Post-mining hydrogeology in Alberta's mineable Athabasca oil sands region

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ABSTRACT
The Athabasca oil sands region is a global hydrocarbon resource located in northeastern Alberta. The surface mineable area is 4,800 km^2. Devonian carbonates and evaporates overlie the Precambrian basement. The overlying Cretaceous-age sedimentary sequence hosts the oil sands ore within the McMurray Formation at its base. Glacial and glacio-fluvial Quaternary deposits up to 40 m thick cap the bedrock sequence. Local topographic relief is limited, except for the deeply incised Athabasca River that bisects the mineable region. The deep Devonian-Cretaceous aquifer-aquitard sequence is characterized by intermediate to regional scale groundwater flow systems and brackish to brine water quality. Local-scale groundwater flow systems, with fresh to brackish water quality, occur in the Quaternary-Cretaceous aquifer-aquitard sequence.

Mining removes geologic materials to the base of the Cretaceous deposits, up to 100 m depth. Overburden is placed in dumps up to about 50 m high. Oil sands ore is mined and processed to extract bitumen. Residual tailings and process water are deposited in above-ground tailings storage facilities and within mined-out pits. Many mined-out pits will be capped with water, which is projected to create over 30 new lakes under current mine reclamation plans. Hydrostratigraphy, morphology, and water quality of the post-mining landscape will differ from the pre-disturbance landscape.

This talk explores how post-mining groundwater flow systems will evolve. New gravity-driven flow systems will develop in response to reclaimed topography and hydrostratigraphy. However, long-term consolidation and settlement will modify the land surface and the gravity-driven flow system for centuries. Water quality along groundwater flow paths will evolve in response to flushing of tailings deposits and weathering in dumps. Meeting the water quantity and quality needs of the reclaimed landscapes will require groundwater engineering and flow-system reconstruction on scales of hundreds to thousands of square kilometres, integrated with multi-disciplinary mine and reclaimed landscape engineering.