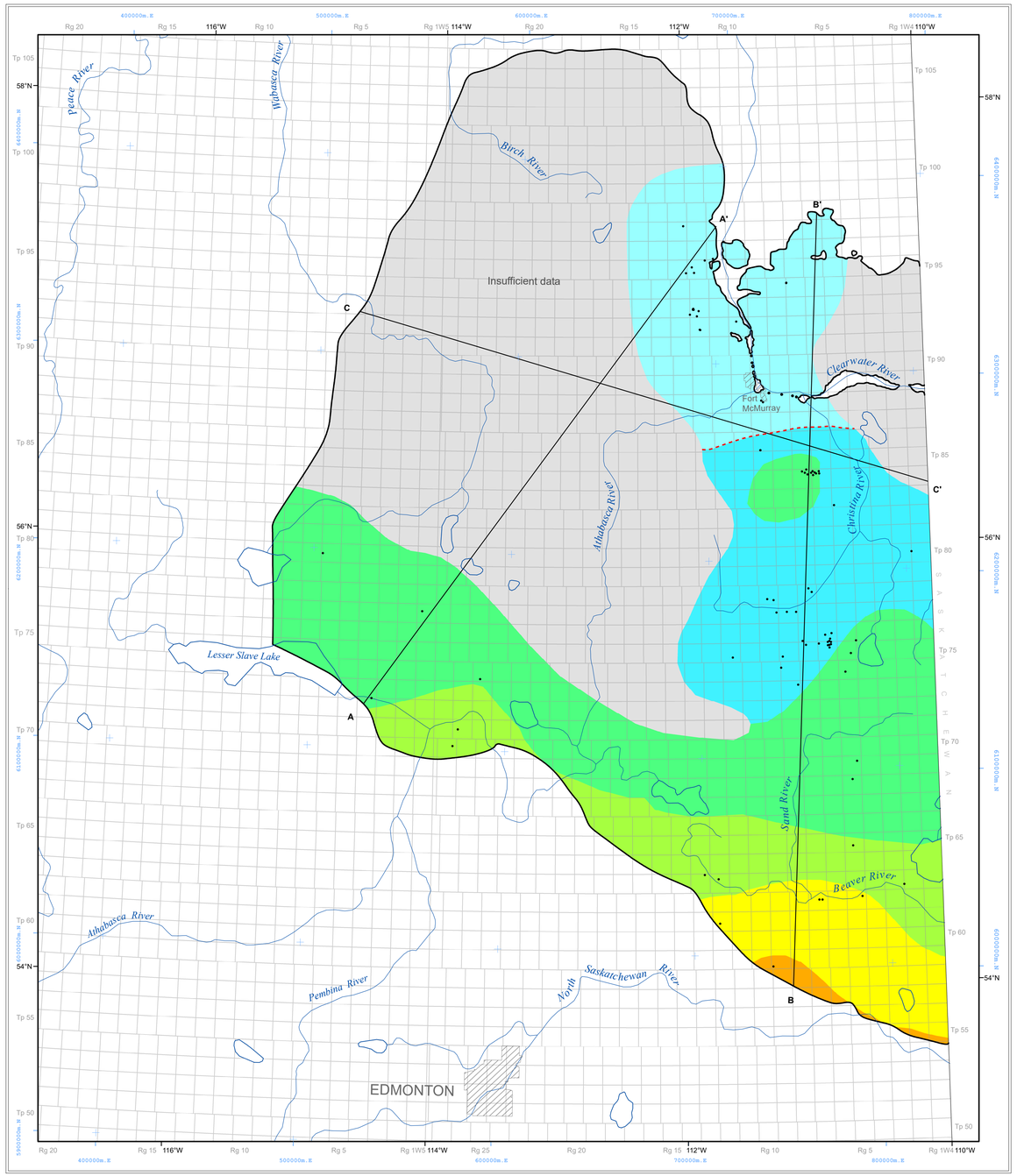
TOTAL DISSOLVED SOLIDS
CLEARWATER HSU




## SYMBOL LEGEND

Total dissolved solids (mg/L)

- 670 - 4 000
- 4 001 - 10 000
- 10 001 - 20 000
- 20 001 - 30 000
- 30 001 - 40 000
- 40 001 - 43 000

Well data point

Hydrostratigraphic unit extent

Cross-section line A ——— A'

Non-saline / saline boundary (4 000 mg/L)

Insufficient data

This map depicts the distribution of total dissolved solids (TDS) in groundwater in the Clearwater hydrostratigraphic unit (HSU). More specifically, the map depicts the hydrogeological characteristics of the Clearwater HSU where it predominantly acts as weak aquitard. The heterogeneous nature of the Clearwater HSU is discussed in more detail in Bachu and Underschultz (1993). The horizontal and vertical extent of the unit was adopted from the 3D Provincial Geological Framework Model of Alberta, Version 2 (Alberta Geological Survey, 2019a).The relationship of the Clearwater HSU with the units above and below as well as its geometry can be seen in Figures 1 and 2.

### Methodology

The TDS distribution map is a result of an ordinary kriging technique using publicly available data from 35 water chemistry analyses from monitoring well locations compiled into an Alberta Environment and Parks database for the mineable and in-situ oil sands areas, 6 water chemistry analyses from water wells in the Alberta Water Well Information Database, 17 water chemistry analyses from locations compiled from environmental impact assessments, 25 water chemistry analyses from oil and gas wells, and 62 water chemistry analyses submitted to the AER under Directive 044. A screening process modified from Jensen et al. (2013) was used to ensure that only representative formation water chemistries were used. Measured TDS values range from 278 mg/L to approximately 43 000 mg/L. The final gridded map surface was clipped based on the spatial distribution of representative chemistry data and where the trend in TDS appears plausible even though there is not enough data control to fully support the trend. Residual values are plotted at each location (Figure 3) to indicate where underprediction and overprediction occurs compared to the measured TDS values.

Additional formation-scale hydrogeological maps for the Clearwater HSU are presented in Figures 4 and 5. Figure 4 shows the distribution of hydraulic head in the Clearwater HSU, with hydraulic heads calculated using fresh water density. Figure 5 shows the water driving force (WDF) map for the Clearwater HSU. The WDF vector map allows identification of areas where the buoyancy effect has the potential to change the inferred magnitude and direction of groundwater flow. Buoyancy does not appear to have a significant effect on groundwater flow in the Clearwater HSU.

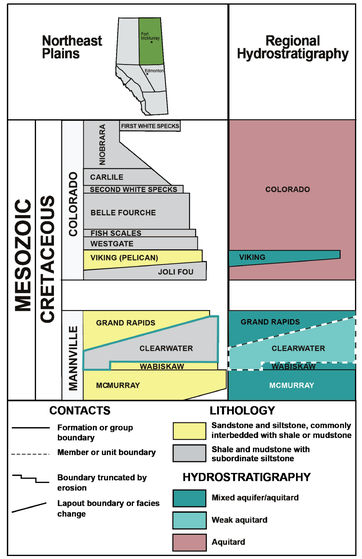



Figure 1. Regional lithostratigraphy and hydrostratigraphy (based on Alberta Geological Survey, 2019b). Solid teal lines highlight the Clearwater stratigraphic unit exclusive of the Wabiskaw Member. Dashed white lines depict the Clearwater HSU within the regional hydrostratigraphy. Strata above the Colorado Group are not shown.

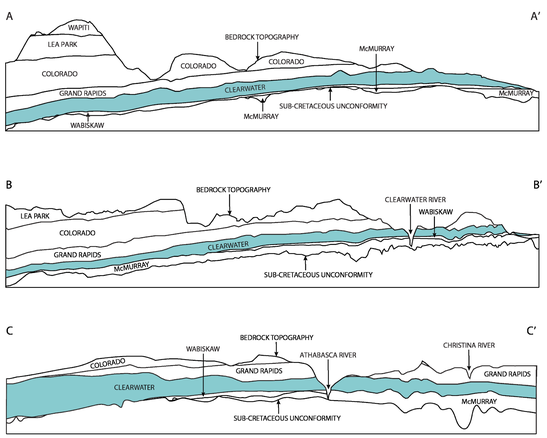



Figure 2. Schematic cross-sections identifying the geometry and variable thickness of the Clearwater HSU (not to scale).

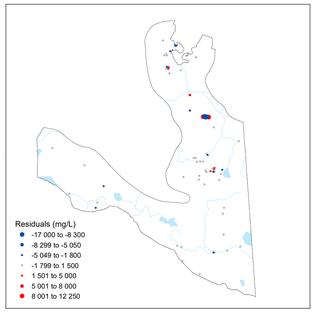



Figure 3. Calculated residuals between the modelled distribution of TDS and measured TDS values. Symbol classes are based on the standard deviation of the calculated residuals.

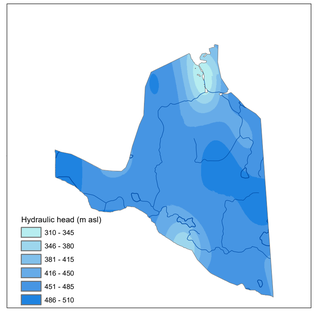



Figure 4. Distribution of hydraulic head in the Clearwater HSU (Singh and Lemay, 2021). The map extent is based on the spatial distribution of hydraulic head data and differs from the extent of the main map.

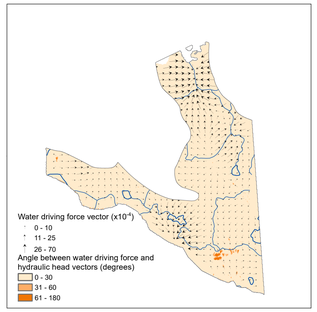



Figure 5. Water driving force map of the Clearwater HSU. The map only covers the area where hydraulic head and TDS gridded surfaces overlap.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**Map 606**

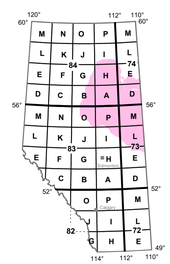
# Distribution of Total Dissolved Solids in the Clearwater Hydrostratigraphic Unit

**Hydrogeology by: T.G. Lemay and A. Singh**

Scale 1:1 250 000

50 25 0 50 100 kilometres
25 12.5 0 25 50 miles

Projection: 10 Degree Transverse Mercator
Datum: North American Datum, 1983





### Acknowledgements

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Singh, A., Palombi, D., Nakevska, N., Jensen, G. and Rostron, B. (2017): An efficient approach for characterizing basin-scale hydrodynamics; Marine and Petroleum Geology, p. 332-340, URL <http://dx.doi.org/10.1016/j.marpetgeo.2017.02.015>.


### Recommended Reference Format

Lemay, T.G. and Singh, A. (2021): Distribution of total dissolved solids in the Clearwater hydrostratigraphic unit; Alberta Energy Regulator / Alberta Geological Survey, AER/AGS Map 606, scale 1:1 250 000.

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