GRAND LAKE O' THE CHEROKEES

Natural Resource Damages: Restoration and Compensation Determination Plan

Image by Andre Bonacin

April 2014

(This page intentionally left blank)

Table of Contents

List of Figures

EXECUTIVE SUMMARY

Grand Lake O' the Cherokees (Grand Lake) is an impoundment that begins in Ottawa County, Oklahoma, extends through Delaware County, and ends at the Pensacola Dam in Mayes County. Grand Lake was created in 1940 upon completion of the Pensacola Dam construction by the Grand River Dam Authority (GRDA), an agency of the State of Oklahoma, as authorized by federal legislation.

Grand Lake is downstream of the Tri-State Mining District, an approximately 2,500 square mile area that includes Ottawa County in Oklahoma and also extends to neighboring counties in Kansas and Missouri. The Tri-State Mining District was 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 soils, surface waters, ground water, and biota. Cadmium, lead, and zinc are toxic at sufficiently high concentrations, and contamination by these metals has resulted in injuries to natural resources in several states (Tar Creek PAS 2004; State of Kansas and DOI 2003; MDNR and DOI 2002, 2008). 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 Compensation and Determination Plan (RCDP) applies only to Grand Lake, Oklahoma, and does not address restoration alternatives for any other parts of the Tri-State Mining District.

This RCDP has been prepared on behalf of the U.S. Department of the Interior (DOI), the State of Oklahoma, the Eastern Shawnee Tribe of Oklahoma, the Cherokee Nation, the Miami Tribe of Oklahoma, the Ottawa Tribe of Oklahoma, the Peoria Tribe of Indians of Oklahoma, the Seneca-Cayuga Tribe of Oklahoma, and the Wyandotte Nation (individually and collectively referred to in this document as "Trustees"). (This list is not comprehensive and other Tribal governmental entities also may be natural resource trustees but are not participating in this RCDP.)

On behalf of the public, the Trustees are authorized to pursue potentially responsible parties for damages associated with natural resource injuries resulting from the release of hazardous substances. The Trustees are required to use any recovered funds to restore, rehabilitate, replace, and/or acquire the equivalent of the natural resources and those associated services. This RCDP summarizes currently available information concerning injuries to Grand Lake natural resources and describes the Trustees' priorities and general plans with respect to any potentially recovered funds. This approach reflects the fact that the total amount and timing of funding to implement restoration is not yet known, while providing stakeholders with information sufficient to understand the type and rationale for preferred restoration options. This plan also serves to facilitate public involvement in the plan and to comply with environmental decision-making requirements.

Metals levels in Grand Lake fish are sufficiently elevated that in 2003, the Oklahoma Department of Environmental Quality (ODEQ) advised the public to limit consumption of whole fish caught in the Spring and Neosho Rivers at the upper end of the lake (OSE 2005), and in 2008, ODEQ issued a fish consumption advisory that includes all of Grand Lake. Residents living in the Tar Creek area are advised not to eat more than six meals per month of non-game fish prepared with bones, and non-residents are advised not to eat more than 11 meals per month of non-game fish prepared with bones from Grand Lake (ODEQ 2008a). Non-game fish include carp, freshwater drum, redhorse sucker, and smallmouth buffalo. This fish consumption advisory constitutes an injury under the DOI's NRDA regulations (43 CFR §11.62(f)(1)(iii)).

The Trustees have made use of readily available information in an effort to begin to understand the potential magnitude of impact of the advisory on Tribal fish collection activities. While the advisory has likely adversely affected recreational and subsistence angling for non-Tribal populations, at this time the Trustees have not pursued estimation of these impacts. The Trustees reserve the right to collect and evaluate information on these issues and revise this RCDP accordingly.

Grand Lake sediments are also injured. Sediment resources are injured if concentrations and duration of substances are sufficient to cause injury to other natural resources (43 CFR § 11.62 (b)(1)(v)). Because Grand Lake fishery resources have been injured by exposure to metals in Grand Lake sediments, Grand Lake sediments are injured.

The Trustees also conducted a study to evaluate the toxicity of Grand Lake sediments to sediment dwelling organisms. Based on study results, Grand Lake sediments do not appear to be causing or contributing to toxicity to sediment dwelling organisms, although additional analyses are needed to determine if the 40 sediment samples evaluated in the current study represent the spatial and temporal variability of metals and/or Acid Volatilized Sulfides (AVS) in Grand Lake sediments.

This RCDP identifies and describes and evaluates seven potential restoration alternatives to compensate for injuries to Grand Lake resources, taking into account a variety of factors including (43 CFR §11.82(d)):

(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 relationship of the expected costs of the proposed actions to the expected benefits from the restoration, rehabilitation, replacement, and/or acquisition of equivalent resources;

(5) The relative cost-effectiveness of different alternatives (*i.e.*, if two alternatives are expected to produce the same or 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 additional injury to the environment if the alternative is implemented;

(8) Potential effects on human health and safety;

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

(10) Compliance with applicable Federal, State, and Tribal laws; and

(11) Consistency with relevant Federal, State, and Tribal policies.

Considering the factors set forth at 43 CFR §11.82(d), the Trustees have designated two restoration alternatives as preferred: Alternative 5 (dredge selected areas within Grand Lake), and Alternative 7 (Tribal cultural projects).

With respect to the need for targeted dredging, metals levels in lake sediments are sufficient to have resulted in the establishment of fish consumption advisories for several species of fish in the Lake. Metals levels are significantly higher towards the northern end of the lake, where the Neosho and Spring Rivers terminate.[1]

As part of the Superfund program under CERCLA, the U.S. Environmental Protection Agency (EPA) is currently investigating the numerous creeks and streams upstream of Grand Lake that drain areas heavily impacted by historic lead-zinc mining, including the Neosho and Spring Rivers. EPA has designated this as Operable Unit (OU) 5 in Region VI and as OU2 and OU5 in EPA Region VII. [2] EPA will determine whether measures to cleanup or remediate these rivers and creeks (e.g., sediment removal or capping) to mitigate the risks to human health and the environment are appropriate. Further, natural resource trustees for the Tri-State Mining District may undertake measures to restore the

[1] Oklahoma Water Resources Board and Oklahoma State University (OWRB and OSU). 1995. Diagnostic and feasibility study of Grand Lake O' the Cherokees. Phase I of a Clean Lakes Project, Final Report. 10 March.

[2] Operable Unit (OU) 5 of the Oronogo-Duenweg Mining Belt Site (Jasper County, Missouri) addresses contaminated surface water and sediments in the perennial streams (Spring River and its major tributaries including the North Fork of the Spring River, Center Creek, Turkey Creek, Short Creek, and Shoal Creek). Investigation of water and sediment quality and the toxicity of stream sediments is ongoing. Final cleanup decisions will consider the effectiveness and completeness of upland mine and mill wastes (USEPA, Five-Year Review Report, Oronogo-Duenweg Mining Belt Site, Jasper County, Missouri, September 2007).

OU-2 of the Cherokee County Site (southeastern Kansas) addresses the Spring River Basin. Characterization work was conducted from 2004 through 2007 and results related to the selection of appropriate clean up criteria were released in 2009 and 2010. A floodplain soil characterization study began in 2009 and is ongoing (USEPA, Cherokee County Site Status Summary, May 21, 2012, as viewed at www.epa.gov/region7/cleanup/npl_files/ksd980741862.pdf on August 13, 2012).

OU-5 of the Tar Creek Site (Ottawa County, Oklahoma) addresses contaminated sediments in Elm Creek, Tar Creek, and the Neosho River upstream of Grand Lake (USEPA, Record of Decision, Operable Unit 4, Tar Creek Superfund Site, February 20, 2008, pp. 6-7). Characterization of sediments and surface water throughout the Spring and Neosho River basins is ongoing (USEPA, Tar Creek Site Status Summary, July 17, 2012, as viewed at http://www.epa.gov/region6/6sf/oklahoma/tar_creek/index.htm on August 13, 2012).

aquatic habitat and level of ecological service (e.g., additional sediment removal, protection and enhancement of riparian corridors, and fish and mussel propagation) provided by these creeks and streams.

Because upland mine wastes are being addressed first and because sediments are still in the very early stages of characterization, it will likely be several decades before the upstream creeks and streams are addressed. In the meantime, metal-contaminated sediments will continue to migrate to and accumulate in Grand Lake until remediation and/or restoration of these upstream creeks and rivers is complete. Further, in-stream remedial activities may result in the abrupt, short-term release of contaminated sediments (e.g., by uncovering or resuspending contaminated sediments during dredging operations). As a result, the aquatic and cultural habitats in Grand Lake are and will continue to be threatened over an extended period of time.

A cost-effective and practical restoration approach for addressing contaminated sediments in the lake involves the periodic removal of sediment from its northern end. Such an approach would address the general area most impacted spatially and temporally as contaminated sediments continue to accumulate over time, even after remediation and/or restoration of these upstream creeks and rivers are completed. The specific timing of sediment removal events will be determined by the Trustees at a later date, based on upstream cleanup developments and any additional data characterizing the spatial distribution of metals contaminants in northern Grand Lake and/or Oklahoma portions of the Spring and Neosho Rivers.

Currently available data doesn't allow the Trustees to identify specific areas where sediment removal should be undertaken (i.e., areas with the highest level of contamination). However, gravel bars or natural depositional areas located along curved portions of the river or lake shoreline near or downstream of OU5 where the Neosho and Spring Rivers terminate and upstream of where the lake becomes markedly wider appear to be good, accessible candidate areas for sediment removal.

Based on a variety of planning assumptions, the Trustees estimate a total cost of approximately **$9.9 million (2014$)** for targeted dredging efforts, on a present value basis using an annual discount rate of 3 percent. Inputs, assumptions and calculations underlying this estimate are described in detail in this RCDP.

With respect to Tribal fish collection loss arising from the Grand Lake fish consumption advisory, analysis of readily available information presented in the RCDP indicates that a minimum compensation of **$5.8 to 7.6 million (2014$)** would need to be contributed to the development and operational costs of Tribal cultural center projects. The Trustees support the use of damages recovered as compensation for Tribal fish collection losses to contribute towards the creation and operation of components of a Tribal cultural center. The Trustees expect that the center will have aquaculture facilities, to allow for the farming of desired fish species uncontaminated with hazardous substances. In addition, the facility will provide educational services to help inform and ensure the continuance of fishing-related and other culturally important activities in a manner appropriate for the Tribes.

The Trustees recognize that data gaps introduce uncertainties into the estimation of the magnitude of monetary loss; however, based on available data combined with explicit assumptions and supporting rationale, the current analysis is more likely to under- than over-state actual loss.

CHAPTER 1 | INTRODUCTION

This Restoration and Compensation Determination Plan (RCDP) describes injuries and restoration options for Grand Lake O' the Cherokees (Grand Lake) in Oklahoma. Grand Lake is an impoundment that begins in Ottawa County, extends through Delaware County, and ends at the Pensacola Dam in Mayes County. Grand Lake was created in 1940 upon completion of the Pensacola Dam construction by the Grand River Dam Authority (GRDA), an agency of the State of Oklahoma, as authorized by federal legislation. Grand Lake is the third largest reservoir in Oklahoma with a surface area of approximately 46,500 acres and a shoreline of 1,300 miles. At normal pool elevation, the lake averages about 35.9 feet (11 meters) in depth (OSE 2005).

Grand Lake's watershed exceeds 10,000 square miles and extends into four states (Figure 1, OSE 2004). Three major rivers drain into the lake: the Elk River, which enters the lake from the east, and the Neosho and Spring Rivers. These latter two rivers terminate at the lake's northern end, and as described in Chapter 2, the Neosho and Spring Rivers drain areas heavily impacted by historic lead-zinc mining. Grand Lake serves as a sink for the metal-contaminated sediments transported by these rivers (OWRB and OSU 1995). Specific contaminants of concern include cadmium, lead, and zinc.

Available information indicates that certain natural resources in Grand Lake have been injured by the release of mining-related metals. This RCDP summarizes currently available information about natural resource injuries to Grand Lake, identifies and evaluates possible restoration alternatives, and estimates monetary value for appropriate compensation for these injuries based on the preferred alternatives.

1.1 Authority

The Comprehensive Environmental Response, Compensation, and Liability Act as amended (CERCLA, 42 U.S.C. 9601 *et. seq.*), the Oil Pollution Act of 1990 (OPA), 33 U.S.C. 2701 *et. seq.*, and the Federal Water Pollution Control Act (the "Clean Water Act" (CWA)), as amended (33 U.S.C. 1251 *et. seq.*), authorize the Federal government, states, and Indian Tribes to recover, on behalf of the public, damages for injuries to, destruction of, or loss of natural resources belonging to, managed by, appertaining to, or otherwise controlled by them (42 U.S.C. §9607(f)(1); 9601(16)). The National Oil and Hazardous Substances Pollution Contingency Plan, more commonly known as the National Contingency Plan (NCP), designates natural resource trustees to act on behalf of the public when there is injury to, destruction of, loss of, or threat to natural resources and their supporting ecosystems (40 CFR Subpart G § 300.600). Furthermore, individual Tribes exercise trusteeship over resources through the implementation and enforcement of laws such as the Cherokee Nation's Hunting and Fishing Code and Culturally Protected Species Act.

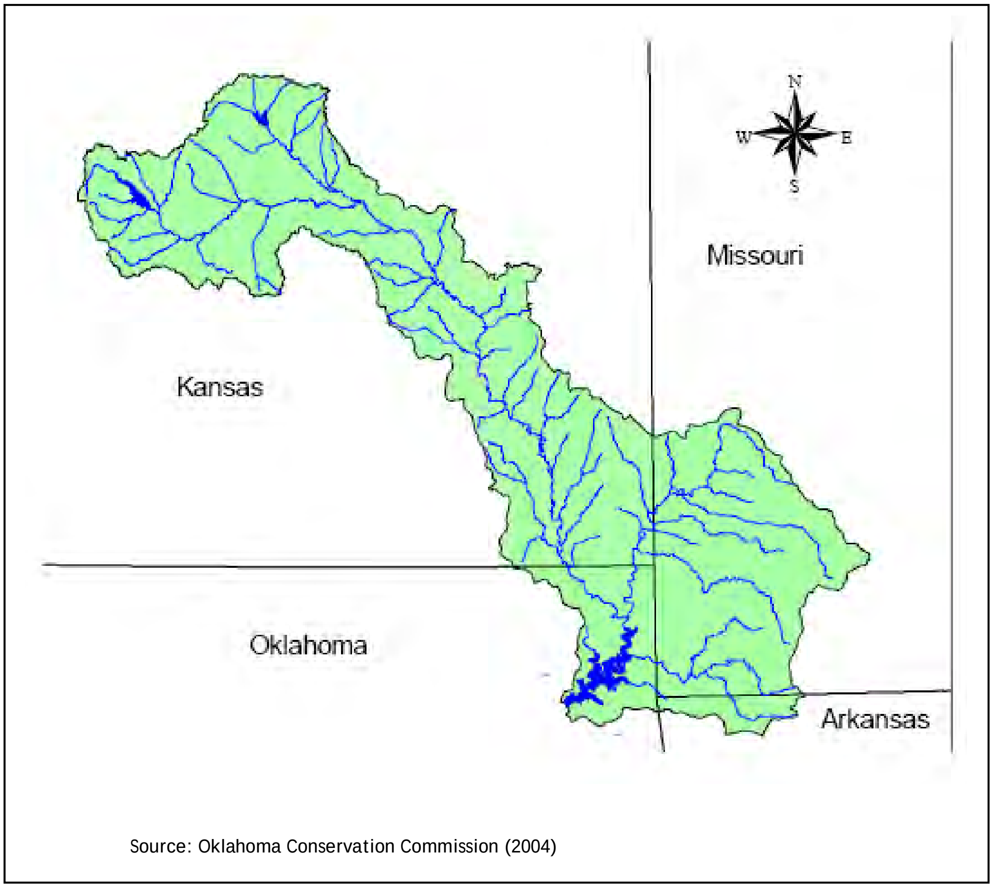


Figure 1 Grand Lake O' The Cherokees Watershed

In accordance with 42 U.S.C. § 9607(f)(2)(A) and the NCP (40 CFR § 300.600), the President has designated the Secretary of the Department of Interior (DOI) to act on behalf of the public as trustee for those natural resources and their supporting ecosystems that are managed or controlled by the DOI and those resources for which an Indian Tribe would otherwise act as trustee in those cases where the United States acts on behalf of the Indian Tribe.[3] The authorities under which the DOI may act include, but are not limited to: the Endangered Species Act (ESA), as amended (16 U.S.C. 1531 *et. seq.*); and the Migratory Bird Treaty Act (MBTA), as amended (16 U.S.C. 701 *et. seq.*). The official authorized to act on behalf of the Secretary for the Tri-State Mining District sites is the U.S. Fish and Wildlife Service Regional Director for Region 2.

In accordance with 42 U.S.C. § 9607(f)(2)(B), the NCP (40 CFR § 300.605), and state law (27A Okl. St. Ann.1-2-101), the Governor of Oklahoma has designated the Oklahoma Secretary of Environment as the natural resource trustee for the State of Oklahoma. The Secretary of Environment acts on behalf of the public, as a trustee for

[3] At this time, the United States is not acting on behalf of any of the tribes involved with this RCDP.

natural resources including their supporting ecosystems, that are within the boundary of Oklahoma or belonging to, managed by, controlled by, or appertaining to Oklahoma.

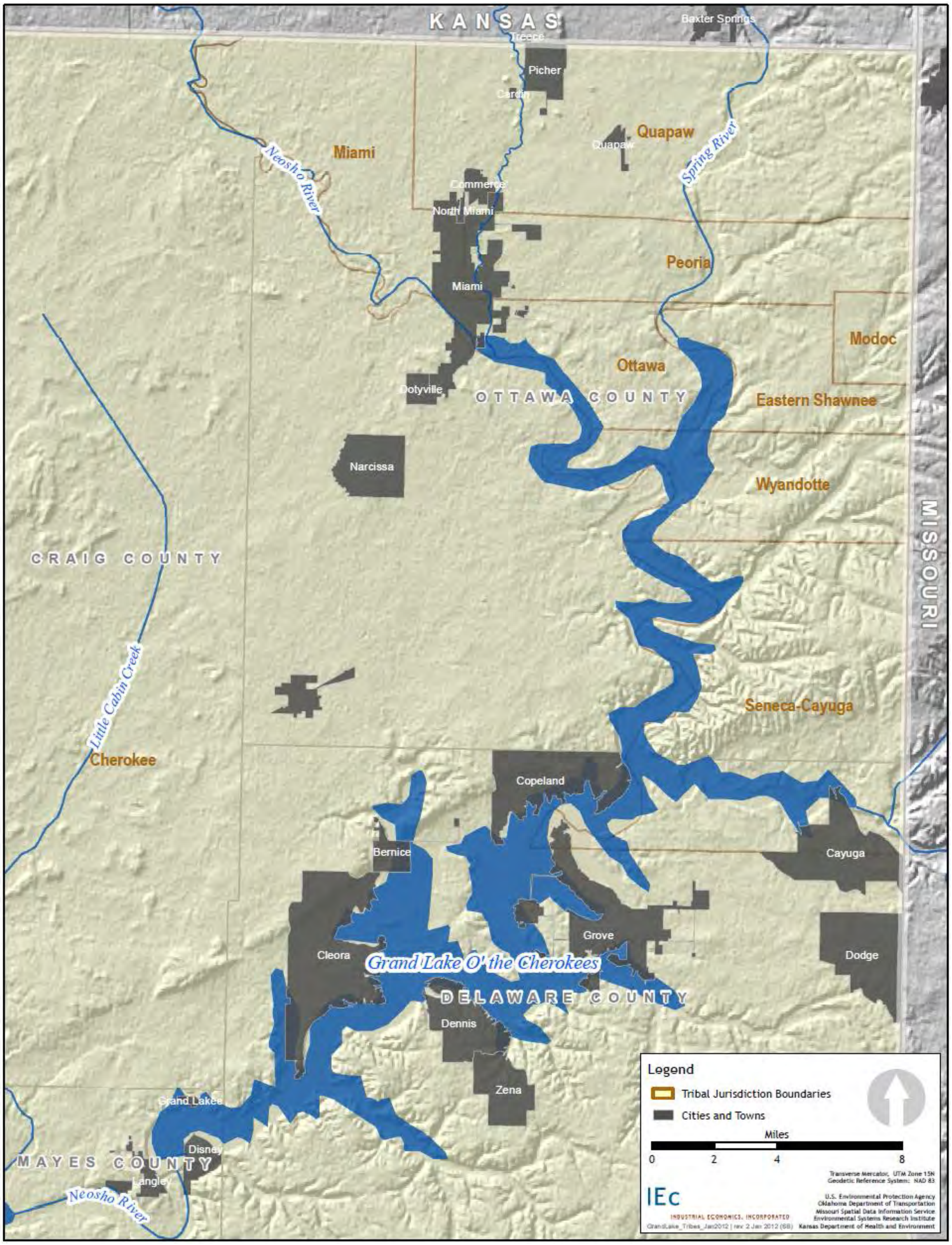
CERCLA, FWPCA and the NCP (40 CFR § 300.610) also authorize Indian tribes to serve as trustees for the natural resources including their supporting ecosystems, belonging to, managed by, controlled by, or appertaining to such Indian tribe, or held in trust for the benefit of such Indian tribe, or belonging to a member of such Indian tribe, if such resources are subject to a trust restriction on alienation. Tribal Trustees for Grand Lake include the Eastern Shawnee Tribe of Oklahoma, the Cherokee Nation, the Miami Tribe of Oklahoma, the Ottawa Tribe of Oklahoma, the Peoria Tribe of Indians of Oklahoma, the Seneca-Cayuga Tribe of Oklahoma, and the Wyandotte Nation (Figure 2). (This list is not comprehensive and other Tribal governmental entities also may be natural resource trustees but are not participating in this RCDP.)

The above mentioned Federal, state, and Tribal Grand Lake Trustees have the authority to assess potential contaminant-related injuries to natural resources, to recover damages from responsible parties, and to plan and implement actions to restore, replace, or rehabilitate natural resources or their services injured or lost as a result of releases of hazardous substances. Natural resources considered within this RCDP include Grand Lake's surface waters, including its sediments, as well as all the living organisms that depend on the lake for food, habitat, and shelter.

The Grand Lake Trustees are currently pursuing a natural resource damage assessment (NRDA) of Grand Lake. Although this assessment is still underway, information currently available indicates that Grand Lake has been injured by exposure to mining-related metals. The Trustees are pursuing or will pursue compensation for related injuries from a number of potentially responsible parties (PRPs) who participated in mining and mining-related activities in the Tri-State Mining District.

When compensation is recovered, the Trustees are required to spend the recovered funds on projects to restore, rehabilitate, replace, and/or acquire the equivalent of the injured natural resources and their associated services. This RCDP describes the Trustees' broad priorities and general plans with respect to the use of any such funds recovered.

Figure 2 Tribal Jurisdictions in Northeast Oklahoma



1.2 Public Participation

Public participation is an important part of RCDP development (43 CFR §11.81(d)). Comments and input on this RCDP from the public were solicited during a 30 day comment period. A 30 day extension was requested by the public and was granted to allow a reasonable time for review and comment on the RCDP.

1.3 About Restoration Project Selection

This RCDP describes the Trustees' broad priorities and general plans with respect to the use of any funds recovered in connection with injuries to Grand Lake's natural resources. In particular, this document:

- Identifies potential restoration projects that would address the injuries caused by the release of hazardous substances from mining operations in the Tri-State Mining District; and
- Describes the rationale of preferred alternatives.

This RCDP does not identify specific locations, scales, or other detailed information on potential restoration projects. Instead, the RCDP identifies generally-preferred types of restoration projects to address injuries to natural resources or their services. This approach reflects the fact that the total amount and timing of funding to implement restoration is not yet known, while providing stakeholders with information sufficient to understand the type and rationale for preferred restoration options.

After determination of the amount of the award of a natural resource damages claim, the Trustees will publish a Restoration Plan for public comment. The Restoration Plan will describe restoration projects in more detail, including a process to review, prioritize, and select preferred restoration actions that will restore, replace, or rehabilitate injured resources to their baseline condition, and/or lost resource services. Restoration projects presented in the RCDP will be incorporated and evaluated in the Tar Creek Restoration Plan and Programmatic Environmental Assessment (RP/PEA). The RP/PEA will be put out to the public and all comments received will be incorporated into the document

1.4 Report Organization

The remainder of this report contains the following chapters.

- Chapter 2 briefly describes the history of mining in the Tri-State Mining District and explains how contaminants reached Grand Lake from mining-impacted areas. This chapter also describes the natural resources of Grand Lake, identifies the contaminants of concern, and presents available information about the extent of contamination in the lake.
- Chapter 3 presents currently available information about injuries and potential injuries to Grand Lake's natural resources and their services.
- Chapter 4 introduces the restoration alternatives.
- Chapter 5 evaluates the restoration alternatives according to a number of criteria and presents the Trustees' preferred alternatives.

- Appendix A provides estimated costs for Alternative 5 (Dredge Selected Areas within Grand Lake).
- Appendix B presents the Trustees' Tribal Fish Collection Loss Use Analysis.
- Appendix C provides a summary of existing Tribal community/cultural center costs which appertain to Alternative 7 (Tribal Cultural Projects).

(This page intentionally left blank)

CHAPTER 2 | NATURAL RESOURCES OF THE ASSESSMENT AREA, CONTAMINANTS OF CONCERN AND SOURCES

2.1 History of Mining in the Tri-State Area

Because mining activities in the Tri-State Mining District are an important source of metals contamination in Grand Lake, this chapter provides a brief summary of mining and contaminant transport within and from the Tri-State area.

The Tri-State Mining District (TSMD) is a historic lead and zinc mining area that includes portions of Kansas, Missouri, and Oklahoma covering an area of more than 6,400 square kilometers (MacDonald et al. 2009). Lead ore was first discovered in Joplin, Missouri in 1848, marking the beginning of a long history of mineral extraction in the Tri-State area of Kansas, Oklahoma, and Missouri. Mining expanded slowly at first and then rapidly with the advent of extractive and processing technologies, reaching a high-point in the 1920s. Annual production peaked in 1926 at 956,000 tons of lead and zinc concentrate, placing the Tri-State Mining District among the world's top producers of these metals. Production fell in the 1930s during the Great Depression and continued to decline, with occasional surges in production until all operations ceased in 1970 (Bull 2007).

In the history of mining in the United States, the Tri-State Mining District ranks first in terms of past zinc production and fourth in terms of past lead production (Long et al. 1998), producing 23 million tons of zinc concentrates and four million tons of lead concentrates over the course of more than a century of mining (Brosius and Sawin 2001).

Mining and mineral processing, and the generation of wastes

Although shallow mining was used in some areas such as Galena (Brosius and Sawin 2001), other mining operations in the district used underground techniques (Dames & Moore 1993). 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, Medine 2007). Some of the mined rock layers were aquifers, which necessitated constant pumping to keep ground water at bay and maintain dry conditions for mining operations (Dames & Moore 1993a).

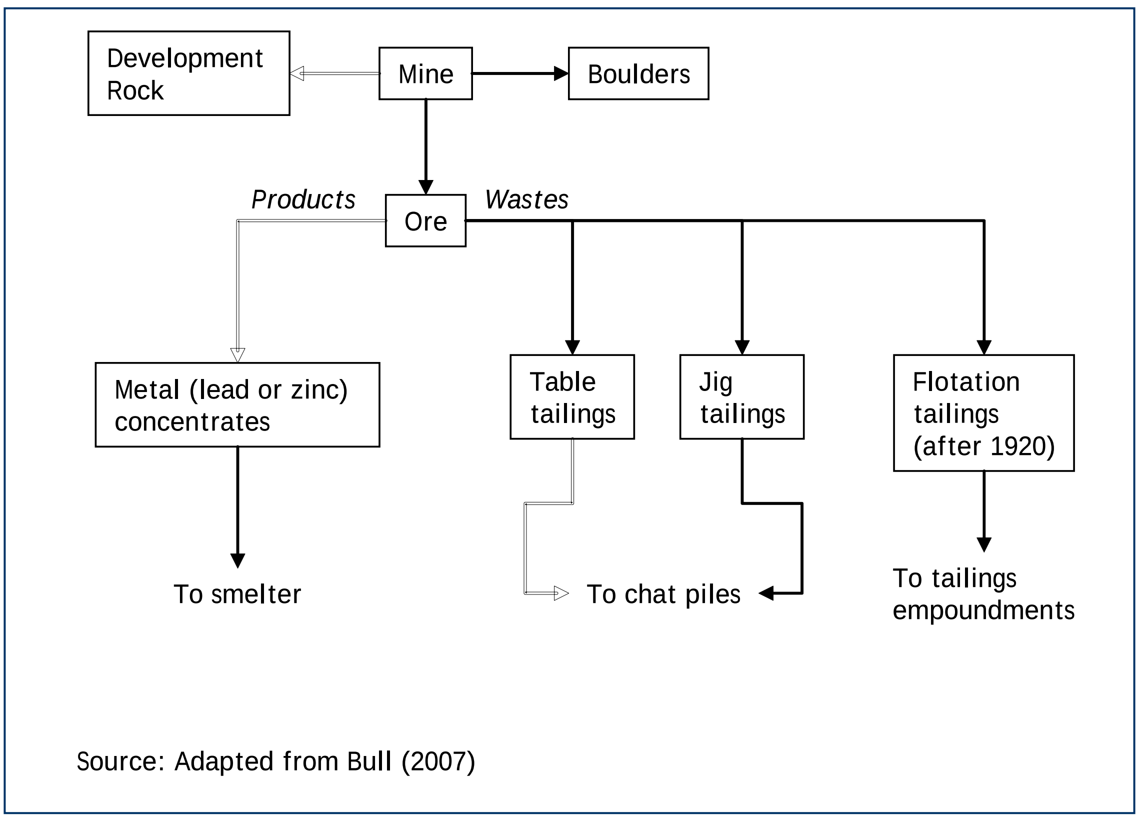
Due to leasing requirements, early mining was characterized by numerous individual operations each conducting mining and milling operations on-site. This resulted in the creation of numerous shafts, waste piles, and mine structures (Dames and Moore 1993 and Bull 2007). The creation of waste was also perpetuated by the geologic nature of ore deposits in the Tri-State: the primary sources of lead and zinc are galena and sphalerite (lead and zinc sulfides, respectively), which constitute only 5-10 percent of the millions of tons mined. The remaining 90-95 percent consists of valueless chert, jasperoid, and dolomite, resulting in the creation of substantial waste during the mining and milling process (Bull 2007). 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 containing residual metals, including waste rock, chat, and tailings (Figure 3):

- Waste rock, also known as bullrock, consists of cobble to boulder-sized rocks that were excavated but not milled. Bullrock includes rock that overlays an ore body, rock removed in the creation of air shafts, and mined rock containing little usable ore (Dames & Moore 1993a).
- Chat 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 (Dames & Moore 1993a).
- Tailings 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 water (Dames & Moore 1993a).

As described below, mine wastes–particularly chat and tailings–have served as a source of metals to the local environment.

Figure 3 Schematic of Lead/Zinc Production and Waste Generation



2.2 Releases and Pathways

Mining and milling in the Tri-State Mining District resulted in the generation of numerous waste piles across the district and within the Grand Lake watershed (Figure 4). Over the years, some chat from these piles has been removed and used for paving driveways, making concrete, constructing railroad ballasts, and for flood control (Bull

2007). While much of the larger chat material was removed for these purposes, the finer materials were left behind (Bull 2007). Those chat and tailings piles that remain still cover thousands of acres.

The contribution of former and current waste piles to area contamination has occurred through a variety of pathways (Figures 5 and 6). For instance, materials from the piles are washed by rain or flooding into nearby streams, and even today, a number of streams in the watershed contain mine waste bars (e.g., Figure 7). Fine materials are released by strong winds (eolian transport), and can also be released during the destabilization of chat piles by all-terrain vehicles (Bull 2007). The primary variables influencing the nature and degree of contamination from waste piles include their locations, the particle size distribution of the waste material, and the timing of its generation (*e.g.*, the metal content of waste product decreased over time as extraction and treatment technologies improved) (Medine 2007, Bull 2007). Remedial activities to contain the waste piles in TSMD are in a variety of stages—from initial clean up to completed. Releases from the waste piles have been a continuing source of contamination into the Grand Lake watershed.

Another pathway through which metals have reached and are continuing to reach the area's natural resources originates in the abandoned underground mine shafts. Following the cessation of mining activity, these mine shafts became flooded with ground water, resulting in both the acidification of the water and the release of metals into it. When the contaminated ground water surfaces through old mineshafts and boreholes or leaches into nearby streams, the metals in the ground water contribute to surface water contamination. Tar Creek in particular has been subject to contamination from such acid mine drainage (GRDA 2008, Medine 2007).

Once present in the streams and rivers within the Grand Lake watershed, dissolved and particulate metals are transported into the lake itself, which serves as a sink for these contaminants (Pita and Hyne 1975, Aggus et al. 1987, OWRB and OSU 1995, Medine 2007).

Figure 6 summarizes, for each mining area, the major pathways through which contaminants reached natural resources. Altogether, past mining and milling operations have contaminated air, soil, and water resources, resulting in metals entering the Spring and Neosho Rivers, which terminate in Grand Lake. The contamination continues to move through the Grand Lake watershed and cause adverse effects to natural resources and their services. Area biota are exposed to metals through direct contact, inhalation, ingestion, and absorption of metals from the contaminated environmental media, and/or from the consumption of contaminated prey items.

Figure 4 Grand Lake O' The Cherokees and Mining/Milling Waste Areas

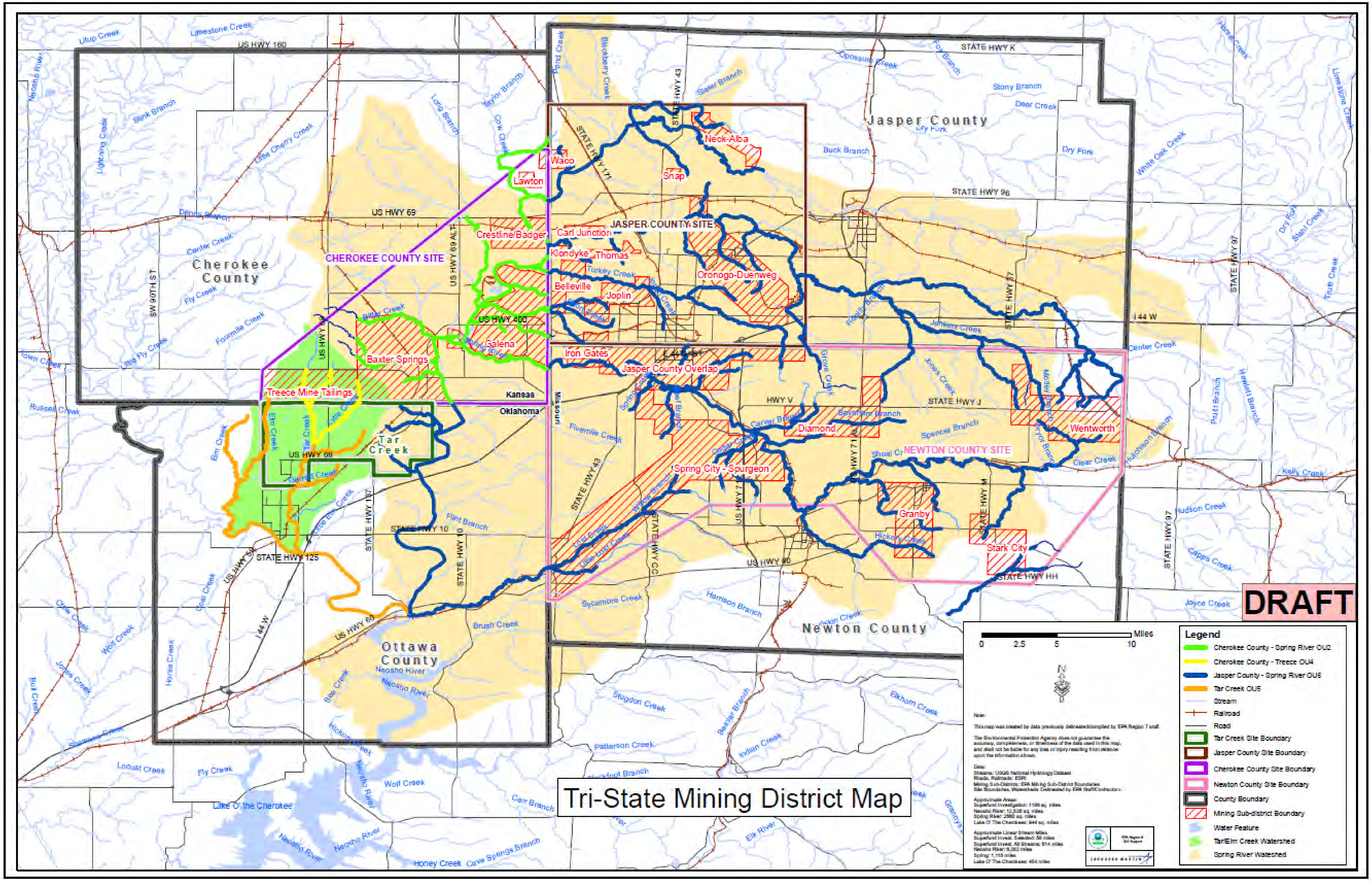
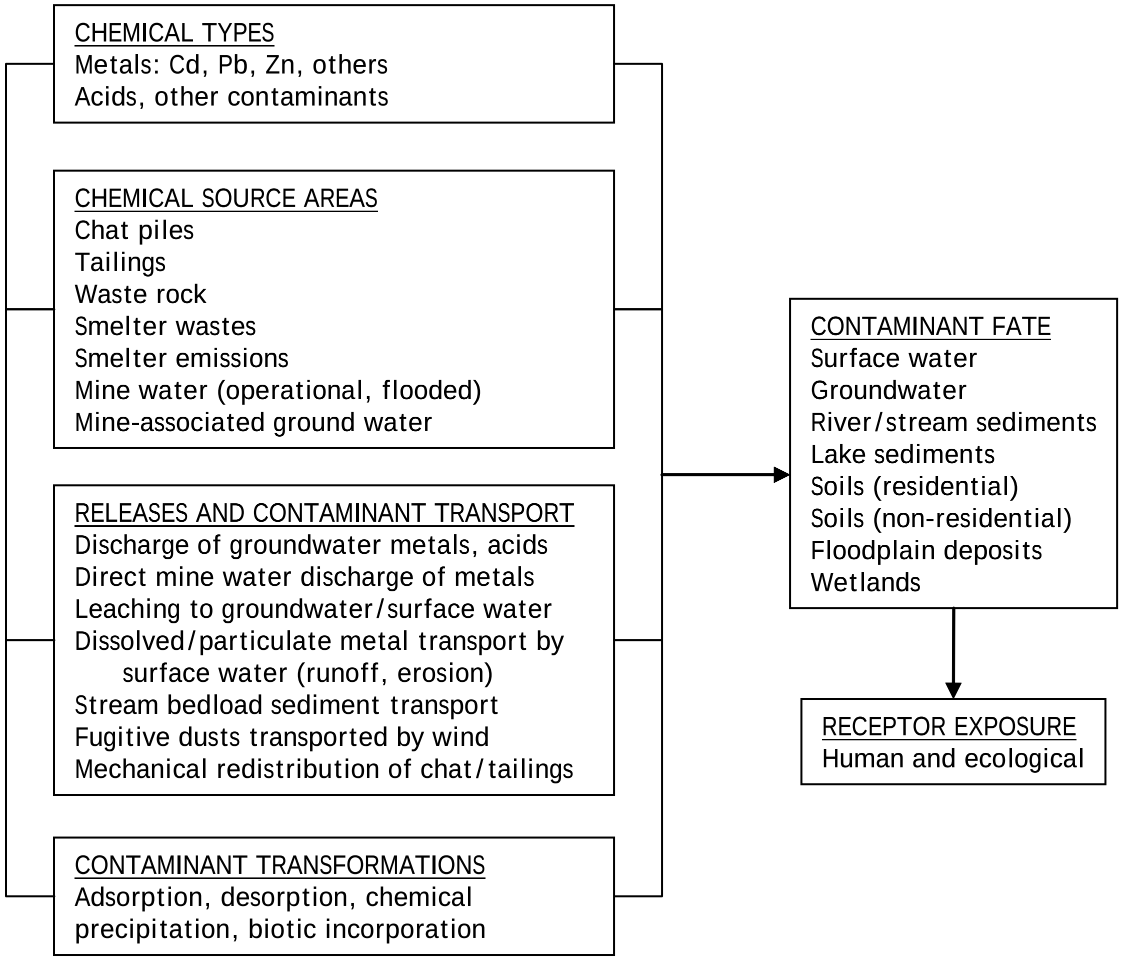


Figure 5 Conceptual Model for Metal Sources, Transport, and Fate in the Tri-State Mining District



Source: Adapted from Medine (2007)

Figure 6 Overview of Mining in the Subsites, Designated Areas, and Subdistricts of the TSMD

<table>
<tr><th>Mining area</th><th>Size of mining/milling operations</th><th>Affected watershed(s)</th><th>Nature of mining</th><th>Major releases Pathways</th></tr>
<tr><td>TAR CREEK SUPERFUND SITE</td><td>• Tar Creek site spans 40 square miles in Ottawa County, OK
• 3,670 acres once contained mining/milling waste
• Mining occurred at over 200 small mines throughout the subsite</td><td>• Neosho River via Tar, Elm, Quapaw, and Lytle Creeks
• Spring River via Ontario, and Beaver Creeks</td><td rowspan="4">Predominantly underground, leaving large volumes of surface waste, underground voids filled with water in addition to subsidence featurs.</td><td rowspan="4">• Erosion, runoff, and leaching from overburden rock, chat and tailings piles; flooding and washout of tailings impoundments, and mechanical transport of these materials for various means (e.g. landscaping, fill, paving).
• Discharge of contaminated ground water from underground shafts to surrounding streams; particularly from the Boone formation into Tar and Lytle Creeks.
• Wind deposition to local soils from historic operations of the Galena Smelter in Cherokee County and numerous smeltering operations in Jasper County.
• Air deposition of finer waste materials from chat and tailings piles during heavy wind and tornado events, particularly in Oklahoma.</td></tr>
<tr><td>CHEROKEE COUNTY SUPERFUND SITE</td><td>• Six subsites over 115 square miles in Cherokee County, KS
• 1,905 acres waste rock, chat, and tailings in the three largest subsites</td><td>• Spring River via Shawnee, Short, Shoal, Brush, Turkey, Center and Willow Creeks
• Neosho River via Tar Creek</td></tr>
<tr><td>ORONOGO-DUENWEG MINING BELT SITE</td><td>• 11 Designated Areas in Jasper County, MO
• 10 million tons of mining/milling waste are estimated to be present throughout the site</td><td>• Spring River via Spring Branch and Center, Short, and Turkey Creeks</td></tr>
<tr><td>NEWTOWN COUNTY MINE TAILINGS SUPERFUND SITE</td><td>• Six subdistricts covering several hundred square miles in Newton County, MO
• 10- to 20,000 tons of tailings remain in Granby, but is more limited in other subdistricts</td><td>• Spring River via Shoal Creek and Lost Creek</td></tr>
<tr><td colspan="5">Source: Medine (2007) and Jacobs Engineering Group (1995)</td></tr>
</table>

Figure 7 Turkey Creek with Mine Waste Bars, Kansas

2.3 Natural Resources in the Assessment Area

Grand Lake was created in 1940 through the construction of the Pensacola Dam in Mayes County, Oklahoma. The lake originates at the convergence of the Spring and Neosho Rivers, flowing in a southwesterly direction from the Twin Bridges State Park to the Pensacola Dam, which straddles the towns of Langley and Disney. It is the third largest reservoir in Oklahoma, covering 46,500 acres with 1,300 miles of shoreline. Draining approximately 10,000 square miles across four states, Grand Lake is the recipient of water running through the rivers and streams of the highly contaminated Tri-State Mining District (Tolbert 2004).

Grand Lake is a significant natural resource in Oklahoma, supporting a diversity of habitats and species as well as providing a range of recreational opportunities and supplying hydroelectric power to surrounding communities. The following paragraphs briefly describe the natural resources of the lake and the services they provide.

Surface water resources

Designated beneficial uses of Grand Lake in Oklahoma include public and private water supply, primary body contact recreation, Class I irrigation, and warm water aquatic community (GRDA 2008). The primary pollution concerns in the lake are heavy metal contamination originating within the upstream part of the watershed and eutrophication from nutrient loading (GRDA 2008). The 2008 Integrated Report of Impaired Waters indicates that Grand Lake is impaired under the warm water aquatic community category due to low dissolved oxygen and turbidity, both stemming from nutrient enrichment (ODEQ 2008). Water impairments from various sources including heavy metals, nutrients, and other sources of pollution occur throughout the Grand Lake watershed. Waterbodies on the 303(d) impaired waters lists of Kansas, Missouri, Oklahoma, and Arkansas drain into the lake (GRDA 2008).

Biotic resources

Fish

Grand Lake is among the premier sport fish destinations in Oklahoma, hosting several nationally recognized fishing tournaments and supporting one of the top bass fisheries in the state (GRDA 2008). The Oklahoma Department of Wildlife Conservation periodically evaluates lakes' bass productivity through electrofishing, and among large lakes, Grand Lake routinely ranks high in terms of bass abundance and size.[4]

In addition to bass, the lake supports numerous other sport fish, panfish, and forage fish (Figure 8). One species of particular note is the paddlefish (*Polyodon spathula*), a primitive species that is one of the largest North American freshwater fish. Over the past century, paddlefish have declined dramatically in most parts of their former range (Graham 1997), but in Grand Lake the species achieved record population levels in 2003 and 2004 (ODWC 2007). The state and federally threatened Neosho madtom (*Noturus placidus*) is also found in the Grand Lake watershed, north of the lake, and the federally threatened Ozark cavefish (*Amblyosis rosae*) is found in nearby caves (GRDA 2008).

Figure 8 Partial List of Grand Lake Fish

Recreational Sport fish	panfish	forage fish	other species
Largemouth bass Smallmouth bass Hybrid striped bass White bass Black crappie White crappie Flathead catfish Blue catfish Channel catfish Paddlefish	Warmouth Longear sunfish Bluegill Green sunfish	Threadfin Gizzard shad	Longnose gar Carp River carpsucker Smallmouth buffalo Logperch Emerald shiner River shiner Red shiner Ghost shiner Silverband shiner Bullhead minnow Blue sucker River redhorse River darter
Source: GRDA 2008			

Grand Lake is actively managed for fishing by the Oklahoma Department of Wildlife Conservation (ODWC), whose efforts have included stocking of recreational fish species as well as fish habitat creation and enhancement (GRDA 2008). Current fishing regulations limit take of certain species and are intended to increase the total abundance and quality of the primary sport fish, bass and crappie (GRDA 2008).

[4] http://www.wildlifedepartment.com/fishing/electrofishing.htm, visited 7 February 2012.

Aquatic-Dependent Fauna: Birds, Amphibians, and Reptiles

In addition to providing habitat for many aquatic species, Grand Lake supports birds and mammals. Grand Lake is an important migratory destination for waterfowl and shorebirds en route to their southern destinations (GRDA 2008). Species that frequent the reservoir annually include pelicans, cormorants, egrets, herons, and various duck species, although overwintering habitat is limited by aquatic vegetation, which is sparse in the lake (GRDA 2008). Other aquatic birds such as Canada geese and wood ducks are year round inhabitants, as are non-aquatic species that live in the area including various raptors and songbirds. Aquatic-dependent species residing in and around Grand Lake also include an assortment of amphibians and reptiles such as the American toad, the western slender glass lizard, as well as various snakes and turtles.

Mammals

Mammals of the Grand Lake watershed include species typical of the bottomland forest and grassland habitat that characterizes this area: red fox, white-tailed deer, eastern cottontail, armadillo, muskrat, beaver, badger, and other rodent species (GRDA 2008). In addition, caves around Grand Lake provide habitat for the state and federally endangered gray bat (*Myotis grisescens*), which is discussed in more detail in the next section.

Threatened and Endangered Species

Although no threatened or endangered species are known to exist in the lake itself, as noted above, the lake's vicinity is home to three such species: the state and federally threatened Neosho madtom (*Noturus placidus*), the federally threatened Ozark cavefish (*Amblyosis rosae*), and the state and federally endangered gray bat (*Myotis grisescens*). Grand Lake also provides wintering habitat for the federally protected bald eagle (*Haliaeetus leucocephalus*).

The Neosho madtom is a small mottled brown catfish, generally less than three inches in length (MDC 2008a). Endemic to the Grand River system, the madtom prefers riffle areas in clear, gravel-bottom streams and is not expected to occur frequently within the lake itself (GRDA 2008).

The Ozark cavefish also prefers clear flowing-stream habitats, although it is restricted to dark cave streams, two of which are near the Pensacola Dam. It is a small, colorless and sightless fish generally about two inches in length (MDC 2008b). Well adapted to its cave environment, it has a commensal relationship with the endangered gray bat, as it is thought to feed on the guano of this fellow cave species (GRDA 2008, USFWS 1989).

The gray bat lives in karst caves of the southeastern U.S., including two that occur on the shores of Grand Lake (GRDA 2008). The bats are migratory and spend summers along the shores of Grand Lake while hibernating during the winter in caves found in northern Arkansas and Missouri (GRDA 2008).

Tribal resource use

Tribes of the Grand Lake watershed have close ties to natural resources including but not limited to water, soil, plants, birds, game, crayfish, fish and freshwater mussels.

Traditional gathering practices have occurred since remembered history; Tribal members have visited springs, hunted, fished, and gathered plants for subsistence, ceremonies, crafts, family traditions, and medicine. These cultural traditions were passed down through generations and were followed closely even after the Tribes were relocated to Indian Territory in the 1800s. Today, Tribal members continue to practice their culture by gathering, hunting, and fishing along the riverine areas of the Grand Lake watershed, which includes the Spring and Neosho rivers and their tributaries.

Natural resources in the area used by Tribes include hundreds of species of culturally significant plants, freshwater mussels, crayfish, many different species of fish, large game such as deer, many species of small game, clays and soils, natural springs, and surface and ground waters. In addition to providing important sources of sustenance, several Tribal natural resources play important roles in ceremony and cultural ideology.

With respect to the significance and importance to Tribes of surface water and associated resources most relevant to this Grand Lake-focused RCDP, several examples are summarized below. Fish are an important resource for Tribes from both a cultural and subsistence perspective. Tribal members take part in fishing throughout the year. Tribal members are reported to eat fish more often and in greater quantity than other populations (ODEQ 2007). Fish is eaten in several ways: fried whole but eviscerated, fried fillets, canned whole but eviscerated, smoked, grilled, and boiled. Bones and skin are traditionally left in or on the fish when it is cooked.

Aquatic-dependent birds are important to Tribal members for subsistence, as well as for ceremony, medicine, crafts, and tradition. This is evidenced by the dances and powwow rituals that mimic the plumages and behaviors of different species of birds. For example, the Miami Tribe of Oklahoma has a crane on its seal. In fact, the name “Myaamia” is translated to mean “cry of the crane.” The Eastern Shawnee Tribe of Oklahoma has a swan on its seal. The importance of birds, especially birds of prey, is shown in numerous artifacts, legends, and ceremonies. For example, this can be seen at the Wyandotte Annual Powwow. The start of the ceremony is marked by the appearance of the sacred Eagle Staff that is made of an eagle head mounted on a staff with feathers and talons. Feathers are used by Tribes as symbols of prayers or marks of honor. Eagle feathers are used in the smoking ceremony to cleanse dancers before a dance or to connect the user with the Creator by carrying prayers. Head-dresses are made from eagle or hawk feathers to symbolize victories and courage or to represent status. Feathers, talons, and skulls are all used for artwork such as jewelry, clothing, and ceremonial adornments.

Reptiles and amphibians have always had a significant importance to Tribal culture, used for subsistence, ceremonial, traditional, craft, and medicinal purposes. Throughout history, the turtle has been regarded as mythical, symbolical, and sacred. Turtles are associated with the creation story by many Tribes including the Wyandotte Nation of Oklahoma. It is believed that the Earth itself was borne on the back of a turtle. Expressed in oral stories and songs, the turtle has been revered for its ability to survive many difficult situations and is an important symbol of protection. Many Tribes believe the back of the turtle consists of 13 moons, which reflect the single cycle of the Earth’s revolution of the sun and thus serves as a calendar. The turtle is so important to the Wyandotte that five of their twelve clans are named for various turtle species. The Seneca-Cayuga Tribe of Oklahoma also has a Turtle Clan, and the Miami Tribe of Oklahoma has a turtle on its Tribal seal. Turtle shells are used by Tribal members for shakers during powwows and ceremonies. The turtle can be seen in many forms of artwork such as basketry, pottery, and jewelry.

In addition to their use as a food source, frogs are used by Tribal members for traditional and cultural purposes. Frogs are important in storytelling. Immature frogs (tadpoles) are used as a calendar to signal spring and the renewal of life after winter. Because tadpoles can metamorphose into an adult, they are considered to be very powerful in stories and art.

There are many species of invertebrates within the assessment area that are important to Tribes. Freshwater mussels, crayfish, and freshwater shrimp are used by Tribal members for subsistence. These biota are gathered from local surface waters, boiled, and eaten. Night crawlers were also found to be important for subsistence and tradition, since they have traditionally been used as bait for fishing. Freshwater mussels are also used by Tribal members for ceremony, tradition, and crafts. Freshwater mussel shells are used in jewelry and artwork. Shells are traditionally used to make tools such as scrapers, lures for fishing, and ceremonial spoons. Crushed shells, which contain lime, are added to pottery to give it strength, durability and resiliency. In addition, shells were incorporated for decorative artwork.

For generations, plants have been very important to Tribal culture. Within the assessment area, there are virtually hundreds of plant species that are used by Tribal members for subsistence, ceremony, tradition, crafts, and medicine. Roots, stems, leaves, and seeds are gathered from both terrestrial and aquatic habitats throughout the year. A common area for gathering occurs within riverine areas. Once gathered, plants are dried, frozen, canned, or used fresh. Wild asparagus is abundant throughout the sandy, riverine areas, and during the spring it is gathered, frozen, and eaten all year. Wild nuts and fruits are gathered seasonally and stored. Pokeberry is commonly used for greens. Watercress, an aquatic plant associated with springs, is gathered to use in salads. Mushrooms such as morels and hen of the woods are hunted, gathered, and eaten each spring. Other plants such as sassafras and mints are used to make teas. Cattail have medicinal uses, its pollen is ground for flour, stems and roots eaten, and stems and leaves used in crafts, basket and mat making.

Depending upon the Tribe, a variety of plants are used for ceremonial practices. For example, gourd shakers and the smoke of cedar are used in prayer, song, and ceremony. Some plants also act as calendars to mark the beginning of certain ceremonies. A full moon during the part of the year when blackberries are ripe denotes the start of the blackberry dance, and Tribal children that were born during the past year are given their Indian names. The ripening of corn signifies the start of the green corn dance. The blooming of dogwoods also marks the beginning of ceremony for a number of Tribes.

Certain plants are also important in the making of crafts. For example, buckbrush, cattail, and honeysuckle are gathered to make baskets. By tradition, the basket maker holds the stems in his/her mouth to strip the stem of its bark. Other plants such as walnut or bloodroot are used as dyes to color baskets and other artwork. As noted above, gourds are used to make shakers to use in ceremony.

Tribal culture is dependent upon the use of plants for medicine. For example, the leaves, stem, and roots of Echinacea are used for curing head colds. Roots of mayapples are used for fevers, constipation, and the expellant of worms. The roots and leaves of willow are used in teas for headaches and fever.

In addition to resource uses described above, Tribes also must compete in the modern economy. The presence of hazardous substances in natural resources has a limiting effect on potential Tribal economic activities, particularly where upstream discharges maximize the loads of pollutants and contaminants that the receiving streams are permitted to carry.

<u>Other human use</u>

The following summary description of Grand Lake recreational use is excerpted from the Grand Lake O' the Cherokees Public Recreation Management Plan (September 2006).

> "Construction of Grand Lake resulted in the development of a significant recreational resource in the region. The lake currently supports 5 state parks and approximately 14 municipal parks. Collectively these provide approximately 22 public boat ramps. In addition, there are approximately 350 commercial and residential boat ramps on the lower half of the lake alone. All of those ramps are also available for public use. Commercial outfits, such as marinas, support approximately 300 boat docks. It is this access to the lake that attracts tourism dollars to the local economy. The Oklahoma Tourism and Recreation Department (OTRD) estimated that Grand Lake generated in excess of $28 million in tourism-related revenue to the area in 1987 (Oklahoma Office of the Secretary of the Environment, 2005). Newer estimates are not available, but it is reasonable to expect that current day tourism-related revenue now exceeds $28 million.
>
> Grand Lake is one of Oklahoma's more popular recreational areas for boating and fishing. Grand Lake supports a high-quality sport fishery for largemouth bass, striped bass, white bass, crappie, catfish and paddlefish. Organizations and businesses sponsor a number of major fishing tournaments at the lake each summer (GRDA, unpublished data). The lake also supports a large number of powerboats, large houseboats and sailboats and hosts several regattas and other boating events each year.
>
> Vehicular access to Grand Lake is excellent. Interstate 44 (Will Rogers Turnpike) runs between the local population centers of Joplin, Missouri and Tulsa, Oklahoma and has several exits that provide access to Grand Lake.

Numerous US, state, and county highways combine to provide direct arterial access to the lake.

The major population centers of Kansas City, Joplin and Springfield, Missouri; Fayetteville and Fort Smith, Arkansas; Kansas City and Wichita, Kansas; Tulsa and Oklahoma City, Oklahoma are within three to five hours driving time from Grand Lake. Immediately surrounding Grand Lake are smaller communities which have shown growth and demographic change during the previous decades" (pp. 2-3).

2.4 Contaminants of Concern

Although mining and related activities can cause the release of a number of 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 the Tri-State Mining District, and although NRDA activities are ongoing, substantial relevant data suggests that these metals may be adversely affecting natural resources. The following paragraphs provide some general information about the potential adverse effects of these metals on organisms.

<u>Cadmium</u>

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 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[5] (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[6] effects of cadmium, though exposure to high levels can be fatal (Eisler 2000).

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

---

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

[6] 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.

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). There is 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, Fransen and Pain 2011). 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 (Kansas) 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).

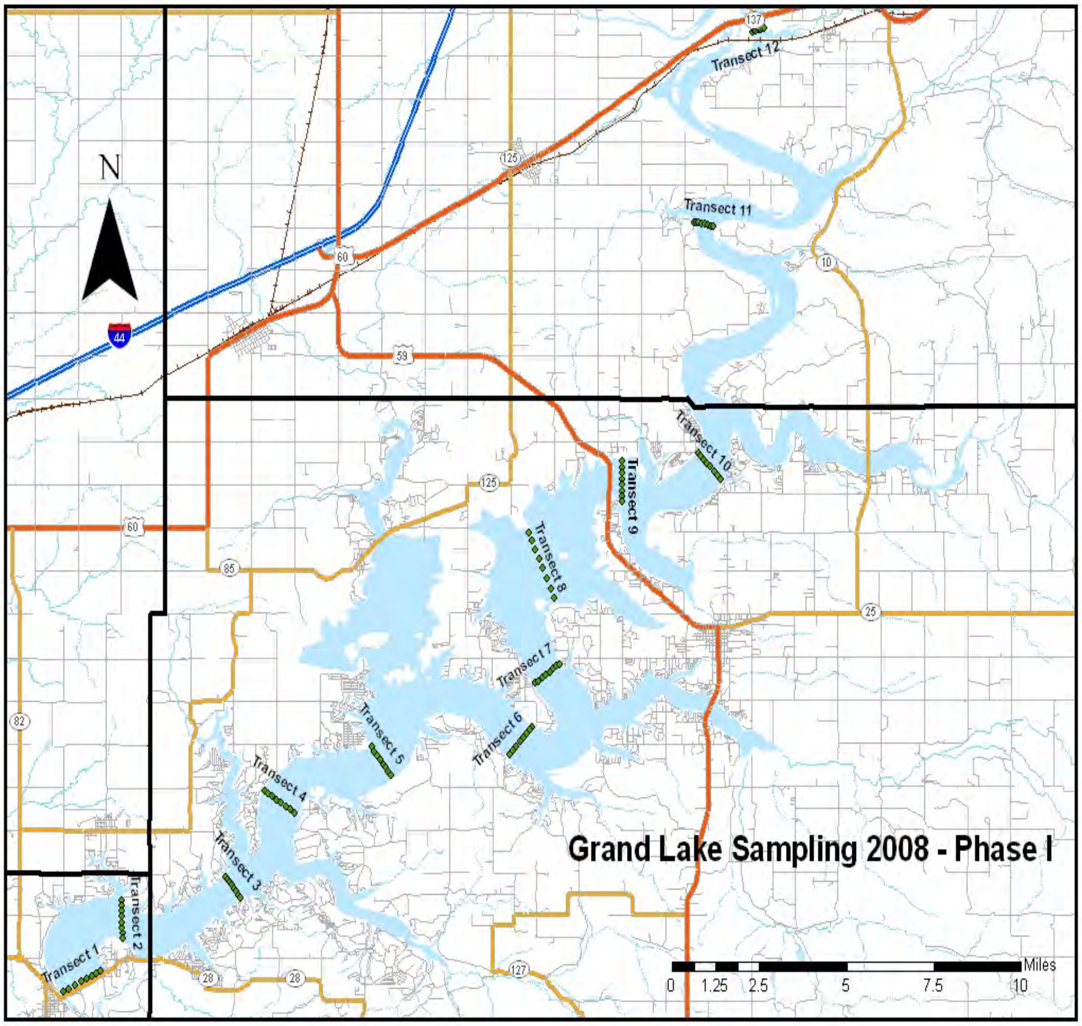
2.5 Nature and extent of contamination

Sediments

A number of studies have shown that Grand Lake sediments have been and continue to be subject to mining-associated contamination. The first analysis of metals in the Grand Lake environment was conducted by Pita and Hyne (1975) in the mid-1970s. This investigation showed elevated levels of lead and zinc in Grand Lake sediments compared to background levels in other reservoirs. These results were confirmed a decade later during a study of Grand Lake by Aggus et al. (1987). In this study, the authors found high levels of metals from the Neosho and Spring Rivers to be entering the lake, where they concentrated in bed sediments. GRDA et al. (2004) also found elevated levels of cadmium, lead, and zinc in the lake's sediments, as have recent studies conducted by the Trustees, discussed below.

Because past data on metals concentrations in lake sediments are relatively few, the Trustees undertook various sampling efforts. For example, Trustee efforts included a "Phase I" evaluation of 93 sediment samples taken along 12 transects spaced throughout the lake (Figure 9). Metals levels in the sediments were measured using X-ray fluorescence (XRF), with approximately 10 percent of samples being subject to sieving and laboratory spectroscopic analysis for confirmation. Summary data from this and other recent studies is presented in Figure 10.[7]

Figure 9 Location of 2008 Phase 1 Grand Lake Sediment Sampling Stations



Source: Ingersoll et al. 2009

[7] For the USGS (2007) study, cadmium levels were generally below the XRF instrument's detection limits, so cadmium concentrations were estimated based on zinc concentrations and on a regression of zinc to cadmium concentrations, using the subset of the samples that were also subject to laboratory spectroscopic analysis.

Figure 10 Summary of 2008 Grand Lake Metal Concentration Measurements

metal and medium	count	minimum (ppm)	maximum (ppm)	median (ppm)
PHASE I SAMPLING, WHOLE SURFICIAL SEDIMENTS (PPM)[a]				
Cadmium	93	Below detection limit	15	3
Lead	93	19	115	52
Zinc	93	113	1,708	501
PHASE II SAMPLING, PORE WATER (PPB)[b]				
Cadmium	40	< 0.04 (detection limit)	0.26	< 0.04 (detection limit)
Lead	40	0.09	3.21	0.42
Zinc	40	2.9	237	15
PHASE III CORE SAMPLING (PPM)[c]				
Cadmium	5	2.3	3.6	3.5
Lead	50	35	102	59
Zinc	50	380	986	765
USGS 2007 BOTTOM SURFICIAL SEDIMENTS (PPM)[d]				
Cadmium	20	0.4	19	2.7
Lead	20	17	90	40
Zinc	20	56	1,523	497
USGS 2007 CORE SECTIONS (PPM)[d]				
Cadmium	140	0.2	31	1.4
Lead	140	17	248	27
Zinc	140	64	3,340	278
USGS 2007 REFERENCE AREA CORE SECTIONS (PPM)[e]				
Cadmium	44	0.2	0.5	0.3
Lead	44	14	22	16
Zinc	44	43	74	52

Notes:

(a) Suzanne Dudding, USFWS, Tulsa OK; personal communication; also see Jones and Donlan (2009).

(b) Ingersoll et al. (2009).

(c) Juracek and Becker (2009). The count figure represents the total number of sections evaluated across five cores (10 sections/core were generated). The presented concentrations for lead and zinc represent XRF measurements, whereas values for cadmium represent results from spectroscopic methods, as cadmium concentrations fell below the XRF detection limit.

(d) Fay et al. (2010). Surficial data represent results from surficial grabs (15) and composites of the top sections of cores (5). Core section data reflect results across the four non-reference cores.

(e) Fay et al. (2010). Data reflect results in a single reference area core.

The Trustees used Phase I results to target additional (Phase II) sampling as part of a sediment toxicity study (Ingersoll et al. 2009). In the Phase II sampling, 40 samples were subject to XRF analysis and also were evaluated for simultaneously-extracted metals

(SEM), AVS, and total organic carbon (TOC); in addition, metal concentrations in sample pore water were analyzed.

In Phase III of the study, five cores from different parts of the lake were collected (see Figure 11). Each core was divided into 10 sections, each of which was subject to XRF, with a subset of samples being additionally subject to laboratory spectroscopic analysis for confirmation of metals concentrations (Juracek and Becker 2009).

The cores were also subject to cesium-137 dating to verify whether the sampled segments had been disturbed since they were laid down, and (if not disturbed), to estimate the ages of the core sections and draw conclusions about likely changes in metal concentrations over time. Key findings from the coring study (Juracek and Becker 2009) include the following:

- Across all core sections, cadmium concentrations ranged from 2.3 to 3.6 ppm; lead ranged from 35 to 102 ppm, and zinc ranged from 380 to 986 ppm. Median values were 3.5 ppm (cadmium), 59 ppm (lead), and 765 ppm (zinc).
- These values represent a substantial increase over estimated background (pre-mining) concentrations: historic mining activity has increased median concentrations in lake sediments by approximately 75 to 410 percent (lead), 280 to 500 percent (cadmium), and 280 to 890 (zinc) percent.
- The northernmost core's cesium-137 analysis indicated considerable post-depositional disturbance, such that no conclusions could be drawn regarding changes in metals concentrations over time on the basis of this core.
- The four other cores had little depositional disturbance, allowing inferences to be made about metals concentrations over time. From these cores, it appears that lead and zinc concentrations peaked in the 1970s and have been slowly declining since then.

Figure 11 Location of 2008 Grand Lake Core Sampling Stations

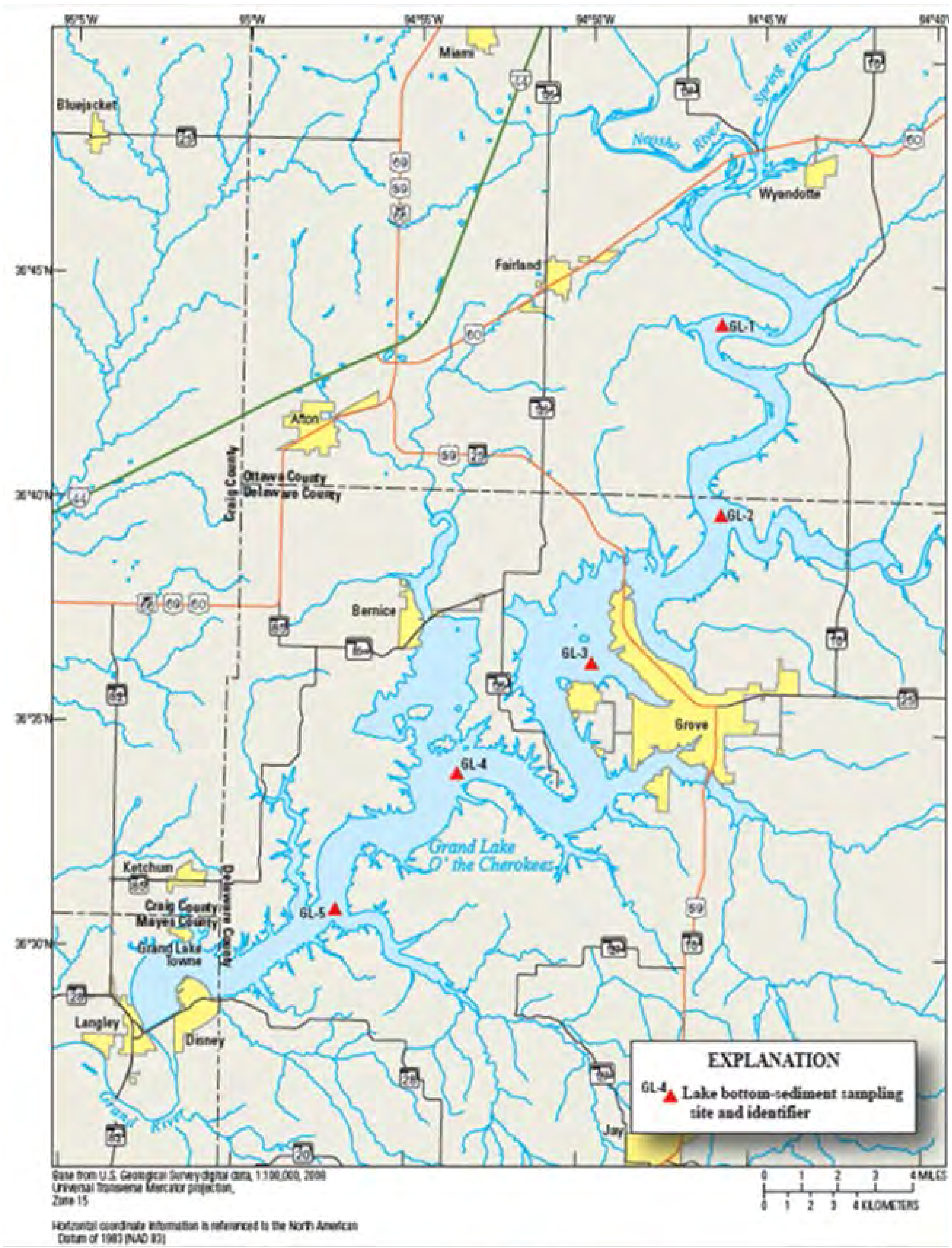


Figure 12 Location of 2007 Grand Lake Core Sampling Stations

Base map from ArcGIS online services, ESRI, 2009, Redlands Calif.
Inset map from Juracek and Becker (2009).

In addition to the above efforts, in 2007 the U.S. Geological Survey (USGS) collected cores and bottom sediment sample grabs from the northern half of Grand Lake (Figure 12). Of the collected samples, sections from five cores and 15 composite grabs were analyzed for metals (Fey et al. 2010). Key findings from this study include the following:

- The distribution of zinc in reservoir bottom sediments (including grabs and composites of the upper subsections of cores) "shows a general elevation of zinc in those drainages affected by historical mining operations," in particular having concentrations almost 10 times the local background. In terms of distribution, "zinc is fairly evenly distributed at the surface", present in lower concentrations where there are areas of enhanced local terrestrial sedimentation.
- Cadmium concentrations in bottom sediments was enhanced by a factor of about 8 on average, while lead levels were increased on average by approximately a factor of 2.6.
- One of the five cores was collected at a location expected to represent local background concentrations of sediments (i.e., to be unaffected by Tri-State mining activities). One core, 300 cm deep, from the Neosho River above the reservoir, had surface samples at near-background levels; however, as depths increased, so did levels of zinc, lead, and cadmium. The other three cores appear to have penetrated below mining-affected sediments. Core GLOC-3, collected in the Spring River above the reservoir, had elevated metals levels at the surface that increased to depths of roughly 100 cm; however, at 145 cm and below, concentrations were closer to crustal abundance levels. Core GLOC-7, collected in the reservoir about 3.5 km downstream from the confluence of the Neosho and Spring Rivers, showed affected sediment down to a depth of about 85 cm (33 inches), below which mining-related metals were similar to local background levels. Core GLOC-8's location near Twin Bridges State Park was selected to represent a possible mixing zone of sediments from the Neosho and Spring Rivers; however, analysis suggests that contributions from the Spring River likely contributed more. Metal concentrations were significantly higher than crustal abundance levels for much of the core; however, in the bottom three depth intervals (i.e., 65-75 cm), metal concentrations approached background.

<u>Fish</u>

Two studies have analyzed the concentration of metals in fish collected from Grand Lake. Aggus et al. (1987) and ODEQ (2007). The earlier study also assessed the impact of heavy metals on fish species diversity and community structure in Tar Creek, Spring River and the Neosho River. Results from the study indicated impacts to benthos and fish in Tar Creek, but no significant effects on fish in the Neosho River. The authors also concluded that discharges of metals from Tar Creek did not have a significant impact on "species composition, standing crop, or functional (trophic) interactions in the fish community of Grand Lake" (p. 39). Data from this study also indicate that metals concentrations are higher in fish livers than in other tissues and that overall concentrations in fish are higher in areas where the highest levels of metals were found (i.e. Tar Creek and Spring River). However, the distribution of metals by trophic habitat indicate that biomagnification is not an issue in Grand Lake; levels are higher in detritvores and planktivores than in predatory fish species.

Whereas Aggus et al. (1987) explored community structure and trophic organization, ODEQ (2007) focused exclusively on metals content of fish in the Grand Lake watershed in order to assess the risk of human health impacts through consumption. The study was conducted in response to local residents' concerns. As discussed previously, local Tribes consume fish from Grand Lake for subsistence and may be more likely to consume whole fish for ceremonial purposes, which has important implications for health effects due to the concentration of heavy metals in bones and other portions of the fish that are not typically consumed. The results of ODEQ (2007) indicated that non-game fish from Grand Lake contain lead concentrations sufficiently high for ODEQ to issue a consumption advisory for certain species of fish prepared whole. (Further information about this advisory is presented in Chapter 3). ODEQ (2007) estimated mean concentrations of 0.26 ppm lead, <0.05 ppm cadmium, and 15.1 ppm zinc in carcasses of non-game fish (defined to include carp, freshwater drum, redhorse sucker and smallmouth buffalo) collected from Grand Lake.

CHAPTER 3 | SUMMARY OF INJURY EVALUATIONS

This chapter summarizes the results of Grand Lake natural resource injury analyses undertaken by Trustees to date and may be updated as additional information becomes available.

3.1 Surface Water - Sediments

Injury to sediment occurs when concentrations of a contaminant in sediment are sufficient to cause adverse effects to biota (43 CFR § 11.62 (b)(1)(iv-v)).

Macroinvertebrates represent a key and highly diverse community of aquatic animals. They live on and in sediments, and also on debris, rocks, and aquatic plants (macrophytes).[8] This group of animals includes some species that may be more familiar such as crayfish, mussels, and snails, as well as aquatic worms, immature (larval) forms of certain insects, and many other species.

Potential injury to benthic macroinvertebrates is of concern to the Trustees not only for their own sake but also because of the importance of these animals to the health of the aquatic community as a whole. Macroinvertebrates are a major food source for many fish at least during some parts of their life cycle (Diehl and Kornijów 1997). Duckling diets also consist in large part of aquatic invertebrates, and the abundance of aquatic invertebrates has been linked to mallard duckling growth and survival (Cox et al. 1998). Some riparian birds eat the adult forms of the insects that spend the larval portion of their lifecycle in the water.

Comparisons with Sediment Quality Guidelines

One way to evaluate potential injuries is through the use of sediment quality guidelines (SQGs). SQGs are contaminant concentrations that have been associated with some degree of adverse impacts to organisms, typically benthic invertebrates. SQGs differ in their derivation and purpose; furthermore, some are site-specific whereas others are intended to have a broader applicability. All else equal, site-specific values are preferable, when available.

MacDonald et al. (2009) developed site-specific sediment thresholds for the Tri-State Mining District. In particular, concentrations of metals were identified that are predicted to reduce the survival of the amphipod *Hyalella azteca* by 10 percent or more: zinc (2,083 ppm), lead (11.1 ppm) and cadmium (150 ppm).

Figure 13 indicates the proportions of samples from the 2007-2008 collections that exceed each of these SQGs. Exceedances are present in 10-20% of the core sections collected by USGS in 2007, suggesting that in the past, impacts to benthic invertebrates may have been more likely in some parts of the lake.

[8] Those that live primarily on plants are often referred to as epiphytic macroinvertebrates rather than benthic (sediment-dwelling) macroinvertebrates. Some macroinvertebrates live both on sediments and on plants.

Figure 13 Summary of Grand Lake Sediment Threshold Exceedances

sampling effort	% of samples exceeding threshold		
	Cadmium	Lead	Zinc
Site-specific threshold (ppm) from MacDonald et al. (2009)	11.1	150	2,083
Phase I sampling, surficial sediments[a]	2%	0%	0%
Phase III core sampling[b]	0%	0%	0%
USGS 2007 surficial sediments[c]	5%	0%	0%
USGS 2007 core sections[c]	19%	10%	9%

Notes:

(a) Suzanne Dudding, USFWS, Tulsa OK; personal communication; also see Jones and Donlan (2000).

(b) Juracek and Becker (2009). The count figure represents the total number of sections evaluated across five cores (10 sections/core were generated). The presented concentrations for lead and zinc represent XRF measurements, whereas values for cadmium represent results from spectroscopic methods, as cadmium concentrations fell below the XRF detection limit.

(c) Fay et al. (2010). Surficial data represent results from surficial grabs (15) and composites of the top sections of cores (5). Core section data reflect results across the four non-reference cores.

Sediment Toxicity Testing

OWRB and OSU (1995) conducted water toxicity testing and sediment extract toxicity testing using samples collected in 1989 from four stations that spanned the lake's length.

The authors evaluated surface water toxicity to the daphnid *Ceriodaphnia dubia.* They evaluated the toxicity of sediment extracts (extracted under differing pH conditions) to *C. dubia*¸ and also to the daphnid *Daphnia magna*, the amphipod *Hyalella azteca*, and to the fathead minnow (*Pimephales promelas*).

OWRB and OSU (1995) did not generally find evidence of statistically significant toxicity; however, for NRDA purposes, the OWRB and OSU (1995) testing results are limited in several important respects. First, the number of locations evaluated is small, and only one of the four evaluated stations fell in the upper portion of the lake within Ottawa County near the confluence with the Spring and Neosho Rivers. In addition, in the case of the sediment extract exposures, the authors used shorter-term (acute) exposure durations and assessed primarily the survival of the tested organisms, which may be a less sensitive measure of effects than growth and/or reproduction under chronic conditions. In addition, the testing did not utilize whole sediment exposures.

The Trustees therefore undertook a more extensive toxicity assessment of Grand Lake sediments (Ingersoll et al. 2009). Forty sediment samples were collected from the lake, and effects on survival, length, and biomass of the amphipod *Hyalella azteca* were evaluated after a 28-day exposure. The study found mean survival or growth of this amphipod on Grand Lake sediments to be statistically different from reference sediments in only two of the 40 samples. The authors also compared sediment and pore water metals concentrations against several toxicity thresholds from the literature and found these thresholds to be only infrequently exceeded. Even where exceedances were observed, toxicity was observed infrequently. Altogether, the authors conclude that metals levels in the collected Grand Lake sediments "were not likely causing or contributing to toxicity to sediment dwelling organisms" although they note that " … additional analyses are needed to determine if the 40 sediment samples evaluated in the current study represent the spatial and temporal variability of metals or AVS in Grand Lake sediments. Sampling Grand Lake sediments in October may represent a relatively high seasonal concentration of AVS compared to other times of the year. Additionally, the current study did not evaluate bioaccumulation of sediment-associated metals by amphipods. Bioaccumulation of contaminants has been demonstrated to result in injury to fish and wildlife resources at other sites at concentrations lower than is required to injure sediments or sediment-dwelling organisms (e.g., there is a fish consumption advisory for Grand Lake based on concentrations of lead in fish tissues [Oklahoma Department of Environmental Quality, 2007]) (Ingersoll et al. 2009).

Pathway

The term 'pathway' is defined by the DOI NRD regulations to mean "the route or medium through which oil or a hazardous substance is or was transported from the source of the discharge or release to the injured resource" (43 CFR § 11.14 (dd)). Surface water/sediment resources are defined to be injured if concentrations and duration of substances is sufficient to cause injury to other natural resources (43 CFR § 11.62 (b)(v)). As described in subsequent sections of this chapter, Grand Lake fishery resources have been injured by exposure to metals in Grand Lake sediments. Therefore, Grand Lake sediments are injured.

3.2 Surface Water – Water quality

The DOI's natural resource damage assessment regulations provide several definitions of injury to surface waters. One commonly-evaluated injury is that which occurs when "Concentrations and duration of substances in excess of water quality criteria established by section 304(a)(1) of the CWA [Clean Water Act], or by other Federal or State laws or regulations that establish such criteria, in surface water that before the discharge or release met the criteria and is a committed use… as a habitat for aquatic life, water supply, or recreation" (43 CFR §11.62(b)(iii)).

Grand Lake has committed uses, including "public and private water supply, warm water aquatic community, agriculture, municipal and industrial uses, hydroelectric power generation, primary body contact recreation, and aesthetics" (Oklahoma Conservation Commission 2004). The lake has been studied for a number of years with particular respect to eutrophication concerns from point and non-point nutrient (primarily phosphorous) runoff, and different parts of the lake are listed as impaired due to low levels of dissolved oxygen and/or turbidity (ODEQ 2008b).

The lake was at one time listed as being impaired by metals, but the impairment status was revoked because of insufficient data (ODEQ 2002). ODEQ (2002) did note that the absence of a "waterbody-pollutant pair … does not necessarily indicate that the waterbody is no longer impaired." Both the warm water aquatic use of the Neosho River and the cool water aquatic use of the Spring River are impaired by metals (ODEQ 2008b), and these rivers drain into the northern end of Grand Lake.

3.3 Fish

Aggus et al. (1987) evaluated several fish population metrics in Grand Lake and in upstream areas. Sampling locations included two on a reference stream (Fourmile Creek), plus two stations on Tar Creek, four on the lower Neosho River, one on the lower Spring River, one station on Grand River/Lake near the confluence with the Neosho and Spring Rivers, and three coves downstream in the lake itself (Wildcat Hollow, Boy Scout Cover, and Woodard Hollow). The authors found few clear effects, concluding "there was no evidence that discharges from Tar Creek produced significant impacts on species composition, standing crop, or functional (trophic) interactions in the fish community of Grand Lake."

Metals levels in Grand Lake fish are sufficiently elevated that in 2003, DEQ advised the public to limit consumption of whole fish caught in the Spring and Neosho Rivers at the upper end of the lake (OSE 2005), and in 2008, ODEQ issued a fish consumption advisory that includes all of Grand Lake. Residents living in the Tar Creek area are advised not to eat more than six meals per month of non-game fish prepared with bones, and non-residents are advised not to eat more than 11 meals per month of non-game fish prepared with bones (ODEQ 2008a). Non-game fish are culturally significant to the Tribes and include carp, freshwater drum, redhorse sucker, and smallmouth buffalo. This fish consumption advisory constitutes an injury under the DOI's NRDA regulations (43 CFR §11.62(f)(iii)).

The preservation of fish with bones is reported to be a traditional preparation method used by local Tribes (ODEQ 2007). In addition to the cultural significance to local Tribes of both carp and buffalo species, these fish have served as a major subsistence resource for Tribal members. The Trustee evaluation of damages resulting from the Tribal lost fish collections, based on currently available information, is summarized below. Additional information is provided in Appendix B of this RCDP.

3.4 Tribal lost use

In 2009 the Six Treaty Tribes[9] designed and implemented the Tribal Cultural Resource Survey (Garvin 2009) to generate information that can help inform the Trustees' understanding of the nature and extent of impacts. The Peoria Tribe also conducted a similar survey in 2009. The Six Treaty Tribes also designed and implemented an additional Tribal Cultural Resource Survey in 2011 (Garvin et al. 2011). As discussed in more detail in Appendix B, it is clear from Tribal survey data and anecdotal information

[9] The Six Treaty Tribes consist of the Cherokee Nation, the Wyandotte Nation, the Eastern Shawnee Tribe of Oklahoma, the Miami Tribe of Oklahoma, the Ottawa Tribe of Oklahoma, and the Seneca-Cayuga Tribe of Oklahoma.

from Tribal representatives that Tribal use of Grand Lake natural resources has been adversely affected by the presence of mining-related contamination.

Overall, available surveys confirm use of Grand Lake watershed resources on the part of Tribal members, who hunt traditional game, eat traditional foods, gather traditional plants, and practice their culture. The survey(s) also indicates considerable concern on the part of Tribal members with respect to contamination in their traditional hunting and gathering areas. Some individuals continue to pursue these traditional activities while changing the areas used and/or the items gathered and consumed, whereas other Tribal members have reduced their participation in these traditional activities.

The Trustees have evaluated TCRS and other readily available data to estimate the approximate magnitude and potential value of one aspect of Tribal loss -- use of the fish species in Grand Lake subject to the fish consumption advisory. As noted previously, Grand Lake has been subject to a fish consumption advisory issued by the Oklahoma Department of Environment Quality (ODEQ) in 2008. The advisory recommends residents living in the Tar Creek area not eat more than six meals per month of non-game fish prepared with bones and non-residents not eat more than 11 meals per month of non-game fish prepared with bones. The advisory is based on lead levels and applicable to four fish species found in Grand Lake (carp, freshwater drum, redhorse sucker, and smallmouth buffalo). These species are culturally significant. The presence of a fish consumption advisory is an injury under DOI NRD regulations.

Injury quantification – summary of approach

Two types of changes as a result of the metal-driven fish consumption advisory are the focus of the injury quantification and damage estimation presented in this RCDP for Tribal Lost Use: 1) degraded fish collection experiences in Grand Lake by Tribal members; and 2) reduction in fish collection trips to Grand Lake. In particular, the RCDP presents approximate estimates of lost value, measured in present value dollars, associated with these two changes. The estimate of lost value is based on an estimation of the numbers of trips in each category (degraded quality and reduced number), multiplied by per-trip valuation figures documented in the natural resource economic literature for other, similar sites. This approach is typically referred to as the 'benefits transfer' method for estimating damages.

Before describing the injury quantification and damage estimation approach in more detail, it is essential to acknowledge that for Tribal Trustees, the damage estimates presented are approximate and could substantially underestimate actual damages, for several reasons:

1) Per-trip valuation estimates available in the technical literature typically are generated in the context of recreational fishing by members of the general public, and do not focus on Tribal resource users. Such values do not reflect the integral role that hunting/ gathering activities play with respect to Tribes' social identity, cultural integrity, and spiritual lives. Nor do they likely capture the full

value of resources gathered for subsistence purposes, which is an important resource use for many Tribal members;

2) Potentially relevant valuation studies typically provide value estimates on a ‘per-trip’ basis, using measures of travel cost to alternative sites to reveal the values the public holds for participating in these activities. Representatives of the Six Treaty Tribes and the Peoria Tribe indicate that Tribal cultural practice emphasizes sharing of hunted and gathered natural resources with family members (local and non-local), Tribal elders, and with the broader community (e.g., at feasts). Thus, benefits from the hunting/gathering of natural resources extend beyond the individual(s) taking the ‘trip’. Food sharing has been repeatedly documented as core socioeconomic practice among native peoples to the present day (e.g., Collings et al. 1998, Enloe 2003). The 2011 Tribal Survey, for example, confirms consumption of fish by children of Tribal members who fish in Grand Lake. Because studies readily available for transfer purposes only capture a portion of the benefits to direct activity participants, the approach inherently underestimates their value to Tribes as a whole; and

3) Trips taken by children are not explicitly included in this analysis, largely because estimated adult trip values from relevant literature can incorporate values to accompanying children and we were unable to identify studies of child values appropriate for benefits transfer in the context of this analysis. Nevertheless, 2011 Tribal Survey information confirm that children (defined in this document as people younger than 18 years of age) are frequent participants in fishing trips to Grand Lake, and these trips likely have additional value not captured by loss estimates due to the cultural importance of intergenerational coherence and the opportunity to pass on traditional knowledge and practices, ensuring future continuity of Tribal culture.

These limitations are discussed in more detail in Appendix B of this RCDP. Nevertheless, this approach provides some quantitative understanding of the magnitude of potential damages to the Tribes using readily available information, and in the Trustees’ view provides a reasonable, lower-bound estimate of loss.

This RCDP separately quantifies Tribal use losses in two categories, reflecting related but different types of loss and valuation considerations:

1. Losses experienced by Tribal users of Grand Lake resources who continue to use injured fishery resources suffer a degraded experience due to the presence of natural resource injuries; and

2. Losses experienced by Tribal members who have either reduced or eliminated their usage of injured Grand Lake fishery resources due to the presence of natural resource injuries.

Trustee analysis of readily available information suggests that 58,630 trips are taken annually to Grand Lake by adult Tribal members to collect fish subject to consumption advisories. These trips are associated with the first category of loss identified above.[10] With respect to the second category of loss, the Trustees assume an annual loss of 3,000 trips to Grand Lake.

The loss in value that Tribal members experience due to the presence of contamination when trips are taken, and the loss in value when trips are foregone, represent not simply a loss of a recreational activity or food source, for which substitutes are typically readily available; rather, these losses run much deeper, as they relate to culture, heritage, social connections, intergenerational continuity, and spiritual life. In short, it is difficult to appreciate traditional or subsistence losses in the same conceptual framework that is applied in a recreational context. The notion of a willingness to pay or accept in monetary terms for changes in fishing access or quality may not be consistent with Tribal culture.

Grand Lake is an important Tribal fishing subsistence and cultural resource, and the presence of consumption advisories has discouraged traditional uses and reduced the value of ongoing uses. For purposes of this RCDP, it is necessary to value these losses, and to that end, this RCDP relies on values developed for recreational fishing and for the broader population. These values are used not because they are especially suitable but because they are the most suitable values presently available.

Losses Arising from Continued Use of Injured Fish Species

Acknowledging the important caveats discussed earlier, and considering potentially relevant technical literature, this RCDP utilizes a per-trip reduction estimate of $4.10 (2014$), which is slightly less than the mean across three studies judged to be most comparable (Jakus et al. 1997 and 1998, and Parsons et al. 1999).[11] As noted previously, for purposes of this RCDP, this estimate reflects the *minimum* per-trip loss experienced by Tribal subsistence users who continue to fish in Grand Lake despite the presence of the fish consumption advisory.

Losses Arising from Forgone Trips

The 2009 TCRS and 2011 TCRS indicate that Tribal members have diverted trips to other locations and/or simply not taken trips. To estimate the total value of a fishing trip in the assessment area, we searched the economics literature for additional valuation studies addressing sites with similar attributes (while again noting that this literature is subject to the same types of caveats and limitations mentioned previously for purposes of the Tribal lost use).

Relatively few studies of the value of Oklahoma warmwater fishing opportunities exist. McCollum et al. (1990) utilize data from the Public Area Recreation Visitor Survey (PARVS) to estimate a random utility travel cost model. The authors report an estimate

---

[10] 58,630 annual trips = 45,630 'local' annual trips + 13,000 'non-local' annual trips.

[11] While the studies differ considerably, the estimates are more likely to underestimate than overestimate losses to anglers. This is because the studies generally report average losses or gains per trip and changes in avidity for all anglers in the sample. Thus, these averages include anglers who visit contaminated sites and anglers who do not. Of the two groups, the anglers who visit the contaminated site will likely suffer the greatest losses.

of $20 (adjusted to 2014$ via the GDP Implicit Price Deflator) per fishing day in Forest Service Region 8 (which includes OK). Aiken and LaRouche (2003) provide values by state based on contingent valuation questions included in the 2001 National Survey of Fishing, Hunting and Wildlife-Associated Recreation. They report a value of $43 per day ($2014) for bass fishing in OK. Fisher et al. (2002) utilize the results of a telephone survey to develop a travel cost demand model for trips to eastern OK streams and rivers. They estimate a per-trip value of $12. Finally, Bennear et al. (2005) estimate a fishing access demand model based on license sales data to derive a per-day value by state. They report an average per-day value from 1975-1989 of $26 ($2014) for OK. Though these studies may not match exactly fishing conditions on Grand Lake, they provide a range of estimates that likely bound the value a primary study would reveal. Considering these four studies, we utilize a per-day value of $24.40, the approximate average of the four studies.

Injury timeframe

Finally, to estimate damages it is necessary to assume a time period over which the damages occurred. Because the fish consumption advisory was first promulgated in 2008, this RCDP estimates damages beginning in that year. Contamination certainly was present in Grand Lake for decades prior to the promulgation of this advisory, and it is unlikely that overall contamination levels were lower in the past (e.g., as indicated by higher concentrations of metals in sediments at depth). However, this RCDP conservatively estimates damages beginning in the year that injury, pursuant to the DOI NRDA regulations, occurred—the year the fish consumption advisory was issued (43 CFR § 11.62(f)(iii)). The Trustees calculate damages through 2027 and 2037, assuming that a fish consumption advisory will remain in place for 20 to 30 years after its establishment in 2008. Because of the propensity of metals to adsorb to particles, the slow movement of sediment through the aquatic system, and the fact that metals do not readily degrade, contaminants such as cadmium, lead, and zinc typically have a long residence time in aquatic sediments. While lead and zinc depositional profiles indicate that concentrations in the bottom sediment of Grand Lake have decreased since about the 1980s (Juracek and Becker, 2009), natural burial processes in the lake are slow. In the absence of actions to remove contaminated sediments, fish consumption advisories are likely to remain in place for multiple decades.

It should be noted that at this time, EPA does not have an Operable Unit identified for Grand Lake nor is any other remedial activity anticipated. While the Trustees have proposed “hot spot” primary sediment restoration of some areas in the lake (see Alternative 5 discussed in this document), the scale of these actions is modest relative to the size of the lake. The Trustees believe that calculation of damages through 2027 and 2037 reasonably reflects the above circumstances.

Tribal Cultural Damage

Overall, minimum estimated losses are between approximately $5.8 and $7.6 million (2014$). The Trustees characterize these results as ‘minimum’ valuation estimates because of the use of several assumptions that the Trustees believe are conservative. In particular, the Trustees note that this analysis does not apply a premium to trip values, to reflect the higher values Tribal members may place on culturally-related fishing activity, relative to the recreational anglers from which the value estimates are derived.

3.5 Other lost use

The presence of fish consumption advisories likely has adversely affected recreational angling in Grand Lake by non-Tribal populations, and potentially other recreational activity at the lake. However at this time, the Trustees have not pursued the number of non-Tribal trips affected and/or forgone. The Trustees reserve the right to collect and evaluate such information and revise this RCDP accordingly.

CHAPTER 4 | RESTORATION ALTERNATIVES

4.1 Introduction

As noted in Chapter 2, releases of hazardous substances (cadmium, lead, and zinc) have occurred in upstream areas, and these contaminants have entered Grand Lake through the Spring and Neosho Rivers. The Trustees believe that these releases have injured the lake's natural resources. 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 sediments water can provide habitat services–*i.e.*, a place to live–for aquatic organisms. Sediments also provide foraging opportunities, another kind of ecological service, for animals that eat benthic organisms. Examples of human use include recreational and subsistence fishing. The Trustees are required to use all natural resource damages recovered from responsible parties to restore, rehabilitate, replace, and/or acquire the equivalent of the injured natural resources and their associated services.

To that end, the Trustees have identified a number of potential restoration alternatives. These alternatives were selected to generally address the kinds of ecological and human-use services that the Trustees believe have been impacted by releases of hazardous substances from mining operations. Prior to implementation of any restoration project, the Trustees will publish a site-specific Restoration Plan which will discuss in further detail possible restoration projects and the selection criteria.

To best match restoration projects to associated injuries, many of the restoration alternatives described in this RCDP are intended to be applicable to Grand Lake. However, the Trustees recognize that adequate opportunities for restoration activities may not be fully available at the lake and may pursue restoration projects in other areas, with a preference for projects in Oklahoma within the Grand Lake watershed. The restoration alternatives discussed in this RCDP are explicitly not intended to replace or duplicate efforts undertaken by any other organization.

The discussion of alternatives below begins with the "no action" alternative. Then, the preservation-based alternatives are presented, followed by a variety of other restoration projects. The order in which alternatives are presented is not intended to reflect Trustee preferences.

4.2 Aquatic Restoration Alternatives

Alternative 1: No Action

Under this alternative, the Trustees 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 ODEQ but would not include additional activities aimed either at reducing contamination, reducing potential exposure to contaminants, or enhancing ecosystem biota or processes.

Alternative 2: Preserve grand Lake Buffer

This alternative aims to preserve those stretches of higher quality habitat adjacent to Grand Lake. To help ensure adequate buffering capacity of the preserved areas, the

Trustees prefer 300 foot corridors (on each side of the lake) in width, but will accept less protective corridors of 100 feet in width. 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. Occasional flash-grazing or timber removal may be appropriate for wooded riparian buffers, to encourage understory development and stimulate younger plants.

Specific locations for the preservation of high quality Grand Lake buffer habitat have not been identified. However, as part of its management responsibilities, the Grand Lake Dam Authority has prepared a shoreline management plan (GRDA 2008) that includes shoreline management classifications (SMCs) for the lake. The classification categories include areas designated for 'wildlife management', for 'stewardship', and for 'responsible growth', among others. For purposes of this RCDP, areas designated as 'wildlife management' or 'stewardship' are likely subject to strong protection as part of the GRDA's management of the lake and unlikely to be developed. However, areas targeted for 'responsible growth' may become developed, and the increasing popularity of the lake suggests that development pressure may be significant. Some of these areas contain palustrine wetlands not included in the stewardship SMC, and/or may have other features consistent with the general priorities described above for habitat preservation, and may be targets for preservation under this RCDP.

Alternative 3: Preserve High Quality Riparian Corridors

Similar to Alternative 2, this alternative aims to preserve those stretches of high quality riparian corridor that remain within the Oklahoma portion of the Grand Lake watershed. 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 agriculturally-impacted areas as well as stabilize existing near stream areas that have easily erodible soils and degrade stream quality. The protection and enhancement of the riparian corridors will promote the health of aquatic organisms in Grand Lake.

Specific locations for the preservation of high quality Grand Lake buffer habitat have not been identified, but the methods used to identify candidate parcels for preservation would be similar to those described for Alternative 2 above. In particular, the Trustees' approach would be to prioritize for preservation those parcels that are of the highest quality. The Trustees 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. The Trustees prefer 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 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 instance, fencing of some parcels may be necessary to keep out cattle. Occasional flash-grazing or timber removal may be appropriate to encourage understory development and stimulate younger plants. 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.

Specific locations for the preservation of high quality riparian habitat have not been identified. The GRDA's shoreline management plan (GRDA 2008), however, includes shoreline management classifications (SMCs) for portions of the Spring and Neosho Rivers that fall within its area of responsibility. Because areas designated as 'wildlife management' or 'stewardship' are considered to be likely to be subject to strong protection as part of the GRDA's management of the lake, these are not generally considered to be targets for preservation under this RCDP. In contrast, properties targeted for 'responsible growth' may be developed, and some of these areas contain palustrine wetlands not included in the stewardship SMC, and/or may have other features consistent with the general priorities described above for habitat preservation, and may be targets for preservation under this RCDP. The Trustees may also consider parcels adjacent to waterways outside of the GRDA's area of authority but within the watershed, which includes 389 stream miles (AMEC 2007). Parcels within Oklahoma are strongly preferred over those in neighboring states.

Alternative 4: Improve Riparian Buffers

Riparian buffer areas next to waterways provide a variety of valuable ecological services. Not all waterways in the Grand Lake watershed have high quality riparian buffer or have adequate riparian buffer areas: some riparian buffers are of low quality or are eroding, and other areas effectively have no riparian buffer at all. This restoration alternative, therefore, includes: the purchase of land or easements on land next to waterways that provide service to Grand Lake, creation of high quality riparian buffer ecosystem, and monitoring and maintenance of the restoration project site. Prior to selecting any particular site for restoration, the Trustees would test site soils to ensure they would not be creating an attractive nuisance to animals or a pathway of potential exposure to the public, including, in particular, Tribal members.

The specific restoration approach for a particular site will depend 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 specific treatment needed (and thus, costs) would depend in part on the desired habitat type and 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.

To maximize species richness, seed mixes should be of high quality and diversity, with a full complement of species (Robertson 1996). The Trustees anticipate that the seed mix in this alternative would include at least half a dozen warm grass species, and in excess of 15 forb species. The Tribal Trustees may add seeds for culturally significant plants to enhance the mixture and provide replacement of lost Tribal Services. 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).

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. The Tribal Trustees may plant culturally significant species to enhance the diversity and provide replacement of lost Tribal Services. 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 restored grasslands, 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. 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). For wooded corridors, occasional flash-grazing or timber removal may be appropriate.

For both grassy corridors and woody areas, fencing is important 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. 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.

<u>Alternative 5: Dredge selected areas within grand lake</u>

Grand Lake has been identified as a sink for the metal-contaminated sediments transported by the Neosho and Spring Rivers (OWRB and OSU 1995). Metals levels in lake sediments are sufficient to have resulted in the establishment of fish consumption advisories for several species of fish in the Lake. Metals levels in lake sediments are significantly higher towards the northern end of the lake, where these rivers join it (OWRB and OSU 1995).

This restoration alternative entails dredging the more contaminated portions of the lake. However, several key aspects of this alternative, including the timing of lake dredging, its extent, and location, cannot yet be definitively determined. As part of the Superfund program under CERCLA, the USEPA is currently investigating the numerous creeks and streams upstream of Grand Lake that drain areas heavily impacted by historic lead-zinc mining, including the Neosho and Spring Rivers. [12] If necessary, EPA will then plan and implement measures to cleanup or remediate these rivers and creeks (e.g., sediment removal or capping) to mitigate the risks to human health and the environment. Further, natural resource trustees for the Tri-State Mining District may undertake measures to restore the aquatic habitat and level of ecological service (e.g., additional sediment removal, protection and enhancement of riparian corridors, and fish and mussel propagation) provided by these creeks and streams.

Because upland mine wastes are being addressed first and surface water and sediments are still in the very early stages of characterization, it will likely be several decades before the upstream creeks and streams are addressed. In the meantime, metal-contaminated sediments will continue to migrate to and accumulate in Grand Lake until remediation and/or restoration of these upstream creeks and rivers is complete. Further, in-stream remedial activities may result in the abrupt, short-term release of contaminated sediments (e.g., by uncovering or resuspending contaminated sediments during dredging operations). As a result, the aquatic and cultural habitats in Grand Lake are and will continue to be threatened over an extended period of time. Dredging of Grand Lake prior to the development (and, likely, the implementation) of a plan to address ongoing upstream sources of metals into the lake, would not likely be cost effective. Additional data characterizing the spatial distribution of metals contaminants in northern Grand Lake and/or Oklahoma portions of the Spring and Neosho Rivers, is also necessary.

With these considerations in mind, the specific timing of sediment removal events will be determined by the Trustees at a later date; however, for purposes of preliminarily estimating the costs of this alternative in this RCDP, dredging of Grand Lake sediments under in this alternative is assumed to commence in 2030.

The extent of Grand Lake dredging is also uncertain. Gravel bars or natural depositional areas located along curved portions of the shoreline near or downstream of where the

[12] Operable Unit (OU) 5 of the Oronogo-Duenweg Mining Belt Site (Jasper County, Missouri) addresses contaminated surface water and sediments in the perennial streams (Spring River and its major tributaries including the North Fork of the Spring River, Center Creek, Turkey Creek, Short Creek, and Shoal Creek). Investigation of water and sediment quality and the toxicity of stream sediments is ongoing. Final cleanup decisions will consider the effectiveness and completeness of upland mine and mill wastes (USEPA, Five-Year Review Report, Oronogo-Duenweg Mining Belt Site, Jasper County, Missouri, September 2007).

OU-2 of the Cherokee County Site (southeastern Kansas) addresses the Spring River Basin. Characterization work was conducted from 2004 through 2007 and results related to the selection of appropriate clean up criteria were released in 2009 and 2010. A floodplain soil characterization study began in 2009 and is ongoing (USEPA, Cherokee County Site Status Summary, May 21, 2012, as viewed at www.epa.gov/region7/cleanup/npl_files/ksd980741862.pdf on August 13, 2012).

OU-5 of the Tar Creek Site (Ottawa County, Oklahoma) addresses contaminated sediments in Elm Creek, Tar Creek, and the Neosho River upstream of Grand Lake (USEPA, Record of Decision, Operable Unit 4, Tar Creek Superfund Site, February 20, 2008, pp. 6-7). Characterization of sediments and surface water throughout the Spring and Neosho River basins is ongoing (USEPA, Tar Creek Site Status Summary, July 17, 2012, as viewed at http://www.epa.gov/region6/6sf/oklahoma/tar_creek/index.htm on August 13, 2012).

Neosho and Spring Rivers terminate and upstream of the where the lake becomes markedly wider may be good, accessible candidate areas for sediment removal. However, currently available data is insufficient for the Trustees to identify specific areas where sediment removal should be undertaken, or the depths to which sediments should be removed.

For planning purposes the Trustees assume that approximately 20,000 cubic yards of sediment would be removed during each removal event, either through the use of an in-water barge-mounted dredge or an excavator located along the shoreline, depending on where the sediments targeted for removal are located and other accessibility factors. [13] For planning purposes the Trustees assume that after an initial removal event in 2030, dredging would be repeated every five years thereafter for the next 20 years. [14]

The Trustees assume that a local repository would be constructed nearby to accept the removed sediments, consistent with the disposal method selected for upland mine and mill wastes removed from the Tar Creek Superfund site. During sediment removal operations, water treatment, water quality monitoring, and quality assurance activities would be undertaken to mitigate the adverse effects of residuals that may be generated. The removed sediments would be solidified and hauled by truck for disposal in the repository. In the event an excavator and other heavy equipment are used at the lake shoreline, the affected shoreline would be restored and revegetated. Finally, following the completion of the last removal event in the year 2050, a soil cap will be placed on the repository, contoured to promote drainage, and vegetated, with maintenance of this cap continuing for another 20 years.

<u>Alternative 6: Native aquatic plant establishment</u>

For most of its existence, Grand Lake has not supported a significant aquatic plant (macrophyte) community, although native macrophyte communities can enhance the ecological functioning of freshwater lakes and reservoirs in a variety of ways. The Oklahoma Water Resources Board has recently undertaken a study to evaluate the potential for establishing native aquatic plants in the lake (OWRB and LAERF 2007). This coverage goal is likely to be well within the lake's capacity to support aquatic vegetation: Duarte et al. (1986) developed an empirical relationship between lake size and the area of the lake that is covered by submerged or emergent macrophytes. Using their equations,[15] a lake the size of Grand Lake might be expected to support roughly 6,400 acres of submergent vegetation and 3,400 acres of emergent vegetation, or 9,800 acres of macrophytes altogether.

---

[13] Assuming a removal depth of 1.5 feet, 20,000 cubic yards of sediments would entail a total area of about 360,000 square feet or 8.2 acres.

[14] According to the Record of Decision for OU-4 for the Tar Creek Superfund site, the first phase of remedial activities, which includes the removal, sale, and disposal of mine and mill wastes and in-stream source materials, is expected to take place from 2009 through 2023 (USEPA, Table 11, Estimated Costs for Alternative 5, Record of Decision, Operable Unit 4, Tar Creek Superfund Site, February 20, 2008). The removal of mine and mill waste in distal areas, where access has been granted, started in January 2010 (USEPA, Remedial Action Activities Update, Tar Creek Superfund Site, Operable Unit 4, July 2011).

[15] In particular, we use equations (1) and (8) from Duarte et al. (1986).

The feasibility study planted twelve acres of plants across 10 sites within Grand Lake (OWRB and LAERF 2007). The study tested 25 native plant species, including 12 emergent species, three floating-leaved species, and 10 submersed species. Three years after the initiation of the plantings, the study concluded that founder colonies of a number of species had been established at many of the sites. The establishments were most successful for certain plants at certain elevations (e.g., emergent species between 742 and 744 msl[16], and submersed plants between 740 and 741 msl), and when herbivores (e.g., small turtles) were successfully excluded from the initial planting areas (OWRB and LAERF 2007).

Although OWRB and LAERF (2007) determined that establishing macrophytes in Grand Lake is technically feasible, the opportunity exists to build on past work to more rapidly build the lake's macrophyte population, and to ensure its continuity into the future.

In particular, after establishment of the cages and putting in the initial plantings, unusual high water events resulted in overtopping of the cages designed to protect against herbivores, leading to vegetation losses. Currently available funding does not allow for as much ongoing monitoring and management of the existing founding colonies as is desirable (e.g., to right cages that have been knocked down, remove herbivores from cages after overtopping events, and replant within empty cages). These kinds of management activities are key to ensuring the founder colonies' long-term survival, and to developing a seed bank that can help regenerate and expand the community (Dr. Gary Dick, LAERF, personal communication 19 February 2009).

In addition to funding monitoring and maintenance activities, an expansion of the initial colony planting effort is appropriate, either by expanding the size of the existing founding colonies, and/or by adding colonies at additional locations in the lake. It is noted that prior to selecting any particular site for restoration, the Trustees would test site sediments to ensure they would not be creating an attractive nuisance.

<u>Alternative 7: Tribal cultural projects</u>

This alternative contemplates partial construction of a local Tribal cultural center, in particular focusing on those components of a cultural center that would support the Tribal communities through the preservation of traditional cultural practices, knowledge, and values. Examples of components of a cultural center that could serve these functions include, but are not limited to: a native plant nursery, a native fish aquaculture program, and a language library.

[16] MSL is a measure of elevation and refers to "mean sea level", measured in feet.

CHAPTER 5 | EVALUATION OF ALTERNATIVES, INCLUDING ENVIRONMENTAL CONSEQUENCES

5.1 Introduction

This chapter presents an evaluation of the restoration alternatives described in Chapter 4. As provided by 43 C.F.R. § 11.82(d), trustees selecting which alternative to pursue evaluate each possibility based on all relevant considerations, including the following:

(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 relationship of the expected costs of the proposed actions to the expected benefits from the restoration, rehabilitation, replacement, and/or acquisition of equivalent resources;

(5) The relative cost-effectiveness of different alternatives (*i.e.*, if two alternatives are expected to produce the same or 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 additional injury to the environment if the alternative is implemented;

(8) Potential effects on human health and safety;

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

(10) Compliance with applicable Federal, State, and Tribal laws; and

(11) Consistency with relevant Federal, State, and Tribal policies.

Superior projects are those that provide 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 entities, as noted.

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.

5.2 Aquatic Restoration Alternatives

Alternative 1: No Action

The No Action alternative is essentially that of natural recovery. The U.S. EPA has not designated an Operable Unit associated with Grand Lake and has not yet issued a Record of Decision (ROD) for cleanup of the Spring River basin (Operable Unit 5 within the Tar Creek Superfund Site), and although the U.S. EPA has issued a ROD for terrestrial remediation within the Tar Creek Superfund Site, full implementation of remedial actions described in that document is expected to take 30 years, and remedial actions within the Spring River basin itself would not be expected to commence until after completion of the terrestrial remediation. Consequently, there is no reason to expect inputs of metals that currently exist in the Spring and Neosho Rivers to decline in realistic timeframes, and the No Action alternative is correspondingly not anticipated to produce significant ecological or other environmental benefits. Current levels of ecological risk and associated environmental injuries are anticipated to continue indefinitely. Incremental costs are anticipated to be zero.

Alternative 2: Preserve grand Lake Buffer

Benefits

The maintenance of the protective buffers provides water quality filtration and other services to the lake. Preservation will also ensure the availability of this ecologically valuable habitat for native flora and fauna. Without preservation, some of these areas may become developed, with residential development representing the most likely scenario. Buffers serve to capture and filter terrestrial runoff before it enters the lake and may be able to serve as access points for Tribal citizens to utilize the lake for cultural fishing practices. 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

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 buffer areas can be successfully maintained in their current state is high. Risks for adverse collateral impacts of this alternative are low. However, the Trustees note that lake buffer 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 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. Property values vary both over space and time, but for purposes of this RCDP the Trustees estimate that the approximate per-acre cost for purchasing these areas is similar to that for high quality riparian buffer areas (i.e., $2,100 to $2,700 per acre (2014$) to purchase, or an easement cost $1,100 to $1,300 per acre).[17] Vegetation management and fencing costs are approximately $3,600 per acre for a 30-year period and $2.00 per linear foot, respectively (2014$). Total restoration costs would therefore be $4,700 to $6,300 per acre, plus fencing at $2.00 per linear foot (2014$).

<u>Alternative 3: Preserve High Quality Riparian Corridors</u>

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 area'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 be developed. Riparian corridor serves to capture and filter terrestrial runoff before it enters streams and may be able to serve as access points for Tribal citizens to utilize the lake for cultural fishing practices. 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 2, the risks of riparian corridor preservation are few. However, the Trustees note that preservation of riparian corridors 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 the Trustees estimate that the approximate per-acre cost for purchasing these areas is $2,100 to $2,700 per acre and that an easement would therefore cost $1,100 to $1,300 per acre (2014$). The Trustees estimate two water wells per stream mile (one well on each bank) at a cost of $24,000 per well or $47,000 per stream mile, in 2014$, including installation, pumps, power, tankage, and maintenance.[18] Depending on whether the preserved corridor is 50 or 300 feet wide, well costs could range from approximately

[17] Estimated land purchase costs provided by Trustees in 2007. Costs were adjusted to 2014$ using House Price Indices for non-metropolitan areas within the State of Oklahoma obtained on-line from the Federal Housing Finance Agency (http://www.fhfa.gov/Default.aspx?Page=87) and forecasted 2013 to 2014 inflation rate (GDP Chained Price Index) from Blue Chip Financial Forecasts (December 1, 2012).

[18] 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. Costs were adjusted to 2014$ using Construction Cost Indices from Engineering News-Record and forecasted 2013 to 2014 inflation rate (GDP Chained Price Index) from Blue Chip Financial Forecasts (December 1, 2012).

$700 to $3,900 per acre. [19] Long-term management and fencing costs are about $3,600 per acre (present-value over a 30-year time period), and $2.00 per linear foot (2014$), respectively. Total costs therefore range from $5,400 to $10,200 per acre, plus fencing at $2.00 per linear foot (2014$).

Alternative 4: Improve Riparian Buffer

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, the Trustees note 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 the Trustees estimate that the approximate per-acre cost for purchasing these areas is $2,100 to $2,700 per acre and that an easement would therefore cost $1,100 to $1,300 per acre (2014$). The Trustees estimate riparian buffer improvement costs of $1,100 per acre (2014$), including site preparation, tree plantings, herbicide treatments, and invasive plant and brush management.[20] Vegetation management costs are approximately $3,600 per acre for a 30-year period (2014$). If necessary, the Trustees estimate two water wells per stream mile at a cost of $24,000 per well (or $47,000 per stream mile in 2014$), 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 $700 to $3,900 per acre. Total restoration costs are therefore approximately $6,500 to $11,300 per acre (2014$), including easement or land purchase costs, plus fencing at $2.00 per linear foot.

---

[19] 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 $47,000 per mile for wells, this becomes about $3,900 per acre (i.e., $447,000 multiplied by 0.0825 miles).

[20] Riparian buffer improvement 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). Costs were adjusted to 2014$ using Construction Cost Indices from Engineering News-Record and forecasted 2013 to 2014 inflation rate (GDP Chained Price Index) from Blue Chip Financial Forecasts (December 1, 2012).

Alternative 5: Dredge selected areas within grand lake

Benefits

Dredging portions of the lake would result in the removal of a large quantity of contaminated sediments from the Grand Lake ecosystem. Furthermore, this alternative is the only alternative that would directly address the presence of contaminants in the ecosystem. In the long run, this alternative is likely to result in a healthier biological ecosystem, where benthic organism productivity was less impaired by the presence of metals at toxic concentrations. It may reduce the length of time for which fishing advisories are in place.

Risks

Dredging would result in the removal of sediments from the targeted areas of the lake. The short-term negative effects to the existing lake biota would likely be significant, inasmuch as the dredging results in removal of both habitat and the associated benthic organisms. It is difficult to predict the amount of time required for full benthic recovery after the completion of dredging. In general, benthic recovery may take between 2 and 10 years, and may be on the lower end of this range if refugia for benthic organisms exist in nearby areas (Korsu 2004, Muotka et al. 2001), and if changes in substrate type after dredging can be avoided (Bolton and Shellberg 2001). However, at some sites researchers have found full recovery to require considerably longer periods of time (e.g., Haynes and Makarewicz 1982).

Dredging operations inevitably result in some resuspension of targeted sediments and releases of contaminants associated with the sediments (NRC 2007). It is therefore important that dredging projects include monitoring combined with engineering performance standards and best management practices to minimize releases and the associated risks (NRC 2007). Furthermore, all dredging projects leave a fraction of the targeted sediments behind (residuals) (NRC 2007).

Dredging on the proposed scale would necessarily 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.

Finally, until upstream measures are taken to reduce metals loads into Grand Lake, the Spring and Neosho Rivers are expected to continue to contribute metal-contaminated sediments to the lake and may require additional dredging over time. The specific timing of sediment removal events will be determined by the Trustees at a later date, based on upstream cleanup developments and any additional data characterizing the spatial distribution of metals contaminants in northern Grand Lake and/or Oklahoma portions of the Spring and Neosho Rivers.

Costs

Using assumptions discussed in Chapter 4 about the timing, extent, and type of dredging, the Trustees estimate a total cost of approximately **$9.9 million,** on a present value basis using a discount rate of 3 percent. Appendix A presents the key assumptions and calculations that support this cost estimate including quantities of sediments removed, water requiring treatment, and repository size. These assumptions are largely based on similar assumptions developed for sediment remedial cost estimates that are provided in detail in the following two documents provided by reference: 1) the 2002 Final Feasibility Study for OU-5 (Green Bay Zone 3A) of the Lower Fox River and Green Bay, which involves the removal of 14,400 cubic yards of PCB-contaminated sediments, and 2) the 2008 Record of Decision (ROD) for OU-4 of the Tar Creek Superfund site, which involves the removal of 18,400 cubic yards of source material (chat) from streams. The cost estimate for the Lower Fox River and Green Bay site provides detail on the various assumptions and cost components relating to the mechanical dredging of a roughly similar amount of sediments from a barge. The Tar Creek ROD provides detail on the various assumptions and cost components relating to the removal of sediments from shoreline and the construction, operation, and closure of a local repository.

Alternative 6: Native aquatic plant establishment

Benefits

The establishment of a thriving macrophyte community in Grand Lake is expected to increase the abundance and diversity of aquatic macroinvertebrates, enhance the ability of the lake to support resident and migratory waterfowl, and to support the lake's fish populations.

Much research has shown that macrophytes have significant effects on the structure and function of lake and reservoir ecosystems (e.g., Cronin et al. 2006, Gasith and Hoyer 1997, Durocher et al. 1984, Bettioli et al. 1993), influencing physical, chemical, and biotic processes (Carpenter and Lodge 1986). Many authors have specifically investigated the effect of freshwater macrophytes on abundance and diversity of invertebrates. Cronin et al. (2006), for instance, found the presence of a native macrophyte community to increase the abundance of major invertebrate taxa in a small Colorado reservoir by 70 to 1725 percent, depending on the invertebrate community type (e.g., copepods vs. gastropods, etc.); considering all taxa, the percent increase was 520 percent. Cowell and Hudson (1967) evaluated benthic invertebrate abundance in a Missouri River reservoir of 28,000 acres in area. The authors found densities in sediments to be nearly twice as high in macrophyte stands compared to bare areas; densities on the plants themselves were approximately 15 times as high as in bare sediments.

Watkins et al. (1983) similarly found vegetated areas in a 12,000 acre Florida lake to support over 2.5 times as many benthic macroinvertebrates as unvegetated areas. Rasmussen (1988) found plant biomass to be a strong predictor of the variance in littoral zoobenthic biomass in the 25,000-acre Lake Memphremagog in Vermont/Quebec. Downing and Cyr (1988) examined ten Montreal lakes and found the abundance of phytophilic (epiphytic) invertebrates in general to be positively correlated with macrophyte abundance. In an experimental manipulation of a pond, Gilinsky (1984) found the presence of plants to increase both species richness and density of most macroinvertebrates.

Macroinvertebrates, in turn, are key components of freshwater aquatic communities, and their abundance, biomass, and diversity are important measures of ecological health. Duckling diets consist in large part of aquatic invertebrates, and the abundance of aquatic invertebrates has been linked to mallard duckling growth and survival (Cox et al. 1998). Mallards are the most abundant duck seen on Grand Lake and are the only dabbling ducks that over-winter on the lake (GRDA 2008). The absence of a significant macrophyte community in Grand Lake may be limiting the lake's utility as an over-wintering and migratory stop for shorebirds and waterfowl (GRDA 2008).

Macroinvertebrates are also primary food items for many forage and sport fish, and many authors have evaluated the relationship between macrophytes and fishery health. For instance, Durocher et al. (1984) examined 30 Texas reservoirs ranging in size from 200 to nearly 90,000 acres. These reservoirs contained submerged vegetation cover at percentages ranging from less than 0.01 percent to approximately 20 percent. The authors found a significant correlation between the percent cover and the standing crop of largemouth bass. Diehl and Kornijów (1997) conclude that both empirical evidence and predator-prey modeling "suggest that increasing the density of submerged vegetation enhances the density of both macroinvertebrates and their fish predators."

The effect of macrophytes on invertebrate and fish assemblages is attributed to a variety of mechanisms, such as providing habitat (i.e., providing a significantly increased surface area for colonization), the stabilization of local sediments, increasing foraging opportunities for macroinvertebrates (by providing surfaces for biofilms to colonize, which are consumed by macroinvertebrates), and by providing refugia (e.g., Carpenter and Lodge 1986, Cronin et al. 2006, Downing and Cyr 1988).

Risks

The primary risks associated with this alternative are: (a) failure of the founding colonies to establish in protected areas, a risk that can be substantially reduced with appropriate long-term monitoring and management, and (b) uncertainty with respect to the speed and extent to which the founding colonies will be able to spread beyond the founding colonies more broadly within the lake. This latter uncertainty is driven by a number of factors including water level fluctuations (which in turn depend on weather patterns and GRDA's operational requirements), the impact of ongoing eutrophication and associated impacts on water clarity, and the amount of grazing pressure from animals such as turtles, fish, and birds.

The Trustees also note that establishing more areas of littoral vegetation will not have any effect on reducing the extent, bioavailability, or toxicity of residual metal contamination in the area.

Costs

Macrophyte planting costs are based on OWRB and LAERF (2007), which reports $375,000 for planting 12 acres of submergent and emergent vegetation in Grand Lake, Oklahoma between 2004 and 2006. In 2014 dollars, this figure is approximately $41,000 per acre.[21] For purposes of this report, it is assumed that these reported costs include project planning and design expenses as well as project construction. In addition to initial planting, this type of project requires active monitoring and maintenance for the first few years as the colonies become established. In particular, post-construction monitoring and maintenance are estimated as 50 percent of project costs for the first three years and as 15 percent of project costs annually for each subsequent year, through 10 years post-construction. Trustee oversight is assumed to be 20 percent of the subtotal of all the above costs, and it is assumed that no land acquisition expenses are required. The total estimated costs for this project are therefore about $175,000 per acre.

Alternative 7: Tribal Cultural Projects

Benefits

Tribal cultural projects have the potential to serve as a community focus, helping encourage Tribal members and potentially the broader public, to learn more about the Tribes' values and cultural practices, enhancing the ability of interested individuals to practice their culture. Tribal cultural projects will help preserve knowledge and artifacts so that these can be passed down to future generations. Projects like an aquaculture program, may be able to help supplement community members' food supplies, to help offset losses associated with reduced fishing in Grand Lake.

Risks

A primary risk associated with this alternative is the extent to which it will be able to effectively compensate for the human use losses associated with reduced use of Grand Lake. Although the Tribal cultural project's purposes include both generation of native fish for Tribal consumption, and preservation of traditional cultural practices, knowledge, and values, the equivalence in human services provided by such a projects will not be an exact match to those that have been lost.

Costs

Costs are estimated based on the estimated extent of economic damages associated with reduced/impaired Tribal fishing losses in Grand Lake. Appendix B describes the approach used to calculate these damages in more detail. Overall, based on the analysis of readily available information, the Trustees estimate that, at a minimum, **$5.8 to $7.6 million** (2014$) should be contributed to the development and operational costs of Tribal cultural projects as compensation for the Tribal lost uses and services that resulted from the Grand Lake fish consumption advisories. The Trustees recognize that data gaps introduce uncertainties into the estimation of the magnitude of monetary loss, but explicitly identify assumptions made and supporting rationales, and believe that on

[21] We use the ENR Construction Cost Index and forecasted 2013 to 2014 inflation rate (GDP Chained Price Index) from Blue Chip Financial Forecasts (December 1, 2012) to inflate past costs into 2014 dollars.

balance, assumptions included in the current analysis are more likely to under- than over-state actual loss.

The Trustees support the use of damages recovered as compensation for Tribal fishing losses to contribute towards the creation and operation of Tribal cultural projects. The Tribes have not developed specific plans or budgets for the cultural projects. Costs for these type of projects range widely, depending on the size and location as well as general design, materials used, and specific features. For context, Appendix C includes summary information for several existing Tribal cultural centers. Facilities included in this list had construction costs ranging from approximately $1 - $15 million. Operational and maintenance costs will also vary considerably depending upon facility specifics. In addition, for context, Appendix D provides a summary of costs that one of the Tribes incurred to build its existing aquatic facility. This facility can propagate fish that could replace or restore injured fish species listed on ODEQ's Fish Consumption Advisory for Grand Lake. The Tribe has not yet developed associated costs of operation and maintenance. The Trustees recognize that the costs in Appendices C & D are for entire Tribal facilities and the Trustees are only allowed to use funds on projects that replace services and not on portions of buildings that have other functions (e.g. daycare, recycling center etc.), however, they are presented for comparison.

5.3 Summary of Impacts by Alternative

The evaluation of restoration alternatives can be framed in different ways. As noted previously, factors considered by the Trustees 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 relationship of expected costs of the proposed actions to the expected benefits from the restoration, rehabilitation, replacement, and/or acquisition of equivalent resources;

(5) The relative cost-effectiveness of different alternatives (*i.e.*, if two alternatives are expected to produce the same or 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 additional injury to the environment if the alternative is implemented;

(8) Potential effects on human health and safety;

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

(10) Compliance with applicable Federal, State, and Tribal laws; and

(11) Consistency with relevant Federal, State, and Tribal policies.

In other words, superior projects are those that provide 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.

Figure 14 provides an overview of the alternatives retained for consideration, highlighting the key benefits and risks of the types listed above. Consistent with NEPA guidance, this figure also notes the potential to impact biological, physical, social, cultural, and economic conditions. This information will be incorporated into the Tar Creek RP/EA.

5.4 Preferred Alternatives

Considering the factors set forth at 43 CFR §11.82(d), the Trustees have designated two restoration alternatives as preferred among those evaluated: Alternative 5 (dredge selected areas within Grand Lake), and Alternative 7 (Tribal cultural projects). Although costly, Alternative 5 is the only alternative that will help reduce the extent of contamination in the lake, and that has the potential to reduce the time for which the fishing advisory will be in place. Alternative 7 represents the best match between the largest contaminant-associated losses identified to date–i.e. reduced/impaired Tribal use—and the likely services provided by the various alternatives. Both alternatives, as described, are technically feasible, take into account anticipated future response actions, are unlikely to adversely affect public health and safety, and are compliant with applicable Federal, state, and Tribal laws and policies.

Figure 14 Restoration Alternatives: Benefits and Risks

No.	Name	Approx. Costs	Ecological / Human Use Benefits	Ecological / Human Use Risks
1	No action	None	• None	• No substantial improvement in environmental conditions.
2	Preserve Grand Lake buffer	$4,700 - $6,300 / acre	• Enhanced water quality through filtration of runoff. • Avoids loss of habitat for shoreline flora and fauna. • Potential to provide lake access and for traditional uses of native flora/fauna.	• No effect on the extent, bioavailability, or potential toxicity of existing metals in the lake.
3	Preserve high quality riparian corridors	$5,400 - $10,200 / acre	• Enhanced river water quality through filtration of runoff; potential for prevention of future erosion. • Avoids loss of habitat for shoreline flora and fauna. • Potential to provide waterway access and for traditional uses of native flora/fauna.	• No effect on the extent, bioavailability, or potential toxicity of existing metals in the lake.
4	Improve riparian buffer	$6,500 - $11,300 / acre	• Enhanced river water quality through filtration of runoff; potential for erosion reduction. • Increases availability of high quality habitat for shoreline flora and fauna. • Potential to provide waterway access and for traditional uses of native flora/fauna.	• No effect on the extent, bioavailability, or potential toxicity of existing metals in the lake.
5	Dredge selected areas within Grand Lake	$9.9 million	• Reduces metals in the sediments of the dredged areas and thus the potential for toxicity from these metals.	• Impacts to benthos in dredged area. • Potential for impacts associated with resuspension of sediments. • Appropriate disposal of dredged materials is required to avoid undesired ecological impacts.
6	Native aquatic plant establishment	$175,000 / acre	• Enhance the ability of the lake to support fish and waterfowl.	• No effect on the extent, bioavailability, or potential toxicity of existing metals in the lake. • Technical challenges associated with successful, long-term establishment of the new plants.
7	Tribal cultural projects	$1 million - $15 million	• Cultural use services, including enhancing the preservation of knowledge and artifacts. • Aquaculture component may help supplement community members' food supplies to offset losses associated with reduced Grand Lake fishing.	• No effect on the extent, bioavailability, or potential toxicity of existing metals in the lake. • Inexact match between the type of cultural benefits and the service losses experienced.

REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR). 1999a. ToxFAQs: Cadmium. Accessed 4/15/08 at <http://www.atsdr.cdc.gov/tfacts5.html>.

Agency for Toxic Substances and Disease Registry (ATSDR). 1999b. Toxicological Profile: Cadmium. Health Effects. Accessed 4/15/08 at <http://www.atsdr.cdc.gov/toxprofiles/tp5-c2.pdf>.

Aggus, L.R. et al. 1987. Effects of Acid Mine Drainages from Tar Creek on Fishes and Benthic Macroinvertebrates in Grand Lake, Oklahoma. National Reservoir Research Program, U.S. Fish and Wildlife Service. Prepared for: Oklahoma Ordnance Works, Pryor, OK. Cooperative Agreement 14-06-0009-83-1801.

Aiken, Richard and Genevieve Pullis LaRouche. *Net Economic Values for Wildlife-Related Recreation in 2001*. (Report 2001-3). Addendum to the 2001 National Survey of Fishing, Hunting, and Wildlife Associated Recreation.) U. S. Department of the Interior, Fish and Wildlife Service. Washington, D.C. September 2003.

AMEC Earth and Environmental (AMEC). 2007. Grand Lake watershed assessment to support nutrient BMP implementation targeting. Submitted to Oklahoma Conservation Commission. May.

Bennear, Lori S., Robert N. Stavins, and Alex Wagner (2005) “Using Revealed Preferences to Infer Environmental Benefits: Evidence from Recreational Fishing Licenses,” Journal of Regulatory Economics, 28(2):157-180.

Bettioli, P.W., M.J. Maceina, R.L. Noble, and R.K Betsill. 1993. Response of a reservoir fish community to aquatic vegetation removal. North American Journal of Fisheries Management 13:110-124.

Beyer, W.N., J. Dalgarn, S. Dudding, J.B. French, R. Mateo, J. Miesner, L. Sileo, and J. Spann. 2004. Zinc and lead poisoning in wild birds in the Tri-State Mining District (OK, KS, MO). Archives of Environmental Contamination and Toxicology 48:108-117.

Bolton, S.M. and J. Shellberg. 2001. Ecological issues in floodplains and riparian corridors. Center for streamside studies, University of Washington. Prepared for Washington Department of Fish and Wildlife.

Brosius, L. and R.S. Sawin. 2001. Lead and zinc mining in Kansas. Kansas Geological Survey, Public Information Circular (PIC) 17. Web version created October 2001. Accessed 4/18/08 at <http://www.kgs.ku.edu/Publications/pic17/pic17_1.html>.

Bull, W.R. 2007. Mineral concentration of the lead-zinc ores of the Tri-State Old Lead Belt and Viburnum Trend Districts. Expert report. In re: ASARCO LLC, et al. debtors, Case No. 05-21207. Prepared for U.S. Department of Justice.

Carpenter, G.W., G.A. Andrews, and W.N. Beyer. 2004. Zinc toxicosis in a free-flying trumpeter swan (*Cygnus buccinator*). Journal of Wildlife Diseases 40(4):769-774.

Carpenter, S.R. and D.M. Lodge. 1986. Effects of submersed macrophytes on ecosystem processes. Aquat. Bot. 26:341-370.

Collings, P., G. Wenzel, and R.G. Condon. 1998. Modern food sharing networks and community integration in the central Canadian Arctic. Arctic 54(4):301-314.

Cowell, B.C. and P.L. Hudson. 1967. Some environmental factors influencing benthic invertebrates in two Missouri River reservoirs. In: Lane, C.E., Jr., chairman. Reservoir Fishery Resources Symposium. Apr. 5-7, 1967; Athens, GA. pp. 541-555. American Fisheries Society, Washington, D.C.

Cox, R.R., M.A. Hanson, C.C. Roy, N.E. Euliss, D.H. Johnson, and M.G Butler. 1998. Mallard duckling growth and survival in relation to aquatic invertebrates. J. Wildlife Management 62(1):124-133.

Cronin, G. W.M. Lewis, Jr., and M.A. Schiehserb. 2006. Influence of freshwater macrophytes on the littoral ecosystem structure and function of a young Colorado reservoir. Aquatic Botany, 85(1):37-43.

Dames & Moore. 1993a. Final remedial investigation for Cherokee County, Kansas, CERCLA Site: Baxter Springs/Treece subsites. January 27.

Demayo, A., M.C. Taylor, K.W. Taylor, and P.V. Hodson. 1982. Toxic effects of lead and lead compounds on human health, aquatic life, wildlife, plants, and livestock. CRC Crit. Rev. Environ. Control 12(4):257- 305.

Deihl, S. and Ryszard Kornijów. 1997. Influence of submerged macrophytes on trophic interactions among fish and macroinvertebrates. In: E. Jeppesen, Martin Søndergaard, Morten Søndergaard, and K. Christoffersen (eds.). Ecological Studies 131. The Structuring Role of Submerged Macrophytes in Lakes. Springer-Verlag, New York.

Downing, J.A. and H. Cyr. 1988. Empirical relationships of phytomacrofaunal abundance to plant biomass and macrophyte bed characteristics. Can. J. Fisheries Aqat Sci 45(6):976-984.

Duarte, C.M., J. Kalff, and R.H. Peters. 1986. Patterns in biomass and cover of aquatic macrophytes in lakes. Can. J. Fish. Aquat. Sci. 43:1900-1908.

Durocher, P.P., W.C. Provine, and J.E. Kraai. 1984. Relationship between abundance of largemouth bass and submerged vegetation in Texas reservoirs. North Am. J. Fish. Manage. 4: 84-88.

Eisler, R. 2000. Handbook of Chemical Risk Assessment: Health Hazards to Humans, Plants, and Animals. Volume 1: Metals. Boca Raton: Lewis Publishers.

Enloe, J. G. 2003. Food sharing past and present: Archaeological evidence for economic and social interactions. Before Farming 1:1-23.

Fey, D.L., M.F. Becker, and K.S. Smith. 2010. Geochemical data for core and bottom-sediment samples collected in 2007 from Grand Lake O' the Cherokees, northeast Oklahoma. Open-File Report 2010-1298.

Fisher, W. L., D. F. Schreiner, C. D. Martin, Y. A. Negash, and E. Kessler. 2002. Recreational fishing and socioeconomic characteristics of eastern Oklahoma stream anglers. Proceedings of the Oklahoma Academy of Science 82:79-87.

Garvin, M.S. 2009. Summary of Preliminary Draft Results of Northeast Oklahoma Tribal Cultural Resource Use Survey. Unpublished Raw Data.

Garvin,M.S., E.M. Garvin, and C.F. Bridge. 2011. Tribal Cultural Resources Survey of 2011 Six Treaty Tribes of Oklahoma. Unpublished Raw Data.

Gasith, A., and M.V. Hoyer. 1997. Structuring role of macrophytes in lakes: Changing influence along lake size and depth gradients. In: E. Jeppesen, Martin Søndergaard, Morten Søndergaard, and K. Christoffersen (eds.). Ecological Studies 131. The Structuring Role of Submerged Macrophytes in Lakes. Springer-Verlag, New York.

Gilinsky, E. 1984. The role of fish predation and spatial heterogeneity in determining benthic community structure. Ecological Society of America 65(2):455-468.

Grand River Dam Authority, U.S. Fish and Wildlife Service, Oklahoma Water Resources Board. 2004. Ecological Risk Assessment: Evaluating concentrations of Cadmium, Chromium, Lead, and Zinc in Lake Hudson, Oklahoma. Agencies Response to FERC - Additional Information Request.

Grand River Dam Authority. 2008. Pensacola Project FERC No. 1494. Shoreline Management Plan. Final Draft, June 11.

Graham, K. 1997. Contemporary status of the North American paddlefish, *Polyodon spathula.* Environmental Biology of Fishes 48:279-289.

Haynes and Makarewicz 1982

Ingersoll, C.G., C.D. Ivey, W.G. Brumbaugh, J.M. Besser, and N.E. Kemble. 2009. Toxicity assessment of sediments from the Grand Lake O' the Cherokees with the amphipod *Hyalella azteca.* August 27. U.S. Geological Survey Administrative Report CERC-8335-FY09-20-01.

Jacobs Engineering Group Inc. 1995. Final Expanded Site Inspection Report for Newton County Mine Tailings Site, Newton County, Missouri. Prepared for the United States Environmental Protection Agency, Region VII. Work Assignment No. 53-7JZZ. July 1995.

Jones, A.J. and M. Donlan. 2009. Memorandum: 2008 Grand Lake Sampling Results. To: Suzanne, Dudding, U.S. FWS. 15 June. Available February 2012 at: http://www.fws.gov/southwest/es/oklahoma/Documents/Contaminants/2008%20Chemistry Results Overview final.pdf

Jakus, Paul M., Mark Downing, Mark S. Bevelhimer, and J. Mark Fly. 1997. "Do Fish Consumption Advisories Affect Reservoir Anglers' Site Choice?" Agricultural and Resource Economics Review 26(2):198204.

Jakus, Paul M., Dimitrios Dadakas, and J. Mark Fly. 1998. "Fish Consumption Advisories: Incorporating Angler Specific Knowledge, Habits, and Catch Rates in a Site Choice Model." American J. Agricultural Economics 80(5):10191024.

Juracek, K.E. and M.F. Becker. 2009. Occurrence and trends of selected chemical constituents in bottom sediment, Grand Lake O' the Cherokees, Northeast Oklahoma, 1940-2008. U.S. Geological Survey Scientific Investigations Report 2009-5258.

Korsu, K. 2004. Response of benthic invertebrates to disturbance from stream restoration: the importance of bryophytes. Hydrobiologia 523:37-45.

Larson, J.L. 1991. Prairie restorations what to expect and why. Accessed 4/18/08 at <http://www.appliedeco.com/Projects/PrairieRestorations.pdf>.

Long, K.R., J.H. DeYoung, Jr., and S.D. Ludington. 1998. Database of significant deposits of gold, silver, copper, lead, and zinc in the United States. Part A: Database description and analysis. U.S. Geological Survey Open File Report 98-206A.

MacDonald DD, Smorong DE, Ingersoll CG, Besser JM, Brumbaugh WG, Kemble NE, May TE, Ivey CD, Irving S, O'Hare M. 2009. Development and evaluation of sediment and pore-water toxicity thresholds to support sediment quality assessments in the Tri-state Mining District (TSMD), Missouri, Oklahoma and Kansas. Prepared by USGS, Columbia MO and MacDonald Environmental Sciences Ltd., Nanaimo, BC for the USEPA, Dallas, TX; USEPA Kansas City, MO; and USFWS, Columbia, MO.

McCollum, D.W., G.L. Peterson, J.R. Arnold, D.C. Markstrom and D.M. Hellerstein, 1990. The Net Economic Value of Recreation on the National Forests: Twelve Types of Primary Activity Trips Across Nine Forest Service Regions, U.S. Forest Service Research Paper RM-289, 1990.

Medine, A.J. 2007. Analysis of contaminant source, fate and transport in the Tri-State Mining District and Southeast Missouri Mining District. In re: ASARCO LLC, et al. debtors, Case No. 05-21207. Prepared for U.S. Department of Justice.

Memorandum from F. Foshag, Jr., Kansas Department of Health and the Environment, Re: Memo Regarding Drilling Costs (May 3, 2007).

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)Agency for Toxic Substances and Disease Registry (ATSDR). 2005. ToxFAQs: Zinc. Accessed 4/15/08 at <http://www.atsdr.cdc.gov/tfacts60.html>.

Mills, O. 2004. Press release: OWRB coordinates new study at Grand Lake. Lakes and Special Studies Section, Water Quality Division, Oklahoma Water Resources Board. August 23. Available 13 February 2009 at < http://www.owrb.ok.gov/news/news2/pdf_news2/press_rel/Grand_Lake_Study_08_2004.pdf >.

Missouri Department of Conservation (MDC). 2008a. Endangered Species Guidesheet – Neosho Madtom *Noturus placidus.* Accessed February 18, 2008: http://mdc.mo.gov/nathis/endangered/endanger/madtom/.

Missouri Department of Conservation (MDC). 2008b. Endangered Species Guidesheet – Ozark Cavefish. Accessed February 18, 2008: http://mdc.mo.gov/nathis/endangered/endanger/cavefish/.

Missouri Department of Natural Resources (MDNR) and U.S. Department of the Interior (DOI). 2002. Preassessment Screen and Determination. Jasper County Superfund Site, Jasper County Missouri. Accessed 5/21/08 at http://www.dnr.mo.gov/env/hwp/news/final-jasper-county-pas-tds-02-06-18.pdf.

Missouri Department of Natural Resources (MDNR) and U.S. Department of the Interior (DOI). 2008. Preassessment Screen and Determination. Newton County Mine Tailings Superfund Site, Newton County Missouri. Accessed 3/12/08 at < http://www.dnr.mo.gov/env/hwp/docs/newton-county-mine-tailingspas2008.pdf>.

Muotka, T., R. Paavola, A. Haapala, M. Novikmec, and P. Laasonnen. 2001. Long-term recovery of stream habitat structure and benthic communities from in-stream restoration. Biological Conservation 105:243-253National Research Council (NRC). 2007. Sediment dredging at Superfund Megasites: Assessing the Effectiveness. ISBN-10: 0-309-10977-9.

Office of the Secretary of the Environment (OSE). 2005. Comprehensive study of the Grand Lake watershed. Final Report per Senate Bill 408, 2003 Legislative Session. December 31.

Oklahoma Conservation Commission. 2004. Watershed Based Plan: Grand Lake (Oklahoma Portion) for Control of Nutrients, Sediment, and Fecal Bacteria. Updated August 2004. Draft 4.

Oklahoma Department of Environmental Quality (ODEQ). 2002. The State of Oklahoma 2002 Water Quality Assessment Integrated Report. Prepared pursuant to Section 303(d) and Section 305(b) of the Clean Water Act.

Oklahoma Department of Environmental Quality (ODEQ). 2007. Fish tissue metals analysis in the Tri-State Mining Area follow-up study. FY 2006 Final Report.

Oklahoma Department of Environmental Quality (ODEQ). 2008a. News Release: DEQ Issues Fish Consumption Advisory for Tar Creek Area. February 27.

Oklahoma Department of Environmental Quality (ODEQ). 2008b. Water quality in Oklahoma: 2008 Integrated Report. Prepared pursuant to Section 303(d) and Section 305(b) of the Clean Water Act.

Oklahoma Department of Wildlife Conservation (ODWC). 2007. Oklahoma paddlefish information for conservation management. January 24, 2003 through December 31, 2007. Federal Aid Grant No. T-3-P-1.Conservation Management Grant. December Report.

Oklahoma Water Resources Board and Oklahoma State University (OWRB and OSU). 1995. Diagnostic and feasibility study of Grand Lake O' the Cherokees. Phase I of a Clean Lakes Project, Final Report. 10 March.

Oklahoma Water Resources Board (OWRB) and Lewisville Aquatic Ecosystems Research Facility (LAERF). 2007. Feasibility of establishing native aquatic plants in Grand Lake. Final Report & Recommendations for GRDA Fish & Wildlife Mitigation Project.

Parsons, George R., Paul M. Jakus, and Theodore D. Tomasi. 1999. “A Comparison of Welfare Estimates from Four Models for Linking Seasonal Recreational Trips to Multinomial Logit Models of Site Choice.” J. Environmental Economics and Management, 38(2):143-157.

Pita, F.W. and N.J. Hyne. 1975. The depositional environment of zinc, lead and cadmium in reservoir sediments. Water Research 9:701-706.

Preassessment Screen for the Tar Creek Superfund Site (PAS). 2004. Prepared for the Natural Resource Trustees for the Tar Creek Superfund Site. Accessed 2/11/09 at: <http://www.fws.gov/southwest/es/oklahoma/Documents/Contaminants/Final%20Tar%20Creek%20PAS.pdf>.

Rasmussen, J. B. 1988. Littoral zoobenthic biomass in lakes, and its relationship to physical, chemical, and trophic factors. Can. J. Fish. Aquat. Sci 45:1436-1447.

Robertson, K.R. 1996. The Tallgrass Prairie in Illinois. Champaign: Illinois Natural History Survey. Accessed 4/21/08 at <http://www.inhs.uiuc.edu/~kenr/tallgrass.html>.

Sileo, N., W.N. Beyer, and R. Mateo. 2003. Pancreatitis in wild zinc-poisoned waterfowl. Avian Pathology 32(6):655-660.

State of Kansas and U.S. Department of the Interior (DOI). 2003. Preassessment screen and determination: Cherokee County Superfund Site, Cherokee County, Kansas.

Tolbert, M. 2004. Comprehensive Study of the Grand Lake Watershed Initial Report. Prepared by the Office of the Secretary of the Environment. Oklahoma City, Oklahoma. January 30, 2004.

U.S. Environmental Protection Agency (EPA). 2004b. Record of Decision for Oronogo-Duenweg Mining Belt, Operable Unit 1, Jasper County, Missouri. EPA/ROD/R07-04/656. September 30, 2004.

U.S. Environmental Protection Agency (EPA), Remedial Action Activities Update, Tar Creek Superfund Site, Operable Unit 4, July 2011.

USEPA, Cherokee County Site Status Summary, May 21, 2012, as viewed at www.epa.gov/region7/cleanup/npl_files/ksd980741862.pdf on August 13, 2012).

U.S. Environmental Protection Agency (EPA), Tar Creek Site Status Summary, July 17, 2012, as viewed at http://www.epa.gov/region6/6sf/oklahoma/tar_creek/index.htm on August 13, 2012).

U.S. Fish and Wildlife Service. 1989. Ozark Cavefish Recovery Plan. U.S. Fish and Wildlife Service. Atlanta, Georgia.

Watkins, C.E., J.V. Shiremen, and WT. Haller. 1983. The influence of aquatic vegetation upon zooplankton and benthic macroinvertebrates in Orange Lake, Florida. J. Aquat. Plant Manage. 21:78-83.

Whitney, B. 1998. Ecological restoration of high-diversity prairie: PPRI's basic guide. Prairie Plains Journal 13.

World Health Organization (WHO). 1992. Cadmium - Environmental Aspects. International Programme on Chemical Safety: Environmental Health Criteria 135. Published under the joint sponsorship of the United Nations Environment Programme, the International Labour Organisation, and the World Health Organization. Geneva.

(This page intentionally left blank.)

APPENDIX A | ESTIMATED COSTS FOR ALTERNATIVE 5

Figure 15 Grand Lake Dredging Restoration Quantities and Assumptions

	Unit	Quantity	Source
Volume of sediment removal (per event)	cy	20,000	
Density	tons/cy	1.01	1
Number of removal events		5	
Alternative 1: Sediment Removal (Mechanical from Barge)			
Removal rate per dredge per 10-hour shift	cy/day	1,200	2
Number of dredges		1	
Number of shifts per day		2	
Total removal rate	cy/day	2,400	
Days of sediment removal per event	days	9	
Total number of dredge shifts		18	
Volume of water per cy dredged	gal/cy	20	1
Total volume of water requiring treatment (per removal event)	1000 gal	400	
Alternative 2: Sediment Removal from Shoreline			
Days of sediment removal per event	days	18	2X Alt. 1
Shoreline area disturbed	acre	35	3
Volume of shoreline soils disturbed/requiring regrading	cy	50,000	3
Volume of rip-rap or revetment required	cy	3,600	3
Sediment Solidification			
Percent lime	%	10%	1
Amount of lime required (per removal event)	ton	2,020	
Sediment Disposal at Repository			
Volume of solidified sediments (per removal event)	ton	22,220	
	cy	22,000	
Volume of solidified sediments (all removal events)	ton	111,100	
	cy	110,000	
Distance to repository	mi	6	
Depth of repository	ft	20	3
Required area of repository (for all removal events)	sq ft	148,500	
	acre	3.4	
Required property acquisition area (repository plus 200-ft buffer area)	sq ft	342,643	3
	acre	7.9	

	Unit	Quantity	Source
Thickness of clay liner, filter sand, and cover (each)	ft	2	3
Volume of clay liner, filter sand, and cover soils (each)	cubic ft	297,000	
	cy	11,000	

Sources:

(1) Appendix H, Detailed Cost Estimate Worksheets, OU-5 Green Bay, Zone 3A, pp. 219 - 221, *Final Feasibility Study, Lower Fox River and Green Bay, Wisconsin Remedial Investigation and Feasibility Study*, The Retec Group, Inc., December 2002.

(2) *Final Basis of Design Report, Lower Fox River and Green Bay Site*, Shaw Environmental, Inc., p. 61.

(3) Table 11, Estimated Costs for Alternative 5, *Record of Decision, Operable Unit 4, Tar Creek Superfund Site*, February 20, 2008.

Figure 16 presents a breakdown of the costs calculated for each component of the restoration approach, including sediment removal (by barge or from shoreline), water treatment, sediment solidification and disposal, and repository construction, closure, and long-term maintenance. The unit costs are based on those developed in the documents listed in the figure, adjusted for inflation to 2014 dollars. Because the Trustees do not know at this time whether removal will be accomplished primarily from the water or shoreline, we use an average of the two costs we developed, on a per removal event basis. Allowances for indirect costs such as contingencies, project management and engineering, and construction management were obtained from USEPA guidance on estimating feasibility study costs.

Figure 17 presents the Trustees' calculation of the total cost on a present value basis, which shows the timing and amount of the costs incurred each year. One-time capital costs include the purchase cost of the water treatment unit and construction and closure of the repository. Costs incurred every five years include the costs for sediment removal and disposal and water treatment. Operations and maintenance costs include maintenance of the repository cap from the repository's inception date until 20 years after closure

Figure 16 Grand Lake Dredging Restoration Costs

	Quantity	Unit	Base Unit Cost	Source	Inflation Factor (5)	Adjusted Unit Cost	Cost (Undiscounted)
CAPITAL COSTS							
Alternative 1: Sediment Removal Using Barge-Mounted Dredge (Each Removal Event)							
Mobilization - Equipment and Silt Curtain	1	per dredge	$350,000	1	1.49	$521,001.05	$521,001
Mobilization - Barge	1	EA	$100,000	1	1.49	$148,857.44	$148,857
Dredging (per 10-hr shift)	18	shift	$30,000	1	1.49	$44,657.23	$803,830
Dredge Monitoring (Water Quality)	9	day	$3,000	1	1.49	$4,465.72	$40,192
Sediment Removal QA	9	day	$1,200	1	1.49	$1,786.29	$16,077
Direct Capital							$1,529,957
Contingencies		%	30%	4			$458,987
Subtotal							$1,988,944
Project Management and Engineering		%	13%	4			$258,563
Construction Management		%	6%	4			$119,337
Total Capital							**$2,366,843**
Alternative 2: Sediment Removal Using Excavator from Shoreline (Each Removal Event)							
Mobilization	1	EA	$100,000.00		1.00	$100,000.00	$100,000
Clear and grub stream banks	35	acre	$1,800.00	2	1.21	$2,172.61	$76,041
Excavate sediments	20,000	cy	$17.51	2	1.21	$21.13	$422,694
Dredge Monitoring (Water Quality)	18	day	$3,000	1	1.49	$4,465.72	$80,383
Sediment Removal QA	18	day	$1,200	1	1.49	$1,786.29	$32,153
Shoreline work and regrading	50,000	cy	$2.26	2	1.21	$2.73	$136,392
Furnish and install rip-rap or revetment	3,600	cy	$39.11	2	1.21	$47.21	$169,942
Amend shoreline soils prior to revegetation	35	acre	$320.00	2	1.21	$386.24	$13,518
Revegetate shoreline	35	acre	$1,200.00	2	1.21	$1,448.41	$50,694
Direct Capital							$1,081,818
Contingencies		%	30%	4			$324,545
Subtotal							$1,406,363
Project Management and Engineering		%	13%	4			$182,827
Construction Management		%	6%	4			$84,382
Total Capital							**$1,673,572**
Average Sediment Removal		**event**					**$2,020,208**

	Quantity	Unit	Base Unit Cost	Source	Inflation Factor (5)	Adjusted Unit Cost	Cost (Undiscounted)
Cost (Each Removal Event)							
CAPITAL COSTS COMMON TO BOTH ALTERNATIVES							
Water Treatment Unit Purchase (One-Time Cost)	1	EA	$569,927	1	1.49	$848,378.76	**$848,379**
Water Treatment (Each Removal Event)							
Water Treatment (Including Operator)	400	1000 gal	$0.40	1	1.49	$0.60	$238
Water Treatment QA	9	day	$200	1	1.49	$297.71	$2,679
Direct Capital							$2,918
Contingencies		%	30%	4			$875
Subtotal							$3,793
Project Management and Engineering		%	13%	4			$493
Construction Management		%	6%	4			$228
Total Capital							**$4,514**
Sediment Disposal - Construct Repository (One-Time Cost)							
Property acquisition including buffer area	7.9	acre	$1,000	2	1.21	$1,207.01	$9,494
Clear and grub	3.4	acre	$533	2	1.21	$643.33	$2,193
Grading and site work	3.4	acre	$2,400	2	1.21	$2,896.82	$9,876
Furnish and load clay liner soil	11,000	cy	$10.24	2	1.21	$12.36	$135,957
Haul and dump clay liner soil	11,000	cy	$3.41	2	1.21	$4.12	$45,275
Compact clay liner soil	11,000	cy	$1.26	2	1.21	$1.52	$16,729
Furnish, load, and install filter sand	11,000	cy	$5.00	2	1.21	$6.04	$66,385
Direct Capital							$285,910
Contingencies		%	30%	4			$85,773
Subtotal							$371,682
Project Management and Engineering		%	13%	4			$48,319
Construction Management		%	6%	4			$22,301
Total Capital							**$442,302**
Sediment Disposal - Load and Haul Sediments to Repository (Each Removal Event)							
Solidification	22,220	ton	$25.00	1	1.49	$37.21	$826,903
Lime purchase	2,020	ton	$60.00	1	1.49	$89.31	$180,415
Load sediments	22,000	cy	$1.70	2	1.21	$2.05	$45,142

	Quantity	Unit	Base Unit Cost	Source	Inflation Factor (5)	Adjusted Unit Cost	Cost (Undiscounted)
Haul, dump, and place sediments in repository	22,000	cy	$3.11	2	1.21	$3.75	$82,583
Direct Capital							$1,135,044
Contingencies		%	30%	4			$340,513
Subtotal							$1,475,557
Project Management and Engineering		%	13%	4			$191,822
Construction Management		%	6%	4			$88,533
Total Capital							**$1,755,913**
Sediment Disposal - Close Repository (One-Time Cost)							
Furnish and load cover soils	11,000	cy	$10.24	2	1.21	$12.36	$135,957
Haul and dump cover soils	11,000	cy	$3.41	2	1.21	$4.12	$45,275
Compact cover soils	11,000	cy	$1.26	2	1.21	$1.52	$16,729
Amend soils prior to vegetation	3.4	acre	$320.00	2	1.21	$386.24	$1,317
Revegetate	3.4	acre	$1,200.00	2	1.21	$1,448.41	$4,938
Institutional control	1	parcel	$1,000	2	1.21	$1,207.01	$1,207
Direct Capital							$205,423
Contingencies		%	30%	4			$61,627
Subtotal							$267,050
Project Management and Engineering		%	13%	4			$34,716
Construction Management		%	6%	4			$16,023
Total Capital							**$317,789**
O&M COSTS							
Repository Cap Management (Annual Cost)	3.4	acre/yr	$250.00	3	1.34	$334.66	$1,141
Project management		%	5%	4			$57
Technical support		%	10%	4			$114
							$1,312
Total O&M		**year**					**$1,312**

Sources and Notes:

(1) Appendix H, Detailed Cost Estimate Worksheets, OU-5 Green Bay, Zone 3A, pp. 219 - 221, *Final Feasibility Study, Lower Fox River and Green Bay, Wisconsin Remedial Investigation and Feasibility Study*, The Retec Group, Inc., December 2002.

(2) Table 11, Estimated Costs for Alternative 5, *Record of Decision, Operable Unit 4, Tar Creek Superfund Site*, February 20, 2008.

(3) Table 12, Detailed Cost Analysis for Alternative 4, *EPA Superfund Record of Decision, Oronogo-Duenweg Mining Belt, EPA/ROD/R07-04/656*, September 30, 2004.

(4) USEPA, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002*, July 2000.

	Quantity	Unit	Base Unit Cost	Source	Inflation Factor (5)	Adjusted Unit Cost	Cost (Undiscounted)
(5) Inflation Factors calculated from Engineering News-Record Construction Cost Indices. Projected inflation for June 2014 estimated assuming half the forecasted year-over-year percent change in the GDP chained price index from 2013 to 2014 (2.1 percent) obtained from Blue Chip Financial Forecasts, December 1, 2012.							

Figure 17 Present Value Dredging Restoration Cost Calculations

Year	Present Value Factor	One-Time Capital Costs	Per Removal Event Capital Costs	Total Capital Cost (undiscounted)	Total Capital Cost (Present Value)	O&M Costs (undiscounted)	O&M costs (Present Value)
Current Year	**2014**						
Discount Rate	**0.03**						
2030	0.623167	$1,290,681	$3,780,634	$5,071,315	$3,160,276	$1,312	$818
2031	0.605016					$1,312	$794
2032	0.587395					$1,312	$771
2033	0.570286					$1,312	$748
2034	0.553676					$1,312	$726
2035	0.537549		$3,780,634	$3,780,634	$2,032,277	$1,312	$705
2036	0.521893					$1,312	$685
2037	0.506692					$1,312	$665
2038	0.491934					$1,312	$645
2039	0.477606					$1,312	$627
2040	0.463695		$3,780,634	$3,780,634	$1,753,060	$1,312	$608
2041	0.450189					$1,312	$591
2042	0.437077					$1,312	$573
2043	0.424346					$1,312	$557
2044	0.411987					$1,312	$541
2045	0.399987		$3,780,634	$3,780,634	$1,512,205	$1,312	$525
2046	0.388337					$1,312	$510
2047	0.377026					$1,312	$495
2048	0.366045					$1,312	$480
2049	0.355383					$1,312	$466
2050	0.345032	$317,789	$3,780,634	$4,098,423	$1,414,089	$1,312	$453
2051	0.334983					$1,312	$440
2052	0.325226					$1,312	$427
2053	0.315754					$1,312	$414
2054	0.306557					$1,312	$402
2055	0.297628					$1,312	$390
2056	0.288959					$1,312	$379
2057	0.280543					$1,312	$368
2058	0.272372					$1,312	$357

Year	Present Value Factor	One-Time Capital Costs	Per Removal Event Capital Costs	Total Capital Cost (undiscounted)	Total Capital Cost (Present Value)	O&M Costs (undiscounted)	O&M costs (Present Value)
2059	0.264439					$1,312	$347
2060	0.256737					$1,312	$337
2061	0.249259					$1,312	$327
2062	0.241999					$1,312	$318
2063	0.23495					$1,312	$308
2064	0.228107					$1,312	$299
2065	0.221463					$1,312	$291
2066	0.215013					$1,312	$282
2067	0.20875					$1,312	$274
2068	0.20267					$1,312	$266
2069	0.196767					$1,312	$258
2070	0.191036						
Total					**$9,871,907**		**$19,466**

Notes:
(1) Note: The Tar Creek ROD (Feb 2008) spreads upland and some in-stream remedial costs from 2009 through 2023 in its present value calculation. As a result, we assume 2030 would be the first year for sediment removal.

APPENDIX B | TRIBAL FISH COLLECTION LOST USE ANALYSIS

OVERVIEW

Tribal survey data and anecdotal information from Tribal representatives demonstrate that Tribal use of other Grand Lake aquatic and terrestrial resources, in addition to fish species subject to consumption advisories, has been adversely affected by the presence of mining-related contamination. The Trustees are continuing to evaluate the presence and extent of injury (as defined by DOI NRD regulations) to such resources, and may amend this RCDP as additional data become available.

In 2009 the Six Treaty Tribes[22] designed and implemented the Tribal Cultural Resource Survey (TCRS 2009) to generate information to better understand the nature and extent of impacts on Tribal members. A total of 901 members of the Six Treaty Tribes and 265 members of other Tribes were surveyed at Tribal functions, Pow-wows and Tribal service locations (e.g., health service centers and Title 6 food service administrative offices) of the Ottawa Tribe of Oklahoma, the Wyandotte Nation of Oklahoma, the Miami Tribe of Oklahoma, the Seneca-Cayuga Tribe and the Eastern Shawnee Tribe of Oklahoma.[23] The survey identifies the natural resources gathered by Tribal members, their intended use, and the proportion of Tribal members that have altered their resource use in some manner in response to contamination in their traditional gathering areas. The Peoria Tribe also conducted a similar survey in 2009: of the 148 surveys mailed to Peoria tribal members, 19 were returned (these 19 individuals were separate from the 23 Peoria members who responded to the Six Treaty Tribe survey described above).

In 2011, the Six Treaty Tribes designed and implemented another Tribal Cultural Resource Survey (TCRS 2011) to generate additional information with respect to the nature and extent of impacts to Tribal members. A total of 909 members of the Six Treaty Tribes and 130 members of other Tribes were surveyed.

Summary response information to these surveys was made available to the Trustees. Overall, these surveys confirm use of Grand Lake watershed resources by Tribal members who rely on its waters for fish, and who hunt traditional game, eat traditional foods, gather traditional plants, and otherwise practice their culture within the watershed. The survey(s) also indicate considerable concern on the part of Tribal members with respect to contamination in their traditional hunting and gathering areas. Some individuals continue to pursue these traditional activities, while changing the areas used and/or the items gathered and consumed, while other Tribal members have reduced their participation in these traditional activities.

The remainder of this appendix is devoted to the analysis of Tribal survey information and other readily available data to estimate the approximate magnitude and potential value of one aspect of Tribal loss -- use of the fish species in Grand Lake subject to the fish consumption advisory. Grand Lake has been subject to a fish consumption advisory issued by the Oklahoma Department of Environment Quality (ODEQ) in 2008. The advisory recommends consumption of no more than six meals per month of non-game fish prepared with bones, a traditional Tribal preparation method, and non-residents are advised not to eat more than 11 meals per month of non-game fish prepared with bones (ODEQ 2008a).

---

[22] The Six Treaty Tribes consist of the Cherokee Nation, the Wyandotte Nation, the Eastern Shawnee Tribe of Oklahoma, the Miami Tribe of Oklahoma, the Ottawa Tribe of Oklahoma, and the Seneca-Cayuga Tribe of Oklahoma.

[23] Other Tribes with members that completed surveys include the Quapaw (46), Peoria (23), Sioux (14), Sac and Fox (14), Ponca (13), Osage (12) and several others with fewer than 10 surveys completed.

The advisory is based on lead levels and applicable to four fish species found in Grand Lake (carp, freshwater drum, redhorse sucker, and smallmouth buffalo). The presence of a fish consumption advisory is an injury under DOI NRD regulations.

Based on the analysis of readily available information presented in the remainder of this appendix, the Trustees estimate minimum damages of, **$5.8 to $7.6 million** (2014$) to compensate for lost Tribal fish collection resulting from Grand Lake fish consumption advisories. The Trustees recognize that data gaps introduce uncertainties into the estimation of the magnitude of monetary loss, but explicitly identify assumptions made and supporting rationales, and believe that on balance, assumptions included in the current analysis are more likely to under- than over-state actual loss.

INJURY QUANTIFICATION – SUMMARY OF APPROACH

This appendix describes the development of estimates of lost value, measured in present value dollars, associated with reductions in the quality and quantity of trips taken by Tribal members to Grand Lake targeting injured fishery resources.[24] The estimate of lost value is based on an estimation of the numbers of trips that fall in each category (reduced quality and reduced number), multiplied by per-trip valuation figures documented in the natural resource economic literature for other, similar sites. This approach is typically referred to as the 'benefits transfer' method for estimating damages.

Before describing the injury quantification and damage estimation approach in more detail, it is essential to acknowledge that for Tribal Trustees, the damage estimates presented are approximate and could substantially underestimate actual damages, for several reasons:

1) Per-trip valuation estimates available in the technical literature typically are generated in the context of recreational fishing by members of the general public, and do not focus on Tribal resource users. Such values do not reflect the integral role that hunting/ gathering activities play with respect to Tribes' social identity, cultural integrity, and spiritual lives. Nor do they likely capture the full value of resources gathered for subsistence purposes, which is an important resource use for many Tribal members;

2) Potentially relevant valuation studies typically provide value estimates on a 'per-trip' basis, using measures of travel cost to alternative sites to reveal the values the public holds for participating in these activities. Representatives of the Six Treaty Tribes and the Peoria Tribe indicate that Tribal cultural practice emphasizes sharing of hunted and gathered natural resources with family members (local and non-local), Tribal elders, and with the broader community (e.g., at feasts). Thus, benefits from the hunting/gathering of natural resources extend beyond the individual(s) taking the 'trip'. Food sharing has been repeatedly documented as core socioeconomic practice among native peoples to the present day (e.g., Collings et al. 1998, Enloe 2003). The 2011 Tribal Survey, for example, confirms consumption of fish by children of Tribal members who fish in Grand Lake. Because studies readily available for transfer purposes only capture a portion of the benefits to direct activity participants, the approach inherently underestimates their value to Tribes as a whole; and

3) Trips taken by children are not explicitly included in this analysis, largely because estimated adult trip values from relevant literature can incorporate values to accompanying children and

[24] For the purposes of this analysis, a fishing 'trip' is defined to take place within a single day, consistent with our understanding of the typical practice of many Tribal members who collect fish at Grand Lake. Thus, in this document the terms fishing 'trip' and fishing 'day' are used interchangeably.

we were unable to identify studies of child values appropriate for benefits transfer in the context of this analysis. Nevertheless, 2011 Tribal Survey information confirm that children (defined in this document as people younger than 18 years of age) are frequent participants in fishing trips to Grand Lake, and these trips likely have additional value not captured by loss estimates due to the cultural importance of intergenerational coherence and the opportunity to pass on traditional knowledge and practices, ensuring future continuity of Tribal culture.

Nevertheless, this approach provides some quantitative understanding of the magnitude of potential damages to the Tribes using readily available information, and in the Trustees' view provides a reasonable, lower-bound estimate of loss.

BACKGROUND INFORMATION ON FISHING ACTIVITY IN GRAND LAKE

The 2011 Tribal survey data provides information on the frequency with which Tribal members take fishing trips to Grand Lake. Before addressing Tribal-specific survey information, we first provide general context for the Tribal lost use analysis through presentation of publicly available information on fishing activity provided by the GRDA, summarized below.

Grand Lake is extensively used for a variety of recreational purposes, including recreational fishing. In September 2006, the GRDA published the Grand Lake O' the Cherokees Public Recreation Management Plan. The GRDA estimates that in 2002, Grand Lake supported 4 million daylight and 1.5 million nighttime recreation days annually, and is one of Oklahoma's more popular recreational areas for boating and fishing. Five state parks and approximately 14 municipal parks provide access to the lake. In addition to the substantial number of public access points, GRDA has documented approximately 3,700 private docks, 300 private boat ramps, and 300 commercial docks on the lake.

With respect to fishing activity in particular, GRDA notes that fishing is a year round activity on Grand Lake, and that secluded coves, boat docks, fish shelters and heated docks provide fishing opportunities to all segments of the lake. Fishing tournaments are popular; an average of 135 tournaments were held annually between 1996 and 2004, with an average of 52 boats participating in each tournament. The GRDA data doesn't provide avidity estimates (i.e., estimates of the typical number of trips taken by anglers).

The GRDA data reflect boat-based recreation, providing information about the number of boats and relative popularity of different boat-based activities on weekends. The data is based on 10 helicopter overflights during 2005, each covering approximately one-half of Grand Lake. Non-holiday weekend data are summarized in Figure 18. As shown in the figure, fishing is the most popular boat-based activity, accounting for between 44% and 84% of boat-based recreational activity by lake section. Based on the overflights, GRDA estimates that approximately 130 boats can be found on the lake at peak times on weekends. Similar data for holiday weekends shows much greater boating activity, but a much lower proportion of fishing activity (and a corresponding increase in 'pleasure boating' and 'rafting').

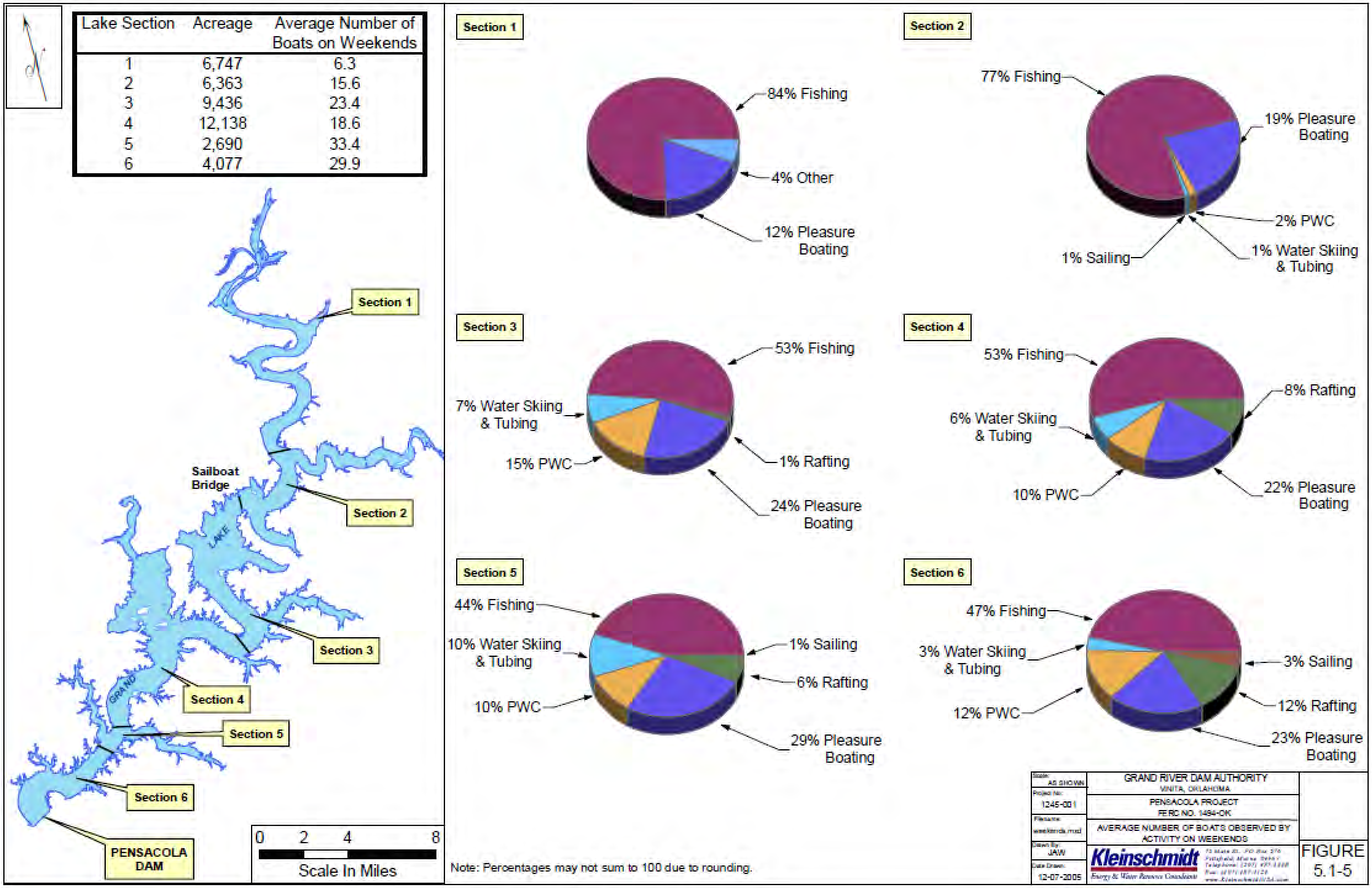
The Trustees note that this data was collected prior to the issuance of the fish consumption advisory. Nevertheless, the Trustees believe that the GRDA data likely understate actual fishing activity, for several reasons, including (but not necessarily limited to): 1) shore-based fishing activity is not captured; 2) night time boat-based fishing is not captured; 3) boat counts were taken July through October, while peak fishing typically occurs April through June; and 4) criteria for assigning boats to 'fishing' activity (i.e., boats that were not moving) would not account for boats that were trolling or moving to a fishing destination. In general terms, these data confirms that substantial fishing activity takes place on Grand Lake.

For background informational purposes, the Trustees also consider state-wide data collected from a periodic survey of Oklahoma anglers, summarized below.

BACKGROUND INFORMATION ON ANGLER ACTIVITY FROM PERIODIC STATE-WIDE SURVEYS

The Oklahoma Department of Wildlife Conservation conducts an angler opinion survey approximately every five years. The most recent survey (February 2007) obtained responses from 1,292 resident fishing license holders (563 annual license holders, 297 lifetime license holders and 432 senior citizen license holders). Results for selected questions are provided in Figure 19.

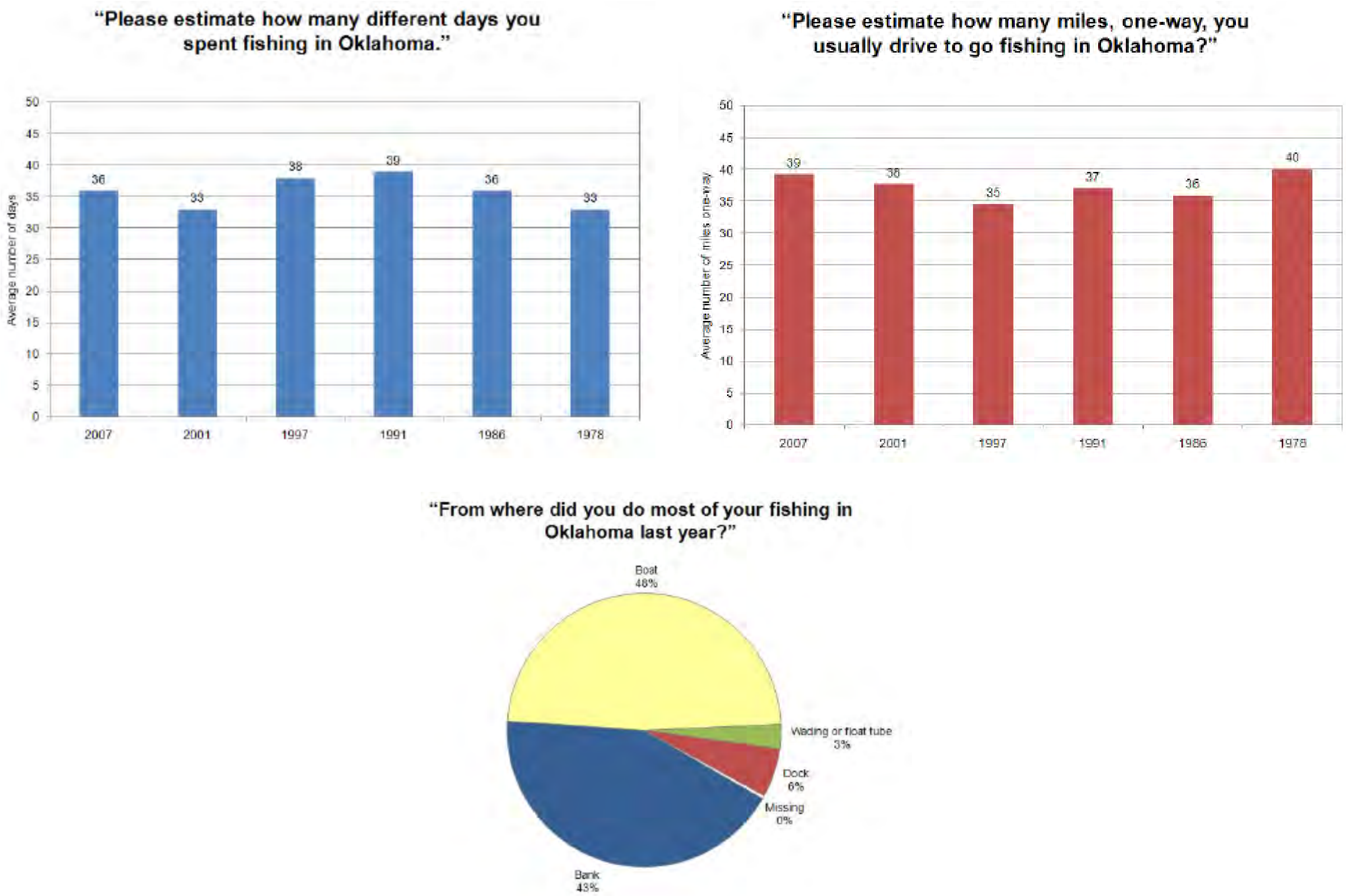
Figure 18 Average Number of Boats Observed by Activity on Weekends



Lake Section	Acreage	Average Number of Boats on Weekends
1	6,747	6.3
2	6,363	15.6
3	9,436	23.4
4	12,138	18.6
5	2,690	33.4
6	4,077	29.9

Note: PWC = personal watercraft

Figure 19 Oklahoma Angler Activity Data from Periodic State-Wide Angler Survey



This data indicate that surveyed anglers spent an average of 36 days fishing in Oklahoma in 2007. In addition, anglers drove an average of 39 miles (one way) to get to their desired fishing locations. The data also indicates that 48% of angling activity is boat-based, 43% bank (shore)-based, 6% dock-based, and 3% wading/float use.

Although not specific to Grand Lake nor to Tribal members, these data are Oklahoma-specific, recently collected, publicly available, and therefore used as background context for estimates of Tribal fishing activity developed for this RCDP.

INJURY QUANTIFICATION

This appendix separately quantifies Tribal use losses in two categories, which reflect related but different types of loss and valuation considerations:

1. Losses experienced by Tribal users of Grand Lake resources who continue to use injured fishery resources and suffer a degraded experience due to the presence of natural resource injuries; and
2. Losses experienced by Tribal members who have either reduced or eliminated their usage of injured Grand Lake fishery resources due to the presence of natural resource injuries.

Losses Arising from Continued Use of Injured Fish Species

The evaluation presented below addresses the first category of loss described above (i.e., continued, albeit degraded use of injured fishery resources by Tribal members). While it is difficult to precisely quantify the number of Tribal members who continue to utilize injured fishery resources in Grand Lake, estimates can be derived by combining Tribal population data (Figure 20) with information on the percentage of 2009 Tribal survey respondents who collect the four species of fish subject to the Grand Lake fish consumption advisory (Figure 21).

Figure 20 Trustee Tribal Population Data

Tribe	Within 50 miles of grand lake[a]
Seneca-Cayuga of OK	1,425
Ottawa of OK	620
Miami of OK	680
Eastern Shawnee of OK	885
Wyandotte	749
Cherokee	78,212
Peoria	421
Total	**82,992**

Source:
a Data provided by Tribes.

Figure 21 Tribal Use of Fish Species Subject to Grand Lake Consumption Advisory

Species	Subsistence	Ceremonial	Culture/ Tradition	Crafts	Medicinal
Sucker	4.8%	0.8%	1.2%	0.0%	0.0%
Carp	14.8%	0.0%	2.1%	0.0%	0.0%
Smallmouth-Buffalo	11.2%	0.0%	1.4%	0.0%	0.0%
Drum	9.9%	0.3%	3.9%	0.0%	0.0%

Source:
2010 Treaty Tribe Report, Table 5

For this portion of the RCDP analysis, the Trustees focus on the Tribal population within 50 miles of Grand Lake. Although slightly more than the 39 miles (one-way) traveled by Oklahoma anglers cited in the Oklahoma 2007 survey (see Figure 19 above), this assumption is reasonable in light of Tribal member customs for collecting fish from Grand Lake. In addition, information from the 2011 Tribal survey confirms that many Tribal members are willing to drive distances of this approximate magnitude to fish in Grand Lake.

Of the 82,992 Tribal members that reside within 50 miles of Grand Lake (see Figure 20), US Census data indicates that approximately 61,663 are adults (i.e., at least 18 years old).[25] For reasons previously described, the Trustees estimate trip participation for adults only.

With respect to Tribal usage of injured fishery resources, between 4.8% and 14.8% of 2009 Tribal survey respondents collect, for subsistence purposes, one or more of the species for which there is an advisory. Between 1.2% and 3.9% of respondents collect one or more of these species for cultural/traditional purposes, and less than one percent collect them for ceremonial use. No craft or medicinal use was identified.

In light of this information, the Trustees conservatively assume 14.8% of survey respondents participate in fishing trips to collect fish subject to the consumption advisory for subsistence, ceremonial, and/or cultural/traditional purposes.[26] This suggests that 9,126 adult Tribal members within 50 miles of Grand Lake participate in these fishing trips.[27]

Preliminary evaluation of 2011 Tribal Survey summary data suggest that Tribal members who fish in Grand Lake do so approximately 25 days per year.[28] For context, the Trustees note that this is somewhat less than the average number of fishing days (36) taken by Oklahoma recreational anglers to Oklahoma fishing destinations, based on the state's 2007 angler survey (see Figure 19). For damages estimation purposes, the Trustees apply the 25 days per year figure, which is the only Tribal-specific fishing frequency information available. This suggests that each year adult Tribal members residing within 50 miles of Grand Lake take a total of 228,150 fishing trips that target fish subject to a consumption advisory.[29]

Because the geographic focus of this RCDP is on Grand Lake, the Trustees must estimate the proportion of trips these Tribal anglers take to Grand Lake, rather than other waterbodies that adult Tribal members living within 50 miles of Grand Lake might utilize. There are no data documenting this proportion. Figure 22 shows a map identifying area waterbodies that might be utilized by Tribal anglers residing within 50 miles of Grand Lake, including other lakes (e.g., Oologah Lake, Lake Hudson, Lake Eucha, Fort Gibson Lake and Beaver Lake) and rivers/streams (e.g., Neosho River, Spring River).

While Grand Lake has a greater size and length of shoreline compared to other waterbodies accessible to Tribal anglers residing within 50 miles of Grand Lake, there are multiple fishing destinations available. For the purposes of this analysis, the Trustees assume 20% of the trips taken by adult Tribal anglers

---

[25] 61,663 = 82,992 * 74.3%. US Census Data indicate that 25.7% of Delaware & Ottawa County population is under 18 years old. These two counties include most of the land immediately surrounding Grand Lake, and substantial portions of both counties are close (e.g., within 10 miles) to the lake. This analysis assumes that the Tribal age distribution is similar to the overall age distribution of the general population.

[26] The Trustees believe that this is a lower bound participation estimate. For example, to the extent Tribal members who collect smallmouth buffalo, drum and/or sucker for subsistence purposes are distinct from those who collect carp, this assumption will understate losses. In addition, Tribal members customarily share gathered resources. The analyses presented here do not include potential impacts arising from reductions in shared food or sharing contaminated food, and so does not fully capture contamination-related effects.

[27] 9,126 = 61,663 * 14.8%.

[28] The 2011 TCRS asked the frequency with which survey respondents fished in Grand Lake (never, daily, weekly, monthly or yearly). The average number of trips cited above was calculated for who fish at least once per year in Grand Lake, and assumes that respondents answering daily, weekly, monthly or yearly fished an average of 365, 52, 12 and 1 days per year, respectively.

[29] 228,150 = 9,126 * 25.

residing within 50 miles of Grand Lake are to Grand Lake. This implies an annual total of 45,630 Grand Lake fishing trips that target fish subject to a consumption advisory.[30]

The Trustees also consider continued use of injured Grand Lake fishery resources by 'non-local' Tribal members, defined in this RCDP to be Tribal members residing beyond 50 miles from Grand Lake. While 'non-local' Tribal members participated in the 2009 and 2011 Tribal surveys, the summary information made available to the Trustees does not allow segregation of their responses. Nevertheless, it is clear that non-local Tribal members make use of Grand Lake fishery resources during Pow-wows, ceremonial and other gatherings. The Trustees assume that 13,000 'non-local' trips are taken annually that involve collection of fish species subject to a consumption advisory.[31] In the Trustees' view this is a reasonable, conservative estimate given the large in-state (Oklahoma) Tribal population,[32] the proximity of Grand Lake to neighboring states, the relatively large size of Tribal gatherings in the area and the fact that 'non-local' Tribal members are known to return to this area to renew relationships and take part in Tribal activities.

Overall, the analysis presented above suggests that 58,630 trips are taken annually to Grand Lake by adult Tribal members to collect fish subject to consumption advisories.[33]

The Trustees note that Tribes may continue to gather and analyze information related to damages estimation issues, and update information presented in this document accordingly. In particular, the 2011 Tribal Survey provides information on a variety of factors that could affect damages estimates, such as awareness of and concern with the Grand Lake fish consumption advisory, partial lists of Grand Lake fish targeted by Tribal members, information about fish preparation methods and consumption, and general information about Tribal member avoidance of Grand Lake for fishing purposes.

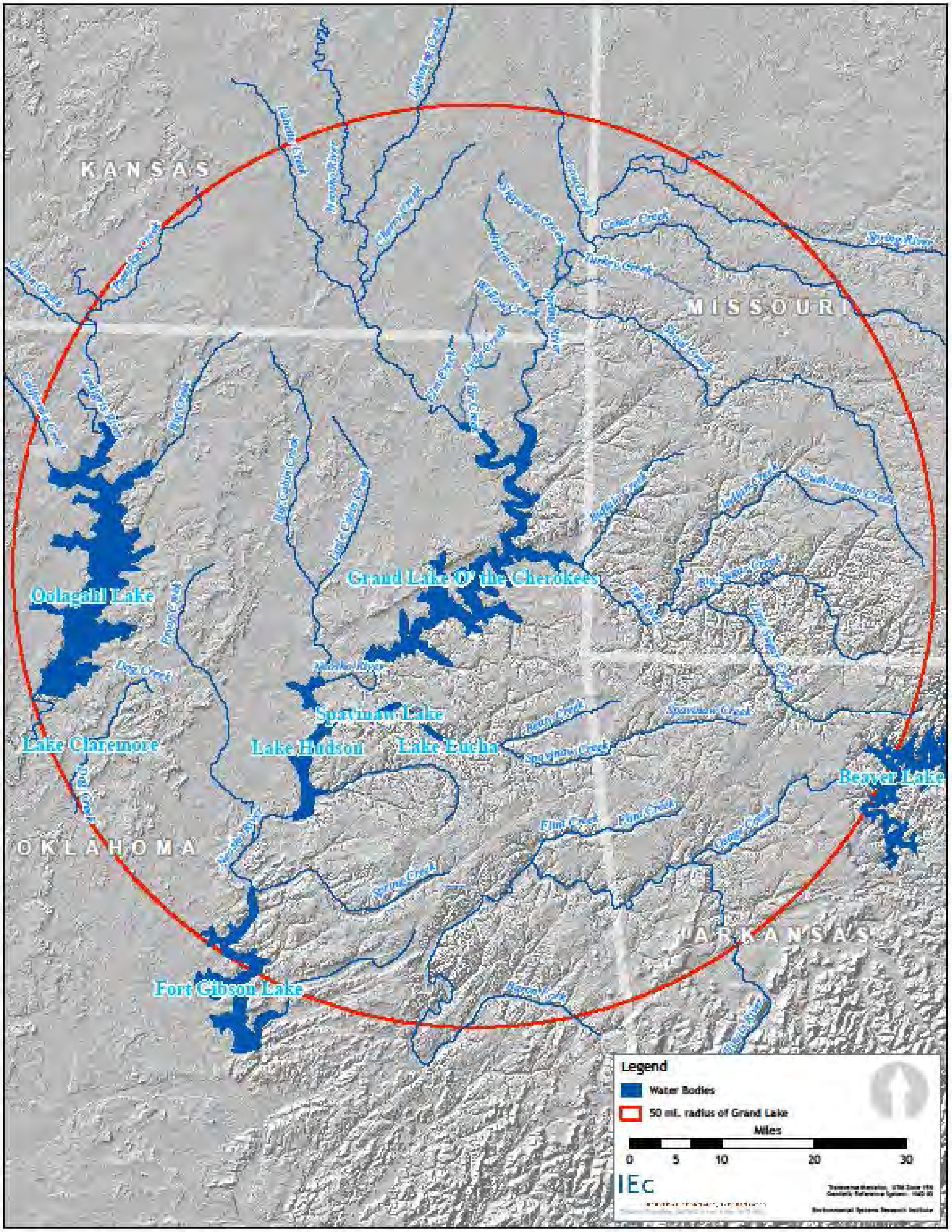
[30] 45,630 = 228,150 * 20%.

[31] The Tribes indicate that a very conservative estimate for annual non-local trips would be to assume one such trip by 5% of the non-local tribal population (i.e., that excludes members within the 50 mile radius), which results in an estimate of 13,000 trips based on Tribal estimates of their non-local population.

[32] Approximately 187,899, as estimated in the OK Office of Indian Affairs Nations Information Handbook 2008-2009.

[33] 58,630 annual trips = 45,630 'local' annual trips + 13,000 'non-local' annual trips.

Figure 22 Map of Grand Lake with Surrounding Counties



Losses Arising from Forgone Trips

The Six Treaty Tribes' survey indicates that some Tribal members have restricted resource consumption and/or changed areas utilized to collect resources (Figure 23). Some respondents to the Peoria Tribe's survey also offered comments that noted reduced use of natural resources due to concerns about contamination. While this data suggests that mining-related contamination has had a substantial impact on Tribal use of area natural resources, it doesn't directly inform estimation of the extent to which Tribal members have reduced their usage of fishery resources due to the presence of natural resource injuries.

Figure 23 Percentage of Tribal Survey Respondents who have Restricted Consumption or Changed Collection Areas due to Contamination in Grand Lake Watershed

Survey Response		Cherokee	Eastern Shawnee	Miami	Ottawa	Seneca Cayuga	Wyandotte
Restrict consumption	Yes	107	71	27	7	30	53
	% of responses	28%	47%	52%	12%	42%	29%
Change areas	Yes	114	65	21	14	50	73
	%	30%	43%	40%	23%	69%	40%
Total Participants		**385**	**151**	**53**	**61**	**72**	**182**
Notes:							
Data from Treaty Tribe Report, Table 10							

For example, the data in Figure 23 is not specific to fishery resources. Because a large number of Tribal member use of fish species subject to consumption advisories for subsistence purposes (see Figure 21), it is unclear how much consumption of this particular resource (and associated numbers of fishing trips) might have decreased. The 2011 Tribal Survey provides additional information on Tribal member avoidance of Grand Lake resources due to the presence of contamination, although not enough to develop quantitative estimates of foregone trips. Nevertheless, survey information and conversations with Tribal representatives suggest that the number of trips has been reduced. For the purposes of this analysis the Trustees conservatively assume an annual loss of 3,000 Grand Lake fishing days.[34]

DAMAGES DETERMINATION

To develop an estimate of losses associated with a diminished angling experience and reduced avidity within the assessment area, we evaluated a number of studies from the economic literature (Figure 24). These studies utilize data on anglers' choices among available fishing sites to determine how they trade off attributes such as catch rates, water quality, presence of fish consumption advisories (FCAs) and access conditions with travel costs. The estimated economic values represent the per-trip gain associated with improving contaminated conditions and/or removing/reducing FCAs or, equivalently for purposes of this RCDP, the loss associated with their presence.

[34] Typically, a small percentage of anglers will choose to reduce fishing activity in response to a consumption advisory, choosing instead to spend more time on other activities. The 2009 and 2011 Tribal Surveys confirm that this is a relevant issue for Tribal members, but do not provide sufficient data to precisely estimate foregone trips. The 3,000 fishing days used in this analysis is intended as a general approximation of foregone trips, about equal 5% of the estimated annual total fishing days taken by Tribal members to Grand Lake (58,630). The Trustees believe that this is a conservative estimate.

Figure 24 Summary of Recreational Fishing Valuation Literature – Effect of Changes in FCAs and Water Quality on Trip Values

Authors	Study Location	Scenario Evaluated	Change in value ($2014)
Jakus et al. 1997	Tennessee reservoirs	Remove FCAs	$2.71 to $4.19 per trip
Jakus et al. 1998	Tennessee reservoirs	Remove FCAs at 6 of 14 sites	$2.10 to $10.27 per trip
Parsons et al. 1999	Middle Tennessee reservoirs	Remove FCAs at 2 of 14 sites	$2.59 to $2.72 per trip
Breffle et al. 1999	Wisconsin waters of Green Bay	Removal of or reduction in FCAs	$5.72 to $11.67 per trip
MacNair and Desvousges 2007	Wisconsin waters	Remove "do not eat" advisory	$8.64 per trip
Montgomery and Needelman 1997	New York lakes	Remove FCAs from 23 lake sites	$2.09 per trip
Morey and Breffle 2006	Wisconsin waters of Green Bay	Reduce FCA from "do not eat" to statewide	$19.34 per trip
Chen and Cosslett 1998	Great Lakes	Remove area of concern designation for 14 of 41 Michigan sites	$0.96 to $4.70 per trip
Herriges et al. 1999	Wisconsin Great Lakes region	20% reduction in toxin levels	$13.39 to $16.53 per trip
Parsons and Hauber 1998	Maine rivers	Remove toxic contamination	$2.85 per trip

Note: Values adjusted for inflation to 2014 dollars using Gross Domestic Product Implicit Price Deflators available through the third quarter of 2013, then rounded up to account for additional inflation through second quarter of 2014.

Best-practice guidelines for benefit transfer analyses (e.g., USEPA 2000) emphasize the similarity of resources and valuation context when selecting relevant studies. Thus, we consider only those that examine changes in FCAs specifically, as opposed to general changes in water quality or scenarios not explicitly describing changes in FCAs (e.g., Chen and Cosslett 1998; Herriges et al. 1999; Parsons and Hauber 1998). Of these, the three studies that rely on data from Tennessee reservoirs are likely to be the most similar to Grand Lake in terms of angler experience. These studies are listed at the top of Figure 24.

Although the Trustees have tried to select the studies most relevant to lost fish collection for Tribal cultural and subsistence use, it is essential to acknowledge that the utilized studies fall short in fundamental ways. In particular, this economic valuation literature was developed to address values associated with recreational fishing, and to characterize the value of this activity to the broader U.S. population. The literature does not specifically address subsistence use, and it does not address Tribal-specific values. Unfortunately, no public studies of Tribal fishing losses have been conducted in the context of natural resource damage assessment. This is a fundamental shortcoming and for reasons described below, likely results in an underestimate of actual values held by Tribal members who participate in fishing activities.

As has been established in the anthropological literature in studies of other North American native peoples, the importance of traditional foods and their use is complex and not readily measurable through standard economic valuation approaches. Attempting to value subsistence production, for example, "run[s] the risk of misrepresenting and devaluing the cultural significance of subsistence activities [which] cannot be quantified exclusively in economic terms" (Natcher 2009). In particular, reliance on wildlife and other natural resources "is not done to simply satisfy economic or nutritional needs, but rather to provide a fundamental basis for the social identity, cultural survival, and spiritual life… [it is] of *fundamental importance* to not only an individual's economic wellbeing but also … social vitality" (*ibid.*, emphasis added).

The loss in value that Tribal members experience due to the presence of contamination when trips are taken, and the loss in value when trips are foregone, represent not simply a loss of a recreational activity, or a food source, for which substitutes are typically readily available; rather, these losses run much deeper, as they relate to culture, heritage, social connections, intergenerational continuity, and spiritual life. In short, it is difficult to appreciate traditional or subsistence losses in the same conceptual framework that is applied in a recreational context. The notion of a willingness to pay or accept in monetary terms for changes in fishing access or quality may not be consistent with Tribal culture.

Grand Lake is an important Tribal fishing subsistence and cultural resource, and the presence of consumption advisories has discouraged traditional uses and reduced the value of ongoing uses. For purposes of this RCDP, it is necessary to value these losses, and to that end, this RCDP relies on values developed for recreational fishing and for the broader population. These values are used not because they are especially suitable but because they are the most suitable values presently available. For purposes of this preliminary estimate, it is highly likely that losses associated with Tribal use/harvest are at least as large as those associated with recreational uses.

Acknowledging these important caveats, and considering the information in Figure 24, this RCDP utilizes a per-trip estimated loss of $4.10 (2014$), which is approximately equal to the mean across the three Tennessee studies (Jakus et al. 1997 and 1998, and Parsons et al. 1999).[35] As noted previously, for purposes of this RCDP, this estimate reflects the *minimum* per-trip loss experienced by Tribal members who continue to fish in Grand Lake despite the presence of the fish consumption advisory.

To develop an estimate of losses associated with diverted trips to other locations and/or trips not taken in the assessment area, we searched the economics literature for additional valuation studies addressing sites with similar attributes (while again noting that this literature is subject to the same types of caveats and limitations mentioned above).

Relatively few studies of the value of Oklahoma warmwater fishing opportunities exist. McCollum et al. (1990) utilize data from the Public Area Recreation Visitor Survey (PARVS) to estimate a random utility travel cost model. The authors report an estimate of $20 (adjusted to 2014$ via the GDP Implicit Price Deflator) per fishing day in Forest Service Region 8 (which includes OK).[36] Aiken and LaRouche (2003) provide values by state based on contingent valuation questions included in the 2001 National Survey of Fishing, Hunting and Wildlife-Associated Recreation. They report a value of $43 per day ($2014) for bass fishing in OK. Fisher et al. (2002) utilize the results of a telephone survey to develop a travel cost demand model for trips to eastern OK streams and rivers. They estimate a per-trip value of $12. Finally, Bennear et al. (2005) estimate a fishing access demand model based on license sales data to derive a per-

---

[35] While the studies differ considerably, the estimates are more likely to underestimate than overestimate losses to anglers. This is because the studies generally report average losses or gains per trip and changes in avidity for all anglers in the sample. Thus, these averages include anglers who visit contaminated sites and anglers who do not. Of the two groups, the anglers who visit the contaminated site will likely suffer the greatest losses.

[36] Reported values were adjusted for inflation to 2014 dollars using Gross Domestic Product Implicit Price Deflators available through the third quarter of 2013, then rounded up to account for additional inflation through second quarter of 2014.

day value by state. They report an average per-day value from 1975-1989 of $26 ($2014) for OK. Though these studies may not match exactly fishing conditions on Grand Lake, they provide a range of estimates that likely bound the value a primary study would reveal. Considering these four studies, we utilize a per-day value of $25.40, the approximate average of the four studies.

Finally, to estimate damages from lost Tribal fish collection as a result of fish consumption advisories, it is necessary to assume a time period over which the damages occurred. Because the fish advisory was first promulgated in 2008, this RCDP estimates damages beginning in that year. Of course, contamination was present in Grand Lake for decades prior to the promulgation of this advisory, and it is unlikely that overall contamination levels were lower in the past. However, this RCDP conservatively assumes damages commence in 2008.

The Trustees calculate damages through 2027 and 2037, assuming that a fish consumption advisory will remain in place for 20 to 30 years after its establishment in 2008. This assumption is reasonable because of the propensity of metals to adsorb to particles, the slow movement of sediment through the aquatic system, and the fact that metals do not readily degrade, contaminants such as cadmium, lead, and zinc typically have a long residence time in aquatic sediments. While lead and zinc depositional profiles indicate that concentrations in the bottom sediment of Grand Lake have decreased since about the 1980s (Juracek and Becker, 2009), natural burial processes in the lake are slow. In the absence of actions to remove contaminated sediments, fish consumption advisories are likely to remain in place for multiple decades.

It should be noted that EPA does not have an Operable Unit identified for Grand Lake and at this time no remedial action for Grand Lake is planned or anticipated. While the Trustees have proposed “hot spot” primary sediment restoration of some areas in the lake (see Alternative 5), the scale of these actions is modest relative to the size of the lake. The Trustees believe that calculation of damages through 2027 and 2037 reasonably reflects the above circumstances.

Figures 25, 26, and 27 present minimum valuation results for degraded trips, lost trips, and both kinds of trips, respectively. The Trustees characterize these results as ‘minimum’ valuation estimates because of previously described limitations in the ability of this benefits transfer application to fully value Tribal loss, as well as the use of several assumptions that the Trustees believe are conservative. In particular, the Trustees note that this analysis does not apply a premium to trip values, to reflect the higher values Tribal members may place on culturally-related fishing activity, relative to the recreational anglers from which the value estimates are derived. Overall, minimum Tribal lost use damages are estimated to be between approximately $5.8 to $7.6 million (2014$).

Figure 25 Minimum Valuation of Degraded Tribal Trips Taken to Grand Lake Targeting Injured Fish Species*

Timeframe	Estimated Degraded Trips	Per-Trip Loss (2014$)	Loss (2014$)
Annual	58,630	$4.10	$240,383
20 Year Total (2008-2027)	1,072,800	$4.10	$4,398,400
30 Year Total (2008-2037)	1,413,355	$4.10	$5,794,756

*Consistent with standard practice, an annual discount rate of 3% is applied to the estimated number of past and future trips to generate the Present Value (2014) loss estimates shown in the figure.

Figure 26 Minimum Valuation of Foregone Tribal Trips to Grand Lake Targeting Injured Fish Species*

Timeframe	Estimated Lost Trips	Per-Trip Loss (2014$)	Loss (2014$)
Annual	3,000	$25.40	$76,200
20 Year Total (2008-2027)	54,900	$25.40	$1,394,460
30 Year Total (2008-2037)	72,300	$25.40	$1,836,420

*Consistent with standard practice, an annual discount rate of 3% is applied to the estimated number of past and future trips to generate the Present Value (2014) loss estimates shown in the figure.

Figure 27 Minimum Valuation Summary: Degraded and Lost Use*

Loss Type	20 Year Estimated Loss Value (2014$)	30 Year Estimated Loss Value (2014$)
Degraded use	$4,398,400	$5,794,756
Lost use	$1,394,460	$1,836,420
Total	**$5,792,860**	**$7,631,176**

*Consistent with standard practice, an annual discount rate of 3% is applied to the estimated number of past and future trips to generate the Present Value (2014) loss estimates shown in the figure.

Uncertanties

Key uncertainties inherent in this estimation of damages associated with Tribal fishing loss in Grand Lake arising from the presence of a consumption advisory are identified throughout this appendix. As discussed, the Trustees believe that overall, damages estimates are more likely to understate than overstate actual losses.

As previously noted the Tribes may continue to gather and analyze information related to damages estimation issues, and update information presented in this document accordingly. In particular, the 2011 Tribal Survey provides information on a variety of factors that could affect damages estimates, such as awareness of and concern with the Grand Lake fish consumption advisory, partial lists of Grand Lake fish targeted by Tribal members, information about fish preparation methods and consumption, and general information about Tribal member avoidance of Grand Lake for fishing purposes. To facilitate evaluation of such factors, the Tribes likely would need to provide response data from individual surveys, in addition to the summary data already made available. Additional follow up with survey respondents also might be useful to help interpret and make appropriate use of survey responses.

References for Appendix B

Aiken, Richard and Genevieve Pullis LaRouche. *Net Economic Values for Wildlife-Related Recreation in 2001*. (Report 2001-3). Addendum to the 2001 National Survey of Fishing, Hunting, and Wildlife Associated Recreation.) U. S. Department of the Interior, Fish and Wildlife Service. Washington, D.C. September 2003.

Bennear, Lori S., Robert N. Stavins, and Alex Wagner (2005) "Using Revealed Preferences to Infer Environmental Benefits: Evidence from Recreational Fishing Licenses," Journal of Regulatory Economics, 28(2):157-180.

Breffle, William S., E R Morey, R D Rowe, D M Waldman, S M Wytinck 1999. Recreational Fishing Damages from Fish Consumption Advisories in the Waters of Green Bay, Report to US Fish and Wildlife Service, prepared by Stratus Consulting, Inc.

Chen, H. and S. Cosslett (1998) Environmental quality preference and benefit estimation in multinomial probit models: A simulation approach. American Journal of Agricultural Economics 80, 512-520.

Collings, P., G. Wenzel, and R.G. Condon. 1998. Modern food sharing networks and community integration in the central Canadian Arctic. Arctic 54(4):301-314.

Enloe, J. G. 2003. Food sharing past and present: Archaeological evidence for economic and social interactions. Before Farming 1:1-23.

Franson, J.C. and D.J. Pain. 2011. Lead in birds. Pp. 563-593 in W.N. Beyer and J.P. Meador (eds.), Environmental Contaminants in Biota: Interpreting Tissue Concentrations, 2nd ed. CRC Press, Boca Raton, FL

Herriges, J.A, and C. L. Kling (eds). Valuing Recreation and the Environment; Revealed Preference Methods in Theory and Practice. 1999. 290 pp.

Jakus, Paul M., Mark Downing, Mark S. Bevelhimer, and J. Mark Fly. 1997. "Do Fish Consumption Advisories Affect Reservoir Anglers' Site Choice?" Agricultural and Resource Economics Review 26(2):198204.

Jakus, Paul M., Dimitrios Dadakas, and J. Mark Fly. 1998. "Fish Consumption Advisories: Incorporating Angler Specific Knowledge, Habits, and Catch Rates in a Site Choice Model." American J. Agricultural Economics 80(5):10191024.

Juracek, K.E. and M.F. Becker. 2009. Occurrence and trends of selected chemical constituents in bottom sediment, Grand Lake O' the Cherokees, Northeast Oklahoma, 1940-2008. U.S. Geological Survey Scientific Investigations Report 2009-5258.

MacNair, D.J. and W.H. Desvousges. 2007. "The Economics of Fish Consumption Advisories: Insights from Revealed and Stated Preference Data." Land Economics 83(4): 600-616.

McCollum, D.W., G.L. Peterson, J.R. Arnold, D.C. Markstrom and D.M. Hellerstein, 1990. The Net Economic Value of Recreation on the National Forests: Twelve Types of Primary Activity Trips Across Nine Forest Service Regions, U.S. Forest Service Research Paper RM-289, 1990.

Montgomery, M., and M. Needelman. 1997. The Welfare Effects of Toxic Contamination in Freshwater Fish. Land Economics 73(2):211–23.

Morey, E.R. and W.S. Breffle. 2006. Valuing a change in a fishing site without collecting characteristics data on all fishing sites: a complete but minimal approach. The American Journal of Agricultural Economics 88(1):150-161.

Natcher, D.C. 2009. Subsistence and the social economy of Canada's Aboriginal north. Northern Review, Spring (No. 30).

OK Office of Indian Affairs Nations Information Handbook 2008-2009.

Parsons, G.R., and A.B. Hauber. 1998. Spatial Boundaries and Choice Set Definition in a Random Utility Model of Recreation Demand. Land Economics 74 (1):32–48.

Parsons, George R., Paul M. Jakus, and Theodore D. Tomasi. 1999. "A Comparison of Welfare Estimates from Four Models for Linking Seasonal Recreational Trips to Multinomial Logit Models of Site Choice." J. Environmental Economics and Management, 38(2):143-157.

Shaw Environmental, Inc. Final Basis of Design Report, Lower Fox River and Green Bay Site, p. 61.

The Retec Group, Inc. 2002. Appendix H, Detailed Cost Estimate Worksheets, OU-5 Green Bay, Zone 3A, pp. 219 - 221, Final Feasibility Study, Lower Fox River and Green Bay, Wisconsin Remedial Investigation and Feasibility Study, December 2002.

USEPA. 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002, July 2000.

USFWS. 2004. Table 12, Detailed Cost Analysis for Alternative 4, EPA Superfund Record of Decision, Oronogo-Duenweg Mining Belt, EPA/ROD/R07-04/656, September 30, 2004.

USFWS. 2008. Table 11, Estimated Costs for Alternative 5, Record of Decision, Operable Unit 4, Tar Creek Superfund Site, February 20, 2008appendix D | SUMMARY of existing tribal community/cultural center costs[37]

[37] The presented costs are based on readily available public information and are provided as general context. The tribal cultural projects include components of a tribal community center to the extent that they provide tribal cultural human use services. Aquaculture facility/cost information has not been included in this table, but might incorporated into Tribal center design. Funding for other potential functions that certain tribal community centers may provide (e.g., day care, recycling center), is not contemplated in this RCDP.

Center Name Location Status	Size	Features	Construction cost	Source(s)
Duwamish Longhouse & Cultural Center Port of Seattle, WA Opened Sept 2008	6,000 SF	Post and beam structure of Alaskan yellow cedar Art gallery, museum, gift shop, Tribal offices, 1,500 SF meeting space with full commercial kitchen	$3 million	Faturechi, Robert, "Duwamish returning to roots; cultural center to open," Seattle Times, September 10, 2008. *Words of Wisdom*, a Potlatch Fund publication, Spring 2009
Native American Cultural Center, Northern Arizona University Flagstaff, AZ Planned completion Spring 2010	14,000 SF	Academic offices and classrooms, auditorium, and lounges	$8 million	"NAU gets $2 million donated toward Native center," *Inside NAU*, Vol. 6, No. 1, January 14, 2009. "What We Build: Current Projects," Brignall Construction, at http://brignall.com/projects.php
Circle of Life Indian Cultural Center Davisdon County/Nashville, TN Currently fundraising (goal of $1.5 million)	6,500 SF	Administration headquarters Community meeting room (~30 person) Exhibit museum and research library 80,000 SF pow-wow grounds Event parking for 500 cars Constructed of wood and stone with fabric entrance canopy	$1.1 million (Does not include costs for land purchase, furnishings, environmental assessments, legal fees) Pow-wow grounds and event parking ($200K), building ($800K), architectural fees ($50,000)	http://www.naiatn.org/center/index.html
Native American Cultural Center & Museum Aberdeen, SD Currently fundraising	Unknown	Restoration of old road depot to cultural center and museum	$5.7 million to complete restoration and endow a fund for O&M	http://www.naccmaberdeen.com/opportunity.html
California Indian Museum and Cultural Center Santa Rosa, CA Opened Late 2000s	16,000 SF	Complete renovation of existing office/industrial building Offices, exhibit rooms, gift shop, event space, outdoor exhibit area	$3 million	http://www.hendersonarchitect.com http://www.cimcc.org
Native American Cultural Center New Mexico State University Currently fundraising	11,000 SF	Academic offices and classrooms, community center, gathering spaces, gallery	$3.5 million	http://foundation.nmsu.edu/s/422/giving-interior.aspx?sid=422&gid=1&pgid=962 Minutes of the Board of Regents, New Mexico State University, March 10, 2008
Puyallup Tripe Multi-Purpose Community/Youth Facility Puget Sound, WA Opened July 2009	31,453 SF	Great room for gatherings and events Meeting and activity rooms, Basketball court and running track, Deli, Youth center, Commercial kitchen, Shower rooms	$10.2 million	http://www.puyallup-tribe.com
Native American Center University of Montana Opened Fall 2009	19,900 SF	Academic offices and classrooms, Tribal gathering space, LEED certified	$9.7 million	http://www.reznetnews.org/blogs/tribalog/um-native-american-center...
Intertribal Education and Community Center	13,920 SF	Academic offices and classrooms	$4.3 million	http://web.cwc.edu/what/CWCFoundation/Intertribal

Center Name Location Status	Size	Features	Construction cost	Source(s)
Central Wyoming College, Riverton, WY Planned Fall 2010		Artifact and art collection		
Columbia River Indian Cultural Center and Archaeological Repository Delta Park, Portland, OR Proposed 1985	40,500 SF on 20 acres	Repository building, museum and gift shop (13,500 SF), Community center building (w/ kitchen, meeting rooms, and round Pow-wow dance arena/convention hall) (20,000 SF), Social and health services (10,000 SF), Parking, open space, and encampment grounds	$3.8 million Repository/museum ($1.1 million), community center ($1.8 million), social and health services ($0.9 million) $480,000 in annual expenses 100,000 annual visitors	Oct 1985 proposal
Tamastslikt Cultural Institute Pendleton, OR Opened Aug 1998	45,000 SF	Exhibit and meeting space, archives, research library, museum store, offices	$18.5 million	Burke, Nancy, "Walking in two worlds," *The Oregonian*, January 17, 2009. http://www.history cooperative.org/cgi-bin/
Museum at Warm Springs Warm Springs, OR Opened Mar 1993	25,000 SF	Museum, exhibit gallery, gift shop, library/archive, education room, conference/board room, artifact collection space and office, administrative offices	$7.6 million	Burke, Nancy, "Walking in two worlds," *The Oregonian*, January 17, 2009. http://www.museumatwarmsprings.org
Evergreen State College Longhouse Education and Cultural Center Olympia, WA Opened 1995	12,177 SF	Post-and-beam construction: Academic offices and classrooms, student resource center and lounge, large open space and full commercial kitchen, outdoor garden	$2.2 million	http://www.evergreen.edu/longhouse http://www.jonesandjones.com/work/living.html
House of Knowledge University of Washington, Seattle, WA Planned 2012	19,000 SF	Longhouse facility with large central gathering space, smaller meeting and classroom space, student welcome space and lounge, computer and resource room, student and administrative offices, kitchen LEED-certified	$12 million to $15 million	http://www.washington.edu/diversity/hok/index.html
Many Nations Longhouse University of Oregon, Eugene, OR Opened Jan 2005	3,000 SF	Post-and-beam great room for large gatherings, office, kitchen	$1.2 million	http://www.uoregon.edu/~uplan/projects/projects-completed.htm http://www.jonesandjones.com/work/living.html
Tohono O'odham Nation Cultural Center and Museum Topawa, AZ Open June 2007	38,000 SF	Cultural and education center, artist studios, museum exhibits, art gallery, gift shop, conference rooms, workrooms, library, special collections archive, artifact/document repositories, covered patio, amphitheater, storytelling circle	$15.2 million	http://gosw.about.com/od/topattraction1/a/tohonooodham.htm Scheurich, Samuel, "Tohono O'odham museum celebrates opening Friday," *Tucson Citizen*, June 14, 2007

Center Name Location Status	Size	Features	Construction cost	Source(s)
Alaska Native Heritage Center Museum Anchorage, AK Opened May 1999	26,000 SF on 26 acres	Welcome house (exhibits, educational center, 700-person gathering room, theater) Six outdoor village sites	$14.5 million	http://www.alaskanative.net

APPENDIX C | SUMMARY OF ESTIMATED COSTS TO DEVELOP TRIBAL AQUATIC FACILITY[38] [39]

Existing buildings	$750,000
OUTDOOR RACEWAYS – CONCRETE	$60,000.00
INDOOR RACEWAYS – FIBERGLASS	$78,594.00
COVER FOR OUTDOOR RACEWAYS	$38,426.00
DEEP WELL AND HIGH VOLUME PUMP	$150,000.00
PUMPS, PLUMBING, ELECTRIC	$390,000.00
inner hatchery transport system	$30,500.00
automatic feeding system for all raceways	$29,000.00
10 ponds	$178,000.00
Transport vehicle	$62,485.00
Total – estimated costs	$1,617,005.00

[38] The presented costs are based on readily available public information and are provided as general context.

[39] Interoffice comm. Fall 2009, from M. Welchand J. Downs, Envtl. Specs., Peoria Indian Tribe., to L. Tippit, Envtl. Spec., Peoria Indian Tribe., Summarizing expenditures for existing Peoria Indian Tribe aquaculture facility and estimated facility expansion costs.

APPENDIX D | PUBLIC COMMENTS RECEIVED BY THE TRUSTEE COUNCIL

Shook, Hardy & Bacon L.L.P.
www.shb.com

Thomas J. Grever

2555 Grand Blvd.
Kansas City
Missouri 64108-2613
816.474.6550
816.559.2375 DD
816.421.5547 Fax
tgrever@shb.com

June 14, 2013

Via Electronic Mail and U.S. Mail

Ms. Suzanne Dudding
U.S. Fish and Wildlife Services
9014 East 21st Street
Tulsa, OK 74129

Suzanne_Dudding@fws.gov

Re: Comments on the Draft "Grand Lake O' The Cherokees / Natural Resource Damages: Restoration and Compensation Determination Plan"

Dear Ms. Dudding:

On behalf of Gold Fields Mining, LLC and Blue Tee Corp. (the "Companies"), we are submitting the following comments on the Draft Restoration and Compensation Determination Plan (the "Plan") for Grand Lake (the "Site" or "Grand Lake"), which was released for public review and comment in February 2013.

In submitting these comments, the Companies do not admit to any liability for natural resource damage claims and reserve all defenses against any such claims, including but not limited to statute of limitations defenses, exclusions from liability under CERCLA, and divisibility of harm. The Companies also reserve their rights to provide additional and more specific comments in the future, including comments in response to any modifications or additions to the Plan or to applicable regulations.

INTRODUCTION

The Trustees, comprised of the U.S. Department of the Interior ("DOI"), the State of Oklahoma, the Eastern Shawnee Tribe of Oklahoma, the Cherokee Nation, the Miami Tribe of Oklahoma, the Ottawa Tribe of Oklahoma, the Peoria Tribe of Indians of Oklahoma, the Seneca-Cayuga Tribe of Oklahoma, and the Wyandotte Nation (collectively, "Trustees"), have prepared the Plan. The Plan purports to address possible losses for a limited fish consumption advisory on non-game species in Grand Lake due to potential concerns about heavy metal concentrations in these species. According to the Plan, the advisory could affect uses by various Native American Tribal members who live in the area. The Plan attempts to quantify the amount of restoration compensation purportedly required to offset the injury associated with the limited fish consumption advisory. To address the alleged impacts of the limited fish consumption advisory, the Trustees propose to dredge certain areas of Grand Lake (beginning approximately 17 years from now) and to build a tribal cultural center.

Geneva
Houston
Kansas City
London
Miami
Orange County
Philadelphia
San Francisco
Tampa
Washington, D.C.

As we discuss below, the Plan is premature because the upstream remedial action is incomplete. Furthermore, there is insufficient information and evidence to properly and fully comment on the Plan. Such a limited advisory that applies only to less-desirable species and to eating fish with bones would result in, at most, only a small change in angler behavior and loss in fishing benefits. Consequently, the damages claimed by the Trustees are grossly overestimated. In addition, the Trustees have performed a benefits transfer, which uses results of studies from other locations to draw inferences about potential losses in Grand Lake fishing. But that analysis is based on unsubstantiated assumptions about fishing behavior and the value of non-game fishing on Grand Lake. The potential damage calculations also include several critical errors such as the failure to discount future losses and costs, resulting in further inflation of damages.

COMMENTS

1. The Plan is premature because any alleged natural resource injuries and damages will not be fully understood until after upstream response actions are completed.

The Plan relies on data from past studies in determining injury and damages. This is problematic on many levels.

Pursuant to the CWA and CERCLA, damages recovered by a trustee are retained by the trustee to restore, replace, or acquire the equivalent of the natural resource that was injured. *See* 42 U.S.C. § 9607(f)(1); 33 U.S.C. § 1321(f)(5). However, neither of these statutes permits a trustee to recover damages in excess of the costs of assessment and restoration, replacement or acquisition.

Assessing injuries and calculating damages at this time is premature. The Trustees acknowledge the significant uncertainty associated with the Plan, stating:

> This RCDP does not identify specific locations, scales, or other detailed information on potential restoration projects. Instead, the RCDP identifies generally-preferred types of restoration projects to address injuries to natural resources or their services. This approach reflects the fact that the total amount and timing of funding to implement restoration is *not yet known*, . . . (Plan, at 10) (emphasis added).

Based on the Trustees' concerns articulated above, the appropriate time to assess natural resource damages is after the remedial work is completed at upstream areas and the alleged injuries are calculated using more accurate data. As a legal matter, claims for natural resource damages cannot be brought until completion (or at least determination) of CERCLA remedies at the Site. *See* 51 Fed. Reg. 27674 (Aug. 1, 1986) ("this rule provides that natural resource damages are for injuries residual to those injuries that may be ameliorated in the response action…"); *Quapaw Tribe of Oklahoma v. Blue Tee Corp.*, No. 03-CV-0846-CVE-PJC, 2008 WL 2704482, at *13 (N.D. Okla. July 7, 2008) ("NRD, even interim and lost use damages, cannot be fully measured until the EPA's remedial work is completed." (citations omitted)); *Utah v. Kennecott Corp.*, 801 F. Supp. 553, 568 (D. Utah 1992) ("As a residue of the cleanup action,… [natural resource damages] are thus generally not settled prior to a cleanup settlement.").

The past studies the Trustees rely on do not take into consideration what changes have occurred from upstream remedial actions, and will not reflect the changes that will result from current and future upstream remedial activities. As the Plan states, it is estimated that more than 30 years may pass before upstream remedial actions are completed. (Plan, at 55, App. B-14). Significant changes and improvements will be realized during that timeframe. Any data collected now will be outdated by the time upstream remedial actions are completed.

The Companies therefore object to the premature calculation of alleged natural resource damages because there is a substantial risk of over-estimating the injuries to natural resources and the associated damages.

2. The Fish Consumption Advisory for Grand Lake is based on insufficient evidence, relies on evidence that is over five years old, and contains unsupported conclusions.

The Plan relies heavily on the Grand Lake Fish Consumption Advisory as providing the basis for most of the natural resource injuries. However, this advisory is over five years old and relied on little evidence. The Grand Lake Fish Advisory is based on metals found in six carp, six freshwater drum, no redhorse sucker, and ten smallmouth buffalo Grand Lake fish. This small sample of fish is statistically insufficient to conclude that every non-game fish contains elevated heavy metals such that a consumption advisory is required.

Furthermore, the Grand Lake Fish Consumption Advisory is for fish prepared whole, with bones; however, for those not preparing the fish with bones, there is no advisory. The Plan does not address what percentage of the members of interested tribal communities' meals include the preparation of fish with bones or how many of the survey respondents that indicated they target the non-game advisory species prepare only the filets and not the whole fish.

3. The Plan lacks a sufficient scientific record to evaluate the potential restoration projects.

The Plan does not include a sufficient scientific record to fully determine whether each potential restoration project—i.e., no action, preservation of Grand Lake buffer, preservation of high quality riparian corridors, improvement of riparian buffers, dredging selected areas within Grand Lake, establishment of native aquatic plants, or construction of tribal cultural projects—would restore natural resource losses. For example, the Trustees select dredging as a preferred restoration alternative in Grand Lake. However, although the Plan acknowledges potential risks to natural resources associated with such dredging, it does not analyze or quantify the potential impacts of such risks, including the potential resuspension of metals, potential harm to game fish habitat, and potential impacts on recreational activities. The Plan also does not specify the depth of dredging or whether there are clean sediments overlaying allegedly contaminated sediments.

4. The Plan's loss calculations are based on unverified assumptions.

A benefits transfer is used to calculate the value of lost fishing service on Grand Lake in the Plan. The two components of a benefits transfer are (1) the quantity of affected fishing trips, and (2) the lost value in those trips. The Trustees purport to rely on a Tribal Cultural Resource Survey (Garvin 2009; Garvin, et al. 2011) as the basis for the estimate of affected fishing trips in the Plan. However, the survey data are not publicly available and cannot be evaluated for appropriateness to this application. Surveys can be subject to a number of biases, which result from sampling error, nonresponse bias, interviewer biases, and recall bias. It is impossible to verify the reliability of the results without reviewing the survey instrument, sampling plan, and results.

Incorrect distance-travelled assumption for Oklahoma anglers

The basis for some of the Plan's assumptions regarding the valuation of "lost trips" to Grand Lake is derived from the Tribal surveys. However, the form of the questions asked in the survey influence the responses. It is not possible to evaluate the reliability of the responses without information about what questions are asked and in what format. For example, the Trustees assume that 14.8% of survey respondents participate in fishing trips to collect fish subject to the consumption advisory based on the Tribal survey. However, there is no information provided about the questions asked to obtain this estimate. In addition, there is no information about the number of trips this would affect and whether participants would be preparing the fish they caught whole (the only circumstance in which the advisory would apply).

The assumption of the distance traveled to fish appears significantly overestimated. The distance comes from the 2007 Oklahoma Periodic Statewide Angler Survey. The distance traveled of 39 miles is an average for <u>all</u> fishing trips, which includes sport fishing. The majority of fishing trips will be targeting sport-fish species. The value of a sport-fishing trip is higher than a non-sport fishing trip, which is evidenced by the distance that anglers are willing to travel to fish. (MacNair and Desvousges 2007). The assumption is made that this distance also applies to non-sport species on Grand Lake and is even increased from the 39-mile average to 50 miles. Assuming a longer average distance traveled to fish increases the potentially affected population in the analysis and consequently overestimates damages. The U.S. Census states that population of Native Americans living in the seven counties that surround Grand Lake totals 21,923. (U.S. Census). This population is 74% less than the 82,992 people the Trustees include in their loss calculations. Anglers beyond this range would have much closer substitutes for fishing and would be unlikely to travel beyond those substitutes to subsistence fish for

Shook, Hardy & Bacon L.L.P.
www.shb.com

non-sport species. By assuming an exaggerated affected population, the Trustees overestimate potential damages by more than 74%, not taking into account other errors as discussed herein.

Incorrect assumption of nonresident trips and substitute lakes

The Trustees add to the number of fishing trips that occur at Grand Lake by assuming that there are a number of nonresident trips that occur at the lake, 22% of the total trips. While people who may travel to the area to vacation or visit family may fish, the Trustees provide no evidence to support the number of trips that occur and how many of these would be targeting the affected species. Moreover, a nonresident angler would not likely take as many trips as a resident angler, making the likelihood that the less restrictive consumption advisory of 11 meals per month prepared with bones would apply. Consequently, there is no support for including these nonresident trips in the damage analysis. By itself, including these trips overestimates damages by at least an additional 22%.

The Trustees present no information about the number of trips taken to Grand Lake versus other substitute lakes. Regardless, the Plan assumes that 20% of all trips are taken to Grand Lake. However, anglers should be assumed to take steps to maximize their benefits by the choices they make. Grand Lake is the only lake in the region with a lead advisory on non-game species. If an angler plans to prepare fish of a non-game species with bones, it is likely they would choose a fishing site without an applicable advisory. There is no verifiable evidence that anglers fishing for carp and buffalo who prepare the fish with bones are choosing Grand Lake to fish. If substitute sites were not of inferior quality or a greater distance than Grand Lake, then there would be no loss in benefits.

Failure to adequately characterize recreation activities at Grand Lake

According to publicly-available information, Grand Lake was created in 1940 when the Grand River Dam Authority ("GRDA") completed the Pensacola Dam. It is the third largest reservoir in Oklahoma, covering 46,500 acres with 1,300 miles of shoreline. (www.grda.com). Grand Lake is considered a premiere sport fishing destination in Oklahoma. The major sport fish include largemouth bass, spotted bass, white bass, hybrid striped bass, white crappie, black crappie, blue catfish, channel catfish, flathead catfish, and paddlefish. Grand Lake plays host to several nationally recognized fishing tournaments and supports one of the top bass fisheries in the state. Grand Lake is rated as the second best lake in the state for bass tournament success and number one in average bass weight and winning weight. (www.fishinghotspots.com). The lake also supports the largest population of paddlefish in the world, which attracts people from all over the globe. (www.fishinghotspots.com). The Oklahoma Department of Wildlife Conservation actively manages the lake. Its duties include fish stocking and fish habitat creation. Current fishing regulations limit the take of certain species and are intended to increase the total abundance and quality of the primary sport fish, bass and crappie. (Plan, at 20).

Geneva
Houston
Kansas City
London
Miami
Orange County
Philadelphia
San Francisco
Tampa
Washington, D.C.

In addition, Grand Lake is a popular recreation destination for boaters and other recreators. The lake has five state parks and approximately 14 municipal parks. There are 22 public boat ramps and approximately 350 commercial and residential boat ramps on the lower half of the lake. Marinas are also available with approximately 300 boat docks. (Plan, at 24).

None of these recreation activities are affected by the limited advisory of non-game species. Therefore, any potential losses should reflect the limited nature and scope of the advisory, and not include any potential effects on other recreational uses including sport fishing. Moreover, such activities provide high quality substitute uses at the same location where the advisory is present. These substitute uses do not appear to have been considered by the Trustees.

Compounding affect of the incorrect assumptions

Combining the potential errors in measurement that may be imbedded in the loss calculations is likely to result in damages that are overestimated by an order of magnitude. Not only are the estimates based on unverifiable assumptions, these assumptions are not consistent with the economic literature. *See, e.g.,* MacNair and Desvousges (2007)(discussed further below).

5. The Plan incorrectly alleges injury to flora and fauna at Grand Lake.

The Trustees have asserted that there are injurious levels of lead in Grand Lake. However, their own studies show no injuries to fish and other lake organisms. There has been no documented injury to aquatic ecosytems in the lake as a result of alleged lead contaminants. A study of fish by Aggus, et al. (1987) concluded "discharges of metals from Tar Creek did not have a significant impact on species composition, standing crop, or functional (trophic) interactions in the fish community of Grand Lake." The study also indicated that biomagnification is not an issue in Grand Lake. (Plan, at 34).

There has been no injury to water or sediment organisms in Grand Lake. OWRB and OSU (1995) did not find evidence of statistically significant toxicity in water and sediment extract. The Trustees undertook additional more extensive toxicity assessments of sediments. (Ingersoll, et al. 2009). The study found that only two out of forty samples were statistically different than reference samples of the survival rate of sediment arthropods. The authors concluded: "[m]etals levels in the collected Grand Lake sediments were not likely causing or contributing to toxicity to sediment dwelling organisms." (Plan, at 37).

However, in 2008 Oklahoma Department of Environmental Quality (ODEQ) issued a fish consumption advisory pertaining to lead for all of Grand Lake. The advisory stated that residents living in the Tar Creek area are advised not to eat more than six meals per month of non-game fish prepared with bones. Non-residents are advised not to eat more than 11 meals per month of non-game fish prepared with bones. Non-game fish include carp, freshwater drum, redhorse sucker, and smallmouth buffalo. (Plan, at App. B-2).

According to the Plan, the preservation of fish with bones is a traditional preparation method used by local Tribes, and both carp and buffalo species are considered a subsistence resource for Tribal members. (Plan, at 38). However, there is no substantiated evidence of the number of fishing days that target these less desirable species. Numerous recreation-demand models have valued sport species rather than non-sport species. (Boyle, et al. 1998; Desvousges, MacNair and Smith 2000; MacNair and Desvousges 2007). Based on the characteristics of this type of fishery, the value of a non-game trip would be substantially lower than a game species trip. Moreover, a recent paper by Charbonneau and Caudill (2010) indicate that there are no Tribal fish stocking programs for these species. Instead, most stocking programs focus on salmon, trout, and walleye, the more highly valued game species.

In addition, only fish that is prepared with the bones falls under the limited consumption advisory. Likewise, there is no evidence provided in the Plan that supports the level of consumption that includes the bones of the fish. Fish prepared without the bones is not under advisory and would, therefore, not be subject to losses in natural resource services.

There are a number of lakes without a lead consumption advisory on carp and buffalo fish in this area of Oklahoma. If anyone desired to prepare these fish with the bones there are substitutes available. Only Spring River, Neosho River and Grand Lake have a limited consumption lead advisory. (Tar Creek Fish Consumption Booklet). No other lake in the area has a lead advisory on these fish. Any assessment of the effects of a limited consumption advisory would need to account for these factors in the calculation of potential damages.

6. The benefits transfer did not provide any information on the similarity and soundness of the studies that are used in the calculations.

The value component of a benefits transfer comes from a study or studies in the literature that exhibit qualities of soundness and similarity. Two values are used in the damages calculation. One value reflects the loss in quality of a trip that continues to occur under the advisory and the second value reflects a trip that may not have occurred as a result of the advisory.

The Trustees use a study by Paul Jakus on the effect of fish consumption advisories on consumer surplus. This study uses a random utility model based on travel cost to estimate the change in value that occurs when advisories are removed on a Tennessee reservoir. Although this is an appropriate methodology for estimating lost consumer surplus for fishing in the presence of advisories, the advisory scenario does not match Grand Lake. The advisories in the Jakus study are not specified. Instead in the model, the site is identified as either with or without an advisory. The advisories could be anything from a do not eat any fish from the reservoir to a limited consumption on nonsport fish. Therefore, the results of an analysis only reveal an average advisory effect. However studies (such as in the Fox River Study (MacNair and Desvousges 2007)) have shown that limited consumption advisories show a much smaller loss in consumer surplus than a full "do not eat" advisory. In fact, the MacNair and Desvousges study showed that the effect was statistically insignificant in the case of a limited consumption advisory. Therefore, the values produced by the Jakus study would overestimate the loss in consumer surplus that would occur in the presence of a limited consumption advisory such as that of Grand Lake. The MacNair and Desvousges study showed that even the strictest fish consumption warning—do not eat any fish—placed on sport fish species results in a loss in value ranging from $1.36-$3.54 per trip. Based on these results, the $4 loss per trip the Trustees use in their damages calculation overestimates the losses associated with a limited advisory on non-sport fish species.

The value of a lost fishing day is based on sport fishing studies done in Oklahoma. Although values of Oklahoma fishing adds a level of similarity versus fishing in different regions, the Oklahoma studies are for sport fishing trips, in particular bass fishing. It has been shown that sport fishing trips are more highly valued than nonsport fishing trips. Anglers are willing to drive a longer distance to fish for bass and other sport fish. Therefore, the Trustees' trip value overestimates of the value of a non-game fishing trip on Grand Lake.

7. The Trustees have failed to provide any rationale as to why their restoration alternatives are preferred.

The Trustees have identified two potential restoration alternatives as "preferred." The first is dredging the north end of the lake periodically to remove the sediment that contains lead. The Trustees' claim that it is the only alternative that will remove the contaminant from the lake and may remove the consumption advisory more quickly. However, the Trustees have not evaluated the effectiveness in providing the public benefits for this project relative to the costs. Dredging could temporarily decrease fishing benefits because it would disturb habitat and temporarily cause lead sediment to become reexposed to the surface water. The reexposure of lead may actually lead to further fish consumption advisories for a period of time.

The second proposal is to build an Indian Cultural Center. The Trustees provide no rationale for why this alternative would be preferred over others. Although this alternative might serve the relevant population, there needs to be a comparison of how the benefits of each of the restoration alternatives compare to the costs.

Geneva
Houston
Kansas City
London
Miami
Orange County
Philadelphia
San Francisco
Tampa
Washington, D.C.

Shook, Hardy & Bacon L.L.P.
www.shb.com

8. The Plan does not discount future losses and thus improperly overvalues the present value of the alleged damages.

For the time period of the natural resource loss, the Plan begins in 2008 and estimates that the losses will continue for 20 to 30 years. (Plan, at 49, B-14). The Trustees must discount the claim for natural resource damages. Based on the time value of money theory, the value of something lost in the past is worth more now and the value of something that will be lost in the future is worth less now. When calculating damages the regulations for natural resource damage assessment calls for stating losses and gains that occur in the past and the future in terms of present value.

> Where possible damages should be estimated in the form of an expected present value dollar amount. In order to perform this calculation, a discount rate must be selected. 43 CFR § 11.84(e)(1).

Typically a discount rate of 3% is used to discount the value of lost consumer surplus from changes in the value of natural resources. Because most of the alleged losses will occur in the future, by not discounting future losses, the Trustees have overestimated damages. In fact, applying a 3% discount rate to the Trustees' calculation of damages would by itself reduce the range of damages by approximately $2 million from the Trustees' estimate for losses. This reduction would still not account for the gross exaggeration contained in the various damage calculations.

Trustees used a 3% discount rate to estimate a present value for future dredging costs; however, a 7% discount rate should be used for capital costs. *See* TTN/ECONOMICS & COST ANALYSIS SUPPORT OAQPS ECONOMIC ANALYSIS RESOURCE DOCUMENT / 8.3 DISCOUNTING BENEFITS AND COSTS, *Section 8.3.6 Discounting Recommendations* ("The OMB-recommended discount rate (7 percent) is the suggested default value for the real private cost of capital."), *available at*: http://www.epa.gov/ttnecas1/econdata/Rmanual2/8.3.html. Applying a 7% discount rate to the cost of future dredging results in a present value cost of dredging that is less than half of the Trustees' estimated cost. (USEPA 2010). This reduction is based only on applying the correct present value, and does not account for other errors. By not reflecting the present value of alleged future losses, the Plan substantially overvalues the natural resource damage restoration or potential compensation.

Geneva
Houston
Kansas City
London
Miami
Orange County
Philadelphia
San Francisco
Tampa
Washington, D.C.

L.E.A.D. Agency, Inc.
Local Environmental Action Demanded 19257 S. 4403 Dr. Vinita, OK 74301
223 A. St. S.E. Miami, OK 74354

Rebecca Jim, Executive Director

Phone: (918) 542-9399
www.leadagency.org

NRDAR Trustee Council
U.S. Fish and Wildlife Service
9014 E. 21st St.
Tulsa, OK 74112

April 10, 2013

To Whom It May Concern:

This letter is L.E.A.D. Agency's (Local Environmental Action Demanded) comments regarding the Natural Resource Damage Assessment-RCDP currently under public comment.

As a stakeholder we would like to congratulate the trustees for their years of hard work in taking the NRDAR process this far. We are pleased with this document and look forward to working with you throughout this process of planning and restoration. If there is anything that we can, do we are pleased to be of service.

Again, congratulations and thank you all.

Sincerely,

Rebecca Jim, Executive Director

Louis "Red" Mathia, President Board of Directors

Fred Cata, Vice-President
Tony Booth, Secretary/Treasurer
Earl L. Hatley, Grand Riverkeeper

APPENDIX E | RESPONSES TO PUBLIC COMMENTS RECEIVED BY THE TRUSTEE COUNCIL

Below are the responses to the public comments received by the Trustee Council.

Comment 1. The Plan is premature because any alleged natural resource injuries and damages will not be fully understood until after upstream response actions are completed

Trustee response:

For over a decade, the Tar Creek Trustee Council has been implementing a Type B natural resource damage assessment in compliance with the implementing regulations of the Comprehensive Environmental Response, Compensation, And Liability Act. See generally 43 C.F.R. Part 11 (2013). In 2004, the Trustees developed a Preliminary Assessment Screen (43 C.F.R. § 11.23) and determined that a natural resource damage assessment (NRDA) was warranted. A Notice of Intent to Perform an Assessment was sent to the potentially responsible parties at the Tar Creek natural resource damage assessment site and the parties were invited to participate cooperatively in the assessment. (43 C.F.R. § 11.32(a)(2)(iii)(A)). No PRPs agreed to a cooperative assessment. The Tar Creek Trustee Council developed an Assessment Plan (43 C.F.R. §§ 11.30-11.32) and proceeded to the Injury Determination and Quantification Phases of the assessment (43 C.F.R. §§ 11.61-11.72). Various studies were implemented to investigate the extent and severity of the hazardous substances released into the site, including Grand Lake, and the effects on natural resources and their services which duration of exposure to the concentrations of hazardous substances present would cause. After several years of study, the Trustees continued the Tar Creek NRDA and proceeded to the Damage Determination Phase by preparing and releasing for public comment the Draft "Grand Lake O' The Cherokees/Natural Resource Damages: Restoration and Compensation Determination Plan." (43 C.F.R. §§ 11.81-11.84). Pursuant to the regulations, the Grand Lake O' The Cherokees RCDP identifies a number of possible alternatives for the restoration, rehabilitation, replacement, and/or acquisition of the equivalent of the injured natural resources to their baseline level of services. (43 C.F.R. § 11.82).

As described in the Grand Lake O' The Cherokees RCDP, the data collected to date support the determination of injuries to natural resources and their services in Grand Lake as a result of the release of hazardous substances from upstream mining. These injuries continue to occur through time, thus the current data is pertinent to understanding the nature and extent of the injury. The contaminants of concern are heavy metals (e.g., lead and zinc), which persist in the environment and can bioaccumulate, meaning more of the heavy metals add up in an organism than are passed through, thus unless the heavy metals are removed from the environment, they will continue to accumulate in the organism, and the injuries will also continue to persist.

Finally, the Trustees disagree with the commenter's assertion that there is "substantial risk of over-estimating the injuries to natural resources and the associated damages" due to "current and future upstream remedial activities." First, a substantial portion of the Trustees' assessment reflects injury and associated damages pertaining to past conditions (beginning as early as 1981). Current and future remedial activities have no bearing on the determination and quantification of injury and damages associated with the period 1981 through the current time (2013). Second, the assertion that unspecified future remedial activities, occurring at unspecified locations, at unspecified times, using unspecified methods creates a "substantial" risk of overestimating injuries, is unsupported speculation. Future upstream remedial actions, depending on the specifics of actions taken, could have negligible, beneficial or adverse impacts on resources associated with the Grand Lake O' The Cherokees, or there could be a mix of such impacts over time. Currently available information does not credibly suggest a high likelihood of substantial impacts (positive or negative) of upstream remedial activities on resources associated with Grand Lake O' The Cherokees. Third, Trustee analyses presented in this document do not assume injury in perpetuity; rather, they presume some improvement in resource conditions over future decades, thereby providing a degree of accounting for potential natural and/or remedial recovery mechanisms.

Comment 2. The Fish Consumption Advisory for Grand Lake is based on insufficient evidence, relies on evidence that is over five years old, and contains unsupported conclusions.

Trustee response:

The ODEQ is the agency responsible for issuing fish consumption advisories in Oklahoma. In 2008, following standard procedures, ODEQ issued the advisories for carp, smallmouth buffalo, freshwater drum and redhorse sucker caught in Grand Lake, based on 2003 and 2007 studies that were peer reviewed by EPA. The advisories remain in effect today. As stated in DOI's NRD regulations (43 C.F.R. §11.62(f)(1)(iii) ("Exceed levels for which an appropriate State health agency has issued directives to limit or ban consumption of such organism.")), natural resource damage injury is defined to occur when concentrations of a substance "exceed levels for which an appropriate State health agency has issued directives to limit or ban consumption of such organism." The Grand Lake fish advisory constitutes such an Injury under DOI NRD regulations. Any suggestion or implication to the contrary is inaccurate. As a factual matter, the Trustees also note that information provided in the comment is misleading; for example, the fish samples cited in the comment were actually "composite" samples collected and made from multiple fish, a common practice in consumption advisory programs to reduce data variability and costs. Any suggestion or implication, for example, that five samples represent only five individual fish, is inaccurate.

With respect to the frequency of different preparation methods for Advisory fish, the Trustee RCDP analysis is based on Tribal anglers who, Tribal consumers commonly prepare non-game fish with the bones remaining in them, even when filleted, for multiple reasons. First, these particular fish are very boney by nature and generally not amenable to bone removal preparations. Second, the bones and skin of these species are important components of the overall services provided by them to Tribal consumers. Tribal traditional methods of preparing these fish species leaving bones and skin on them results in more flavorful and higher nutrient meals that Tribal users greatly value. Moreover, this traditional preparation serves to perpetuate Tribal cultural uses of the fish.

Comment 3. The Plan lacks a sufficient scientific record to evaluate the potential restoration projects.

Trustee Response:

The CERCLA NRDAR regulations state:

"The purpose of the Damage Determination phase is to establish the amount of money to be sought in compensation for injuries to natural resources resulting from a … release of a hazardous substance. The measure of damages is the cost of (i) restoration or rehabilitation of the injured natural resources to a condition where they can provide the level of services available at baseline, or (ii) the replacement and/or acquisition of equivalent natural resources capable of providing such services. Damages may also include, at the discretion of the [Trustees], the compensable value of all or a portion of the services lost to the public for the time period from the discharge or release until the attainment of the restoration, rehabilitation, replacement, and/or acquisition of equivalent of baseline." (43 C.F.R. § 11.80).

Further, the CERCLA NRDAR regulations provide that the Restoration Compensation and Determination Plan (RCDP) shall be "of sufficient detail to evaluate the possible alternatives for the purpose of selecting the appropriate alternative[s] to use in determining the cost of restoration, rehabilitation, replace and/or acquisition of the equivalent resources, and, where relevant, the compensable value…. ." (43 C.F.R. § 11.81).

Consistent with the CERCLA NRDAR regulations pertaining to the Damage Determination Phase of the NRDA, the Grand Lake O' The Cherokees RCDP provides information and describes a methodology through which an amount of money can be calculated to compensate the public for injuries to natural resources. The Grand Lake O' The Cherokees RCDP contains a description of a reasonable number of possible alternatives for restoration, rehabilitation, replacement, and/or acquisition of equivalent resources as well as the cost estimating and valuation methodologies applied by the Trustees in calculating the damages. (43 C.F.R. §§ 11.80-11.82). It is the monetary amount that the Trustees then seek to recover from the potentially responsible parties. (43 C.F.R. § 11.91).

Additional detail concerning restoration actions that will occur is made available to the public for review and comment in the form of a Restoration Plan but only after the recovery of money from potentially responsible parties. (43 C.F.R. § 11.93). Timing is a practical limitation, as implementation of any restoration project is dependent upon the amount of funding available. The RCDP serves as the foundation for the Restoration Plan, however the Restoration Plan(s) will describe in detail how the monies will be used to address natural resources. (43 C.F.R. § 11.93). Additionally, the Restoration Plan(s) must comply with applicable federal, tribal and state laws, including, where applicable, the National Environmental Policy Act (NEPA). Thus, should the Trustees succeed in recovering monies from the potentially responsible parties for injuries to natural resources in Grand Lake, the resulting Restoration Plan(s) will contain additional description and discussion of the restoration action to occur, including analysis of potential risks to natural resources associated with a particular restoration action and strategies that can be used to mitigate such risks, and public review will be conducted as required under NEPA.

Comment 4. The Plan's loss calculations are based on unverified assumption.

Trustee response:

Commenter asserts that Trustee loss calculations are based on unverified assumptions. Many of the Commenter's assertions reflect the fact that the Commenter does not have access to Tribal survey information collected by the Trustees and utilized in loss calculations presented in the RCDP. Because Responsible Parties associated with this matter have not agreed to participate in a cooperative assessment and this matter could be subject to litigation, it is inappropriate for the Trustees to release Tribal survey information to the public at this time. And as pointed out below, Commenter's assertions fail to account for tribal preferences and values associated with subsistence fishing. (RCDP, Appendix B at pg. B-2 - B-3).

More specifically, the Commenter asserts that the distance traveled to fish utilized in Trustee calculations is significantly overestimated. The Commenter's claim that the Oklahoma 2007 angler survey cited by the Trustees in the RCDP (for background context), and a single article (MacNair and Desvouges 2007) concerning the relative preferences of the public for sport and non-sport fish, support the use of a lower travel distance input for this analysis is unconvincing. The cited MacNair and Desvouges article does not address Tribal preferences, which is a critical issue. Based on Tribal survey and anecdotal information the Trustees find use of the 50 mile distance used in the RCDP analysis to be reasonable.

The comment that anglers beyond the 50 mile range would have much closer substitutes for fishing and would be unlikely to travel beyond those substitutes to subsistence fish for non-sport species again ignores Tribal preferences, is inconsistent with Tribal survey data and anecdotal information, and doesn't explain the known behavior of non-local tribal members who return to the Grand Lake area to renew relationships and take part in Tribal cultural activities, such as traditional subsistence fishing. (RCDP at pg. B-9). With respect to population estimates, the trustees' loss calculations based on 82,992 people within a 50 mile radius of Grand Lake corresponds to the collective enrollment numbers of the tribes. (RCDP at pg. B-7). The trustees didn't include all 82,992 people in estimating tribal losses; rather they included only the estimated 61,663 adults within that population. (RCDP at pg. B-8). For these reasons, no adjustment to the Trustee analysis is warranted.

Regarding comments on fish preparation methods, the non-game fish species listed in the fish advisory are very boney by nature and not amenable to removing bones from them pre-preparation. This is why these species are commonly prepared with the bones remaining in them, even when filleted. Furthermore, Tribal traditional methods of preparing these fish species leaving bones and skin on them results in more flavorful and higher nutrient meals that Tribal users greatly value. This traditional preparation serves to perpetuate Tribal cultural uses of the fish. Finally, as catch limits generally don't apply to these species, they are available for Tribal users capture and consumption in greater numbers than would be possible with game species, and thus important to supporting Tribal subsistence diets.

The Commenter's assertion that the Trustees have not adequately characterized recreational activities in Grand Lake is both incorrect and irrelevant. While the Trustees appropriately provide background contextual information about recreational activities in Grand Lake (RCDP, Appendix B at pg. B-3, 4 and 5), the Trustees' analysis is explicitly focused on Tribal fishing for species with a consumption advisory in Grand Lake. The RCDP does not include loss estimates for other types of Tribal use or public recreational activities. The Commenter's unsupported speculation that Tribal member fishing trips included in the Trustees' analysis are repurposed to target other fish and/or activities (e.g., boating or going to parks) reflects a misunderstanding of Tribal preferences and is inconsistent with Tribal survey data and anecdotal information. For these reasons, no adjustment to the Trustee analysis is warranted.

Comment 5. The Plan incorrectly alleges injury to flora and fauna at Grand Lake.

Trustee response:

Grand Lake sediments and fish resources subject to the consumption advisory are injured, as that term is defined in relevant NRDA regulations. Any assertion to the contrary is incorrect. As stated in the RCDP:

> - "Metals levels in Grand Lake fish are sufficiently elevated that in 2003, DEQ advised the public to limit consumption of whole fish caught in the Spring and Neosho Rivers at the upper end of the lake (OSE 2005), and in 2008, ODEQ issued a fish consumption advisory that includes all of Grand Lake. Residents living in the Tar Creek area are advised not to eat more than six meals per month of non-game fish prepared with bones, and non-residents are advised not to eat more than 11 meals per month of non-game fish prepared with bones (ODEQ 2008a). Non-game fish are culturally significant to the Tribes and include carp, freshwater drum, redhorse sucker, and smallmouth buffalo. This fish consumption advisory constitutes an injury under the DOI's NRDA regulations (43 CFR §11.62(f)(iii))" (RCDP, at pg. 38).
>
> - "The term 'pathway' is defined by the DOI NRD regulations to mean "the route or medium through which oil or a hazardous substance is or was transported from the source of the discharge or release to the injured resource" (43 CFR § 11.14 (dd)). Surface water/sediment resources are defined to be injured if concentrations and duration of substances is sufficient to cause injury to other natural resources (43 CFR § 11.62 (b)(v)). As described in subsequent sections of this chapter, Grand Lake fishery resources have been injured by exposure to metals in Grand Lake sediments. Therefore, Grand Lake sediments are injured" (RCDP, at pg. 37).

Comments about fish preparation methods used by Tribal members and the value assigned to affected fishing trips are repeated elsewhere in the comment submission and addressed by the Trustees in responses to Comments 4 and 6, respectively.

Comment 6. The benefits transfer did not provide any information on the similarity and soundness of the studies that are used in the calculations.

Trustee response:

To estimate the loss per trip associated with the presence of consumption advisories the Trustees relied on values from three published and peer-reviewed studies of reservoir fishing in Tennessee (Jakus et al. 1997 and 1998 and Parsons et al. 1999). The commenters assert that these values overstate losses because they reflect an "average advisory effect" and do not differentiate between full and limited consumption advisories. The commenters reference results from the Fox River Study, which examined advisories varying in severity in and around Green Bay Wisconsin. To the Trustees' knowledge, the referenced report is not publicly available. Results from the study appear in a published article by the same authors (MacNair and Desvousges, 2007) but do not match those referenced in the comments. In addition, the commenters assert that the Trustees' per-trip value, applied to lost trips associated with the consumption advisories, is also overstated. In both cases the commenters do not suggest an alternative value.

The Trustees believe that the use of the Jakus et al. and Parsons et al. studies identified in the RCDP is reasonable. While the Trustees' and commenters disagree as to what constitutes sufficient similarity in the context of benefit transfer, it is important to recognize that losses to Tribal members associated with the presence of consumption advisories are unlikely to be fully reflected in values estimated in a recreational context. Importantly, these values do not take into account the cultural, subsistence and social values that are necessarily diminished by the restrictions. The Trustees maintain that the values applied in the RCDP reflect a reasonable lower-bound estimate of Tribal fishing losses.

Comment 7. The Trustees have failed to provide any rationale as to why their restoration alternatives are preferred.

Trustee response:

DOI draft response: The Trustees have selected two alternatives, dredging selected areas within Grand Lake and Tribal cultural projects, as appropriate for consideration in the RCDP and these alternatives are evaluated in Chapter 5. In section 5.2 (pages 52-59) the Trustees discuss the benefits and risks associated with all the Alternatives, including Alternative 5 (dredge selected areas within Grand Lake). As stated in the RCDP:

> "this alternative [5] is the only alternative that would directly address the presence of contaminants in the ecosystem. In the long run, this alternative is likely to result in a healthier biological ecosystem, where benthic organism productivity was less impaired by the presence of metals at toxic concentrations. It may reduce the length of time for which fishing advisories are in place."

The Trustees go on to discuss why Alternative 5 and Alternative 7 (Tribal cultural projects) are selected as the preferred alternatives in section 5.4. However, the RCDP does not replace the Restoration Plan/Programmatic Environmental Assessment (RP/PEA) document. The RP/PEA will describe restoration projects in more detail, include a NEPA analysis, and prioritize restoration actions that will restore, replace, or rehabilitate injured resources to their baseline condition, and/or lost resource services.

Comment 8. The Plan does not discount future losses and thus improperly overvalues the present value of the alleged damages.

Trustee response:

The Trustees disagree with the Commenter's assertion that a 7% annual discount rate is appropriate for use in the Trustees' dredging cost analysis. That discount rate needs to reflect the annual return Trustees can reasonably expect on funds deposited in the current specified year, to meet costs that will be incurred in future years. The 7% rate cited by the Commenter is not appropriate for that specific purpose, and substantially overestimates annual rates of return the Trustees could reasonably expect on deposited funds, which are likely to be limited to investments in US government securities and/or similar conservative instruments. Overestimating the actual annual return Trustees would receive on deposited funds would result in insufficient funds available to the Trustees to meet forecasted future restoration cost needs. The 3% annual rate used by the Trustees is more appropriate for this purpose, and retained in the Trustees' analysis. However, the Trustees recognize that this 3% discount rate should be applied to the Trustees' Tribal fishing loss estimate and we have made this change in the Final RCDP in addition to updating costs from 2012$ to 2014$.