

Derivation of a Liquid-to-Solid Ratio for ASTM Method D3987-85 for Soils Containing Chromite Ore Processing Residue Using Selected Unsaturated Zone Models

Paul K. Scott,¹ John C. Petura,² and Mark Harris³

¹Glasland, Bouck, and Lee, 600 Waterfront Drive, Pittsburgh, PA 15222, phone: 412-631-6624, fax: 412-231-6147; ²Applied Environmental Management Inc., Malvern, PA 19355, phone: 610-251-0450, fax: 610-251-0711; ³Exponent, Houston, TX 77099, phone: 281-983-4016, fax: 281-879-0687

While most health-based cleanup levels for hexavalent chromium [Cr(VI)] in soil are established to protect the general population against cancer, the New Jersey Department of Environmental Protection (NJDEP) has established a Cr(VI) soil cleanup criterion to protect Cr(VI)-sensitive individuals against allergic contact dermatitis (ACD). For this criterion, exposure is assumed to occur when a Cr(VI)-sensitized individual contacts a puddle in which rainfall has dissolved Cr(VI) from the associated surface soils. To simulate the movement of Cr(VI) from surface soil into puddle water after rainfall events,

this soil cleanup criterion requires that the Cr(VI) concentration extracted from soil using ASTM Method D3987-85 at a 2:1 liquid-to-solid ratio (LSR) be less than 25 mg/L. However, this LSR is based on several simplifying assumptions that may not be appropriate for many soil types. In this article, three unsaturated zone transport models—Chemflo, SWIM, and HYDROGEOCHEM—are evaluated for developing LSRs for sites with soil containing chromite ore processing residue (COPR). Based on this evaluation, SWIM was found to be the most appropriate model for simulating Cr(VI) transport into puddles because of its ability to simulate rainfall and evaporation rate changes during and following precipitation events. A more refined evaluation using only SWIM was performed to determine the effects of various factors on COPR-specific LSRs, including saturated hydraulic conductivity, daily rainfall rate, daily evaporation rate, and groundwater depth. The refined evaluation demonstrated that the LSR ranges from 1.4 to 30, with a mean of 7.4 and a median of 7.0. Thus, an LSR of 7:1 is the most appropriate to represent the puddle scenario at COPR sites.

KEY WORDS: hexavalent chromium, allergic contact dermatitis, puddle formation, soil cleanup criteria.