A Hydro-Geohazard Management System for Managing Aquifer Risk to Oil Sands Mining Operations, Fort McMurray Alberta.

Kate Holder and Warren Vincent-Lambert, Klohn Crippen Berger Ltd.

The Basal Aquifer is a fully saturated, confined, fluvial sand aquifer that underlies the oil bearing McMurray Formation in some areas of Alberta’s oil sands region. The continuity and extent of the aquifer is related to the paleotopography of the underlying Devonian Formation.

Pre-mining hydraulic heads in the Basal Aquifer are typically above the pit floor elevation in active mining areas. As heavy equipment and machinery (shovels, heavy haulers) work on the pit floor, there is the potential to induce cyclic loading on the Basal Aquifer, due to the normal passage of traffic during mining. If the hydraulic head is not lowered sufficiently, the dynamic action of the equipment may generate high pore pressures near the pit floor surface, causing a quickening condition in the Basal Aquifer and resulting in a loss of bearing capacity.

Elevated hydraulic heads also have the potential to cause pit floor heave concerns for mining operators. Understanding and managing the Basal Aquifer pressures is necessary to allow safe and/or efficient mining of the oil-bearing sands of the McMurray Formation.

In order to better manage the Basal Aquifer impacts to mining, a hydro-geohazard classification and management system has been developed to characterize and quantify the aquifer risks to mining. The system takes into account aquifer characteristics and conditions, overlying geological layers, and planned mining surfaces, to provide an indication of the potential risk of pit trafficability issues or floor heave. Outputs from the system include maps of target groundwater elevations, which enable mining operators to assess the need for, and complete the design of, advanced aquifer depressurization with respect to planned mining activities. In many instances this system has enabled depressurization to be deferred, reduced, or not implemented at all; thus resulting in significant operational cost savings and positive impacts to mine water balances.

When integrated with operational monitoring systems, the system can be adjusted for improved aquifer management. Additional benefits from application of the system include lowering the risks of Devonian aquifer impacts to mining operations. Through better control and minimizing the depressurization of the Basal Aquifer, vertical gradient differentials between deeper Devonian aquifer and the mining pits can be managed, thus reducing the driving force for upward migration of hyper-saline fluids from the Devonian aquifers.