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Regional Fluid Flow in the Weyburn CO₂ Project Area: Implications for CO₂ Sequestration

The Weyburn CO₂ Project is a pioneer EOR/sequestration undertaking currently injecting CO₂ into a Mississippian-aged carbonate reservoir in Saskatchewan, Canada. Hydrogeology has been identified as a key component in the analysis of sequestration because the migration of CO₂ may be strongly affected by the flow of formation waters. Thus, a hydrogeological analysis of the entire geologic section above and below the reservoir has been undertaken to identify driving forces, determine flow directions and rates, and locate possible conduits for cross-formational flow of formation waters and potential leakage pathways for CO₂.

Detailed mapping of hydraulic heads and formation water salinities has been conducted on 18 aquifers (above, below, and including the sequestration target). Flow directions determined from maps of equivalent fresh-water hydraulic-head (EFWH) indicate dominantly updip flow of formation waters from SW to NE across the study area. Mapped formation water salinities indicate significant density variations between formations and across the area. Waters range in total salinity from 5 to 350 mg/L. Density-dependent fluid flow is predicted in certain aquifers and certain areas thus, consequent errors introduced by EFWH mapping have been assessed. The relative strength of hydraulic gradients and buoyancy forces were mapped and have been used to identify areas of significant downdip flow in deeper aquifers. Downdip flow decreases the upward driving force for cross-formational flow and enhances CO₂ trapping capacities. These results have important implications for the storage of CO₂ in the Weyburn reservoir.