#### *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.

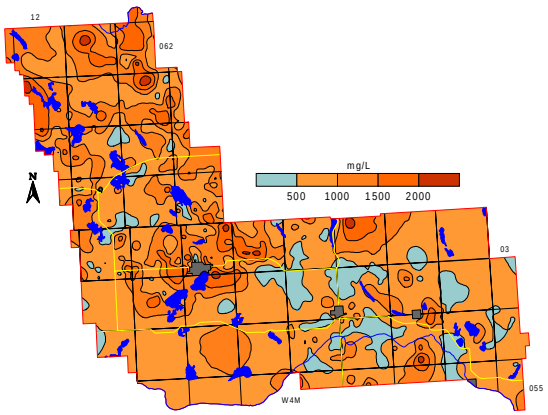


***Figure 8. Total Dissolved Solids in Groundwater from Surficial Deposits***

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 total dissolved solids from less than 500 to more than 1,000 mg/L. Most of the groundwaters from the northern part of the County have concentrations of dissolved solids in excess of 1,000 mg/L. The majority of the groundwaters from the southern part of the County have total dissolved solids of less than 1,000 mg/L. All of the groundwater from the surficial deposits is expected to have concentrations of dissolved iron of greater than 1 mg/L.

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.

### 5.2.3 Upper Sand and Gravel Aquifer

The Upper Sand and Gravel Aquifer includes saturated sand and gravel deposits in the upper surficial deposits. These aquifers typically occur above an elevation of 540 metres AMSL. The saturated sand and gravel deposits are not continuous and are expected over approximately 80% of the County.

#### *5.2.3.1 Aquifer Thickness*

The thickness of the Upper Sand and Gravel Aquifer is in part a function of the elevation of the non-pumping water level associated with the upper surficial deposits and in part a result of the depth to the bedrock surface. Since the non-pumping water level tends to be a subdued replica of the bedrock surface, the thickness of the Upper Sand and Gravel Aquifer tends to be directly proportional to the thickness of the surficial deposits. The main exception occurs close to major topographic features, where the surficial deposits can be thick but, because of the large topographic relief, the surficial deposits drain

more easily and the Aquifer can be very thin or absent. This phenomenon is apparent in areas close to the North Saskatchewan River Valley.

While the sand and gravel deposits of the upper surficial deposits are not continuous, the Upper Sand and Gravel Aquifer includes all of the aquifers present in the upper surficial deposits. The Upper Sand and Gravel Aquifer is more than ten metres thick in some areas, but over the majority of the County, is less than five metres thick or is absent. Most of the greater thickness in the Upper Sand and Gravel Aquifer occurs in the southwestern and eastern parts of the County.

#### *5.2.3.2 Apparent Yield*

The permeability of the Upper Sand and Gravel Aquifer can be high. The high permeability combined with significant thickness leads to an extrapolation of water wells with high yields; however, because the sand and gravel deposits occur mainly as hydraulically discontinuous pockets, the long-term yield of the water wells is limited. The yield map shows that, in less than 10% of the County, higher short-term yields can be expected. The main area of high short-term yields is in the eastern part of the County. The long-term yields for water wells completed in this Aquifer are expected to be mainly less than 30 m³/day. Where the upper aquifer is absent and where the yields are low, the development of water wells for the domestic needs of single families may not be possible.

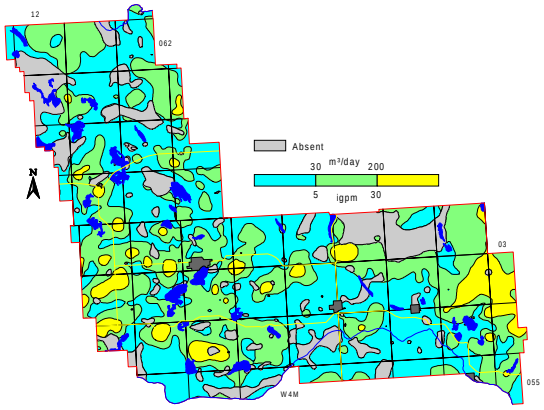


***Figure 9. Apparent Yield for Water Wells Completed through Upper Sand and Gravel Aquifer***

### 5.2.4 Lower Sand and Gravel Aquifer

The Lower Sand and Gravel Aquifer is a saturated sand and gravel deposit that occurs at or near the base of the surficial deposits in the deepest of the pre-glacial linear bedrock lows of the Buried Beverly and Vermilion Valleys. The Lower Sand and Gravel Aquifer may be a continuous aquifer in the Buried Beverly Valley, where the thickness of the sand and gravel deposits may reach ten metres. In all, the Aquifer occupies less than 20% of the County.

#### *5.2.4.1 Apparent Yield*

Water wells completed in the Lower Sand and Gravel Aquifer may have yields in excess of 100 m³/day. The highest yields are expected in townships 059 and 060, ranges 09 to 11, W4M. In this area, the projected long-term yield from individual water wells could be more than 300 m³/day. The Lower Sand and Gravel Aquifer is absent from the majority of the County.

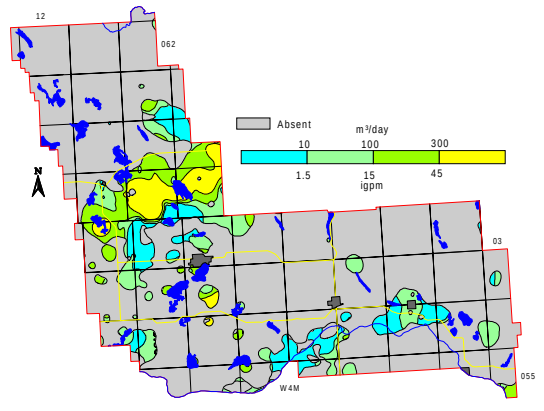


***Figure 10. Apparent Yield for Water Wells Completed through Lower Sand and Gravel Aquifer***

## 5.3 Bedrock

### 5.3.1 Geological Characteristics

The upper bedrock includes the Lea Park Formation and parts of the Belly River Group. The Belly River Group in the area of the County has a maximum thickness of 150 metres and includes both the *continental* and *marine* facies of the Foremost Formation.

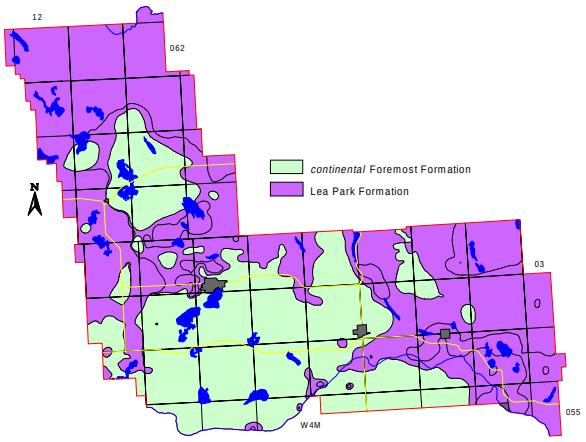


***Figure 11. Bedrock Geology***

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.

In the County, the *marine* Foremost Formation, an offshore deposit, includes patches of the Victoria Member. The Victoria Member is a fine-grained sandstone and siltstone less than ten metres thick, which occurs in relatively small isolated areas that cover less than a few tens of square kilometres. The largest area where the Victoria Member is present is in the western part of the County.

The Lea Park Formation underlies the Foremost Formation and has two parts. The upper part is primarily a shale deposit, with minor amounts of fine-grained sandstone, siltstone and bentonite. The bentonite is both a cementing agent for some of the sandstone and siltstone deposits and an individual sedimentary layer. The upper Lea Park Formation is less than 100 metres thick and is the uppermost bedrock under most of the northern and eastern parts of the County. Unless fractured or weathered, the upper Lea Park is an aquitard.

The lower part of the Lea Park Formation is primarily shale and is 60 to 110 metres thick. Unless fractured or weathered, the lower Lea Park, which underlies the entire County, is an aquitard. This part of the Lea Park Formation is equivalent to the Milk River Formation.

A regional lineament analysis using DEM maps indicates that a group of collapsed structures may be present within the County. The collapsed structures occur in a northwest-southeast trending zone that passes through the eastern and northern parts of the County. In these areas, blocks of the Foremost Formation may have subsided a few tens of metres and the Lea Park Formation may be fractured. These conditions could be responsible for anomalous hydraulic conductivity values attributed to the Lea Park Formation.

### 5.3.2 Aquifers

The groundwater database has 574 records that indicate the top of the completion interval for a water well or water test hole is below the bedrock surface. Of these 574 records, 125 have sufficient data to calculate apparent yields. In addition to these water wells, there have been 48 water test holes that have been abandoned, presumably as “dry holes”. A distribution of these records shows that most of the dry holes have been in the southern and southeastern parts of the County. In these areas, the upper bedrock is the Lea Park Formation or, if the upper bedrock is the *continental* Foremost Formation, it is either thin or drained.

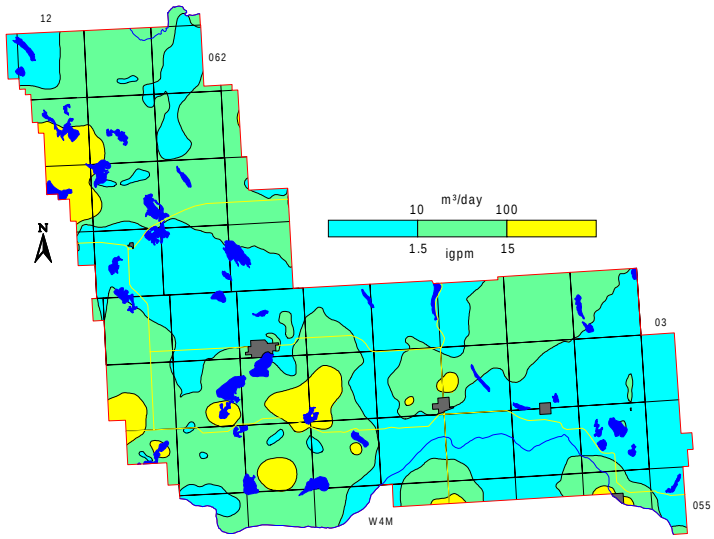


***Figure 12. Apparent Yield for Water Wells Completed in Upper Bedrock Aquifer(s)***

The producing water wells mainly occur within the area underlain by either the *continental* Foremost Formation or the Victoria Member of the *marine* Foremost Formation. Some of the bedrock water wells are completed in areas where the Lea Park Formation is indicated as being the uppermost bedrock. The water wells completed where the upper bedrock is the Lea Park Formation are not indicative of the normal hydrogeological conditions for the Lea Park Formation. These water wells, which are indicated as being completed in the Lea Park Formation, may be completed in the Foremost Formation and are not identified as such because of inadequate stratigraphic control, or there may be local fracturing in the Lea Park Formation.