Modeling Natural Attenuation of Nickel in an Acidic Plume

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Past releases associated with metal plating activities resulted in an acidic sulfate plume with elevated concentrations of Ni, Cu, Cd, and Zn in the shallow aquifer beneath a metal plating facility located adjacent to a waterway in the northwestern United States. Extensive field and laboratory investigations, including subsurface stratigraphy, hydraulic testing, aquifer mineralogy, sorption capacity, and hydrochemistry, provided the basis for developing a conceptual model for Ni fate and transport in groundwater and parametrizing a reactive transport model using PHAST to assess the viability of natural attenuation processes for long-term protection of groundwater and surface water quality. Simulations were performed to generate spatially distributed dissolved, adsorbed, and solid-phase Ni concentrations reflecting present-day conditions, and used as a starting condition for predictive simulations to evaluate effectiveness and cleanup timeframes of several remedial alternatives under considation. Long-term (1,000 year) simulation results indicate that millerite (NiS) precipitation and Ni adsorption on iron oxides effectively attenuate the elevated Ni concentrations in groundwater immediately downgradient of the source area, resulting in an essentially immobile groundwater plume that shrinks over time. Sensitivity analyses were conducted to assess the influence of sulfate reduction rates in driving millerite precipitation and overall natural attenuation of Ni. Reactive transport modeling quantitatively demonstrated the robustness of natural processes in regulating Ni concentrations and transport in groundwater and provided support for continued protectiveness of water quality in the waterway.