1. Project Overview

"Water is the lifeblood of the earth." - Anonymous

How a County takes care of one of its most precious resources - groundwater - reflects the future wealth and health of its people. Good environmental practices are not an accident. They must include genuine foresight with knowledgeable planning. Implementation of strong practices not only commits to a better quality of life for future generations, but also creates a solid base for increased economic activity. **Though this report's scope is regional, it is a first step for Strathcona County in managing their groundwater. It is also a guide for future groundwater-related projects.**

1.1 Purpose

This project is a regional groundwater assessment of Strathcona County prepared by Hydrogeological Consultants Ltd. (HCL) with financial assistance from Prairie Farm Rehabilitation Administration (PFRA). 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 will:

- identify the aquifers[1] within the surficial deposits[2] and the upper bedrock
- spatially identify the main aquifers
- describe the quantity and quality of the groundwater associated with each aquifer
- identify the hydraulic relationship between aquifers
- identify possible groundwater depletion areas associated with each upper bedrock aquifer.

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 Strathcona County.

[1] See glossary
[2] See glossary

1.2 The Project

This regional study should only be used as a guide. Detailed local studies are required to verify hydrogeological conditions at given locations.

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

Task 1 - Data Collection and Review
Task 2 - Hydrogeological Maps, Figures, Digital Data Files
Task 3 – Hydrogeological Evaluation and Preparation of Report
Task 4 - Groundwater Information Query Software
Task 5 – Review of Draft Report and GIS Data Files
Task 6 – Report Presentation and Familiarization Session
Task 7 – Provision of Report, Maps, Data Layers and Query
Task 8 – Provision of Compact Disk for Sale to General Public.

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

1.3 About This Report

This report provides an overview of (a) the groundwater resources of Strathcona County, (b) the processes used for the present project, and (c) the groundwater characteristics in the County.

Additional technical details are available from files on the CD-ROM to be provided with the final version of this report. The files include the geo-referenced electronic groundwater database, maps showing distribution of various hydrogeological parameters, the groundwater query, ArcView files and ArcExplorer files. Likewise, all of the illustrations and maps from the present report, plus additional maps, figures and cross-sections, are available on the CD-ROM. For convenience, poster-size maps and cross-sections have been prepared as a visual summary of the results presented in this report. Copies of these poster-size drawings have been forwarded with this report, and are included as page-size drawings in Appendix D.

Appendix A features page-size copies of the figures within the report plus additional maps and cross-sections. An index of the page-size maps and figures is given at the beginning of Appendix A.

Appendix B provides a complete list of maps and figures included on the CD-ROM.

Appendix C includes the following:

1) a procedure for conducting aquifer tests with water wells[3]
2) a table of contents for the Water (Ministerial) Regulation under the new Water Act
3) a flow chart showing the licensing of a groundwater diversion under the new Water Act
4) interpretation of chemical analysis of drinking water
5) additional information.

The Water (Ministerial) Regulation deals with the wellhead completion requirement (no more water-well pits), the proper procedure for abandoning unused water wells and the correct procedure for installing a pump in a water well. The new Water Act was proclaimed 10 Jan 1999.

Appendix D includes page-size copies of the poster-size figures provided with this report.

Appendix E provides a list of water wells recommended for field verification.

[3] See glossary

2. Introduction

2.1 Setting

Strathcona County is situated in central Alberta. This area is part of both the Low Boreal Mixedwood and the Aspen Parkland regions. The County is within the North Saskatchewan River basin; a part of the County's northwestern boundary is the North Saskatchewan River and a part of the County's eastern border is Elk Island National Park. The other County boundaries follow township or section lines. The area includes parts of the area bounded by township 050, range 24, W4M in the southwest and township 057, range 20, W4M in the northeast.

Regionally, the topographic surface varies between 580 and 780 metres above mean sea level (AMSL). The lowest elevations occur in the northwestern part of the County along the North Saskatchewan River Valley and the highest are in the southern parts of the County as shown on Figure 1 and page A-2.

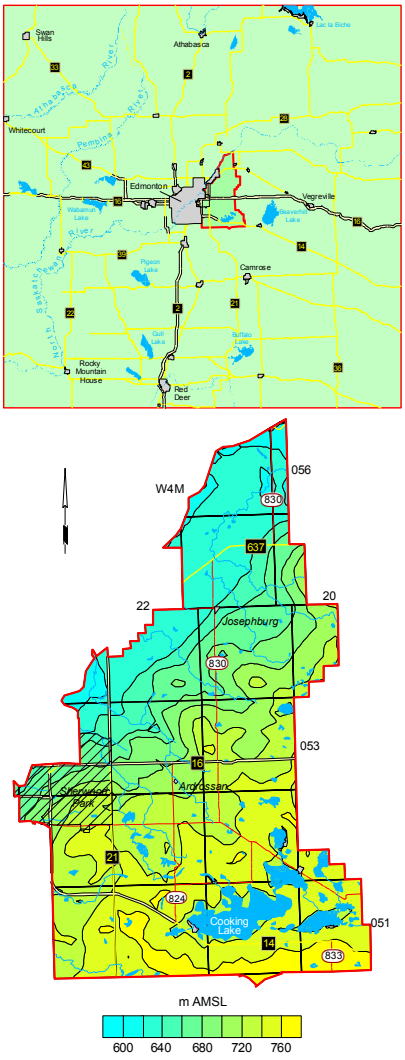

Figure 1. Index Map

2.2 Climate

Strathcona County lies within the Dfb climate boundary. This classification is based on potential evapotranspiration[4] 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 Leggatt, 1981) shows that the County is located in both the Low Boreal Mixedwood region and the Aspen Parkland region. Increased precipitation and cooler temperatures, resulting in additional moisture availability, influence this vegetation change.

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.

The mean annual precipitation averaged from six meteorological stations measured 478 millimetres (mm), based on data from 1958 to 1993. The mean annual temperature averaged 2.8° C, with the mean monthly temperature reaching a high of 16.7° C in July, and dropping to a low of -12.5° C in January. The calculated annual potential evapotranspiration is 531 millimetres.

[4] See glossary

2.3 Background Information

2.3.1 Number, Type and Depth of Water Wells

There are currently records for 9,029 water wells in the groundwater database for the County. Of the 9,029 water wells, 6,984 are for domestic/stock purposes. The remaining 2,045 water wells were completed for a variety of uses, including industrial, municipal, observation, injection, irrigation, investigation and dewatering. Based on a rural population of 23,639 (Strathcona County, 2000), there are 1.2 domestic/stock water wells per family of four. It is unknown how many of these water wells may still be active. The domestic or stock water wells vary in depth from 3.0 metres to 134 metres below ground level. Details for lithology[5] are available for 3,942 water wells.

2.3.2 Number of Water Wells in Surficial and Bedrock Aquifers

There are 2,743 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 top of the bedrock are water wells completed in surficial aquifers. Of the 2,743 water wells for which aquifers could be defined, 509 are completed in surficial aquifers, with 75% having a completion depth of more than 20 metres. The adjacent map shows that the water wells completed in the surficial deposits occur throughout the County, frequently in the vicinity of linear bedrock lows. The map also shows a number of water wells located in surface-water bodies. Some of the locations are a result of plotting in the centre of the quarter section; others have the incorrect location.

The 2,234 water wells that have the top of their completion interval deeper than the top of the bedrock are referred to as bedrock water wells. From Figure 2, it can be seen that water wells completed in bedrock aquifers occur throughout the County.

There are currently records for 36 springs in the groundwater database. More than 75% of the 32 available chemical values for springs indicate the groundwaters have total hardness concentrations of more than 200 milligrams per litre (mg/L) and total dissolved solids (TDS) concentrations ranging from 165 to 1,700 mg/L.

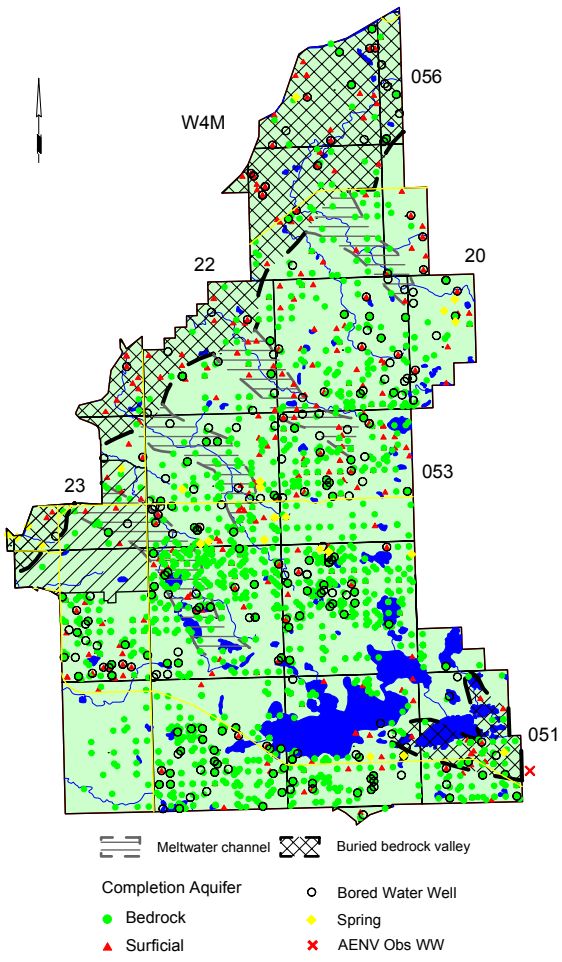

Figure 2. Location of Water Wells and Springs

[5] See glossary

2.3.3 Casing Diameter and Type

Data for casing diameters are available for 3,111 water wells, with 2,812 (90%) indicated as having a diameter of less than 275 mm and 299 water wells having a surface-casing diameter of more than 275 mm. The casing diameters of greater than 275 mm are mainly bored or dug water wells and those with a surface-casing diameter of less than 275 mm are drilled water wells. The locations of the 299 water wells with large-diameter casings are shown on Figure 2 as bored water wells.

In the County, steel, galvanized steel and plastic surface casing materials have been used in 99% of the drilled water wells over the last 40 years. Until the mid-1950s, 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 ten percent of the water wells being drilled in the County in the mid-1990s.

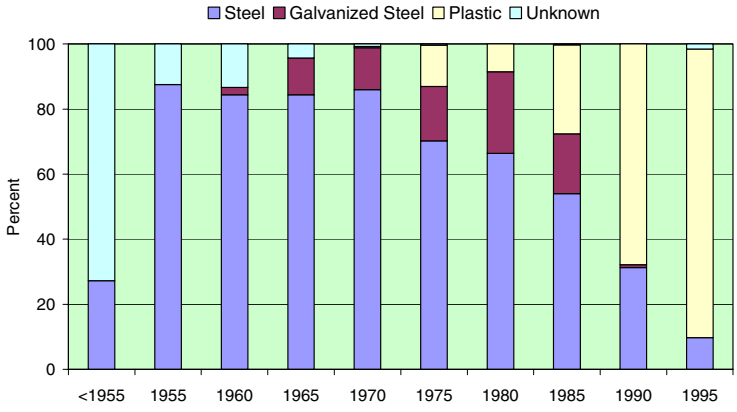

Figure 3. Surface Casing Types Used in Drilled Water Wells

Galvanized steel surface casing was used in a maximum of 25% of the drilled water wells from the early 1960s to the early 1990s. Galvanized steel was last used in March 1990. Plastic casing was first used in June 1977. The percentage of water wells with plastic casing has increased and in the mid-1990s, plastic casing was used in 89% of the drilled water wells in the County.

2.3.4 Requirements for Licensing

Water wells used for household needs in excess of 1,250 cubic metres per year and all other groundwater use must be licensed. The only groundwater uses that do not need licensing are (1) household use of up to 1,250 m^3/year and (2) groundwater with total dissolved solids in excess of 4,000 mg/L. At the end of 1999, 59 groundwater allocations were licensed in the County. Of the 59 licensed groundwater users, 38 could be linked to the Alberta Environment (AENV) groundwater database. Of the 59 licensed groundwater users, 32 are for agricultural purposes, and the remaining 27 are for commercial, municipal or dewatering purposes. The total maximum authorized diversion from the water wells associated with these licences is 12,841 cubic metres per day (m^3/day), although actual use could be less. Of the 12,841 m^3/day, 12,261 m^3/day (96%) is authorized for dewatering purposes from six water dewatering water wells as shown in Table 1 on the following page. Of the remaining 580 m^3/day, 43% is allotted for agricultural use, 29% is allotted for commercial use, and 28% is allotted for municipal use. A figure showing the locations of the licensed users is in Appendix A (page A-5) and on the CD-ROM.

The largest single potable groundwater allocation within the County is for Strathcona County, having a diversion of 40 m^3/day. This water supply well, used for municipal purposes, is completed in the Bearpaw Aquifer.

The adjacent table shows a breakdown of the 59 licensed groundwater allocations by the aquifer in which the water well is completed. The largest total licensed allocations are in the Lower Sand and Gravel Aquifer; the largest total licensed allocations not used for dewatering purposes are in the Lower Horseshoe Canyon and Bearpaw aquifers.

Aquifer **	No. of Diversions	Licensed Groundwater Users* (m³/day) Agricultural	Commerical	Municipal	Dewatering	Total	Percentage
Upper Sand and Gravel	6	22	10	0	270	302	2
Lower Sand and Gravel	9	0	58	0	11,990	12,048	94
Lower Horseshoe Canyon	25	177	0	68	0	244	2
Bearpaw	12	37	101	54	0	193	1
Oldman	3	13	0	24	0	37	0
Unknown	4	0	1	17	0	17	0
Total	59	249	170	162	12,261	12,841	100
Percentage		2	1	1	96	100	

* - data from AENV ** - identification of Aquifer by HCL

Table 1. Licensed Groundwater Diversions

Based on the 1996 Agriculture Census, the calculated water requirement for livestock for the County is in the order of 5,131 m³/day. Of the 5,131 m³/day average calculated livestock use, AENV has licensed a groundwater diversion of 249 m³/day (5%) and a surface-water diversion of 351 m³/day (7%). The remaining 88% of the calculated livestock use would have to be from unlicensed sources.

2.3.5 Groundwater Chemistry and Base of Groundwater Protection

Groundwaters from the surficial deposits can be expected to be chemically hard, with a high dissolved iron content. High nitrate and nitrite (as N) concentrations were evident in 6% of the available chemical data for the surficial aquifers and 1% of the available chemical data for the upper bedrock aquifer(s); a plot of nitrate and nitrite (as N) in surficial aquifers is on the accompanying CD-ROM. The TDS concentrations in the groundwaters from the upper bedrock in the County range generally from 750 to 1,500 mg/L (page A-28). Groundwaters from the bedrock aquifers frequently are chemically soft, with generally low concentrations of dissolved iron. The chemically soft groundwater is high in concentrations of sodium. Nearly 5% of the chemical analyses indicate a fluoride concentration above 1.5 mg/L, with most of the exceedances occurring in the northern part of the County (see CD-ROM).

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, average values of TDS and sodium concentrations exceed the guidelines; maximum values of all five constituents exceed the guidelines.

Constituent	Range for County in mg/L Minimum	Maximum	Average	Recommended Maximum Concentration GCDWQ
Total Dissolved Solids	6	7830	1255	500
Sodium	0	5199	432	200
Sulfate	0	2056	208	500
Chloride	0	4400	86	250
Fluoride	0	6.9	0.5	1.5

Concentration in milligrams per litre unless otherwise stated
Note: indicated concentrations are for Aesthetic Objectives except for Fluoride, which is for Maximum Acceptable Concentration (MAC)

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)