8

Exploration and Development of a New Water Disposal Zone for Steam Assisted Gravity Drainage

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In areas of the Athabasca Oil Sands where deposits are too deep to mine, the steam assisted gravity drainage (SAGD) process is commonly used for the in-situ recovery of bitumen. Despite high water recycle rates, steam generation processes produce a significant volume of wastewater that requires subsurface disposal. The basal McMurray aquifer is the most commonly used disposal zone by SAGD operators. However, where the basal McMurray aquifer is in direct hydraulic communication with the overlying bitumen reservoir, disposal into this zone can create substantial operational challenges. As a result, SAGD operators have made significant efforts exploring for and evaluating alternative disposal zones with varying degrees of success.

Devon Canada (Devon) has completed a multi-year program to develop alternate disposal zones for its current Jackfish and future Pike projects. After unsuccessful attempts exploring for deeper and remote disposal options, Devon turned its focus towards the evaluation of shallower zones within the Upper Manville Group. In particular, a highly saline region of the Lower Grand Rapids aquifer beneath the Pike project area was identified as a potential disposal prospect that merited further evaluation.

Evaluation of the Lower Grand Rapids aquifer for disposal presented significant unusual challenges because of its shallow depth and potential concerns of communication with non-saline groundwater resources. Devon led a multi-disciplinary investigation program comprising, geologic mapping, petrophysical analyses, numerical flow modelling, and geochemical/isotopic studies to better resolve the complex hydrogeological system that produced this high salinity region.

The weight-of-evidence from the combined investigations suggests that groundwater flow within the high salinity region of the Lower Grand Rapids aquifer has been largely stagnant since at least the Tertiary period. Because the stagnant zone has been effective at preserving formation water over the scale of millions of years, the same zone can be inferred to be highly effective for containing wastewater. Furthermore, modelling results indicate that disposal at the proposed rates would not significantly alter the natural hydrodynamic conditions and that injected fluid would remain contained within the high salinity zone.

Nonetheless, there remains a greater concern for vertical containment of fluid disposal in the Lower Grand Rapids aquifer relative to deeper disposal schemes. This concern will be addressed through a robust monitoring and mitigation plan that exceeds standard regulatory requirements for disposal well operation (per the Alberta Energy Regulator's Directives 65 and 51). Environmental protection measures will include a conservative maximum injection pressures to prevent any vertical containment breach and a comprehensive monitoring program with early warning triggers to ensure any potential breach is quickly arrested and impacts mitigated.

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Michael Brewster is the leader of Devon Canada's hydrogeology team and geoscience advisor for technology development. Mike has been working on groundwater resource management and environmental protection for in situ oil sands developments since 2009. Prior to that, he was an environmental consultant leading a range of contaminant and physical hydrogeology projects in Western Canada and internationally. He currently leads several projects on behalf of the Canadian Oil Sands Innovation Alliance (COSIA), serves on the industry review panel for the Southern Athabasca Oil Sands groundwater monitoring program and is a past project leader for the Cumulative Effects Management Association (CEMA). Outside of work Mike is an avid mountain biker and backcountry skier. He has two awesome kids who are just about to leave the nest. Even more awesome is his wife Christine; she an accomplished artist who compensates for Mike's missing right brain.