8 RECOMMENDATIONS

The present study has been based on information available from the groundwater database. The database has three problems:

1) the quality of the data;
2) the coordinate system used for the horizontal control; and
3) the distribution of the data.

The quality of the data in the groundwater database is affected by two factors: a) the technical training of the persons collecting the data, and b) the quality control of the data. The possible options to upgrade the database include the creation of a "super" database, which includes only verified data. The level of verification would have to include identifying the water well in the field, obtaining meaningful horizontal coordinates for the water well and the verification of certain parameters such as water level and completed depth. An attempt to update the quality of the entire database is not recommended.

There is a shortage of hydrogeological information for the Lower Sand and Gravel Aquifer and the Aquifer needs to be better defined. The Lower Sand and Gravel Aquifer may be a source of large volumes of groundwater for the Village of Mannville. The development of water wells to ease drought conditions or disaster relief programs could be very significant. There is a water well used for domestic purposes in 01-29-050-09 W4M that is completed in the Lower Sand and Gravel Aquifer. An apparent yield of more than 300 m^3/day was calculated from the available aquifer testing data recorded on the drilling log. It is recommended that a water test hole be drilled within 150 metres of this water well and completed within the Lower Sand and Gravel Aquifer. The water test hole should be used to conduct an extended aquifer test to better evaluate the Aquifer in the eastern part of the County.

There are very significant meltwater channels present in the northern part of the County. There is a domestic water well in NW 32-052-09 W4M that has a projected yield of in the order of 1,000 m^3/day. There are indications that other significant meltwater channels are present and investigation of the aquifers associated with these features could be used to establish locations for high-yield water wells.

The present analysis has shown that the groundwater flow in the Victoria Aquifer may not be sufficient to sustain the authorized diversion by AEP. However, because this analysis is based on a regional study, the results should be considered no more than an indication. It is recommended that a detailed study be completed to assess the volume of groundwater flowing through the Victoria Aquifer. The study would need to obtain all of the data for individual water wells authorized to divert groundwater from the Victoria Aquifer, document the quantity of groundwater being diverted, establish the water-level trends, and evaluate the hydraulic parameters for the Aquifer. The best method to analyze the data would be through the use of a computer model study.

One of the main shortages of data for the determination of a groundwater budget is water levels as a function of time. There are only five observation-water-well-data sources in the County from which to obtain water levels for the groundwater budget. One method to obtain additional water-level data is to solicit the assistance of the water well owners who are stakeholders in the groundwater resource. In the M.D. of Rocky View, for example, water well owners are being provided with a tax credit if they accurately measure the water level in their water well once per week for a year. A pilot project indicated that approximately five years of records are required to obtain a reasonable data set. The cost of a five-year project involving 50 water wells would be less than the cost of one drilling program that may provide two or three observation water wells.

In general, for the next level of study, the database needs updating. It requires more information from existing water wells, and additional information from new ones.

Before an attempt is made to upgrade the level of interpretation provided in this report and the accompanying maps and groundwater query, it is recommended that all water wells for which water well drilling reports are available be subjected to the following actions:

1. The horizontal location of the water well should be determined within 10 metres. The coordinates must be in 10TM NAD 27 or some other system that will allow conversion to 10TM NAD 27 coordinates.
2. A four-hour aquifer test (two hours of pumping and two hours of recovery) should be performed with the water well to obtain a realistic estimate for the transmissivity of the aquifer in which the water well is completed.
3. Water samples should be collected for chemical analysis after 5 and 115 minutes of pumping, and analyzed for major and minor ions.

In addition to the data collection associated with the existing water wells, all available geophysical logs should be interpreted to establish a more accurate spatial definition of individual aquifers.

There is also a need to provide the water well drillers with feedback on the reports they are submitting to the regulatory agencies. The feedback is necessary to allow for a greater degree of uniformity in the reporting process. This is particularly true when trying to identify the bedrock surface. The water well drilling reports should be submitted to the AEP Resource Data Division in an electronic form. The money presently being spent by AEP and Prairie Farm Rehabilitation Administration (PFRA) to transpose the paper form to the electronic form should be used to allow for a technical review of the data and follow-up discussions with the drillers.

An effort should be made to form a partnership with the petroleum industry. The industry spends millions of dollars each year collecting information relative to water wells. Proper coordination of this effort could provide significantly better information from which future regional interpretations could be made. This could be accomplished by the County taking an active role in the activities associated with the construction of lease sites for the drilling of hydrocarbon wells and conducting of seismic programs.

Groundwater is a renewable resource and it must be managed.

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10 GLOSSARY

Aquifer	a formation, group of formations, or part of a formation that contains saturated permeable rocks capable of transmitting groundwater to water wells or springs in economical quantities.
Aquitard	a confining bed that retards but does not prevent the flow of water to or from an adjacent aquifer.
Available Drawdown	in a confined aquifer, the distance between the non-pumping water level and the top of the aquifer. in an unconfined aquifer (water table aquifer), two thirds of the saturated thickness of the aquifer.
Facies	the aspect or character of the sediment within beds of one and the same age (Pettijohn, 1957).
Fluvial	produced by the action of a stream or river.
Friable	poorly cemented.
Hydraulic Conductivity	the rate of flow of water through a unit cross-section under a unit hydraulic gradient; units are length/time.
Kriging	a geo-statistical method for gridding irregularly-spaced data.
Lacustrine	fine-grained sedimentary deposits associated with a lake environment and not including shore-line deposits.
Surficial Deposits	includes all sediments above the bedrock.
Transmissivity	the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient: a measure of the ease with which groundwater can move through the aquifer. Apparent Transmissivity: the value determined from a summary of aquifer test data, usually involving only two water-level readings. Effective Transmissivity: the value determined from late pumping and/or late recovery water-level data from an aquifer test. Aquifer Transmissivity: the value determined by multiplying the hydraulic conductivity of an aquifer by the thickness of the aquifer.
Yield	a regional analysis term referring to the rate a properly completed water well could be pumped, if fully penetrating the aquifer. Apparent Yield: based mainly on apparent transmissivity. Long-Term Yield: based on effective transmissivity.

COUNTY OF MINBURN NO. 27

Appendix B

MAPS AND FIGURES ON CD-ROM

CD-ROM

A) Database
B) ArcView Files
C) Query
D) Maps and Figures

1) General

Index Map
Surface Casing Types used in Drilled Water Wells
Location of Water Wells
Depth of Existing Water Wells
Depth to Base of Groundwater Protection
Bedrock Topography
Bedrock Geology
Cross-Section A - A'
Cross-Section B - B'
Geologic Column
Generalized Cross-Section (for terminology only)
Risk of Groundwater Contamination
Relative Permeability
Hydrographs - AEP Observation Water Wells

2) Surficial Aquifers

a) Surficial Deposits

Thickness of Surficial Deposits
Non-Pumping Water-Level Surface in Surficial Deposits
Total Dissolved Solids in Groundwater from Surficial Deposits
Sulfate in Groundwater from Surficial Deposits
Chloride in Groundwater from Surficial Deposits
Fluoride in Groundwater from Surficial Deposits
Total Hardness of Groundwater from Surficial Deposits
Piper Diagram - Surficial Deposits
Amount of Sand and Gravel in Surficial Deposits
Thickness of Sand and Gravel Aquifer(s)
Water Wells Completed in Surficial Deposits
Apparent Yield for Water Wells Completed in Sand and Gravel Aquifer(s)

b) First Sand and Gravel

Thickness of First Sand and Gravel
First Sand and Gravel - Saturation

c) Upper Sand and Gravel

Thickness of Upper Surficial Deposits
Thickness of Upper Sand and Gravel (not all drill holes fully penetrate surficial deposits)
Apparent Yield for Water Wells Completed through Upper Sand and Gravel Aquifer

d) Lower Sand and Gravel

Structure-Contour Map - Top of Lower Surficial Deposits
Depth to Top of Lower Sand and Gravel Aquifer
Thickness of Lower Surficial Deposits
Thickness of Lower Sand and Gravel (not all drill holes fully penetrate surficial deposits)
Apparent Yield for Water Wells Completed through Lower Sand and Gravel Aquifer
Non-Pumping Water-Level Surface in Lower Sand and Gravel Aquifer

3) Bedrock Aquifers

a) General

Apparent Yield for Water Wells Completed in Upper Bedrock Aquifer(s)
Total Dissolved Solids in Groundwater from Upper Bedrock Aquifer(s)
Sulfate in Groundwater from Upper Bedrock Aquifer(s)
Chloride in Groundwater from Upper Bedrock Aquifer(s)
Fluoride in Groundwater from Upper Bedrock Aquifer(s)
Total Hardness of Groundwater from Upper Bedrock Aquifer(s)
Piper Diagram - Bedrock Aquifers
Recharge/Discharge Areas between Surficial Deposits and Upper Bedrock Aquifer(s)
Non-Pumping Water-Level Surface in Upper Bedrock Aquifer(s)

b) Oldman Aquifer

Depth to Top of Oldman Formation
Structure-Contour Map - Top of Oldman Formation
Non-Pumping Water-Level Surface - Oldman Aquifer
Apparent Yield for Water Wells Completed through Oldman Aquifer
Total Dissolved Solids in Groundwater from Oldman Aquifer
Sulfate in Groundwater from Oldman Aquifer
Chloride in Groundwater from Oldman Aquifer
Piper Diagram - Oldman Aquifer
Recharge/Discharge Areas between Surficial Deposits and Oldman Aquifer

c) *continental* Foremost Aquifer

Depth to Top of *continental* Foremost Formation
Structure-Contour Map - Top of *continental* Foremost Formation
Non-Pumping Water-Level Surface - *continental* Foremost Aquifer
Apparent Yield for Water Wells Completed through *continental* Foremost Aquifer
Total Dissolved Solids in Groundwater from *continental* Foremost Aquifer
Sulfate in Groundwater from *continental* Foremost Aquifer
Chloride in Groundwater from *continental* Foremost Aquifer
Piper Diagram - *continental* Foremost Aquifer
Recharge/Discharge Areas between Surficial Deposits and *continental* Foremost Aquifer

d) Birch Lake Aquifer

Depth to Top of Birch Lake Member
Structure-Contour Map - Top of Birch Lake Member
Non-Pumping Water-Level Surface - Birch Lake Aquifer
Apparent Yield for Water Wells Completed through Birch Lake Aquifer
Total Dissolved Solids in Groundwater from Birch Lake Aquifer
Sulfate in Groundwater from Birch Lake Aquifer
Chloride in Groundwater from Birch Lake Aquifer
Piper Diagram - Birch Lake Aquifer
Recharge/Discharge Areas between Surficial Deposits and Birch Lake Aquifer

e) Ribstone Creek Aquifer

Depth to Top of Ribstone Creek Member
Structure-Contour Map - Top of Ribstone Creek Member
Non-Pumping Water-Level Surface - Ribstone Creek Aquifer
Apparent Yield for Water Wells Completed through Ribstone Creek Aquifer
Total Dissolved Solids in Groundwater from Ribstone Creek Aquifer
Sulfate in Groundwater from Ribstone Creek Aquifer
Chloride in Groundwater from Ribstone Creek Aquifer
Recharge/Discharge Areas between Surficial Deposits and Ribstone Creek Aquifer

f) Victoria Aquifer

Depth to Top of Victoria Member
Structure-Contour Map - Top of Victoria Member
Non-Pumping Water-Level Surface - Victoria Aquifer
Apparent Yield for Water Wells Completed through Victoria Aquifer
Total Dissolved Solids in Groundwater from Victoria Aquifer
Sulfate in Groundwater from Victoria Aquifer
Chloride in Groundwater from Victoria Aquifer
Recharge/Discharge Areas between Surficial Deposits and Victoria Aquifer

g) Brosseau Aquifer

Depth to Top of Brosseau Member
Structure-Contour Map - Top of Brosseau Member

h) Lea Park Aquitard

Depth to Top of Lea Park Aquitard
Structure-Contour Map - Top of Lea Park Aquitard

COUNTY OF MINBURN NO. 27
Appendix C

GENERAL WATER WELL INFORMATION