

5.3 Bedrock

5.3.1 Geological Characteristics

The upper bedrock in the County includes the Belly River Group and the Lea Park Formation. The Lea Park Formation underlies the Belly River Group.

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

The upper part of the Belly River Group is the Oldman Formation. Within the County the Oldman Formation is present and forms the uppermost bedrock in predominantly the western part of the County and in 30% of the eastern half of the County. The Oldman Formation has a maximum thickness of 70 metres within the County and is composed of sandstone, siltstone, shale, and coal deposits of the Comrey and Upper Siltstone members.

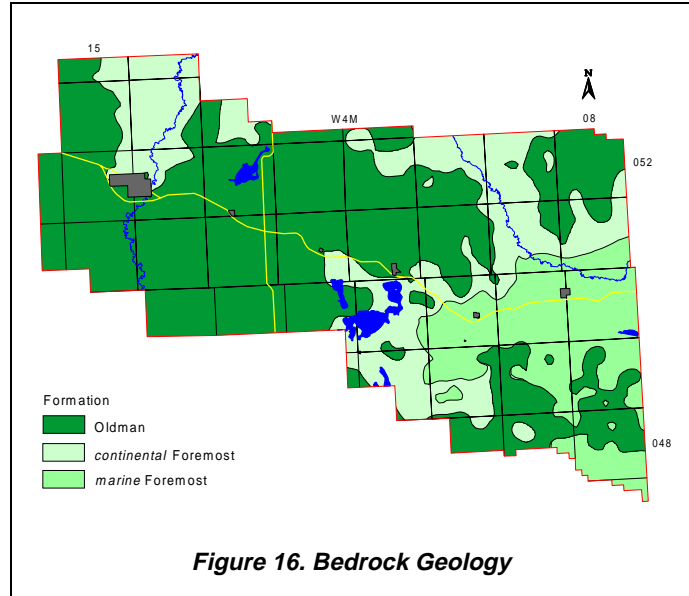


Figure 16. Bedrock Geology

The *continental* Foremost Formation underlies the Oldman Formation and subcrops under the surficial deposits in the northwestern part of the County and in 35% of the eastern half of the County. The *continental* Foremost Formation has a thickness of less than 200 metres within 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 the *continental* Foremost Formation. Where the *continental* Foremost Formation is close to the bedrock surface, it can be fractured or weathered and can have significant local permeability.

The *marine* Foremost Formation has a maximum thickness of 200 metres within the County and underlies the *continental* Foremost Formation in the western and northern parts of the County. In the southeastern part of the County, the *marine* Foremost Formation subcrops.

In parts of eastern Alberta, the *marine* Foremost Formation can be separated into individual sandstone and shale members. However, close to the upper part of the *marine* Foremost Formation, and particularly toward the western extent, the sandstones making up the *marine* Foremost Formation cannot always be separated into individual members. This situation occurs because the sandstone members of the *marine* Foremost Formation thicken and the intervening shale layers thin toward the top and the western extent of the marine facies. Even though the individual members cannot be distinguished, the sandstone occurrence can be a significant aquifer and has been designated the "Milan Aquifer". The top of the Milan Aquifer extends up to ten metres into the overlying *continental* Foremost Formation and can

occupy the upper 40 metres of the *marine* Foremost Formation. The western extent of the Milan Aquifer coincides with the position where the Basal Belly River Sand can be distinguished. The Milan Aquifer is present in the western half of the County under the *continental* Foremost Formation.

The *marine* Foremost Formation facies can include most of the Milan Aquifer and up to four sandstone and intervening shale members. Because the significant individual aquifers can be distinguished in most of the area and because the upper bedrock discussion includes aquifers mainly associated with the *marine* Foremost Formation, there will be no direct review of the Milan Aquifer or the *marine* Foremost Formation in this report or on the CD-ROM.

The Lea Park Formation is mostly composed of shale, with only minor amounts of bentonitic sandstone present in some areas. Regionally, the Lea Park Formation is an aquitard. Because the Lea Park Formation is an aquitard, there will be no direct review of the Lea Park Aquifer in the text of this report. However, maps associated with the Lea Park Aquitard are included on the CD-ROM.

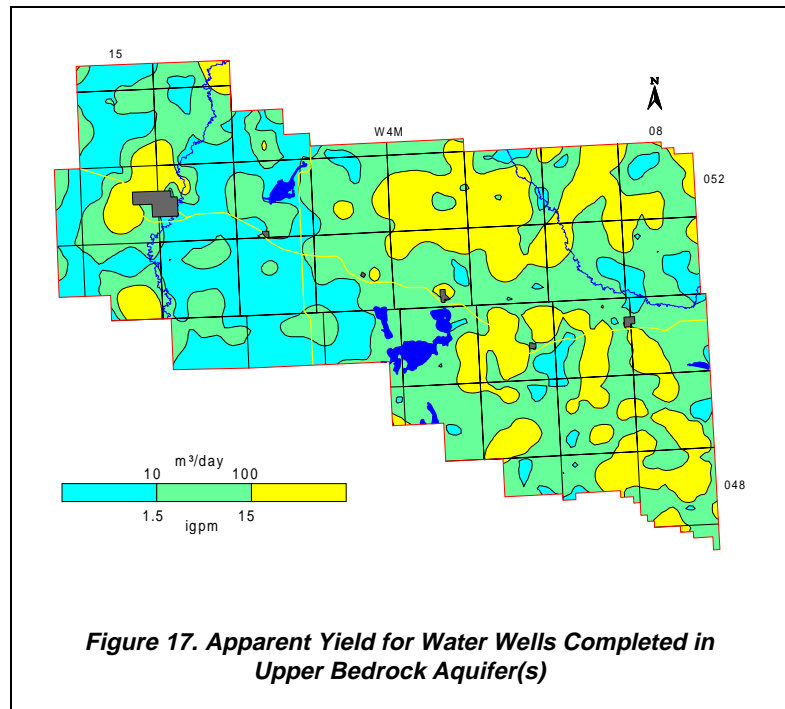
5.3.2 Aquifers

Of the 3,329 water wells in the database, 909 were defined as being completed in bedrock aquifers based on the top of the completion interval being below the bedrock surface. However, less than half of the water well records in the database have values for the top of their completion intervals. The information that is available for the majority of water wells is their completion depth. In order to make use of additional information within the groundwater database, it was statistically determined that water wells typically have completion intervals equivalent to one quarter of their completed depth. This relationship was used to increase the number of water wells identified as completed in bedrock aquifers to 2,204 from 909. With the use of geological surfaces that were determined from the interpretation of geophysical logs, it has been possible to assign the water wells completed in bedrock aquifers to specific aquifers based on their completion intervals. Of the 2,204 bedrock water wells, 1,937 could be assigned a specific aquifer. The bedrock water wells are mainly completed in the Oldman and *continental* Foremost aquifers as shown in the adjacent table. There are 33 records that are not included in the six main aquifers ("Other" in adjacent table).

Bedrock Aquifer	No. of Water Wells
Oldman	433
<i>continental</i> Foremost	1008
Birch Lake Member	246
Ribstone Creek Member	140
Victoria Member	106
Brosseau Member	4
Other	33
Total	1970

Table 3. Completion Aquifer

There are 698 records for bedrock water wells that have apparent yield values. In the County, water well yields in the upper bedrock aquifer(s) are mainly less than 100 m³/day. The areas of higher yields that are indicated on the adjacent figure are mainly in the eastern half and the lower yields are mainly in the western half of the County. The higher yields in the western part of the County may be a result of increased permeability resulting from the weathering process in association with the Buried Vegreville Valley.



There are 618 apparent yield values that can be assigned to a specific bedrock aquifer. The majority of the water wells completed in the bedrock aquifers have apparent yields that range from 10 to 100 m³/day, as shown in the table below.

Aquifer	No. of Water Wells with Apparent Yields	Number of Water Wells with Apparent Yields		
		<10 m ³ /day	10 to 100 m ³ /day	>100 m ³ /day
Oldman	71	32	35	4
continental Foremost	303	88	123	92
Birch Lake Member	118	7	68	43
Ribstone Creek Member	73	9	40	24
Victoria Member	52	10	35	7
Brosseau Member	1	0	0	1
Totals	618	146	301	171

Table 4. Apparent Yields of Bedrock Aquifers

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 80% of the area, TDS values are less than 1,500 mg/L, with only a few areas having TDS concentrations of less than 500 mg/L. The higher values are expected mainly in the western and southwestern parts of the County.

The 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 chloride concentrations in the groundwaters from the upper bedrock aquifer(s) are less than 100 mg/L in more than 80% of the County.

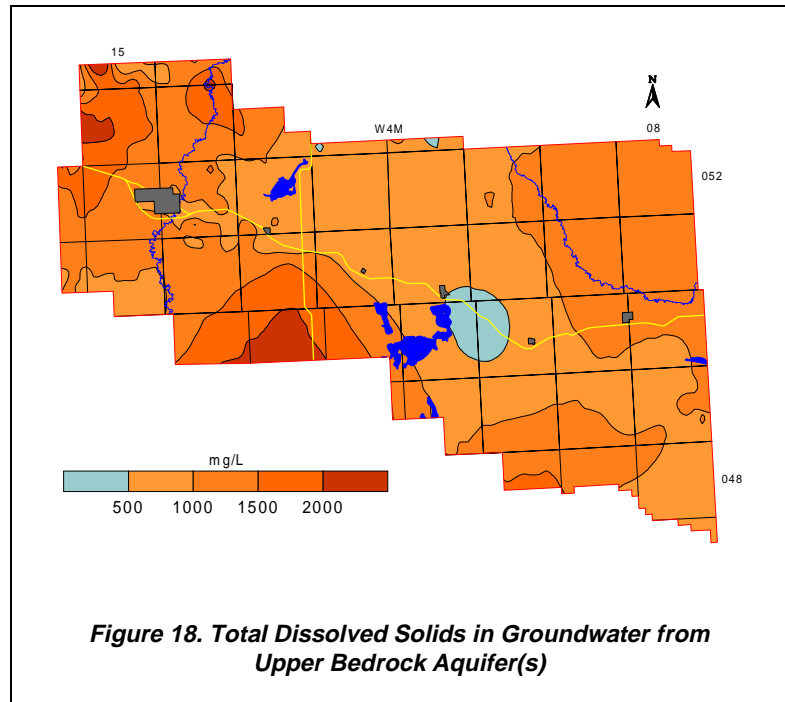


Figure 18. Total Dissolved Solids in Groundwater from Upper Bedrock Aquifer(s)

In more than 95% of the County, the fluoride ion concentrations in the groundwaters from the upper bedrock aquifer(s) are less than 1.5 mg/L.

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 types.

5.3.4 Oldman Aquifer

The Oldman Aquifer comprises the porous and permeable parts of the Oldman Formation that underlies the surficial deposits predominantly in the western part of the County and in 30% of the eastern half of the County. The thickness of the Oldman Formation varies from less than 20 metres at the edge of the subcrop to more than 60 metres at the western edge of the County. The thickness of the Oldman Formation decreases in the vicinity of the Vermilion River Valley as a result of erosional processes.

5.3.4.1 Depth to Top

The depth to the top of the Oldman Formation is mainly less than 20 metres in the northern two-thirds of the County, where it subcrops. In the southeastern part of the County, the depth to the top of the Oldman Formation can be more than 40 metres.

5.3.4.2 Apparent Yield

The apparent yields for individual water wells completed in the Oldman Aquifer in the western part of the County are mainly less than 10 m³/day and predominantly between 10 and 100 m³/day east of range 13, W4M.

5.3.4.3 Quality

The groundwaters from the Oldman Aquifer are mainly sodium-bicarbonate or sodium-sulfate types (see CD-ROM). The TDS concentrations are expected to be mainly less than 1,500 mg/L. The higher values are in the northwestern and southeastern parts of the County. The sulfate concentrations are mainly less than 500 mg/L. Chloride concentrations in the groundwaters from the Oldman Aquifer are mainly less than 100 mg/L.

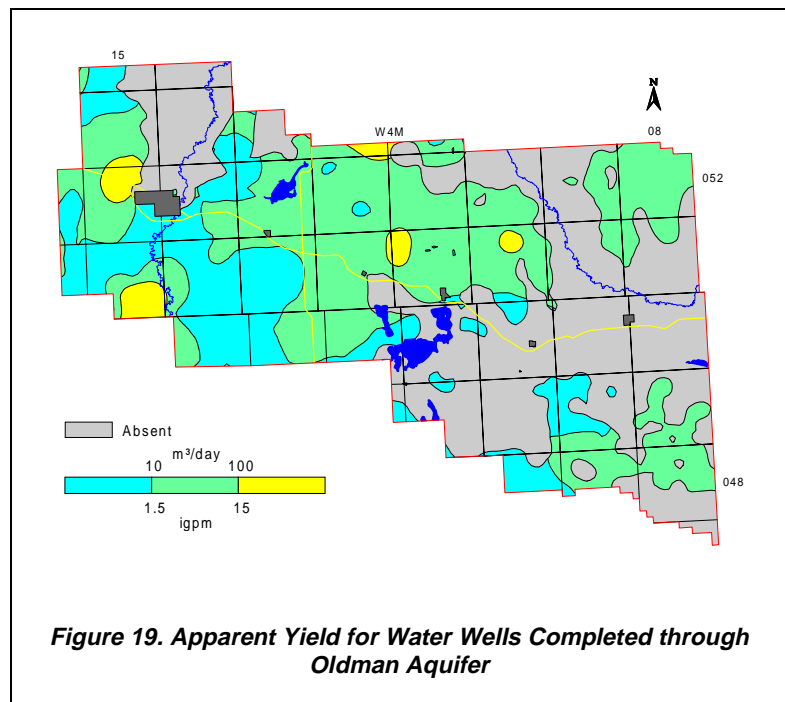


Figure 19. Apparent Yield for Water Wells Completed through Oldman Aquifer

5.3.5 *continental* Foremost Aquifer

The *continental* Foremost Aquifer comprises the porous and permeable parts of the *continental* Foremost Formation that underlies the Oldman Formation, and subcrops under the surficial deposits in the northwestern part of the County and in 35% of the eastern half of the County. The thickness of the *continental* Foremost Formation varies from less than 20 metres at the eastern edge of the subcrop to more than 200 metres in Tp 050, R 14, W4M. The *continental* Foremost Aquifer does not include the lower 10 metres of the Formation, which is the Milan Aquifer.

5.3.5.1 *Depth to Top*

The depth to the top of the Formation is variable, ranging from less than 20 metres to more than 80 metres at the western edge of the County.

5.3.5.2 *Apparent Yield*

The apparent yields for individual water wells completed in the *continental* Foremost Aquifer are mainly less than 10 m³/day west of range 12, W4M and between 10 and 100 m³/day east of range 13, W4M. The adjacent map indicates that apparent yields of more than 100 m³/day can be expected in townships 051 and 052, ranges range 08 to 12, W4M.

5.3.5.3 *Quality*

The groundwaters from the *continental* Foremost Aquifer are mainly sodium-bicarbonate, sodium-sulfate or sodium-chloride types (see CD-ROM). The TDS concentrations are expected to be mainly less than 1,500 mg/L. The higher values are in the northwestern and southwestern parts of the County. The sulfate concentrations are mainly less than 500 mg/L. Chloride concentrations in the groundwaters from the Oldman Aquifer are mainly less than 250 mg/L. The indications are that in the western part of the County, the chloride concentrations are expected to be more than 250 mg/L.

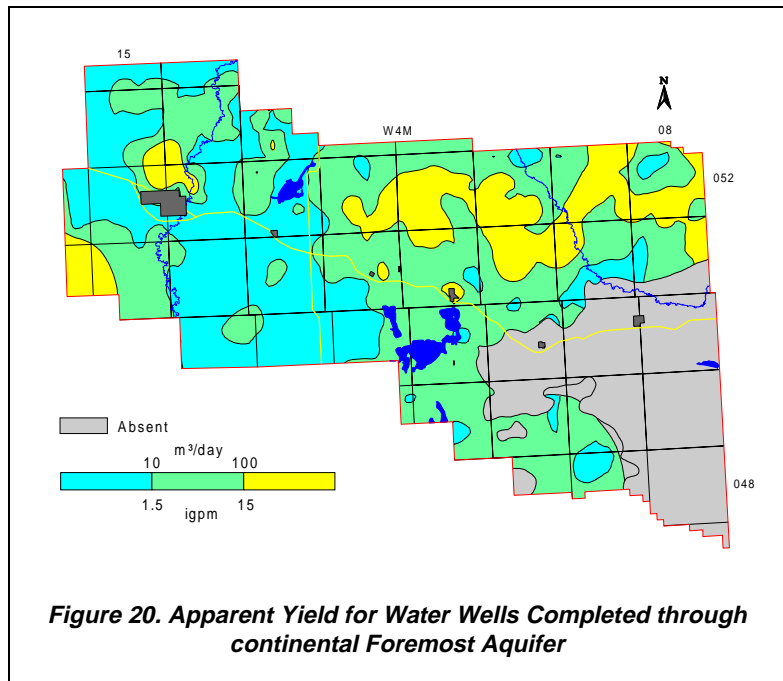


Figure 20. Apparent Yield for Water Wells Completed through *continental* Foremost Aquifer

5.3.6 *marine* Foremost Aquifer

There is no detailed discussion for the *marine* Foremost Aquifer in this report; however, discussions for three of the four sandstone members that comprise the *marine* Foremost Aquifer are provided in the following sections. Due to the lack of available data for the Brosseau Member, there is no discussion for this Member in this report.

5.3.7 Birch Lake Aquifer

The Birch Lake Aquifer comprises the porous and permeable parts of the Birch Lake Member. Structure contours have been prepared for the top and bottom of the Member, which underlies the southeastern part of the County. The structure contours show the Member being mostly less than 30 metres thick. The thickness of the Birch Lake Member is generally less than 10 metres at its northern edge.

5.3.7.1 Depth to Top

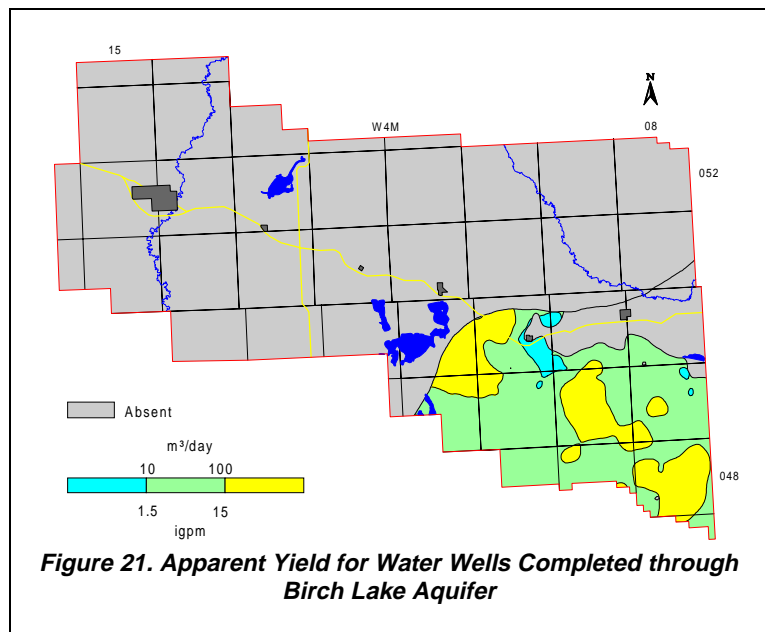
The depth to the top of the Birch Lake Member is mainly less than 60 metres below ground level, but can be more than 100 metres in the southern part of the County in township 048, range 10, W4M.

5.3.7.2 Apparent Yield

The apparent yields for individual water wells completed through the Birch Lake Aquifer are mainly in the range of 10 to 100 m³/day. The areas where water wells with higher yields are expected are mainly in a northwest-southeast-trending direction where the Aquifer is present in the County.

5.3.7.3 Quality

There are nine water well records in the database with sufficient information to determine the chemical type of groundwaters from the Birch Lake Aquifer. The groundwaters from the Birch Lake Aquifer are mainly a sodium-bicarbonate type (see CD-ROM).



The TDS concentrations in the groundwaters from the Birch Lake Aquifer are expected to be less than 1,000 mg/L. The sulfate concentrations are mainly less than 300 mg/L. Chloride concentrations in the groundwaters from the Birch Lake Aquifer are mainly less than 10 mg/L.

5.3.8 Ribstone Creek Aquifer

The Ribstone Creek Aquifer comprises the porous and permeable parts of the Ribstone Creek Member. Structure contours have been prepared for the top and bottom of the Member, which underlies the southeastern part of the County, predominantly south of township 051 and east of range 12, W4M. The structure contours show the Member being mostly less than 20 metres thick.

5.3.8.1 Depth to Top

The depth to the top of the Ribstone Creek Member is mainly less than 100 metres below ground level but can be more than 120 metres in townships 048 and 049, ranges 09 and 10, W4M.

5.3.8.2 Apparent Yield

The apparent yields for individual water wells completed through the Ribstone Creek Aquifer are mainly in the range of 10 to 100 m³/day. The areas where water wells with higher yields are expected are mainly in parts of townships 049 and 050, W4M.

5.3.8.3 Quality

There are not enough available data to determine the chemical type of the groundwaters from the Ribstone Creek Aquifer in the County. However, data available from the Aquifer in the M.D. of Wainwright suggest that, typically, the groundwaters from the Ribstone Creek Aquifer are a sodium-bicarbonate type.

The TDS concentrations in the groundwaters from the Ribstone Creek Aquifer are mainly less than 1,000 mg/L. The sulfate concentrations are mainly less than 200 mg/L. The higher sulfate concentrations are mainly along the southern edge of the County, where the Aquifer is present. Chloride concentrations in the groundwaters from the Ribstone Creek Aquifer are mainly less than 50 mg/L. The higher chloride values occur primarily in townships 049 and 050, range 08, W4M.

