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Nature-Based Solutions Linking Reclamation to Remediation and Restoration on Derelict Mining Sites

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Reclamation of mined lands and waters often does not lead to adequate ecological restoration, which is confounded at sites requiring remediation of hazardous materials. Despite decarbonization efforts, the global transition to a renewable energy economy requires continued mining. Nature-based solutions (NBS), recognizing the inherent interdependencies of humanity and nature, are key to building a sustainable future. Much can be learned from NBS applications at mine sites. The Tar Creek (Kansas-Oklahoma, USA) watershed of the Tri-State Lead-Zinc Mining District is a test bed to explore linking reclamation, remediation, and restoration on over 100 km² of degraded land contaminated by mining wastes. Artesian flowing mine waters, along with waste leachate and runoff, contribute elevated ecotoxic metals concentrations to receiving streams. Land reclamation activities have been ongoing for decades, with substantial initial efforts focused on soil removal in residential locations. Remediation of source materials has increased dramatically in the past decade, led by the Quapaw Nation, and has resulted in the return of previously derelict lands to agricultural use. Two full-scale mine water passive treatment systems, led by the University of Oklahoma, were installed to address selected source waters. They produce circumneutral pH, net alkaline effluents containing ecotoxic metals concentrations meeting in-stream water quality criteria. The receiving stream has demonstrated substantial water quality improvement and ecological recovery, with documented increases in both fish species richness and abundance, as well as the return of North American beaver and river otter. Although ecological restoration is implied by these reclamation and remediation activities, it is not an implicit goal of these efforts. New guidelines may provide a framework for coordinated restoration efforts.