Evaluating Sources, Mass Loadings and Fate of Total and Dissolved Metals to Prioritize Restoration in a Mining-Impacted Watershed[1]

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Abstract: Surface and ground waters in the Tar Creek and adjacent watersheds[3] of the Oklahoma portion of the Tri-State Lead-Zinc Mining District were deemed to be degraded due to "irreversible man-made damages" over 35 years ago. This administrative decision resulted in minimal effort to address risk from legacy mine waters. Stream water quality is degraded by both artesian mine water discharges (point sources) and waste pile leachate and runoff (nonpoint sources). Stream water quality is net alkaline with circumneutral pH and elevated concentrations of iron, zinc, lead, cadmium, nickel, sulfate, calcium, magnesium, and sodium. Stream hydrology is flashy and event-driven, with discharge rates ranging from near zero to greater than 30 million m^3/day for the period of record (1989-2022). A long-term comprehensive analysis of stream water quality and quantity data demonstrates the distinct influence of artesian discharges, which tend to be ferruginous, with iron concentrations several orders of magnitude greater than those found in waste pile leachate and runoff. Artesian discharge volumetric flow rates are seasonally variable and considerable, and typically provide mass loadings of more than one million g/day of metals to the streams. Tens of millions of tons of mining waste remain on the land surface, contributing contaminated leachate and runoff to local streams, as well as providing physical disturbance to aquatic and riparian habitats through erosion and subsequent deposition. Analysis of this dataset indicates that both point and nonpoint sources of ecotoxic metals contribute to stream degradation, and comprehensive watershed management is necessary for successful environmental restoration. Although land reclamation activities have been ongoing, with particularly increased efforts over the past decade, and two full-scale passive treatment systems are treating specific artesian discharges, a holistic reclamation strategy has not been implemented. By analyzing stream loading data i) upstream of mining influences ii) in stream reaches with solely nonpoint influences, and iii) in stream reaches with both point and nonpoint influences, prioritization plans for targeted reclamation activities may be developed.

Additional key words: Passive treatment, water quality geochemical modeling, stream ecology.

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3. Work reported here was conducted near 36°57’29” N, 94°50’41” W.