absence of toxicity 81 percent of the time), samples above the TEC will exhibit toxicity in some cases, but not others (MacDonald et al. 2000). The TEC in parts per million is 0.99 for cadmium, 121 for lead, and 35.8 for zinc. The PEC is defined as the Concentration above which adverse effects are expected to occur "more likely than not". The PEC in parts per million is 4.98 for cadmium, 459 for lead, and 128 for zinc. Finally, the OMOE-Severe is the concentration above which pronounced disturbance of the sediment-dwelling community is expected; detrimental to the majority of benthic species; 95th percentile of incidence of adverse effects, as defined by Persaud and Jaagumagi (1996). The OMOE-Severe threshold in parts per million is 10 for cadmium, 820 for lead, and 250 for zinc.

KDHE's 303(d) list for 2002 states that Cow Creek is impaired by sulfate, and the 2004 list adds low dissolved oxygen as an additional impairment. Pope (2005) notes that Cow Creek has relatively low streambed sediment metals concentrations, compared with the lower reaches of the Spring River, Shoal Creek and Spring Branch Creek. Despite the listed impairments, as shown in Exhibit 10, Cow Creek supports a mussel community of the sort expected for the habitat type (Angelo *et al.* 2007).

Center Creek is an Ozarkian stream located in Missouri that joins the Spring River near the Kansas/Missouri border. Center Creek is a significant contributor of metal contaminants to the Spring River (Davis and Schumacher 1992); indeed, KDHE (1980) states that "Short and Center Creeks contribute the greatest amount of lead-zinc mine pollutants to the Spring River in Kansas," and Davis and Schumacher (1992) found that lead and zinc levels exceeded chronic aquatic life criteria (ALC)[26] from 1965 to 1989. KDHE monitoring data collected during the past two decades confirm the continuation of high metals loadings from Center Creek and other tributaries to the Spring River (KDHE 2004b).

The importance of Center Creek as a source of metals to the Spring River is also shown by Pope's (2005) comparison of sediment samples from the Spring River upstream and downstream of the confluence with Center Creek. Downstream samples (taken from an area about 100 ft downstream of the confluence with Center Creek) have cadmium (41 mg/kg), lead (510 mg/kg) and zinc (5,400 mg/kg) levels about 10 times higher than samples taken just 0.8 mile upstream (Pope 2005).

Center Creek's ability to fully support native aquatic biota appears to be impaired. Dames & Moore (1995) found the fish community to be both more diverse and more abundant upstream of Oronogo-Duenweg than downstream. The abundance and diversity of mussels are lower in downstream reaches of Center Creek compared both to a non-mining area in the North Fork of the Spring River and to upstream areas (Clarke and Obermeyer 1996, Angelo *et al.* 2007; see Exhibit 10). Certain mussel species historically found in this area–the western fanshell and rabbitsfoot (*Cyprogenia aberti* and *Quadrula (Orthonymus) cylindrica*)–are no longer present (Clark and Obermeyer 1996).

Turkey Creek flows through Missouri before joining the Spring River south of Center Creek, just west of the border in Kansas. Like Center and Short Creeks, Turkey Creek is a typical Ozarkian stream, characterized by alternating pools and riffles with a mixture of sand, gravel, and boulder streambed bottoms (Dames & Moore 1995). Turkey Creek flows through Joplin, Missouri and receives discharges from several industries and several sewage treatment plants as well as runoff from historic mine-related areas (Dames & Moore 1995). Davis & Schumacher (1992) characterized this creek as Missouri's most contaminated interstate stream. KDHE's 2002 303(d) list indicates Turkey Creek is impaired by cadmium, lead, copper, and zinc. Some parts of the creek contain visible mine waste bars (Exhibit 11).

[26] Aquatic life criteria (ALC), are water quality standards issued by EPA and are designed to protect aquatic life from acute (short-term) and chronic (long-term) effects of contaminants. ALC also serve as guidance to states and tribes authorized to establish their own water quality standards under Section 304a of the Clean Water Act.

During some high flow sampling events in Missouri, neither cadmium nor lead concentrations exceeded chronic ALC; however, data suggest that runoff from the Oronogo-Duenweg designated area causes Turkey Creek to exceed chronic ALC for zinc (Dames & Moore 1995). Turkey Creek sediments contain elevated metals concentrations. Pope (2005) found very high sediment concentrations in Turkey Creek (cadmium - 52 mg/kg; lead - 640 mg/kg; zinc - 5,200 mg/kg) and concluded that these are "probably responsible for elevated Spring River results immediately downstream from Turkey Creek."  As shown in Exhibit 10, sediment concentrations of zinc regularly exceed literature-based effects thresholds for impacts to benthic organisms.

Further, tissues from Turkey Creek fish had elevated levels of metals, and parts of the creek have altered benthic communities, indicating that these communities "may have been altered possibly by physical or chemical conditions" (Dames & Moore 1995). Angelo *et al.* (2007) found impaired or absent mussel communities on this waterway.

**EXHIBIT 11 TURKEY CREEK WITH MINE WASTE BARS**

Photo courtesy of Industrial Economics, Inc.

Shawnee Creek originates in north-central Cherokee County. It merges with Little Shawnee Creek before joining the Spring River near the Galena subsite. KDHE's 2002 303(d) list indicates that water quality impairments in Shawnee Creek include contamination by lead, zinc, copper, and fecal coliform.  The Crestline subsite drains into Shawnee Creek.

Sediments in the area show elevated metals levels. Pope (2005) found the vast majority (78-100 percent) of samples from Shawnee Creek to exceed the threshold effects concentration (MacDonald *et al.* 2000) for all three metals of concern, and at least 10 percent of samples exceeded the probable effects concentration for cadmium and zinc.

Short Creek (Exhibit 12) passes through Missouri and the Galena subsite before joining the Spring River. The creek is highly contaminated with metals (Ferrington *et al.* 1989). CH2M Hill (1987) remarks that "[t]he USGS results show that Short Creek was a major contributor of zinc to the Spring River… Based on these [USGS] data, Short Creek was also the largest contributor of cadmium and lead loadings." KDHE's 2002 303(d) list states that water quality impairments in Short Creek include contamination by cadmium, copper, lead, and zinc.

Pope (2005) found 100 percent of samples from Short Creek to exceed the PEC for cadmium, lead, and zinc (also see Exhibit 10). Metals in the creek may be impacting local biota: KDHE (1980) notes that Short Creek is "extremely polluted [in Kansas] with toxic heavy metals concentrations, especially zinc… This is reflected in the benthic samples by the continuous low taxa numbers… as well as the complete absence of the pollution sensitive mayfly-stonefly groups."

**EXHIBIT 12 PORTION OF SHORT CREEK NEAR GALENA, WITH ALGAE**

Photo courtesy of Industrial Economics, Inc.

Shoal Creek runs through Missouri, forms the southern border of the Galena subsite, and joins the Spring River at Empire Lake. The creek has been described as "the only Ozark-type stream in Kansas" (KDHE 1980).[27] As an Ozarkian stream, Shoal Creek has exceptionally clear water and a rocky bottom (Exhibit 13). These features make Shoal Creek "unique... for its aesthetic qualities" (KDHE 1980).

Parts of Shoal Creek suffer from metals contamination. KDHE's 2002 303(d) list indicates that water quality impairments in Shoal Creek include contamination by lead and zinc. Ferrington *et al.* (1989) notes that the Shoal Creek arm of the Empire Lake reservoir "has higher concentrations of metals than expected" and "it must be concluded that movements of metals out of tailings areas via one or more of these intermittent streams [that join with Shoal Creek]… contribute significantly to the elevated metals concentrations in sediments of the Shoal Creek arm."

Exhibit 10 illustrates patterns of zinc contamination in Shoal Creek, and their relationship to literature-based benthic effects thresholds. As indicated in this exhibit, the creek is highly contaminated. Pope (2005) similarly concludes that almost all samples from Shoal Creek exceed the PEC for several metals: 100 percent of samples exceed the PEC for cadmium and zinc, while 89 percent of samples exceeded the PEC for lead.

**EXHIBIT 13 SHOAL CREEK AT LOW FLOW NEAR SCHERMERHORN PARK**

Photo courtesy of Industrial Economics, Inc.

[27] Although Center Creek is also an Ozarkian stream, only a very small portion of the creek lies within Kansas. Most of Center Creek is in Missouri.

Data on unionid mussel communities in Shoal Creek suggest that the creek undergoes a radical transformation in quality downstream of Joplin, Missouri. Cope (1985) found only a single living mussel plus a small number of dead mussels at a Shoal Creek station south of the Galena subsite. Obermeyer *et al.* (1997) found the Neosho mucket (*Lampsilis rafinesqueana)* to be present in the more upstream reaches of Shoal Creek in Missouri, but in the Kansas stations closest to the creek's confluence with the Spring River, found either no evidence of the species or only weathered/relic mussel shells. Angelo *et al.* (2007) similarly found evidence of severe impacts to the mussel community in more downstream reaches (Exhibit 10).

Brush Creek is an intermittent[28] stream that originates in the northwestern portion of the Spring River basin and flows southeasterly before converging with the Spring River near Riverton, Kansas (KDHE 1980). Although there was little mining activity in its watershed (KDHE 1980), Pope (2005) found exceedences of sediment quality thresholds for cadmium (40 percent of samples), lead (90 percent of samples) and zinc (90 percent of samples). Ten percent of samples also exceeded the PEC for zinc. This suggests widespread effects of mining, even in areas not directly downstream of mines.

Willow Creek is an intermittent tributary that runs through the Baxter Springs subsite and also contributes to Spring River metal loads. KDHE (1980) found that during times of high runoff or mine "dewatering" operations, high concentrations of metal contaminants were introduced into the Spring River via Willow Creek. Dames and Moore (1993a) state that mine water has discharged into the creek from the Bruger shafts, and that the shaft discharge may have accounted for a significant part of the metal load carried by the creek. The mine water discharge contained zinc concentrations that can be acutely toxic to resident aquatic organisms, although some data suggest that populations of key aquatic species have not been significantly reduced (Dames & Moore 1993a). As part of the ongoing Superfund process, EPA attempted to control minewater discharge to the creek by diverting mine water overflow to a clay borrow pit (i.e., a holding pond), while offsite surface water runoff was diverted around the pit to Willow Creek (ESC 2003). Despite these remedial actions, water levels have at times been sufficiently high to overflow the pit and/or to discharge into culverts that lead to Willow Creek (Rykaczewski 2008).

Willow Creek sediments show elevated cadmium, lead and zinc (*i.e.*, Exhibit 10). Pope (2005) found the vast majority of sediment samples from Willow Creek exceeded the PEC for all three metals (79 percent for cadmium; 67 percent for lead, and 100 percent for zinc). Metals concentrations in Willow Creek surface waters (EPA 2006) continue to be elevated above levels harmful to the biota.

Spring Branch is an intermittent tributary to the Spring River with a watershed of 3.3 square miles, all of which is contained in the Baxter Springs subsite (Dames & Moore 1993a). Land use in the Spring Branch watershed is primarily agricultural but also includes the city of Baxter Springs (Dames & Moore 1993a). Water quality in the Spring

[28] Intermittent, streams and creeks only contain flowing water for part of the year. The rest of the year, they contain standing pools separated by dry areas.

Branch has been and continues to be impacted by past mining activities. In the early 1990s (prior to its remediation), mill waste areas were still present in 16 percent of its watershed, and outwash tailings were located in the stream channel (Dames & Moore 1993a). Similarly, "cadmium and zinc concentrations exceeded chronic ALC in all samples tested," and lead concentrations exceeded ALC during periods of higher flow (Dames & Moore 1993a). At the time, a portion of the high metal loads in Spring Branch was attributed to overflow from the Ballard tailings impoundment, a site that was addressed in EPA's ROD for the Baxter Springs/Treece OU and the associated remedial action (USEPA 1997, ESC 2003).

As reported in the ROD and Remedial Action Report (USEPA 1997, ESC 2003), the Ballard tailings impoundment was drained, filled, regraded, and revegetated to prevent deposition of tailings in Spring Branch and Willow Creek during storm events. Exhibits 30 through 33 show the Spring Branch itself and adjacent upland areas before and after restoration. Despite efforts to reduce human health risk and control mine waste discharge, however, metals levels in Spring Branch surface waters (EPA 2006) and sediments (Exhibit 10) continue to be elevated above levels harmful to the biota.

### EMPIRE LAKE

Empire Lake, located near Riverton, was formed by a dam first erected in the early 1900s. The lake is owned by the Empire District Electric Company, which uses lake water as a coolant in its coal-fired power plant. Considerable sediment has accumulated behind the dam, resulting in shallow water depths throughout most of the lake: KDHE's 2002 303(d) list (KDHE 2002) states that the lake is impaired by siltation. In part because of this sedimentation, the lake "is thought to act as a sink for both nutrients and heavy metals" (KDHE 1980).

Ferrington *et al.* (1989) evaluated the lake's benthic invertebrate community and concluded that "the main effect of high concentrations of cadmium, lead and zinc in the sediments of Empire Lake is reduction of the standing crop density of aquatic macroinvertebrates, and presumably overall productivity of the reservoir system." More recently, Juracek (2006) evaluated the status and trends in sedimentation and metals concentrations in the lake. An extensive field investigation was done to assess metals concentrations and estimate metals volumes throughout the lake. Median concentrations of cadmium, lead, and zinc were 29 mg/kg, 270 mg/kg, and 4,900 mg/kg, respectively, and almost every sample from the lake bottom far exceeded MacDonald *et al.* (2000)'s probable effects concentrations for sediment. Estimated cadmium, lead, and zinc volumes in the lake were 78,000 pounds, 650,000 pounds, and 12,000,000 pounds, respectively. Trend analysis suggests that concentrations of these metals in bottom sediments decreased following the end of mining in the watershed. However, concentrations in the most recently deposited bottom sediments still far exceed the probable effects guidelines for all three metals (Juracek 2006).

While the lake does serve as a sink for metals, it may also serve as a source for downstream areas, at least during high-flow periods. Contaminated sediment was found immediately downstream from Empire Lake in the Spring River, indicating that some contaminated sediment may pass through the lake (Juracek 2006).

### TAR CREEK

Tar Creek is the principal stream in the Treece subsite and flows into Oklahoma from Cherokee County where it joins the Neosho River (Dames & Moore 1993a). Available data suggest that Tar Creek is highly impacted by metal concentrations. KDHE's 2002 303(d) list (KDHE 2002) indicates that Tar Creek is impaired by lead, cadmium, zinc, and sulfate. As shown in Exhibit 10, zinc levels in sediments frequently exceed values associated in the literature with adverse impacts to benthic organisms.

Dames & Moore (1993a) similarly indicate that the concentration of zinc in Tar Creek exceeds levels that are acutely toxic to some of the more sensitive species that could inhabit these ephemeral streams, and therefore could be affecting the species composition. Fish numbers in the lower segment of the Kansas section of Tar Creek were low relative to other streams in the subsite, and the only fish collected were of the sunfish family (*Centrarchidae*) (Dames & Moore 1993a).

## 3.2 GEOLOGIC RESOURCES

Cherokee County lies within the Ozark Plateau and Cherokee Lowlands physiographic provinces. The Ozark Plateau is characterized by thin, rocky soil and steep slopes, while the Cherokee Lowlands have gentler slopes and deeper soils more suitable to cropland (Dames & Moore 1993a). In its natural state, the soils support diverse ecosystems, such as tallgrass prairie and deciduous woodland.

Many geologic resources within the Cherokee County Site are either currently covered by mine waste piles, fall within the footprints of former piles, or are near mine waste piles. These areas tend to have higher metals concentrations than occur in other, nearby areas: in the Baxter Springs and Treece subsites, for example, researchers found that near-pile soils had metal concentrations that “are generally higher than concentrations in agricultural and A Horizon [surficial] soils (Dames & Moore 1993a). Furthermore, mill site soils had concentrations “similar to bulk chat values.”

## 3.3 GROUND WATER

Two major aquifers, one shallow and one deep, underlie the Cherokee County mining area. The shallow aquifer, called the Boone aquifer, is comprised of Mississippian limestones, which also contain the lead-zinc deposits mined in the area (Dames & Moore 1993b). The rock underlying the Boone aquifer is impermeable limestone, which confines the deep aquifer and largely prevents downward movement of the water (Dames & Moore 1993a). Water from the surface (for example, precipitation) can sink into the ground and enter the Boone through natural areas of permeability in the limestone or through mine workings (Dames & Moore 1993a), recharging the aquifer.

During times of heavy precipitation, ground water in the Boone aquifer discharges into mine shafts and drill holes, as observed in the Baxter Springs subsite in June 1990

(Dames & Moore 1993a). Some discharge also occurs directly from the Boone along the streambeds of tributaries to the Spring River (Dames & Moore 1993a).

For instance, the Boone aquifer was once routinely used as a source of drinking water by the residents of Galena, but EPA determined that metal contamination of the aquifer was significant enough to render the water unsafe to drink and in 1997 provided an alternate water supply as part of its selected remedial action for the Galena Alternate Water Supply OU (EPA 1997). The selected remedy included the provision of water from the deep aquifer, called the Roubidoux, to area residents. At the current time, there is little evidence of contamination in the Roubidoux.

The Roubidoux is the principal source of water for public, industrial, domestic, and stock supplies for the area (Dames & Moore 1993b). Its ground water tends to flow out of Cherokee County to the west, then turns south towards Oklahoma (Dames & Moore 1993a). Recharge occurs via precipitation falling on the western flank of the Ozark Dome in Missouri (Dames & Moore 1993a). There may also be downward leakage from the Boone through fractures and well shafts, but evidence suggests that this is not a significant source of recharge (Dames & Moore 1993a). Discharge occurs primarily through removal for human needs (Dames & Moore 1993a).

The Roubidoux is used not only by Cherokee County residents but also by residents of neighboring Missouri and Oklahoma. A recent study of water supplies in Missouri's Jasper and Newton Counties noted that "groundwater withdrawals from the [Roubidoux] aquifer are increasing rapidly" and that this poses a future risk of contamination of the lower aquifer by the upper (Springfield Plateau) aquifer in Missouri (Wittman *et al.* 2003). Future water demands are expected to increase further; this, "combined with the limited capacity of the aquifer, make it likely that [resource] conflicts will occur" (Wittman *et al.* 2003).

## 3.4 BIOTIC ENVIRONMENT

### THREATENED AND ENDANGERED SPECIES

As indicated in Appendix A, a number of species present in Cherokee County are included on state or Federal threatened and endangered species lists or are otherwise of special concern. These species have been identified at different locations throughout the county. The Spring River, for instance, supports the federally and state-threatened Neosho madtom (*Noturus placidus*). Obermeyer *et al.* (1997) found the Neosho mucket, a candidate species for Federal listing, to be relatively abundant in the Spring River between Stott City, Missouri and the river's confluence with Center Creek.[29] The federal candidate and state threatened Arkansas darter is found in the Spring River basin, as are a number of other fish species designated by the State of Kansas as threatened or SINC (*i.e.*, a species in need of conservation).

Cherokee County amphibians include a number of special status species. The Shoal Creek drainage basin is believed to host the cave salamander (*Eurycea lucifuga)* and the

[29] The abundance of this mussel declines appreciably below Center Creek, and it appears to be absent below Turkey Creek.

grotto salamander (*Typhlotriton splaeus*) (CH2M Hill 1988). State-designated threatened (T) or endangered (E) amphibian species with designated critical habitat in the Cherokee County Spring River basin include: cave salamander (E), many-ribbed salamander (*Eurycea multiplicata*, E), grotto salamander (E), eastern newt (*Notophthalmus viridescens*, T), longtail salamander (*Eurycea longicauda*, T), eastern narrowmouth toad (*Gastrophryne carolinensis*, T), green frog (*Rana clamitans*, T), and spring peeper (*Pseudacris crucifer*, T) (Collins *et al.* 1995, KAR 2003, KDWP 2005).

Special status avian species include the state threatened bald eagle (*Haliaeetus leucocephalus*) and the state endangered peregrine falcon (*Falco peregrinus*), among others. Special status mammals include the Kansas-threatened eastern spotted skunk (*Spilogale putorius*), the Kansas- and federally-endangered gray bat (*Myotis grisecens*). There are no known special status terrestrial plants in Cherokee County.

### AQUATIC AND AMPHIBIOUS SPECIES

Cherokee County's aquatic organisms include a wide variety of plants and animals. Among these are a number of larger or recreationally important fish species such as smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), walleye (*Stizostedion vitreum*), and many others.[30] Some fish species inhabit subsidence pits and flotation tailings ponds; these consist primarily of green sunfish, although local residents report that largemouth bass and crappie may also be found in some mine or mill ponds (Dames & Moore 1993a). Certain ponds are stocked and may support non-native fish species (Dames & Moore 1993b). Although few formal fish surveys have been conducted in ephemeral streams, some likely support yellow bullhead, black bullhead, green sunfish, various minnow species, slough darter (*Etheostoma gracile*), brook silverside (*Labidesthes sicculus*) and mosquitofish (*Gambusia spp.*) (Dames & Moore 1993b). The Ozark cavefish (*Amblyopsis rosae*) is present throughout parts of the Ozark uplift in Missouri and Oklahoma and may also be present in Cherokee County.

Freshwater mussels also occur in both the Spring and Neosho River basins. The "Surface Water Resources" section above presents some available evidence of potential contaminant-related injuries to Cherokee County fish and mussels.

### BIRDS

Birds make use of both aquatic and terrestrial habitat in Cherokee County. The North American Breeding Bird Survey effort regularly surveys birds through the Tri-State District, including parts of Cherokee County, and has identified at least 100 species in the district as a whole (Beyer *et al.* 2004). Water-affiliated species observed during these surveys in Cherokee County include the great blue heron (*Ardea herodias*), several egret

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[30] Additional larger or recreationally important fish in the area include: shortnose gar (*Lepisosteus platostomus*), river carpsucker (*Carpiodes carpio*), white sucker (*Catostomus commersoni*), black bullhead (*Ameiurus melas*), channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictis olivaris*), white bass (*Marone chrysops*), rock bass (*Ambloplites rupestris*), green sunfish (*Lepomis cyanellus*), warmouth (*Lepomis gulosus*), bluegill (*Lepomis macrochirus*, spotted bass (*Micropterus punctulatus*), white crappie (*Pomoxis annularis*), black crappie (*Pomoxis nigromaculatus*), and many others (Cross and Collins 1995).

species, and mallard (*Anas platyrhynchos*) (Sauer *et al.* 2001, as cited in Beyer *et al.* 2004). Dames & Moore (1993a) report that larger species, such as duck, geese, herons, egrets, pelicans, swans and shorebirds specifically use Spring River and Empire Lake, among other wetlands. Waterbirds observed in the Baxter Springs/Treece subsite include the Canada goose (*Branta canadensis*), mallard, wood duck (*Aix sponsa*), blue-winged teal (*Anas discors*), great blue heron, and an egret (Dames & Moore 1995).

Bird species attracted to native prairie and other open areas include, but are not limited to, the common bobwhite (*Colinus virginianus*), mourning dove (*Zenaida macroura*), western meadowlark (*Sturnella neglecta*), and field sparrow (*Spizella pusilla*) (Dames & Moore 1993a). The North American Breeding Bird Survey effort observed all these in Cherokee County as well as numerous other bird species (Sauer *et al.* 2001, as cited in Beyer *et al.* 2004). Dames & Moore (1993a) report the presence of wild turkey (*Meleagris gallopavo*), owls, hawks, thrushes, and woodpeckers in the Baxter Spring/Treece subsite.

### MAMMALS

Cherokee County mammals rely on both aquatic and terrestrial habitats. Muskrat, mink, and beaver can be found near wetlands and along streams (Dames & Moore 1993a). Mammals observed in both the Baxter Spring/Treece subsite and on the Missouri side of the Spring River include raccoon (*Procyon lotor*), coyote (*Canis latrans*), striped skunk (*Mephitis mephitis*), red fox (*Vulpes vulpes*), grey fox (*Urocyon cinereoargenteus*), long-tailed weasel (*Mustela frenata*), bobcat (*Lynx rufus*), mink (*Mustela vison*), opossum (*Didelphis virginiana*), eastern cottontail (*Sylvilagus floridanus*), whitetail deer (*Odocoileus virginianus*), badger (*Taxidea taxus taxus*), squirrels, shrews, and various other small rodents (Dames & Moore 1993a, Dames & Moore 1995).

### VEGETATION

Prior to significant European settlement of the area, Cherokee County was dominated by prairie (*i.e.*, Exhibit 14): “when there was scarcely any land in the county that had been touched with the plow, and when there were no roads established by any public act, the meager woodland was found only along Spring River and its larger tributaries, and probably a mere fringe along the Neosho River and the larger streams which flow into it. The county was almost a solid sward of prairie grass” (Allison 1904). In Cherokee County today, croplands, grasslands, woodlands, and wetlands are interspersed with spaces dominated by mining impacts (Dames & Moore 1993a).

Open areas such as cropland, pasture, meadows, and overgrown areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The remaining areas of native prairie, including native prairie hay meadows, are highly valued because they are among the most endangered ecosystems in the world. Although native prairies formerly covered vast areas, they are rare today and continue to be lost to human development. The continent's tallgrass prairie once covered 400,000 square miles of North America, from Indiana to Kansas and from Canada to Texas. Today, after years of farming, grazing and development, less than one percent of the original tallgrass prairie remains (Packard and Mutel 1997).

**EXHIBIT 14 NATIVE PRAIRIE, DIAMOND GROVE, MISSOURI**

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

Native tallgrass prairies support native plants and support exceptionally high numbers of plant species, including rare Midwest species. Thirty acres of hay meadow in eastern Kansas probably contain a few hundred native plant species, including grasses and forbs[31] (Exhibit 15) (Robertson 1996). The seed banks[32] are exceptionally rich, even in areas used as hay meadows. Native prairies may also support important rangeland grass species, such as the big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparius*), and Indiangrass (*Sorghastrum nutans*) (Dames & Moore 1993a).

Native prairies are also of value because they support many species of insects and fungi, which live in the ground in close association with prairie plants. In fact, a large percentage of the biological activities that take place as a part of the prairie tallgrass environment actually occur underground (Packard and Mutel 1997). Native prairies are one of Kansas's climax communities. They take decades or longer to form, and even restoration projects that replant native grasses cannot fully replicate the complex insect, small mammal, bacteria, fungi and soil invertebrate communities that occur in the original, natural prairie areas (Whitney 1998).

Cherokee County's vegetative habitat also includes cool season grasslands, which support cool season grasses such as brome (*Bromus* spp.), fescue (*Festucu arundinacea* Schreb.), Canada wildrye (*Elymus canadensis*), Kentucky bluegrass (*Poa pratensis*), western wheatgrass (*Agropyron smithii*), and little barley (*Hordeum pusillum*) (Packard and Mutel 1997). Cool season grasses dominated the area thousands of years ago when temperatures were colder. As the climate warmed, warm season grasses began to predominate, although the cool season species have not been fully out-competed and are still a part of the native complement of grassland plants (Owensby *et al.* 1999).

Both cool and warm season grasslands have agricultural value. Cool season grasses green-up earlier in the season. They also grow in the fall after warm season grasses have finished their major growth of the year. Farmers tend to graze their herds on cool season grasses between the green-up and the end of May, and from September through October. During the height of summer, cattle are put to pasture on warm season fields (Missouri Department of Conservation undated).

[31] Forbs are herbaceous, non-grass species.

[32] Seed banks are reserves of viable seeds present naturally on the surface and in the soil.

## EXHIBIT 15 NATIVE PRAIRIE FORBS, DIAMOND GROVE, MISSOURI

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

In addition to supporting grasslands, Cherokee County also supports some forests, which altogether cover about nine percent of the county's area. These woodlands tend to occur as irregular areas or strips and as riparian corridors (Dames & Moore 1993a). Woodlands also occur as strips on upland drainageways and on steep upland slopes. Native forests are characterized by a variety of oak species (*Quercus* spp.), black walnut (*Juglans nigra*), pecan and other hickory species (*Carya* spp.), and associated shrubs, grasses, legumes, and wild herbaceous plants. The southeast corner of the county is the most biologically diverse region of the state in terms of the number of native woody species.

Some of the most valued wooded areas in the county occur as riparian corridors. Prior to European settlement of the area, woodlands were found "only along Spring River and its larger tributaries, and probably a mere fringe along the Neosho River and the larger streams which flow into it" (Allison 1904). Today, some of these areas remain. Wooded riparian corridors occur along larger surface waters, such as the Spring River, while grassland corridors are more common along smaller creeks and streams.

When continuous, these corridors allow species to migrate from location to location. Riparian corridors also provide important habitat for a variety of species, including aquatically-linked birds and mammals such as, raccoons, mink, wood ducks, and others. Squirrels, deer, turkeys, and songbirds also make use of wooded riparian areas (KDWP and KFS undated). Woodlands offer wildlife protection from wind, snow, and predators (KDWP and KFS undated), as well as providing food sources not included in prairies (*i.e.*, nuts and certain berries). Mulberry, oaks, hickory, pecan, walnut, and hackberry are common woodland species with high wildlife food values. Riparian corridors also help aquatic resources, protecting or buffering them from various landward disturbances, including pesticide runoff, fertilizer runoff, and erosion: Zaimes *et al.* (2004) found that streams edged by forest buffers had significantly lower erosion rates than either row-crop fields or continuously grazed pastures.

The Trustees have estimated that approximately 4,000 terrestrial acres in Cherokee County have been affected by mining activities (State of Kansas and DOI 2003). Chat piles in Cherokee County do not support normal stands of terrestrial vegetation. In addition, terrestrial vegetation has been significantly altered, and habitat has been lost because of hazardous substances at sites where chat piles formerly existed but have since been removed. Plant communities in many of these areas now provide little habitat for birds and wildlife. Vegetation communities adjacent to mine wastes also appear to have been affected, though to a lesser extent, and the ability of these areas to provide habitat may have been impaired as well (State of Kansas and DOI 2003).

**3.5 CULTURAL ENVIRONMENT AND HUMAN USE**

### DEMOGRAPHICS

The total population of Cherokee County is 21,451 (USCB undated). Within the Cherokee County Superfund Site, population centers include the towns of Baxter Springs (pop. 4,246), Galena (pop. 3,163), and Treece (pop. 144) (USCB 2005). The population of the three towns decreased six percent, one percent, and 13 percent, respectively, between the 1990 and 2000 censuses. Exhibit 16 summarizes age and race information for the county and for the State of Kansas.

**EXHIBIT 16 CHEROKEE COUNTY DEMOGRAPHICS - 2006**

| | CHEROKEE COUNTY | STATE OF KANSAS |
|---|---|---|
| **AGE** | | |
| Persons under 18 years old | 24.3% | 25.2% |
| Persons over 65 years old | 15.1% | 12.9% |
| **RACE**[A] | | |
| White persons | 90.7% | 81.1% |
| American Indian and Alaska Native persons | 3.8% | 1.0% |
| Hispanic or Latino persons | 1.2% | 8.6% |
| Black or African American persons | 0.7% | 6.0% |
| Asian persons | 0.5% | 2.2% |
| Source: USCB undated.<br>Notes: Percentages do not sum to 100 because not all censused categories are included. | | |

### EMPLOYMENT AND INCOME

Approximately 10,800 individuals comprise Cherokee County's labor force (USCB 2000). In 2006, unemployment was approximately 5.1 percent, a value that exceeded the statewide figure of 4.5 percent. Cherokee County's unemployment rate has exceeded that of the state in every year since 1990.[33]

Employed civilians work in a variety of industries, including: (a) manufacturing (25.5 percent); (b) educational, health and social services (22.0 percent); and (c) retail trade (10.4 percent). About 3.8 percent of the employed civilian population works in the agriculture, forestry, fishing, hunting, and mining group of industries (USCB 2000).

Cherokee County's residents have lower income and are poorer than Kansas residents as a whole. Median household income for the county, reported as $33,151 in 2004, was significantly lower than the state median of $41,664 (USCB undated). That same year, 15.6 percent of Cherokee County's population was below poverty level, compared to 11.1 percent of the state's population (USCB undated). Although the Cherokee County's

[33] Analysis based on data from the Real Estate Center at Texas A&M University, viewed 4/21/08 at <http://recenter.tamu.edu/data/empc/> and < http://recenter.tamu.edu/data/emps/emps20.htm>.

homeownership rate in 2000 was slightly higher than that of Kansas (76.1 versus 69.2 percent), the median value of owner-occupied housing units in the county was roughly half that of the state ($46,900 versus $83,500) (USCB undated).

### LAND USE

Cherokee County is largely agricultural. The 2002 Census of Agriculture reported 746 farms in the county, totaling approximately 290,000 acres (NASS 2002). By acreage, the main crops are soybeans and wheat, with smaller areas devoted to forage production, sorghum, and corn (NASS 2002). The main pasture grass is tall fescue, a cool season grass (Dames & Moore 1993a). Exhibit 17 presents additional information about land uses in the county.

**EXHIBIT 17 CHEROKEE COUNTY LAND USE**

| LAND USE | ACRES |
|---|---|
| Cropland | 228,595 |
| Grassland | 97,004 |
| Woodland | 37,828 |
| Water | 6,587 |
| Residential | 3,787 |
| Commercial/Industrial | 489 |
| Other | 3,946 |
| Data source: Land Cover [ArcInfo Interchange]. Published 1993. Lawrence, KS: Kansas Applied Remote Sensing. | |

### ECONOMIC ACTIVITY

Industrial facilities within the Cherokee County Superfund Site include a coal-fired power plant on the Spring River, near Empire Lake, operated by the Empire District Electric Power Company, in addition to various small manufacturing facilities concentrated around Galena and Baxter Springs (Dames & Moore 1993a, EPA 2003). Processing of chat for commercial use in road base and asphalt is conducted throughout the site by such companies as Southwest Rock and Chat Company, Inc., O'Brian Rock Co., Inc. (Dames & Moore 1993a, EPA 2003), and Bingham Sand and Gravel. The surface and mineral rights within the site are mostly privately owned, except for land within city limits, roads or highways (Dames & Moore 1993a).

Agricultural production in the county includes both crops and livestock. In 2002, crop sales accounted for about 58 percent of total sales of US$49,586,000; livestock sales accounted for the remaining 42 percent. Grains, oilseeds, dry beans, and dry peas comprised over 90 percent of crop sales (NASS 2002). Turkeys were the largest livestock product both numerically and in value terms. Other livestock include both beef and dairy cattle, (Dames & Moore 1993a), as well as much smaller numbers of hogs and pigs (NASS 2002).

### RECREATIONAL AND CULTURAL RESOURCES

Empire Lake is the only lake in Cherokee County and is used by residents for recreational purposes. In addition, Cherokee County contains two nature reserves. The Spring River Wildlife Area is north of the city of Galena, and is 424 acres in size. Activities in the Spring River Wildlife Area include hunting, fishing, hiking, and other outdoor recreation. Schermerhorn Park is located on 24 acres that span Shoal Creek two miles south of Galena, and contains a cave that is habitat to the Kansas endangered dark-sided salamander (*Eurycea longicauda melanopleura)*, cave salamander (*Eurycea lucifiga)*, and graybelly salamander (*Eurycea multiplicata*).[34] Recreational opportunities include hiking and wildlife observation. The Southeast Kansas Nature Center of Galena, is located in the park.[35]

Although not within the Cherokee County Superfund Site, the Mined Land Wildlife Area is a large wildlife reserve located in the northwestern part of Cherokee County. The site of former coal strip-mining, today the strip pits have become lakes that support a variety of wildlife. The Mined Land Wildlife Area includes 14,500 acres (KDWP undated). Hunting opportunities in these areas include white-tailed deer, eastern turkey, quail, mourning dove, and various waterfowl (KDWP undated). Fishing takes place in both natural streams and mining-created lakes and ponds (KDWP undated). Sportfish include largemouth bass, rainbow trout, walleye, channel catfish, crappie, bluegill and warmouth (KDWP undated). Other recreational opportunities include hiking, canoeing, and wildlife observation.

Cultural resources include the Brush Creek Bridge and Johnston Library in Baxter Springs, which are listed in the National Register of Historic Places, as is the Edgar Backus Schermerhorn House in Galena (NRHP). Baxter Springs is located on historic Rt. 66 and the Military Frontier Scenic Byway, and contains 16 Civil War sites as well as the Baxter Springs Heritage Center and Museum (Baxter Springs Chamber of Commerce, Kansas State Library). Galena is also located on Rt. 66 and contains the Galena Mining and Historical Museum (Kansas State Library).

The Kansas State Historical Society also maintains records of historic and archaeologically important sites in the county.

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[34] See http://www.naturalkansas.org/schermerhorn.htm, accessed 4/21/08.

[35] See http://www.apexcorp.com/~rmangile/Sgas/GalenaNC.html, accessed 4/21/08.

# CHAPTER 4 | RESTORATION ALTERNATIVES

As noted in Chapter 3, releases of hazardous substances (cadmium, lead, and zinc) have occurred in Cherokee County. FWS believes that these releases have injured the county's natural resources, including surface water resources, ground water resources, plants, and animals. In their uninjured state, these natural resources provided a variety of "services," both to the environment and to people. Services provided to the environment are called "ecological services." For example, clean surface water can provide habitat services–*i.e.*, a place to live–for certain aquatic threatened and endangered species as well as to other aquatic organisms. Surface water also provides foraging opportunities, another kind of ecological service, for animals that eat fish and shellfish. Similarly, clean soils help support healthy vegetation, and the different plant communities that grow in turn provide animals with foraging opportunities, nesting or denning areas, and protective cover, all of which are essential ecological services for different species.

In addition to providing ecological services, healthy natural resources can provide services to people. For instance, healthy surface waters can provide opportunities for fishing and boating. Clean ground water can be a source of drinking water. Hunting opportunities may exist where environmental conditions can support sufficiently large populations of favored species.

Releases of cadmium, lead, and zinc due to mining activities in Cherokee County have injured some of its natural resources, and have reduced the quantity and/or value of the ecological and human-use services that these resources would otherwise have been able to provide. Some portion of these injuries was caused by Eagle-Picher's and LTV's mining activities (although other companies were involved as well), and FWS is required to use NRD funds recovered as a result of these activities, as well as any natural resource damages recovered from other responsible parties in the future to restore, rehabilitate, replace, and/or acquire the equivalent of these natural resources and their associated services.

To that end, FWS has identified a number of potential restoration alternatives (Exhibit 18). The restoration alternatives discussed in this RP/EA were selected to generally compensate for the kinds of ecological and human-use services that FWS believes were impacted by local mining operations. For instance, because FWS believes that mine piles have reduced the availability of suitable terrestrial habitat for plants and animals, a variety of restoration alternatives are focused on either preserving high-quality existing habitat or enhancing the quality of poorer habitat.

Most alternatives are divided into those applicable for terrestrial areas and aquatic areas (*i.e.*, rivers and streams, and Empire Lake). An additional "miscellaneous" category of alternatives includes two options not easily categorizable into either of the above two groups.

This restoration plan does not identify specific areas to which restoration alternatives might be applied because the final selection of locations depends on information not available at this time, including information on the current ecological status of many parcels of land as well as information on individual landowner preferences. To best match restoration projects to associated injuries, the restoration alternatives described in this plan are generally intended to be applicable to areas of Cherokee County impacted by the companies from which restoration funds were obtained. However, FWS recognizes that adequate opportunities for restoration activities may not be fully available within these areas. Thus, FWS may pursue restoration projects in other areas. These areas may include "orphan" areas within Cherokee County (*i.e.,* areas for which the responsible party(ies) have not been determined, or are no longer in existence). In certain circumstances, FWS and the State may even choose to implement restoration activities outside of Cherokee County (*i.e.*, neighboring Crawford, Neosho, and Labette Counties, see Alternatives T2 and T3).

Some alternatives are not independent—*i.e.*, they would only be conducted in conjunction with other alternatives. For example, aquatic restocking would only occur if sediments in the area to be restocked had been restored to reduce contamination levels, because without restoration, the restocked fish and shellfish would not survive. Exhibit 18 indicates which alternatives are contingent upon the co-implementation of others.

As noted above, restoration alternatives discussed in this RP/EA are explicitly not intended to replace or duplicate efforts undertaken by EPA or other organizations. Rather, some restoration alternatives could be undertaken to address areas of contamination for which no current EPA or other remediation plans exist; some alternatives address interim losses to natural resources, and some supplement efforts already being undertaken by EPA or other organizations to more rapidly restore injured natural resources to their baseline condition (*i.e.*, see Alternatives T9 and T10).

For both the terrestrial and aquatic restoration alternatives, the discussion begins with the "no action" alternative. Then, the preservation-based alternatives are presented, followed by a variety of other restoration project types, some for former mine waste areas, and others for areas where mine wastes yet remain. The order in which alternatives are presented is not intended to reflect FWS preferences.

## EXHIBIT 18 RESTORATION ALTERNATIVES CONSIDERED

| NAME | DESCRIPTION | INITIAL HABITAT TYPE | ENDPOINT | REQUIRED CO-ALTERNATIVE(S) |
|---|---|---|---|---|
| **TERRESTRIAL HABITATS** | | | | |
| T1 | No action | All | No change | None |
| T2 | Preserve native prairies | Unprotected native prairies | Protected native prairies | None |
| T3 | High quality prairie restoration | Former mine waste area, CRP grasslands, agricultural land, cool season pasture | High quality prairie | None |
| T4 | CRP grassland restoration | Former mine waste area, agricultural land or cool season pasture | CRP grassland | None |
| T5 | Cool season grassland restoration | Former mine waste area, agricultural land | Cool season grassland | None |
| T6 | Remove and dispose of terrestrial mine wastes in subsidences; cap subsidence* | Terrestrial mine waste area | Depends on subsequent restoration action | T3, T4, or T5 |
| T7 | Mine waste recontouring* | Terrestrial mine waste area | Depends on subsequent restoration action | T3, T4, or T5 |
| T8 | Mine waste recontouring and encapsulation* | Terrestrial mine waste area | Depends on subsequent restoration action | T3, T4, or T5 |
| T9 | Apply biosolid amendments beneath planned EPA caps** | Encapsulated mine waste area, revegetated by EPA with native seed mix | More thickly encapsulated mine waste area, revegetated by EPA with native seed mix | None |
| T10 | Improve EPA mine waste caps (through soil amendments and fencing) | Encapsulated mine waste area, revegetated by EPA with native seed mix | Encapsulated mine waste area, with improved native vegetative community | None |
| **AQUATIC HABITATS** | | | | |
| A1 | No action | Waterways and Empire Lake | No change | None |
| A2 | Preserve high quality riparian corridor | High quality wooded or grassland riparian corridor | Protected high quality wooded or grassland riparian corridor | None |
| A3 | Preserve Empire Lake buffer | Higher quality Empire Lake buffer | Protected lake buffer | None |
| A4 | Improve riparian buffer | Waterways with poor quality buffers | Buffer of appropriate type and width | None |
| A5 | Dredge waterway(s) | Waterways | Less contaminated waterway | A2 |
| A6 | Dredge Empire Lake; install underwater sediment retention structures on Short Creek | Empire Lake | Less contaminated, deeper lake | None |
| A7 | Drain and cap Empire Lake; channelize Spring River | Empire Lake | Terrestrial; habitat type depends on subsequent restoration action | None |
| A8 | Cap Empire Lake sediments in place | Empire Lake | Shallower lake with less-contaminated surficial bottom sediments | None |
| A9 | Aquatic biota stocking | Waterways and Empire Lake | Healthier aquatic community | A5 |

| NAME | DESCRIPTION | INITIAL HABITAT TYPE | ENDPOINT | REQUIRED CO-ALTERNATIVE(S) |
|---|---|---|---|---|
| **MISCELLANEOUS PROJECTS** | | | | |
| M1 | Pilot project development | Varies | Varies | None |
| M2 | Public outreach and communication | N/A | N/A | None |
| * = This alternative applies to areas where EPA has no future remediation/encapsulation plans.<br>** = This alternative applies to areas where EPA plans to encapsulate mine wastes and is intended to be implemented in conjunction with EPA's remedial activities, including replanting of the encapsulated areas. | | | | |

## 4.1 TERRESTRIAL RESTORATION ALTERNATIVES

### NO ACTION: ALTERNATIVE T1

Under this alternative, FWS would rely on natural recovery and would take no direct action to restore injured natural resources or compensate for interim lost natural resource services. This alternative would include the continuance of extant, ongoing monitoring programs such as those operated by the Kansas Department of Health and Environment (KDHE) but would not include additional activities aimed at either reducing contamination, reducing potential exposure to contaminants, or enhancing ecosystem biota or processes. Under this alternative, interim losses suffered would not be compensated.

### PRESERVE NATIVE PRAIRIES: ALTERNATIVE T2

This alternative aims to preserve those remnants of native prairie that exist (*i.e.*, Exhibit 19), usually as hay meadows, preferably in Cherokee County but also potentially in the neighboring Crawford, Neosho, and Labette Counties. For this alternative, the first task would be to identify those areas of native prairie that remain and to evaluate the ecological health of each. The Kansas Biological Survey (KBS)[36] maintains a Heritage Trust Database that includes records of many candidate properties; additional survey efforts might identify additional parcels for consideration.

**EXHIBIT 19 NATIVE PRAIRIE, DIAMOND GROVE, MISSOURI**

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

[36] KBS is a non-regulatory public service unit of the state of Kansas and a non-degree granting progressive environmental research unit for the University of Kansas. KBS states that its basic mission is to "gather information on the kinds, distribution, and abundance of plants and animals across the State of Kansas, and to compile, analyze, interpret, and distribute this information." See http://www.kbs.ku.edu (viewed 11/14/08) for more information.

This alternative is aimed at preserving those prairie remnants that are of the highest quality. Prairie quality can be determined using the floristic quality index (FQI), a measure developed by the KBS to evaluate the quality of vegetative communities in Kansas. Additional considerations relating to the selection of specific parcels are set forth in Chapter 6.

Preservation of native prairie remnants could be accomplished either by direct purchase of the land or through the purchase of easements. At this point, FWS has not selected the organizations that would hold the titles to any purchases or easements; options potentially include agencies within the State of Kansas or non-governmental organizations. Land acquisitions may be conducted by government agencies using settlement monies, or directly by settling with PRPs.

To ensure ongoing protection, management of the preserved land is also required. Maintenance of prairie sites should include regular burns (Exhibit 20), as fire is an integral part of prairie health (Packard and Mutel 1997). Fire removes dead stem and leaf litter. This prevents the accumulation of mulch and allows soil to warm faster in the spring, thus lengthening the growing season (Packard and Mutel 1997). Appropriate burning enhances vitality of many prairie grass species, producing taller grasses and more forbs (Duebbert *et al.* 1981). Fire controls the invasion of woody shrubs and trees and also stimulates microbes in the soil. The ash left behind provides small amounts of nutrients.

**EXHIBIT 20 PRAIRIE BURN, KONZA BIOLOGICAL RESEARCH STATION, MANHATTAN, KANSAS**

Photo courtesy of USDA Natural Resources Conservation Service.

Although fire is the preferred method of prairie rejuvenation, alternatives exist. These include yearly mowing or haying, which can simulate fire by removing dead plant matter and reducing the encroachment of deciduous forest and exotic plants (Robertson 1996). Occasional grazing (on a less-than-annual basis) is another approach (Duebbert *et al.* 1981). One or more of these alternatives may be used in areas where fire is not practical.

Ideal management would likely include a combination of regular burning with haying. Excessive burning can be destructive, resulting in a high mortality of insects and invertebrates (Robertson 1996). Similarly, the disproportionate use of haying and total absence of fire can result in the invasion of exotic cool season grasses (Robertson 1996).

Fencing of native prairie areas is important to prevent over-grazing by domestic stock, such as cattle. Over-grazing degrades prairie grasses by eliminating many native grass and forb species, encouraging the increase of several weedy native and non-native species (Robertson 1996).

### HIGH QUALITY PRAIRIE RESTORATION: ALTERNATIVE T3

This alternative is aimed at improving the quality of existing, lower-quality land such that it becomes more fully like a native, natural prairie. In theory, high quality prairie restoration could begin with any local habitat type, including agricultural land (Exhibits 21 and 22), cool season pasture (Exhibit 23), Conservation Reserve Program[37] (CRP) grasslands (Exhibit 25), unvegetated former mine waste areas, capped mine wastes, and so forth; however, improving existing moderate-quality prairie would be more efficient. Areas to be restored would either be purchased, or an easement for the area would be purchased from the current landowners.

Although the specific treatment needed (and thus, costs) would depend in part on the initial condition of the land, in general restoration to a high quality prairie would require: site preparation, seed selection and storage, planting, and management (Robertson 1996). The mode of site preparation depends on the vegetation present on the site before restoration and the status of the soil. For instance, a selective herbicide may control most weeds that invade the site during preparation and before any native grasses have grown (Larson 1991). In the case of perennial weeds, these may be treated by exposing roots to winter temperatures before a spring planting. Woody vegetation (*i.e.*, cedars) will also have to be controlled as part of site preparation.

[37] The Conservation Reserve Program is a voluntary program through which private landowners receive annual rental payments and cost-sharing subsidies in exchange for establishing long-term, resource-conserving covers on eligible farmland.

## EXHIBIT 21 AGRICULTURAL LAND: SOYBEAN AND CORN STUBBLE, CHEROKEE COUNTY

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

## EXHIBIT 22 AGRICULTURAL LAND: WINTER WHEAT, CHEROKEE COUNTY

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

**EXHIBIT 23 COOL SEASON PASTURE, MANHATTAN, KANSAS**

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

To maximize species richness, seed mixes should be of high quality and diversity, with a full complement of species (Robertson 1996). FWS anticipates that the seed mix in this alternative would include at least half a dozen warm grass species, and in excess of 15 forb species. Ideally, seeds should originate within a few hundred miles of the restoration site. Planting in the fall, winter, or early spring ensures that seeds have germination moisture (Whitney 1998). Exhibit 24 shows an upland area restored by EPA using a native species mix.

To ensure ongoing development and protection of the new prairie areas, management of the land is required. Anticipated management tasks include: targeted reseeding; burning, and haying or mowing; fence maintenance; and (possibly) application of herbicide. Targeted reseeding can enhance diversity if certain plants do not grow after an initial seeding attempt. As noted above, burning and/or haying are important to rejuvenate the prairie. Fencing is necessary to prevent livestock from excessively removing native species (thereby providing an opportunity for invasive weeds), as well as to prevent general habitat degradation such as trampling and soil disturbance. Herbicides may also be used to control invasive species; however, they should be used cautiously, as these chemicals can harm native plants. If appropriate, herbicides may be used to reduce the population size of a particularly aggressive species, after which mechanical methods such as mowing or hand-pulling, or natural methods such as burning can further eliminate the problem, as some non-native weeds are not adapted to fire (Larson 1991). Evaluation of the success of this alternative could include reliance on measures such as the Kansas Biological Survey's FQI, species abundance/diversity measurements, percent cover, vegetative biomass measurements, or other metrics.

**EXHIBIT 24 UPLAND AREA NEAR SPRING BRANCH, CHEROKEE COUNTY, RESTORED WITH NATIVE SPECIES**

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

### CRP GRASSLAND RESTORATION: ALTERNATIVE T4

Restoration to CRP grassland (Exhibit 25) could begin with habitat types where current ecological conditions are inferior to those that would be provided by the restored grassland. These habitat types include agricultural land (*i.e.*, Exhibits 21 and 22), cool season pasture (Exhibit 23), and unvegetated or sparsely vegetated former mine waste areas. Areas to be restored would either be purchased, or an easement for the area would be purchased from the willing landowners. The level of interest from landowners is not currently known.

## EXHIBIT 25 CRP GRASSLAND, CHEROKEE COUNTY

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

Although the specific treatment needed would depend in part on the initial state of the land, in general a CRP restoration effort would be similar to the prairie restoration process described above. First, seeds used for planting restoration sites should be collected from areas proximal to the site, and as diverse a mix of native species as possible should be used. At a minimum, the seed mix would be similar to that employed by the CRP program in Kansas, which is a mix of five warm season[38] native grass species, including switchgrass (*Panicum virgatum*), Indiangrass (*Sorghastrum nutans*), little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardii*), and sideoats grama (*Bouteloua curtipendula*). Herbicides may be helpful to control proliferation of cool season weeds if used sparingly and in conjunction with mechanical or natural methods (Cunningham 1997).

As for prairie restoration, fencing and long-term maintenance are required. Once planted, native grasses take about three years to establish (Packard and Mutel 1997; Kindscher and Tieszen 1998). After the stand matures, maintenance usually involves occasional mowing or burning, usually at a frequency of three to five years or more (Cunningham 1997). This frequency depends on local climate and field conditions and will not only benefit native plants, but will help control non-native weeds as well. Evaluation of the

[38] Warm season grasses use a carbon dioxide-concentrating mechanism to photosynthesize efficiently in hot, dry climates. This mechanism reduces water loss by minimizing $CO_2$ diffusion, making these grasses highly water use efficient and able to live in hotter, drought-prone climates.

success of this alternative could include reliance on measures such as the Kansas Biological Survey's FQI, species abundance/diversity measurements, percent cover, vegetative biomass measurements, or other metrics.

FWS notes that the CRP grassland restoration projects described in this RP/EA (and conducted using bankruptcy funds) are not part of the official NRCS CRP program. The CRP term is used here merely to describe the typical type of seed mix proposed for this warm season grassland restoration alternative.

### COOL SEASON GRASSLAND RESTORATION: ALTERNATIVE T5

Cool season grassland establishment (with species such as brome or fescue) is most appropriate for habitat types where current ecological conditions are inferior to those that would be provided by the restored grassland (Exhibit 26). These habitat types include agricultural land, and unvegetated or sparsely vegetated former mine waste areas. Areas to be restored would either be purchased, or an easement for the area would be purchased from the current landowners.

Although the specific treatment needed would depend in part on the initial state of the land, in general a cool season grassland restoration effort would require site preparation, seed selection, planting, and management.

As for other ecological replanting efforts described above, fencing and long-term maintenance are required. Cool season grass stands may persist for many years with the right management, including fertilization. Cool season grasses require substantial fertilization with nutrients such as phosphorous, nitrogen, potash, calcium, magnesium, sulfur, and potassium (MDNR 2003, KSU 1998). Soil should be tested on a regular basis (MDNR 2003).

Haying or mowing should be delayed at least three years after initial seeding until the plants have a well-developed root system, or else young seedlings may be uprooted and destroyed (Redmon 1997). Other management techniques for newly established cool-season perennial grasses include the use of herbicides to control unwanted weed competition and the use of insecticides to prevent insect damage to young seedlings (Redmon 1997). Every three to four years, reseeding with legumes, which enrich soil nitrogen, can help maintain forage quality (MDNR 2003).

EXHIBIT 26 COOL SEASON GRASSLAND, CHEROKEE COUNTY

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

### REMOVE AND DISPOSE OF TERRESTRIAL MINE WASTES:[39] ALTERNATIVE T6

Although the vast majority of mine wastes originally in Cherokee County have been removed, significant amounts remain and have not been fully remediated. Currently remaining mine wastes include orphan piles at Baxter Springs, as well as mine wastes at Treece. Although EPA initially did not address these orphan piles "due to technical impracticability" (EPA 1997), in 2006 EPA retracted the technical impracticability waiver and issued an amendment to the Record of Decision that addresses the remaining mine waste through 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). However, at this time, it is unclear as to exact extent of orphan mine waste that will eventually be addressed–for example, EPA's plans rely on responsible chat sales before and during remedy implementation to reduce the volume of mine wastes. As a result, there may be some unquantifiable amount of unaddressed mine wastes that will remain following the EPA remedy. Furthermore, prior EPA remediation of the Galena subsite has not met restoration goals: 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 (Exhibits 27 and 28). EPA has

[39] 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.

no current plans to more completely address the problems that these mine wastes continue to pose, and consequently, these areas are potential targets for this restoration alternative.

As described in the Cherokee County Phase I Damage Assessment Plan (IEc 2004), plants will not thrive on mine wastes, which also increase the loadings of metals into local creeks and rivers and may contribute to ground water contamination.

This alternative includes physically removing remaining chat or bullrock piles, or other mine wastes, and disposing of them. Removed wastes must be disposed of in a manner that minimizes human health and ecological risks. In theory, options for the disposal of wastes include: (a) emplacement in subsidences or other mine workings in the area, (b) emplacement in an offsite repository, and (c) beneficial re-use. Emplacement in an offsite repository is likely to be prohibitively expensive. This alternative therefore contemplates disposal of these wastes on-site in appropriate subsidences. To minimize the potential for metals from the wastes to leach into surface waters, these subsidences must not be located near streams or floodplains.

After filling the subsidence with mine wastes, the subsidence would be capped with 18 inches of clay and topsoil, amended with biosolids at a rate of 100 tons per acre and associated materials (lime and carbon-rich matter),[40] and then revegetated using one of the above-mentioned revegetation alternatives (*i.e.*, high quality prairie replanting or CRP grassland replanting). Cap material would also come from a nearby location to minimize transportation costs and to ensure that the soil type is consistent with that naturally present in the area. The borrow sites (*i.e.*, the sites from which the capping soil is taken) would need to be carefully reconstructed to aid their recovery. Borrow material would only come from previously disturbed areas, not pristine sites. The areas from which mine wastes are removed would be revegetated using one of the above-mentioned revegetation alternatives (*i.e.*, high quality prairie replanting or CRP grassland replanting).

Ongoing monitoring and maintenance tasks would likely include regular checks of the cap's stability, patching if needed, fence maintenance, plus activities associated with maintenance of the cap's vegetation (discussed previously).

#### MINE WASTE RECONTOURING: ALTERNATIVE T7

Instead of removing and disposing of mine wastes, another option is to recontour the wastes to reduce erosion and runoff. This would entail the use of earthmoving equipment to even out the profiles of some tall piles of wastes and make them more consistent with the surrounding area. EPA selected this alternative for much of the mine wastes at the Galena subsite (OU 5) (EPA 1989). Mine waste recontouring would be conducted in combination with one of the revegetation alternatives described above,[41] and would require long-term monitoring.

[40] For a description of biosolids, see Alternative T9.

[41] EPA's implementation of this alternative included the addition of other materials to the recontoured wastes, such as compost, prairie hay mulch, lime, and annual rye grass as well as replanting with native warm season grasses.

### MINE WASTE RECONTOURING AND ENCAPSULATION: ALTERNATIVE T8

Similar to the remedial alternative selected by EPA for the Baxter Springs subsite (OU 3) (EPA 1997) and remaining mine wastes in Cherokee County (EPA 2006), this alternative includes recontouring remaining mine wastes, followed by capping with soil from a nearby borrow site. To minimize maintenance costs and maximize the likely longevity of this remedy, this alternative includes a cap at least 18 inches deep, constructed of clay and topsoil.[42] Cap material would come from a nearby location, to minimize transportation costs and to ensure that the soil type is consistent with that naturally present in the area. The borrow sites would need to be carefully reconstructed to aid their recovery.[43]

FWS anticipates that the capped area would also be amended with biosolids at a rate of 100 tons per acre and associated amendments (lime and carbon-rich matter) and revegetated using one of the revegetation alternatives described above (*i.e.,* high quality prairie replanting or CRP grassland replanting).[44] Encapsulated areas must be fenced to prevent cattle from inadvertently disturbing the cap and re-exposing the mine wastes. Ongoing monitoring and maintenance tasks would likely include regular checks of the cap's stability, patching if needed, fence maintenance, plus activities associated with maintenance of the cap's vegetation (discussed previously).

### APPLY BIOSOLID AMENDMENTS BENEATH PLANNED EPA CAPS: ALTERNATIVE T9

This alternative includes integrating biosolids application with the anticipated EPA remedy by deep-tilling biosolids, additional organic matter, and lime into consolidated mine wastes prior to placement of EPA's soil cap. Deep tilling these amendments, at a rate of 100 tons per acre, will help to rehabilitate the soil and support a healthy native plant community.

Biosolids refer to the semi-solid residual materials from municipal wastewater treatment plants that use activated sludge treatment processes (also known as sewage sludge) or other composted, nutrient-rich waste products. Biosolids have been shown to stabilize metals, rendering them less biologically available and therefore unable to exhibit toxicity. In addition to biosolids, lime is added to the amendment mixture to keep the soil calcareous. Carbon-rich matter, such as hay, yard wastes, wood chips, or sawdust, is also added to maintain the proper carbon-nitrogen ratio within the treated soil. FWS prefers native prairie hay because it tends to contain native seeds that result in an improved restoration result.

Adding the proposed biosolids amendments to EPA's intended site remedial actions will build a thicker soil profile with a subsoil under the cap that has been stabilized to reduce

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[42] Although EPA's Baxter Springs remedy used a six-inch thick cap in some places and an 18-inch cap in others, the proposed remedy for the Badger/Waco/Crestline subsites includes an 18-inch cap over all areas (EPA 2004a).

[43] It may also be possible to construct a borrow site such that it can be subsequently used as a small wetland, thereby benefiting aquatic and water-associated species.

[44] For a description of biosolids, see Alternative T9.

metal availability and improve restoration of native prairie soil. Consistent with EPA's Record of Decision, EPA will then cover the biosolids application/mine waste mixture with a soil cap one foot to eighteen inches deep and revegetate with a native seed mixture. Encapsulated areas must be fenced to prevent cattle from inadvertently disturbing the cap and re-exposing the mine wastes. Ongoing monitoring and maintenance tasks would likely include regular checks of the cap's stability, patching if needed, fence maintenance, plus activities associated with maintenance of the cap's vegetation (discussed previously). These tasks would be undertaken by the State of Kansas, and are not included in the Trustees' estimated expenditures for this alternative.

### IMPROVE EPA MINE WASTE CAPS: ALTERNATIVE T10

At some sites in Cherokee County including Baxter Springs, EPA has previously undertaken mine waste recontouring and encapsulation remedial actions. Under this Alternative, the Trustees would add seed and soil amendments (but no biosolids) and would fence the area to protect new growth from livestock if necessary. This will generally increase the area's ability to support healthy native plant community for many years. Ongoing monitoring and maintenance tasks would likely include regular checks of the cap's stability, patching if needed, fence maintenance, plus activities associated with vegetation maintenance. These tasks also would be undertaken by the State of Kansas, and are not included in the Trustees' estimated expenditures for this alternative.

## 4.2 AQUATIC RESTORATION ALTERNATIVES

### NO ACTION: ALTERNATIVE A1

Under this alternative, FWS would rely on natural recovery and would take no direct action to restore injured natural resources or compensate for lost natural resource services pending environmental recovery. This alternative would include the continuance of extant, ongoing monitoring programs such as those operated by KDHE but would not include additional activities aimed at either reducing contamination, reducing potential exposure to contaminants, or enhancing ecosystem biota or processes.

### PRESERVE HIGH QUALITY RIPARIAN CORRIDORS: ALTERNATIVE A2

This alternative aims to preserve those stretches of high quality riparian corridor that remain in Cherokee County. FWS will also consider areas of high quality riparian corridor in Jasper County, Missouri, near the state line. Riparian corridors are an integral part of the ecosystem health of surface water bodies. Healthy riparian corridors contribute to overall water quality and ensure the health of the aquatic ecosystem. Riparian corridors reduce runoff from lead and zinc mining impacted areas as well as stabilize existing near stream areas that have easily erodible soils and degrade stream quality. Furthermore, riparian corridor restoration would be necessary after sediment restoration (Alternative A5) to repair construction-impacted banks. The protection and enhancement of the riparian corridors will promote the recovery of aquatic organisms, in some cases federally and state listed and candidate aquatic species (*i.e.*, Neosho madtom and Neosho mucket) as well as other fish, mussels, and aquatic life from the direct effects of mine waste contamination.

The first task would be to identify those areas that remain and to evaluate the ecological health of these areas. As noted previously, the KBS maintains a database that includes records of many candidate properties; additional survey efforts might identify additional parcels for consideration.

Under this alternative, FWS's approach would be to prioritize for preservation those parcels that are of the highest quality. Ecosystem quality can be determined in part using KBS's floristic quality index. FWS will also consider the width of the corridor: wider corridors are more protective and provide more ecological services, including enhanced connectivity of the site to other high quality areas. FWS prefers 300 foot corridors (on each side of the river) in width for perennial streams, or at least 100 feet in width (on each side) for ephemeral or intermittent creeks and streams, but will accept less protective corridors of 100 feet width for perennial streams, or 50 feet width for ephemeral or intermittent streams. Areas that are less wooded may be improved and restored (see Alternative A4). Areas to be preserved would either be purchased, or an easement for the area would be purchased from willing landowners.

To ensure ongoing protection, management of the preserved land is also required. For grassy corridors, preservation techniques are likely to be similar to those for prairies. However, techniques for wooded corridors would differ: for instance, controlled burning is not generally recommended. Fencing is important to keep out cattle, although to encourage understory development and stimulate younger plants, occasional flash-grazing or timber removal may be appropriate. Because cattle will generally be excluded from these areas, it may be necessary to provide an alternate water source for any livestock. Where this alternative is carried out, alternate water supplies would be evaluated, and the most efficient method would be used to provide water to livestock.

### PRESERVE EMPIRE LAKE BUFFER: ALTERNATIVE A3

Similar to A2, this alternative aims to preserve those stretches of higher quality habitat adjacent to Empire Lake. FWS expects that this alternative would only apply to the eastern shores of the lake, which is less developed than the western shores.

The methods used to identify candidate parcels for preservation would be similar to that described for A2 above. To help ensure adequate buffering capacity of the preserved areas, FWS prefers 300 foot corridors (on each side of the river) in width, but will accept less protective corridors of 100 feet width for Empire Lake shores. Areas to be preserved would either be purchased, or an easement for the area would be purchased from willing landowners. To ensure ongoing protection, management of the preserved land is required. Fencing is important to keep out cattle, although as for wooded riparian buffers, to encourage understory development and stimulate younger plants occasional flash-grazing or timber removal may be appropriate.

### IMPROVE RIPARIAN BUFFER: ALTERNATIVE A4

Buffer areas next to waterways provide a variety of valuable ecological services. Not all waterways in the impacted area have adequate buffer areas: some buffers are of low quality, and other areas effectively have no buffer at all. This restoration alternative, therefore, includes: the purchase of land or easements on land, activities needed to create an appropriate buffer ecosystem for the site, and monitoring and maintenance of the site.

The appropriate buffer ecosystem to restore depends in significant part on the size of the waterway. For intermittent streams and small creeks, high quality prairie or grassland may be the most appropriate buffer. For larger creeks or rivers, buffers would more likely be forested.

The restoration approach for prairie or grassland buffers would be similar to that described previously. For forested areas, specific restoration actions would include site preparation (possibly including mowing, herbicide application, and tillage), followed by planting a combination of seeds, seedlings, and older plants. Additional applications of herbicide may be needed at appropriate junctures to allow the trees to better establish themselves relative to weedy species or grasses. Species will be selected to match the growing conditions of the planting site.

To ensure ongoing protection, management of the new buffer areas is also required. For both grassy corridors and woody areas, fencing is important to keep out cattle. Because cattle will generally be excluded from the new buffer areas, it may be necessary at certain locations to provide an alternate water source for any livestock. Additional preservation techniques for grassy buffers are similar to those described above for prairies. As noted above, for wooded corridors, occasional flash-grazing or timber removal may be appropriate. Evaluation of the success of this alternative could include reliance on measures such as the Kansas Biological Survey's FQI, species abundance/diversity measurements, percent cover, vegetative biomass measurements, or other metrics.

### DREDGE WATERWAY(S): ALTERNATIVE A5

Several miles of Cherokee County's streams and rivers have been contaminated by mining activities, and in a number of spots, visible bars of mine wastes remain. These bars and other areas of high contamination ("hot spots") contribute to waterborne contamination and pose a risk to the fish and other animals that live in the water. This alternative entails dredging these hotspots.

Under this alternative, areas of high contamination would be identified through the use of X-ray fluorescence (XRF) and potentially other techniques. Once identified, these areas can be dredged using equipment appropriate to stream-specific conditions. Hydrological, geological, and morphological conditions will be taken into account in the specific dredging design process in order to maintain and/or improve the stream's ability to support native flora and fauna. In some cases, this may include replacing the contaminated material with clean fill from another site. The major goal of sediment restoration is 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 head-cutting in streams. FWS anticipates adopting one or more of the following four sediment removal techniques:

1) Sediment removal in tributaries: Dredging of wetted sediments (those sediments located under water) may be required for some streams or specific reaches (*i.e.*, "hot spot dredging"), depending on stream size and extent of contamination. To prevent serious damage to stream hydrology and ecology, flow control structures would be installed to protect excavated areas and restore the natural hydrology of the stream following sediment removal. Following sediment removal, clean sediment, or the larger uncontaminated fraction of sediments separated after screening, could be returned to the stream to allow normal stream channel and flow. Contaminated sediments would be dewatered and hauled by truck for disposal (*i.e.*, in repositories or subsidences or other mine workings in the area).

2) Sediment removal from confluences in the Spring River with major tributaries: Confluence areas created where major tributaries enter into the mainstem of a larger river are prime areas for deposition of highly contaminated fine sediments. A 2005 USGS report on the Spring River in Cherokee County found relatively higher levels of contaminants in sediments immediately downstream of confluences with major tributaries such as Center Creek and Turkey Creek (Pope 2005). As a result, they offer an area from which sediments could be removed periodically over time based on redeposition rates. Such areas include the confluences of the Spring River and Center Creek, Turkey Creek, and Short Creek. Depositional area dredging involves either the complete removal of all sediment or the finer contaminated fraction separated from the sediments by screening and the larger uncontaminated fraction returned to the river.

3) Sediment removal behind dams: Sediments and streams will typically transport and accumulate behind impediments to stream flow. These impediments act as sediment traps and include structures such as dams. Dams are not 100 percent effective in trapping sediments; some amount of contaminated sediments is still transported beyond the dams. Even so, since dams act as sediment traps: they offer an area from which sediments could be removed on a periodic and repeating basis. Dams in Kansas include low-head dams that can be installed in tributaries just upstream of their confluences with the Spring River, an existing low-water dam located in the Spring River near Baxter Springs (south of Highway 166), and two existing dams that create Empire Lake (Alternative A6). Dredging behind dams could occur periodically with time between removals based on sediment accumulation rates.

4) Gravel bar mining: Gravel bar mining is the removal of sediment associated with exposed gravel bars (above the water line) during low flow conditions. By removing only the exposed portion of the gravel bar, stream erosion and head-cutting are minimized or eliminated. Gravel bar mining could include either the

complete removal of all exposed sediment or the finer contaminated fraction separated from the sediments by screening and the larger uncontaminated fraction returned to the gravel bar. Gravel bar mining will occur periodically over time between removals based on type of gravel bar mining used and gravel bar redeposition rates.

FWS anticipates that removing the mine wastes described above from Cherokee County's streams and rivers would be a significant effort. Due to its likely scale, FWS believes that the only reasonable alternatives for disposal of the removed materials are subsidences or other mine workings in the area, locally-constructed repositories, and consolidation and encapsulation with existing surface mine wastes.

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

Considerable sediment has accumulated behind the Empire Lake dam resulting in shallow water depths throughout most of the lake. Findings from a 2006 USGS report on Empire Lake indicate that although Empire Lake is no longer net depositional, it contains sediments with metal concentrations well above sediment quality guidelines, impairing its use as habitat for animals (Juracek 2006). One restoration alternative to address this situation is to dredge the lake, which is about 400 acres in size. Ideally, all mine waste materials in the lakes would be removed, and the lake's bottom would be returned to the original contour it possessed when first dammed. The total volume of contaminated sediments in Empire Lake estimated in the USGS report is about 1.6 million cubic yards.

FWS anticipates that EPA will remove all contaminated sediments from Empire Lake; however, EPA has not yet made a formal decision on OU2, which includes the lake. Furthermore, contaminated sediments remaining in the Spring River watershed not addressed by EPA, FWS, or other organizations will continue to migrate downstream to Empire Lake. The USGS report indicated that a large portion of the current sediment bed was deposited following a major flood event in the early 1950s, and that by 2006, Empire Lake had re-established its sediment bed and was no longer capable of trapping sediments in all flow regimes. Based on this report, FWS assumes that the contaminated sediment bed in Empire Lake would return within 50 years following EPA's assumed removal action, and that a second removal action would be required. The second sediment removal action is expected to occur 50 years after completion of the first removal action (*i.e.,* 2074), and will also take five years to complete (*i.e.,* 2079).

Clearly, removal of all these sediments would be a large effort. FWS estimates that dredging operations alone, excluding time for the preparation and detailed design of dredging activities, could take about five years. Due to the anticipated costs and scale of the effort, FWS believes that the only reasonable alternatives for disposal of the removed materials are subsidences or other mine workings in the area, locally-constructed repositories, and consolidation and encapsulation with existing surface mine wastes.

A significant fraction of the sediment load to Empire Lake comes from Short Creek (KDHE 1980). Dredging the lake makes the most sense in combination with additional actions to reduce the load of mine waste materials that enter the lake. This alternative therefore also includes the construction of three underwater sediment retention structures (*i.e.*, underwater dams) (Alternative A5, No. 3). These dams would be designed to allow continuous water flow and would include a V-notch or similar feature to facilitate fish and other aquatic organism movement over the dams. Designed to retain sediments, the sediment collection basin created by these dams would need to be dredged regularly as part of ongoing monitoring and maintenance of the project.

### DRAIN AND CAP EMPIRE LAKE: ALTERNATIVE A7

Empire Lake is an artificial lake that was formed when a dam was erected by the Empire District Electric Company in the early 1900s. Draining the lake and capping the contaminated sediments that today comprise the bottom of the lake is one way to reduce the impact of these sediments on aquatic biota. As part of this effort, the Spring River's original flow pathway through the area would need to be redirected temporarily.

FWS does not believe that draining and capping Empire Lake is an acceptable solution. For one, the lake is private property, owned by the Empire District Electric Company, and the company asserts that it needs the lake to operate its coal-fired power plant. For another, Empire Lake is the only lake in the county and has significant recreational value to the county's inhabitants. Furthermore, private property owners with access to the lake would likely see the value of their property reduced. For all these reasons, FWS does not consider this alternative to be acceptable and does not consider it further.

### CAP EMPIRE LAKE SEDIMENTS IN PLACE: ALTERNATIVE A8

In theory, one alternative for addressing contamination in a lake is to engineer and install a cap over the contaminated sediments. The cap would be designed to reduce the mobility of the contaminants and render them less accessible to aquatic plants and animals. However, the inputs of sediment and mine waste inputs over many decades have made Empire Lake quite shallow, such that capping the lake is not technically feasible. FWS therefore does not consider this alternative further.

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

Available data suggest that the aquatic biota in Cherokee County has been impacted by mining wastes. Many stretches of Cherokee County's rivers and streams lack the species diversity originally present in the region, and some stretches lack even the diversity that is present in upstream reaches less impacted by mining wastes (*i.e.*, Angelo *et al.* 2007, Obermeyer *et al.* 1995). Available data also suggest that Empire Lake's biota may be impacted by mining wastes (Ferrington *et al.* 1989).

An aquatic biota stocking program would help replace some of the lost native species, with a goal of restoring the population to its baseline condition (*i.e.*, the condition that would have existed in the absence of mining-related releases of hazardous substances). Restoring fish and mussel populations an essential part in restoring ecological function to streams within the Spring River watershed. Notably, the Neosho mucket mussel is a candidate species for listing pursuant to the Endangered Species Act because of declining populations across its historical range. Only black bass (largemouth, smallmouth, and spotted) serve as the host for Neosho mucket larvae, called glochidia, which the female releases in late spring. Restoring mussels also provides important ecological and economic public benefits. Mussels serve as a food resource for other aquatic and terrestrial predators, filter particulate matter from the water column which improves water quality, provide biogenic structure as habitat, and facilitate the benthic invertebrate community by altering the availability of resources through nutrient excretion and biodeposition (Spooner and Vaughn 2006). Fortunately, attempts to grow the Neosho mucket mussel on hatchery bass and restocking larval mussels into suitable habitat have proven successful (*i.e.*, Great Plains Nature Center (Kansas), Missouri Department of Conservation, Kansas Department of Wildlife and Parks), supporting the feasibility of this restoration option.

Culture and reintroduction of mussels and fish species would be calculated on a species basis. FWS would review the state and federal Threatened and Endangered (T&E) lists and the list of state species of concern to identify those species to be included in the stocking program.[45] FWS anticipates that the total number of species restocked in this program would be fewer than ten and would include native fish, mussel, and snail species. Restocking would occur on an annual basis but could include different groups of organisms at different frequencies. For instance, mussels might be restocked every five years, snails every two years, and fish every two to five years depending on the species. The program would include monitoring to evaluate the success of the restocking effort. Possible metrics of success would include (for example) average count of mussel larvae and snail transplants per square meter. As noted previously, FWS would consider an aquatic biota stocking program only if an aquatic dredging program were first implemented to reduce current contaminant concentrations in the surface water environment. Given current levels of contamination, FWS believes that an aquatic biota stocking program would be unlikely to succeed within affected reaches of Tar Creek, Spring River and tributaries on the site.

## 4.3 MISCELLANEOUS ALTERNATIVES

In this last category are two restoration alternatives not easily categorizable into either terrestrial or aquatic habitats. Although these alternatives would not have direct, substantive effects on Cherokee County's natural resources, they are potentially important restoration components that would be part of an overall restoration development and management program.

### PILOT PROJECTS: ALTERNATIVE M1

As described in more detail in Chapter 5, a substantial amount of information is available about a number of the restoration alternatives considered in this RP/EA. However, in

[45] This approach is consistent with Kansas' listing process and the recovery of imperiled mussel and fish species across known habitats within the Tri-State watershed.

certain cases pursuing one or more pilot studies would maximize the probability of success and allow FWS to use available funds in the most efficient fashion. Examples of such studies include (but are not necessarily limited to):

- **Revegetation method development.** Although a reasonable amount of information exists about methods for prairie restoration and warm season grassland restoration, Cherokee County is faced with some unusual challenges, including the existence of soils subject to contamination, compaction, and possibly other kinds of degradation. Relatively little information exists on methods for maximizing the success of restoration efforts under these circumstances. Initial studies of new and/or modified approaches to vegetative restoration might greatly aid in the long-term success of any revegetation efforts conducted under this program.

- **Subsidence disposal evaluations.** At the current time, only preliminary information exists about the potential for ground water contamination if mine wastes are disposed of in subsidences. Additional experiments, with more extensive and closer monitoring, would aid in the evaluation of this alternative and its potential for application at different sites within Cherokee County.

- **Biosolids amendment evaluations.** Additional evaluation of integrating biosolids amendments with existing and planned EPA caps is needed to reduce the risk of project failure. The optimal mix and composition of amendments (biosolids, lime, and carbon-rich matter) will have to be developed, which will likely vary with contaminant concentrations, site conditions, and EPA's remedy. In addition, nearby reliable sources of biosolids will have to be found and tested.

### PUBLIC OUTREACH: ALTERNATIVE M2

FWS values communication with the public and input from the public. Public participation and interest is a key consideration in the evaluation of restoration alternatives. FWS also recognizes the central role that landowners will play in the ultimate success of any restoration alternative in Cherokee County: indeed, success is absolutely dependent on identifying landowners who are willing to sell land or easements on land, in order to allow restoration to take place. To help identify those individuals and to encourage participation, FWS is interested in developing a variety of educational materials, potentially including:

- Development of an educational film, potentially including oral history recordings. This film would focus on the history of mining in Cherokee County, its impacts, and restoration options; and

- Development of fact sheets, newsletters, or other educational materials (electronic and hard-copy) on relevant topics for distribution to interested parties.

The likely topics to be addressed include the history of mining in the area, information on natural resources injuries, and descriptions of proposed restoration options.

As part of its public outreach efforts, FWS also proposes to fund public meetings. These meetings would both serve as another opportunity for the public to learn about FWS's proposed restoration program and would provide opportunities for the public to provide input and ask questions about the program.

# 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. 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 at some locations 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 at least a 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 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.

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[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.

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, FWS estimates that the removal and subsidence placement of mine wastes would cost about $86,900 per acre of wastes (2007$).[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

[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.

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 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

[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.

[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.

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.

## 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 annually for ongoing maintenance of 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 T7. 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 of cap (12 inches of clay covered by 6 inches of topsoil) 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

[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 may overstate costs for two reasons: first, because consolidation of the mine wastes will likely reduce the area of the cap required, and also it is likely that the cap area will be reduced by excavating deeper in borrow areas than assumed in this Restoration Plan.

biosolid amendments is prescribed as part of the remedy for mine wastes in Jasper 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. For instance, EPA has already issued a ROD amendment for remaining terrestrial mine wastes in Cherokee County (EPA 2006) and is expected to begin remediation shortly.

Nearby reliable sources of biosolids will have to be found and may be limited. Potential sources include municipal wastewater treatment plants (Springfield, Missouri and Tulsa, Oklahoma) and poultry farms (chicken litter). The application of biosolids may also entail certain risks, depending on the source of the material. The nature and extent of these risks would need to be evaluated for specific identified source(s).

Finally, as described above, this alternative relies on a mix of amendments 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.

#### 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

[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.<br>• Technically feasible. | • No significant improvement in environmental conditions anticipated. |
| T2 | Preserve native prairies | • Preserve rare, rich ecosystem remnants.<br>• Technically feasible. | • No reduction in metals levels or associated injuries. |
| T3 | High quality prairie restoration | • Increase quantity of high quality habitat.<br>• 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.<br>• 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.<br>• 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.<br>• Technically feasible at least for some quantity of wastes. | • Potential risk of ground water contamination.<br>• Unclear if sufficient subsidence space available to accommodate all wastes.<br>• 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.<br>• 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.<br>• Technically feasible. | • Cap failure and re-exposure to contaminated materials, although these risks can be minimized with good cap design and a monitoring program.<br>• 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.<br>• May also have a treatment effect by fixing and stabilizing metals in mine wastes.<br>• Technically feasible. | • May be difficult to coordinate with EPA capping remedy.<br>• 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.<br>• May also have a treatment effect by fixing and stabilizing metals in mine wastes.<br>• 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.<br>• Technically feasible. | • No substantial improvement in environmental conditions. |
| A2 | Preserve high quality riparian corridor | • Preserve highly-valued ecosystem type.<br>• Technically feasible. | • No reduction in metals levels or associated injuries. |
| A3 | Preserve Empire Lake buffer | • Increase quantity of high quality habitat.<br>• 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.<br>• 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.<br>• Technically feasible. | • Ongoing input from Missouri may result in re-contamination of some areas.<br>• Potential disturbance to existing ecosystem.<br>• 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.<br>• Enhances recreational value of lake.<br>• 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.<br>• Technically feasible for at least some key species. | • No reduction in metals levels or associated injuries.<br>• In the absence of reductions in current metals levels, some stocked biota might not be able to survive and/or reproduce.<br>• 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.<br>• 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.<br>• No impacts to physical natural resources are anticipated.<br>• 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.<br>• 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.<br>• 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.<br>• 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.<br>• Potential risk of groundwater contamination<br>• 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.<br>• Potential for cap failure and re-exposure to contaminated materials, although these risks can be minimized with good cap design and a monitoring program<br>• 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, although the source-specific potential risks of biosolids need to be evaluated and managed.<br>• Reduces exposure of terrestrial and aquatic biota to metals.<br>• 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.<br>• Reduces exposure of terrestrial and aquatic biota to metals.<br>• 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.<br>• 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.<br>• 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.<br>• 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.<br>• Potential for short-term increase in metals exposure during dredging, which can be minimized with careful monitoring of dredging operations.<br>• 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.<br>• Potential for positive impacts to local economy, depending on size of effort. | • Reduces exposure of aquatic biota to metals.<br>• 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.<br>• 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. |

# CHAPTER 6 | PREFERRED ALTERNATIVES

As noted in Chapter 5, FWS must consider a variety of factors (43 CFR §11.82(c)) in the evaluation of the identified restoration alternatives. In general, 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 comply with applicable laws and policies.

Considering the factors set forth at 43 CFR §11.82(c), as well as the extent of currently available funding, FWS has developed a set of restoration priorities (Exhibit 40) that reflects the restoration alternatives it prefers among those evaluated. As shown in Exhibit 40, and as discussed in Chapter 5, the restoration options vary greatly in terms of cost and in the types of effects each may have on the environment.

FWS has developed a set of restoration priorities rather than selecting specific restoration projects or locations because a final selection of specific alternatives is dependent on information that is not available at this time. This information includes public input; EPA involvement and approval; the results of restoration pilot projects and EPA's remedial activities; further evaluation of technical and administrative feasibility and costs; availability of and access to native prairie areas, degraded habitat, mine waste areas, riparian corridor habitat, and impacted streams; and individual landowner preferences. For many potential projects, either areas to be restored or preserved or easements for these areas would have to be purchased from willing landowners, and which alternative(s) to use on a given parcel of land will depend on landowner interest.

For these reasons, FWS believes that the most reasonable approach is to set forth its overall priorities (Exhibit 40) and to discuss the reasons for those priorities rather than strictly adhering to one or two approaches.

## EXHIBIT 40 PRELIMINARY PREFERRED RESTORATION OPTIONS

| PRIORITY | DESCRIPTION | APPROXIMATE COST (2007$) | APPROX. MAXIMUM RESTORABLE AREA[1] |
|---|---|---|---|
| **TERRESTRIAL** | | | |
| 1 | T2 – Preserve native prairie | \$4,300 to \$5,600 per acre plus fencing[2] | 470 to 600 acres |
| 2 | T3 – High quality prairie restoration | \$6,000 to \$7,500 per acre plus fencing[2] | 350 to 430 acres |
| | T4 – CRP grassland restoration | \$6,700 to \$8,200 per acre plus fencing[2] | 320 to 390 acres |
| | T10 – Improve EPA mine waste caps (through soil amendments and fencing) | \$2,700 per acre[4] plus fencing[2] | 980 acres |
| | T5 – Cool season grassland restoration | \$6,700 to \$8,200 per acre plus fencing[2] | 320 to 390 acres |
| 3 | T6 (with T3, T4, or T5) – Remove and dispose of terrestrial mine waste in subsidences; cap subsidences | \$124,000 per acre[3] plus fencing[2] | 20 acres |
| | T8 (with T3, T4, or T5) – Mine waste recontouring and encapsulation | \$81,000 per acre[3] plus fencing[2] | 30 acres |
| | T9 – Apply biosolid amendments beneath planned EPA caps | \$10,100 per acre[4] plus fencing[2] | 260 acres |
| | T7 (with T3, T4, or T5) – Mine waste recontouring | \$10,300 per acre[3] plus fencing[2] | 250 acres |
| **AQUATIC** | | | |
| 1 | A2 – Preserve high quality riparian corridors | \$4,600 to \$8,900 per acre plus fencing[2] | 290 to 560 acres |
| | A3 – Preserve Empire Lake Buffer | \$4,100 to \$5,600 per acre plus fencing[2] | 470 to 640 acres |
| 2 | A4 – Improve riparian buffer | \$7,600 to \$11,900 per acre plus fencing[2] | 220 to 340 acres |
| 3 | A5 (with A4 and A9) – Dredge waterway(s), improve buffer, restock | \$292,500 to \$3.22 million per stream mile,[5] plus buffer improvement and fencing (see A4 above), \$10 million for water treatment system, and \$5,000 to \$113,000 per species per stream mile | <1 to 5 stream miles dredged (with one mussel and one fish species restocked)[6] |
| | A6 – Dredge Empire Lake and install underwater sediment retention structures on Short Creek | \$149,000 per acre plus \$1,300,000 for dams and \$350,000 for dam operation and maintenance | 6 acres[6] |
| **MISCELLANEOUS** | | | |
| 1 | M1– Pilot projects | \$30,000 to \$100,000 per pilot project | |
| | M2 – Public outreach | \$50,000 per educational film or brochure | |

[1] Approximate area, assuming that all currently available funds (about \$2.6 million) are expended on a single alternative. Available money is not sufficient to pursue all alternatives. Calculations are rounded.
[2] Fencing costs are not specified because they will depend on the size and shape of the area(s) being restored.
[3] The presented values include the costs of any of the potential vegetation restoration alternatives (*i.e.,* T3, T4, or T5) that could be implemented in combination with the primary alternative.
[4] Assumes KDHE will be responsible for long-term vegetation management and cap monitoring and maintenance.
[5] Assumes 11,700 cubic yards per stream mile (dredge sediments to a depth of 18 inches across a stream width of 40 feet).
[6] Excludes water treatment system costs.

As described above, some of the restoration alternatives are specific to mine waste areas while other alternatives are appropriate for non-mine waste areas. For restoration projects in non-mine waste areas, FWS prefers parcels with one or more of the following characteristics:

- Those that fall within areas designated as critical habitat for threatened or endangered species;
- Those that are larger, as larger areas generally provide superior habitat than would smaller, fragmented areas even if equal in total size;
- Those that are contiguous with or close to other protected areas, as this helps to provide wildlife corridors and decrease habitat fragmentation;
- Those that are of higher habitat quality; and
- Those with greater proximity to mining-affected areas. All else equal, areas within Cherokee County are preferred over areas in adjacent counties (Crawford, Montgomery, and Labette).

Furthermore, for projects in mine waste areas that would require coordination with EPA, issues of timing are also important—*i.e.*, those projects that allow coordination with EPA remedial actions will be preferred.

## 6.1 TERRESTRIAL PREFERRED ALTERNATIVES

For terrestrial habitat, FWS's preferred alternative is T2, the preservation of existing native prairie areas. Native prairies are high-quality habitats that provide the richest set of ecological services of all the alternatives. As such, native prairie preservation is well-suited to compensate for terrestrial, habitat-based ecological services lost as a consequence of mining-related contamination. Additional motivations for the selection of this alternative include the lack of technical challenges in preserving these areas, and the relatively low cost, in that the main costs are acquisition of land or easements and management of the area thereafter. Native prairie preservation will not result in collateral injury to the environment, poses no risk to the public health, and can be accomplished in a manner that is consistent with state and Federal laws and policies. In addition, habitat preservation will not delay EPA's remedial activities and will not be a detriment to the achievement of EPA's remedial goals.

For similar reasons, FWS's second overall priority is to improve habitat quality in other non-mine waste areas (Alternatives T3, T4, and T5), and to improve the habitat quality provided by EPA's mine waste caps (Alternative T10).

Of the alternatives in Group 2, FWS prefers Alternative T3; however, FWS notes that some landowners may prefer other alternatives. FWS therefore wishes to present some additional general information about its preferences with respect to restoration options. As noted above, native or high quality prairies reflect FWS's overall highest priority for terrestrial areas. If a high quality prairie planting is unacceptable, FWS considers a warm season grass planting to be the next best option. Although these mixes lack forbs, warm season grasses leave more nutrients in the soil and provide superior habitat and forage opportunities for many native species of birds and mammals. Cool season grasses are the least ecologically desirable.

In general, the techniques for establishing a high quality prairie ecosystem, as well as the other habitat types are well-understood and have a high probability of success. Like native prairie preservation, these restoration alternatives will not result in collateral injury to the environment, pose no risk to the public health, and can be accomplished in a manner that is consistent with state and Federal laws and policies. Because of the need for additional restoration activities such as seeding, the total cost is higher than that of native prairie preservation. Both the higher cost and the lower level of ecological services provided by restored prairie relative to native prairie, make the Group 2 alternatives a lower priority than native prairie preservation.

With the exception of Alternative T10, FWS's Group 1 and Group 2 restoration alternatives are appropriate for areas that have not been significantly contaminated by mining and milling wastes. FWS's third priority group is appropriate for more contaminated areas, including contaminated lands--*i.e.*, former mine waste areas or contaminated lands around mine wastes, as well as mine waste areas themselves.

Alternative T10 and the restoration alternatives in Group 3 have the potential to reduce the bioavailability of metal contaminants; however, they are more likely to present technical challenges, and some (*i.e.,* T6 and T8) are considerably more expensive. Currently available funding from the Eagle-Picher and LTV bankruptcies is insufficient to pursue these alternatives to a large extent. Furthermore, Alternative T7 is not expected to be as effective as other Group 3 activities in reducing the bioavailability of metals in mine wastes. In addition, it is unclear as to the exact extent of mine wastes and contaminated lands 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. It is a combination of all these considerations that make most alternatives for restoring addressing mine wastes and contaminated lands FWS's third priority.

## 6.2 AQUATIC PREFERRED ALTERNATIVES

For aquatic habitats, FWS prefers Alternatives A2 and A3, the preservation of existing high quality riparian corridors and Empire Lake buffer. This preference is based on: (a) the high value of the ecological services provided by these areas and their local rarity, (b) the lack of technical challenges in preserving these areas, and (c) the relatively low cost, in that the main costs are acquisition of land or easements and management of the area thereafter. Habitat preservation will not result in collateral injury to the environment, poses no risk to the public health, and can be accomplished in a manner that is consistent with state and Federal laws and policies.

For similar reasons, FWS's second priority is to restore other riverine areas such that they provide a high quality habitat with associated buffering services (Alternative A4). In general the techniques for establishing these ecosystems, whether woody or grassy, are well-understood and have a high probability of success. Buffer restoration will not result in collateral injury to the environment, poses no risk to the public health, and can be accomplished in a manner that is consistent with state and Federal laws and policies. Because of the need for additional restoration activities such as amending soil and seeding, the total cost is higher than that of preservation. Both the higher cost and the potentially lower level of ecological services provided by restored buffer areas, relative to existing high quality areas, make this alternative to be a lower priority than buffer preservation.

FWS's first and second overall priorities do not address the issue of metals contamination in aquatic resources. FWS's third priority does address aquatic contamination;[67] however, addressing this issue in any reasonably effective fashion is expensive, and it is this consideration that makes addressing mine wastes FWS's third priority. As for terrestrial mine wastes, FWS anticipates that currently available natural resource damage funds from the bankruptcy proceedings are not likely to be sufficient to significantly address the issue of remaining mine wastes in local streams and rivers, much less in Empire Lake (following EPA remedial activities around the year 2020). However, FWS recognizes that actions directed at reducing the bioavailability of the metals in these wastes is the only way to reduce overall risks to natural resources and restore habitat for threatened species. If significant additional natural resource damage funds become available, Alternative A5 (dredging of waterways) will be considered to be equal to Alternative A4 (improving riparian buffer). FWS anticipates that dredging activities would be supplemented with both buffer improvements (to mitigate any potential adverse effects of dredging on stream banks) and with an aquatic biota stocking program, to hasten ecological recovery to the extent possible.

## 6.3 MISCELLANEOUS ALTERNATIVES

To complement the terrestrial and aquatic preferred alternatives proposed above, FWS wishes to implement both Alternatives M1 (pilot projects) and M2 (public outreach). FWS believes that adequate methods development and public outreach are key components to restoration project success. Although in and of themselves they do not result in significant direct improvements in project conditions, they will both, indirectly, likely improve project outcomes. Thus, two alternatives are not assigned a distinct priority relative to the other restoration projects but FWS intends to implement them regardless of the final terrestrial and aquatic–specific alternatives selected.

[67] FWS notes that the Spring River basin is Operable Unit 2 within the Cherokee County Superfund Site. Currently FWS is aware that EPA remedial activities will be likely limited to Empire Lake and portions of the Spring River downstream of Empire Lake. Thus, FWS does not anticipate that EPA would necessarily address contamination in the smaller, contaminated waterways within Cherokee County.

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## APPENDIX A | ENDANGERED, THREATENED, AND SINC SPECIES IN CHEROKEE COUNTY

| SPECIES | FEDERAL STATUS | KANSAS STATUS |
|---|---|---|
| **INVERTEBRATES** | | |
| American burying beetle (*Nicrophorus americanus*) | Endangered | Endangered |
| Butterfly mussel (*Ellipsaria lineolata*) | | Threatened |
| Ellipse mussel (*Venustaconcha ellipsiformis*) | | Endangered |
| Creeper mussel (*Strophitus undulatus*) | | SINC* |
| Elktoe mussel (*Alasmidonta marginata*) | | Endangered |
| Fat mucket mussel (*Lampsilis radiata*) | | SINC* |
| Flat floater mussel (*Andonta suborbiculata*) | | Endangered |
| Flutedshell mussel (*Lasmigona costata*) | | Threatened |
| Neosho mucket mussel (*Lampsilis rafinequeana*) | Candidate | Endangered |
| Ouachita kidneyshell mussel (*Ptychobranchus occidentalis*) | | Threatened |
| Rabbitsfoot mussel (*Quadrula cylindrica*) | | Endangered |
| Round pigtoe mussel (*Pleurobema coccineum*) | | SINC* |
| Spike mussel (*Elliptio dilatata*) | | SINC* |
| Wabash pigtoe mussel (*Fusconaia flava*) | | SINC* |
| Wartyback mussel (*Quadrula nodulata*) | | SINC* |
| Western fanshell mussel (*Cyprogenia aberti*) | | Endangered |
| Yellow sandshell mussel (*Lampsilis teres*) | | SINC* |
| **FISH** | | |
| Arkansas darter (*Etheostoma cragini*) | Candidate | Threatened |
| Banded darter (*Etheostoma zonale*) | | SINC* |

| SPECIES | FEDERAL STATUS | KANSAS STATUS |
|---|---|---|
| Banded sculpin<br>(*Cottus carolinae*) | | SINC* |
| Black redhorse<br>(*Moxostoma duquesnei*) | | SINC* |
| Bluntnose darter<br>(*Etheostoma chlorosoma*) | | SINC* |
| Brindled madtom<br>(*Notorus miurus*) | | SINC* |
| Gravel chub<br>(*Erimystax x-punctatus*) | | SINC* |
| Greenside darter<br>(*Etheostoma blennioides*) | | SINC* |
| Neosho madtom<br>(*Noturus placidus*) | Threatened | Threatened |
| Northern hog sucker<br>(*Hypentelium nigricans*) | | SINC* |
| Ozark minnow<br>(*Notropis nubilus*) | | SINC* |
| Plains minnow<br>(*Hybognathus placitus*) | | SINC* |
| Redspot chub<br>(*Nocomis asper*) | | Threatened |
| River darter<br>(*Percina shumardi*) | | SINC* |
| River redhorse<br>(*Moxostoma carinatum*) | | SINC* |
| Slough darter<br>(*Etheostoma gracile*) | | SINC* |
| Speckled darter<br>(*Etheostoma stigmaeum Jordan*) | | SINC* |
| Spotfin shiner<br>(*Cyprinella spiloptera Cope*) | | SINC* |
| Spotted sucker<br>(*Minytrema melanops*) | | SINC* |
| Stippled darter<br>(*Etheostoma punctulatam*) | | SINC* |
| **AMPHIBIANS** | | |
| Cave salamander<br>(*Eurycea lucifiga*) | | Endangered |
| Longtail salamander<br>(*Eurycea longicauda)* | | Threatened |
| Eastern narrowmouth toad<br>(*Gastropryne carolinensis)* | | Threatened |
| Eastern newt<br>*(Notophtalmus viridescens)* | | Threatened |
| Many-ribbed (graybelly) salamander<br>(*Eurycea multiplicata)* | | Endangered |

| SPECIES | FEDERAL STATUS | KANSAS STATUS |
|---|---|---|
| Green frog<br>(*Rana clamitans*) | | Threatened |
| Grotto salamander<br>(*Typhlotriton spelaeus*) | | Endangered |
| Crawfish frog<br>(*Rana areolata*) | | SINC* |
| Spring peeper<br>(*Pseudacris crucifer)* | | Threatened |
| **REPTILES** | | |
| Broadheaded skink<br>(*Eumeces laticeps*) | | Threatened |
| Common map turtle<br>(*Graptemys geographica*) | | Threatened |
| Eastern hognose snake<br>(*Heterodon platirhinos*) | | SINC* |
| Redbelly snake<br>*(Storeria occipitomaculata)* | | Threatened |
| Smooth earth snake<br>(*Virginia striatula*) | | SINC* |
| **MAMMALS** | | |
| Eastern spotted skunk<br>*(Spilogale putorius)* | | Threatened |
| Gray bat<br>*(Myotis grisescens)* | Endangered | Endangered |
| Southern flying squirrel<br>(*Glaucomys volans*) | | SINC* |
| Texas mouse<br>(*Peromyscus attwateri*) | | SINC* |
| **BIRDS** | | |
| Eskimo curlew<br>(*Numenius borealis*) | Endangered | Endangered |
| Bald eagle<br>(*Haliaeetus leucocephalus)* | | Threatened |
| Black tern<br>(*Chlidonias niger*) | | SINC* |
| Bobolink<br>(*Dolichonyx oryzivorus*) | | SINC* |
| Least tern<br>(*Sterna antillarum*) | Endangered | Endangered |
| Peregrine falcon<br>(*Falco peregrinus*) | | Endangered |
| Piping plover<br>(*Charadrius melodus*) | Threatened | Threatened |
| Short-eared owl<br>(*Asio flammeus*) | | SINC* |

| SPECIES | FEDERAL STATUS | KANSAS STATUS |
|---|---|---|
| Snowy plover (*Charadrius alexandrinus*) | | Threatened |
| Whip-poor-will (*Camprimulgus vociferous*) | | SINC* |
| Yellow-throated warbler (*Dendroica dominica*) | | SINC* |

Source: KDWP 2005, U.S. Fish and Wildlife Service Threatened & Endangered Species System (http://ecos.fws.gov/tess_public/).

* Species In Need of Conservation-- a species that is likely to become a threatened species within the foreseeable future, as designated by the State of Kansas.

## APPENDIX B | PREPARERS AND CONTRIBUTORS

**List of Preparers**

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## APPENDIX C | PUBLIC COMMENTS AND RESPONSES

The U.S. Fish and Wildlife Service (FWS) has engaged in a number of public outreach activities in connection with restoration planning at the Cherokee County Superfund site.

On July 24, 2008, FWS published a Notice of Availability of the Public Review Draft Restoration Plan/Environmental Assessment in the Federal Register (73 FR 43255). The public comment period for this document commenced as of the Notice of Availability date and continued through August 25, 2008.

To increase public awareness of the Draft Restoration Plan/Environmental Assessment (RP/EA), FWS issued a press release announcing its availability. FWS sent this press release to 443 media outlets, political representatives, and tribal nations. FWS also sent the press release to eight potentially responsible parties and provided two press interviews to local media outlets. In addition, FWS publicized and organized a public meeting at the Baxter Springs Community Center in Baxter Springs, Kansas. The meeting occurred on August 15, 2008, and 14 people, including six general members of the public, seven agency representatives, and one member of the press, attended.

The draft RP/EA was made available to the public both online[68] and at the FWS's Kansas Ecological Services Field Office in Manhattan, Kansas. Copies were also available at the public meeting and at the Columbus, Baxter Springs, and Galena public libraries. During the months of July and August 2008, the draft RP/EA, or parts of it, was accessed online 2,233 times.[69]

The following comments were received during the comment period.

**RESPONSES TO PUBLIC COMMENTS TO THE DRAFT CHEROKEE COUNTY RESTORATION PLAN / ENVIRONMENTAL ASSESSMENT**

1. One commenter stated:
   a. *The draft plan does not contain information specific to the Treece Subsite (i.e., Operable Unit No. 4 "OU 4" of the Cherokee County Superfund Site) (the "Site").*

      The draft plan addresses the entire Cherokee County Superfund Site, of which OU 4 is part.

   b. *The Draft Plan simply provides very broad programmatic priorities and generalized plans for how certain recoveries from bankrupt entities may be expected at the site.*

      It was DOI's intention to outline very broad programmatic priorities and generalized plans for how all recoveries may be expended at the site, not just recoveries from bankrupt entities.

[68] See http://www.fws.gov/mountain-prairie/NRDA/CherCO_KS/CherokeeCounty.htm and http://www.fws.gov/mountain-prairie/NRDA/CherCO_KS/EA/Public_Review_Draft_RP_5_May_2008.pdf.

[69] This figure reflects the number of visits to the site, not the number of distinct individuals (or IP addresses) visiting the site.

2. A second commenter stated:
    a. *If land parcels are selected and identified for purchase or easement to provide for appropriate buffer ecosystems or riparian enhancement, it is imperative that coordination be established with (electrical utilities) and other landowners to ensure that land management or other site protection activities do not limit or modify the flow direction or quality of the water into Empire Lake that is utilized by (associated entity).*

       Any activities conducted under the restoration plan that could affect the flow direction or quality of water in Empire Lake will be coordinated with all interested parties.

    b. *The proposal alternative in A3 would include essential structures at the (associated power station) and other electrical facilities. Special consideration of these will be necessary and FWS must begin communication with (associated entity) at the onset regarding the issue.*

       DOI concurs and will afford special consideration to all structures that may be affected by implementation of alternatives and will coordinate with the (associated entity).

    c. *Detailed and timely coordination must be established between (associated entities), the FWS, its contractors and the multiple federal and state government regulatory agencies, to include the Federal Energy Regulatory Commission (FERC) prior to any proposed dredging operation at Empire Lake.*

       Coordination will occur with all affected or interested federal, state and private entities prior to any proposed dredging operations at Empire Lake.

    d. *If the (associated power station) was placed out of service for an extended time, the costs associated with its removal from the national regional electrical grid including the costs for replacement purchased power is estimated to be about $72,000 per day. In addition, grid reliability would deteriorate due to the reduction of generating capacity to meet instantaneous demand.*

       Comment noted; coordination will occur with all affected or interested federal, state and private entities prior to undertaking any proposed action at Empire Lake which could impact operations at the power station.

    e. *Clarification is needed for a statement in the report on page 68 of the plan that reads as follows;*

       "FWS anticipates that EPA will remove all contaminated sediments from Empire Lake; However, EPA has not yet made a formal decision on OU2, which includes the lake."

*(Associated entity) has not been in direct communication with the EPA on the mitigating issues regarding the operation of (electrical facilities) potentially involved with dredging Empire Lake. (Associated entity) is not familiar with the referenced <u>OU2</u> document.*

For clarification, EPA has not yet published a formal Record of Decision for the Cherokee County Operable Unit 2, of which Empire Lake is part. The EPA Remedial Program Manager for the Cherokee County Superfund Site should be contacted concerning potential ramifications associated with remedial alternatives at Empire Lake.

f. *(Associated entity) concurs with the FWS conclusion that draining and capping Empire Lake, due to the operational needs of the power plant and the recreational value of the lake to the community is not an acceptable alternative.*

   Comment noted.

g. *(Associated entity) concurs with the FWS conclusion that added sediment and mine waste have reduced the water retention capacity of Empire Lake and that capping the lake is not technically feasible.*

   Comment noted.

3. A third commenter stated:

   a. *The runoff waters of the Tri-State mining district in Oklahoma is a great place to get cadmium, especially with electrowinning and other techniques.*

      Comment noted. However, the purpose of the Restoration Plan is to describe alternatives to restore natural resources injured by the release of hazardous substances at the Cherokee County Superfund site. It is beyond the scope of the Restoration Plan for DOI to address the value of commercial sources for heavy metals.

4. A fourth commenter stated:
   a. *(Associated entity) concurs with the U.S. Fish and Wildlife analysis of the alternatives.*

      Comment noted.

   b. *(Associated entity) understands that other settling parties or the Trustees may use this document in the future for other settlements in the Cherokee County Superfund Site.*

      We concur.

c. *(Associated entity) also understands the restoration alternatives may be modified in the future if new or additional information is gathered that indicate changes are necessary.*

   We concur.

5. A fifth commenter stated:
   a. *The overall plan is well-written and (Associated entity) concurs with the preferred alternatives.*

      Comment noted.

   b. *Page 1, 3rd paragraph, Executive Summary – There is no mention of the second Eagle-Picher bankruptcy in 2006.*

      The text has been modified to note the 2006 Eagle-Picher bankruptcy.

   c. *Page 13, Exhibit 3 – The Designated Area "DA" term is not used at the Cherokee County Superfund site. The site is divided into subsites and operable units.*

      The exhibit has been modified to include the correct terminology.

   d. *Page 17, 2nd paragraph – Typographical edits: ….Real Estate "in" effect … and ….. within 12 months of the "date" of acquisition.*

      The text has been corrected.

   e. *Page 21, 1st paragraph – The text uses information from the 1993 Dames and Moore reference and thus does not account for the Baxter Springs remediation conducted by potentially responsible parties (PRPs) that was completed in 2004. The PRP clean-up addressed approximately 160 acres and one million cubic yards of mining wastes.*

      The text has been modified to include the more current information.

   f. *Page 24, 1st and 2nd paragraphs – The Bruger Shaft, Spring Branch, and Ballard pile discussions are based on the historic 1993 Dames and Moore reference. The Bruger shaft does not currently discharge into Willow Creek, Spring Branch is not currently flowing through mining wastes, and the Ballard pile no longer exists. Footnote 20 references the Record of Decision but the work is complete. (Associated entity) suggests using and referencing the Remedial Action Completion Report and the most recent Operation and Maintenance (O&M) Inspection Report for the Baxter Springs subsite since they have the updated current information pertaining to these areas. Additionally, all collapse features are not likely a result of pillar-robbing. Annual weathering cycles and associated water movement erode materials from the mined areas creating unstable conditions that lead to collapses.*

The text has been modified to include information from the suggested citations.

g. *Page 28, 2nd paragraph – The Waco subsite should be added to the list of areas with expected natural resource impacts.*

   The text has been modified to include all currently designated subsites in Cherokee County.

h. *Page 36, last sentence – Historic 1993 information is not current today, same comment as above.*

   The text has been modified to include information from the suggested citations.

i. *Page 37, 2nd paragraph - O&M data for the Baxter Springs subsite and information from the State of Kansas' Total Maximum Daily Load (TMDL) program show water quality improvements in Spring Branch following the clean-up.*

   The text has been modified to include the more current information. However, while the remedial actions at Baxter Springs may have resulted in water quality improvements in Spring Branch, FWS believes that metal concentrations are still sufficient to cause injury to certain aquatic biota.

j. *Page 38, 3rd paragraph – I believe the stated provinces are "physiographic" provinces.*

   The text has been modified.

k. *Page 38, 5th paragraph – The bedrock underlying the Boone aquifer acts to confine the lower aquifer.*

   The text has been modified to more accurately state the role of the confining layer of bedrock in the groundwater system.

l. *Page 39, 1st paragraph – As of 2008 there is no evidence of contamination in the Roubidoux aquifer.*

   Comment noted.

m. *Page 47, 2nd paragraph – Bingham Sand and Gravel is also a chat processor in Cherokee County.*

   The text has been modified to include Bingham Sand and Gravel as a chat processor in Cherokee County.

n. *Page 58 – Exhibit #24 was not referenced or discussed in the text.*

The text has been modified to include a reference to Exhibit #24.

o. *Page 61 and subsequent portions of the text on this topic – EPA will ultimately remediate all of the remaining mining wastes at the Cherokee County Superfund site; thus, the extent of the future clean-up is not unclear. EPA's remedy does not rely on chat sales. The sale of chat augments EPA's remedy but the remedy will be carried out regardless of the amount of chat that may or may not be sold. There will be no unaddressed mining wastes at the completion of EPA's remedy.*

   Comment noted. FWS understands that the remedial action at the Treece subsite will require approximately 10 years to complete, and we estimate completion by the year 2019. However, FWS intends to conduct actions described in this Restoration Plan/Environmental Assessment before then. During this time, FWS may be presented an opportunity to conduct restoration actions in conjunction with EPA and/or the PRPs at sites where mine wastes currently exist. Alternative T6 is included to account for this possibility.

p. *Page 61 and subsequent portions of the text on this topic – (Associated entity) is in agreement that some areas of the remediated Galena subsite currently support sparse to little vegetation. The text implies that many or most of the remediated areas in Galena fit this description; however, historic O&M assessments conducted by EPA and the Kansas Department of Health and Environment have indicated that approximately 20% of the remediated areas contain sparse to little vegetation.*

   Comment noted. It was not FWS's intention to suggest that the majority of the Galena subsite supports sparse to little vegetation. Rather, that the remediated areas at the Galena subsite bear little resemblance to a healthy native community.

q. *Page 64, 2$^{nd}$ paragraph – EPA has not previously implemented mine waste re-contouring and encapsulation remedial actions at the Treece subsite. This work is expected to begin in late 2008. EPA has implemented mine waste remedies (non-residential) at the Galena subsite and is currently implementing a remedy at the Waco subsite. PRPs have implemented a non-residential mine waste clean-up at the Baxter Springs subsite and are currently implementing a remedy at the Crestline subsite. EPA will implement future non-residential mine waste clean-ups at the Badger, Lawton, Baxter Springs, and Treece subsites while the PRPs will likely implement future clean-ups at the Waco and Treece subsites.*

   The text has been modified by removing reference to Treece.

r. *Page 76, last paragraph – Alternative T3 is slated for non-mining waste sites as stated in Exhibit ES-1 but the risk discussion includes language implying the restoration is in former mine waste areas.*

For clarification, Alternative T3 could also be conducted at areas with mining wastes in conjunction with other Alternatives, such as T6, T7, and/or T8, as shown in Exhibit ES-1.

s. *Page 78, 5th paragraph – Alternative T4 is also slated for non-mining waste areas and has the same waste area language discussed in the above comment.*

For clarification, Alternative T4 could also be conducted at areas with mining wastes in conjunction with other Alternatives, such as T6, T7, and/or T8, as shown in Exhibit ES-1.

t. *Page 80 – Same comment as above for Alternative T6. Also, EPA's ROD Amendment as well as many other documents provides information indicating that the available pit disposal volume is not nearly sufficient to contain all of the mining wastes at the site. The 1988 Andes information is outdated. As an example, the Remedial Design for the Waco subsite determined that the pit volumes at this subsite were not sufficient to contain all of the wastes and the PRP design and construction work at the Crestline subsite has arrived at the same conclusion.*

The text has been modified to reflect that available pit volumes may not be sufficient to contain mine wastes present at the various subsites.

u. *Page 82, first sentence – EPA did not estimate the remedial cost to be nearly $87,000 per acre as stated in the text.*

The text has been modified to indicate that the estimated costs were developed by FWS.

v. *Page 83 – See comment" p". Also, Ferrington's reports on the Galena remedy did find some improvements that are not discussed in the text. The remedy also involved more than re-contouring and planting a CRP mix of warm season grasses. The cover material included 40 tons of compost per acre, 2 tons of prairie hay mulch per acre, 2 tons of lime per acre, and 2 tons of annual rye per acre in addition to the 12.4 pounds of native warm season grasses per acre.*

Comment noted, please see response to comment "p". Also, a footnote has been added to describe the remedial action at the Galena subsite in more detail.

w. *Page 86, 3rd paragraph – Capping for Alternative T8 is cited as a benefit over Alternative T6. However, the filled subsidence features specified in Alternative T6 would also be capped so there should be no difference between these two approaches in regard to capping.*

The original text incorrectly referenced Alternative T6, and has been modified to correctly reference Alternative T7.

x. *Page 89, 1st paragraph – The Baxter Springs and Treece remedy cap for the tailings ponds consisted of 12 inches of clay overlain by 6 inches of topsoil. Forb species were not planted in certain areas. Spring Branch historically ran through or within mining wastes.*

   The text has been modified to reflect the actual thickness of the caps placed during the Baxter Springs remedial action.

y. *Page 90, footnote 59 – Borrow areas are not typically 18 inches deep and spread over a large area. The footprint is typically as small as possible and the lower more clayey deposits are used for the basal 12 inches of the cap (12 inches of clay overlain by 6 inches of topsoil). Engineering designs typically incorporate borrow areas such as the use of cover materials resulting from excavation of impoundments or water management basins.*

   The footnote has been modified.

z. *Page 91, Risks – Human derived bio-solids also have negative aspects that are not discussed in the text such as possibly containing drugs or medications and other recalcitrant compounds. A potential source of cattle bio-solids is the Kansas Livestock Association.*

   The text has been modified to reflect the potential for additional risks associated with the use of biosolids. The text also indicates that an evaluation of these risks will be conducted based upon the type of biosolid material used.

aa. *Page 97, 1st paragraph – The overall cost of Empire Lake dredging is not provided.*

   Comment noted. There is sufficient uncertainty in the estimation of this cost to present a total dollar amount at this time.