

Hydrologic Budgets and Conservative Ions: Potentially Important Yet Neglected Tools in the Evaluation of Passive Treatment System Effectiveness¹

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Abstract: The design of passive treatment systems has advanced considerably in recent decades. Individual process unit designs are typically based on contaminant mass loads and empirically-derived mass removal rates, requiring reliable source water quality data and selected design volumetric discharge rates. However, performance evaluations often depend on water quality concentration changes alone, assuming no changes in water throughput rates, ignoring portions of the hydrologic budget, and disregarding any mechanisms affecting water chemical composition other than those designed to directly address constituents of concern. In this study, hydrologic budgets were estimated for two Oklahoma passive treatment systems in the Tri-State Lead-Zinc Mining District. Reliable inflow and outflow volumetric discharge rates were obtained monthly, pressure transducers were installed in each process unit to monitor water level fluctuations continuously, monthly rates of evapotranspiration were calculated, and daily precipitation data were obtained from the Oklahoma Mesonet. Based on soils data collected during construction, seepage rates were considered negligible. Concentrations of conservative ions (e.g., Mg, Na, K), assumed to be those to change only due to dilution or evaporation, were used to estimate the effects of precipitation, drought, and temperature extremes. Annual evapotranspiration exceeded or was equal to total water volumes of the passive treatment systems. Mean monthly rates of evapotranspiration and precipitation were approximately 8% of volumetric inflow rates. Given the dynamic climate of the Great Plains, precipitation varied considerably both intra- and inter-annually. Monthly precipitation volumes accounted for as much as 20% of volumetric inflow rates. Changes in concentrations of conservative ions indicated that evaporative concentration could underestimate contaminant removal rates by up to 20% in summer months, depending on duration of drought. However, temporal matching of influent and effluent samples may introduce error. These techniques may provide insight into improved passive treatment performance evaluation.

Additional Key Words: water budget, evapotranspiration, precipitation, dilution, evaporative concentration

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1. Oral paper presented at the 2018 National Meeting of the American Society of Mining and Reclamation, St. Louis, MO: The Gateway to Land Reclamation, June 3 - 7, 2018. Published by ASMR; 1305 Weathervane Dr., Champaign, IL 61821.
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 3. Work reported here was conducted near 36° 55' 31" N; 94° 52' 16" W.