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 - Familiarization 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 Vermilion River No. 24. 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 Vermilion River is situated in east-central Alberta. This area is part of the Alberta Plains region. The County is within the North Saskatchewan River (NSR) basin; a part of the County's southern boundary is the Battle River. The other County boundaries follow township or section lines. The area includes parts of the area bounded by township 056, range 07, W4M in the northwest and township 045, range 01, W4M in the southeast.

Regionally, the topographic surface varies between 480 and 760 metres above mean sea level (AMSL). The lowest elevations occur in the NSR and the Battle River valleys and the highest are in the southwestern part of the County as shown in Figure 1.

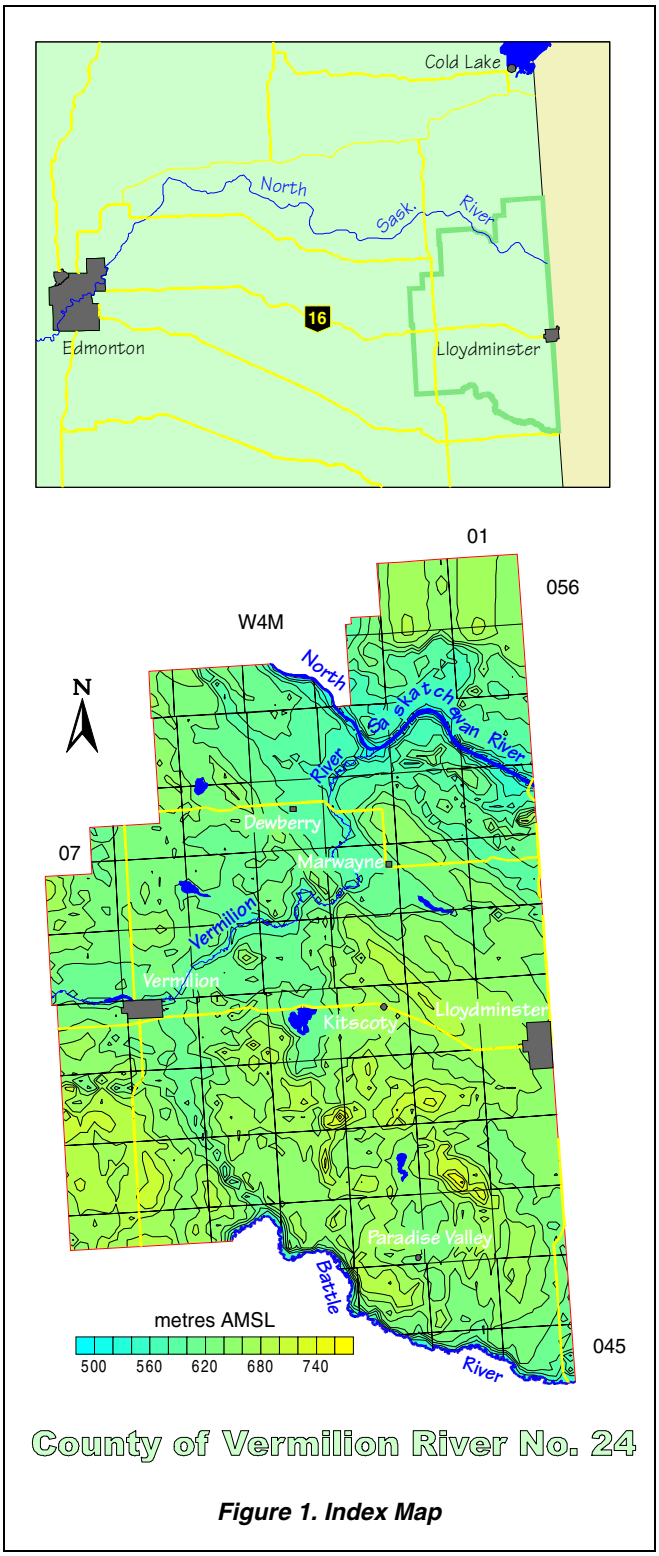

Figure 1. Index Map

2.2 Climate

The County of Vermilion River No. 24 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 four meteorological stations within the County measured 419 millimetres (mm), based on data from 1952 to 1993. The annual temperature averaged 1.7 °C, with the mean monthly temperature reaching a high of 16.7 °C in July, and dropping to a low of -15.8 °C in January. The calculated annual potential evapotranspiration is 517 millimetres.

2.3 Background Information

There are currently records for 6,110 water wells in the groundwater database for the County. Of the 6,110 water wells, 5,081 are for domestic/stock purposes. The remaining 1,029 water wells were completed for a variety of uses, including municipal, industrial, irrigation and observation. Based on a rural population of 7,553, there are 3.2 domestic/stock water wells per family of four. The domestic or stock water wells vary in depth from 0.6 metres to 190 metres below ground level. Lithologic details are available for 3,491 water wells.

Data for casing diameters are available for 3,097 water wells, with 2,552 (82%) indicated as having a diameter of less than 275 mm and 545 having a diameter of more than 300 mm. The casing diameters of greater than 300 mm are mainly bored or dug water wells and those with a surface-casing diameter of less than 275 mm are drilled water wells. Large-diameter water wells are mainly in the areas where significant linear bedrock lows are present.

In the County, steel, galvanized steel and plastic represent 99% of the materials that have been used for surface casing in drilled water wells over the last 40 years. Until the 1960s, the type of surface casing used in drilled water wells was mainly undocumented. Steel casing was in use in the 1950s and is still used in 7% of the water wells being drilled in the County in the 1990s. Steel and galvanized steel were the main casing types until the start of the 1980s, at which time plastic casing started to replace the use of steel and galvanized steel casings.

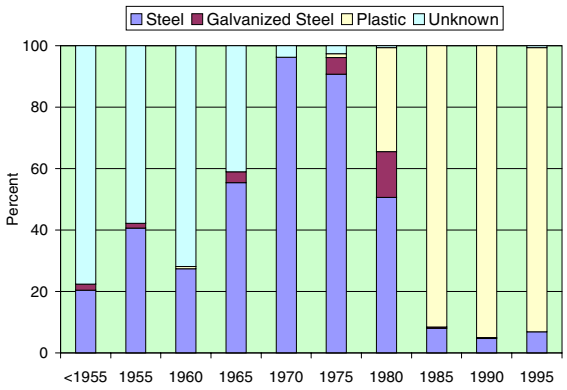

Figure 2. Surface Casing Types used in Drilled Water Wells

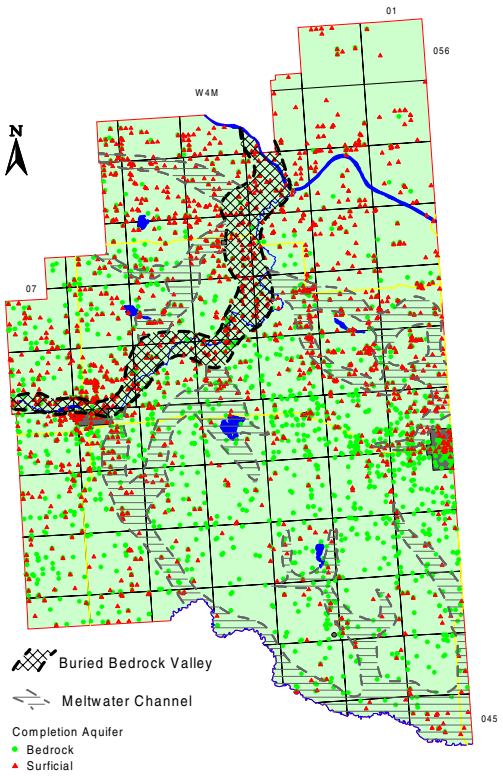

Figure 3. Location of Water Wells

Galvanized steel surface casing was used in a maximum of 15% of the new water wells from the 1950s to the early 1990s. Galvanized steel was last used in May 1990.

There are 3,731 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 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 1,790, with 60% having a completion depth of greater than 20 metres. The adjacent map shows that the majority of the water wells completed in the surficial deposits occur in the northern half of the County, frequently in the vicinity of linear bedrock lows.

The 1,941 water wells that have the top of their completion interval deeper than the top of the bedrock surface are referred to as bedrock water wells. From Figure 3, it can be seen that water wells completed in bedrock aquifers occur mainly in the southern two-thirds of the County.

Water wells not used for domestic needs and providing groundwater with total dissolved solids (TDS) of less than 4,000 milligrams per litre (mg/L) must be licensed. At the end of 1996, 164 groundwater diversions were licensed in the County. Of the 164 licensed groundwater users, 112 are for agricultural purposes, and the remaining 52 are for industrial, municipal, domestic and other purposes. The total maximum authorized diversion from the water wells associated with these licences is 8,503 cubic metres per day (m^3/day); 43% percent of the authorized groundwater diversion is allotted for municipal use, 34% is allotted for industrial use, and 20% is allotted for agricultural use. The remaining 3% has been licensed for domestic and other uses. The largest potable groundwater diversion licensed within the County is for the Town of Vermilion, having a diversion of 929.7 m^3/day. The largest licensed industrial groundwater diversion within the County is for a water source well completed in the Lower Sand and Gravel Aquifer in 16-10-052-04 W4M owned by Canadian Natural Resources Ltd.

The following table shows a breakdown of the 164 licensed groundwater diversions by the aquifer in which the water well is completed. The largest total licensed diversions are in the Lower Sand and Gravel and Ribstone Creek aquifers; the majority of the groundwater is used for municipal and industrial purposes.

	Licensed Groundwater Users (m^3/day)						
Aquifer	Agricultural	Industrial	Municipal	Domestic	Other	Total	Percentage
Upper Sand and Gravel	369	652	91	20	3	1,135	13
Lower Sand and Gravel	432	1,366	2,191	14	0	4,003	47
Oldman	10	0	0	0	0	10	0
Birch Lake	71	0	0	0	27	98	1
Ribstone Creek	660	0	538	0	223	1,421	17
Victoria	148	0	805	0	0	953	11
Brosseau	0	0	0	0	0	0	0
Lea Park	10	0	0	0	0	10	0
Saline	0	849	0	0	0	849	10
Unknown	14	0	10	0	0	24	0
Total	1,714	2,867	3,635	34	253	8,503	100
Percentage	20	34	43	0	3	100	

Table 1. Licensed Groundwater Diversions

Based on the 1996 Agriculture Census, the water requirement for livestock for the County is in the order of 17,442 m^3/day, which is more than ten times the amount of the groundwater diversion that is licensed for agricultural purposes; some of the difference would be related to the use of surface water.

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 1,100 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. Less than 1% of the chemical analyses indicate a fluoride concentration above 1.5 mg/L.

The minimum, maximum and average concentrations of TDS, sodium, sulfate, chloride and fluoride in the groundwaters from water wells completed in the upper bedrock in the County have been compared to the Guidelines for Canadian Drinking Water Quality (GCDWQ) in Table 2. Of the five constituents compared to the GCDWQ, only average values of TDS and sodium concentrations exceed the guidelines.

Constituent	Range for County in mg/L Minimum	Maximum	Average	Recommended Maximum Concentration GCDWQ
Total Dissolved Solids	35.0	6006	1091	500
Sodium	4.0	1283	304	200
Sulfate	1.0	2886	318	500
Chloride	1.0	2340	65	250
Fluoride	0.02	2.65	0.31	1.5

Concentration in milligrams per litre unless otherwise stated
Note: indicated concentrations are for Aesthetic Objectives

GCDWQ - Guidelines for Canadian Drinking Water Quality, Sixth Edition
Minister of Supply and Services Canada, 1996

Table 2. Concentrations of Constituents in Groundwaters from Upper Bedrock Aquifer(s)

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, and the elevation of the Base of Groundwater Protection provided by the Alberta Energy and Utilities Board (EUB), 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 well for agricultural purposes or for a potable water supply. If a water well is completed below the Base of Groundwater Protection with the total dissolved solids of the groundwater exceeding 4,000 mg/L, then the groundwater use does not require licensing by AEP.

Over approximately 60% of the County, the depth to the Base of Groundwater Protection is more than 100 metres. There are only a few areas where the depth to the Base of Groundwater Protection is less than 40 metres; these areas are mainly within a few kilometres of the North Saskatchewan and Vermilion rivers, as shown on the adjacent map.

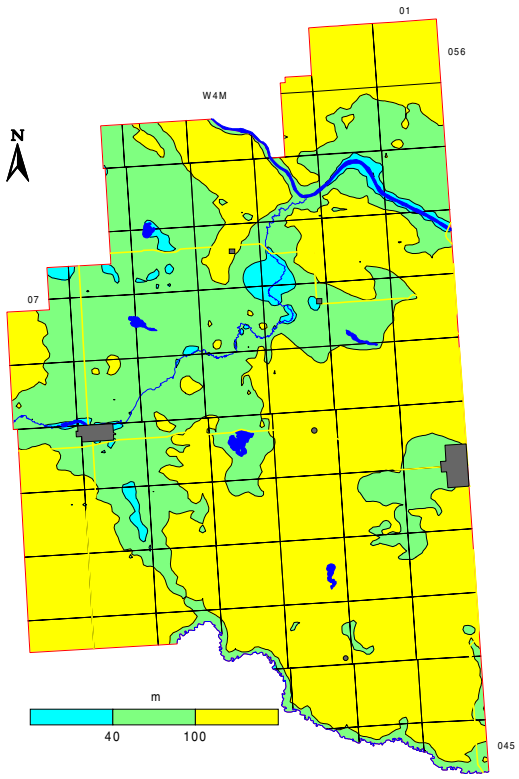

Figure 4. Depth to Base of Groundwater Protection (after EUB, 1995)

Proper management of the groundwater resource requires water-level data. These data are often collected from observation water wells. At the present time, there are eight AEP-operated observation water wells within the County. Additional data can be obtained from some of the licensed groundwater diversions. In the past, the 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.