Investigating the Feasibility of Using Ecozones in the Design of Water Balance Covers for Waste Containment by Analyzing the Sensitivity of Cover Effectiveness to Climate, Vegetation and Soil Parameters

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Abstract. Water-balance landfill covers are a relatively new and innovative design for waste containment that does not require the previously mandated clays or geomembranes that are expensive to manufacture or import. The designs of these covers are often based on one-dimensional unsaturated flow modeling to simulate water fluxes into and out of the cover. Water balance covers are engineered to minimize percolation through the bottom of the cover by managing the storage of water in the cover. The covers store water from precipitation events during the wet seasons and that water is subsequently released due to evapotranspiration in the warmer growing seasons. It has been widely accepted that detailed site specific investigations are required to fully characterize the climate, vegetation and soil parameters that determine the effectiveness of water balance covers. Recent research (Cadmus, 2011) has suggested that the design of water balance covers can be done in a more generic manner, using "ecozones," or regions of similar climate and geographic properties, to define the parameters used in modeling. It is important to understand to what extent it is viable to use ecozones in lieu of site-specific characterization. For this project a sensitivity analysis will be conducted on select climate, vegetation, and soil parameters using a combination of HYDRUS 1-D and UCODE. It was found that cover effectiveness is highly sensitive to soil parameters, particularly saturated hydraulic conductivity and the fitting parameters in the van Genuchten equation, α and n. Water balance covers were also found to be sensitive to the timing of precipitation events in relationship to the growing season. Forward model runs were able to show variations in total yearly percolation rates between less than 1 mm/year and over 10 mm/year within the range of meteorological, vegetation and soil parameters in the front range of Colorado. These parameters that are shown that are most impactful on cover effectiveness are also highly variable within the ecozones of Colorado studied during this research. Due to large variability and uncertainty in climate, vegetation and soil parameters within an ecozone, the methodology of designing water balance covers in a generic manner based on ecozones is put into question. Generic water balance cover design is not ruled out completely, and there is enough evidence supporting the methodology to warrant further investigation.