



Groundwater Resources of the Lake Saint-Martin Area, Manitoba

Sheet 5 of 6
Groundwater Quality

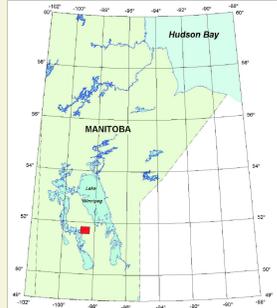
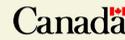


Figure 1: Location of study area

Recommended citation:

Desbarats, A.J. and Pyne, M. (2004), Groundwater Resources of the Lake Saint-Martin Area, Manitoba, Geological Survey of Canada Open File 624, 6 sheets, Scale 1:100 000.

©Her Majesty the Queen in Right of Canada 2004
Available from Geological Survey of Canada
601 Booth Street
Ottawa, Ontario K1A 0E8



Map Notes

Introduction

The quality of groundwaters in bedrock aquifers of the Lake Saint-Martin area (Figure 1) was mapped previously by Betcher (1987) at a scale of 1:250 000. The mapped parameters were total dissolved solids (TDS) and chloride. As part of its detailed groundwater investigations in the area, the Geological Survey of Canada has conducted an extensive sampling of well water chemistry. Results of the groundwater quality survey showed that total dissolved solids, hardness, sodium and fluoride occur naturally at elevated levels. These parameters are mapped here since they may be of concern to domestic users of well water.

Hydrogeological Setting

The geology and hydrostratigraphy of bedrock aquifers in the study area are described on sheets 1 and 3 of this series. Groundwater flow directions in the aquifers are determined from the map of piezometric levels shown in Figure 2 of Sheet 3. Several shallow, local-scale, flow systems can be identified. Outside the impact structure, groundwater flows from recharge areas on low bedrock ridges in the northwest of the study area and between Lakes Manitoba and Pineimuta, toward discharge areas in adjacent lakes and wetlands. Inside the impact structure, groundwater flows south, from karstic uplands north and east of Gypsumville, toward Lake Saint-Martin and Lake Pineimuta. Elevated heads in a deeper regional groundwater flow system may be driving the strong artesian conditions observed in the basin extending north from Lake Pineimuta although the discharging waters themselves are probably derived locally. There may also be some mixing of shallow groundwater with deeper, more saline groundwater in the zone of uplifted and faulted rocks on the margin of the impact structure.

Total Dissolved Solids

Figure 2 shows that the Canadian Drinking Water Quality (CDWQ) aesthetic objective for total dissolved solids (TDS) of 0.5 g/L (Health Canada, 2002) is exceeded throughout the study area. However, TDS concentrations greater than 1 g/L are generally found within the impact structure. Highest levels are found along the flow path extending south-south-east from Gypsumville toward Lake Saint-Martin. A maximum TDS concentration of 7.8 g/L was observed at the southern end of this flow path, in a well on the reserve of the Little Saskatchewan First Nation. Elevated TDS levels are also found in a lobe-shaped region straddling the southern rim of the impact structure and extending toward Lake Pineimuta.

Fluoride

Figure 3 shows that fluoride levels in groundwater exceed the Canadian Drinking Water Quality (CDWQ) maximum allowable concentration of 1.5 mg/L in three areas within the study area. On the Lake Saint-Martin reserve; at the north end of the Little Saskatchewan reserve; and south-west of Gypsumville. These areas of elevated fluoride concentrations are located on the margins of the impact structure where there may be upwelling of deeper formation groundwaters. The median observed fluoride concentration was 0.6 mg/L. The maximum observed level was 15.1 mg/L, from a well located on the reserve of the Lake Saint-Martin First Nation. Approximately 20% of surveyed wells showed fluoride concentrations above the CDWQ limit of 1.5 mg/L.

Hardness

Figure 4 shows that groundwater hardness levels are highest in the Gypsumville area due to the dissolution of gypsum and dolomite in the subsurface. Elevated levels are also found outside the impact structure, in wells tapping the carbonate aquifer. Softer groundwater is found on the reserve of the Lake Saint-Martin First Nation and along the inner rim of the impact structure. The median hardness concentration measured in the survey was 407 mg/L, expressed as calcium carbonate (CaCO₃), while the highest value was 2750 mg/L. Although there are no Canadian Drinking Water Quality guidelines for hardness, levels above 200 mg/L are considered poor and levels above 500 mg/L are considered unacceptable. Hardness concentrations above the acceptable limit were found in 29% of surveyed wells.

Sodium

Figure 5 shows that sodium concentrations in groundwater are highest in the Gypsumville area, on the reserve of the Lake Saint-Martin First Nation and at the northern end of the Little Saskatchewan First Nation reserves. The elevated sodium levels near Gypsumville may be due to cation exchange reactions between groundwater and shales or due to the dissolution of sodium salts found in the evaporite sequence (McCabe and Bannatyne, 1970). The median sodium concentration measured in the survey of 100 mg/L whereas the highest concentration was 2580 mg/L. The Canadian Drinking Water Quality aesthetic objective for sodium is 200 mg/L and this limit was exceeded in 36% of wells surveyed.

Map Production Notes

During the month of August in 1998, 384 water samples were collected from wells and streams within the study area. Water well sample locations are marked on the figures. All samples were analyzed for major cations and anions, as well as trace and ultra-trace metal contents. Waters at 42 sites were sampled for stable isotope analyses. Parameters measured in the field include pH, Eh, conductivity, dissolved oxygen and temperature. All survey results are publicly available from the authors at the Geological Survey of Canada or from Water Branch of Manitoba Water Stewardship.

Mapping of geochemical parameters was performed using the geostatistical spatial interpolation method known as Indicator Kriging, with the median indicator approximation (Deutsch and Journé, 1992). However, because of the high density of sample locations in more populated areas, a preliminary cell declustering was carried out prior to kriging. This involved pooling all samples falling within the same quarter section (64.64 ha) cell. Interpolation by kriging was then performed on a regular 300m by 300m grid using a single global search neighborhood encompassing all pooled data locations.

It is important to recognize that kriged estimates of geochemical parameters, like those obtained by other spatial interpolation methods, are smoothed compared to actual values. In other words, the maps of geochemical parameters shown here represent general trends in values and not their true spatial variability. Thus, individual well analyses should not be expected to agree exactly with mapped values at the same location. The uncertainty in parameter estimates is lower in the central portion of the study area, where well control is better. Where well control is sparse, uncertainty is higher and results should be interpreted with caution. Portions of the study area where uncertainty is unacceptably large are left blank.

References

- Betcher, R.N. (1987): Groundwater Availability Map Series : Dauphin Lake (620), Water Resources Branch, Manitoba Natural Resources, Winnipeg, Manitoba.
- Deutsch, C.V and A.G. Journé (1992): GSLIB : Geostatistical Software Library and User's Guide, Oxford University Press, New York.
- Health Canada (2002): Summary of Guidelines for Canadian Drinking Water Quality, prepared by the Federal-Provincial-Territorial Committee on Drinking Water, Safe Environment Programme, www.hc-sc.ca/waterquality
- McCabe, H.R. and B.B. Bannatyne (1970): Lake Saint-Martin crypto-explosion crater and geology of the surrounding area, Manitoba Mines Branch, Geological Paper 3/70.

Figure 2

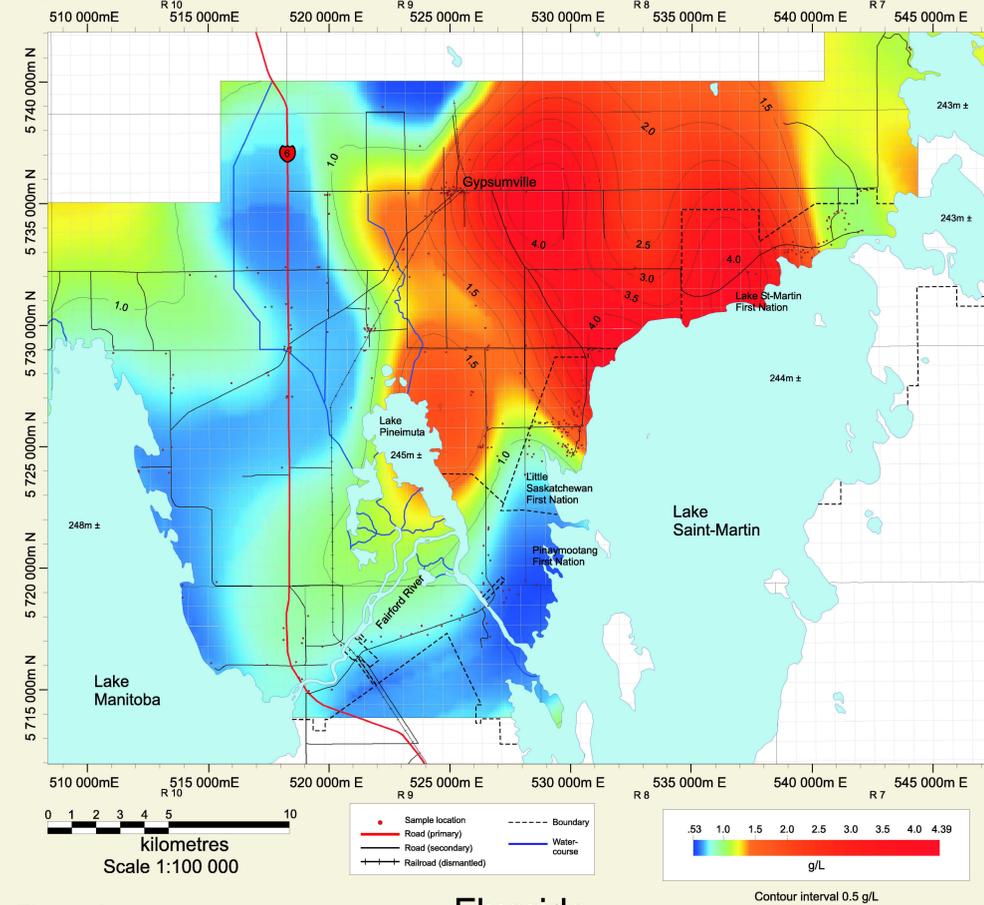


Figure 3

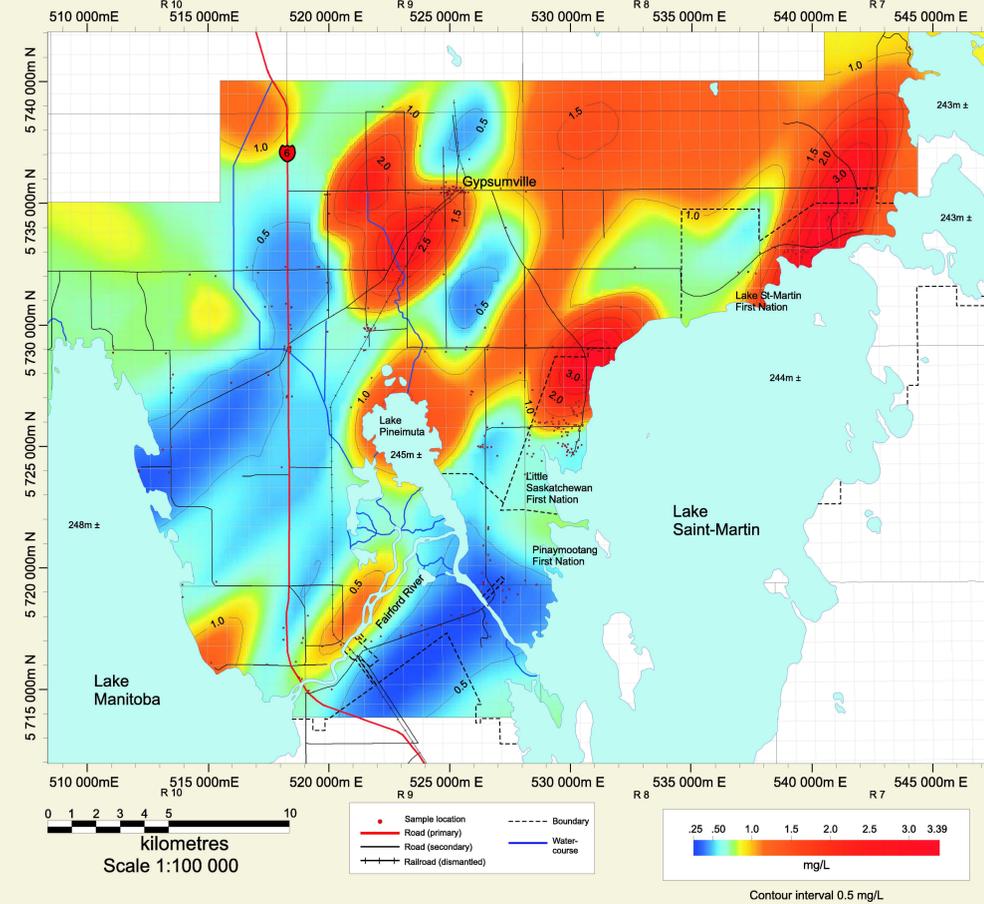


Figure 4

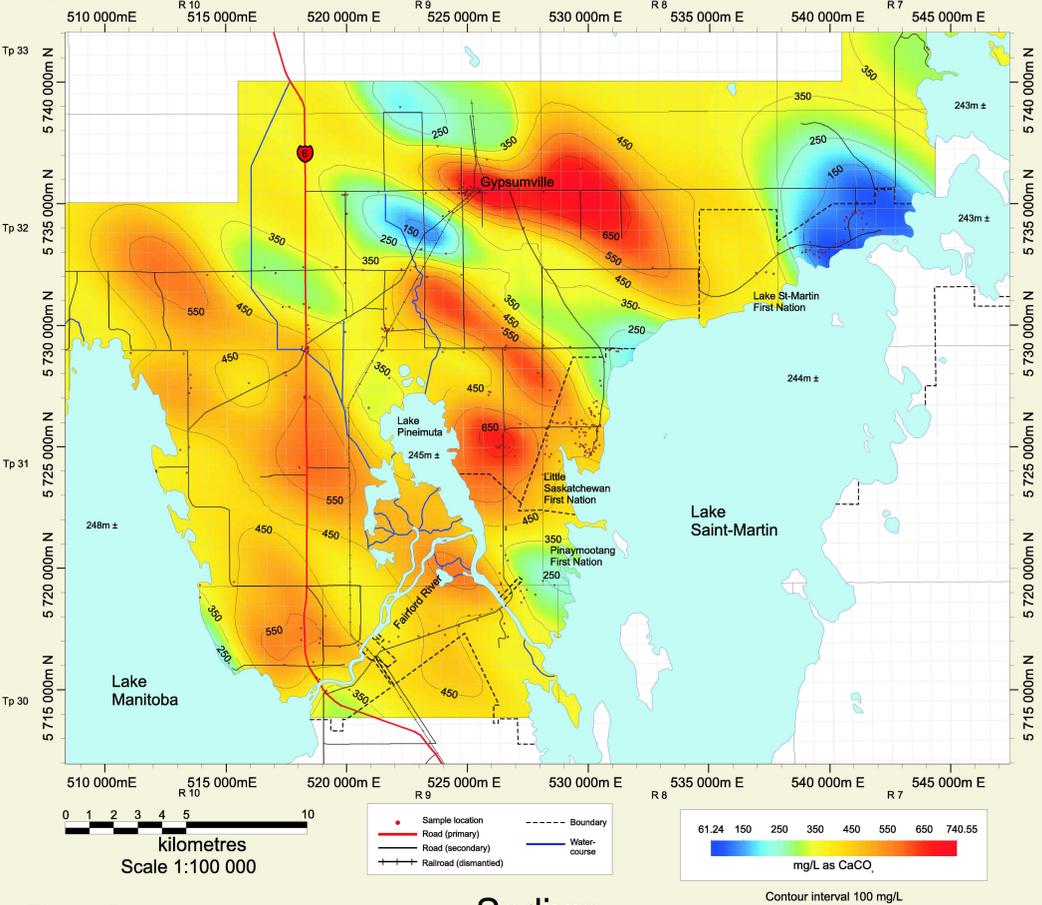


Figure 5

