4 MINUTE READ

Mayer Ranch

from **Engineering With Nature: An Atlas, Volume 3.**

by **US Army Engineer Research and Development Center**

Ottawa County, Oklahoma, United States

Implementing a region's first-of-its-kind, full-scale mine water quality improvement system. Mining and mineral processing around the world have resulted in massive disturbances to and the degradation of land and water. Surface water and groundwater at the Tar Creek Superfund site in Oklahoma's Tri-State Lead-Zinc District were deemed "irreversibly damaged" decades ago, and elevated concentrations of trace metals have severely degraded local streams. In 2008 the University of Oklahoma Center for Restoration of Ecosystems and Watersheds, the U.S. Environmental Protection Agency, the Oklahoma Department of Environmental Quality, and the Quapaw Nation implemented the Mayer Ranch passive treatment system at the site. By merging ecosystem ecology and engineering design, the system uses natural processes to efficiently produce treated water that meets in-stream quality criteria and maximizes diverse benefits, including a recovered fish community and reestablished populations of beavers, otters, and other fauna. Now that initial construction and planting of select process units have been completed, operation and maintenance commitments are minimal. Mayer

Ranch has been the site of several university research projects and class visits, and dozens of public outreach tours are conducted there every year. The collaboration of state, local, and tribal partners has been fundamental to the project's success, and the university's community-engaged, service-learning approach has led to the installation of another passive treatment system and plans to further address other polluted water sources.

Article Cover: University of Oklahoma (OU) Center for Restoration of Ecosystems and Watersheds (CREW) researchers collecting vegetation samples from the surface-flow wetland process units in summer 2023. (Photo by OU CREW)

Producing Efficiencies

The passive treatment approach is based on decades of research to thoroughly understand naturally occurring biogeochemical mechanisms and optimize an Engineering With Nature (EWN) approach. Although conventional methods of improving water quality are available, they often are neither financially nor operationally feasible at abandoned industrial sites. Successful operation of the passive treatment system requires efficient coupling of natural ecosystem processes with a thorough site-specific environmental characterization to design, build, and operate multiple ecosystem-type process units addressing a mix of environmental risk drivers. Coproduction of benefits is efficiently enhanced by allowing ecological selfdesign to dictate and modify system configurations.

Using Natural Processes

Active treatment approaches to improve water quality require the regular addition of refined chemicals, constant use of fossil fuels, and consistent operation and maintenance oversight. Passive treatment approaches rely on environmental conditions to optimize natural processes and maximize benefits. At Mayer Ranch, aerobic (requiring oxygen) and anaerobic (requiring no oxygen) biogeochemical mechanisms are maximized in different process units to address distinct objectives. All hydrologic flows are driven by hydraulic head differences, and solar and wind energies are used to enhance physical, chemical, and biological performance. Operationally, the implemented system requires no fossil fuel commitment and only minimal maintenance.


RED OUT

OU CREW researchers filtering water samples at the final outflow in spring 2017. (Photo by OU CREW)

Broadening Benefits

The passive treatment system has improved water quality, aided the ecological recovery of the receiving stream, and provided wildlife habitat and a broad suite of ecosystem services. Located on the historic treaty lands of the Quapaw Nation and in a region of economic and environmental decline, the project's social benefits include promising ecological restoration alternatives, evidence of the critical role of traditional ecological knowledge in solving environmental challenges, significant opportunities for public outreach, education, and research, demonstration of effective naturebased solutions, and provision of optimistic future expectations. Economic benefits include providing a foundation for economic recovery by demonstrating that intractable environmental problems are solvable.

Sampling one of the mine water inflows to the Mayer Ranch passive treatment system in fall 2022.

(Photo by OU CREW)

Promoting Collaboration

The project demonstrates the power of collaboration to address recalcitrant problems. In addition to state and federal agencies, the role of multiple academic, tribal, local government, and nonprofit partners cannot be overstated. Despite the myriad challenges presented by conducting innovative work on a Superfund site on Native land, the diverse partners recognized the many cobenefits of an EWN approach and provided direct and indirect support to university-led efforts. Most important, because the project is on private land, it required the nurturing and maintenance of trustworthy relationships with agricultural producers.

A North American river otter (Lontra canadensis) captured at the Mayer Ranch outflow by a remote wildlife camera in 2023. River otter were not seen in this watershed until after the return of fish populations in 2009 and beaver (Castor) populations in 2013.

(Photo by OU CREW)

More articles from this publication:

Kaskaskia River Basin

4min pages 284-287

Port of Málaga

4min pages 280-283

Big River at Calico Creek

4min pages 276-279

Shark River

4min pages 272-275

Port Lands

5min pages 268-271

Cape Cod

4min pages 264-267

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4min pages 260-263

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5min pages 252-255

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4min pages 292-297

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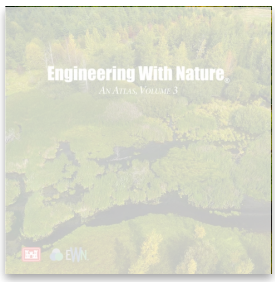

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