

RECLAMING THE COPPER BASIN OF TENNESSEE ¹

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Abstract. For more than 150 years, the Copper Basin in Tennessee was the site of copper mining and acid production. It is one of the most dramatically impacted mining areas in the US. As part of voluntary remediation efforts, Glenn Springs Holdings has committed to actions with long-range goals of restoring biodiversity and biointegrity. This work follows decades of land reclamation and reforestation efforts on the 9,000 hectare site. Included are chemical treatment of acidic surface and underground mine drainage, land reclamation, passive treatment systems, restored streams, tailings and mine waste reclamation, waste characterization and pit disposal, pit limnology and leak studies, lead cap, hazards fencing, subsidence monitoring, stream diversion, bioassessment, and land use planning.

Additional Key Words: Ducktown TN, acid mine drainage, Ocoee River

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Introduction

The Copper Basin Mining Area of Tennessee is one of the most complicated and comprehensive environmental restoration sites in the United States. What was once perhaps the largest man-made biological desert in the nation is being ameliorated to restore biointegrity, while preserving the unique history of the area. Additionally, the Copper Basin Project is distinguished as a model for interagency/corporate cooperation. After more than 150 years of copper and iron mining, more than 13,000 hectares (50 square miles) were denuded by the timbering and emissions associated with the ore processing. With sparse or no vegetation cover, runoff eroded massive quantities of silt to the Ocoee River. Bright orange streams conveyed acidity and metals from the largest shaft metal mines east of the Mississippi. Abandoned and collapsing mine works and other deteriorating facilities and waste piles posed significant physical hazards. Reforestation efforts led by industry assisted by government agencies and academic institutions that began in the 1930's have turned most of the former moonscape into just another drive in the forested countryside of the Smoky Mountains. Some 16 million trees (mostly pine) have eased the visual impact from US 64, and there is hope that the quality of the two affected watersheds, North Potato Creek and Davis Mill Creek will continue to improve. This dramatic change is a result of the years of cleanup effort by the mining and chemical companies operating in the Basin with the assistance of TVA, SCS, and the natural attenuation that only time can provide. Both the Tennessee Department of Environment and Conservation (TDEC) and USEPA Region IV sought a solution to the problems at the site with Glenn Springs Holdings (a subsidiary of Occidental Petroleum) while avoiding Superfund National Priority List status. An unprecedented cooperative agreement led to the area being designated as a Superfund Alternative site. This allowed huge cost savings as the voluntary agreement focused on a phased remedial plan to stop the flow of contaminants to the Ocoee River and restore biological integrity to the North Potato Creek watershed.

Erosion presented in historic photographs of the Copper Basin rivals even the most dramatically abandoned surface mines, but mining, begun in 1843, was conducted solely by open cuts in black copper workings and by underground methods as the ore bodies were narrow and deep. Trees were cut and used to fuel open-pit smelting of the raw ore, which was burned slowly in large heaps for two to three months to lower its sulfur content. The escaping smoke and other steps in the smelting operation released sulfur dioxide into the air. Soon the area's vegetation was either removed for fuel or killed by fumes. It is documented that by 1878, 13,000 hectares (50 miles³ or 32,000 acres) were denuded. This, combined with steep terrain and high annual rainfall, created severe erosion. Sulfuric acid production replaced mining as the prominent industrial activity in the early 1900's.

In the mid 1970's, North Potato Creek was diverted through a one kilometer (3,000 foot) tunnel to Davis Mill Creek, and the first open pit surface mining was conducted within an abandoned reach of North Potato Creek. The 8 hectare (20-acre) final pit was left open to provide a sediment trap to protect the Ocoee River as the stream was restored to its original alignment. Sediment loads for the basin had been so high that planners expected the 60 meter (200 foot) deep pit to fill with sediment in a few years, but the successful reforestation effort has curbed erosion to the extent that the pit will remain viable for many more years to clarify the water from the 3900 hectare (15 square mile) watershed. It is being used as a clarifier and final repository for metal precipitates produced as the new water treatment plant treats up to 27 m³/s (972 cfs or 436,000 gpm) expected in a 10-yr, 24-hr storm in the watershed. The hydrated lime

plant employs a novel approach, drawing highly acidic and metal laden water from deep in the stratified pit to accelerate the neutralization and nucleation reactions of the mildly acidic and low metal content of the creek flow, resulting in formation of stable metal precipitates.

The agreement with EPA required Glenn Springs to conduct a study to determine the appropriate remedial action to alleviate contaminant discharge from North Potato Creek into the Ocoee River. As part of the study, a streamlined risk assessment based on human health risk based screening values determined that current conditions posed no human health risk. Consequently, ecological impacts were the principal focus of the study and chronic and acute ecological screening values were used to determine that aluminum, cadmium, cobalt, copper, iron, manganese, lead, and zinc were the contaminants of potential ecological concern.

In the past few years, Glenn Springs Holdings has accomplished many objectives that move the Copper Basin Project toward the ultimate objective of eliminating health and safety risks, protecting the Ocoee River, and restoring biointegrity in North Potato Creek.

Over 8 kilometers (5 miles) of chain-link fence have been installed to limit access to the mine collapses. Time Domain Reflectometry technology is used to monitor for additional subsidence. Less prominent mine collapses have been stabilized with clean fill. North Potato Creek and Davis Mill Creek were adding enough metals to the Ocoee River to make two automobiles every day. Refurbishing a lime AMD plant in one watershed and constructing a new, second plant in the other (perhaps the world's largest capacity) has reduced this load to nearly zero. The treatment load in the most dramatically affected watershed, (1300 hectare; 5 square mile Davis Mill Creek) has been reduced by diverting the unaffected flow from the upper 900 hectares (3.5 square miles) of the watershed through one kilometer (3000 feet) of the world's largest diameter (1.6 meter or 63 inch) polyethylene pipe. PCBs and lead have been contained by removal and capping of affected areas. A demonstration passive treatment system continues to remedy the 1100 lpm (300 gpm) flow in McPherson Branch after seven years of operation. A constructed stream segment provides suitable habitat for the alkaline, metal free effluent to support benthic macroinvertebrates, verified by an annual biological study. Mine wastes and their hydraulic influence in dumps and along the transportation corridors have been characterized by methods including X-Ray Fluorescence, Acid Base Accounting, and Interstitial Pore Analysis. A First Phase effort to dispose of much of the mine waste in a major mine collapse is underway. The flooded, acidic deep mines have been continuously pumped and chemically treated to prevent gravity discharges to the streams. The Ocoee River has exhibited remarkable visible improvement as seen at the Olympic Whitewater Center several miles downstream. Annual biosurveys that compare the recovering reaches and tributaries against a reference section upstream of mining activities serve as another measure of performance of remedial efforts. Over 120 hectares (300 acres) of barren tailings flats, a major source of wind erosion, have been successfully revegetated and planted with over 80,000 trees. Research has been conducted by the University of Tennessee and Tennessee Wildlife Resources Agency. Glenn Springs has partnered with the Copper Basin High School, and other Basin schools, offering resources and speakers for its ecology and science classes, and provides a full college scholarship each year. The company has also partnered with the Ducktown Basin Museum to help preserve the historic past of the Copper Basin. Former mining engineers and the museum curator assist in archiving valuable mining structures, records and artifacts, all visible at the museum and which overlooks a purposely un-reclaimed portion of the basin. Future-use improvements are designed to provide an economic and recreational asset for the Ducktown/Copperhill region and the State of Tennessee. The improvements would encourage

cultural, historic, and environmental tourism through enhancements of historic mining features, and would be important to the region's economy. Plans within the next 10 years include expanding the Ducktown Copper Basin Museum as the center of walking/bicycle trails that connect with local and regional trail systems, interpretive trails and outdoor classrooms designed to educate the visitor about mining operations, post-mining land stewardship practices, and the natural history of the area.

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