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Aligning Groundwater Mapping with the Scale of Regulation in the Fox Creek Area

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Developing the liquid-rich shale gas plays of the Duvernay and Montney formations in west-central Alberta relies on non-saline water for hydraulic fracturing, which is often sourced from surface water and shallow groundwater in the Fox Creek area. To regulate these developments, the Alberta Energy Regulator (AER) and Alberta Environment and Parks (AEP) have indicated that there is a need for quantifying and managing cumulative effects of water use at a regional scale. Such a regional scale approach requires scientifically defensible geoscience at a scale that is comparable to both the development and regulation.

As part of evaluating Alberta's groundwater inventory, the Alberta Geological Survey (AGS) is nearing completion of a hydrogeological characterization project focussed on a 22 000 km^2 area centred on Fox Creek. This project aims to advance the understanding of regional groundwater resources by: (i) producing a 3D hydrostratigraphic model of the Quaternary, Neogene, and Upper Cretaceous formations (i.e. Lea Park Fm. up to ground surface); (ii) quantifying rates of recharge, discharge, and interaction with surface water; and (iii) developing a conceptual model for non-saline groundwater circulation.

To support hydrostratigraphic modelling for this large area, a variety of data sources are being used, including: boreholes drilled to collect material samples and hydraulic measurements, gamma-ray logs from oil and gas wells; legacy borehole logs, field mapping results, and lithological descriptions from water wells. Together, these data provide evidence for gravel-capped bedrock plateaus, the proximity of bedrock strata to land surface, and the heterogeneity of bedrock units in the region, all which may influence patterns of groundwater circulation.

Compared to hydrostratigraphic modelling, hydrogeological characterization has focused on the uppermost bedrock unit, which is predominantly the Paskapoo Formation. Hydrogeological characterization has mapped hydraulic heads across the upper portion of the bedrock and produced the first measurements of permeability contrast between sandstone and mudstone units. Preliminary mapping indicates a dominance of groundwater recharge across much of the region, except for localized flow systems that provide base flow to rivers. Sampling of environmental tracers (stable isotopes of water, tritium, noble gases) from four rivers in the area is helping better define groundwater interaction with rivers and interpret groundwater residence times.

The objectives and approach of this project have been designed to meet the anticipated needs of regulators and industry, at a scale suitable for cumulative effects management initiatives. The resultant conceptualization will encompass the geologic framework and hydrodynamics, and become the basis for subsequent development of coupled groundwater-surface water numerical models within the Fox Creek region.

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