The viability of water balance covers constructed with mine tailings and waste rock

Mohammad Gorakhki and Christopher A. Bareither
Department of Civil and Environmental Engineering, Colorado State University

Abstract. The focus of this study was to evaluate the re-use potential of mine-waste materials in water balance cover systems. Water balance covers are designed to minimize percolation and oxygen ingress into underlying waste via moisture retention while also providing resistance against slope failure and erosion of cover materials. The two predominant waste materials that require short- and long-term management are tailings and waste rock. Tailings typically are fine-grained particles, whereas waste rock generally is gravel- to cobble-sized material with some sand and fines. Disposal and management of mine waste in impoundment facilities can be challenging due to variability in physical and chemical properties of the tailings. The ability to use mine waste in water balance covers systems will enhance mine sustainability via reducing the overall disposal footprint, decreasing natural resources required for constructing final cover systems, and expediting mine closure. A site-specific investigation on the hydrologic performance of a water balance cover system waste conducted for an operating municipal solid waste (MSW) landfill in Missoula, Montana. The actual water balance cover was designed with 1.22-m-thick storage layer consisting of the native soil (silty sand) and a 0.15-m-thick topsoil layer. In this study, the storage layer soil was replaced in the numerical models with four different types of mine tailings, including (i) copper, (ii) gold, (iii) coal, and (iv) oil sand tailings. Variably saturated, one-dimensional flow modeling was conducted with WinUnsat-H, which is a finite difference model that employs a modified-Richards equation. . Percolation at the base of the cover system was the critical water balance parameter evaluated as this governs model acceptance in actual applications. The percolation in oil sand tailings and coal tailings was lower in comparison with the actual cover, where as gold tailings yielded approximately the same percolation, and copper tailings yielded a higher percolation relative to the actual cover. Analyses conducted that considered the inclusion of waste rock within the tailings layer all led to increased percolation compared to cases of pure tailings water balance covers. These increases in percolation were attributed to a decrease in storage capacity as waste rock particles were simulated as inclusions within the tailings layer with no internal porosity. Increases in the waste rock content for a given water balance cover system systematically decreased storage capacity and increased percolation. Obtaining a comparable low rate of annual percolation in a mixed waste rock and tailings cover design is possible, but requires an increased thickness of the storage layer to offset reductions in storage capacity that accompany inclusion of waste rock.