

5.3 Bedrock

5.3.1 Geological Characteristics

The upper bedrock in the M.D. 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 M.D. has a maximum thickness of 250 metres, and includes the Oldman Formation and both the *continental* and *marine* facies of the Foremost Formation.

The uppermost part of the Belly River Group is the Oldman Formation. Within the M.D. the Oldman Formation is present and forms the upper bedrock in a few areas in the northwestern and southern parts of the M.D. The Oldman Formation has a maximum thickness of 50 metres within the M.D. and is composed of sandstone, siltstone, shale, and coal deposits of the Comrey and Upper Siltstone members.

The *continental* Foremost Formation underlies the Oldman Formation and subcrops under the surficial deposits in the western part of the M.D. The *continental* Foremost Formation has a thickness of less than 100 metres within the M.D. 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 M.D. and underlies the *continental* Foremost Formation in the southwestern part of the M.D. In the northeastern part of the M.D., the *marine* Foremost Formation is the upper bedrock.

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

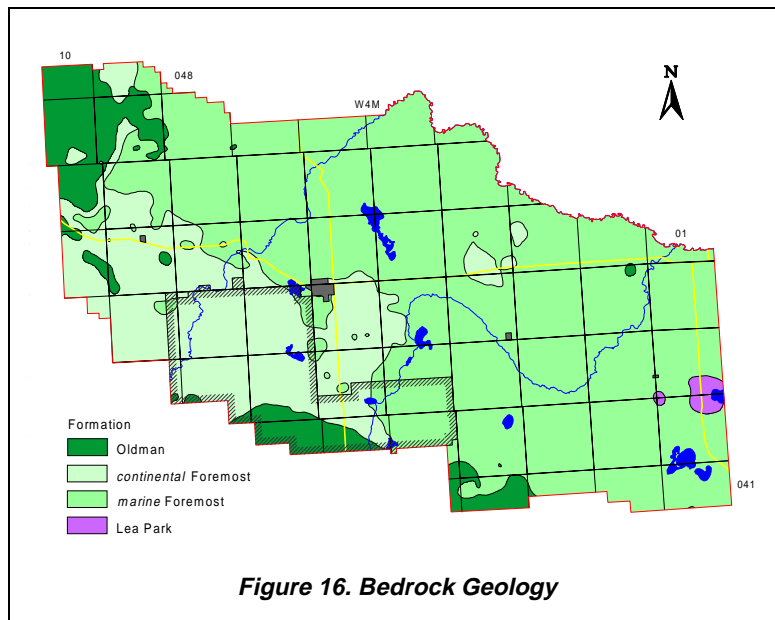


Figure 16. Bedrock Geology

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 M.D. under the *continental* Foremost Formation but does not subcrop anywhere in the M.D.

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.

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 Aquitard in the body of this report. However, maps associated with the Lea Park Aquitard are included on the CD-ROM.

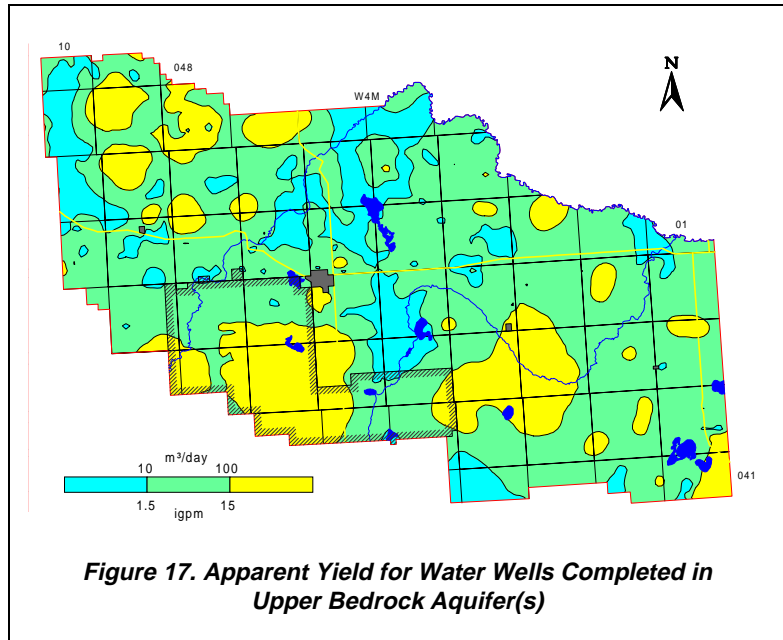
5.3.2 Aquifers

Of the 3,160 water wells in the database, 774 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 1,957 from 774. 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 1,957 bedrock water wells, 1,717 could be assigned a specific aquifer. The bedrock water wells are mainly completed in the Birch Lake and Ribstone Creek aquifers as shown in the adjacent table. There are 69 records that are not included in the six main aquifers (“Other” in adjacent table).

Bedrock Aquifer	No. of Water Wells
Oldman	22
<i>continental</i> Foremost	120
Birch Lake Member	904
Ribstone Creek Member	518
Victoria Member	145
Brosseau Member	8
Other	69
Total	1786

Table 3. Completion Aquifer

There are 642 records for bedrock water wells that have apparent yield values. In the M.D., 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 northwestern and southern parts of the M.D. The higher yields in the southern part of the M.D. may be a result of increased permeability resulting from the weathering process in association with the Buried Wainwright Valley.



There are 606 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	8	2	6	0
continental Foremost	53	24	27	2
Birch Lake Member	281	77	146	58
Ribstone Creek Member	192	66	95	31
Victoria Member	64	16	36	12
Brosseau Member	8	1	6	1
Totals	606	186	316	104

Table 4. Apparent Yields of Bedrock Aquifers

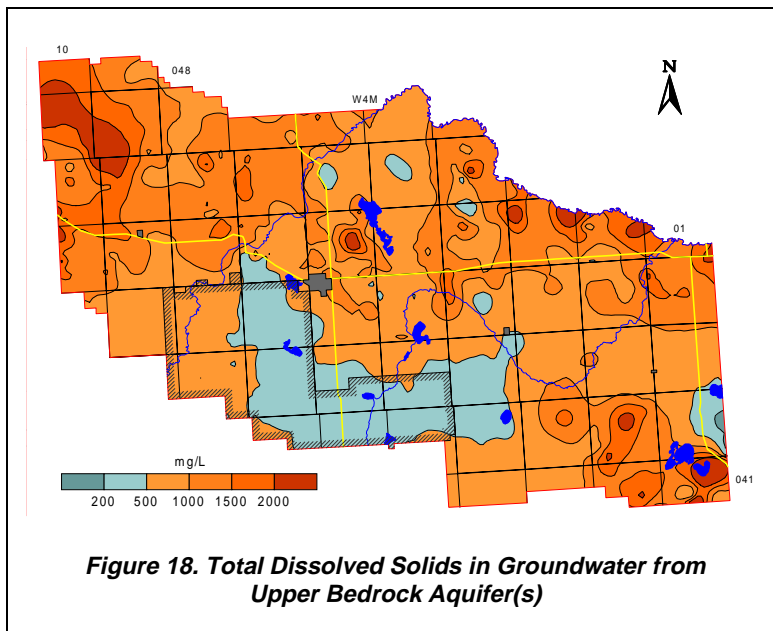
5.3.3 Chemical Quality of Groundwater

The TDS concentrations in the groundwaters from the upper bedrock aquifer(s) range from less than 200 to more than 2,000 mg/L. In more than 60% of the area, TDS values are less than 1,000 mg/L, with approximately 10% of the M.D. having TDS concentrations of less than 500 mg/L. The higher values are expected mainly in the northwestern parts of the M.D.

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 75% of the M.D.

In more than 95% of the M.D., the fluoride ion concentration in the groundwaters from the upper bedrock aquifer(s) is less than 1.0 mg/L.

The Piper tri-linear diagrams (see Appendix A) show that all chemical types of groundwater occur in the upper bedrock aquifer(s). 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 and underlies less than 10% of the M.D., mainly in townships 046, 047 and 048, ranges 09 and 10, W4M in the northwestern part of the M.D and in townships 041 and 042, ranges 04, 06 and 07, W4M in the southern part of the M.D. The thickness of the Oldman Aquifer is mainly less than 30 metres.

5.3.4.1 Depth to Top

The depth to the top of the Oldman Formation is mainly less than 40 metres in the northwestern part of the M.D., where it subcrops. In the southern part of the M.D., the depth to the top of the Oldman Formation can be up to 60 metres.

5.3.4.2 Apparent Yield

The apparent yields for individual water wells completed in the Oldman Aquifer in the northwestern part of the M.D. are mainly less than 10 m³/day but are mainly between 10 and 100 m³/day in the southern part of the M.D.

5.3.4.3 Quality

There are only three water well records in the database with sufficient information to determine the chemical type of groundwaters from the Oldman Aquifer. The groundwaters are a sodium-sulfate type.

TDS concentrations in the groundwaters from the Oldman Aquifer are expected to be mainly greater than 1,500 mg/L in the northwestern part of the M.D. but less than 1,000 mg/L in the southern part of the M.D. The sulfate concentrations are mainly greater than 500 mg/L in the northwestern part of the M.D. but less 500 mg/L in the southern part of the M.D. Chloride concentrations in the groundwaters from the Oldman Aquifer are mainly less than 20 mg/L.

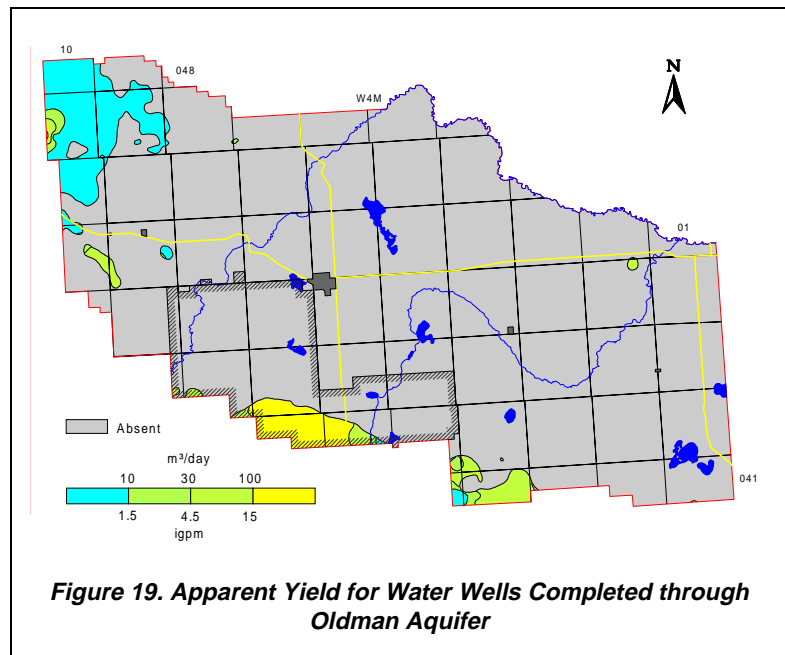


Figure 19. Apparent Yield for Water Wells Completed through Oldman Aquifer

5.3.5 Continental Foremost Aquifer

The *continental* Foremost Aquifer comprises the porous and permeable parts of the *continental* Foremost Formation and subcrops in the western part of the M.D. The thickness of the *continental* Foremost Formation varies from less than 20 metres at the edge of the subcrop to more than 120 metres in Tp 045, R 10, W4M. The thickness of the *continental* Foremost Formation decreases in the vicinity of the Battle River Valley as a result of erosional processes. The *continental* Foremost Aquifer does not include the lower ten 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 100 metres in the southern part of the M.D. where the Formation is present.

5.3.5.2 Apparent Yield

The apparent yields for individual water wells completed in the *continental* Foremost Aquifer are mainly between 10 and 100 m³/day. The adjacent map indicates that apparent yields of more than 100 m³/day are expected mainly in range 08, in proximity to the Battle River.

5.3.5.3 Quality

There are 11 water well records in the database with sufficient information to determine the chemical type of groundwaters from the *continental* Foremost Aquifer; the groundwaters are mainly a sodium-bicarbonate type.

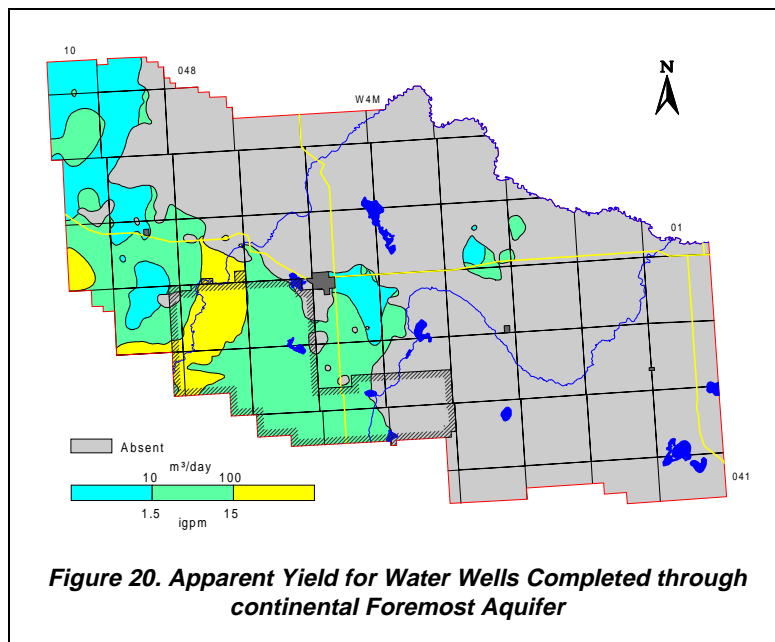


Figure 20. Apparent Yield for Water Wells Completed through continental Foremost Aquifer

TDS concentrations in the groundwaters from the *continental* Foremost Aquifer are expected to be mainly less than 1,500 mg/L. The higher values are mainly north of township 046 where the Formation subcrops in the M.D. The sulfate concentrations are mainly below 500 mg/L. Chloride concentrations in the groundwaters from the *continental* Foremost Aquifer are mainly less than 100 mg/L. The indications are that in the western part of the M.D. where the Formation is present, the chloride concentration is expected to be less than 10 mg/L.