V. Aquifers

A. Background

An aquifer is a porous and permeable rock that is saturated. If the NPWL is above the top of the rock unit, this type of aquifer is an artesian aquifer. If the rock unit is not entirely saturated and the water level is below the top of the unit, this type of aquifer is a water-table aquifer. These types of aquifers occur in one of two general geological settings in the County. The first geological setting includes the sediments that overlie the bedrock surface. In this report, these are referred to as the surficial deposits. The second geological setting includes aquifers in the upper bedrock. The geological settings, the nature of the deposits making up the aquifers within each setting, the expected yield of water wells completed in aquifer(s) within different geologic units, and the general chemical quality of the groundwater associated with each setting are reviewed separately.

1) Surficial Aquifers

Surficial deposits in the County are mainly less than 20 metres thick, except in areas of linear bedrock lows where the thickness of the surficial deposits can exceed 40 metres. The Buried Red Deer River and Buffalo Lake valleys are the main southwest-northeast-trending linear bedrock lows in the County. Cross-section A-A' shown below passes across the Buried Red Deer River and Buffalo Lake valleys and shows the surficial deposits being up to 50 metres thick within the Valley.

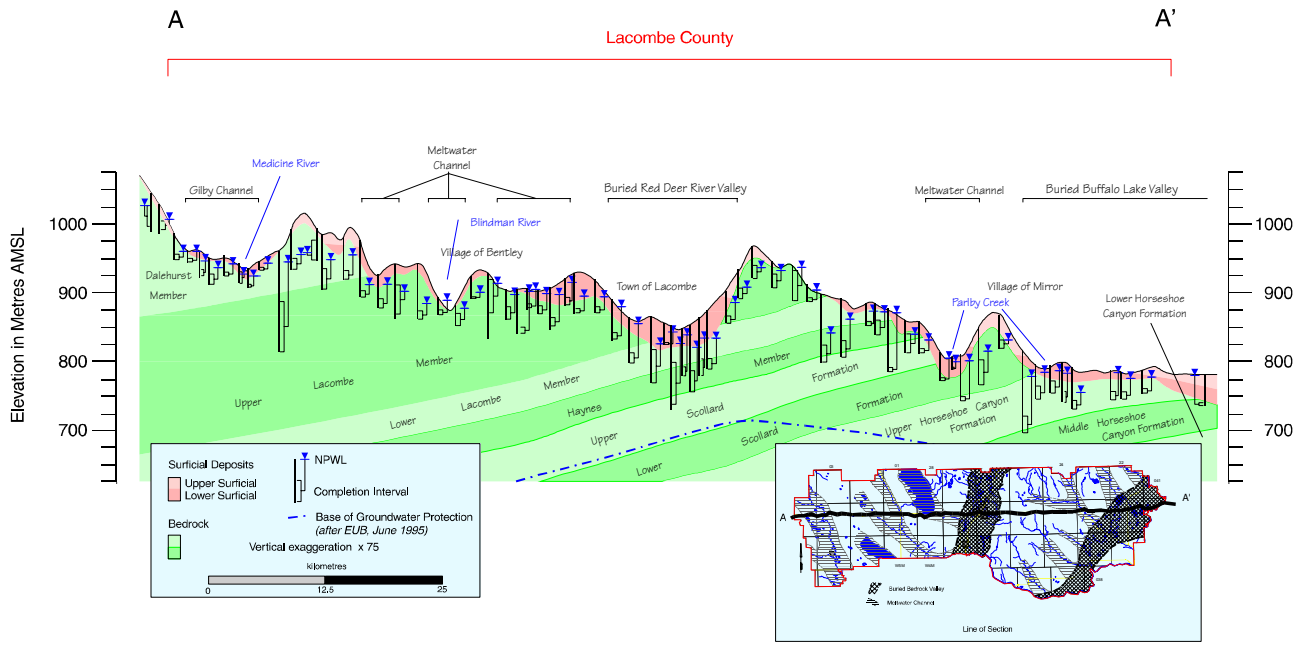

Figure 8. Cross-Section A - A'

The main aquifers in the surficial materials are sand and gravel deposits. In order for a sand and gravel deposit to be an aquifer, it must be saturated; if not saturated, a sand and gravel deposit is not an aquifer. The top of the surficial aquifers has been determined from the NPWL in water wells that are less than 20 metres deep. The base of the surficial deposits is the bedrock surface.

For a water well with a small-diameter casing to be effective in surficial deposits and to provide sand-free groundwater, the water well must be completed with a water well screen. Some water wells completed in the surficial deposits are completed in low-permeability aquifers and have a large-diameter casing. The large-

diameter water wells may have been hand dug or bored and because they are completed in very low permeability aquifers, most of these water wells would not benefit from water well screens. The groundwater from an aquifer in the surficial deposits usually has a chemical hardness of at least a few hundred mg/L and a dissolved iron concentration such that the groundwater must be treated before being used for domestic needs. Within the County, casing-diameter information is available for 104 of the 123 water wells completed in the surficial deposits; four percent of these have a casing diameter of more than 275 millimetres, and are assumed to be bored or dug water wells.

2) Bedrock Aquifers

The upper bedrock includes the Paskapoo, Scollard, Whitemud, Battle and Upper Horseshoe Canyon formations. Cross-section B-B' (Figure 9) shows that the upper bedrock includes rocks that are less than 200 metres below the bedrock surface and above the Middle Horseshoe Canyon Formation. Some of this bedrock contains saturated rocks that are permeable enough to transmit groundwater for a specific need. Water wells completed in bedrock aquifers usually do not require water well screens, although some of the sandstones may be friable[9] and water well screens are a necessity. The groundwater from the bedrock aquifers is usually chemically soft.

The data for 4,234 water wells show that the top of the water well completion interval is below the bedrock surface, indicating that the water wells are completed in at least one bedrock aquifer. Within the County, casing-diameter information is available for 4,140 of the 4,234 water wells completed below the top of bedrock. Of these 4,140 water wells, 99% have surface-casing diameters of less than 275 mm and these bedrock water wells have been mainly completed with either a perforated liner or as open hole; there are 26 bedrock water wells completed with a water well screen.

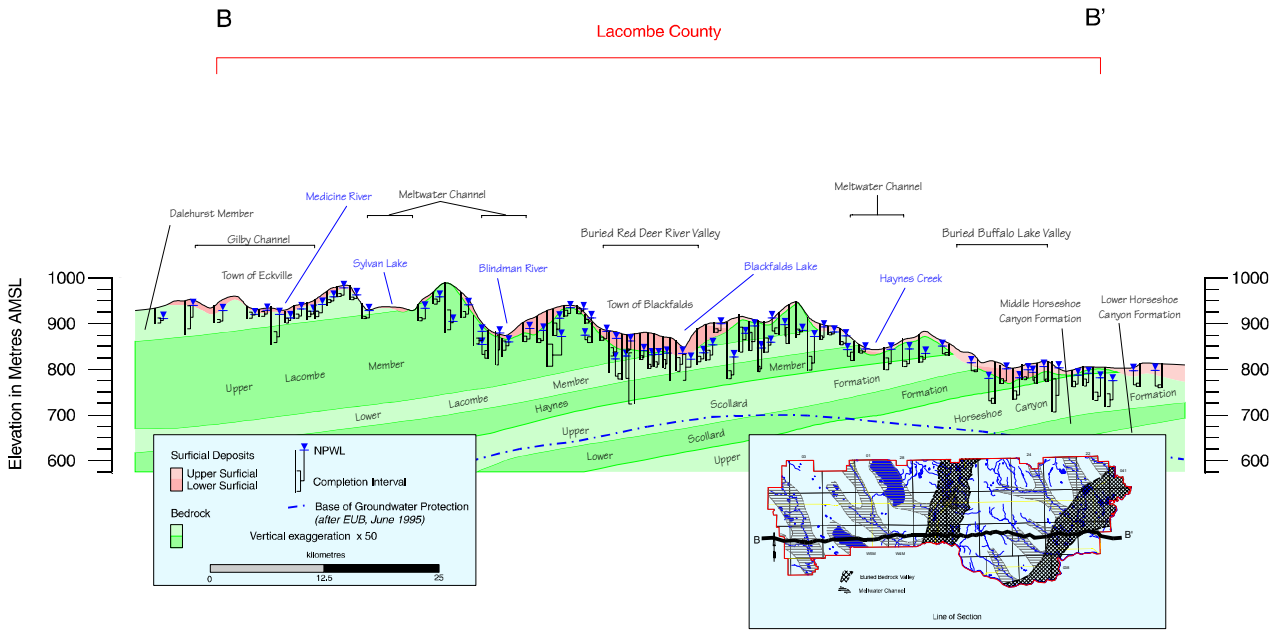

Figure 9. Cross-Section B - B'

[9] See glossary

B. 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 as a result of glaciation. The *lower surficial deposits* include pre-glacial fluvial[10] and lacustrine[11] deposits. The lacustrine deposits include clay, silt and fine-grained sand. The *upper surficial deposits* include the more traditional glacial deposits of till[12] and meltwater deposits. In the County, pre-glacial materials are expected to be mainly present in association with the linear bedrock lows.

1) Geological Characteristics of Surficial Deposits

While the surficial deposits are treated as one hydrogeological unit, they consist of three hydraulic parts. The first unit is the sand and gravel deposits of the lower surficial deposits when present. These deposits are mainly saturated, where present. The second and third hydraulic units are associated with the sand and gravel deposits in the upper surficial deposits. The sand and gravel deposits in the upper surficial deposits occur mainly as pockets. The second hydraulic unit is the saturated part of these sand and gravel deposits; the third hydraulic unit the unsaturated part of these deposits. For a graphical depiction of the above description, please refer to Figure 5, Page 8. While the unsaturated deposits are not technically an aquifer, they are significant as they provide a pathway for liquid contaminants to move downward into the groundwater.

The base of the surficial deposits is the bedrock surface, represented by the bedrock topography as shown on the adjacent map.

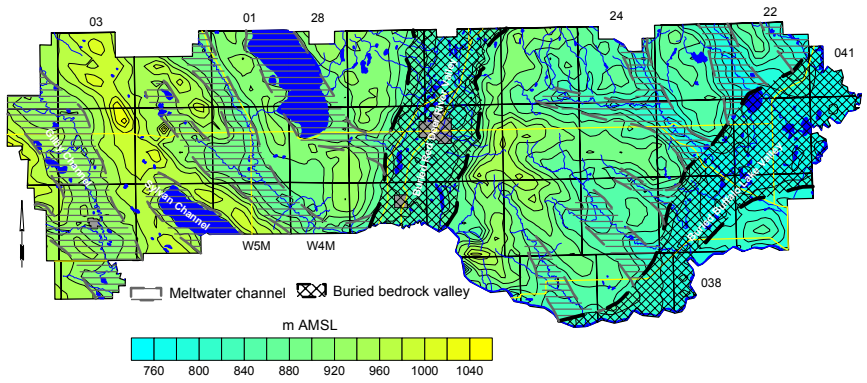

Figure 10. Bedrock Topography

Over the majority of the County, the surficial deposits are less than 30 metres thick (page A-17). The exceptions are mainly in association with areas where buried bedrock valleys are present, where the deposits can have a maximum thickness of close to 50 metres. The main southwest-northeast-trending linear bedrock lows in the County have been designated as the Buried Red Deer River Valley and the Buried Buffalo Lake Valley, as shown above on Figure 10.

The Buried Red Deer River Valley is present in the central part of the County, and extends northeast from the County border through the towns of Blackfalds and Lacombe to the northern County border. The Valley is approximately nine kilometres wide, with local bedrock relief being less than 80 metres. Sand and gravel deposits can be expected in association with this bedrock low, but the thickness of the sand and gravel deposits is expected to be mainly less than 15 metres.

The Buried Buffalo Lake Valley is present in the eastern part of the County, and extends northeast from the Red Deer River through the villages of Alix and Mirror to the northeastern County border. The Valley is approximately six to ten kilometres wide, with local bedrock relief being less than 60 metres. Sand and gravel deposits can be expected in association with this bedrock low, but the thickness of sand and gravel deposits is expected to be mainly less than ten metres.

[10] See glossary
[11] See glossary
[12] See glossary

The lower surficial deposits are composed mostly of fluvial and lacustrine deposits. Lower surficial deposits occur over most of the County, but mainly in linear bedrock lows. The total thickness of the lower surficial deposits is mainly less than 30 metres, but can be more than 30 metres in the buried bedrock valleys. 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 Red Deer River and Buffalo Lake valleys. The lowest sand and gravel deposits are of fluvial origin, are usually less than five metres thick and may be discontinuous.

In the County, there are numerous linear bedrock lows that trend mainly northwest to southeast and are indicated as being of meltwater origin. Because sediments associated with the lower surficial deposits are indicated as being present in these linear bedrock lows, it is possible that the bedrock lows were originally tributaries to the Buried Red Deer River Valley and the Buried Buffalo Lake Valley as shown in the bedrock topography map on Figure 10. The two significant surface-water bodies in the County, Gull Lake and Sylvan Lake, appear to be associated with meltwater channels.

The upper surficial deposits are either directly or indirectly a result of glacial activity. The deposits include till, with minor sand and gravel deposits of meltwater origin, which are expected to occur mainly as isolated pockets. The thickness of the upper surficial deposits is mainly less than 20 metres. The upper surficial deposits occur mainly where linear bedrock lows are not present in the County. The greatest thickness of upper surficial deposits occurs mainly in the eastern half of the County.

Sand and gravel deposits can occur throughout the surficial deposits. The total thickness of sand and gravel deposits is generally less than ten metres but can be more than 15 metres in the areas of the linear bedrock lows.

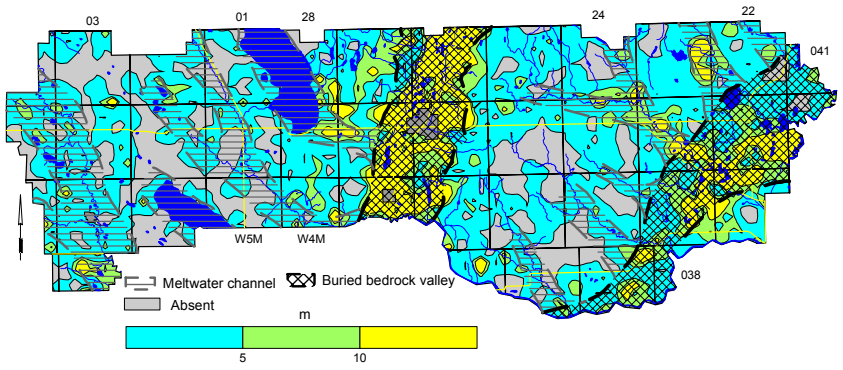

Figure 11. Thickness of Sand and Gravel Deposits

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 County, the sand and gravel deposits, where present, are more than 30% of the total thickness of the surficial deposits (page A-16). The areas where sand and gravel deposits constitute more than 30% of the total thickness of the surficial deposits are mainly in the areas of the buried bedrock valleys and meltwater channels.

2) Sand and Gravel Aquifer(s)

One source of groundwater in the County 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. In the County, the thickness of the sand and gravel aquifer(s) is generally less than five metres, but can be more than ten metres in the vicinity of the Buried Red Deer River and Buffalo Lake valleys (page A-21).

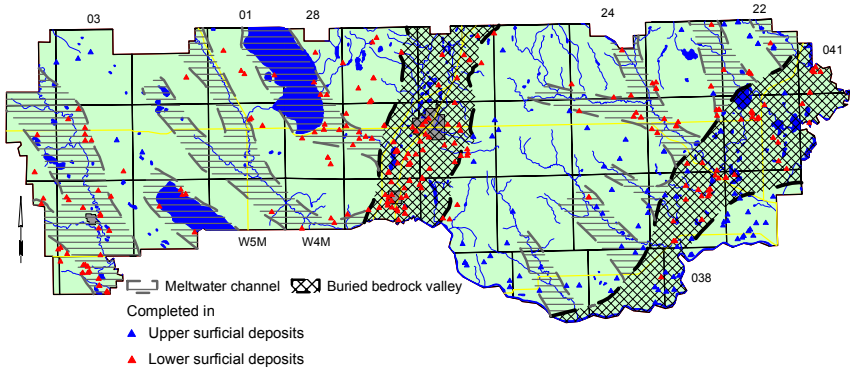

Figure 12. Water Wells Completed in Surficial Deposits

From the present hydrogeological analysis, 325 water wells are completed in aquifers in the surficial deposits. Of the 325 water wells, 92 are completed in aquifers in the upper surficial deposits and 233 are completed in aquifers in the lower surficial deposits. This number of water wells is more than twice the number (123) determined to be completed in aquifers in the surficial deposits, based on lithologies given on the water well drilling reports. The larger number is obtained by comparing the elevation of the reported depth of a water well to the elevation of the bedrock surface at the same location. For example, if only the depth of a water well is known, the elevation of the completed depth can be calculated. If the elevation of the completed depth is above the elevation of the bedrock surface determined from the gridded topography surface at the same location, then the water well is considered to be completed in an aquifer in the surficial deposits.

The majority of the water wells completed in the upper surficial deposits are mainly not in association with linear bedrock lows as shown on Figure 12. A large number of water wells completed in the lower surficial deposits are located along the Buried Red Deer River and Buffalo Lake valleys and the Gilby Meltwater Channel.

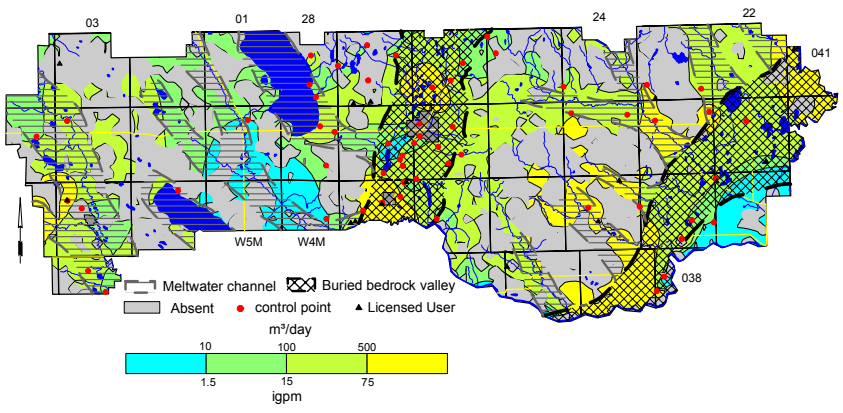

Figure 13. Apparent Yield for Water Wells Completed in Sand and Gravel Aquifer(s)

The adjacent map shows expected yields for water wells completed in sand and gravel aquifers(s). Over approximately 40% of the County, the sand and gravel deposits are not present, or if present, are not saturated.

Based on the 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 most areas of the County. The most notable areas where yields of more than 100 m³/day are expected are in association with the main linear bedrock lows. Higher yields could be a result of the gridding procedure used to process a limited number of data points. Licensed water wells completed in the Sand and Gravel Aquifer(s) are also shown on Figure 13.

a) Chemical Quality of Groundwater from Surficial Deposits

The chemical analysis results of groundwaters from the sand and gravel aquifers in the surficial deposits indicate the groundwaters are generally chemically hard and high in dissolved iron. In Lacombe County, groundwaters from the surficial aquifers mainly have a chemical hardness of greater than 200 and less than 400 mg/L.

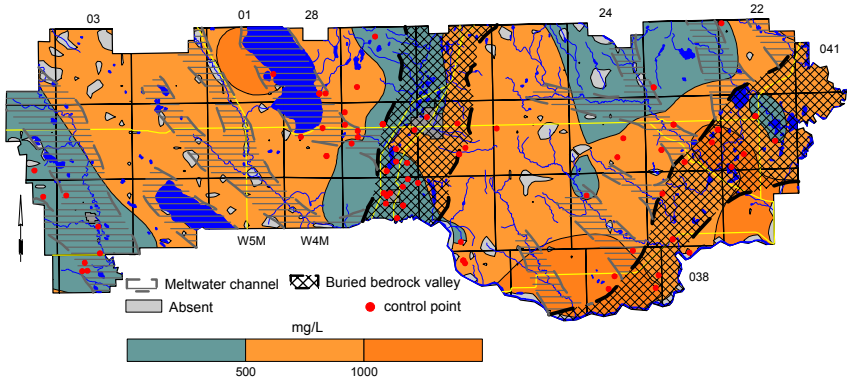

Figure 14. Total Dissolved Solids in Groundwater from Surficial Deposits

The Piper tri-linear diagrams[13] (see Appendix A) show the groundwaters from the surficial deposits are mainly calcium-magnesium-bicarbonate or sodium-bicarbonate-type waters. The records with the sodium-bicarbonate waters were individually checked in the database to confirm the completion aquifer. Sixty percent of the groundwaters have a TDS concentration of more than 500 mg/L. The groundwaters with a TDS concentration of less than 500 mg/L occur in association with several of the linear bedrock lows. An exception is the Buried Buffalo Lake Valley, even though there are the greatest number of control points available, as shown on Figure 14. Seventy-two percent of the groundwaters from the surficial deposits are reported to have dissolved iron concentrations of less than 1 mg/L. However, many iron analyses results are questionable due to varying sampling methodologies.

Although the majority of the groundwaters from the surficial deposits are bicarbonate-type waters, there are groundwaters with sulfate as the main anion. The groundwaters with elevated levels of sulfate generally 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 70% of the samples analyzed in the County, the chloride ion concentration is less than 10 mg/L.

In the County, the nitrate + nitrite (as N) concentrations in the groundwaters from the surficial deposits exceed the maximum acceptable concentrations (MAC) of 10 mg/L in less than 10% of the samples (see CD-ROM).

The minimum, maximum and average concentrations of TDS, sodium, sulfate, chloride and nitrate + nitrite (as N) in the groundwaters from water wells completed in the surficial deposits in the County have been compared to the Guidelines for Canadian Drinking Water Quality (GCDWQ) in the adjacent table. Of the five constituents that have been compared to the GCDWQ, only the average values of TDS concentrations exceed the guidelines.

Constituent	Range for County in mg/L Minimum	Maximum	Average	Recommended Maximum Concentration GCDWQ
Total Dissolved Solids	45	7458	720	500
Sodium	2	536	105	200
Sulfate	3	4064	160	500
Chloride	<1	301	18	250
Nitrate + Nitrite (as N)	<0.05	55	3.8	10

Concentration in milligrams per litre unless otherwise stated
Note: indicated concentrations are for Aesthetic Objectives except for Nitrate + nitrite (as N), which is for Maximum Acceptable Concentration (MAC)
GCDWQ - Guidelines for Canadian Drinking Water Quality, Sixth Edition Minister of Supply and Services Canada, 1996

Table 3. Concentrations of Constituents in Groundwaters from Surficial Aquifers

[13] See glossary