5.2 Aquifers in Surficial Deposits

The surficial deposits are the sediments above the bedrock surface. This includes pre-glacial materials, which were deposited before glaciation, and materials deposited directly or indirectly by glaciation. The lower surficial deposits include pre-glacial fluvial[11] and lacustrine[12] deposits. The lacustrine deposits include clay, silt and fine-grained sand. The upper surficial deposits include the more traditional glacial deposits of till and meltwater deposits. In the southeastern part of the County, there are narrow meltwater channels. These meltwater channels cannot be identified on a regional basis, but could be significant local aquifers.

5.2.1 Geological Characteristics of Surficial Deposits

While the surficial deposits are treated as one hydrogeological unit, they consist of three hydraulic parts. The first is the sand and gravel deposits of the lower surficial deposits, the second is the saturated sand and gravel deposits of the upper surficial deposits and the third is the sand and gravel close to ground level, which is usually unsaturated. The sand and gravel deposits in the upper part of the surficial deposits can extend above the upper limit of the saturation zone and because they are not saturated, they are not an aquifer. However, these sand and gravel deposits are significant since they provide a pathway for liquid contaminants to move downward into the groundwater. Because of the significance of the shallow sand and gravel deposits, they have been mapped where they are present within one metre of the ground surface and are referred to as the “first sand and gravel”.

Over the majority of the County, the surficial deposits are less than 20 metres thick. The maximum thickness occurs in association with the Buried Beverly Valley, which is north of the Village of Bruderheim. In the Buried Beverly Valley, surficial deposits can be up to 60 metres thick.

The lower surficial deposits are composed mostly of fluvial and lacustrine deposits. The total thickness of the lower surficial deposits can be up to 30 metres. If the elevation of the top of the lower surficial deposits is approximately 600 metres AMSL, an elevation that corresponds closely to the top of the Muriel Lake Formation (Andriashek, 1985), the lower surficial deposits can be expected under approximately 10% of the County, in association with linear bedrock lows. The lowest part of the lower surficial deposits includes pre-glacial sand and gravel deposits. These deposits would generally be expected to directly overlie the bedrock surface in the Buried Beverly Valley. The lowest sand and gravel deposits are of fluvial origin and are usually no more than a few metres thick.

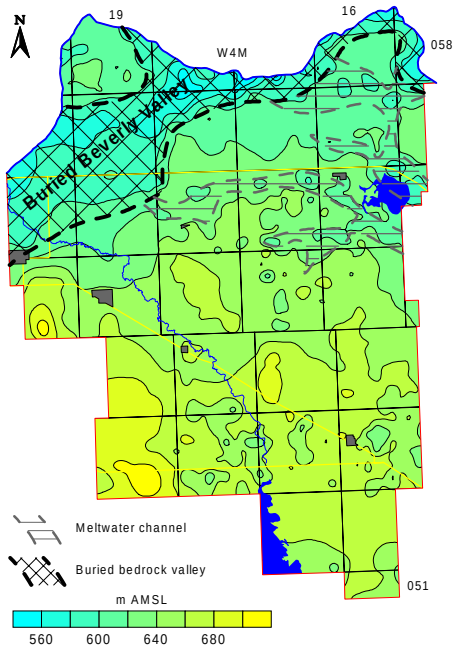

Figure 7. Bedrock Topography

[11] See glossary
[12] See glossary

The upper surficial deposits are either directly or indirectly a result of glacial activity. The deposits include clay and till, and sand and gravel deposits of meltwater origin. The thickness of the upper surficial deposits is mainly less than 20 metres.

Sand and gravel deposits can occur throughout the entire unconsolidated section. The combined thickness of all sand and gravel deposits has been determined as a function of the total thickness of the surficial deposits. Over approximately 25% of the County, the sand and gravel deposits are more than 50% of the total thickness of the surficial deposits. These areas are associated with buried bedrock lows and meltwater channels.

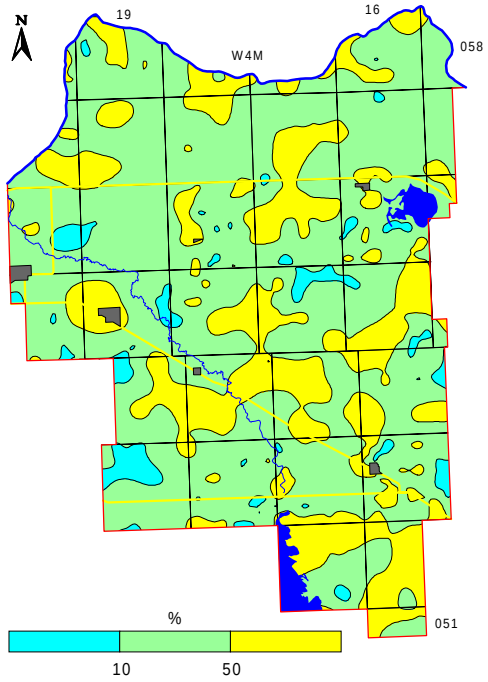

Figure 8. Amount of Sand and Gravel in Surficial Deposits

5.2.2 Sand and Gravel Aquifer(s)

An important source of groundwater in the County is aquifers in the surficial deposits. The particular aquifer used is in a large part dictated by the aquifers present.

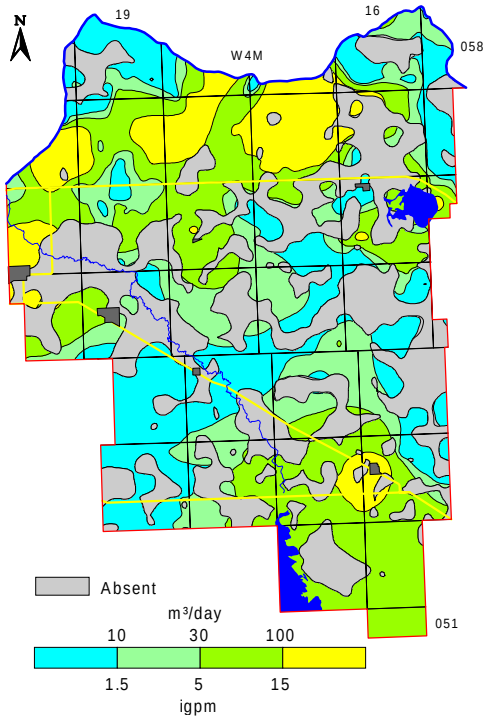

Figure 9. Apparent Yield for Water Wells Completed in Sand and Gravel Aquifer(s)

The adjacent map shows the water well yields that are expected in the County based on the aquifers that have been developed. Based on these data, water well yields of more than 100 m³/day can be expected in 20% of the County; however, water well yields of more than 30 m³/day would be considered exceptional. The higher values for water well yields are more frequently located in the northern part of the County, where the general trend of the Buried Beverly Valley can be seen. The higher yields near the Town of Mundare could be associated with meltwater channels.

A detailed study (Hydrogeological Consultants Ltd., 1976) conducted for the Village of Bruderheim determined that a water supply well located within the Buried Beverly Valley in township 056, range 21, W4M had a long-term yield of more than 1,000 m³/day.

5.2.2.1 Chemical Quality of Groundwater from Surficial Deposits

The chemical analysis results of groundwaters from the surficial deposits have not been differentiated based on aquifers in the upper or lower surficial deposits. The main reason for not separating the chemical analysis results into the different aquifers is the lack of control. The majority of the chemical analysis results are not associated with water wells that have water well drilling reports. Consequently, it is not known from which aquifer the water sample has been obtained. However, all available chemical analysis results have been used; otherwise, only 15% of the available chemical analyses could be used.

The other justification for not separating the analyses was that there appeared to be no major chemical difference between groundwater from the upper and lower sand and gravel aquifers. The groundwaters from these aquifers are generally chemically hard and high in dissolved iron.

The groundwaters from the surficial deposits are mainly calcium-magnesium-bicarbonate-type waters with 30% of the total dissolved solids less than 1,000 mg/L. All of the groundwaters from the surficial deposits are expected to have concentrations of dissolved iron of greater than 1 mg/L.

The groundwater from a water supply well for the Village of Bruderheim (Hydrogeological Consultants Ltd., 1976) had a TDS concentration of more than 1,000 mg/L and an iron concentration of more than 7 mg/L.

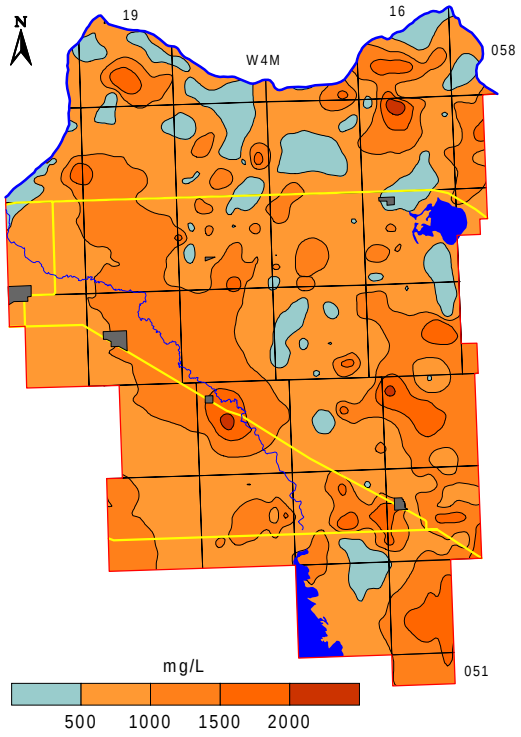

Figure 10. Total Dissolved Solids in Groundwater from Surficial Deposits

Even though the majority of the groundwaters are calcium-magnesium-bicarbonate-type waters, there are groundwaters with sodium as the main cation and there are also groundwaters with significant concentrations of the sulfate ion. The groundwaters with elevated levels of sulfate occur in areas of elevated levels of total dissolved solids. There are very few groundwaters with appreciable concentrations of the chloride ion and in most of the County the chloride ion concentration is less than 100 mg/L.

5.3 Bedrock Aquifers

5.3.1 Geological Characteristics of the Bedrock

The upper bedrock in the County includes the Bearpaw Formation and part of the Belly River Group.

The Bearpaw Formation is the upper bedrock in the southwest portion of the County but has been eroded in two-thirds of the County. The Bearpaw Formation is generally less than 100 metres thick. “The Bearpaw Formation consists of marine shale, siltstone and minor sandstone, and represents the final widespread marine unit in the Western Canada Foreland Basin” (Catuneanu et al, 1997).

The Belly River Group in the area of the County has a maximum thickness of nearly 250 metres and includes the Oldman Formation, and both the *continental* and *marine* facies of the Foremost Formation.

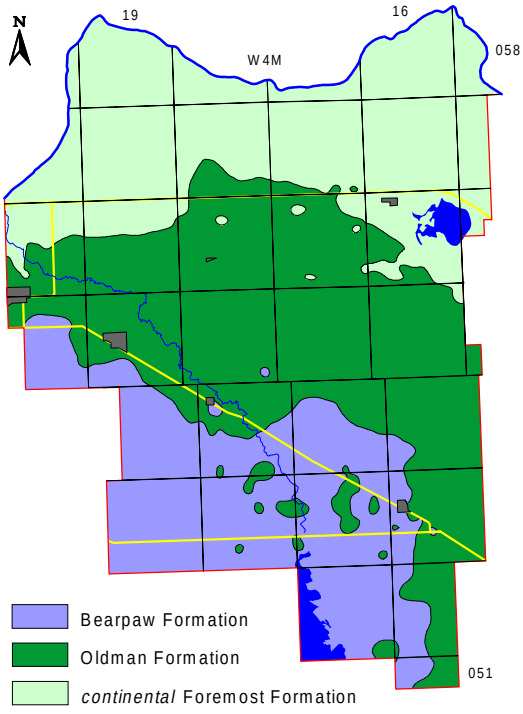

Figure 11. Bedrock Geology

The Oldman Formation is the upper bedrock throughout the central portion of the County. It also subcrops in a few areas to the north and south. The Oldman Formation has a maximum thickness of up to 75 metres and is composed of continental deposits, sandstone, siltstone, shale and coal. The Oldman Formation is the upper part of the Belly River Group and is composed of three parts: the Comrey Member, the Upper Siltstone and the Dinosaur Member. The uppermost part of the Dinosaur Member is the Lethbridge Coal Zone. Sandstone is predominantly present in the Comrey Member, siltstone is the predominant bedrock unit in the Upper Siltstone, and shale and coal are predominantly deposited in the Dinosaur Member.

The *continental* Foremost Formation has been eroded in the southern two-thirds of the County and subcrops in the northern third of the County. The *continental* Foremost Formation, a backshore deposit, consists mainly of shale deposits with minor amounts of sandstone present. Coal zones occur within the *continental* Foremost Formation with the main ones referred to as the McKay and the Taber Coal zones. There are also minor amounts of ironstone, a chemical deposit. In most of the County, the *continental* Foremost Formation is close to the bedrock surface, has been fractured or weathered and can be a significant aquifer. Underlying the *continental* Foremost Formation is the *marine* Foremost Formation, which includes five sandstone members, and has a maximum thickness of less than 50 metres.

The sandstone members thicken toward the western edge of the *marine* Foremost Formation and distinguishing between the individual members is blurred. This condition is evident along the boundary between the *continental* and *marine* facies of the Foremost Formation. Because of the presence of a significant sandstone unit having high permeabilities, this interval has been designated the Milan Aquifer. The Milan Aquifer includes the lower 10 metres of the *continental* Foremost Formation and up to 40 metres of the *marine* Foremost Formation

The Lea Park Formation underlies the Foremost Formation and is mostly composed of shale with only minor amounts of bentonitic sandstone. Generally, the Lea Park Formation is an aquitard.

5.3.2 Aquifers

In general, the upper bedrock aquifer(s) in the County of Lamont can be expected to yield only limited quantities of groundwater. The adjacent map shows the water well yields that are expected in the County based on the upper bedrock aquifer(s) that have been developed. Approximately 40% of the water wells completed in upper bedrock aquifer(s) have apparent yields of more than 10 m³/day.

The producing water wells mainly occur within the area underlain by either the Oldman Formation or the *continental* Foremost Formation. Some of the bedrock water wells are completed in areas where the Bearpaw is indicated as being the upper bedrock.

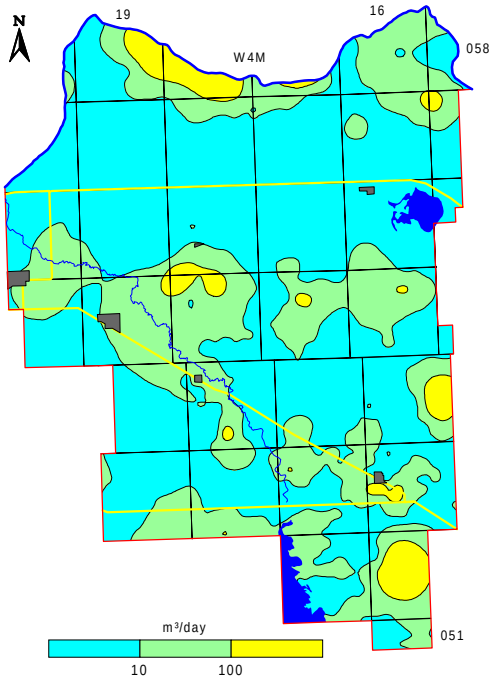

Figure 12. Apparent Yield for Water Wells Completed in Upper Bedrock Aquifer(s)

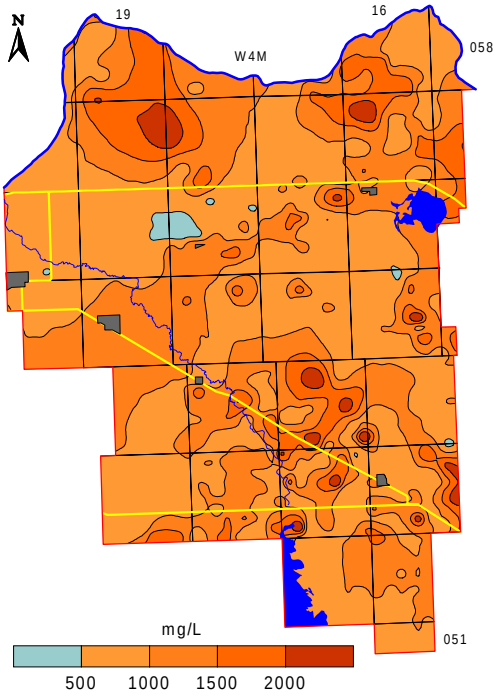

Figure 13. Total Dissolved Solids in Groundwater from Upper Bedrock Aquifer(s)

5.3.3 Chemical Quality of Groundwater

The TDS concentrations in the groundwaters from the upper bedrock aquifer(s) range from less than 500 to more than 2,000 mg/L. In more than 50% of the area, TDS values range from 1,000 to 1,500 mg/L.

A relationship between TDS and sulfate concentrations shows that when TDS values in the upper bedrock aquifer(s) exceed 1,200 mg/L, the sulfate concentrations exceed 400 mg/L.

The Piper tri-linear diagrams show that all chemical types of groundwater occur in the bedrock aquifers. However, the majority of the groundwaters are a sodium-bicarbonate type.

5.3.4 Bearpaw Aquifer

The Bearpaw Aquifer comprises the porous and permeable parts of the Bearpaw Formation that underlies the southwestern one-third of the County. The thickness of the Bearpaw Formation is generally less than 100 metres; in two-thirds of the County, the Bearpaw Formation has been eroded.

5.3.4.1 Depth to Top

The depth to the top of the Bearpaw Formation is mainly less than 20 metres. The largest area where the top of the Bearpaw Formation is more than 40 metres below ground level is in the southwestern part of the County, south of Beaverhill Creek.

5.3.4.2 Apparent Yield

The projected long-term yields for individual water wells completed in the Bearpaw Aquifer are mainly less than 10 m³/day. The higher yields in the southwestern part of the County may correspond to the Elk Island High.

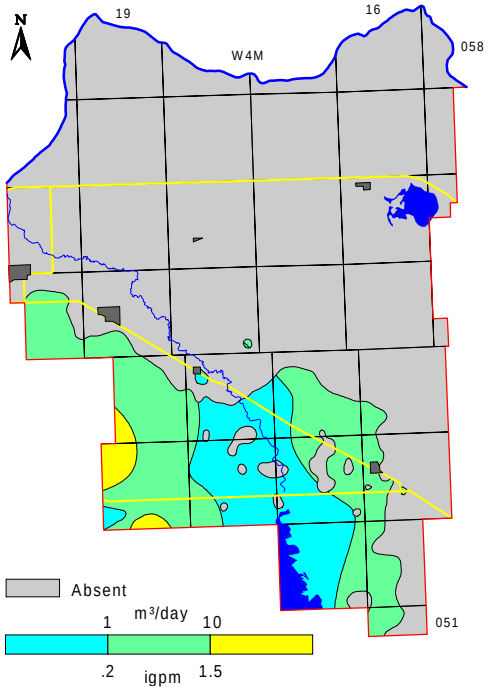

Figure 14. Apparent Yield for Water Wells Completed through Bearpaw Aquifer

5.3.4.3 Quality

The Piper tri-linear diagrams show that all chemical types of groundwater occur in the Bearpaw Aquifer. However, the majority of the groundwaters are sodium-bicarbonate or sodium-sulfate types.

The TDS concentrations range from 500 to over 2,000 mg/L in the Bearpaw Aquifer. The groundwaters with a TDS of less than 1,000 mg/L occur south of Lamont and may correspond to the Elk Island High. Groundwaters with a TDS of over 1,000 mg/L can be expected between Chipman and Mundare. When TDS values in the Bearpaw Aquifer exceed 1,800 mg/L, the sulfate concentrations exceed 400 mg/L.

The chloride concentration of the groundwaters from the Bearpaw Aquifer in some areas is expected to be more than 250 mg/L.

5.3.5 Oldman Aquifer

The Oldman Aquifer comprises the porous and permeable parts of the Oldman Formation that underlies the Bearpaw Formation and is present under the central third of the County. The thickness of the Oldman Formation ranges from 40 to 75 metres; in two-thirds of the County, the Oldman Formation has been eroded.

5.3.5.1 Depth to Top

The depth to the top of the Oldman Formation is mainly less than 20 metres and directly underlies the surficial deposits in the central part of the County. The largest area where the top of the Oldman Formation is more than 60 metres below ground level is in the southwestern part of the County.

5.3.5.2 Apparent Yield

The projected long-term yields for individual water wells completed in the Oldman Aquifer are variable and range from less than 10 m³/day to more than 100 m³/day. There are an equal number of yields that are less than 10 m³/day as there are yields that are greater than 100 m³/day.

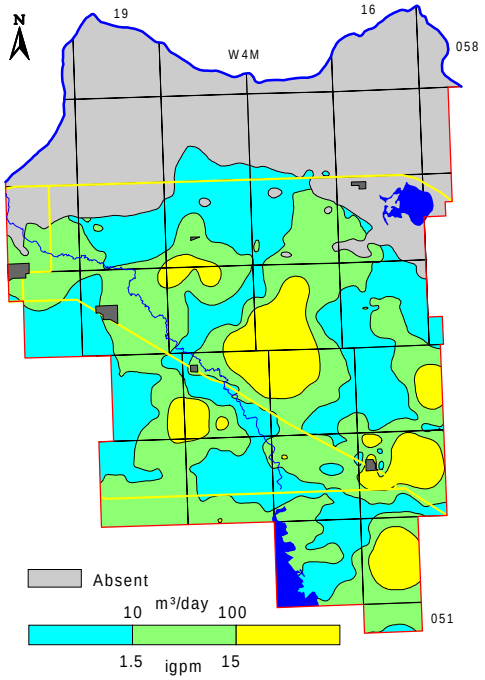

Figure 15. Apparent Yield for Water Wells Completed through Oldman Aquifer

5.3.5.3 Quality

The TDS concentrations in the groundwaters from the Oldman Aquifer range from less than 500 to more than 2,000 mg/L. There are several areas with TDS values of less than 500 mg/L. In addition, there are more areas with TDS less than 1,000 mg/L than in the groundwaters from the Bearpaw Aquifer. When TDS values in the Oldman Aquifer exceed 1,200 mg/L, the sulfate concentrations exceed 400 mg/L.

The chloride concentration of the groundwaters from the Oldman Aquifer in the southwestern part of the County can be expected to be more than 250 mg/L. In water wells completed to depths of less than 40 metres, chloride concentrations are typically less than 400 mg/L.