

Clearwater County

Part of the North Saskatchewan and South Saskatchewan River Basins

Tp 031 to 047, R 04 to 11, W5M

Regional Groundwater Assessment

Prepared for:



In conjunction with:



Agriculture and
Agri-Food Canada

Prairie Farm Rehabilitation
Administration

Agriculture et
Agroalimentaire Canada

Administration du rétablissement
agricole des Prairies

Canada

Prepared by
hydrogeological consultants ltd.
1-800-661-7972
Our File No.: **02-221**

February 2004

PERMIT TO PRACTICE

HYDROGEOLOGICAL CONSULTANTS LTD.

Signature _____

Date _____

PERMIT NUMBER P 385

The Association of Professional Engineers,
Geologists and Geophysicists of Alberta

© 2004 Clearwater County

Table of Contents

1	Project Overview	1
1.1	Purpose	1
1.2	The Project	2
1.3	About This Report.....	2
2	Introduction.....	3
2.1	Setting.....	3
2.2	Climate.....	3
2.3	Background Information	4
2.3.1	Number, Type and Depth of Water Wells	4
2.3.2	Number of Water Wells in Surficial and Bedrock Aquifers.....	4
2.3.3	Casing Diameter and Type	5
2.3.4	Dry Water Test Holes	5
2.3.5	Requirements for Licensing	6
2.3.6	Groundwater Chemistry and Base of Groundwater Protection.....	7
3	Terms.....	9
4	Methodology	10
4.1	Data Collection and Synthesis.....	10
4.2	Spatial Distribution of Aquifers	12
4.3	Hydrogeological Parameters	12
4.4	Maps and Cross-Sections	13
4.5	Software.....	13
5	Aquifers.....	14
5.1	Background.....	14
5.2	Aquifers in Surficial Deposits.....	14
5.2.1	Geological Characteristics of Surficial Deposits	14
5.2.2	Sand and Gravel Aquifer(s).....	16
5.2.3	Upper Sand and Gravel Aquifer	19
5.2.4	Lower Sand and Gravel Aquifer	20
5.3	Bedrock.....	21
5.3.1	Bedrock Aquifers	21
5.3.2	Geological Characteristics.....	22
5.3.3	Upper Bedrock Completion Aquifer(s)	23
5.3.4	Chemical Quality of Groundwater	24
5.3.5	Disturbed Belt Aquifer	25
5.3.6	Dalehurst Aquifer.....	26

6	Groundwater Budget	27
6.1	Hydrographs	27
6.2	Estimated Groundwater Use in Clearwater County.....	30
6.3	Groundwater Flow	32
6.3.1	Quantity of Groundwater	33
6.3.2	Recharge/Discharge.....	33
6.4	Areas of Groundwater Decline	35
6.5	Discussion of Specific Study Areas.....	37
6.5.1	Area 1 – Township 037, Range 06 W5M	37
6.5.2	Area 2 – Potable Water Injection by the Energy Industry	40
6.5.3	Area 3 – Shallow Groundwater Nitrate Levels	42
7	Recommendations.....	43
8	References	45
9	Glossary.....	58
10	Conversions.....	61

List of Figures

Figure 1. Surface Topography.....	3
Figure 2. Location of Water Wells and Springs	4
Figure 3. Surface Casing Types Used in Drilled Water Wells.....	5
Figure 4. Depth to Base of Groundwater Protection (after EUB, 1995)	8
Figure 5. Generalized Cross-Section (for terminology only).....	9
Figure 6. Geologic Column.....	9
Figure 7. Hydrogeological Map.....	11
Figure 8. Bedrock Topography	15
Figure 9. Thickness of Sand and Gravel Aquifer(s).....	16
Figure 10. Water Wells Completed Surficial Deposits	16
Figure 11. Apparent Yield for Water Wells Completed in Sand and Gravel Aquifer(s)	17
Figure 12. Total Dissolved Solids in Groundwater from Surficial Deposits	18
Figure 13. Apparent Yield for Water Wells Completed through Upper Sand and Gravel Aquifer	19
Figure 14. Apparent Yield for Water Wells Completed through Lower Sand and Gravel Aquifer	20
Figure 15. Cross-Section G - G'	21
Figure 16. Bedrock Geology	22
Figure 17. Apparent Yield for Water Wells Completed in Upper Bedrock Aquifer(s)	23
Figure 18. Total Dissolved Solids in Groundwater from Upper Bedrock Aquifer(s)	24
Figure 19. Fluoride in Groundwater from Upper Bedrock Aquifer(s)	24
Figure 20. Apparent Yield for Water Wells Completed through Disturbed Belt Aquifer	25
Figure 21. Apparent Yield for Water Wells Completed through Dalehurst Aquifer	26
Figure 22. Hydrograph – Water Well No. 83-4	27
Figure 23. Annual Production from WSW Nos. 02-33 and 10-28	27
Figure 24. Water-Level Comparison - Obs WW No. 02-28.....	28
Figure 25. Obs WW No. 02-28 Measured Water Level and Early-Summer Precipitation	28
Figure 26. Obs WWs Water Levels and June to August, 1999 Precipitation	29
Figure 27. Water-Level Comparisons – AENV Obs WW No. 95, Obs WW No. 02-28 and DeMonnin Obs WW - 1999.....	29
Figure 28. Estimated Water Well Use Per Section	31
Figure 29. Non-Pumping Water-Level Surface in Surficial Deposits Based on Water Wells Less than 20 Metres Deep	33
Figure 30. Bedrock Recharge/Discharge Areas	34
Figure 31. Changes in Water Levels in Surficial Deposits	35
Figure 32. Areas of Potential Groundwater Depletion - Upper Bedrock Aquifer(s).....	36
Figure 33. Water Levels in Obs WW No. 10-07.....	36
Figure 34. Estimated Water Well Use Per Section – Area 1	37
Figure 35. Changes in Water Levels in Surficial Deposits – Area 1	38
Figure 36. Discharge Rate in Clearwater River and Water-Level Measurements in WSW No. SE 10 – Area 1	38
Figure 37. Areas of Potential Groundwater Depletion in Dalehurst Aquifer(s) – Area 1	39
Figure 38. Licensed Groundwater Diversion for Injection Purposes.....	40
Figure 39. Licensed Groundwater Versus Diversion Reported.....	41

List of Tables

Table 1. Licences and Registrations of Groundwater by Aquifer.....	6
Table 2. Concentrations of Constituents in Groundwaters from Upper Bedrock Aquifer(s).....	7
Table 3. Apparent Yields of Sand and Gravel Aquifer(s).....	17
Table 4. Concentrations of Constituents in Groundwaters from Surficial Deposits.....	18
Table 5. Completion Aquifer for Upper Bedrock Water Wells.....	23
Table 6. Apparent Yields of Bedrock Aquifers	23
Table 7. Total Groundwater Diversions by Aquifer	30
Table 8. Total Groundwater Diversions	31
Table 9. Groundwater Budget	32
Table 10. Water-Level Decline in Sand and Gravel Aquifer(s)	35
Table 11. Water-Level Decline of More than 5 Metres in Upper Bedrock Aquifer(s)	36
Table 12. Concentrations of Nitrate + Nitrite (as N) in Groundwaters.....	42

Appendices

- A. Hydrogeological Maps and Figures
- B. Maps and Figures on CD-ROM
- C. General Water Well Information
- D. Maps and Figures Included as Large Plots
- E. Water Wells Recommended for Field Verification including County-Operated Water Wells