# Groundwater Recharge in a Reclaimed Watershed Following Oil Sands Mining: Implications for Groundwater Flow in Reconstructed Landscapes

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ABSTRACT
Oil sands mining disturbs Alberta's boreal forest, necessitating large-scale reclamation. Reclamation requires reconstructing groundwater flow systems that provide adequate water to down-gradient ecosystems and water bodies. However, this is challenging due to the region's sub-humid climate, salinity of underlying tailings or overburden materials, and need to appropriately prescribe soil reclamation covers that promote forest growth. In 2012, Syncrude Canada Ltd. constructed an experimental watershed, Sandhill Fen Watershed, on a soft tailings deposit. The watershed's basin-scale upland hummocks were designed to function as water sources to a lowland wetland. Therefore, hummocks must facilitate adequate recharge, while simultaneously providing a suitable substrate for forest growth. The purpose of this study was to estimate recharge for hummocks having varying heights, textures, and soil reclamation covers.

Across the watershed, soil moisture, soil tension, and water levels were monitored for four years. Soil moisture contents exhibited variation corresponding to the texture of soil reclamation covers and underlying tailings. These observations were then used to calibrate and verify one-dimensional and two-dimensional numerical models using the HYDRUS software package.

Recharge was primarily dependent on the texture and thickness of soil reclamation covers, water table depth, and vegetation characteristics (e.g., rooting depth). Two-dimensional simulations of upland hummock vertical cross sections highlighted how variability in root water uptake and water table proximity determined their overall recharge function. Long-term scenario testing indicated a decline in recharge due to vegetation development; however, climate cycles lead to substantial variability in recharge. Overall, recharge magnitudes influence the dominant scale of groundwater flow in reconstructed landscapes. Low estimates of recharge for many reclamation scenarios suggest that the potential to develop local-scale groundwater flow systems may be limited. These findings have implications for the management of water and solute balances in reconstructed landscapes and for down-gradient ecosystems and waters bodies of the boreal forest.