6.3.1 Quantity of Groundwater

An estimate of the volume of groundwater stored in the surficial deposits is 0.3 to 1.6 cubic kilometres. This volume is based on an areal extent of 1,100 square kilometres and a saturated thickness of five metres. The variation in the total volume is based on the value of porosity that is used for the surficial deposits. One estimate of porosity is 5%, which gives the low value of the total volume. The high estimate is based on a porosity of 30% (Ozoray, Dubord and Cowen, 1990).

The adjacent water-level map has been prepared from water levels associated with water wells completed in aquifers in the surficial deposits. The water levels from these water wells were used for the calculation of the saturated thickness of the surficial deposits. In areas where the elevation of the water-level surface is below the bedrock surface, the surficial deposits are not saturated (indicated by grey areas on the map). The water-level map for the surficial deposits shows a general flow direction toward the buried bedrock valleys.

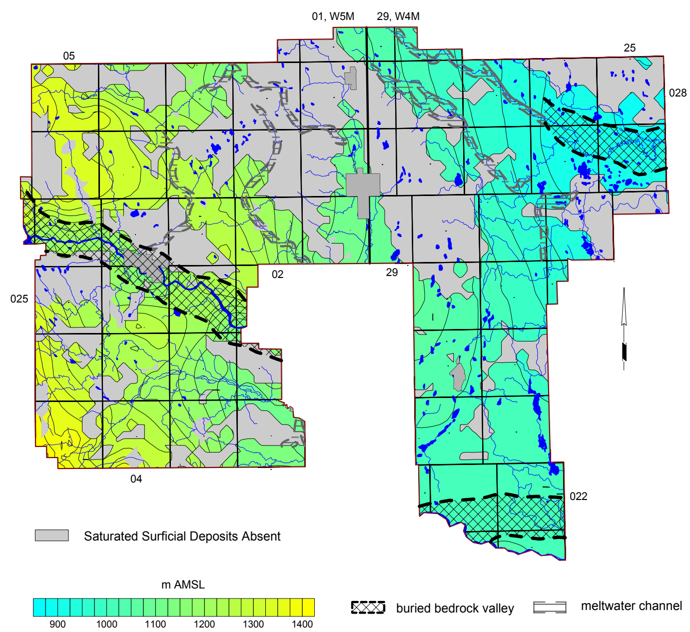

Figure 32. Non-Pumping Water-Level Surface in Surficial Deposits Based on Water Wells Less than 20 Metres Deep

6.3.2 Recharge/Discharge

The hydraulic relationship between the groundwater in the surficial deposits and the groundwater in the bedrock aquifers is given by the non-pumping water-level surface associated with each hydraulic unit. Where the water level in the surficial deposits is at a higher elevation than the water level in the bedrock aquifers, there is the opportunity for groundwater to move from the surficial deposits into the bedrock aquifers. This condition would be considered as an area of recharge to the bedrock aquifers and an area of discharge from the surficial deposits. The amount of groundwater that would move from the surficial deposits to the bedrock aquifers is directly related to the vertical permeability of the sediments separating the two aquifers. In areas where the surficial deposits are unsaturated, the extrapolated water level for the surficial deposits is used.

When the hydraulic gradient is from the bedrock aquifers to the surficial deposits, the condition is a discharge area from the bedrock aquifers, and a recharge area to the surficial deposits.

6.3.2.1 Bedrock Aquifers

Recharge to the bedrock aquifers within the M.D. takes place from the overlying surficial deposits and from flow in the aquifer from outside the M.D. On a regional basis, calculating the quantity of water involved is not possible because of the complexity of the geological setting and the limited amount of data.

In the absence of sufficient water-level data in the surficial deposits, a reasonable hydraulic gradient between the surficial deposits and the upper bedrock aquifer(s) could not be determined. Therefore, the first objective was to determine the location of springs, flowing shot holes and any water wells that had a water level measurement depth of less than 0.1 metres. These locations would reflect where there is an upward hydraulic gradient from the bedrock to the surficial deposits (i. e. discharge). The depth to water level for water wells completed in the upper bedrock aquifer(s) has been determined by subtracting the non-pumping water-level surface associated with all water wells completed in the upper bedrock aquifer(s) from the topographic surface. This resulting depth to water level grid was contoured to reflect the positioning of springs, flowing shot holes and flowing water wells (i. e. discharge). The recharge classification is used where the water level in the upper bedrock aquifer(s) is more than 15 metres below ground surface. The discharge areas are where the water level in the upper bedrock aquifer(s) is less than ten metres below ground surface. When the depth to water level in the upper bedrock aquifer(s) is between ten and 15 metres below ground surface, the area is classified as a transition, that is, no recharge and no discharge.

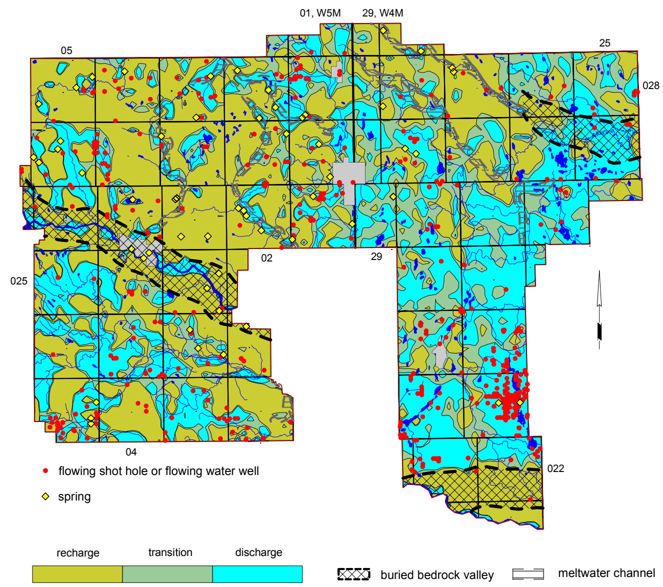

Figure 33. Recharge/Discharge Areas in Upper Bedrock Aquifer(s)

Figure 33 shows that, in more than 60% of the M.D., there is a downward hydraulic gradient from the surficial deposits toward the upper bedrock aquifer(s) (i. e. recharge). Areas where there is an upward hydraulic gradient from the bedrock to the surficial deposits (i. e. discharge) are mainly in the vicinity of creeks and river valleys and major meltwater channels. The remaining parts of the M.D. are areas where there is a transition condition.

Because of the paucity of data, recharge/discharge maps for the individual bedrock aquifers have not been attempted.

With 60% of the M.D. land area being one of recharge to the bedrock, and the average precipitation being 441 mm per year, 5.8% of the precipitation is sufficient to provide the total calculated quantity of groundwater flowing through the upper bedrock aquifer(s).

6.4 Areas of Groundwater Decline

The areas of groundwater decline in both the sand and gravel aquifer(s) and in the bedrock aquifers have been determined by using a similar procedure in both situations. The available non-pumping water-level elevation for each water well completed in the sand and gravel aquifer(s)/bedrock aquifer was first sorted by location, and then by date of water-level measurement. The dates of measurements were required to differ by at least 365 days. Only the earliest and latest control points at a given location were used.

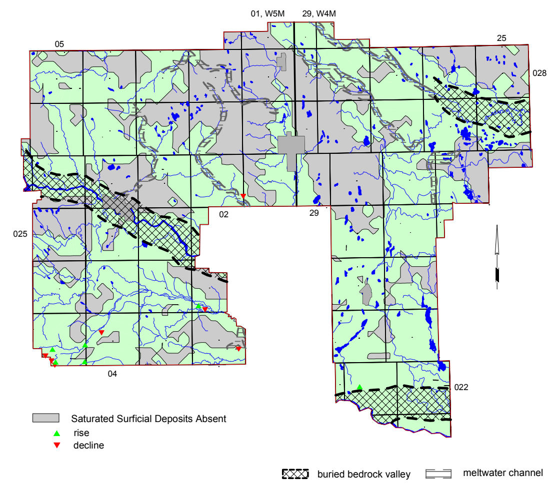

Figure 34. Changes in Water Levels in Sand and Gravel Aquifer(s)

Of the 149 water wells completed in the sand and gravel aquifer(s) with a NPWL and test date, there were only 13 control points. Due to limited control points, the data were not contoured, only posted as shown on the adjacent map. The map shows that the majority of the control points are in the southwestern part of the M.D., and there were approximately the same number of locations where the water level rose, as declined.

The areas of groundwater decline in the bedrock aquifers have been calculated by determining the frequency of non-pumping water level control points per five-year periods from 1925 to 2000. Of the 8,230 bedrock water wells with a non-pumping water level and date, 3,089 are from water wells completed before 1980 and 2,954 are from water wells completed after 1989; the remaining 2,187 are from water wells completed between 1980 and 1990. Where the earliest water level (before 1980) is at a higher elevation than the latest water level (after 1989), there is the possibility that some groundwater decline has occurred. Where the earliest water level is at a lower elevation than the latest water level, there is the possibility that the groundwater has risen at that location. The water level may have risen as a result of recharge in wetter years or may be a result of the water well being completed in a different bedrock aquifer. In order to determine if the water-level decline is a result of groundwater use by licensed users, the licensed groundwater users were posted on the maps.

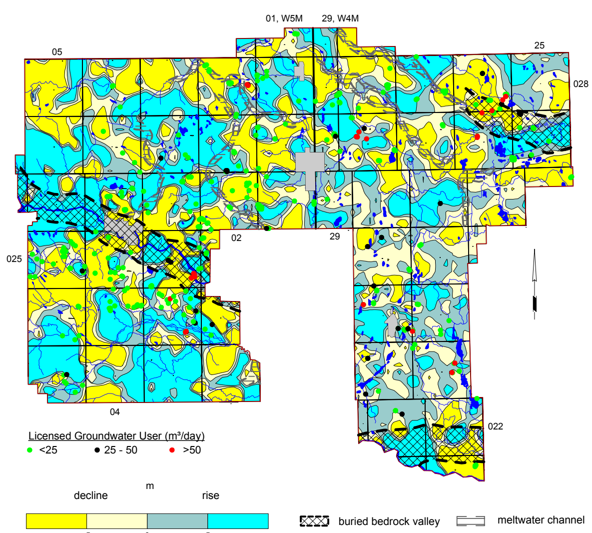

Figure 35. Changes in Water Levels in Upper Bedrock Aquifer(s)

Figure 35 indicates that in 60% of the M.D., it is possible that the non-pumping water level has declined. Of the 362 licensed groundwater users completed in upper bedrock aquifer(s), most occur in areas where a water-level decline may exist. Twenty-eight percent of the areas where there has been a water-level decline of more than five metres corresponds to where the estimated water well use is between 10 and 30 m^3/day per section; 11% of the declines occurred where the estimated water well use is more than 30 m^3/day per section; 41% of the declines occurred where the estimated water well use is less than 10 m^3/day per section; the remaining 20% occurred where there is no groundwater use per section, as shown previously on Figure 31. From this analysis, one area of water-level decline in upper bedrock aquifer(s) is in the Beiseker/Irricana area; local groundwater monitoring by the Wildrose County Ground Water Monitoring Association confirms the water-level decline.

6.5 Discussion on Specific Study Areas

As per the Request for Proposal, the M.D. of Rocky View requested that comments be made, where possible, on the following study areas and issues. The issue is stated at the beginning of each of the following sections. Figure 36 shows the five specific study areas in the M.D.; in Figure 37, the five specific study areas have been color outlined on the bedrock geology map; Figure 38 shows the apparent yield for water wells completed in the Sand and Gravel Aquifer(s); and Figure 39 shows the apparent yield for water wells completed in the Upper Bedrock Aquifer(s).

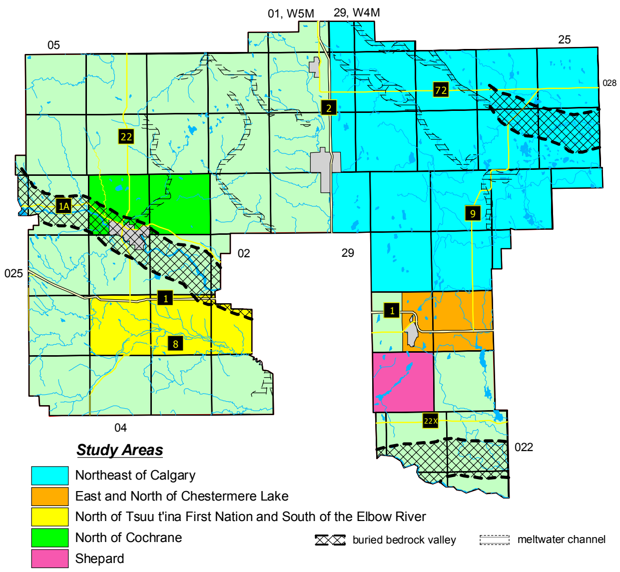

Figure 36. Specific Study Areas

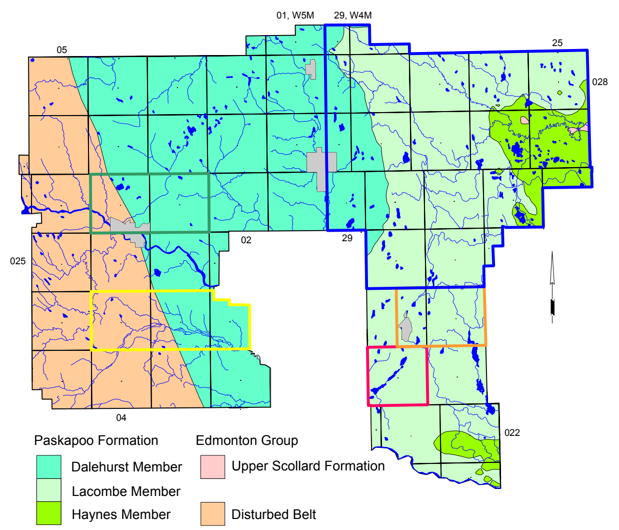

Figure 37. Bedrock Geology of Specific Study Areas

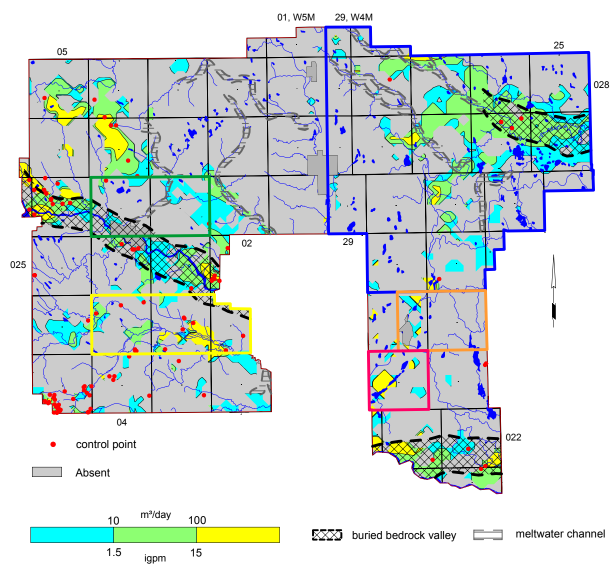

Figure 38. Apparent Yield for Water Wells Completed in Sand and Gravel Aquifer(s) - Specific Study Areas

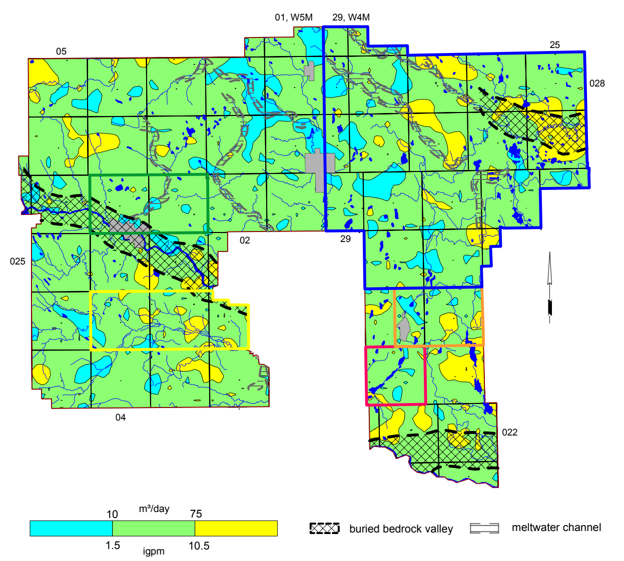

Figure 39. Apparent Yield for Water Wells Completed in Upper Bedrock Aquifer(s) - Specific Study Areas

6.5.1 Area to the Northeast of Calgary

What is the approximate extent and potential (yield and water quality) of the aquifers? Has the drilling of shallow sour gas wells had an effect on water quality and yield?

Although the Lower Sand and Gravel Aquifer is present in parts of the Area, it is primarily the upper bedrock aquifer(s) that are utilized for water supplies. The upper bedrock aquifer(s) include mainly the Dalehurst, Lacombe and Haynes members as shown on Figure 37. Lower apparent yields tend to be present where the Dalehurst Aquifer is the upper bedrock, and the higher yields are associated with the Lacombe and Haynes aquifers, particularly in areas of linear bedrock lows.

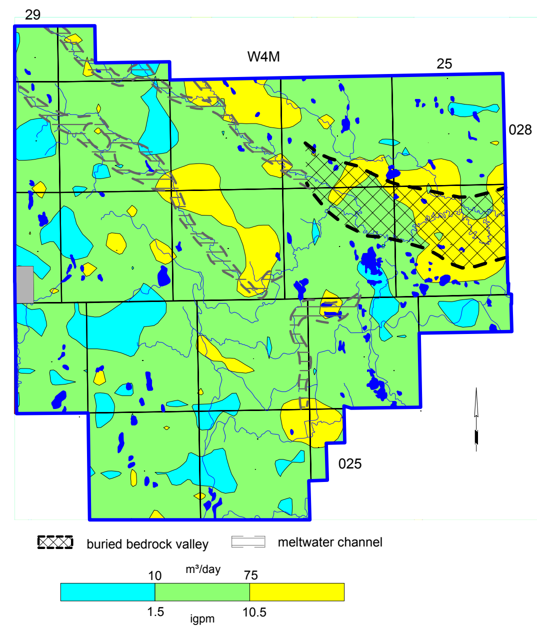

Figure 40. Area Northeast of Calgary - Apparent Yield in Upper Bedrock Aquifer(s)

Groundwaters from water wells completed in the upper bedrock aquifer(s) in this Area are expected to have TDS concentrations of more than 500 mg/L, with TDS concentrations of more than 3,000 mg/L present in parts of townships 026 and 027, ranges 27 and 28, W4M.

In the area to the northeast of Calgary, there are 410 gas wells in the EUB database. Of the 410 gas wells, 13 have a surface casing depth that is less than the maximum depth of an existing water well. These 13 gas wells have a surface casing depth of less than 80 metres and are located primarily in townships 026 and 027, range 25, W4M as shown in the figure below. Of the 410 gas wells, 388 (95%) have a surface casing depth that is above the Base of Groundwater Protection.

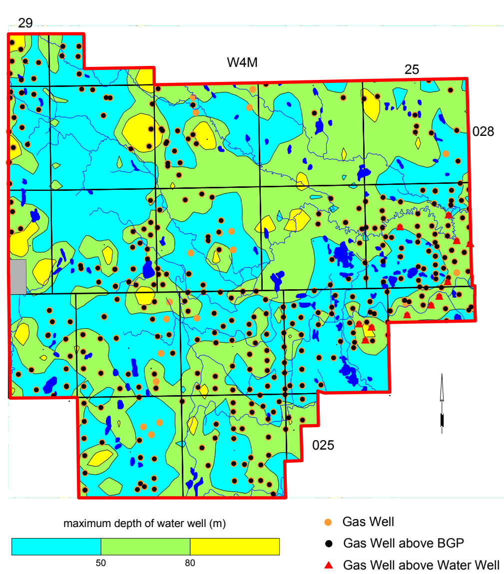

Figure 41. Area Northeast of Calgary - Location of Gas Wells

An investigation for BP Canada Inc. in 1988 (HCL, 1988) was related to lost circulation from their hydrocarbon well in 14-04-048-02 W5M. The investigation showed that a temporary rise in water levels could occur in an aquifer when there is lost circulation. In the BP case, the fluid losses were in the order of 5 cubic metres and the water level was measured in an observation water well at a distance of 125 metres from the hydrocarbon well where the lost circulation occurred. The rise in water level in the observation water well was 0.88 metres over an 11.5-hour interval. The water level declined to its pre-disturbed level within 84 hours. As a result of the lost circulation, there was no detectable change in the chemical quality of the groundwater from a spring located halfway between the hydrocarbon well and the observation water well, where the change in water level was recorded.

The present indications are that the drilling of gas wells does not pose any undue threat to groundwater supplies being used in the area nor to the aquifers from which the water supplies are being obtained.

6.5.2 Area East and North of Chestermere Lake

What is the approximate extent and potential (yield and water quality) of the aquifers?

The Sand and Gravel Aquifer(s) are absent from township 024, range 27, W4M, the township adjacent to the east of Chestermere Lake. Apparent yields in the Sand and Gravel Aquifer(s) are expected to be less than ten m³/day in the Chestermere Lake Area.

Groundwaters from water wells completed in the Chestermere Lake Area in the surficial deposits are expected to have TDS concentrations of more than 500 mg/L.

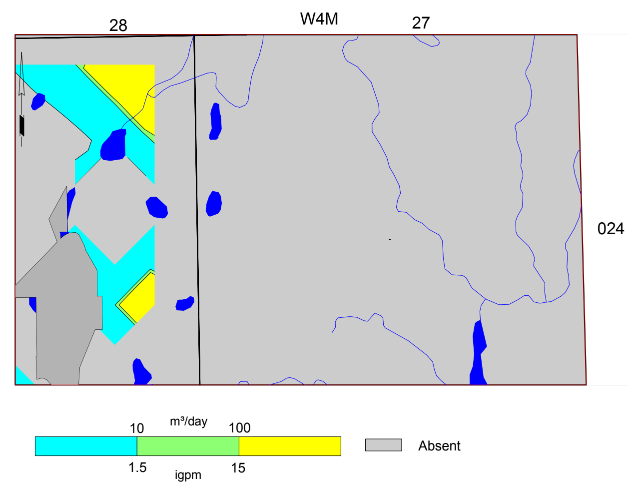

Figure 42. Area East and North of Chestermere Lake - Apparent Yield in Sand and Gravel Aquifer(s)

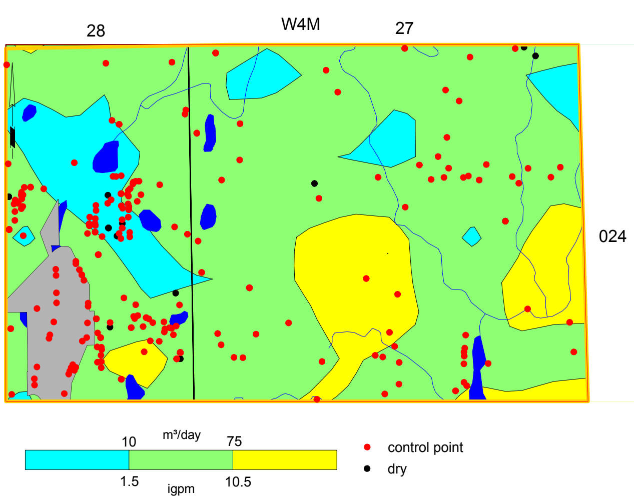

Figure 43. Area East and North of Chestermere Lake - Apparent Yield in Upper Bedrock Aquifer(s)

The upper bedrock in the Area is the Lacombe Member (see Figure 37). The apparent yields in the Lacombe Aquifer immediately northeast of Chestermere Lake are expected to be less than ten m³/day; there are a number of control points within the Town of Chestermere and the data indicate that apparent yields are expected to be between 10 and 75 m³/day. However, higher yields may be encountered in the Lacombe Aquifer in the township east of the Town of Chestermere.

In township 024, range 27, W4M, the largest potable groundwater allocation is 84 m³/day for Rocky View School Div. 41; this water well is used for municipal purposes. In township 024, range 28, W4M, the largest potable groundwater allocation is 30 m³/day for a subdivision water well used for municipal purposes.

Groundwaters from water wells completed in the Chestermere Lake Area in the upper bedrock aquifer(s) are expected to have TDS concentrations of more than 500 mg/L but less than 2,000 mg/L.