

REMEDIATION OF THE TAR CREEK SUPERFUND SITE: AN UPDATE¹

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Abstract: The Tar Creek Superfund Site is a portion of an abandoned lead and zinc mining area known as the Tri-State Mining District (OK, KS and MO) and includes approximately 104 km² of disturbed land and contaminated water resources in extreme northeastern Oklahoma. Underground mining from the 1890s through the 1960s degraded over 1000 surface ha, and produced nearly 500 km of tunnels, 165 million tonnes of processed mine waste materials (chat), 325 ha of tailings impoundments, 94 million m³ of contaminated ground water and over 2600 shafts and boreholes. In 1979, metal-rich waters began to discharge into surface waters from natural springs, bore holes and mine shafts. The site was listed on the National Priorities List in 1983. Approximately 70% of the Superfund site is Native American owned. In 1993, an Indian Health Service study established that 35% of children had blood lead levels above threshold levels dangerous to human health. Since 1995, residential remediation efforts have been ongoing, but a holistic watershed restoration strategy has not been implemented. Current research focuses on the biogeochemistry, ecology and hydrology of existing natural wetlands, and the development of sub-watershed restoration plans. These efforts indicate that environmental problems at this site are not insurmountable, but that solutions do require substantial cooperation among federal, state, tribal and local entities. The principal final recommendation of a recent state task force was the creation of a massive wetland and wildlife refuge to ecologically address health, safety, environmental and aesthetic concerns. This plan involves the removal of two communities, construction of a large reservoir and several treatment wetlands, and creation or restoration of marshes and prairie habitat. However, significant concerns regarding the long-term effectiveness and feasibility of this plan need to be addressed.

Additional key words: ecological engineering, ecosystem restoration, mine land reclamation.

Introduction

Hardrock abandoned mine reclamation (HAMR) has been identified as a major environmental issue to be addressed in the 21st century (MPC, 1997; IIED, 2001). Lyon et al.

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(1993) estimated that over 550,000 abandoned hardrock mine sites exist in 32 states. Projected costs for remediation and reclamation of these sites have been estimated at \$33-72 billion (MPC, 1993).

Although often associated with ore-rich Rocky Mountain mining districts, one of the most challenging HAMR sites is found in northeastern Oklahoma (Nairn et al., 2001). Located in that state's portion of the Tri-State Mining District (Oklahoma, Kansas and Missouri), the Tar Creek Superfund Site includes the Picher Mining Field, one of the world's major lead and zinc-producing regions of the 20th century. It is adjacent to the Cherokee County (Kansas) and Oronogo-Duenweg Mining Belt (Missouri) Superfund Sites. Major underground mining operations dominated the region from the 1890s through approximately 1970. Ore deposits consisted of lead and zinc sulfides associated with fossiliferous dolomite, limestone and nodular chert host rock (McKnight and Fischer, 1970; Luza, 1983). Peak mineral production occurred in the early 1920s when the mines accounted for over 55% of total U.S. zinc production. By the late 1950s, depressed global markets resulted in the suspension of most mining operations. By the early 1970s when mining ceased, almost 2 million tons of lead and 9 million tons of zinc had been produced (McKnight and Fischer, 1970).

In Oklahoma, mining activity was concentrated in the Tar Creek watershed and adjacent drainage basins in Ottawa County. Approximately 1,000 ha are underlain by underground mine workings (Figure 1; Luza, 1983). During active mining, substantial dewatering operations pumped 50,000 m³ of water per day (Reed et al., 1955). When pumping ceased, groundwater filled the mining voids, which now contain approximately 95 million m³ of contaminated waters. In late 1979, metal-rich waters began to discharge to the surface from natural springs, boreholes and abandoned mine shafts. In addition, approximately 75 million tons of unvegetated mine waste materials (chat) still litter the surface in large piles and approximately 325 ha of tailings ponds exist. These materials are contaminated with elevated concentrations of lead, zinc, cadmium and iron (EPA, 2002).

Past and Ongoing Remediation Efforts

The site was proposed for the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund) National Priorities List (NPL) in 1981 and received final

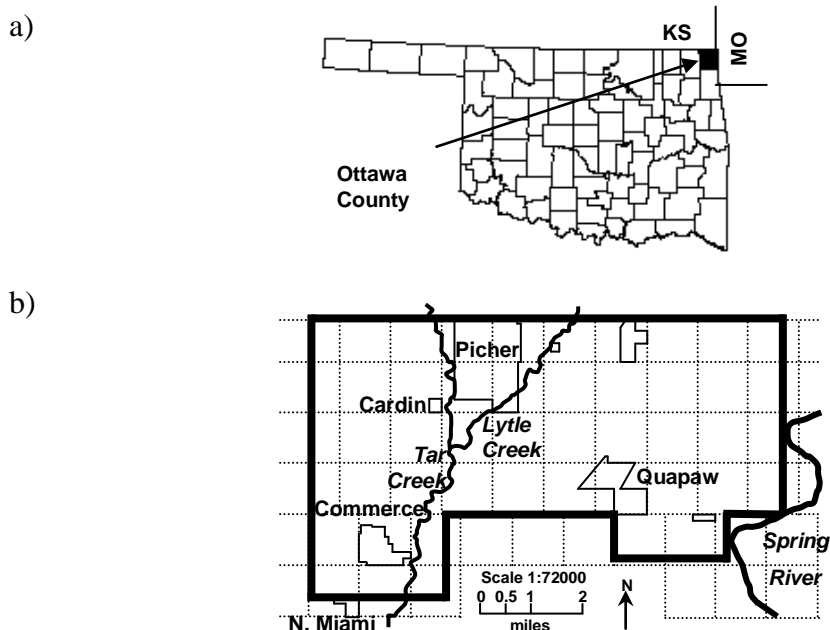


Figure 1. Maps showing a) location of Ottawa County, Oklahoma bordering the states of Kansas and Missouri and, b) the boundaries of the Tar Creek Superfund Site, location of local communities and major surface water drainages. Dotted lines represent section lines.

listing in 1983. The Superfund site encompasses over 100 km² and includes six incorporated communities. Over one-half of the land is Native American owned. Volumes of contaminated waters, sediments, waste materials, and soil are large by any mining industry standard and these materials are in close proximity to residential communities and their inhabitants, thus further complicating remediation efforts. Extensive use of chat as aggregate in road and driveway construction, concrete foundations, buildings, and recreational facilities (i.e., sandboxes and playing fields) helped spread contamination problems outside the mining area. Complex jurisdictional issues regarding Native American sovereignty and land rights also make matters complicated.

Initial remediation efforts (mid-1980s) focused on ground and surface water contamination. Actions included the provision of emergency water supplies and plugging of boreholes and improperly sealed wells to reduce the threat of contamination of the deeper drinking water aquifer. Also, large-scale attempts were made to halt surface water from entering the mine voids via diversion of surface inflows. However, these attempts failed to decrease impacts to the receiving waters. The second EPA Five Year Review cites an Oklahoma Water Resources

Board memorandum that states that Tar Creek has incurred “irreversible man-made damages” resulting from past mining operations (EPA, 2000).

In 1993, an Indian Health Service (IHS) study indicated that approximately 35% of children tested in the Superfund area had blood lead levels (BLLs) greater than 10 ug/dL. BLLs greater than this amount have been identified by the Centers for Disease Control as being dangerous to human health. Fifteen percent of the children had BLLs greater than 20 ug/dL. EPA’s Baseline Human Health Risk Assessment identified lead as the only contaminant of concern and oral ingestion as the only significant exposure route. Remediation efforts were initiated in 1995 to clean up lead contaminated residential areas through soil removal and disposal operations.

Recently Proposed Remediation Strategies

In January 2000, Oklahoma Governor Frank Keating established the Tar Creek Superfund Task Force to take a “vital leadership role in identifying solutions and resources available to address” the problems at this site. Eight subcommittees, composed of volunteer technical experts, were created to address distinct concerns at the site: Health Effects, Mine Shafts, Subsidence, Chat Use, Drainage and Flooding, Water Quality, Native American Issues, and Natural Resource Damage Assessment (NRDA).

In October 2000, technical subcommittee reports were submitted to the Task Force. Each subcommittee offered targeted solutions for the different missions with which they were charged. However, total cost estimates ranging from \$540 million to \$61 billion indicated the possible need for a comprehensive plan of action that would address the myriad problems at a reasonable economic cost, and potentially provide benefit to the local community. Therefore, the task force enlisted the assistance of the U.S. Army Corps of Engineers to develop a holistic solution. The resulting Concept Plan called for creation of a massive wetland and wildlife refuge that required the removal of the towns of Picher and Cardin and creation of a 221 ha reservoir, almost 700 ha of restored and created wetland habitat, and 130 ha of treatment wetlands at a total cost (including land acquisition and relocation assistance) of \$250 million (Governor’s Task Force, 2000). As of early 2002, no action on this proposal has been taken.

Current Situation

Considerable technical concerns regarding the Concept Plan remain unanswered. Despite providing a basic framework for possible comprehensive resolution to human health, environmental, and aesthetic concerns, the scientific foundation of the Concept Plan is questionable. Finding solutions to the massive problems at Tar Creek will require innovative solutions, however, it is essential that any proposed answer be based on sound technical information.

Of prime importance are the possible detrimental effects of impounding a massive load of water over the mining voids, thus considerably increasing mine pool hydraulic head differences. In addition, the current plan does not explicitly address water quality concerns, because the reservoir simply inundates many of the major discharges. Quality of water in the reservoir would therefore be suspect. The plan does not clearly include removal of chat piles, thus allowing a significant source of contamination to remain.

The plan includes provisions for creation of substantial areas of wildlife habitat wetlands. Important concerns regarding bioaccumulation and toxicity exist in these “attractive nuisances” to wildlife. Soils to be seasonally flooded are contaminated with lead, cadmium, zinc and other metals. An ecological risk assessment has not been completed at the Tar Creek site, and extensive experience exists with the detrimental effects of contaminated sediments on wildlife (Ohlendorf et al., 1986, 1993; Presser, 1994; Engberg and Cappellucci, 1993).

Although flood control was described as a major benefit of the Concept Plan, sufficient flood hydrograph information for Tar Creek does not exist. In addition, flooding in downstream communities is likely due to the backwater effects of an existing reservoir. The treatment wetlands component of the plan is two orders of magnitude larger than any project that has been attempted in the past, and placement, design and sizing of these systems is questionable. Comprehensive mine drainage quality and quantity data collection efforts, which are essential to proper implementation of this remedy, ended in the mid-1980s. Also unanswered are socioeconomic questions regarding the acquisition of tribal lands and development of an acceptable relocation proposal. Adequately robust risk assessments (including ecological factors as well as culturally-based issues related to Native American lifestyles) and calculations of resultant risk reduction need to be completed. Prior to implementation, sufficient technical data,

in which the Concept Plan is particularly deficient, must first be gathered and shared with local stakeholders.

In late 2001, the State of Oklahoma asked for the assistance of the White House Council on Environmental Quality (CEQ). A CEQ team was asked to examine the Concept Plan and provide objective feedback on the feasibility and likelihood of success. In January 2002, a CEQ team visited the site and participated in several meetings with both the public and the technical community. The CEQ summary report is due sometime in spring 2002.

Throughout this process, university research has focused on the biogeochemistry, ecology and hydrology of existing natural wetlands, reexamination of mine drainage discharge quality and quantity, and development of sub-watershed restoration plans (e.g., Nairn et al., 1999; Nairn et al., 2001a; Nairn et al., 2001b; Athay et al., 2001; Coffey et al., 2002; Brumley et al., 2002; Nairn et al., 2002). Overall objectives are to establish current baseline environmental measurements and to demonstrate sustainable and cost-effective remediation strategies using the techniques of ecological engineering science. Specific studies examine the practicability of treatment wetlands and other passive techniques for water quality improvement, manufacture of asphalt using mining residuals as aggregate and design of whole watershed restoration approaches. Technical plans calling for creation of an information clearinghouse, comprehensive environmental monitoring programs and a scientific research strategy have been developed.

Conclusions

Despite the added notoriety of recent years, the Tar Creek Superfund Site remains one of the most challenging HAMR sites in the U.S. and on the NPL. Due to the massive areal extent of disturbance and contamination; volumes of contaminated waters, sediments, waste materials, and soil; proximity to several communities; and inclusion of sovereign Native American lands, comprehensive remediation efforts will require innovative solutions. These remediation challenges should be viewed as opportunities to launch sustainable and forward-thinking strategies for remediation of mined lands. However, the long-term success of any remedy will depend on a solid foundation of quality science and engineering, coupled with local cooperation and understanding.

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