3) Chemical Quality of Groundwater

The TDS concentrations in the groundwaters from the upper bedrock aquifer(s) range from less than 500 to more than 1,000 mg/L, with most of the groundwaters with lower TDS concentrations occurring in the western half of the County. The lower TDS concentrations may be a result of more active flow systems and shorter flow paths.

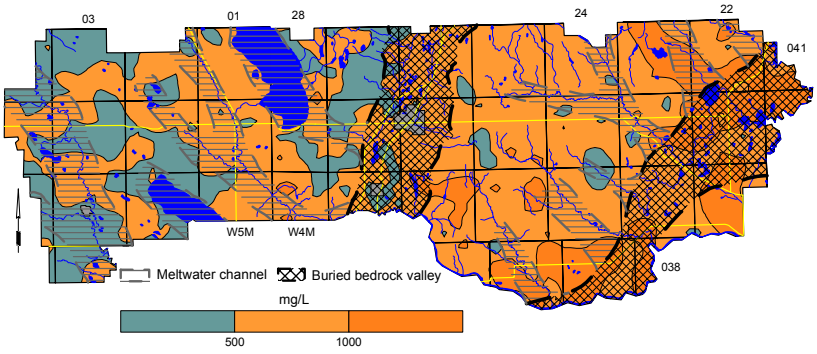

Figure 19. Total Dissolved Solids in Groundwater from Upper Bedrock Aquifer(s)

The relationship between TDS and sulfate concentrations shows that when TDS values in the groundwaters from the upper bedrock aquifer(s) exceed 1,100 mg/L, the sulfate concentrations exceed 400 mg/L. The sulfate concentrations in groundwaters from the upper bedrock aquifer(s) were compared to the distance of completion depth from the top of the Upper Lacombe Member. The maximum sulfate concentrations generally increase with depth, as shown below in Figure 20. Groundwaters from Dalehurst water wells have sulfate concentrations of less than 200 mg/L.

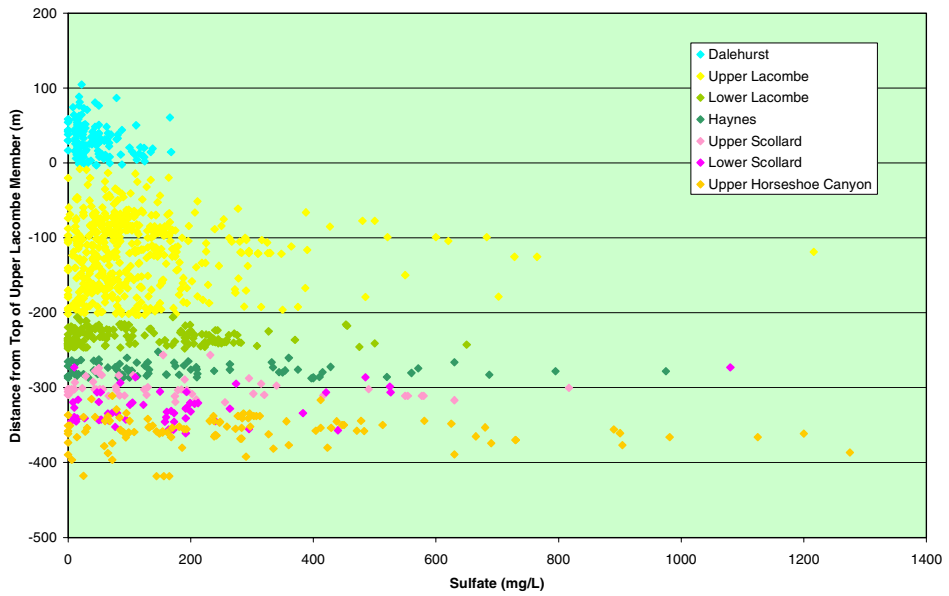

Figure 20. Distance from Top of Lacombe Member vs Sulfate in Groundwaters from Upper Bedrock Aquifer(s)

The chloride concentrations in the groundwaters from the upper bedrock aquifer(s) are less than 10 mg/L in approximately 85% of the County. The nitrate + nitrite (as N) concentrations are less than 0.1 mg/L in 80% of the chemical analyses for bedrock water wells.

In the County, approximately 60% of the groundwater samples from upper bedrock aquifer(s) have fluoride concentrations that are too low (less than 0.5 mg/L) to meet the recommended daily needs of people. Approximately 25% of the groundwater samples from the entire County are between 0.5 and 1.5 mg/L and approximately 15% exceed the maximum acceptable concentration for fluoride of 1.5 mg/L. The fluoride values of greater than 1.5 mg/L occur mainly in the south-central part of the County (page A-31).

The Piper tri-linear diagrams (see Appendix A) show that all chemical types of groundwater occur in the bedrock aquifers. However, the majority of the groundwaters are sodium-bicarbonate or calcium-magnesium-bicarbonate-sulfate types.

4) Dalehurst Aquifer

The Dalehurst Aquifer comprises the porous and permeable parts of the Dalehurst Member. The Dalehurst Member subcrops under the surficial deposits in the Western quarter of the County. The thickness of the Dalehurst Member varies from less than two metres at the eastern edge of the subcrop to more than 125 metres in the western part of the County; in the remaining part of the County, the Dalehurst Member has been eroded. The thickness of the Dalehurst Member decreases in the vicinity of Medicine River and Sylvan Lake as a result of erosional processes.

a) Depth to Top

The depth to top of the Dalehurst Member is a function of the thickness of the surficial deposits, which ranges from less than two metres to more than 50 metres (page A-32).

b) Apparent Yield

The apparent yields for individual water wells completed through the Dalehurst Aquifer are mainly in the range of ten to 100 m³/day. Water wells with higher yields are expected mainly in areas where meltwater channels are present.

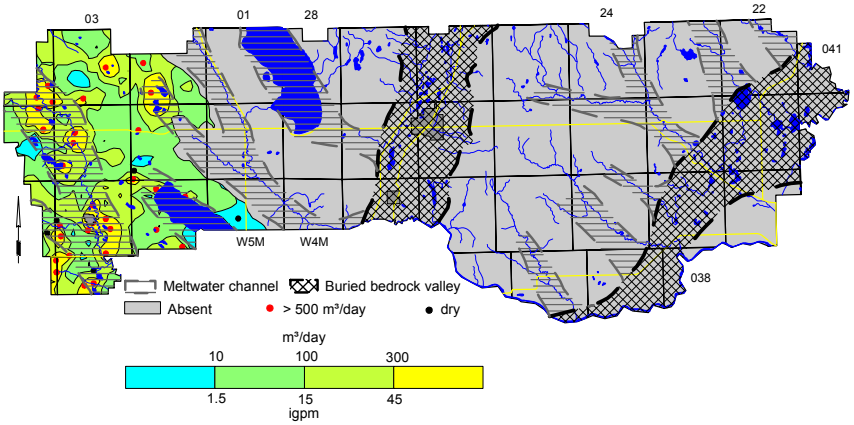

Figure 21. Apparent Yield for Water Wells Completed through Dalehurst Aquifer

Two Enerplus Resources Corporation (Enerplus) water source wells in township 038, range 04, W5M, just outside the County border, are authorized to divert a total of 565 m³/day (Hydrogeological Consultants Ltd. (HCL), 2000. The water source wells are completed in the Dalehurst Aquifer. Long-term monitoring of the two water source wells and five observation water wells indicated an effective transmissivity of 90 metres squared per day (m^2/day) and a corresponding storativity of 0.00001.

In the County, there are 48 licensed water wells that are completed in the Dalehurst Aquifer. The highest allocation of 169 m^3/day is for a Town of Eckville water supply well in 15-16-039-03 W5M.

c) Quality

The groundwaters from the Dalehurst Aquifer are mainly a sodium-bicarbonate-type (see Piper diagram on CD-ROM), with TDS concentrations ranging from less than 400 to more than 600 mg/L. The sulfate concentrations are all below 200 mg/L, and are mainly between ten and 50 mg/L. Chloride concentrations from the Dalehurst Aquifer are mainly less than ten mg/L. There are three out of 130 analyses where fluoride concentrations exceed 1.5 mg/L.

Groundwaters from the Enerplus water source wells that are completed in the Dalehurst Aquifer have TDS concentrations of less than 1,000 mg/L, sulfate concentrations of less than 25 mg/L, and chloride concentrations of less than 2.5 mg/L The groundwater from one water source well is a sodium-bicarbonate-type; the other groundwater is a calcium-magnesium-bicarbonate-type (HCL, 1991).

5) Upper Lacombe Aquifer

The Upper Lacombe Aquifer comprises the porous and permeable parts of the Upper Lacombe Member that underlies the Dalehurst Member, and subcrops under the surficial deposits in most of the middle part of the County. The Upper Lacombe Member has been eroded in the Buried Red Deer River Valley. The structure contours show the Upper Lacombe Member having a maximum thickness of in the order of 300 metres.

a) Depth to Top

The depth to the top of the Upper Lacombe Member ranges from less than ten metres below ground level where the Member subcrops in the eastern part of the County to more than 100 metres in the western part of the County.

b) Apparent Yield

The apparent yields for individual water wells completed through the Upper Lacombe Aquifer are mainly in the range of ten to 100 m³/day. Water wells with higher yields are expected mainly in areas where linear bedrock lows are present.

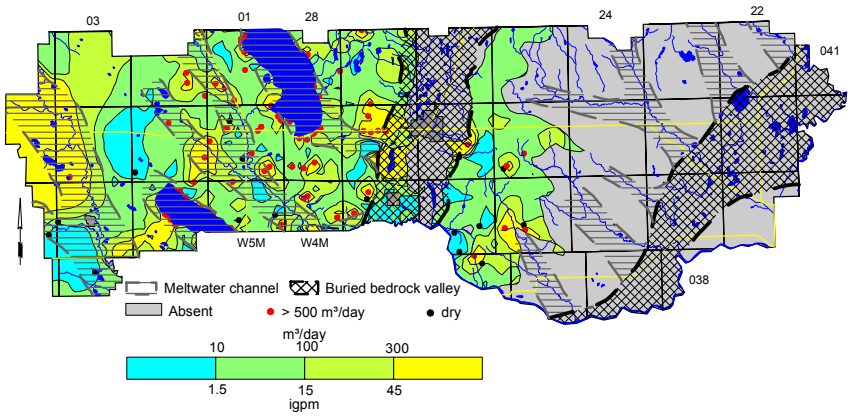

Figure 22. Apparent Yield for Water Wells Completed through Upper Lacombe Aquifer

An extended aquifer test conducted with a water supply well completed in the Upper Lacombe Aquifer for the Village of Bentley indicated a long-term yield of 400 m³/day based on an effective transmissivity of 215 m²/day (HCL, 1976).

The Village of Bentley has two water supply wells in 03-26-040-01 W5M completed in the Upper Lacombe Aquifer that are licensed to divert a total of 320 m^3/day. The largest single allocation for a water well completed in the Upper Lacombe is for a Suncor Resouces Inc. (Suncor) water source well in 12-05-039-03 W5M for 389 m^3/day used for injection purposes. This high yield is not reflected in the above map because there were three dry holes in the vicinity and the Suncor water source well could not be matched up with a record in the groundwater database and, therefore, has not been included.

c) Quality

The groundwaters from the Upper Lacombe Aquifer are mainly a sodium-bicarbonate- or sodium-sulfate-type (see Piper diagram on CD-ROM), with TDS concentrations ranging from less than 500 to more than 1,000 mg/L. The sulfate concentrations are mainly below 250 mg/L. Chloride concentrations from the Upper Lacombe Aquifer are mainly less than ten mg/L. There are 48 out of 362 analyses where fluoride concentrations exceed 1.5 mg/L.

Groundwaters from the Village of Bentley water supply well that is completed in the Upper Lacombe Aquifer, have a TDS concentration of 288 mg/L, a sulfate concentration of less than 18 mg/L, and a chloride concentration of 4 mg/L. The groundwater from this water source well is a sodium-bicarbonate-type (HCL, 1975).

6) Lower Lacombe Aquifer

The Lower Lacombe Aquifer comprises the porous and permeable parts of the Lower Lacombe Member that underlies the Upper Lacombe Member, and subcrops under the surficial deposits in most of the Buried Red Deer River Valley, and mainly in ranges 24 and 25, W4M in the County. Structure contours have been prepared for the top of the Member, which underlies two-thirds of the County. The structure contours show the Lacombe Member having an average thickness of in the order of 50 metres.

i) Depth to Top

The depth to the top of the Lower Lacombe Member ranges from less than ten metres below ground level where the Member subcrops in the eastern part of the County to more than 250 metres in the western part of the County.

ii) Apparent Yield

The apparent yields for individual water wells completed through the Lower Lacombe Aquifer are mainly in the range of ten to 100 m³/day. Water wells with higher yields are expected mainly in the areas where linear bedrock lows are present.

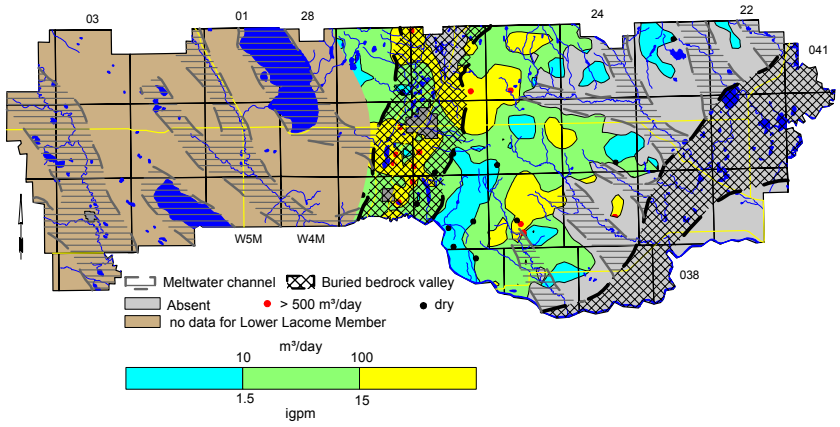

Figure 23. Apparent Yield for Water Wells Completed through Lower Lacombe Aquifer

An extended aquifer test conducted with a water supply well for Eclipse Pork Ltd. completed in the Lower Lacombe Aquifer in SW 26-039-25 W4M indicated a long-term yield of 54 m³/day based on an effective transmissivity of 32.5 m^2/day and corresponding storativity coefficient of 0.0001 (HCL, 1999). This water well is located close to the boundary of where water wells with apparent yields of greater than 100 m^3/day and less than 100 m^3/day are expected.

In the County, there are 33 licensed water wells that are completed in the Lower Lacombe Aquifer, for a total authorized groundwater diversion of 659 m^3/day. The highest single allocation is 118 m^3/day for a water well in 07-03-039-25 W4M.

iii) Quality

The groundwaters from the Lower Lacombe Aquifer are mainly a sodium-bicarbonate type (see Piper diagram on CD-ROM). Total dissolved solids concentrations are expected to range mainly from 500 to 1,000 mg/L, with higher concentrations expected at the southeastern edge of the Aquifer. The sulfate concentrations are mainly below 500 mg/L. The indications are that chloride concentrations in the Lower Lacombe Aquifer are expected to be mainly less than ten mg/L. There are 29 out of 121 analyses where fluoride concentrations exceed 1.5 mg/L.

Groundwaters from the Eclipse Pork Ltd. water supply well that is completed in the Lower Lacombe Aquifer, have a TDS concentration of 1,260 mg/L, a sulfate concentration of 455 mg/L, and a chloride concentration of 0.7 mg/L. The groundwater from this water supply well is a sodium-bicarbonate-type (HCL, 1999).

7) Haynes Aquifer

The Haynes Aquifer comprises the porous and permeable parts of the Haynes Member that underlies the Lower Lacombe Member. The Haynes Member subcrops under the surficial deposits in a small part of the Buried Red Deer River Valley, and further west in range 24, W4M in the County. Structure contours have been prepared for the top of the Member, which underlies most of the County. The structure contours show the Haynes Member having an average thickness of in the order of 40 metres.

i) Depth to Top

The depth to the top of the Haynes Member ranges from less than ten metres below ground level where the Member subcrops in the eastern part of the County to more than 300 metres in the western part of the County.

ii) Apparent Yield

The apparent yields for individual water wells completed through the Haynes Aquifer mainly exceed 100 m³/day. Water wells with higher yields are expected mainly in areas where linear bedrock lows are present.

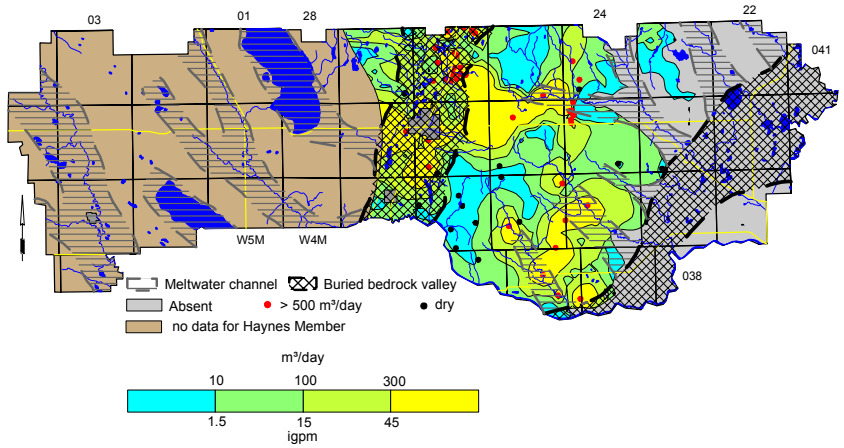

Figure 24. Apparent Yield for Water Wells Completed through Haynes Aquifer

An extended aquifer test conducted with the Town of Lacombe Water Supply Well (WSW) No. 5A completed in the Haynes Aquifer in 12-19-040-26 W4M indicated a long-term yield of more than 1,100 m³/day, based on an effective transmissivity of 50 m^2/day and corresponding storativity coefficient of 9.4 x 10^{-4} (HCL, 1994). However, since this water well was a replacement well for WSW No. 5, and the Town's groundwater supply needs did not require an increase, the existing licence authorizing 460 m³/day was transferred to WSW No. 5A.

In the County, there are 63 licensed water wells that are completed in the Haynes Aquifer, with a total authorized groundwater diversion of 6,050 m^3/day. Of the 6,050 m^3/day authorized to be diverted from the Haynes Aquifer, the Town of Lacombe has seven water supply wells that are authorized to divert 4,532 m^3/day. The Town of Blackfalds has a water supply well completed in the Haynes Aquifer authorized to divert 187 m^3/day.

iii) Quality

The groundwaters from the Haynes Aquifer are mainly a sodium-bicarbonate-type (see Piper diagram on CD-ROM). Total dissolved solids concentrations are expected to range mainly from 500 to 1,000 mg/L, with lower concentrations expected near the Town of Blackfalds and at the northeastern edge of the Aquifer. The sulfate concentrations are mainly below 500 mg/L, with lower concentrations expected near the towns of Lacombe and Blackfalds. The chloride concentrations in the Haynes Aquifer are expected to be mainly less than ten mg/L. There are 11 out of 59 analyses where fluoride concentrations exceed 1.5 mg/L.

Groundwaters from the Town of Lacombe WSW No. 5A have a TDS concentration of 580 mg/L, a sulfate concentration of 3 mg/L, and a chloride concentration of 10 mg/L. The groundwater from this water supply well is a sodium-bicarbonate-type (HCL, 1994).

8) Upper Scollard Aquifer

The Upper Scollard Aquifer comprises the porous and permeable parts of the Upper Scollard Formation that underlies the Haynes Member, and subcrops under the surficial deposits mainly in parts of ranges 23 and 24, W4M. Structure contours have been prepared for the top of the Upper Scollard Formation, which underlies most of the County. The structure contours show the Upper Scollard having an average thickness in the County of 75 metres.

i) Depth to Top

The depth to the top of the Upper Scollard Formation ranges from less than ten metres below ground level where the Formation subcrops in the eastern part of the County to more than 350 metres in the western part of the County.

ii) Apparent Yield

The apparent yields for individual water wells completed through the Upper Scollard Aquifer are mainly more than 100 m³/day. The adjacent map indicates that water wells with apparent yields of more than 500 m³/day are expected mainly in association with areas where meltwater channels are present. In these areas, weathering processes may be increasing the local permeability.

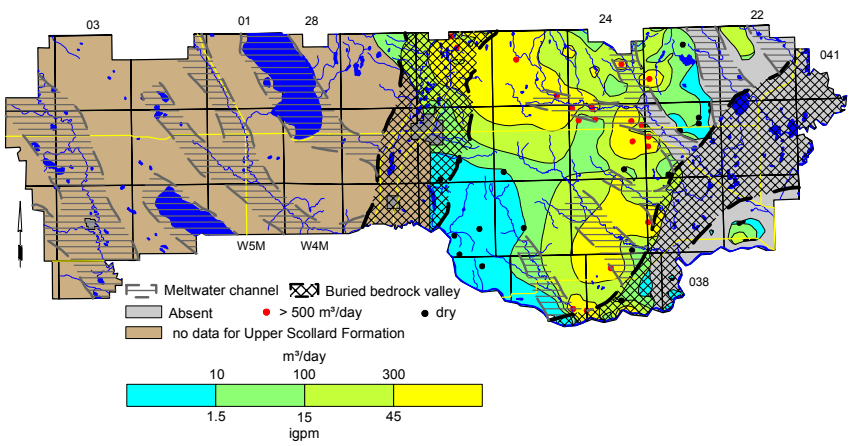

Figure 25. Apparent Yield for Water Wells Completed through Upper Scollard Aquifer

There are a number of dry holes that were encountered in the area south of the Town of Lacombe, creating a low-yield area.

In the County, there are 28 licensed water wells that are completed in the Upper Scollard Aquifer, for a total authorized groundwater diversion of 1,938 m^3/day. The largest single allocation is for the Village of Alix, having a diversion of 1,146 m^3/day.

iii) Quality

The groundwaters from the Upper Scollard Aquifer are mainly a sodium-bicarbonate-type (see Piper diagram on CD-ROM). Total dissolved solids concentrations are expected to range mainly from 500 to 1,500 mg/L. Sulfate concentrations are mainly less than 500 mg/L. There are 12 out of 52 analyses where fluoride concentrations exceed 1.5 mg/L.

The indications are that chloride concentrations in the Upper Scollard Aquifer are expected to be mainly less than ten mg/L.

9) Lower Scollard Aquifer

The Lower Scollard Aquifer comprises the porous and permeable parts of the Lower Scollard Formation that underlies the Upper Scollard Formation, and subcrops under the surficial deposits mainly in range 23, W4M. Structure contours have been prepared for the top of the Lower Scollard Formation, which underlies most of the County. The structure contours show the Lower Scollard Formation having an average thickness of 50 metres.

i) Depth to Top

The depth to the top of the Lower Scollard Formation ranges from less than ten metres below ground level where the Formation subcrops in the eastern part of the County to more than 500 metres in the western part of the County.

ii) Apparent Yield

The apparent yields for individual water wells completed through the Lower Scollard Aquifer range mainly from ten to 100 m³/day. The adjacent map indicates that water wells with apparent yields of more than 500 m³/day are expected mainly in townships 040 and 041, ranges 23 and 24, W4M. In these areas, weathering processes may be increasing the local permeability.

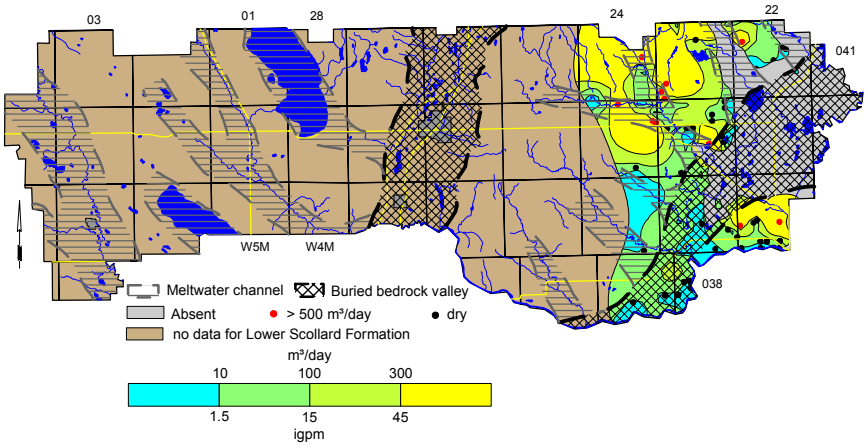

Figure 26. Apparent Yield for Water Wells Completed through Lower Scollard Aquifer

In the County, there are nine licensed water wells that are completed in the Lower Scollard Aquifer with a total authorized diversion of 190 m^3/day. The largest single allocation is used for stock and domestic purposes in 04-28-040-23 W4M, having a diversion of 98 m^3/day.

iii) Quality

The groundwaters from the Lower Scollard Aquifer are a mainly sodium-bicarbonate type (see Piper diagram on CD-ROM). Total dissolved solids concentrations are expected to range from less than 500 to more than 1,000 mg/L. Sulfate concentrations are mainly less than 250 mg/L.

Chloride concentrations in the groundwaters from the Lower Scollard Aquifer are expected to be mainly less than ten mg/L. There are three out of 45 analyses where fluoride concentrations exceed 1.5 mg/L.

Groundwaters from the domestic/stock water supply well in 04-28-040-23 W4M have a TDS concentration of 770 mg/L, a sulfate concentration of 168 mg/L, and a chloride concentration of 2 mg/L..