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Open-Loop Geothermal Exchange: Developing a Low-Carbon Heating and Cooling System Using Groundwater in the Bow Valley

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Summary

The development of a low-carbon operations facility in the Bow Valley near Exshaw, AB required a sustainable heating and cooling solution. Initial groundwater investigations at the site, including the drilling of a deep drinking water supply well, provided valuable insight into the shallower alluvial sediments on which the facility is located. These observations confirmed the presence of a highly permeable sand and gravel aquifer adjacent to the Bow River (Bow River Aquifer), suggesting potential suitability for the high groundwater deliverability necessary to support an open-loop geothermal heat exchange system.

Two water wells were drilled and tested to support the production and return of groundwater to the aquifer via the facility's heat exchange system. Well design, placement and stratigraphic positioning of production and recirculation intervals allowed for high-capacity production and re-injection while limiting the potential for recirculation of heated water.

Aquifer testing yielded high deliverability potential and proof-of-concept open-loop circulation demonstrated that the system could sustain the >100 igpm production and re-circulation rates necessary to support geothermal heat exchange. Although drawdown and injection pressures were small, hydraulic testing data was affected by significant fluctuations related to water level influence in the Bow River and aquifer recharge associated with spring freshet, potentially complicating licencing of an unconfined aquifer connected to the river.

Because the geothermal heat exchange system was designed as a closed loop at surface, where all extracted groundwater is returned to the aquifer, regulatory approval was streamlined for non-consumptive use when compared to conventional groundwater withdrawal applications in Alberta. The closed-loop system design at surface means there will be no net groundwater loss in the aquifer or changes to the groundwater quality. As the intended primary use of the heat exchange system is to heat the building, groundwater entering the system at approximately 7.5°C will discharge at a lower temperature which could have a moderate cooling effect on the aquifer.

Results

The results confirmed that the Bow River Aquifer in the Bow Valley near Exhaw, AB is highly transmissive, allowing for high groundwater deliverability that can be used to develop a non-consumptive use open-loop geothermal heat exchange system. The combination of highly permeable sediments, stable groundwater levels, and limited temperature exchange demonstrated that a sustainable low-carbon heating and cooling system could be developed for the facility, reducing reliance on traditional energy sources. This project highlights the potential for alluvial aquifers to support municipal and industrial open-loop geothermal applications using

engineered well designs and modern heat exchange systems, providing a scalable and environmentally responsible approach to groundwater-based heating and cooling.

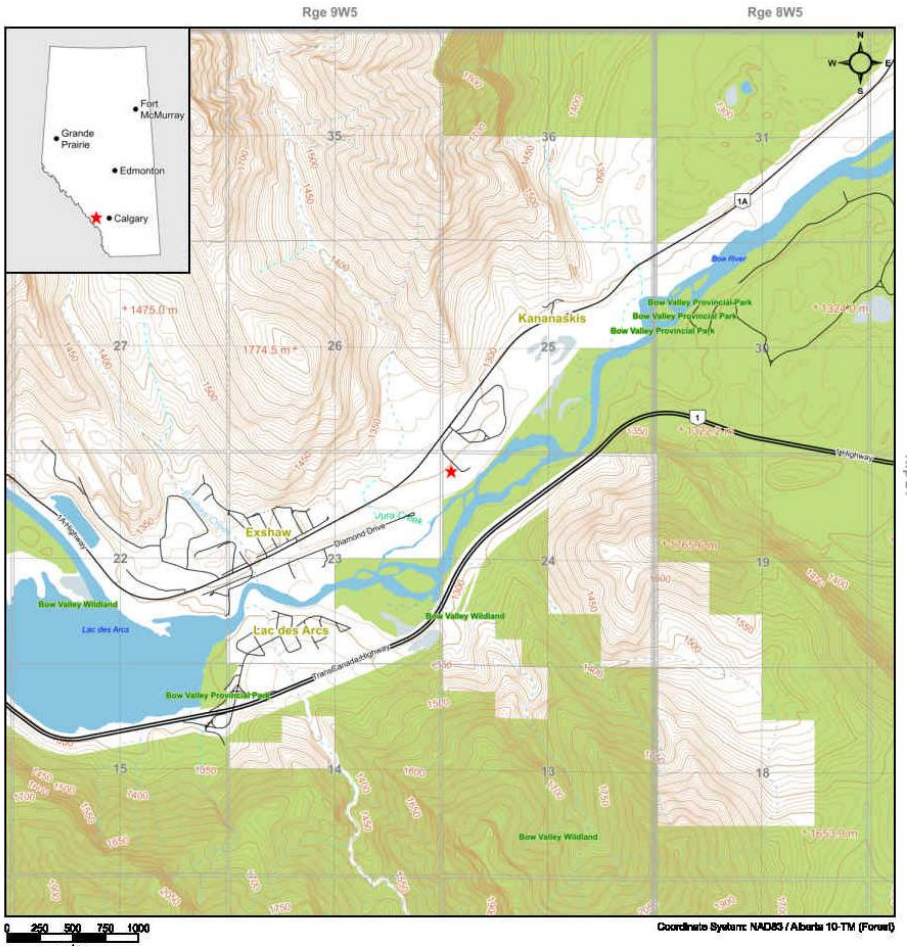

Figure 1: Low-Carbon Open-Loop Geothermal Heat Exchange Project, MD of Bighorn near Exshaw, AB

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