1.2 The Project

It must be noted that the present project is a regional study and as such the results are to be used only as a guide. Detailed local studies are required to verify hydrogeological conditions at given locations.

The present project is made up of five parts as follows:

Module 1 - Data Collection and Synthesis
Module 2 - Hydrogeological Maps
Module 3 - Covering Report
Module 4 - Groundwater Query
Module 5 - Training Session

This report and the accompanying maps represent Modules 2 and 3.

1.3 Purpose

This project is a regional groundwater assessment of the County of Beaver No. 9. The regional groundwater assessment provides the information to assist in the management of the groundwater resource within the County. Groundwater resource management involves determining the suitability of various areas in the County for particular activities. These activities can vary from the development of groundwater for agricultural or industrial purposes, to the siting of waste storage. **Proper management ensures protection and utilization of the groundwater resource for the maximum benefit of the people of the County.**

The regional groundwater assessment includes:

- identification of the aquifers[1] within the surficial deposits[2] and the upper bedrock;
- spatial definition of the main aquifers;
- quantity and quality of the groundwater associated with each aquifer;
- hydraulic relationship between aquifers; and
- identification of the first sand and gravel deposits below ground level.

Under the present program, the groundwater-related data for the County have been assembled. Where practical, the data have been digitized. These data are then being used in the regional groundwater assessment for the County.

[1] See glossary
[2] See glossary

2 INTRODUCTION

2.1 Setting

The County of Beaver No. 9 is situated in east-central Alberta. This area is part of the Alberta Plains region. The County exists within the North Saskatchewan River Basin. The County boundaries follow township or section lines. The area includes parts of the area bounded by township 52, range 21, W4M in the northwest and township 046, range 10, W4M in the southeast.

Regionally, the topographic surface varies between 630 and 810 metres above mean sea level (AMSL), with the lowest elevation occurring in the northern part of the County as shown in Figure 1.

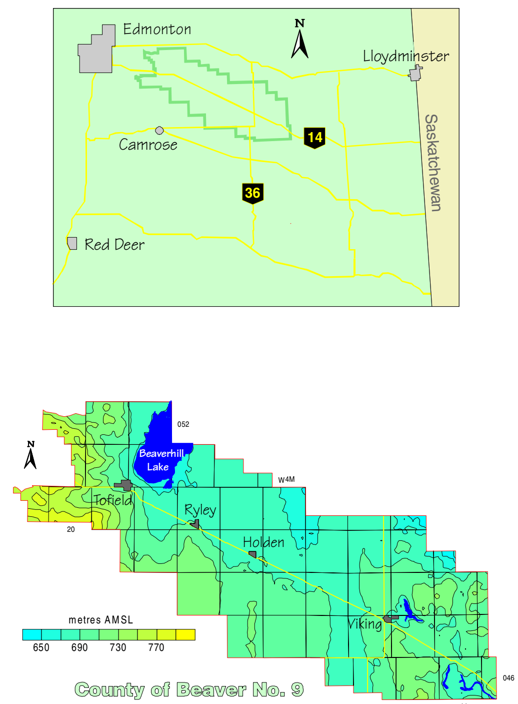

Figure 1. Index Map

2.2 Climate

The County of Beaver lies within the transition zone between a humid, continental Dfb climate and a semiarid Bsk climate. This classification is based on potential evapotranspiration values determined using the Thornthwaite method (Thornthwaite and Mather, 1957), combined with the distribution of natural ecoregions in the area. The ecoregions map (Strong and Legatt, 1981) shows that the County is located in the Aspen Parkland region, a transition between boreal forest and grassland environments.

A Dfb climate consists of long, cool summers and severe winters. The mean monthly temperature drops below –3 °C in the coolest month, and exceeds 10 °C in the warmest month. A Bsk climate is characterized by its moisture deficiency, where mean annual potential evapotranspiration exceeds the mean annual precipitation.

The mean annual precipitation averaged from three meteorological stations within the County measured 420 millimetres (mm), based on data from 1958 to 1993. The annual temperature averaged 2.3 °C, with the mean monthly temperature reaching a high of 16.9 °C in July, and dropping to a low of -15.1 °C in January. The calculated annual potential evapotranspiration is 524 millimetres.

2.3 Background Information

There are currently records for 3,970 water wells in the groundwater database for the County. Of the 3,970 water wells, 3,656 are for domestic/stock purposes. The remaining 314 water wells were completed for a variety of uses, including municipal, investigation, observation and industrial purposes. Based on a rural population of 5,659, there are 2.6 domestic/stock water wells per family of four. The domestic or stock water wells vary in depth from 2.7 metres to 246.8 metres below ground level. Lithologic details are available for 1,618 water wells.

Data for casing diameters are provided on 1,754 records, with 1,580 having a diameter of less than 275 mm and 174 having a diameter of more than 450 mm. The casing diameters of greater than 450 mm are mainly bored water wells and those with a surface casing of less than 275 mm are drilled water wells.

Steel, plastic and galvanized steel represent 99% of the materials that have been used for surface casing in drilled water wells over the last 40 years in water wells completed in the County. From before 1955 to the mid-1960s, the type of surface casing used was unknown in a significant number of the drilled water wells. Steel casing was in use in the 1950s and is still used in 24% of the new water wells being drilled in the County. Galvanized steel surface casing was used in 29% of the new water wells in the mid-1950s. By the mid-1970s, galvanized steel casing was being used in 35% of the new water wells, more than at any other time. The last reported use of galvanized steel was in October 1990. Plastic casing was used for the first time in June 1978. The percentage of water wells with plastic casing has increased and in the mid-1990s, plastic casing was used in 76% of the water wells drilled in the County.

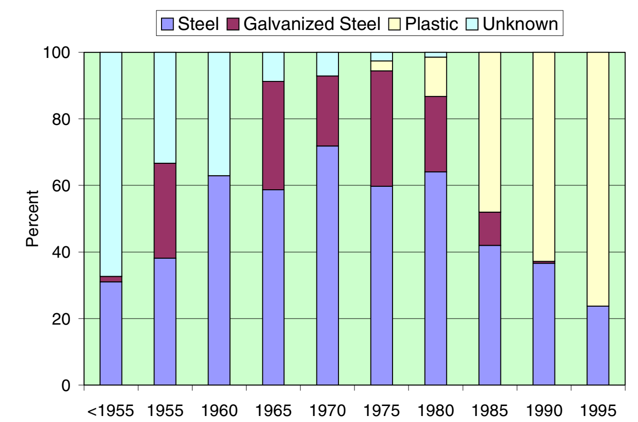

Figure 2. Surface Casing Types Used in Drilled Water Wells

There are 1,757 water well records with sufficient information to identify the aquifer in which the water wells are completed. The water wells that were not drilled deep enough to encounter the bedrock surface plus water wells that have the bottom of their completion interval above the bedrock surface are water wells completed in surficial aquifers. The number of water wells completed in aquifers in the surficial deposits is 555. The adjacent map shows that these water wells occur over most of the County.

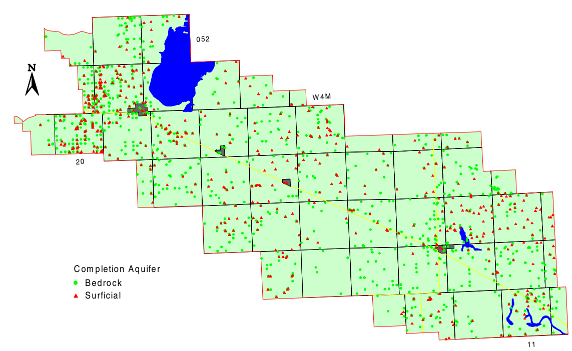

Figure 3. Location of Water Wells

The remaining 1,202 water wells have the top of their completion interval deeper than the depth to the bedrock surface. From Figure 3, it can be seen that the water wells completed in bedrock aquifers also occur over most of the County.

Water wells not used for domestic needs must be licensed. At the end of 1996, 74 groundwater diversions were licensed in the County. The total maximum authorized diversion from these 74 water wells is 512.5 cubic metres per day (m^3/day); more than 80% of the authorized groundwater diversion is allotted for agricultural use. The largest licensed groundwater diversion within the County, of 22 m³/day, is for the Joseph T. Petras water supply well in 04-34-046-13 W4M.

The adjacent table shows a breakdown of the 74 licensed groundwater diversions by the aquifer in which the water well is completed. The highest diversions are for licensed water wells completed in the *continental* Foremost Aquifer, of which the majority of the groundwater is used for agricultural purposes. The highest use of groundwater in the County is also for agricultural purposes.

	Licensed Groundwater Users (m³/day)				
Aquifer	Agricultural	Domestic	Municipal	Industrial	Total
Upper Sand and Gravel	31.4	0.0	0.0	33.8	65.2
Lower Horseshoe Canyon	34.0	0.0	0.0	0.0	34.0
Bearpaw	67.7	0.0	0.0	0.0	67.7
Oldman	94.9	0.0	13.6	0.0	108.5
continental Foremost	183.0	6.8	27.0	6.8	223.6
marine Foremost	13.5	0.0	0.0	0.0	13.5
Total	424.5	6.8	40.6	40.6	512.5

Table 1. Licensed Groundwater Diversions

At many locations within the County, more than one water well is completed at one legal location. Digitally processing this information is difficult. To obtain a better understanding of the completed depths of water wells, a digital surface was prepared representing the minimum depth for water wells and a second digital surface was prepared for the maximum depth. Both of these surfaces are used in the groundwater query on the CD-ROM. When the maximum and minimum water well depths are similar, there is only one aquifer that is being used.

Groundwaters from the surficial deposits can be expected to be chemically hard with a high dissolved iron content. The total dissolved solids (TDS) concentrations in the groundwaters from the upper bedrock in the County are generally less than 1,500 milligrams per litre (mg/L). Groundwaters from the bedrock aquifers frequently are chemically soft with generally low concentrations of dissolved iron. The chemically soft groundwater is high in sodium concentration. Approximately 5% of the chemical analyses indicate a fluoride concentration above 1.5 mg/L.

Alberta Environmental Protection (AEP) defines the Base of Groundwater Protection as the elevation below which the groundwater is expected to have more than 4,000 mg/L of total dissolved solids. By using the ground elevation, the bedrock surface and the Base of Groundwater Protection, a depth to the Base of Groundwater Protection can be determined. This depth, for the most part, would be the maximum drilling depth for a water supply well. Over approximately 70% of the County, the depth to the Base of Groundwater Protection is more than 150 metres. The area where the depth to the Base of Groundwater Protection is less than 150 metres is east of range 17 and west of range 13, W4M as shown on the map above.

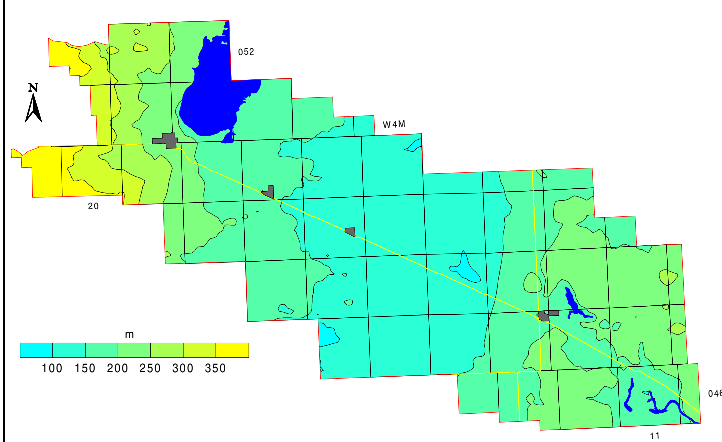

Figure 4. Depth to Base of Groundwater Protection (after EUB, June 1995)

Proper management of the groundwater resource requires water-level data. These data are often collected from observation water wells. At the present time, data are available from three AEP-operated observation water wells within the County. Additional data can be obtained from some of the licensed groundwater diversions. In the past, these data for licensed diversions have been difficult to obtain from AEP, in part because of the failure of the licensee to provide the data.

However, even with the available sources of data, the number of water-level data points relative to the size of the County is too few to provide a reliable groundwater budget. The most cost-efficient method to collect additional groundwater monitoring data would be to have the water well owners measuring the water level in their own water well on a regular basis.

3 TERMS

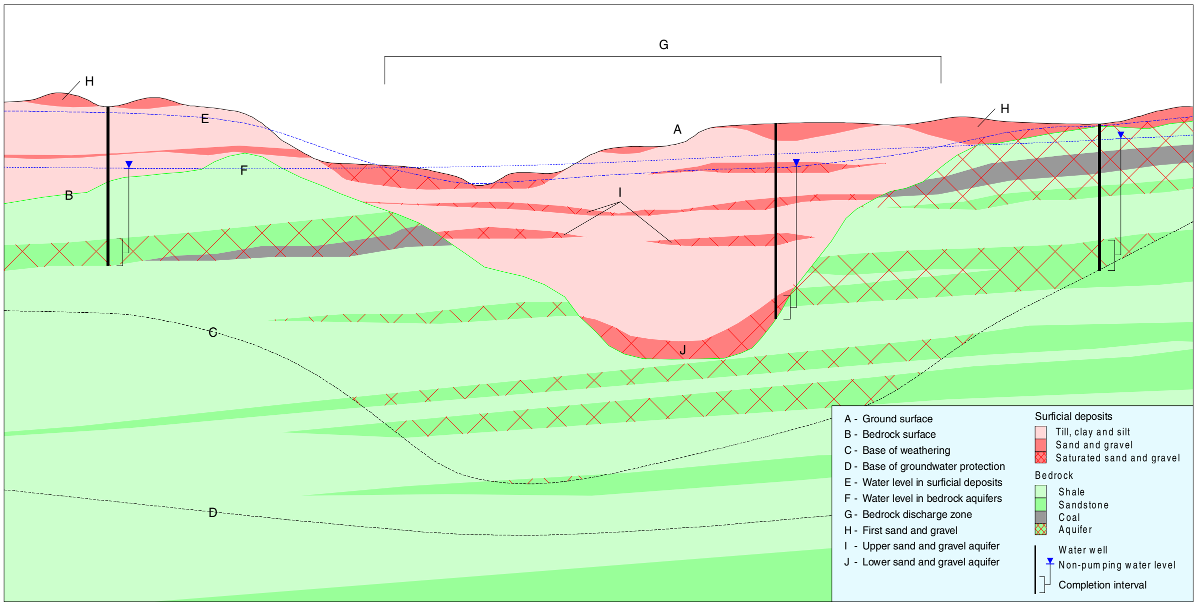

Figure 5. Generalized Cross-Section (for terminology only)

Lithology	Lithologic Description	Group and Formation: Thickness (m)	Group	Group and Formation: Designation	Member: Thickness (m)	Member: Designation	Zone: Thickness (m)	Zone: Designation
	sand, gravel, till, clay, silt	<70		Surficial Deposits	<70	Upper	<15	First Sand and Gravel
	shale, sandstone, coal, bentonite, limestone, ironstone	300-380	Edmonton Group	Horseshoe Canyon Formation	~100	Upper		
					~100	Middle		
					<10	Drumheller Member		
					~170	Lower		
	shale, sandstone, siltstone	60-120		Bearpaw Formation				
	sandstone, siltstone, shale, coal	40-80	Belly River Group	Oldman Formation	<30	Dinosaur Member	<25	Lethbridge Coal Zone
					<20	Upper Siltstone Member		
					8-20	Comrey Member		
	shale, sandstone, coal	10-220		*continental* Foremost Formation			<20	Taber Coal Zone
							<20	McKay Coal Zone
	sandstone, shale	<200		*marine* Foremost Formation (Basal Belly River Sandstone)	<30	Birch Lake Member		
					<30	Ribstone Creek Member		
					<30	Victoria Member		
					<30	Brosseau Member		
	shale, siltstone	100-200		Lea Park Formation	50-100	Upper		
					50-100	Lower		

Figure 6. Geologic Column