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 M.D., pre-glacial material would be expected to be present in association with the Buried Wainwright Valley.

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”.

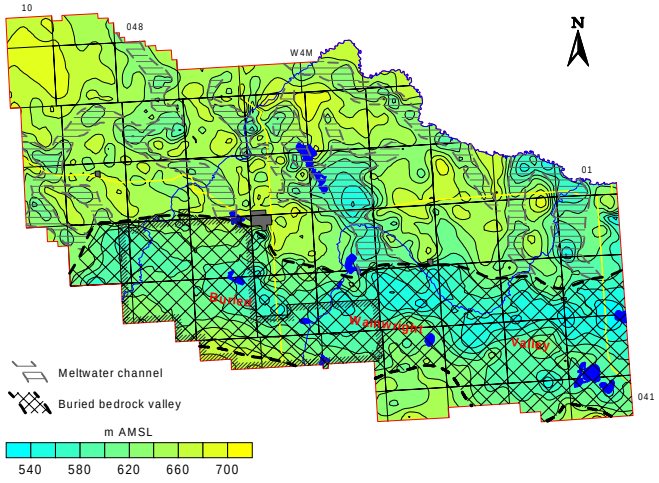

Figure 9. Bedrock Topography

Over the majority of the M.D., the surficial deposits are less than 40 metres thick. The exceptions are mainly in association with the linear bedrock lows where the deposits can have a thickness of more than 100 metres. The most significant linear bedrock low in the M.D. has been designated as the Buried Wainwright Valley. The Buried Wainwright Valley is in the southern part of the M.D. as shown on the adjacent map. The Buried Wainwright Valley trends mainly easterly across parts of the southern border of the M.D. The Buried Wainwright Valley is approximately 10 to 15 kilometres wide within the M.D., with local bedrock relief being less than 80 metres. Sand and gravel deposits can be present in association with this bedrock low, but the thickness of the sand and gravel deposits is expected to be mainly less than 50 metres.

There are other linear bedrock lows shown on the bedrock topography map. The majority of these lows trend northwest to southeast in the M.D. and are indicated as being of meltwater origin. However, because sediments associated with the lower surficial deposits are indicated as being present in these

[11] See glossary
[12] See glossary

linear bedrock lows, it is possible that the bedrock lows were originally tributaries to the Buried Wainwright Valley drainage system.

The lower surficial deposits are composed mainly of fluvial and lacustrine deposits. Lower surficial deposits occur over approximately 65% of the M.D., in association with linear bedrock lows. The total thickness of the lower surficial deposits is mainly less than 30 metres, but ranges from 10 to more than 50 metres, in parts of the Buried Wainwright Valley. 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 Wainwright Valley. The lowest sand and gravel deposits are of fluvial origin and are usually less than 10 metres thick.

The upper surficial deposits are either directly or indirectly a result of glacial activity. The deposits include till plus sand and gravel deposits of meltwater origin. The thickness of the upper surficial deposits is mainly less than 40 metres. The greatest thickness of upper surficial deposits occurs mainly in association with the Buried Wainwright Valley.

Sand and gravel deposits can occur throughout the entire unconsolidated section. The total thickness of sand and gravel deposits is generally less than 30 metres but can be more than 50 metres in the areas of the buried bedrock lows and meltwater channels.

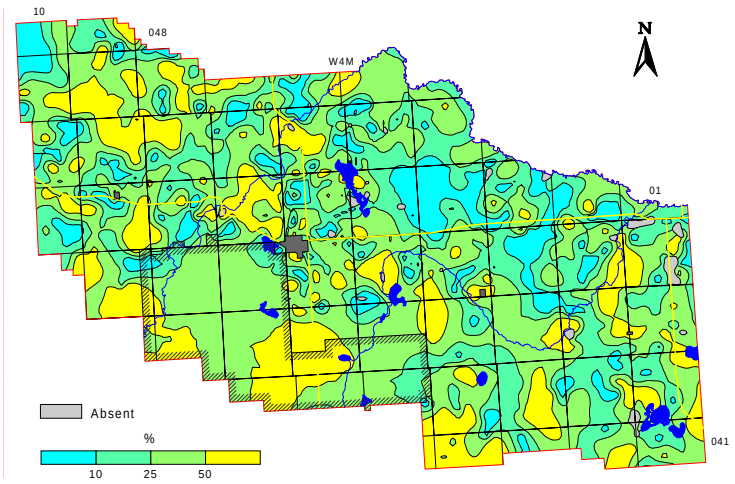

Figure 10. Amount of Sand and Gravel in Surficial Deposits

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 40% of the M.D., the sand and gravel deposits are more than 50% of the total thickness of the surficial deposits. The main areas where the sand and gravel percentages are higher are in association with linear bedrock lows. The other areas where sand and gravel deposits constitute more than 50% of the surficial deposits may be in areas of meltwater channels or areas where linear bedrock lows exist but have not been identified due to a shortage of accurate bedrock control points.

5.2.2 Sand and Gravel Aquifer(s)

One source of groundwater in the M.D. includes aquifers in the surficial deposits. Since the sand and gravel aquifer(s) are not everywhere, the actual aquifer that is developed at a given location is usually dictated by the aquifer that is present. From the present hydrogeological analysis, 443 water wells are completed in aquifers in the lower surficial deposits and 904 are completed in aquifers in the upper surficial deposits. This number of 1,347 water wells completed in aquifers in the surficial deposits is nearly four times the number of water wells determined to be completed in aquifers in the surficial deposits based on the lithologies given on the water well drilling reports.

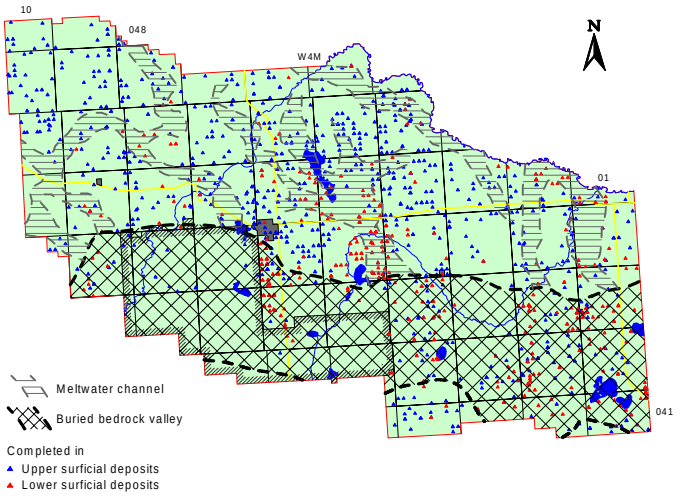

Figure 11. Water Wells Completed in Surficial Deposits

The water wells completed in the upper surficial deposits are located throughout the M.D., as shown in Figure 11. The majority of the water wells completed in the lower surficial deposits are located along the Buried Wainwright Valley and a linear bedrock low of meltwater origin that trends north-south through the middle of the M.D. and joins the Buried Wainwright Valley in Tp 044, R 05, W4M.

The adjacent map shows water well yields that are expected in the M.D., based on surficial aquifers that have been developed by existing water wells. These data show that water wells with yields of more than 100 m³/day from sand and gravel aquifer(s) can be expected in more than 30% of the M.D. The most notable areas where yields of more than 100 m³/day are expected are mainly in or adjacent to the areas of linear bedrock lows. Over the majority of the M.D., water wells completed in the sand and gravel aquifer(s) would have apparent yields of less than 100 m³/day.

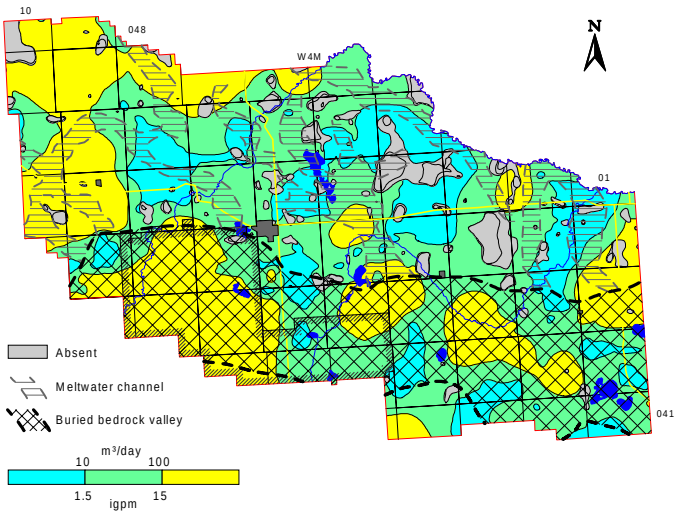

Figure 12. Apparent Yield for Water Wells Completed in Sand and Gravel Aquifer(s)

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. Because of the limited areal extent of the lower surficial deposits, almost all of the analysis results are from the upper surficial deposits.

The other justification for not separating the analyses was that there appeared to be no major chemical difference between groundwaters 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 80% of groundwaters having a TDS concentration of less than 1,500 mg/L. The groundwaters with a TDS of less than 500 mg/L occur mainly in the vicinity of the Buried Wainwright Valley. Groundwaters from the surficial deposits are expected to have dissolved iron concentrations of greater than 1 mg/L. Groundwater from a Town of Wainwright water test hole completed in the Lower Sand and Gravel Aquifer has a TDS of 472 mg/L, a hardness of 217 mg/L and a chloride concentration of 5 mg/L (Hydrogeological Consultants Ltd., 1981).

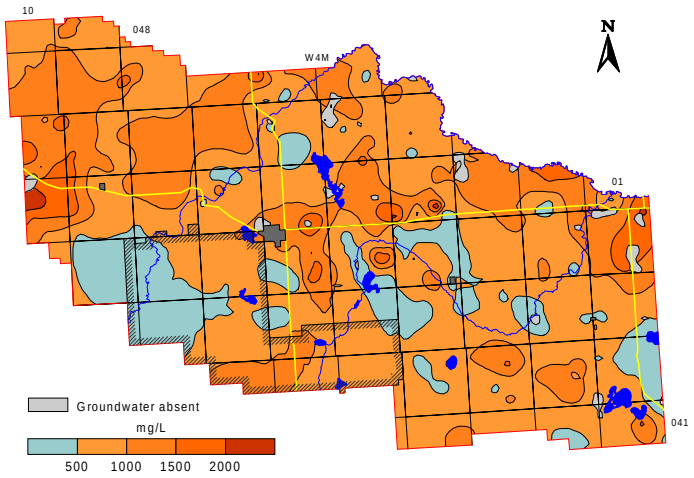

Figure 13. Total Dissolved Solids in Groundwater from Surficial Deposits

Although the majority of the groundwaters are calcium-magnesium-bicarbonate-type waters, there are groundwaters from the surficial deposits with sodium as the main cation; there are also groundwaters with significant concentrations of the sulfate ion. The groundwaters with elevated levels of sulfate occur in areas where there are elevated levels of total dissolved solids. There are very few groundwaters from the surficial deposits with appreciable concentrations of the chloride ion and in most of the M.D., 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 630 metres AMSL in the central and western parts of the M.D. and above an elevation of 610 metres AMSL in the east-central and northeastern parts of the M.D. Saturated sand and gravel deposits are not continuous but are expected over approximately 95% of the M.D.

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 surface associated with the upper surficial deposits and in part a result of the depth to the bedrock surface. Since the non-pumping water-level surface in the surficial deposits 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.

While the sand and gravel deposits in 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 30 metres thick in a few areas, but over the majority of the M.D., is less than ten metres thick; over 5% of the M.D., the Aquifer is absent. Most of the greater thickness in the Upper Sand and Gravel Aquifer occurs in the areas of linear bedrock lows.

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 apparent yields of the water wells are limited. The apparent yields for water wells completed in this Aquifer are expected to be mainly less than 100 m³/day. Where the Upper Sand and Gravel 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.

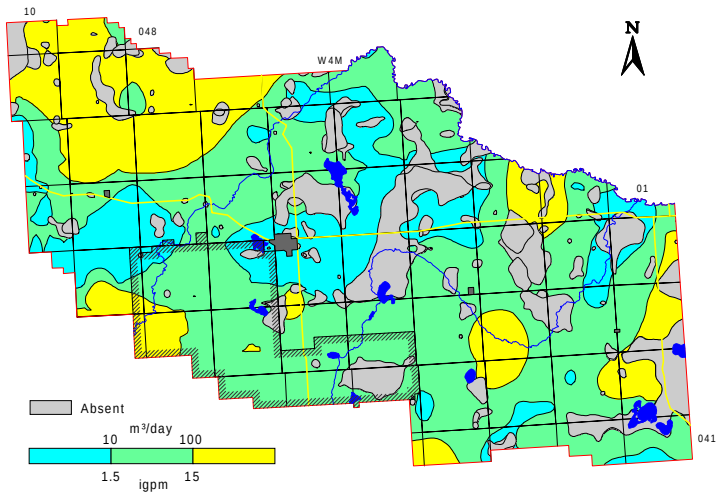

Figure 14. Apparent Yield for Water Wells Completed through Upper Sand and Gravel Aquifer

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 part of the pre-glacial linear bedrock lows. The Lower Sand and Gravel Aquifer may be a continuous aquifer in the Buried Wainwright Valley, where the thickness of the sand and gravel deposits is mainly between 10 and 30 metres. The Lower Sand and Gravel Aquifer is mostly restricted to the Buried Wainwright Valley and meltwater channels in the M.D.

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 the Buried Wainwright Valley in the southern part of the M.D.

The Town of Wainwright has completed at least some of its water test holes in the Lower Sand and Gravel Aquifer associated with the Buried Wainwright Valley in SE 06-044-06 W4M. The projected long-term yield from one of the Town of Wainwright water test holes is in excess of 3,000 m³/day (Hydrogeological Consultants Ltd., 1981).

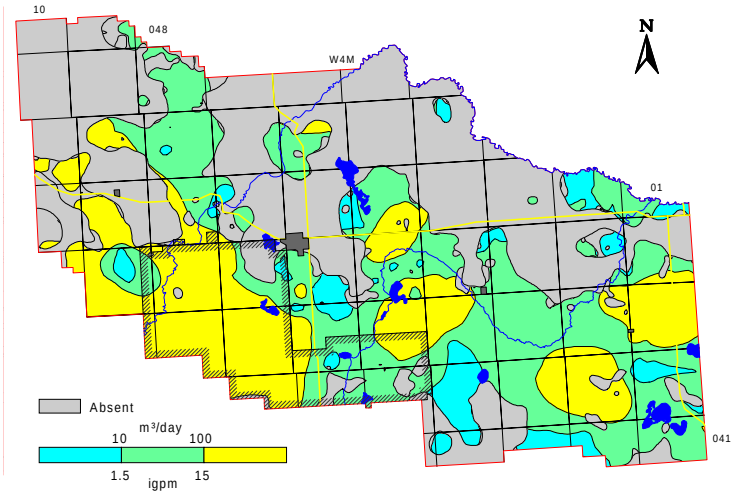

Figure 15. Apparent Yield for Water Wells Completed through Lower Sand and Gravel Aquifer

The Lower Sand and Gravel Aquifer associated with a bedrock low of meltwater origin was encountered by three water test holes drilled for Husky Oil Operations Ltd. in township 046, range 06, W4M. The aquifer test results indicate the Lower Sand and Gravel Aquifer at this location is a non-depletion type and does not have an effective limited areal extent. The projected long-term yield from one of the water test holes completed as Water Supply Well (WSW) No. 10D-16 is 600 m³/day (Hydrogeological Consultants Ltd., March 1985).