Strathcona County

Part of the North Saskatchewan River Basin
Parts of Tp 050 to 057, R 20 to 24, W4M
Regional Groundwater Assessment

Prepared for

Strathcona County

In conjunction with

Agriculture and Agri-Food Canada
Prairie Farm Rehabilitation Administration

Agriculture et Agroalimentaire Canada
Administration du rétablisseme agricole des Prairies

Canada

Prepared by
hydrogeological consultants ltd.
1-800-661-7972
Our File No.: **00-179**

March 2001

PERMIT TO PRACTICE
HYDROGEOLOGICAL CONSULTANTS LTD.
Signature______________________
Date______________________
PERMIT NUMBER P 385
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

hydrogeological consultants ltd.

Table of Contents

List of Figures

List of Tables

Appendices

Acknowledgements

Hydrogeological Consultants Ltd. would like to thank the following people for their excellent cooperation and helpful suggestions on this project:

Mr. Tony Cowen – PFRA

Mr. Keith Schick – PFRA

Mr. Timothy Lau – Strathcona County

Mr. Dave Dubauskas – Strathcona County

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.

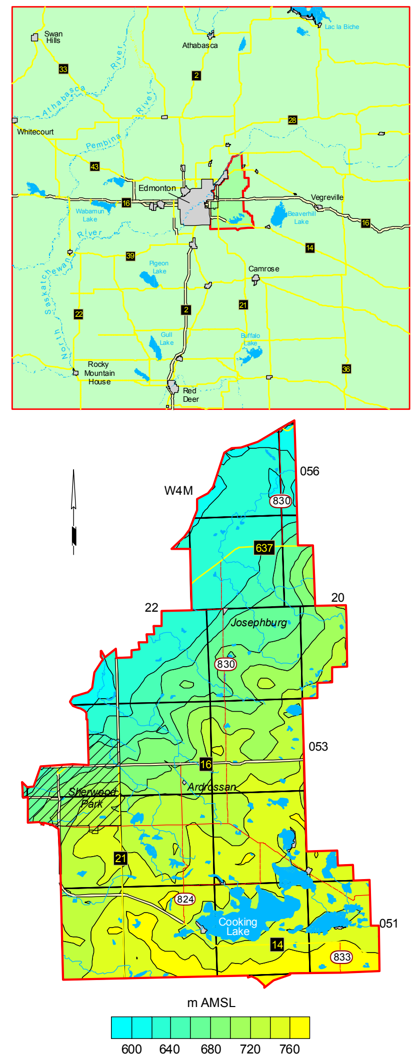


Figure 1. Index Map

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.

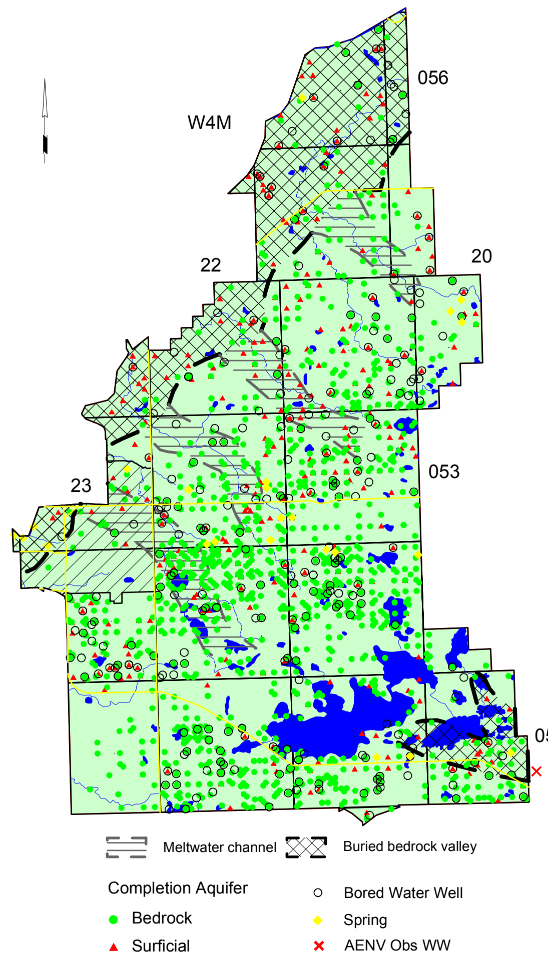


Figure 2. Location of Water Wells and Springs

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.

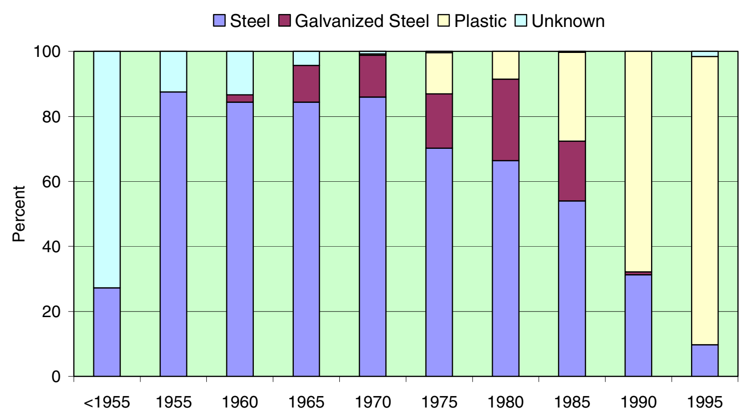


Figure 3. Surface Casing Types Used in Drilled Water Wells

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 m³/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 (m³/day), although actual use could be less. Of the 12,841 m³/day, 12,261 m³/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 m³/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 m³/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)

Alberta Environment defines the Base of Groundwater Protection as the elevation below which the groundwater will have more than 4,000 mg/L of total dissolved solids. By using the ground elevation, formation elevations, and Alberta Energy and Utilities Board (EUB) information indicating the formations containing the deepest useable water for agricultural needs, a value for the depth to the Base of Groundwater Protection can be determined. These values are gridded using the Kriging[6] method to prepare a depth to the Base of Groundwater Protection surface. 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 has total dissolved solids exceeding 4,000 mg/L, the groundwater use does not require licensing by AENV. In the County, the depth to Base of Groundwater Protection ranges from less than 160 metres to more than 260 metres below ground level, as shown on Figure 4 and on each cross-section.

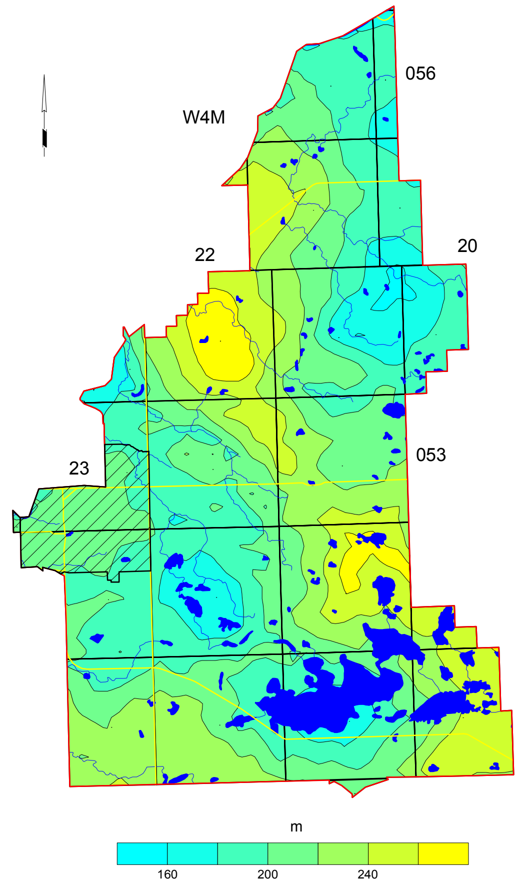


Figure 4. Depth to Base of Groundwater Protection (modified after EUB, 1995)

Of the 5,648 water wells with completed depth data, none are completed below the Base of Groundwater Protection.

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 no AENV-operated observation water wells within the County. However, there are two AENV-operated observation water wells southeast of the County near Cooking Lake in 08-11-051-20 W4M (Figure 2). 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 AENV, 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 (see section 6.0 of this report). 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.

[6] See glossary

3. Terms

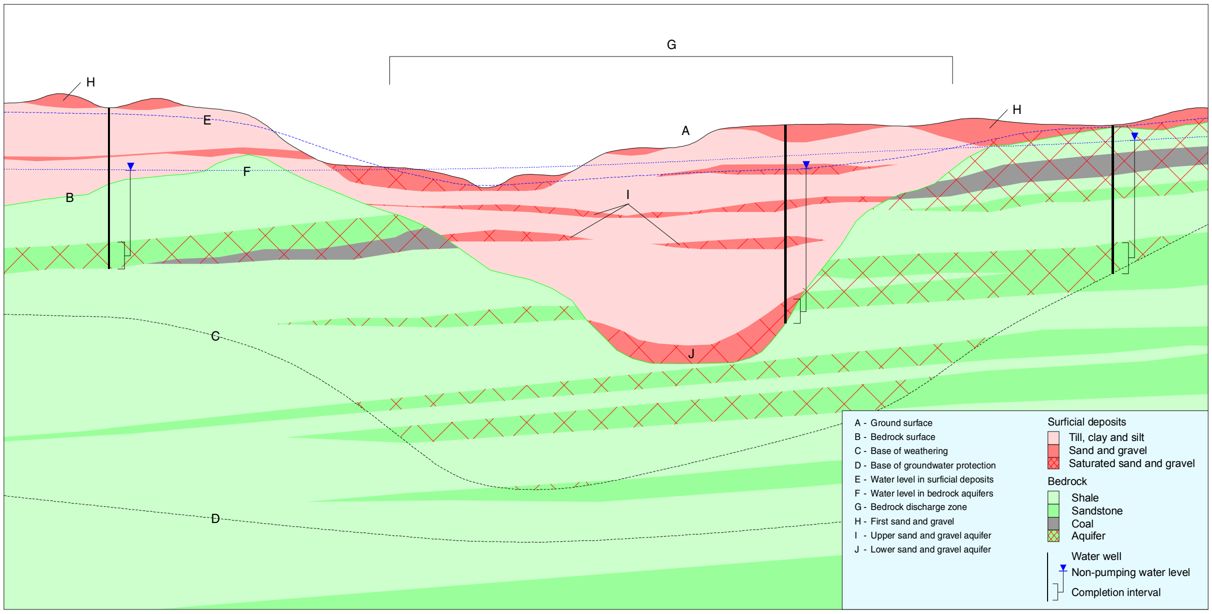


Figure 5. Generalized Cross-Section (for terminology only)

Lithology	Lithologic Description	Group and Formation: Average Thickness (m)	Group	Group and Formation: Designation	Member: Average Thickness (m)	Member: Designation	Zone: Average Thickness (m)	Zone: Designation
	sand, gravel, till, clay, silt	<70		Surficial Deposits	<70	Upper		
					<50	Lower		
	shale, sandstone, coal, bentonite, limestone, ironstone	300-380	Edmonton Group	Horseshoe Canyon Formation	~100	Upper		
					~100	Middle		
					~170	Lower		
	shale, sandstone, siltstone	60-120		Bearpaw Formation				
	sandstone, siltstone, shale, coal	<300	Belly River Group	40-130 Oldman Formation		Dinosaur Member	<25	Lethbridge Coal Zone
						Upper Siltstone Member		
						Comrey Member		
	sandstone, shale			<200 Foremost Formation	<70	Birch Lake Member		Taber Coal Zone
					<60	Ribstone Creek Member		
					<70	Victoria Member		McKay Coal Zone
					0-30	Brosseau Member		

Depth (m): 0, 100, 200, 300, 400, 500, 600, 700, 800

Figure 6. Geologic Column

4. Methodology

4.1 Data Collection and Synthesis

The AENV groundwater database is the main source of groundwater data. The database includes the following:

1) water well drilling reports
2) aquifer test results from some water wells
3) location of some springs
4) water well locations determined during water well surveys
6) chemical analyses for some groundwaters
7) location of some flowing shot holes
8) location of structure test holes
9) a variety of data related to the groundwater resource.

The main disadvantage to the database is the absence of quality control. Very little can be done to overcome this lack of quality control in the data collection, other than to assess the usefulness of control points relative to other data during the interpretation. Another disadvantage to the database is the lack of adequate spatial information. Any duplicate water wells that have been identified within the County have been removed from the database used in this regional groundwater assessment.

The AENV groundwater database uses a land-based system with only a limited number of records having a value for ground elevation. The locations for records usually include a quarter section description; a few records also have a land description that includes a Legal Subdivision (Lsd). For digital processing, a record location requires a horizontal coordinate system. In the absence of an actual location for a record, the record is given the coordinates for the centre of the land description.

The present project uses the 10TM coordinate system. This means that a record for the NW ¼ of section 33, township 051, range 22, W4M, would have a horizontal coordinate with an Easting of 120,151 metres and a Northing of 5,921,280 metres, the centre of the quarter section. If the water well has been repositioned by PFRA using orthorectified aerial photos, the location will be more accurate, possibly within several tens of metres of the actual location. Once the horizontal coordinates are determined for a record, a ground elevation for that record is obtained from the 1:20,000 Digital Elevation Model (DEM); AltaLis Ltd. provides the DEM.

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 at a given location.

After assigning spatial control for the ground location for the records in the groundwater database, the data are processed to determine values for hydrogeological parameters**.** As part of the processing, obvious keying errors in the database are corrected.

Where possible, determinations are made from individual records for the following:

1) depth to bedrock
2) total thickness of sand and gravel
3) total thickness of saturated sand and gravel
4) depth to the top and bottom of completion intervals.

Also, where sufficient information is available, values for apparent transmissivity[7] and apparent yield[8] are calculated, based on the aquifer test summary data supplied on the water well drilling reports. Where valid detailed aquifer test results exist, the interpreted data provide values for aquifer transmissivity and effective transmissivity. Since the last regional hydrogeological map covering the majority of the County was published in 1976 (Stein, 1976), 1,093 values for apparent transmissivity and 754 values for apparent yield have been added to the groundwater database. With the addition of the apparent yield values, a hydrogeological map has been prepared to help illustrate the general groundwater availability across the County. The anticipated groundwater apparent yield is based on the expected yield of a single water well obtaining water from the total accessible stratigraphic section.

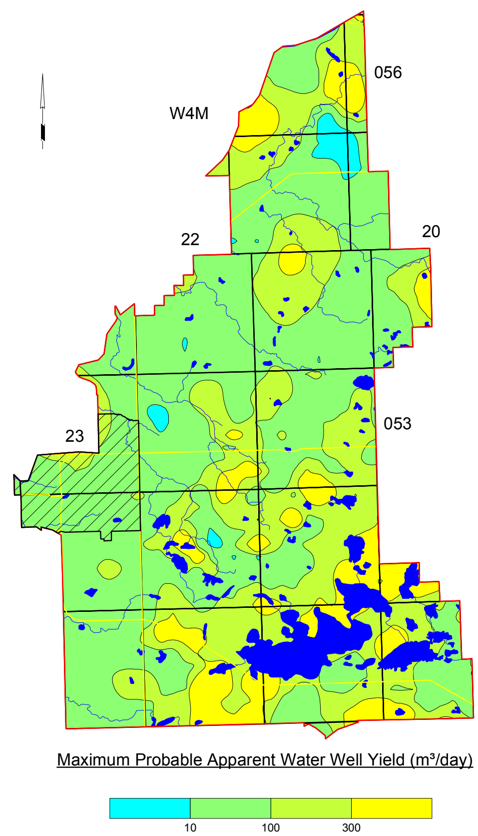


Figure 7. Hydrogeological Map

The EUB well database includes records for all of the wells drilled by the oil and gas industry. The information from this source includes:

1) spatial control for each well site
2) depth to the top of various geologic units
3) type and intervals for various down-hole geophysical logs
4) drill stem test (DST) summaries.

Values for apparent transmissivity, apparent yield and hydraulic conductivity are calculated from the DST summaries.

Published and unpublished reports and maps provide the final source of information to be included in the new groundwater database. The reference section of this report lists the available reports. The only digital data from publications are from the Geological Atlas of the Western Canada Sedimentary Basin (Mossop and Shetsen, 1994). These data are used to support the geological interpretation of geophysical logs but cannot be distributed because of a licensing agreement.

7 For definitions of Transmissivity, see glossary
8 For definitions of Yield, see glossary

4.2 Spatial Distribution of Aquifers

Determination of the spatial distribution of the aquifers is based on:

1) lithologs provided by the water well drillers
2) geophysical logs from structure test holes
3) geophysical logs for wells drilled by the oil and gas industry
4) data from existing cross-sections.

The aquifers are defined by mapping the tops and bottoms of individual geologic units. The values for the elevation of the top and bottom of individual geologic units at specific locations help to determine the spatial distribution of the individual surfaces. Establishment of a surface distribution digitally requires preparation of a grid. The inconsistent quality of the data necessitates creating a representative sample set obtained from the entire data set. If the data set is large enough, it can be treated as a normal population and the removal of extreme values can be done statistically. When data sets are small, the process of data reduction involves a more direct assessment of the quality of individual points. Because of the uneven distribution of the data, all data sets are gridded using the Kriging method.

The final definition of the individual surfaces becomes an iterative process involving the plotting of the surfaces on cross-sections and the adjusting of control points to fit with the surrounding data.

4.3 Hydrogeological Parameters

Water well records that indicate the depths to the top and bottom of their completion interval are compared digitally to the spatial distribution of the various geological surfaces. This procedure allows for the determination of the aquifer in which individual water wells are completed. When the completion interval of a water well cannot be established unequivocally, the data from that water well are not used in determining the distribution of hydraulic parameters.

After the water wells are assigned to a specific aquifer, the parameters from the water well records are assigned to the individual aquifers. The parameters include non-pumping (static) water level (NPWL), apparent transmissivity, and apparent water well yield if neither aquifer nor effective values are available. The total dissolved solids, sulfate and chloride concentrations from the chemical analysis of the groundwater are also assigned to applicable aquifers. In addition, chemical parameters of nitrate + nitrite (as N) are assigned to surficial aquifers and fluoride is assigned to upper bedrock aquifer(s). Since 1986, Alberta Health and Wellness has restricted access to chemical analysis data, and hence the database includes only limited amounts of chemical data since 1986.

Once the values for the various parameters of the individual aquifers are established, the spatial distribution of these parameters must be determined. The distribution of individual parameters involves the same process as the distribution of geological surfaces. This means establishing a representative data set and then preparing a grid. Even when only limited data are available, grids are prepared. However, the grids prepared from the limited data must be used with extreme caution because the gridding process can be unreliable.

4.4 Maps and Cross-Sections

Once grids for geological surfaces have been prepared, various grids need to be combined to establish the extent and thickness of individual geologic units. For example, the relationship between an upper bedrock unit and the bedrock surface must be determined. This process provides both the outline and the thickness of the geologic unit.

Once the appropriate grids are available, the maps are prepared by contouring the grids. The areal extent of individual parameters is outlined by “masks” to delineate individual aquifers. For the upper bedrock aquifer(s) where areas of no data are available from the groundwater database, prepared maps have been masked with a solid brown color to indicate these areas. These brown masks have been added to the Bearpaw and Oldman aquifers. Appendix A includes page-size maps from the text, plus additional page-size maps and figures that support the discussion in the text. A list of maps and figures that are included on the CD-ROM is given in Appendix B.

Cross-sections are prepared by first choosing control points from the database along preferred lines of section. Data from these control points are then obtained from the database and placed in an AutoCAD drawing with an appropriate vertical exaggeration. The data placed in the AutoCAD drawing include the geo-referenced lithology, completion intervals and NPWLs. Data from individual geologic units are then transferred to the cross-section from the digitally prepared surfaces.

Once the technical details of a cross-section are correct, the drawing file is moved to the software package CorelDraw! for simplification and presentation in a hard-copy form. Three cross-sections are presented in this report and as poster-size drawings forwarded with this report. The cross-sections are also included in Appendix A, and are included on the CD-ROM; page-size maps of the poster-size cross-sections are included in Appendix D of this report.

4.5 Software

The files on the CD-ROM have been generated from the following software:

- Acrobat 4.0
- ArcView 3.2
- AutoCAD 2000
- CorelDraw! 10.0
- Microsoft Professional Office 2000
- Surfer 7.0

5. Aquifers

5.1 Background

An aquifer is a porous and permeable rock that is saturated. If the NPWL is above the top of the rock unit, this type of aquifer is an artesian aquifer. If the rock unit is not entirely saturated and the water level is below the top of the unit, this type of aquifer is a water-table aquifer. These types of aquifers occur in one of two general geological settings in the County. The first geological setting includes the sediments that overlie the bedrock surface. In this report, these are referred to as the surficial deposits. The second geological setting includes aquifers in the upper bedrock. The geological settings, the nature of the deposits making up the aquifers within each setting, the expected yield of water wells completed in aquifer(s) within different geologic units, and the general chemical quality of the groundwater associated with each setting are reviewed separately.

5.1.1 Surficial Aquifers

Surficial deposits in the County are mainly less than 30 metres thick, except in areas of linear bedrock lows where the thickness of the surficial deposits can exceed 40 metres. The Buried Beverly Valley is the main linear bedrock low in the County; this Valley has a southwest-northeast trend. The south-north cross-section A-A', shown below, passes across the Buried Beverly Valley and shows the surficial deposits being up to 50 metres thick within the Valley.

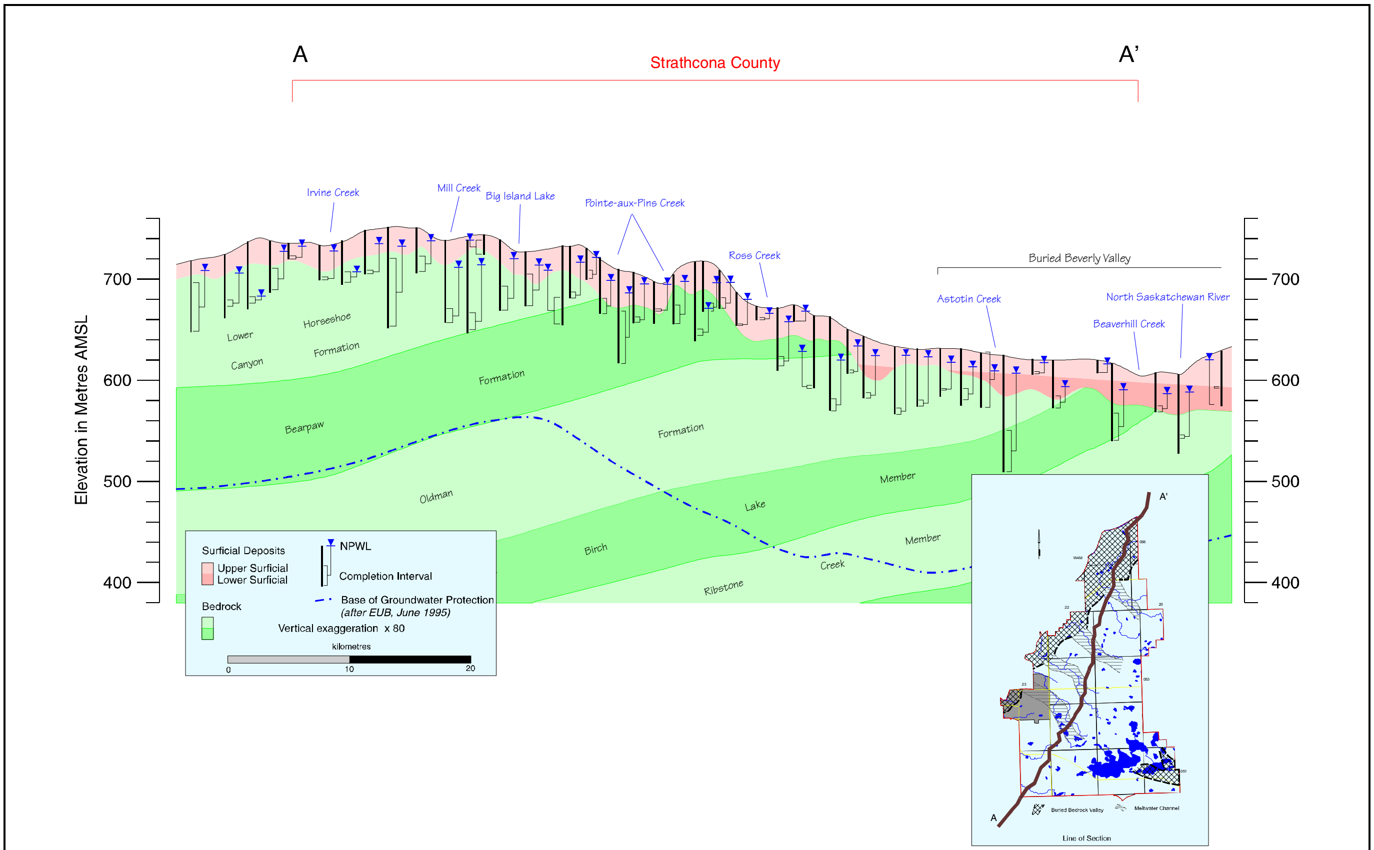


Figure 8. Cross-Section A - A'

The main aquifers in the surficial materials are sand and gravel deposits. In order for a sand and gravel deposit to be an aquifer, it must be saturated; if not saturated, a sand and gravel deposit is not an aquifer. The top of the surficial aquifers has been determined from the NPWL in water wells that are less than 20 metres deep. The base of the surficial deposits is the bedrock surface.

For a water well with a small-diameter casing to be effective in surficial deposits and to provide sand-free groundwater, the water well must be completed with a water well screen. Some water wells completed in the surficial deposits are completed in low-permeability aquifers and have a large-diameter casing. The large-diameter water wells may have been hand dug or bored and because they are completed in very low permeability aquifers, most of these water wells would not benefit from water well screens. The groundwater from an aquifer in the surficial deposits usually has a chemical hardness of at least a few hundred mg/L and a dissolved iron concentration such that the groundwater must be treated before being used for domestic needs. Within the County, casing-diameter information is available for 436 of the 509 water wells completed in the surficial deposits; 20 percent of these have a casing diameter of more than 275 millimetres, and are assumed to be bored or dug water wells.

5.1.2 Bedrock Aquifers

In the County, the upper bedrock includes the Lower Horseshoe Canyon, Bearpaw and Oldman formations, and the Birch Lake Member equivalent of the Foremost Formation. Cross-section B-B’ (Figure 9) shows that the upper bedrock includes rocks that are mainly less than 200 metres below the bedrock surface. Some of this bedrock contains saturated rocks that are permeable enough to transmit groundwater for a specific need. Water wells completed in bedrock aquifers usually do not require water well screens, although some of the sandstones may be friable[9] and water well screens are a necessity. The groundwater from the bedrock aquifers is usually chemically soft.

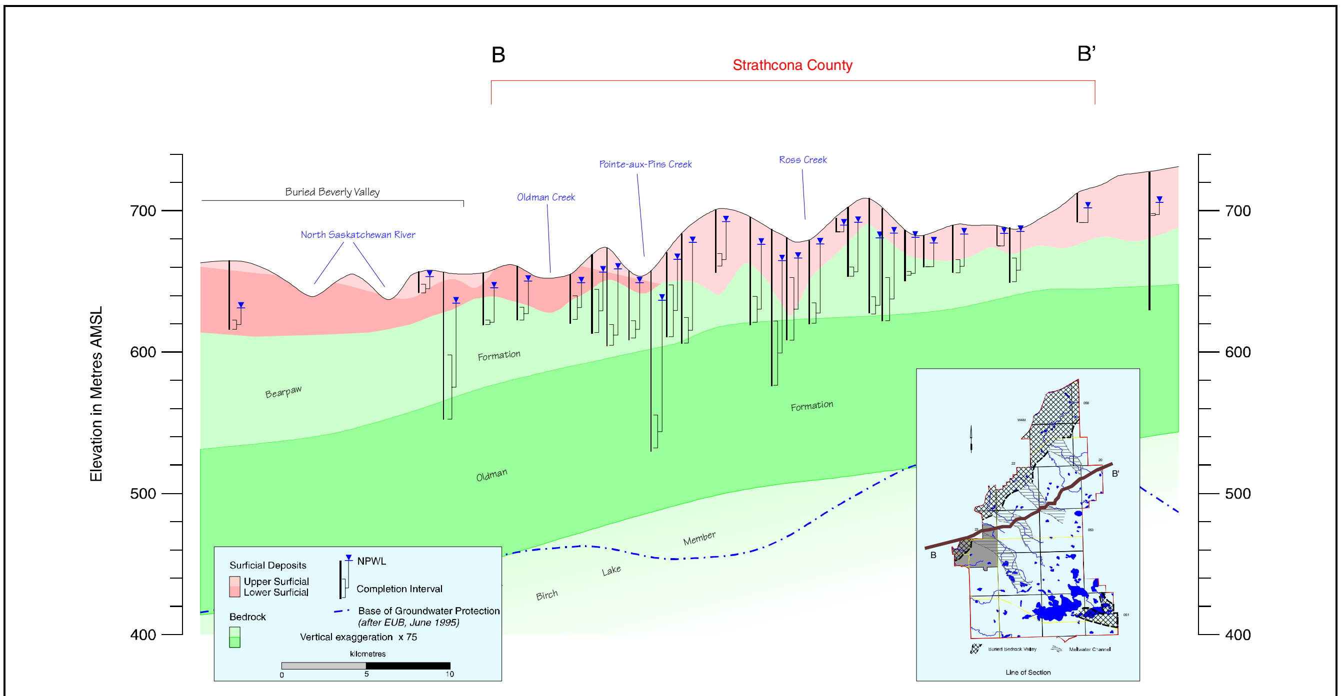


Figure 9. Cross-Section B - B'

The data for 2,234 water wells show that the top of the water well completion interval is below the bedrock surface, indicating that the water wells are completed in at least one bedrock aquifer. Within the County, casing-diameter information is available for 1,938 of the 2,234 water wells completed below the top of bedrock. Of these 1,938 water wells, 98% have surface-casing diameters of less than 275 mm and these bedrock water wells have been mainly completed with either a perforated liner or as open hole; there are 67 bedrock water wells completed with a water well screen.

[9] See glossary

5.2 Aquifers in Surficial Deposits

The surficial deposits are the sediments above the bedrock surface. These include pre-glacial materials, which were deposited before glaciation, and materials deposited directly or indirectly as a result of glaciation. The *lower surficial deposits* include pre-glacial fluvial[10] and lacustrine[11] deposits. The lacustrine deposits include clay, silt and fine-grained sand. The *upper surficial deposits* include the more traditional glacial deposits of till[12] and meltwater deposits. In the County, pre-glacial materials are expected to be mainly present in association with the Buried Beverly Valley.

5.2.1 Geological Characteristics of Surficial Deposits

While the surficial deposits are treated as one hydrogeologic unit, they consist of three hydraulic parts. The first unit is the sand and gravel deposits of the lower surficial deposits, when present. These deposits are mainly saturated, where present. The second and third hydraulic units are associated with the sand and gravel deposits in the upper surficial deposits. The sand and gravel deposits in the upper surficial deposits occur mainly as pockets. The second hydraulic unit is the saturated part of these sand and gravel deposits; the third hydraulic unit is the unsaturated part of these deposits. For a graphical depiction of the above description, please refer to Figure 5, Page 8. While the unsaturated deposits are not technically an aquifer, they are significant as they provide a pathway for liquid contaminants to move downward into the groundwater.

The base of the surficial deposits is the bedrock surface, represented by the bedrock topography as shown on the adjacent map.

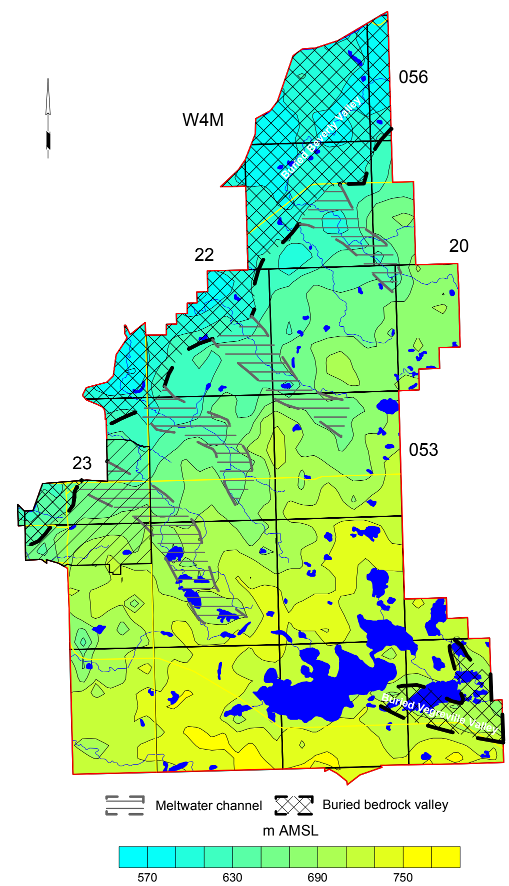


Figure 10. Bedrock Topography

Over the majority of the County, the surficial deposits are less than 30 metres thick (page A-15). The exceptions are mainly in association with areas where buried bedrock valleys are present, where the deposits can have a maximum thickness of close to 50 metres. The main linear bedrock low in the County is a southwest-northeast-trending bedrock low that has been designated as the Buried Beverly Valley, as shown on Figure 10.

The Buried Beverly Valley is present in the northern part of the County, and mainly parallels the present-day North Saskatchewan River. The Valley is four to ten kilometres wide within the County, with local bedrock relief being up to 60 metres. Sand and gravel deposits can be expected in association with this bedrock low, but the thickness of the sand and gravel deposits is expected to be mainly less than 15 metres.

The Buried Vegreville Valley is present in the southeastern part of the County but is not well defined based on the bedrock topography contours. The Buried Vegreville Valley, a southwest-northeast-trending linear bedrock low in Beaver County, joins the Buried Beverly Valley in the County of St. Paul. Within Strathcona County, the Buried Vegreville Valley is three to four kilometres wide, with local bedrock relief being less than 40 metres. Sand and gravel deposits can be

[10] See glossary
[11] See glossary
[12] See glossary

expected in association with this bedrock low, but the thickness of sand and gravel deposits is expected to be mainly less than ten metres. Hastings Lake in township 51, range 20, W4M is present in the area where the Buried Vegreville Valley appears to be present.

Another prominent bedrock feature in the County is the Cooking Lake Divide, which is a regional preglacial feature (Carlson, 1967). This Divide is a general northeast-southwest-trending feature which, according to Carlson (1967), “enters the Edmonton district in Tp 049, R 22, W4M, skirts around the western shore of Cooking Lake, and leaves the study area in Tp 052, R 21, W4M”. In Carlson’s report, it is suggested that the Divide is so prominent that the “Ministik, Joseph, Cooking and Oliver lakes are all located in the drowned headwaters of preglacial valleys that extended down the eastern flank of the Cooking Lake Divide”.

The lower surficial deposits are composed mostly of fluvial and lacustrine deposits. Lower surficial deposits occur mainly in the Buried Beverly Valley. The total thickness of the lower surficial deposits is mainly less than 30 metres, but can be more than 30 metres in the buried bedrock valleys. The lowest part of the lower surficial deposits includes pre-glacial sand and gravel deposits. These deposits would generally be expected to directly overlie the bedrock surface in the Buried Beverly Valley. The lowest sand and gravel deposits are of fluvial origin, are usually less than five metres thick and may be discontinuous.

In the County, there are four linear bedrock lows that trend mainly northwest to southeast and are indicated as being of meltwater origin. Because sediments associated with the lower surficial deposits are indicated as being present in these linear bedrock lows, it is possible that the bedrock lows were originally tributaries to the Buried Beverly Valley as shown in the bedrock topography map on Figure 10.

The upper surficial deposits are either directly or indirectly a result of glacial activity. The deposits include till, with minor sand and gravel deposits of meltwater origin, which are expected to occur mainly as isolated pockets. The thickness of the upper surficial deposits is mainly less than 30 metres, but can be more than 30 metres in the meltwater channels and in the Buried Vegreville Valley.

Sand and gravel deposits can occur throughout the surficial deposits. The total thickness of sand and gravel deposits is generally less than ten metres but can be more than 15 metres in the Buried Beverly Valley.

The combined thickness of all sand and gravel deposits has been determined as a function of the total thickness of the surficial deposits (Figure 11). Over approximately 20% of the County, the sand and gravel deposits are more than 30% of the total thickness of the surficial deposits (page A-17). The areas where sand and gravel deposits constitute more than 30% of the total thickness of the surficial deposits are mainly in the areas of the buried bedrock valleys and meltwater channels.

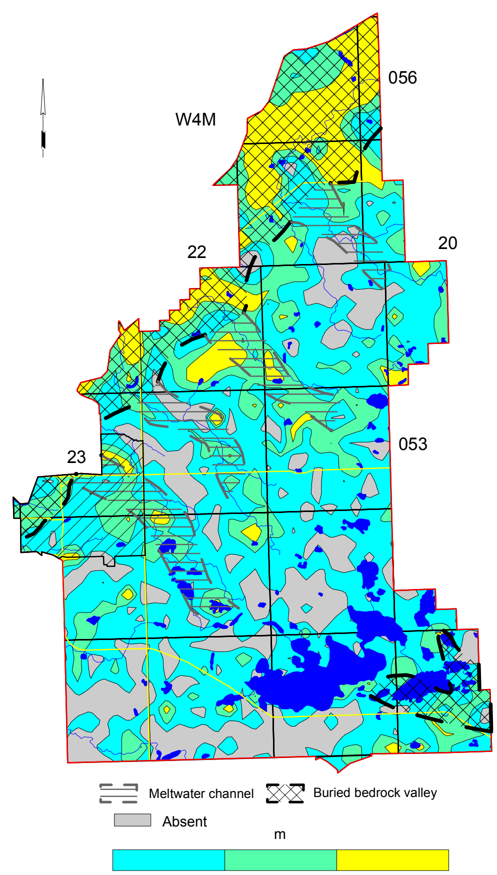


Figure 11. Thickness of Sand and Gravel Deposits

5.2.2 Sand and Gravel Aquifer(s)

One source of groundwater in the County includes aquifers in the surficial deposits. Since the sand and gravel aquifer(s) are not everywhere, the actual aquifer that is developed at a given location is usually dictated by the aquifer that is present. In the County, the thickness of the sand and gravel aquifer(s) is generally less than five metres, but can be more than ten metres in the vicinity of the Buried Beverly Valley (page A-19).

From the present hydrogeological analysis, 2,016 water wells are completed in aquifers in the surficial deposits. Of the 2,016 water wells, 1,885 are completed in aquifers in the upper surficial deposits and 131 are completed in aquifers in the lower surficial deposits. This number of water wells is nearly four times the number (509) determined to be completed in aquifers in the surficial deposits, based on lithologies given on the water well drilling reports. The larger number is obtained by comparing the elevation of the reported depth of a water well to the elevation of the bedrock surface at the same location. For example, if only the depth of a water well is known, the elevation of the completed depth can be calculated. If the elevation of the completed depth is above the elevation of the bedrock surface determined from the gridded bedrock topographic surface at the same location, then the water well is considered to be completed in an aquifer in the surficial deposits.

Water wells completed in the upper surficial deposits occur throughout the County. In the area underlain by the Buried Beverly Valley, there are a large number of water wells completed in the lower surficial deposits (Figure 12).

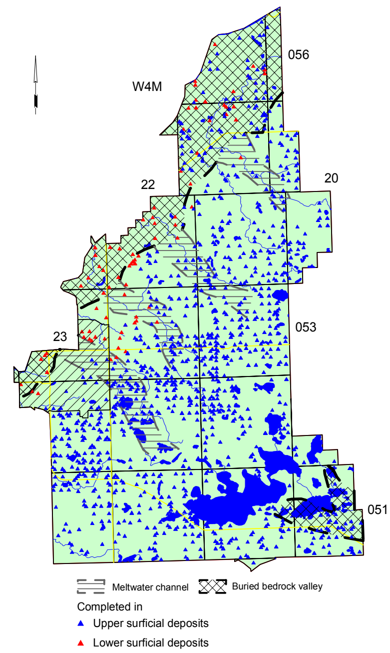


Figure 12. Water Wells Completed in Surficial Deposits

The map to the left shows expected yields for water wells completed in sand and gravel aquifers(s). Over approximately 25% of the County, the sand and gravel deposits are not present, or if present, are not saturated.

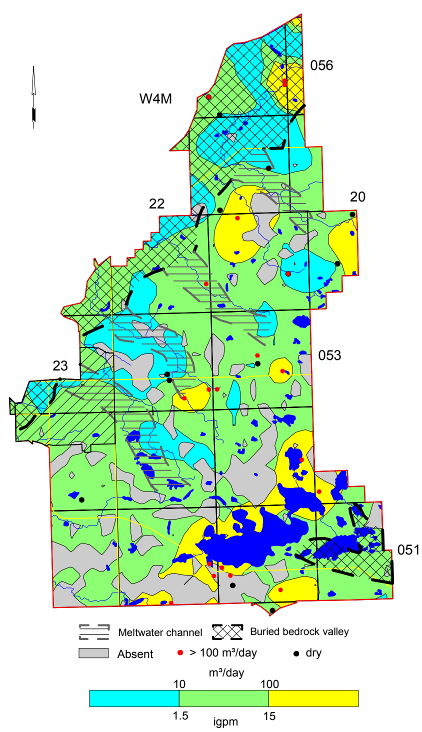


Figure 13. Apparent Yield for Water Wells Completed in Sand and Gravel Aquifer(s)

Based on the aquifers that have been developed by existing water wells, these data show that water wells with yields of more than 100 m³/day from sand and gravel aquifer(s) can be expected in several areas of the County. The most notable areas where yields of more than 100 m³/day are expected are near Cooking Lake and in association with the main linear bedrock lows. Higher yields could be a result of the gridding procedure used to process a limited number of data points. In addition to the 103 records for surficial water wells with apparent yield data, there are 14 records that indicate dry or abandoned with “insufficient water”. In order to depict a more accurate yield map, an apparent yield of 0.1 m³/day was assigned to the 14 dry holes prior to gridding. Also included in these postings is any record that includes comments that state the water well goes dry in dry years.

5.2.2.1 Chemical Quality of Groundwater from Surficial Deposits

The chemical analysis results of groundwaters from the sand and gravel aquifers in the surficial deposits indicate the groundwaters are generally chemically hard and high in dissolved iron. In Strathcona County, groundwaters from the surficial aquifers mainly have a chemical hardness of greater than 200 mg/L (see CD-ROM).

The Piper tri-linear diagrams[13] (page A-26) show the groundwaters from the surficial deposits have no dominant cation or anion ranging from calcium-magnesium-bicarbonate or calcium-magnesium-sulfate to sodium-bicarbonate or sodium-sulfate-type waters. The records with the sodium-bicarbonate waters were individually checked in the database to confirm the completion aquifer. Ninety percent of the groundwaters have a TDS concentration of more than 500 mg/L. The groundwaters with a TDS concentration of less than 500 mg/L occur mainly in association with the Buried Beverly Valley, as shown on Figure 14. Sixty percent of the groundwaters from the surficial deposits are reported to have dissolved iron concentrations of less than one mg/L. However, many iron analysis results are questionable due to varying sampling methodologies.

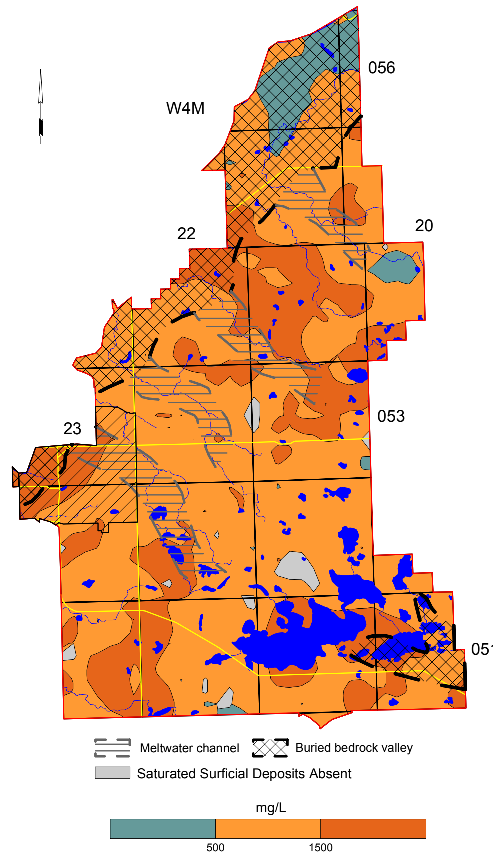


Figure 14. Total Dissolved Solids in Groundwater from Surficial Deposits

There are groundwaters with sulfate as the main anion. The groundwaters with elevated levels of sulfate generally occur in areas where there are elevated levels of total dissolved solids. There are very few groundwaters from the surficial deposits with appreciable concentrations of the chloride ion and in 95% of the samples analyzed in the County, the chloride ion concentration is less than 100 mg/L. Groundwaters with a chloride concentration of more than the GCDWQ (250 mg/L) have been posted on the chloride map (see CD-ROM).

Constituent	Range for County in mg/L Minimum	Maximum	Average	Recommended Maximum Concentration GCDWQ
Total Dissolved Solids	203	5250	1164	500
Sodium	<9	1348	219	200
Sulfate	0	1680	324	500
Chloride	0	1014	24	250
Nitrate + Nitrite (as N)	<0.01	610	2.9	10

Concentration in milligrams per litre unless otherwise stated
Note: indicated concentrations are for Aesthetic Objectives except for Nitrate + Nitrite (as N), which is for Maximum Acceptable Concentration (MAC)
GCDWQ - Guidelines for Canadian Drinking Water Quality, Sixth Edition Minister of Supply and Services Canada, 1996

Table 3. Concentrations of Constituents in Groundwaters from Surficial Aquifers

In the County, the nitrate + nitrite (as N) concentrations in the groundwaters from the surficial deposits exceed the maximum acceptable concentrations (MAC) of 10 mg/L in six percent of the samples. Groundwaters with a nitrate + nitrite (as N) concentration exceeding the GCDWQ (10 mg/L) have been posted on the nitrate + nitrite (as N) map (see CD-ROM).

The minimum, maximum and average concentrations of TDS, sodium, sulfate, chloride and nitrate + nitrite (as N) in the groundwaters from water wells completed in the surficial deposits in the County have been compared to the GCDWQ in the adjacent table. Of the five constituents that have been compared to the GCDWQ, the average values of TDS and sodium concentrations exceed the guidelines.

[13] See glossary

5.2.3 Upper Sand and Gravel Aquifer

The Upper Sand and Gravel Aquifer includes saturated sand and gravel deposits in the upper surficial deposits. Typically, these aquifers are present within the surficial deposits at no particular depth. Saturated sand and gravel deposits are not continuous but are expected over approximately 70% of the County.

5.2.3.1 Aquifer Thickness

The thickness of the Upper Sand and Gravel Aquifer is a function of two parameters: (1) the elevation of the non-pumping water-level surface associated with the surficial deposits; and (2) the depth to the bedrock surface or depth to top of lower surficial deposits when present. In the County, the thickness of the Upper Sand and Gravel Aquifer is generally less than five metres, but can be more than ten metres in the vicinity of the linear bedrock lows (see CD-ROM).

5.2.3.2 Apparent Yield

The permeability of the Upper Sand and Gravel Aquifer can be high. The high permeability combined with significant thickness leads to an extrapolation of high yields for water wells; however, because the sand and gravel deposits occur mainly as hydraulically discontinuous pockets, the apparent yields of the water wells are limited. The apparent yields for water wells completed through this Aquifer are expected to be mainly between 10 and 100 m³/day, except adjacent to parts of the Buried Beverly Valley, meltwater channels, and Cooking Lake as shown on Figure 15. Higher yields present in the eastern part of the County could be a result of the gridding procedure used to process a limited number of data points. In addition to the 75 records for Upper Sand and Gravel Aquifer water wells with apparent yield data, there are 11 records that indicate dry or abandoned surficial water wells with “insufficient water”. In order to depict a more accurate yield map, an apparent yield of 0.1 m³/day was assigned to the 11 dry holes prior to gridding.

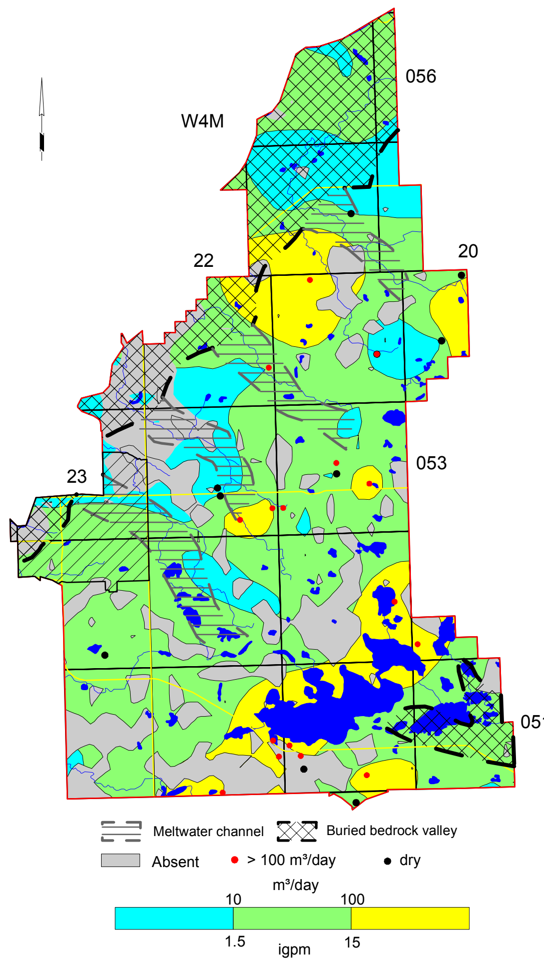


Figure 15. Apparent Yield for Water Wells Completed through Upper Sand and Gravel Aquifer

Where the Upper Sand and Gravel Aquifer is absent and where the yields are low, the development of water wells for the domestic needs of single families may not be possible from these Aquifer(s), and construction of a water supply well into the underlying bedrock may be the only alternative, provided yields and quality of groundwater from the bedrock aquifers are suitable.

In the County, there are nine licensed water wells that are completed through the Upper Sand and Gravel Aquifer, with a total authorized diversion of 302 m³/day. The highest allocation of 270 m³/day is for a water well in SW 16-056-21 W4M used for dewatering purposes.

5.2.4 Lower Sand and Gravel Aquifer

The Lower Sand and Gravel Aquifer is a saturated sand and gravel deposit that occurs at or near the base of the surficial deposits in the deepest part of the pre-glacial linear bedrock lows. The top of the lower surficial deposits is based on more than 1,000 control points across Alberta. In the County, there are twelve control points provided by Allong (1967) and Sham (1984a).

5.2.4.1 Aquifer Thickness

The thickness of the Lower Sand and Gravel Aquifer is mainly less than five metres, but can be more than 15 metres in the Buried Beverly Valley (see CD-ROM).

5.2.4.2 Apparent Yield

Apparent yields for water wells completed in the Lower Sand and Gravel Aquifer range from less than 10 m³/day to more than 100 m³/day. The highest yields are expected in the Buried Beverly Valley in the northeastern part of the County.

In the County, there are nine licensed water wells that are completed through the Lower Sand and Gravel Aquifer, for a total authorized diversion of 12,048 m^3/day. Eight of the nine licensed water wells are authorized to be used for dewatering purposes; the ninth is for commercial purposes.

None of the nine licensed water wells completed through the Lower Sand and Gravel Aquifer could be linked to a water well in the AENV groundwater database.

A detailed study (Hydrogeological Consultants Ltd. (HCL), 1976b) conducted for the Village of Bruderheim, northeast of the County, determined that a water supply well located within the Buried Beverly Valley in township 056, range 21, W4M had a long-term yield of more than 1,000 m³/day.

The groundwater from this water supply well for the Village of Bruderheim (HCL, 1976b) had a TDS concentration of more than 1,000 mg/L, a sulfate concentration of 225 mg/L, a chloride concentration of 16 mg/L, and an iron concentration of more than seven mg/L. Nitrate + nitrite (as N) analytical results were not available.

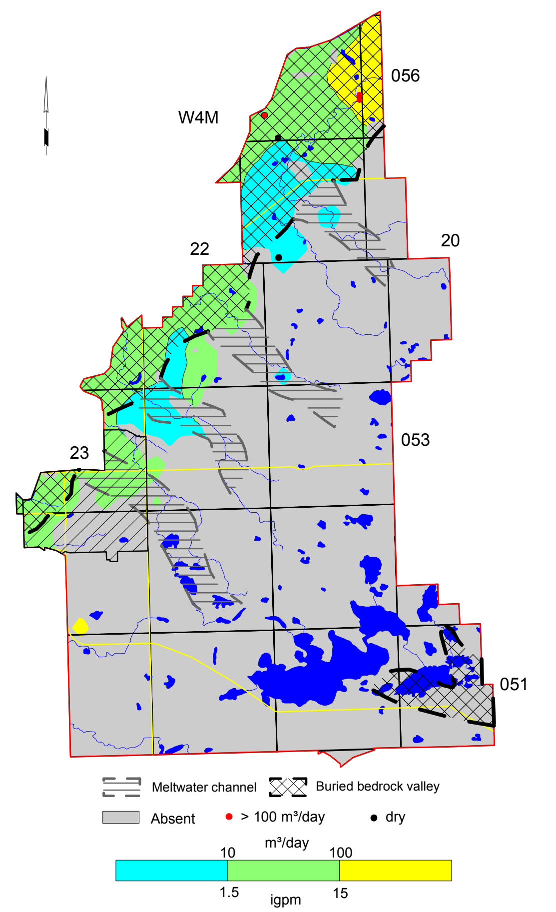


Figure 16. Apparent Yield for Water Wells Completed through Lower Sand and Gravel Aquifer

5.3 Bedrock

5.3.1 Geological Characteristics

The upper bedrock in the County includes the Edmonton Group, the Bearpaw Formation and the Belly River Group. The Edmonton Group in the County includes only the Lower Horseshoe Canyon Formation. The Belly River Group subcrop in the County includes the Oldman Formation and the Birch Lake Member of the Foremost Formation. The adjacent bedrock geology map, showing the subcrop of different geological units, has been prepared in part from the interpretation of geophysical logs related to oil and gas activity. A generalized geologic column is illustrated in Figure 6, in Appendix A and on the CD-ROM.

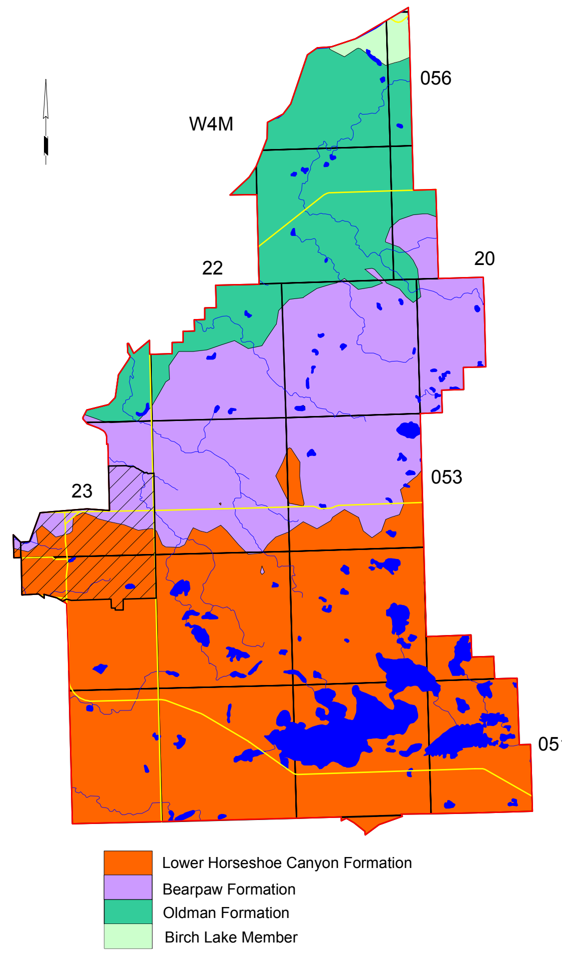


Figure 17. Bedrock Geology

The Horseshoe Canyon Formation is the lower part of the Edmonton Group. The Horseshoe Canyon Formation has a maximum thickness of 350 metres and has three separate units: Upper, Middle and Lower. The Lower Horseshoe Canyon, which can be up to 170 metres thick, is less than 130 metres thick within the County and is the upper bedrock in the southern half of the County.

The Horseshoe Canyon Formation consists of deltaic[14] and fluvial sandstone, siltstone and shale with interbedded coal seams, bentonite and thin nodular beds of limestone and ironstone. Because of the low-energy environment in which deposition occurred, the sandstone, when present, tends to be finer grained. The lower 60 to 70 metres and the upper 30 to 50 metres of the Horseshoe Canyon Formation can include coarser grained sandstone deposits. In the County, the main aquifers are fractured coal seams. If the coal layers are not fractured, the main aquifers are clayey and/or bentonitic sandstones.

The Bearpaw Formation underlies the Horseshoe Canyon Formation, is in the order of 80 to 100 metres thick and is the upper bedrock in the north-central part of the County. The Bearpaw Formation includes transgressive, shallow marine (shoreface) and open marine facies[15] deposits.

The Belly River Group includes the Oldman Formation and the Birch Lake, Ribstone Creek, Victoria and Brosseau members of the Foremost Formation. The Foremost Formation includes the continental facies within the County. The Belly River Group in the County has a maximum thickness of 200 metres. In the County, only the Oldman Formation and the Birch Lake Member are present as the upper bedrock.

The Oldman Formation is present as the upper bedrock in most of the northern part of the County and has a maximum thickness of 120 metres. The Oldman Formation is composed of continental deposits, sandstone, siltstone, shale and coal. The Oldman Formation is the upper part of the Belly River Group and is composed of three parts: the Comrey Member, the Upper Siltstone and the Dinosaur Member.

[14] See glossary
[15] See glossary

The *continental* Foremost Formation has been eroded in most of the County and subcrops in the extreme northern part of the County. The *continental* Foremost Formation is less than 160 metres thick and is between the overlying Oldman Formation and the underlying Lea Park Formation. In the *continental* Formation, individual members have been identified. The members include both sandstone and shale units. Coal zones occur within the *continental* Foremost Formation, with the main ones referred to as the McKay and the Taber Coal zones. There are also minor amounts of ironstone, a chemical deposit. For the present project, the individual members are identified by the designation given to the sandstone members associated with the marine facies, with the underlying shale member being considered as the shale facies of the member. For example, in this report the Birch Lake Member includes the Birch Lake Member (a sandstone deposit, or its equivalent) and the underlying shale deposit. The Taber Coal Zone is associated with the Birch Lake Member. Eastward, the sandstone layers of individual members grade into marine deposits.

The present breakdown of the Foremost Formation would not be possible without identifying a continuous top for the Lea Park Formation. The top of the Lea Park Formation represents a geologic time border between the marine environment of the Lea Park Formation and the mostly continental environment of the Foremost Formation.

The top of the Lea Park Formation is the bottom of the higher resistivity layer that occurs within a few metres below a regionally identifiable bentonite marker, as shown in the adjacent e-log. This marker occurs approximately 100 metres above the Milk River Shoulder.

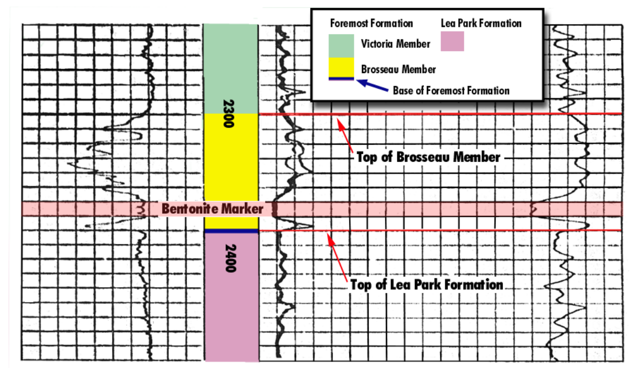


Figure 18. E-Log showing Base of Foremost Formation

In the southern part of the County, the Base of Groundwater Protection is below the Bearpaw Formation, and in the northern part of the County, the Base of Groundwater Protection is below the Birch Lake Member. A map showing the depth to the Base of Groundwater Protection is given on page 7 of this report, in Appendix A, and on the CD-ROM.

5.3.2 Aquifers

Of the 9,029 water wells in the database, 2,234 were defined as being completed below the top of bedrock and 509 completed in surficial aquifers. However, at least a reported completion depth is available for the majority of the remaining 6,286 water wells. Assigning the water well to specific geologic units is possible only if the completion interval is identified. In order to make use of additional information within the groundwater database, it was assumed that if the total drilled depth of a water well was more than ten metres below the top of a particular geologic unit, the water well was assigned to the particular geologic unit. With this assumption, it has been possible to designate the aquifer of completion for 2,978 additional water wells for a total of 5,212 water wells. The remaining 876 of the total 6,088 water wells are identified as being completed in more than one bedrock aquifer.

Geologic Unit	No. of Bedrock Water Wells
Lower Horseshoe Canyon	4,103
Bearpaw	839
Oldman	259
Other	11
Multiple Completions	876
Total	6,088

Table 4. Completion Aquifer

The bedrock water wells are mainly completed in the Lower Horseshoe Canyon Aquifer, as shown in the above table.

There are 664 records for bedrock water wells that have apparent yield values, which is 11% of all bedrock water wells. In the County, yields for water wells completed in the upper bedrock aquifer(s) are mainly between 10 and 100 m³/day. Some of the areas with yields of more than 100 m³/day indicated on the adjacent figure are mainly in the southern half of the County. These higher yield areas may identify areas of increased permeability resulting from the weathering process. In addition to the 664 records for bedrock water wells, there are 57 records that indicate dry, or abandoned with "insufficient water". In order to depict a more accurate yield map, an apparent yield of 0.1 m³/day was assigned to the 57 dry holes prior to gridding. Also included in these postings is any record that includes comments that state the water well goes dry in dry years.

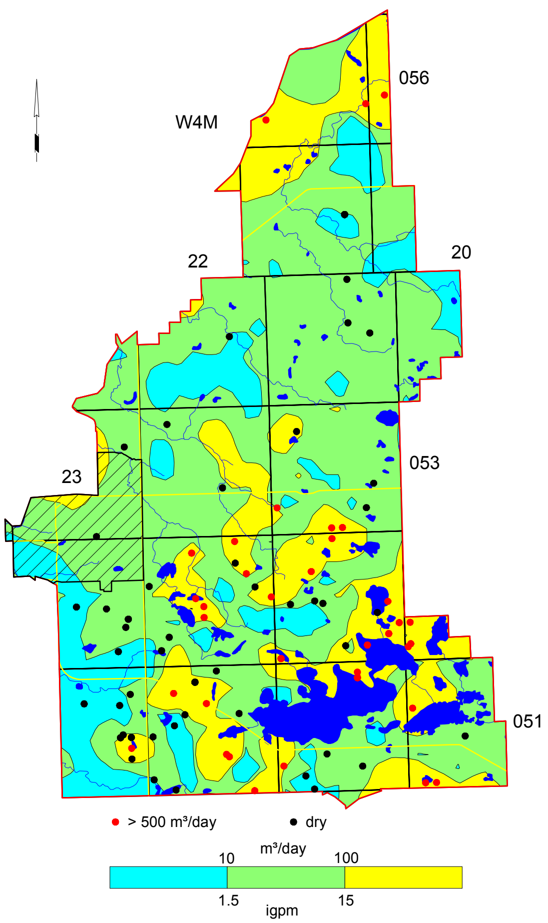


Figure 19. Apparent Yield for Water Wells Completed in Upper Bedrock Aquifer(s)

Of the 664 water well records with apparent yield values, 644 have been assigned to aquifers associated with specific geologic units. Fifty-one percent (339) of the 644 water wells completed in the bedrock aquifers have apparent yields that range from 10 to 100 m³/day, 32% (210) have apparent yield values that are less than 10 m³/day, and 17% (115) have apparent yields that are greater than 100 m³/day, as shown in the adjacent table.

Aquifer	No. of Water Wells with Values for Apparent Yield	Number of Water Wells with Apparent Yields <10 m³/day	10 to 100 m³/day	>100 m³/day
Lower Horseshoe Canyon	473	145	232	96
Bearpaw	114	32	67	15
Oldman	55	19	32	4
Other	2	2	0	0
Multiple Completions	20	12	8	0
Totals	664	210	339	115

Table 5. Apparent Yields of Bedrock Aquifers

5.3.3 Chemical Quality of Groundwater

The TDS concentrations in the groundwaters from the upper bedrock aquifer(s) range from less than 500 to more than 3,000 mg/L. In approximately 25% of the area, TDS values are more than 1,500 mg/L, with one small area in the Buried Beverly Valley having a TDS concentration of less than 500 mg/L. The lower TDS concentration may be a result of more active flow systems and shorter flow paths.

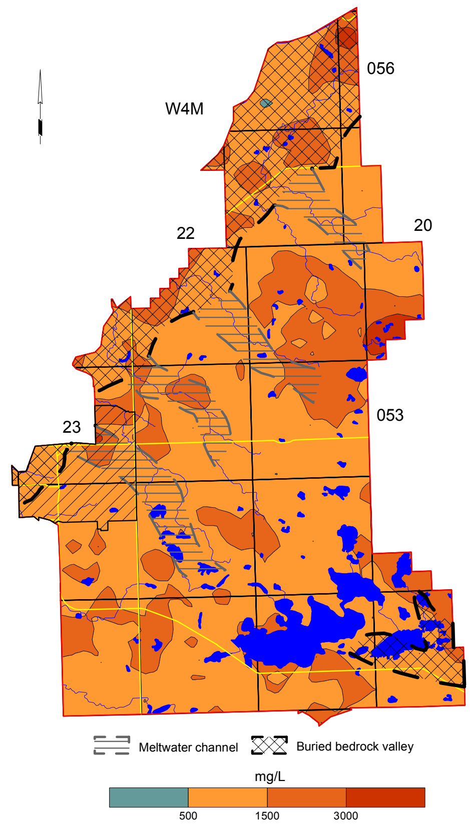


Figure 20. Total Dissolved Solids in Groundwater from Upper Bedrock Aquifer(s)

The relationship between TDS and sulfate concentrations shows that when TDS values in the groundwaters from the upper bedrock aquifer(s) exceed 1,200 mg/L, the sulfate concentrations exceed 400 mg/L.

The chloride concentrations in the groundwaters from the upper bedrock aquifer(s) are less than 100 mg/L in approximately 85% of the County. Chloride values of greater than the GCDWQ of 250 mg/L are mainly in vicinity of the Buried Beverly Valley. The nitrate + nitrite (as N) concentrations are less than 0.1 mg/L in 83% of the chemical analyses for bedrock water wells. Total hardness values in the groundwaters from the upper bedrock aquifer(s) are mainly less than 200 mg/L. The higher total hardness values are expected mainly in the vicinity of the Buried Beverly Valley (see CD-ROM).

In the County, approximately 69% of the groundwater samples from upper bedrock aquifer(s) have fluoride concentrations that are too low (less than 0.5 mg/L) to meet the recommended daily needs of people. Approximately 28% of the groundwater samples from the entire County are between 0.5 and 1.5 mg/L and approximately 3% exceed the maximum acceptable concentration for fluoride of 1.5 mg/L. The fluoride values of greater than 1.5 mg/L occur mainly in the Oldman Aquifer where the Oldman Formation is the upper bedrock, and also sporadically in the southwestern part of the County (page A-29).

The Piper tri-linear diagrams (page A-26) show that all chemical types of groundwater occur in the bedrock aquifers. However, the majority of the groundwaters are sodium-bicarbonate or calcium-magnesium-bicarbonate-sulfate types.

5.3.4 Lower Horseshoe Canyon Aquifer

The Lower Horseshoe Canyon Aquifer comprises the porous and permeable parts of the Lower Horseshoe Canyon Formation that underlies the southern half of the County. The thickness of the Lower Horseshoe Canyon Formation is less than 130 metres; in the northern half of the County, the Lower Horseshoe Canyon Formation has been eroded. The lowest 70 metres of the Horseshoe Canyon Formation tend to contain more porous and permeable materials.

5.3.4.1 Depth to Top

The depth to top of the Lower Horseshoe Canyon Formation is mainly less than 30 metres below ground level and is a function of the thickness of the surficial deposits. Along the western edge of the County, south of Sherwood Park, and close to the southeastern corner of the County, the depth to the top of the Lower Horseshoe Canyon Formation is more than 50 metres below ground level (page A-30). In these areas, water well depths would need to be in the order of 180 metres to fully penetrate the lower part of the Formation.

5.3.4.2 Apparent Yield

The apparent yields for individual water wells completed through the Lower Horseshoe Canyon Aquifer are mainly in the range of 10 to 100 m³/day. There are 473 water well records with apparent yield values, of which 36 have apparent yields of more than 500 m³/day. In addition to the 473 water well records, there are 35 records that indicate dry, or abandoned with “insufficient water”. In order to depict a more accurate yield map, an apparent yield of 0.1 m³/day was assigned to the 35 dry holes prior to gridding.

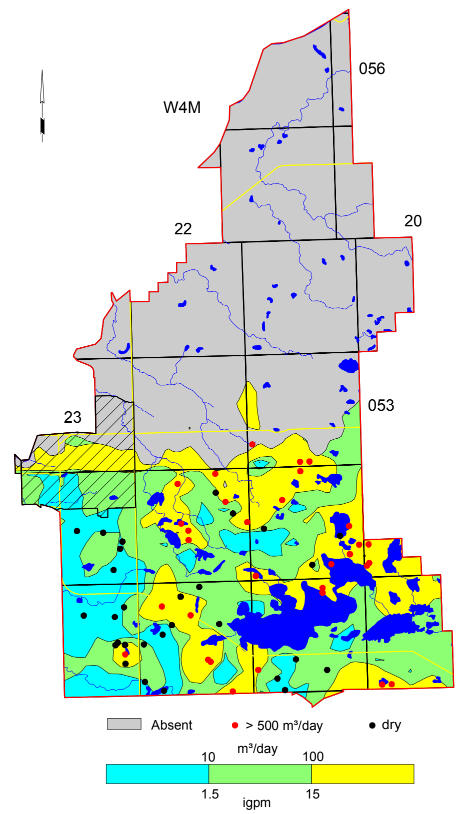


Figure 21. Apparent Yield for Water Wells Completed through Lower Horseshoe Canyon Aquifer

An extended aquifer test conducted with a water supply well completed in the Lower Horseshoe Canyon Aquifer for the Fultonvale School and Recreational Complex in SW 04-052-22 W4M indicated a long-term yield of 20 m³/day based on an effective transmissivity of 0.67 m^2/day (HCL, 1975).

In the County, there are 25 licensed water wells that are completed in the Lower Horseshoe Canyon Aquifer. The highest allocation of 24 m^3/day is for an Antler Lake Water Conservation water supply well in 01-14-052-21 W4M.

5.3.4.3 Quality

The groundwaters from the Lower Horseshoe Canyon Aquifer are mainly a sodium-bicarbonate-type or sodium-sulfate-type (see Piper diagram on CD-ROM), with TDS concentrations ranging from less than 750 to more than 1,500 mg/L. The sulfate concentrations are mainly below 500 mg/L. Chloride concentrations from the Lower Horseshoe Canyon Aquifer are mainly less than 100 mg/L. There are 35 out of 2,160 analyses where fluoride concentrations exceed 1.5 mg/L.

5.3.5 Bearpaw Aquifer

The Bearpaw Aquifer comprises the porous and permeable parts of the Bearpaw Formation that underlies the southern two-thirds of the County. The Bearpaw Formation generally ranges from 80 to 100 metres thick; in the northern one-third of the County, the Bearpaw Formation has been eroded.

5.3.5.1 Depth to Top

The depth to the top of the Bearpaw Formation is mainly less than 100 metres below ground level. The largest area where the top of the Bearpaw Formation is more than 100 metres below ground level is in the southern part of the County. In this area, the Bearpaw underlies the Lower Horseshoe Canyon Formation and the depth to the top of the Bearpaw Formation can exceed 130 metres.

5.3.5.2 Apparent Yield

The apparent yields for individual water wells completed through the Bearpaw Aquifer are mainly in the range of 10 to 100 m³/day. There are 114 water well records with apparent yield values, of which one has an apparent yield of more than 500 m³/day. In addition to the 114 water well records, there are six records that indicate dry, or abandoned with "insufficient water". In order to depict a more accurate yield map, an apparent yield of 0.1 m³/day was assigned to the six dry holes prior to gridding.

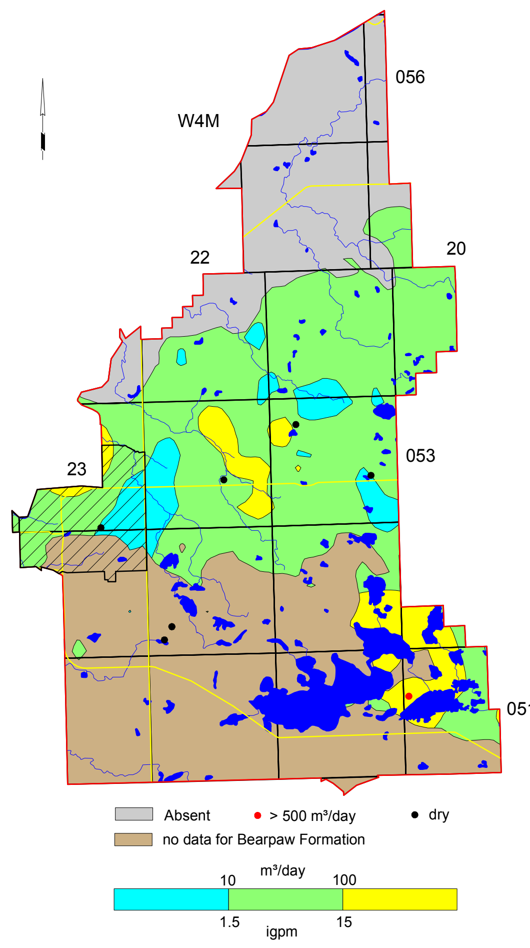


Figure 22. Apparent Yield for Water Wells Completed through Bearpaw Aquifer

An aquifer test conducted with a water test hole completed in the Bearpaw Aquifer for a proposed development east of Ardrossan in SW 07-053-21 W4M indicated the Aquifer encountered was not capable of transmitting a sufficient quantity of groundwater for the entire proposed development (HCL, 1974c).

In the County, there are 12 licensed water wells that are completed in the Bearpaw Aquifer. The two highest allocations totalling 98 m^3/day are for water supply wells at a golf course in 10-24-053-22 W4M.

5.3.5.3 Quality

The groundwaters from the Bearpaw Aquifer are mainly a sodium-bicarbonate-type (see Piper diagram on CD-ROM), with TDS concentrations ranging from less than 1,000 to more than 1,500 mg/L. The sulfate concentrations are mainly below 500 mg/L; the higher sulfate values are mainly associated with the edge of the Aquifer. Chloride concentrations from the Bearpaw Aquifer are mainly less than 250 mg/L, although there are areas throughout the County where the chloride concentrations exceed 250 mg/L. There are 11 out of 345 analyses where fluoride concentrations exceed 1.5 mg/L.

The groundwater from a water test hole that is completed in the Bearpaw Aquifer has a TDS concentration of 1,572 mg/L, a sulfate concentration of 18 mg/L, and a chloride concentration of 221 mg/L. The groundwater from this water test hole is a sodium-chloride-type (HCL, 1974c).

5.3.6 Oldman Aquifer

The Oldman Aquifer comprises the porous and permeable parts of the Oldman Formation. The Oldman Formation is present under most of the County, being absent only in a small area on the northern tip of the County. The thickness of the Oldman Formation is in the order of 120 metres in most of the County. On the northern tip of the County, the Oldman Formation subcrops below the surficial deposits and the thickness decreases to zero in areas where the underlying Birch Lake Member subcrops.

5.3.6.1 Depth to Top

The depth to the top of the Oldman Formation is mainly less than 40 metres in the northern part of the County where it subcrops. In the southern part of the County, where the Oldman is below the Bearpaw and the Lower Horseshoe Canyon formations, the depth to the top of the Oldman Formation can be more than 240 metres.

5.3.6.2 Apparent Yield

The apparent yields for individual water wells completed through the Oldman Aquifer are mainly in the range of 10 to 100 m³/day. There are 55 water well records with apparent yield values, of which three have an apparent yield of more than 500 m³/day. In addition to the 55 water well records, there are 11 records that indicate dry, or abandoned with “insufficient water”. In order to depict a more accurate yield map, an apparent yield of 0.1 m³/day was assigned to the 11 dry holes prior to gridding.

In the County, there are three licensed water wells that are completed in the Oldman Aquifer. The highest allocation of 17 m^3/day is for a County water supply well used for municipal purposes in 13-32-054-21 W4M.

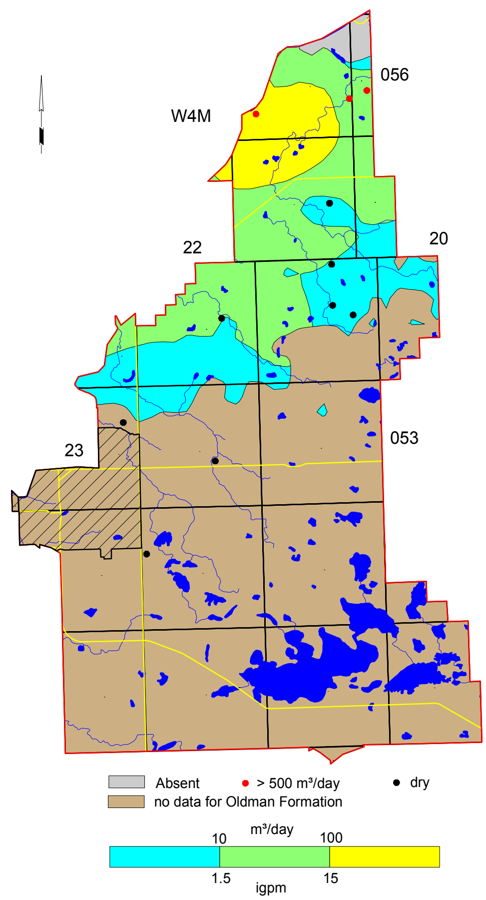


Figure 23. Apparent Yield for Water Wells Completed through Oldman Aquifer

5.3.6.3 Quality

The groundwaters from the Oldman Aquifer are mainly a sodium-bicarbonate type (see Piper diagram on CD-ROM). Total dissolved solids concentrations are expected to range mainly from 750 to 1,500 mg/L, with higher concentrations expected near the northwestern border of the County. The sulfate concentrations are mainly below 500 mg/L. The indications are that chloride concentrations in the Oldman Aquifer are expected to be mainly less than 250 mg/L, although there are areas in the County where the chloride concentrations exceed 250 mg/L. There are 29 out of 132 analyses where fluoride concentrations exceed 1.5 mg/L. There is a higher percentage of fluoride exceedances in the Oldman Aquifer than in the other bedrock aquifers within the County (see CD-ROM).

5.3.7 Birch Lake Aquifer

The Birch Lake Aquifer comprises the porous and permeable parts of the Birch Lake Member and subcrops in a small area on the northern tip of the County. Structure contours have been prepared for the top of the Member, which underlies most of the County. The structure contours show the Member being mostly less than 60 metres thick. Because of the limited amount of hydrogeological information in the County for the Birch Lake Aquifer interval, a complete detailed map set has not been prepared.

5.3.7.1 Depth to Top

The depth to the top of the Birch Lake Member is variable, ranging from less than 20 metres in the northern part of the County to more than 340 metres in the southern part of the County, as shown on the adjacent map.

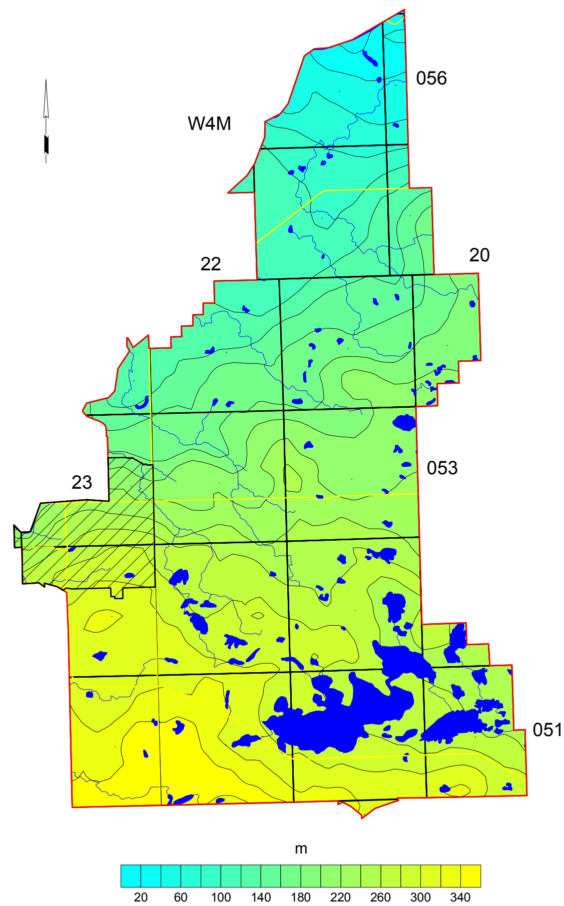


Figure 24. Depth to Top of Birch Lake Aquifer

5.3.7.2 Apparent Yield

There are two water well records in the database with sufficient information to calculate apparent yields for individual water wells completed through the Birch Lake Aquifer. Both of the apparent yields are less than ten m^3/day. In Strathcona County, there are no licensed water wells completed in the Birch Lake Aquifer.

The records for water wells completed in the Birch Lake Aquifer in the County of Lamont, east of Strathcona County, indicated that apparent yields were mainly less than one m^3/day but could be more than 60 m^3/day along the North Saskatchewan River. The higher yields appeared to be related to channels and not to weathering or fracturing (HCL, 1998).

5.3.7.3 Quality

There are no chemical quality data available for the two water well records in Strathcona County that are completed in the Birch Lake Aquifer.

The Piper tri-linear diagrams for Lamont County showed that all chemical types of groundwater occurred in the Birch Lake Aquifer but the majority were sodium-bicarbonate or sodium-chloride types. The TDS concentrations in the groundwaters from the Birch Lake Aquifer in Lamont County ranged from less than 1,000 to more than 2,000 mg/L. When TDS values exceeded 1,200 mg/L, the sulfate concentrations exceeded 600 mg/L. Chloride concentrations of more than 250 mg/L could be expected in the groundwaters and very few chemical analysis results indicated a fluoride concentration above 1.5 mg/L (HCL, 1998).

6. Groundwater Budget

6.1 Hydrographs

There are no locations in the County where water levels are being measured and recorded with time. However, there are two observation water wells (Obs WWs) in 08-11-051-20 W4M in the vicinity of Cooking Lake, west of the Town of Tofield, that are part of the AENV regional groundwater-monitoring network.

AENV Obs WW Nos. 157 and 158 were installed in 1974 to monitor water levels in the major aquifer in the Cooking Lake Moraine area and to determine if any connection exists between declining lake levels and groundwater-level fluctuations (Crowe, 1977).

AENV Obs WW No. 157 is completed at a depth of 34 metres below ground level in the Upper Sand and Gravel Aquifer. AENV Obs WW No. 158 is completed at a depth of 61 metres below ground level in the Lower Horseshoe Canyon Aquifer. The water-level fluctuations in AENV Obs WW Nos. 157 and 158 have been compared to the annual precipitation measured at the Hastings Lake weather station from 1978 to 1985, and at the Cooking Lake weather station from 1986 to 1992; the comparisons are shown in Figures 25 and 26. From 1980 to 1986, there is a water-level decline of more than one metre in AENV Obs WW No. 157. In AENV Obs WW No. 158, there is a water-level decline of more than 1.5 metres, but the decline is from 1981 to 1988. Following the water-level declines in both AENV Obs WWs, the water levels rose in the order of the same magnitude. There are no known licensed water well users in the immediate area of the Obs WWs. The reason for the decline and subsequent rise in the water levels is not apparent. However, the decline does coincide with the drought of the early 1980s in Alberta. There is a loose correlation between the annual precipitation and the water levels measured in AENV Obs WW No. 157 but there is no evident correlation from the annual precipitation at the site of AENV WW No. 158, as shown on the adjacent two figures. It is possible that the water-level decline is regional and is in response to the lack of groundwater recharge associated with the drought.

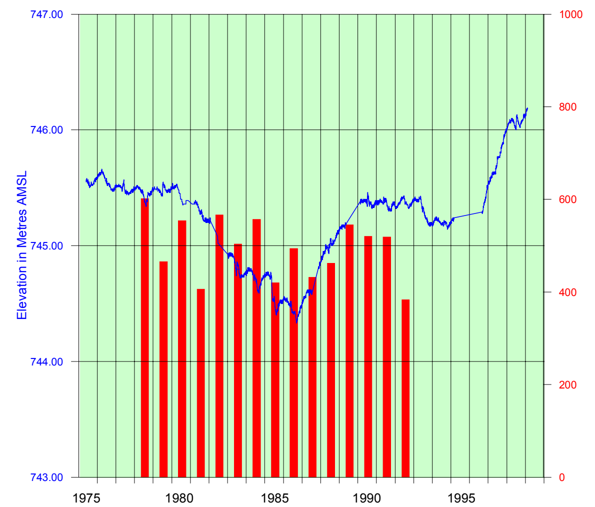


Figure 25. Annual Precipitation vs Water Levels in AENV Obs WW No. 157

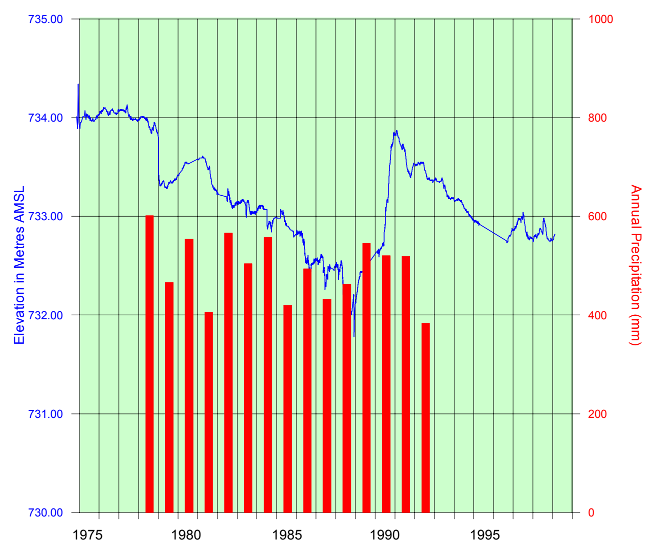


Figure 26. Annual Precipitation vs Water Levels in AENV Obs WW No. 158

During the two years for which groundwater monitoring data were available for Crowe's study, the lake and groundwater hydrographs indicated that while the lake surface levels have slightly declined, the groundwater level remained essentially static and any fluctuations in the AENV Obs WWs were mainly due to seasonal climatic cycles. Based on these limited data, no correlation between groundwater-level fluctuations and lake-level fluctuations could be determined (Crowe, 1977).

The adjacent graph has been prepared from the monitoring data that are presently available. With the addition of 20 years of monitoring data, a similarity in water-level trends is evident after 1981. Variations in the time of the trends may be a reflection of the AENV Obs WW No. 157 being nearly 20 kilometres east of Cooking Lake.

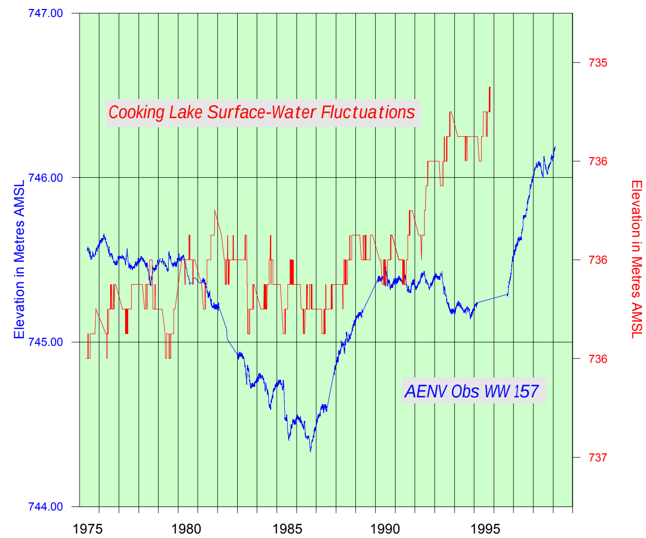


Figure 27. AENV Obs WW No. 157 vs Cooking Lake Water-Level Fluctuations

6.2 Estimated Water Use from Unlicensed Groundwater Users

An estimate of the quantity of groundwater removed from each geologic unit in Strathcona County must include both the licensed diversions and the unlicensed use. As stated previously on page 6 of this report, the daily water requirement for livestock for the County based on the 1996 census is estimated to be 5,131 cubic metres. Of the 5,131 m³/day required for livestock, 600 m³/day has been licensed by Alberta Environment, which includes both surface water and groundwater. To obtain an estimate of the quantity of groundwater being diverted from the individual geologic units, it has been assumed that the remaining 4,531 m³/day of water required for livestock watering is obtained from unlicensed groundwater use. In the groundwater database for the County, there are records for 6,984 water wells that are used for domestic/stock purposes. These 6,984 water wells include both licensed and unlicensed water wells. Of the 6,984 water wells, 382 water wells are used for stock, 507 are used for domestic/stock purposes, and 6,095 are for domestic purposes only.

There are 889 water wells that are used for stock or domestic/stock purposes. There are 32 licensed groundwater users for agricultural (stock) purposes, giving 857 unlicensed stock water wells. (Please refer to Table 1 on page 6 for the breakdown by aquifer of the 32 licensed stock groundwater users). By dividing the number of unlicensed stock and domestic/stock water wells (857) into the quantity of groundwater required for stock purposes that is not licensed (4,531 m³/day), the average unlicensed water well diverts 5.3 m³/day. Because of the limitations of the data, no attempt has been made to compensate for dugouts, springs or inactive water wells, and the average stock use is considered to be 5.3 m³/day per stock water well.

Groundwater for household use does not require licensing. Under the Water Act, a residence is protected for up to 3.4 m³/day. However, the standard groundwater use for household purposes is 1.1 m³/day.

To obtain an estimate of the groundwater from each geologic unit, there are three possibilities for a water well. A summary of the possibilities and the quantity of water for each use is as follows:

Domestic	1.1 m³/day
Stock	5.3 m³/day
Domestic/stock	6.4 m³/day

Based on using all available domestic, domestic/stock, and stock water wells and corresponding calculations, the following table was prepared. The table shows a breakdown of the 6,984 unlicensed and licensed water wells used for domestic, stock, or domestic/stock purposes by the geologic unit in which each water well is completed. The final column in the table equals the total amount of unlicensed groundwater that is being used for both domestic and stock purposes. The data provided in the table below indicate that most of the 11,569 m³/day, estimated to be diverted from unlicensed domestic, stock, or domestic/stock water wells, is from the Lower Horseshoe Canyon and Upper Sand and Gravel aquifers.

	Unlicensed and Licensed Groundwater Diversions							*Licensed Groundwater Diversions*	*Unlicensed Groundwater Diversions*
Aquifer Designation	Number of Domestic	Daily Use (1.1 m³/day)	Number of Stock	Daily Use (5.4 m³/day)	Number of Domestic and Stock	Daily Use (6.5 m³/day)	Totals m³/day	Totals (m³/day)	Totals m³/day
Upper Sand/Gravel	1,228	1,351	109	576	174	1,111	3,038	22	3,016
Lower Sand/Gravel	74	81	12	63	13	83	228	0	228
Bedrock	616	678	18	95	47	300	1,073	0	1,073
Lower Horseshoe Canyon	2,572	2,829	119	629	99	632	4,091	177	3,914
Bearpaw	670	737	45	238	83	530	1,505	37	1,468
Oldman	149	164	39	63	44	281	508	13	494
Birch Lake	4	4	3	16	1	6	27	0	27
Unknown	782	860	37	196	46	294	1,350	0	1,350
Totals	6,095	6,705	382	1,876	507	3,238	11,819	249	11,569

Table 6. Unlicensed and Licensed Groundwater Diversions

By assigning 1.1 m³/day for domestic use, 5.3 m³/day for stock use and 6.4 m³/day for domestic/stock use, and using the total maximum authorized diversion associated with any licensed water well that can be linked to a record in the database, a map has been prepared that shows the estimated groundwater use in terms of volume (licensed plus unlicensed) per section per day for the County.

There are 547 sections in the County. The estimated water well use per section can be more than 50 m³/day in 70 of the 547 sections. The most notable areas where water well use of more than 50 m³/day is expected occur mainly in the south-central part of the County, as shown on Figure 28. The closest AENV-operated observation water wells are outside the County in 08-11-051-20 W4M, east of Hastings Lake as shown on the adjacent figure. From 1980 to the mid-1980s, there was a water-level decline of more than one metre in AENV Obs WW No. 157. This decline could be, in part, due to (1) lack of recharge to the Upper Sand and Gravel Aquifer as a result of decreased precipitation; (2) a delay in the water level reaching equilibrium in the AENV observation water well; or (3) more than 225 water wells that have been drilled in the vicinity of Cooking Lake and Hastings Lake between the mid-1970s and the mid-1980s.

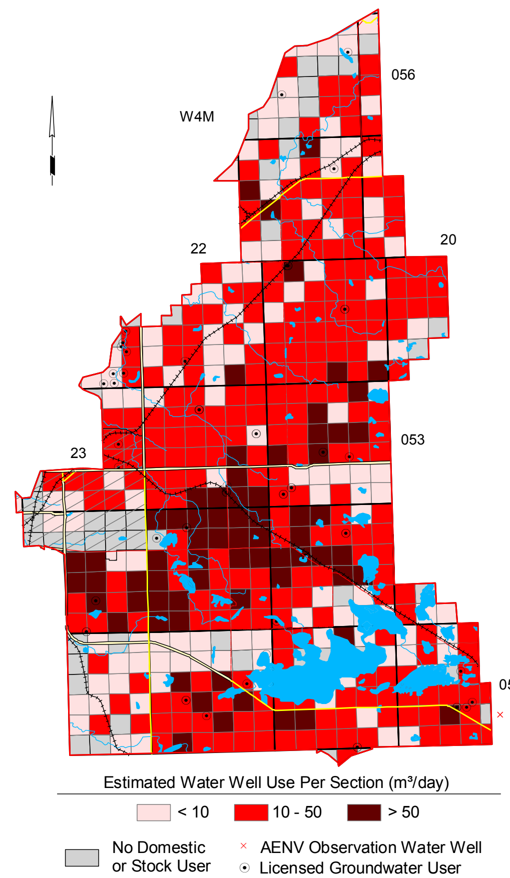


Figure 28. Estimated Water Well Use Per Section

In summary, the estimated total groundwater use within Strathcona County is 24,412 m³/day, with the breakdown as shown in the adjacent table. Approximately 1,367 m³/day is being withdrawn from unknown aquifer units. The remaining 23,045 m³/day could be assigned to specific aquifer units.

Groundwater Use within Strathcona County (m³/day)		%
Domestic/Stock (licensed and unlicensed)	11,819	*48*
Municipal (licensed)	162	*1*
Commercial/Dewatering (licensed)	12,431	*51*
Total	24,412	*100*

Table 7. Total Groundwater Diversions

The range in groundwater use per section is from 1.1 to more than 150 m³/day. The average groundwater use per section across the County is in the order of 43.5 m³/day (6.6 igpm).

Approximately 55% of the total estimated groundwater use is from licensed water wells.

6.3 Groundwater Flow

A direct measurement of groundwater recharge or discharge is not possible from the data that are available for the County. One indirect method of measuring recharge is to determine the quantity of groundwater flowing laterally through each individual aquifer. This method assumes that there is sufficient recharge to the aquifer to maintain the flow through the aquifer and the discharge is equal to the recharge. However, even the data that can be used to calculate the quantity of flow through an aquifer must be averaged and estimated. To determine the flow requires a value for the average transmissivity of the aquifer, an average hydraulic gradient and an estimate for the width of the aquifer. For the present program, the flow has been estimated for those parts of the various aquifers within the County.

The flow through each aquifer assumes that by taking a large enough area, an aquifer can be considered as homogeneous, the average gradient can be estimated from the non-pumping water-level surface, and flow takes place through the entire width of the aquifer; flow through the aquifers takes into consideration hydrogeological conditions outside the County border. Based on these assumptions, the estimated lateral groundwater flow through the individual aquifers can be summarized as follows:

Aquifer/Area	Trans (m^2/day)	Gradient (m/m)	Width (m)	Flow (m^3/day)	Aquifer Flow (m^3/day)	Licensed Diversion (m^3/day)	Unlicensed Diversion (m^3/day)	Total (m^3/day)
Lower Sand and Gravel					3,680	12,048	228	12,276
Beverly Valley								
northeast	600	0.0002	8,000	960				
Upper Surficial								
northwest	8	0.0060	35,000	1680				
southeast	8	0.0020	15,000	240				
north	8	0.0040	25,000	800				
Lower Horseshoe Canyon					1,403	244	3,914	4,158
North Saskatchewan Valley								
northwest	3.8	0.003	20,000	253				
southwest	3.8	0.004	6,000	86				
Cooking Lake								
southeast	3.8	0.003	20,000	253				
north	3.8	0.007	32,000	811				
Bearpaw					1,080	193	1468	1,661
northwest	7.2	0.005	30,000	1,080				
Oldman					394	37	494	531
northwest	2.1	0.00625	30,000	394				

Table 8. Groundwater Budget

The above table indicates that the total of the licensed and unlicensed diversions from the individual aquifers is significantly more than the groundwater flowing through the aquifers. The calculations of flow through individual aquifers as presented in the above table are very approximate and are intended only as a guide for future investigations.

6.3.1 Quantity of Groundwater

An estimate of the volume of groundwater stored in the sand and gravel aquifers in the surficial deposits is 0.3 to 2.0 cubic kilometres. This volume is based on an areal extent of 1,300 square kilometres and a saturated sand and gravel thickness of five metres. The variation in the total volume is based on the value of porosity that is used for the sand and gravel. One estimate of porosity is 5%, which gives the low value of the total volume. The high estimate is based on a porosity of 30% (Ozoray, Dubord and Cowen, 1990).

The adjacent water-level map has been prepared from water levels associated with water wells completed in aquifers in the surficial deposits. The water levels from these water wells were used for the calculation of the saturated thickness of the surficial deposits. In areas where the elevation of the water-level surface is below the bedrock surface, the surficial deposits are not saturated. The water-level map for the surficial deposits shows a general flow direction toward the Buried Beverly Valley.

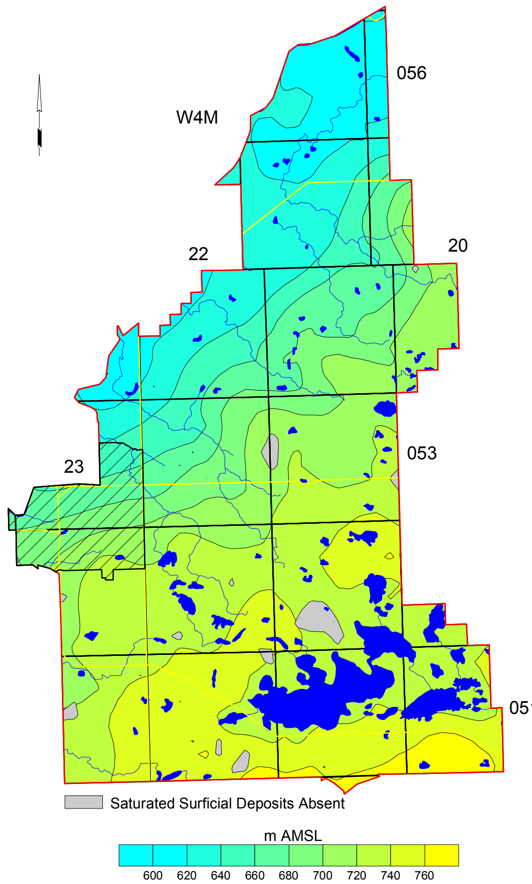


Figure 29. Non-Pumping Water-Level Surface in Surficial Deposits Based on Water Wells Less than 20 Metres Deep

6.3.2 Recharge/Discharge

The hydraulic relationship between the groundwater in the surficial deposits and the groundwater in the bedrock aquifers is given by the non-pumping water-level surface associated with each of the hydraulic units. Where the water level in the surficial deposits is at a higher elevation than the water level in the bedrock aquifers, there is the opportunity for groundwater to move from the surficial deposits into the bedrock aquifers. This condition would be considered as an area of recharge to the bedrock aquifers and an area of discharge from the surficial deposits. The amount of groundwater that would move from the surficial deposits to the bedrock aquifers is directly related to the vertical permeability of the sediments separating the two aquifers. In areas where the surficial deposits are unsaturated, the extrapolated water level for the surficial deposits is used.

When the hydraulic gradient is from the bedrock aquifers to the surficial deposits, the condition is a discharge area from the bedrock aquifers, and a recharge area to the surficial deposits.

6.3.2.1 Surficial Deposits/Bedrock Aquifers

The hydraulic gradient between the surficial deposits and the upper bedrock aquifer(s) has been determined by subtracting the elevation of the non-pumping water-level surface associated with all water wells completed in the upper bedrock aquifer(s) from the elevation of non-pumping water-level surface determined for all water wells in the surficial deposits. The recharge classification on the map below includes those areas where the water-level surface in the surficial deposits is more than five metres above the water-level surface in the upper bedrock aquifer(s). The discharge areas are where the water level in the surficial deposits is more than five metres lower than the water level in the bedrock. When the water level in the surficial deposits is between five metres above and five metres below the water level in the bedrock, the area is classified as a transition.

The adjacent map shows that, in more than 70% of the County, there is a downward hydraulic gradient from the surficial deposits toward the upper bedrock aquifer(s). The few areas where there is an upward hydraulic gradient (i.e. discharge) from the bedrock to the surficial deposits are mainly in the vicinity of linear bedrock lows except in the southwestern part of the County, which may be a result of gridding processes. The remaining parts of the County are areas where there is a transition condition.

Because of the paucity of data, a calculation of the volumes of groundwater entering and leaving the surficial deposits has not been attempted.

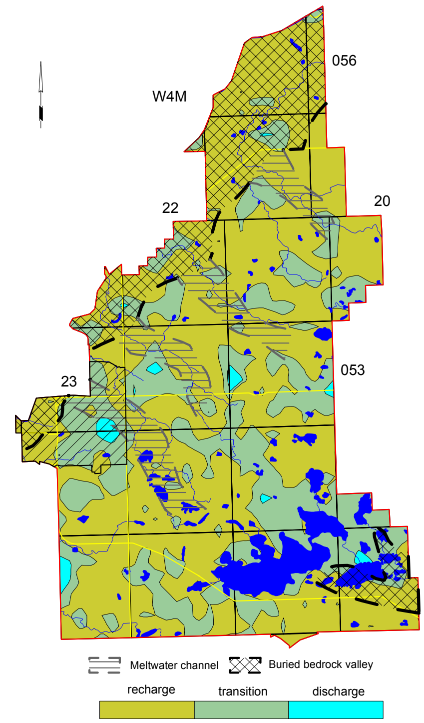


Figure 30. Recharge/Discharge Areas between Surficial Deposits and Upper Bedrock Aquifer(s)

6.3.2.2 Bedrock Aquifers

Recharge to the bedrock aquifers within the County takes place from the overlying surficial deposits and from flow in the aquifer from outside the County. The recharge/discharge maps show that generally for most of the County, there is a downward hydraulic gradient from the surficial deposits to the bedrock, i.e. recharge to the bedrock aquifers. On a regional basis, calculating the quantity of water involved is not possible because of the complexity of the geological setting and the limited amount of data. However, because of the generally low permeability of the upper bedrock materials, the volume of water is expected to be small.

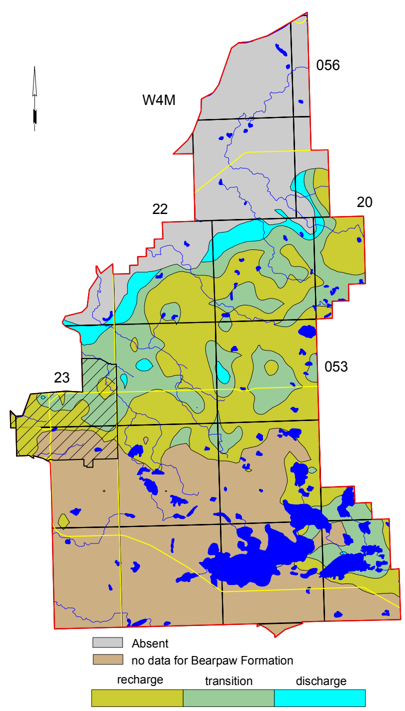


Figure 31. Recharge/Discharge Areas between Surficial Deposits and Bearpaw Aquifer

The hydraulic relationship between the surficial deposits and the Bearpaw Aquifer indicates that in more than 60% of the County where the Bearpaw Aquifer is present and there is data control, there is a downward hydraulic gradient (i.e. recharge). Discharge areas for the Bearpaw Aquifer are mainly associated with the edge of the Aquifer or in areas of linear bedrock lows.

The hydraulic relationship between the surficial deposits and the remainder of the bedrock aquifers indicates there is mainly a downward hydraulic gradient (see CD ROM).

6.4 Areas of Groundwater Decline

The areas of groundwater decline in both the sand and gravel aquifer(s) and in the bedrock aquifers have been determined by using a similar procedure in both situations. Because major development began occurring in the 1970s, the changes in water-level maps are based on the differences between water-level elevations available before 1970 and after 1984. Where the earliest water level is at a higher elevation than the latest water level, there is the possibility that some groundwater decline has occurred. Where the earliest water level is at a lower elevation than the latest water level, there is the possibility that the groundwater has risen at that location. The water level may have risen as a result of recharge in wetter years or may be a result of the water well being completed in a different bedrock aquifer. In order to determine if the water-level decline is a result of groundwater use by licensed users, the licensed groundwater users were posted on the maps.

Of the 463 water wells completed in the sand and gravel aquifer(s) with a NPWL and test date, 119 are from water wells completed before 1970 and 53 are from water wells completed after 1984. The adjacent map shows that it may have been possible there has been a rise in the NPWL in areas of meltwater channels and in the Buried Vegreville Valley. In the area east of Sherwood Park, there has been a rise in the water levels in the sand and gravel aquifer(s). This area is also one of high water use or water demand (see Fig. 28). The rise in water level may be a result of water being introduced into the groundwater from septic systems. The areas that indicate a decline of more than five metres are based on only one or two control points.

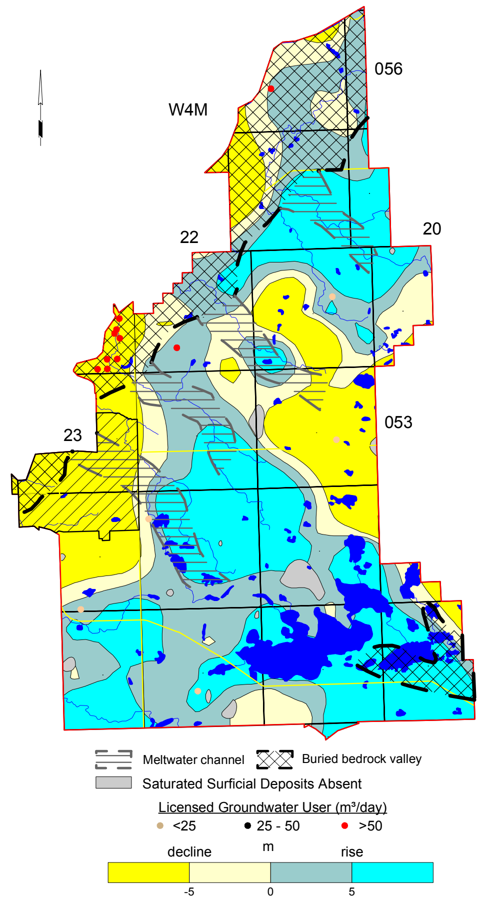


Figure 32. Changes in Water Levels in Sand and Gravel Aquifer(s)

Nearly 46% of the areas where there has been a water-level decline of more than five metres in sand and gravel aquifer(s) corresponds to where the estimated water well use is between 10 and 50 m³/day; 27% of the declines occurred where the estimated water well use is less than 10 m³/day; 13% of the declines occurred where the estimated water well use is more than 50 m³/day; the remaining 14% of the declines occurred where there is no groundwater use shown on Figure 28.

Of the 2,449 bedrock water wells with a NPWL and test date, 276 are from water wells completed before 1970 and 822 are from water wells completed after 1984. The adjacent map indicates that in 60% of the County, it is possible that the NPWL has declined. Of the 59 licensed groundwater users, most occur in areas where a water-level decline exists.

Fifty-one percent of the areas where there has been a water-level decline of more than five metres in upper bedrock aquifer(s) corresponds to where the estimated water well use is between 10 and 50 m³/day; 19% of the declines occurred where the estimated water well use is more than 50 m³/day; 18% of the declines occurred where the estimated water well use is less than 10 m³/day; the remaining 12% occurred where there is no groundwater use shown on Figure 28.

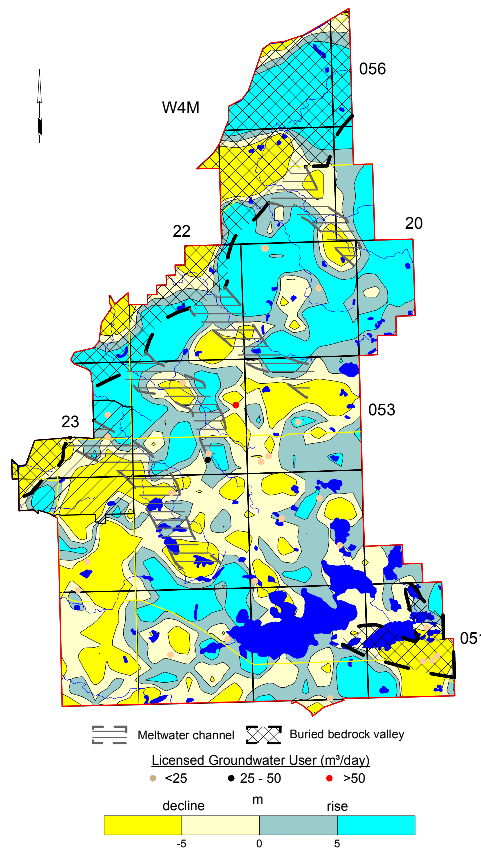


Figure 33. Changes in Water Levels in Upper Bedrock Aquifer(s)

7. 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
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 first step would be to field-verify the 384 existing water wells listed in Appendix E. These water well records indicate that a complete water well drilling report is available along with at least a partial chemical analysis. 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. Even though the two water wells for which the County has responsibility do not satisfy the above criteria, it is recommended that the water wells be field-verified, water levels be measured, a water sample be collected for analysis, and a short aquifer test be conducted; the two County-operated water wells are also included in Appendix E. An attempt to update the quality of the entire database is not recommended.

An attempt in this study to link the AENV groundwater and licensing databases was about 65% successful. About one-third of licensed water wells do not appear to have corresponding records in the AENV groundwater database. There is a need to improve the quality of the AENV licensing database. It is recommended that attempts be made in a future study to find and add missing drilling records to the AENV groundwater database and to determine the aquifer in which the licensed water wells are completed.

While there are a few areas where water-level data are available, on the overall, there are an insufficient number of water levels to set up a 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 and in Flagstaff County, 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. Monitoring of water levels in domestic and stock water wells is a practice that is recommended by PFRA in the “Water Wells That Last for Generations” manual and accompanying videos (Alberta Agriculture, Food And Rural Development, 1996). Of the 384 water wells recommended for field verification, 183 of the bedrock water wells and 39 of the surficial water wells are in areas of water-level decline. Because the flow through the individual aquifers is significantly less than the total of the licensed and unlicensed diversions, it is strongly recommended that a groundwater-monitoring program be established.

A second approach to obtain water-level data would be to conduct a field survey to identify water wells not in use that could be used as part of an observation water well network. County personnel and/or local residents could measure the water levels in the water wells regularly.

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 provide a major upgrade to the level of interpretation provided in this report and the accompanying maps and groundwater query, it is recommended that the 384 water wells for which water well drilling reports are available be subjected to the following actions (see pages C-2 to C-3):

1) The horizontal location of the water well should be determined within ten 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 five and 115 minutes of pumping, and analyzed for major and minor ions.

A list of the 384 water wells that could be considered for the above program is given in Appendix E.

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. One method of obtaining uniformity would be to have the water well drilling reports submitted to the AENV Resource Data Division in an electronic form. The money presently being spent by AENV 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.

8. References

Agriculture Canada Prairie Farm Rehabilitation Administration. Regina, Saskatchewan. 1996. 1996 Agriculture Census (CD-ROM).

Agriculture, Food and Rural Development. 1995. Water Requirements for Livestock. Agdex 400/716-1.

Alberta Department of Environment. 1971. Water Resources Division, Soils, Geology & Groundwater Branch. Sherwood Park South Groundwater Study.

Alberta Energy and Utilities Board. June 1995. AEUB ST-55. Alberta's Usable Groundwater Database.

Alberta Research Council. March 31, 1995. Mapping and Resource Exploration of the Tertiary and Preglacial Formations of Alberta. Canada/Alberta Partnership on Minerals. Project Number: M92-04-008.

Allong, A. F. 1967. Sedimentation and Stratigraphy of the Saskatchewan Gravels and Sands in Central and Southern Alberta. University of Wisconsin. M. Sc. (Geology) Thesis. 130 p.

Andriashek, L. D. 1987. Bedrock Topography and Valley Thalwegs of the Edmonton Map Area.

Andriashek, L. D. 1987. Drift Thickness of the Edmonton Map Area.

Bibby, R. 1974. Hydrogeology of the Edmonton Area (Northwest Segment), Alberta. Alberta Research Council. Report 74-10.

Borneuf, D. M. 1983. Alberta Geological Survey. Springs of Alberta.

Buchanan, Bob; Alberta Agriculture, Food and Rural Development. Engineering Services Branch; Alberta Environment. Licensing and Permitting Standards Branch; Canada. Prairie Farm Rehabilitation Administration. 1996. Water Wells … that Last for Generations.

CAESA. November 1997. Alberta Farmstead Water Quality Survey. Prepared for CAESA Water Quality Monitoring Committee.

CAESA-Soil Inventory Project Working Group. 1998. AGRASID: Agricultural Region of Alberta Soil Inventory Database (Version 1.0). Edited by J. A. Brierley, B. D. Walker, P. E. Smith, and W. L. Nikiforuk. Alberta Agriculture Food & Rural Development, publications.

Canadian Council of Resource and Environment Ministers. 1992. Canadian Water Quality Guidelines.

Carlson, V. A. 1967. Bedrock Topography, Edmonton District, Alberta. NTS 83H. Research Council of Alberta Map.

Carrigy, M. A. 1971. Lithostratigraphy of the Uppermost Cretaceous (Lance) and Paleocene Strata of the Alberta Plains. Research Council of Alberta. Bulletin 27.

Catuneanu, Octavian, Andrew D. Miall and Arthur R. Sweet. 1997. Reciprocal Architecture of Bearpaw T-R Sequences, Uppermost Cretaceous, Western Canada Sedimentary Basin. Bulletin of Canadian Petroleum Geology. Vol. 45, No. 1 (March, 1997), P. 75-94.

Ceroici, W. 1979. Hydrogeology of the Southwest Segment, Edmonton Area, Alberta. Alberta Research Council. Earth Sciences Report 78-5.

Cressie, N. A. C. 1990. The Origins of Kriging. Mathematical Geology. Vol. 22, Pages 239-252.

Crowe, A. 1977. Alberta Department of Environment, Environmental Protection Services, Earth Sciences & Licensing Division, Geology Branch. Preliminary Discussion of the Cooking Lake Observation Well Monitoring Data, November 1974 - September 1977. 11-051-20 W4.

Edwards, W. A. D. 1984. Aggregate Resources of the Irvine Map Area. NTS 72E/16. Alberta Research Council. OFM. 1984-08p. 1:50,000 Map.

Farvolden, R. N. 1963. Figure 14. Bedrock Topography. Edmonton-Red Deer Map Area, Alberta in Early Contributions to the Groundwater Hydrology of Alberta.

Fox, J. C. 1984. Aggregate Resources of the Pedley Map Area. NTS 83 F/6. Alberta Research Council. OFM. 1984 – 14f. 1:50,000 Map.

Freeze, R. Allan and John A. Cherry. 1979. Groundwater. Pages 249-252.

Glass, D. J. [editor]. 1990. Lexicon of Canadian Stratigraphy, Volume 4: Western Canada, including British Columbia, Alberta, Saskatchewan and southern Manitoba. Canadian Society of Petroleum Geologists, Calgary.

Green, R. 1972. Alberta Geological Survey. Geological Map of Alberta.

Hamilton, W. N., M. C. Price, and C. W. Langenberg (co-compilers). 1999. Geological Map of Alberta. Alberta Geological Survey. Alberta Energy and Utilities Board. Map No. 236. Scale 1:1,000,000. Revised from 1972 edition, R. Green.

Hudson, B. 1984. Aggregate Resources of the Medicine Hat Map Area. NTS 72L. Alberta Research Council. OFM. 1984-02p. 1:250,000 Map.

Hydrogeological Consultants Ltd. 1973a. J.B.L. Holdings Ltd. Water Well. Ardrossan Area. 12-052-21 W4M. Unpublished Contract Report.

Hydrogeological Consultants Ltd. 1973b. Stewart, Weir, Stewart, Watson & Heinrichs. A Review of Hydrogeological Data in the Vicinity of NW 29 and SE 30-052-22 W4M. Ardrossan Area. 30-052-22 W4M. Unpublished Contract Report.

Hydrogeological Consultants Ltd. 1974a. Elzinga. A Review of Hydrogeological Data in the Vicinity of SW 21-052-21 W4M. Cooking Lake Area. 21-052-21 W4M. Unpublished Contract Report.

Hydrogeological Consultants Ltd. 1974b. Gillmore. Hydrogeology in the Vicinity of NE 1/4 32-052-22 W4M. Sherwood Park Area. 32-052-22 W4M. Unpublished Contract Report.

Hydrogeological Consultants Ltd. 1974c. Hawreschuk. A Review of Hydrogeological Data. Ardrossan Area. 07-053-21 W4M. Unpublished Contract Report.

Hydrogeological Consultants Ltd. 1974d. McGann. Results of an Aquifer Test. Ardrossan Area. 30-052-22 W4M. Unpublished Contract Report.

Hydrogeological Consultants Ltd. 1974e. Singer. A Review of Hydrogeological Data in the Vicinity of SE 36-052-21 W4M. Antler Lake Area. 36-052-21 W4M

Hydrogeological Consultants Ltd. 1974f. Stetson, R. A Review of Hydrogeological Data in the Vicinity of NE 11-052-23 W4M. Sherwood Park Area. 11-052-23 W4M. Unpublished Contract Report.

Hydrogeological Consultants Ltd. 1974g. Sunnyvale. Groundwater Availability in the Vicinity of NE 06-051-022 W4M. Looma Area. 06-051-22 W4M. Unpublished Contract Report.

Hydrogeological Consultants Ltd. 1975. Strathcona County. Fultonvale Complex: Water Well Test. Sherwood Park Area. 04-052-22 W4M. Unpublished Contract Report.

Hydrogeological Consultants Ltd. 1976a. Redschlag. Groundwater Conditions: S 21-052-21 W4M. Antler Lake Area. 21-052-21 W4M. Unpublished Contract Report.

Hydrogeological Consultants Ltd. 1976b. Village of Bruderheim. Water Well No. 4. Bruderheim Area. 33-055-20 W4M. Unpublished Contract Report.

Hydrogeological Consultants Ltd. 1988. Environment Canada - Parks. 1987 Groundwater Project. Elk Island National Park Area. 054-20 W4M. Unpublished Contract Report.

Hydrogeological Consultants Ltd. 1998. OPUS Oil & Gas Ltd. Opus Fort Sask 08-14-054-22 W4M: Reginald Loren Water Well Testing. Fort Saskatchewan Area. 14-054-22 W4M. Unpublished Contract Report.

McCann and Associates Ltd. 1986. Geotechnical Assessment. Country Residential – Small Holdings Development. County of Strathcona No. 20.

McPherson, R. A., and C. P. Kathol. 1972. Alberta Geological Survey. Stratigraphic Sections and Drill Hole Logs. Edmonton Area. Alberta.

Minister of Supply and Services Canada. 1996. Guidelines for Canadian Drinking Water Quality, Sixth Edition. Prepared by the Federal-Provincial Subcommittee on Drinking Water of the Federal-Provincial Committee on Environmental and Occupational Health.

Moran, S. R. 1986. Surficial Geology of the Calgary Urban Area. Alberta Research Council. Bulletin 53. 46p.

Mossop, G. and I. Shetsen (co-compilers). 1994. Geological Atlas of the Western Canada Sedimentary Basin. Produced jointly by the Canadian Society of Petroleum Geology, Alberta Research Council, Alberta Energy, and the Geological Survey of Canada.

Pawlowicz, J. G. and M. M. Fenton. 1995. Alberta Geological Survey. Bedrock Topography of Alberta.

Pettijohn, F. J. 1957. Sedimentary Rocks. Harper and Brothers Publishing.

Phinney, V. Laverne (Editor and publisher). 2001. The Alberta List.

Richardson, R. J. H. 1984a. Aggregate Resources of the Blue Rapids Map Area. NTS 83 G/3. Alberta Research Council. OFM. 1984 – 15c. 1:50,000 Map.

Richardson, R. J. H. 1984b. Aggregate Resources of the Tomahawk Map Area. NTS 83 G/7. Alberta Research Council. OFM. 1984 – 15g. 1:50,000 Map.

Richardson, R. J. H. 1984c. Aggregate Resources of the Isle Lake Map Area. NTS 83 G/10. Alberta Research Council. OFM. 1984 – 15j. 1:50,000 Map.

Sham, P. 1984a. Aggregate Resources of the Ponoka Map Area. NTS 83 A/12. Alberta Research Council. OFM. 1984 – 13l. 1:50,000 Map.

Sham, P. 1984b. Aggregate Resources of the Wetaskiwin Map Area. NTS 83 A/14. Alberta Research Council. OFM. 1984 – 13n. 1:50,000 Map.

Sham, P. 1986. Aggregate Resources of the Ferintosh Map Area. NTS 83 A/15. Alberta Research Council. OFM. 1984 – 13l. 1:50,000 Map.

Shetsen, I. 1980. Sand and Gravel Resources of the Calgary Region. NTS 82I, J, O. Alberta Research Council. OFR. 1981-8. 96p.

Shetsen, I. 1982. Sand and Gravel Resources of the Lethbridge Area. NTS 82I. Alberta Research Council. Earth Science Report. 81-4. 41p.

Shetsen, I. 1987. Quaternary Geology, Southern Alberta. Produced by the Natural Resources Division of the Alberta Research Council.

Stalker, A. MacS. 1957. Surficial Geology. High River. Alberta. Geological Survey of Canada. Map 14-1957.

Stalker, A. MacS. 1960. Buried Valleys in Central and Southern Alberta. Paper 60-32. Geological Survey of Canada. Department of Mines and Technical Surveys.

Stalker, A. MacS. 1963. Quaternary Stratigraphy in Southern Alberta. Geological Survey of Canada. Paper 62-34. 52p.

Stein, R. 1976. Hydrogeology of the Edmonton Area (Northeast Segment), Alberta. Alberta Research Council. Report 76-1.

Stein, R. 1982. Hydrogeology of the Edmonton Area (Southeast Segment), Alberta. Alberta Research Council. Report 79-6.

Strathcona County, 2000. Strathcona County Municipal Census. Prepared by P. Kreisel, Ph.D. Strategic Information Analyst. Corporate Planning Secretariat.

Strong, W. L. and K. R. Legatt, 1981. Ecoregions of Alberta. Alta. En. Nat. Resour., Resour. Eval. Plan Div., Edmonton as cited in Mitchell, Patricia and Ellie Prepas (eds.). 1990. Atlas of Alberta Lakes. The University of Alberta Press. Page 12.

Thornthwaite, C. W. and J. R. Mather. 1957. Instructions and Tables for Computing Potential Evapotranspiration and the Water Balance. Drexel Institute of Technology. Laboratory of Climatology. Publications in Climatology. Vol. 10, No. 3, P. 181-289.

Winner, G., and O. Tokarsky. Geoscience Consulting Ltd. 1979. Kinlock Underwood & Associates Ltd. Groundwater Evaluation. Part of NW 4-53-22 W4. 04-053-22 W4M.

Znak, M. and T. Yoon. 1974. Department of the Environment, Environmental Protection Services, Earth Sciences and Licensing Division, Groundwater Development Branch. Nitrate Contamination, Ardrossan Area.

9. Conversions

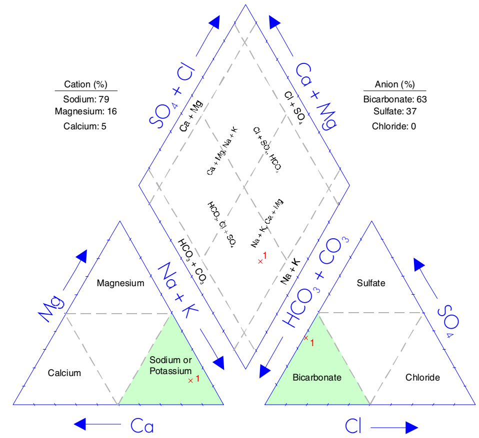
Multiply	by	To Obtain
Length/Area		
feet	0.304 785	metres
metres	3.281 000	feet
hectares	2.471 054	acres
centimetre	0.032 808	feet
centimetre	0.393 701	inches
acres	0.404 686	hectares
inchs	25.400 000	millimetres
miles	1.609 344	kilometres
kilometer	0.621 370	miles (statute)
square feet (ft^2)	0.092 903	square metres (m^2)
square metres (m^2)	10.763 910	square feet (ft^2)
square metres (m^2)	0.000 001	square kilometres (km^2)
Concentration		
grains/gallon (UK)	14.270 050	parts per million (ppm)
ppm	0.998 859	mg/L
mg/L	1.001 142	ppm
Volume (capacity)		
acre feet	1233.481 838	cubic metres
cubic feet	0.028 317	cubic metres
cubic metres	35.314 667	cubic feet
cubic metres	219.969 248	gallons (UK)
cubic metres	264.172 050	gallons (US liquid)
cubic metres	1000.000 000	litres
gallons (UK)	0.004 546	cubic metres
imperial gallons	4.546 000	litres
Rate		
litres per minute (lpm)	0.219 974	UK gallons per minute (igpm)
litres per minute	1.440 000	cubic metres/day (m^3/day)
igpm	6.546 300	cubic metres/day (m^3/day)
cubic metres/day	0.152 759	igpm

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
Borehole	includes all "work types" except springs
Dewatering	the removal of groundwater from an aquifer for purposes other than use
Deltaic	a depositional environment in standing water near the mouth of a river
Dfb	climate classification that relates to long, cool summers and severe winters (Thornthwaite and Mather, 1957)
Evapotranspiration	a combination of evaporation from open bodies of water, evaporation from soil surfaces, and transpiration from the soil by plants (Freeze and Cherry, 1979)
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
km	kilometre
Kriging	a geo-statistical method for gridding irregularly-spaced data (Cressie, 1990)
Lacustrine	fine-grained sedimentary deposits associated with a lake environment and not including shore-line deposits
Lithology	description of rock material
Lsd	Legal Subdivision
m	metres
mm	millimetres
m^2/day	metres squared per day
m^3	cubic metres
m^3/day	cubic metres per day
mg/L	milligrams per litre

Obs WW — Observation Water Well

Piper tri-linear diagram — a method that permits the major cation and anion compositions of single or multiple samples to be represented on a single graph. This presentation allows groupings or trends in the data to be identified. From the Piper tri-linear diagram, it can be seen that the groundwater from this sample water well is a sodium-bicarbonate-type. The chemical type has been determined by graphically calculating the dominant cation and anion. For a more detailed explanation, please refer to Freeze and Cherry, 1979



Piper Tri-Linear Diagram

Rock — earth material below the root zone

Surficial Deposits — includes all sediments above the bedrock

Thalweg — the line connecting the lowest points along a stream bed or valley; *longitudinal profile*

Till — a sediment deposited directly by a glacier that is unsorted and consisting of any grain size ranging from clay to boulders

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

Water Well — a hole in the ground for the purpose of obtaining groundwater; “work type” as defined by AENV includes test hole, chemistry, deepened, well inventory, federal well survey, reconditioned, reconstructed, new, old well-test

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

AENV — Alberta Environment

AMSL — above mean sea level

BGP — Base of Groundwater Protection

DEM — Digital Elevation Model

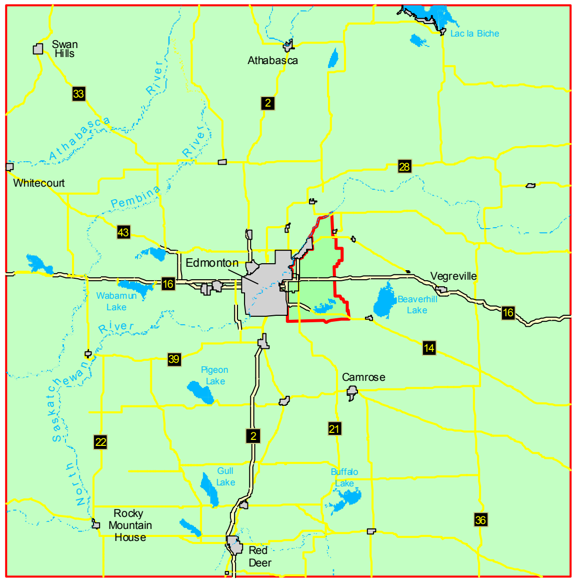
DST — drill stem test

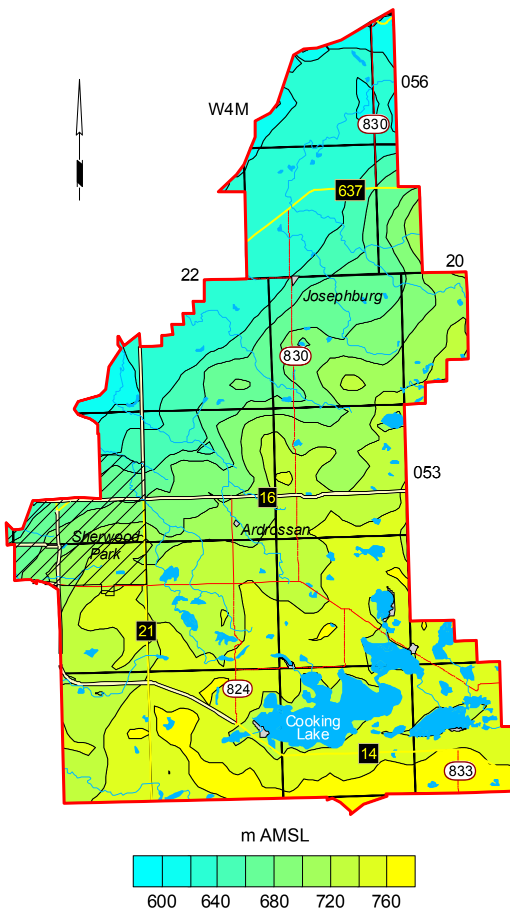
EUB	Alberta Energy and Utilities Board
GCDWQ	Guidelines for Canadian Drinking Water Quality
NPWL	non-pumping water level
PFRA	Prairie Farm Rehabilitation Administration
TDS	Total Dissolved Solids
WSW	Water Source Well or Water Supply Well

STRATHCONA COUNTY
Appendix A

Hydrogeological Maps and Figures

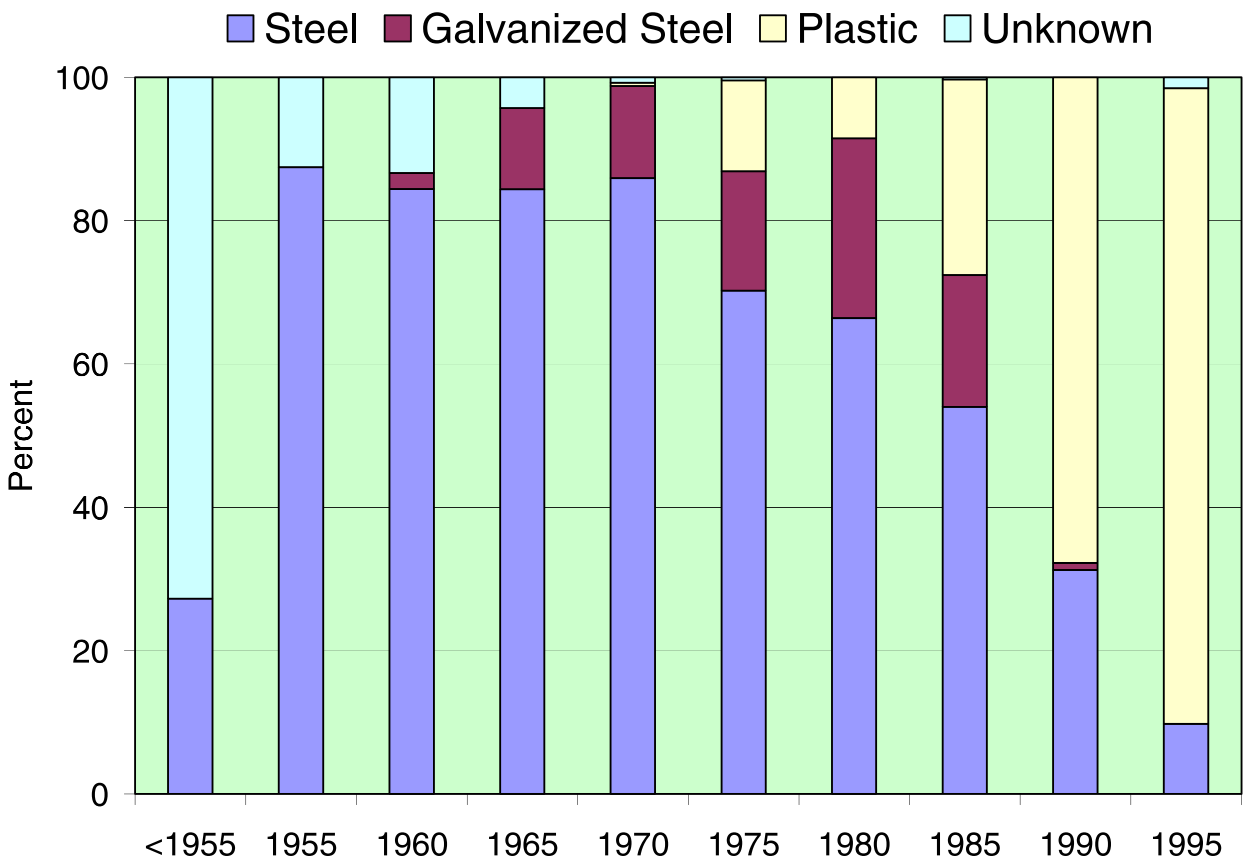
Index Map / Surface Topography



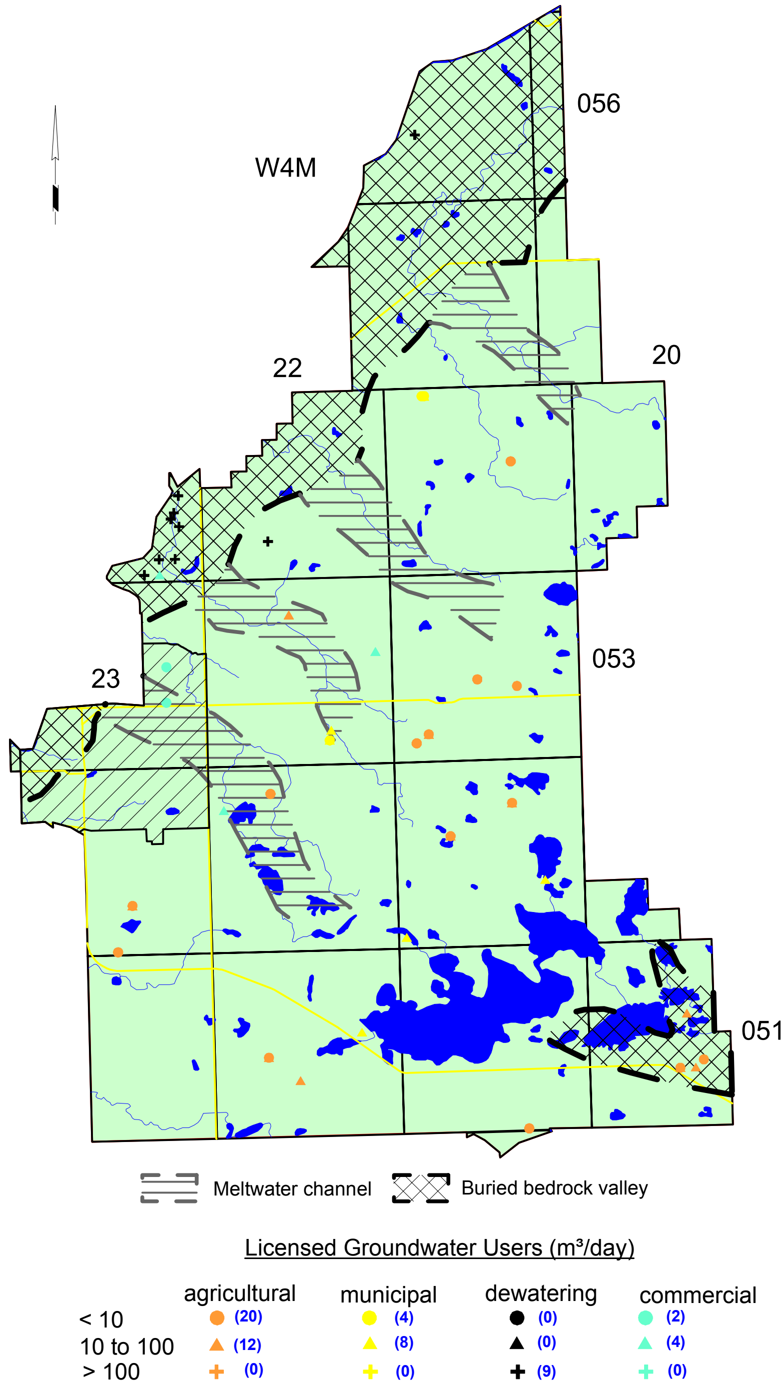


Strathcona County

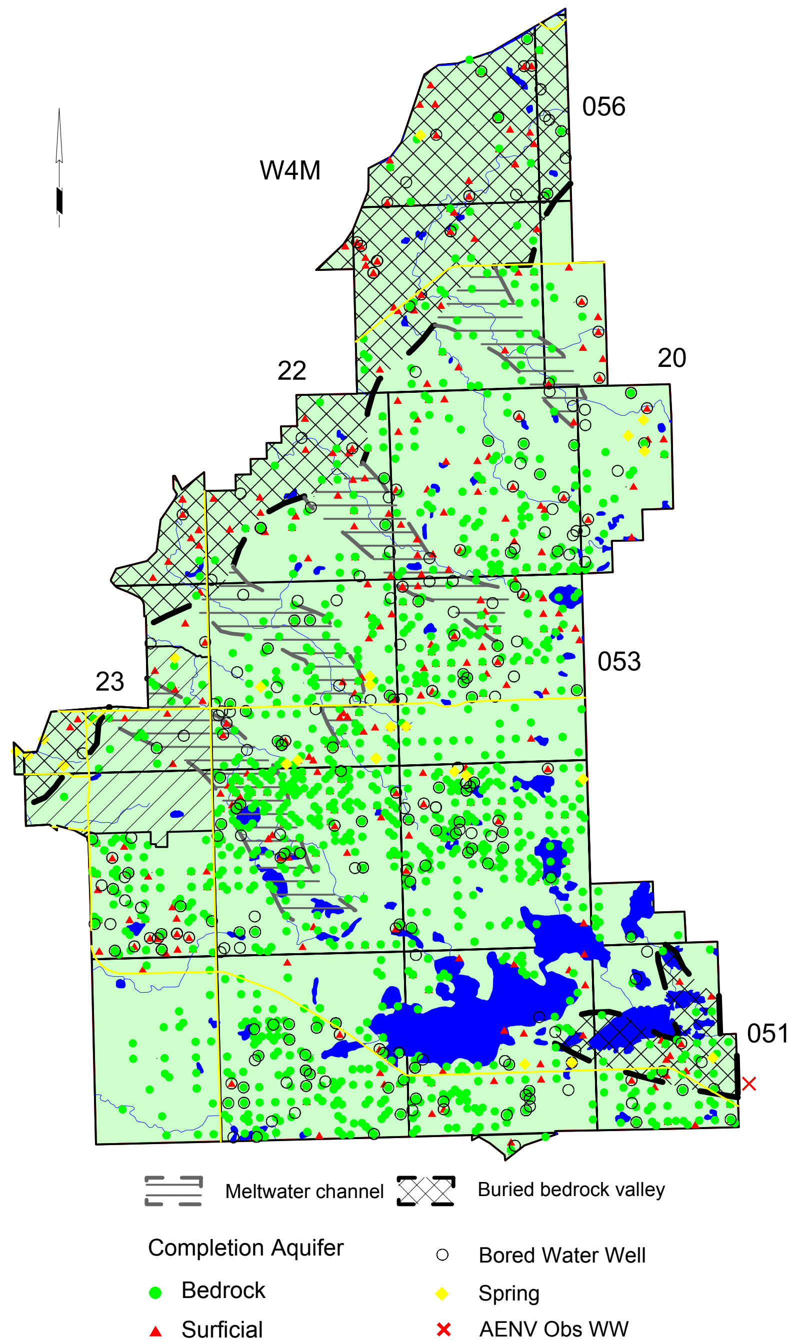
Surface Casing Types used in Drilled Water Wells



Licensed Water Wells

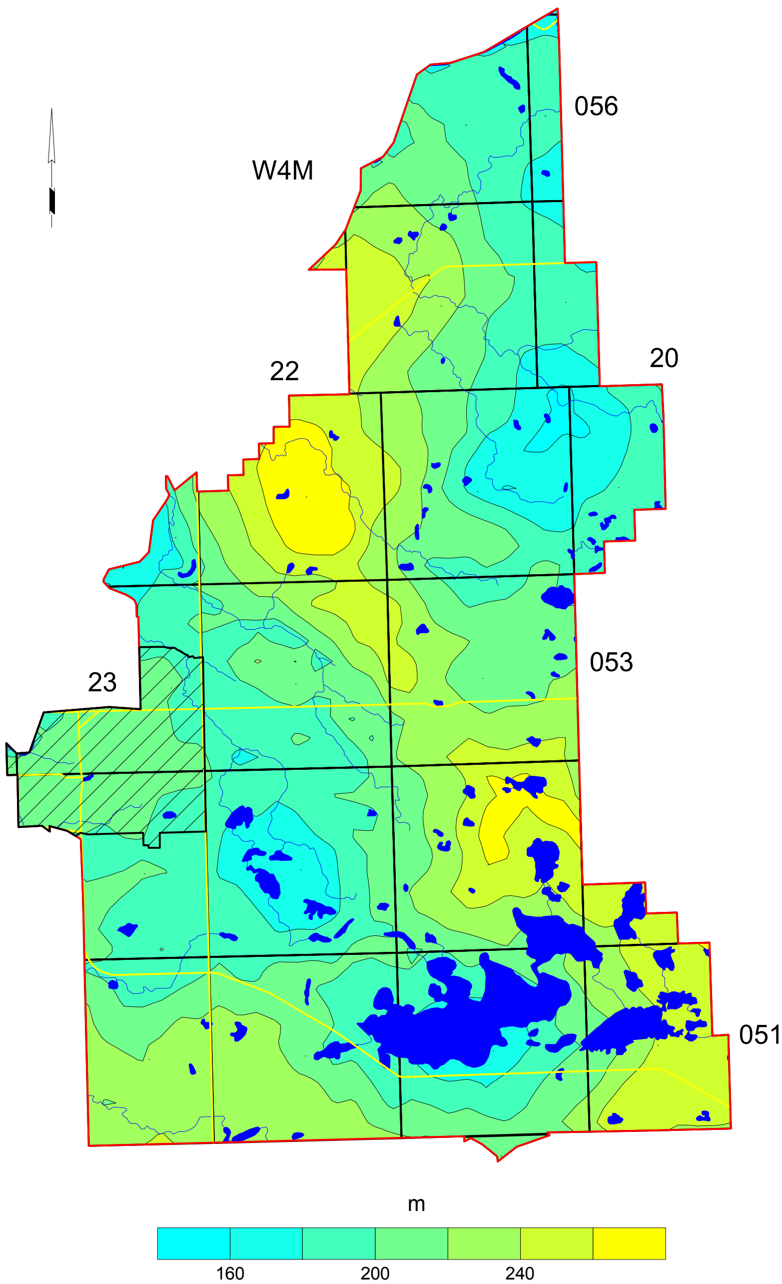


Location of Water Wells and Springs



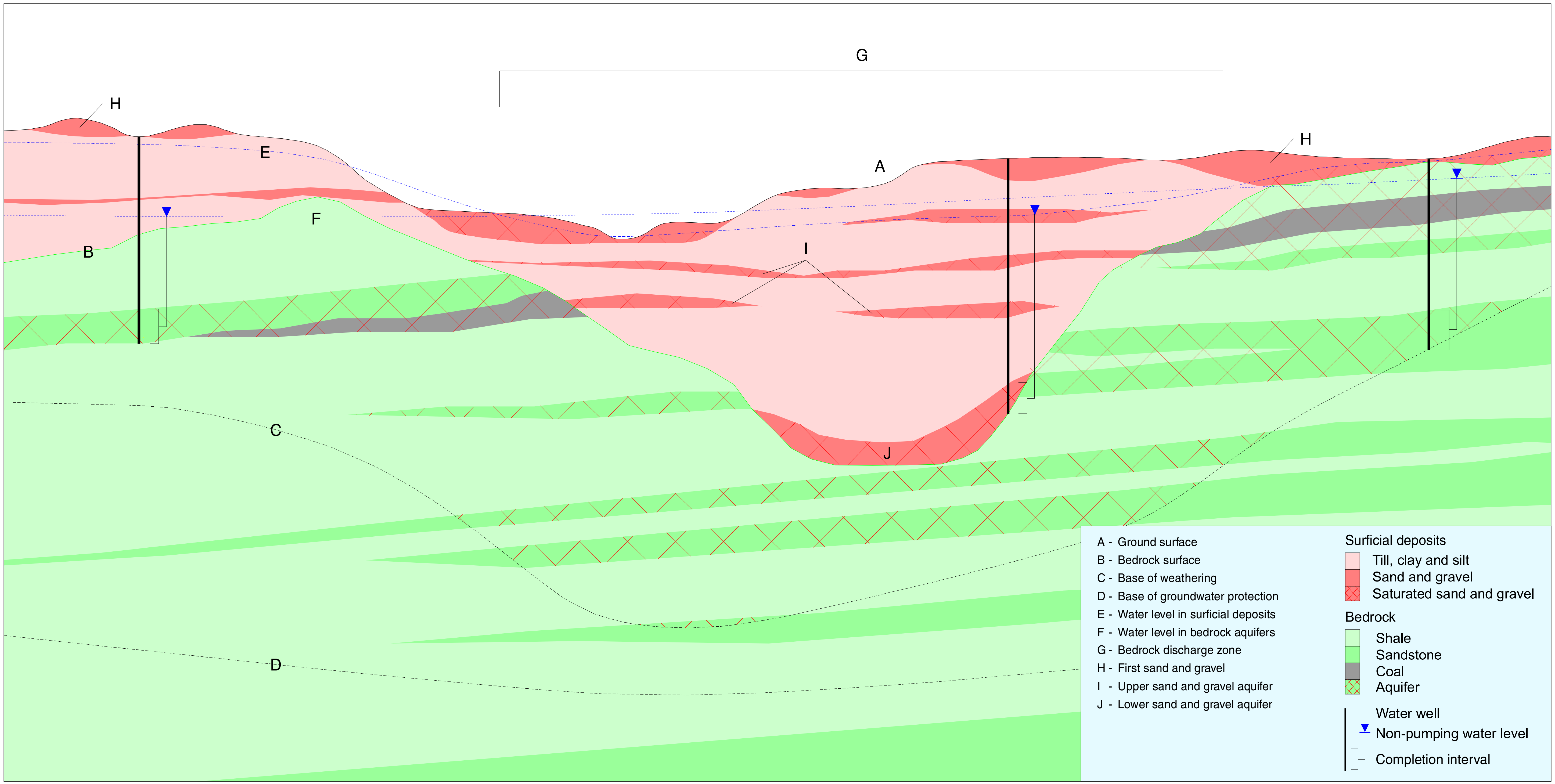
Depth to Base of Groundwater Protection

(modified after EUB, 1995)



Generalized Cross-Section

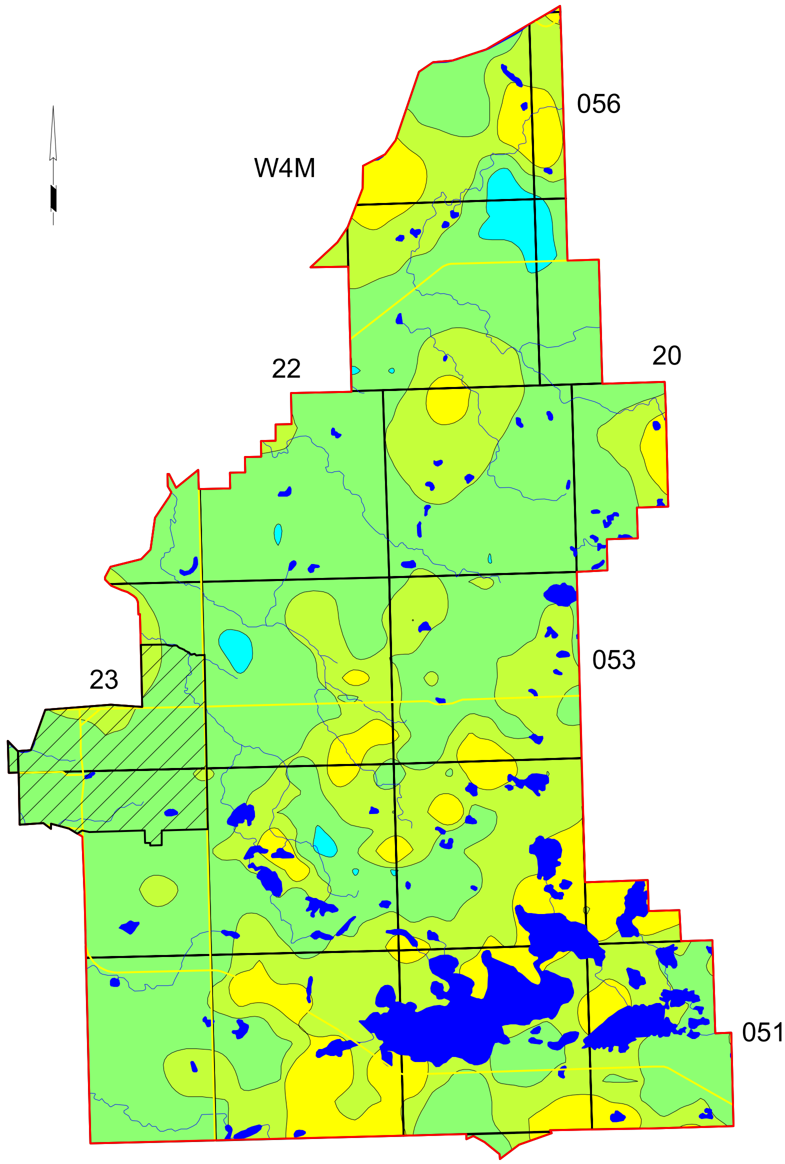
(for terminology only)



Geologic Column

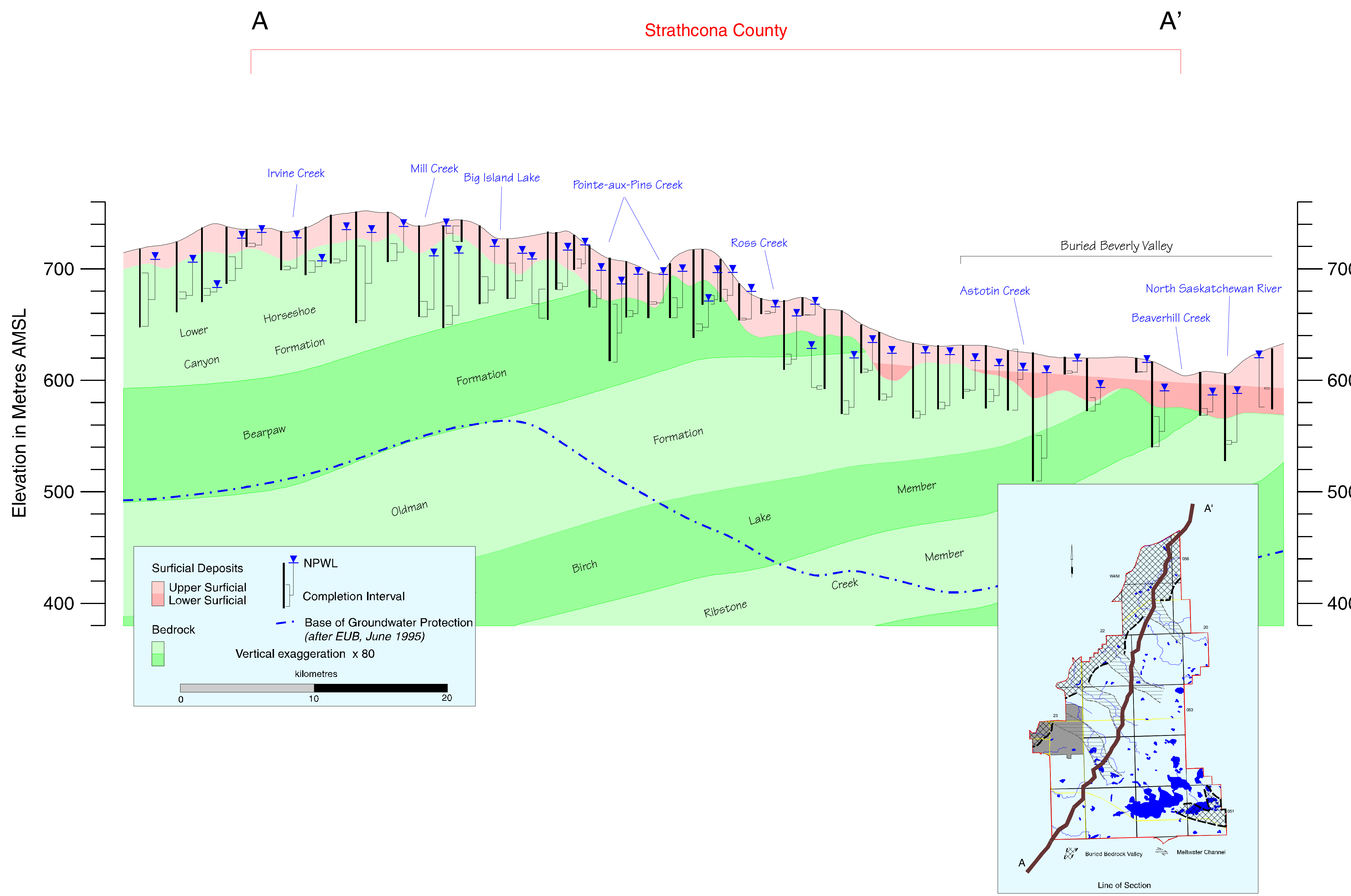
Lithologic Description	Group	Formation: Average Thickness (m)	Formation: Designation	Member: Average Thickness (m)	Member: Designation	Zone: Average Thickness (m)	Zone: Designation
sand, gravel, till, clay, silt		<70	Surficial Deposits	<70	Upper		
				<50	Lower		
shale, sandstone, coal, bentonite, limestone, ironstone	Edmonton Group	300-380	Horseshoe Canyon Formation	~100	Upper		
				~100	Middle		
				~170	Lower		
shale, sandstone, siltstone		60-120	Bearpaw Formation				
sandstone, siltstone, shale, coal	Belly River Group (<300)	40-130	Oldman Formation		Dinosaur Member	<25	Lethbridge Coal Zone
					Upper Siltstone Member		
					Comrey Member		
sandstone, shale		<200	Foremost Formation	<70	Birch Lake Member		Taber Coal Zone
				<60	Ribstone Creek Member		
				<70	Victoria Member		McKay Coal Zone
				0-30	Brosseau Member		

Hydrogeological Map

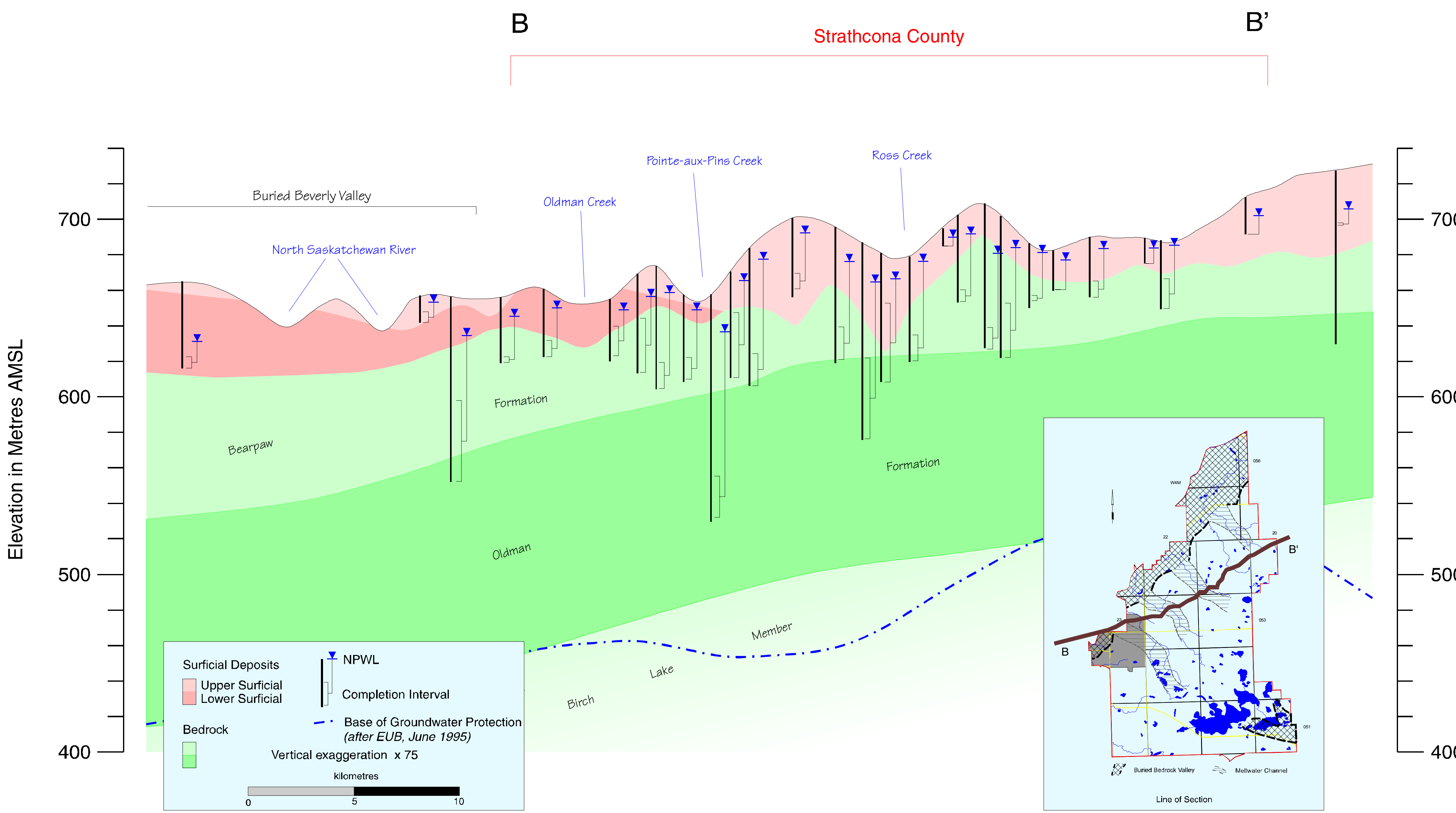


Maximum Probable Apparent Water Well Yield (m^3/day)

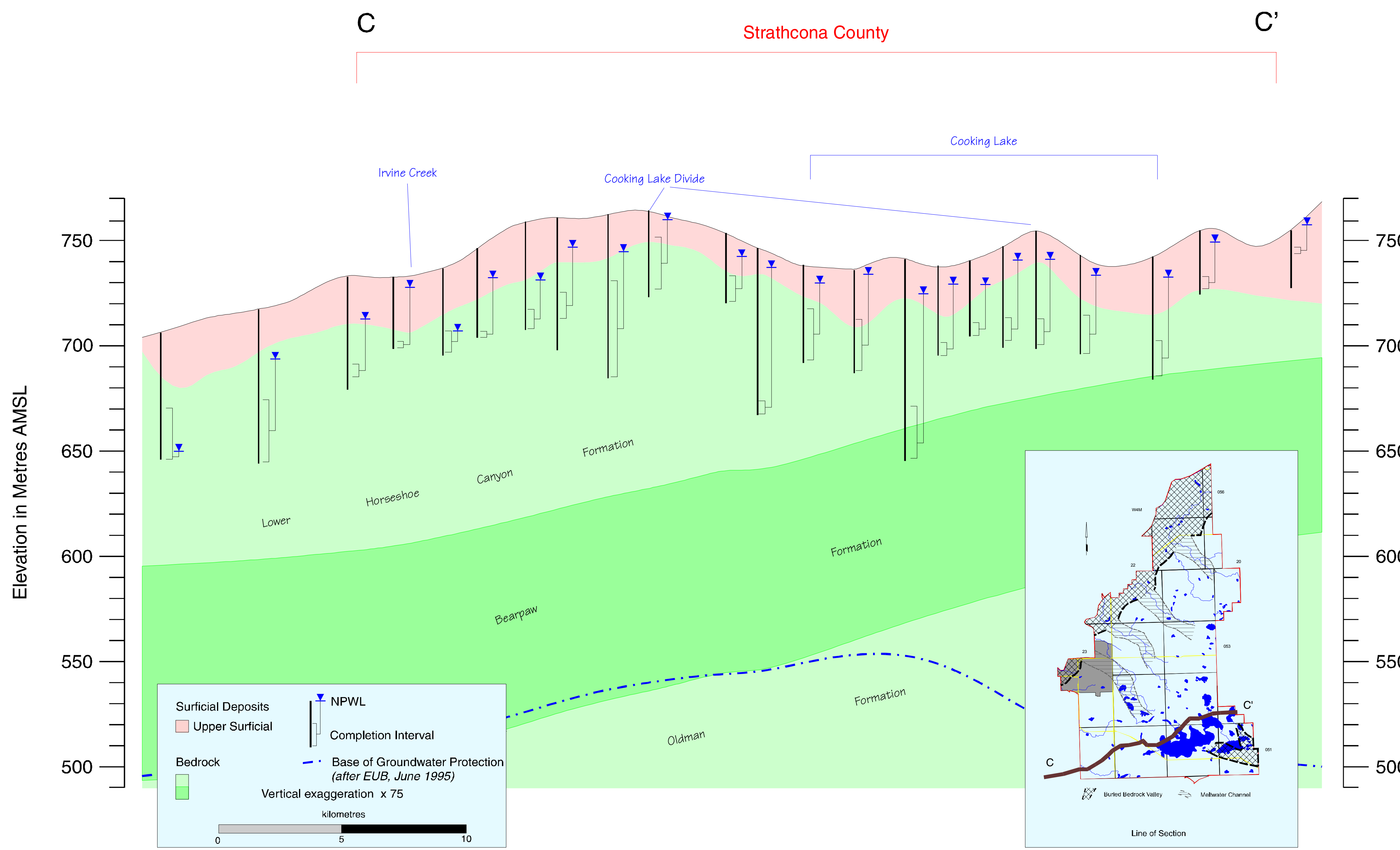
Cross-Section A - A'



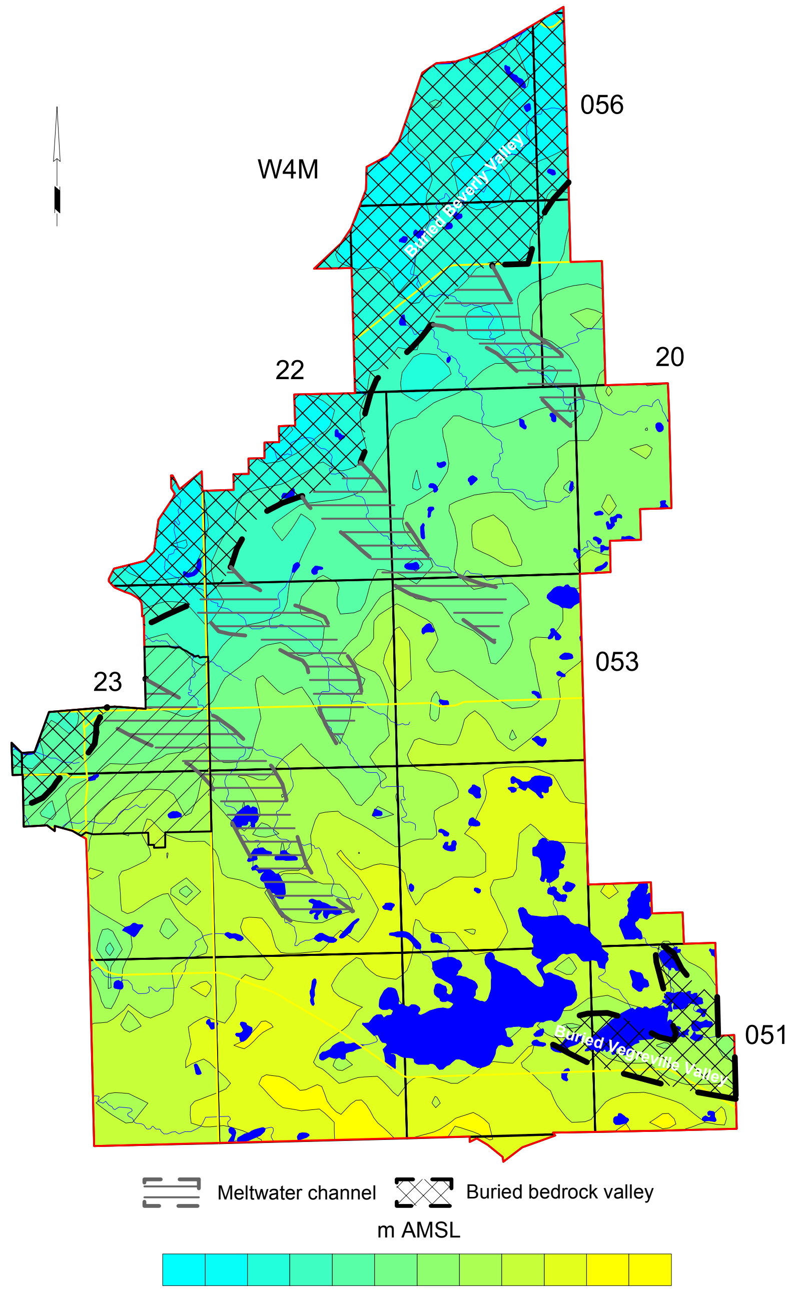
Cross-Section B - B'



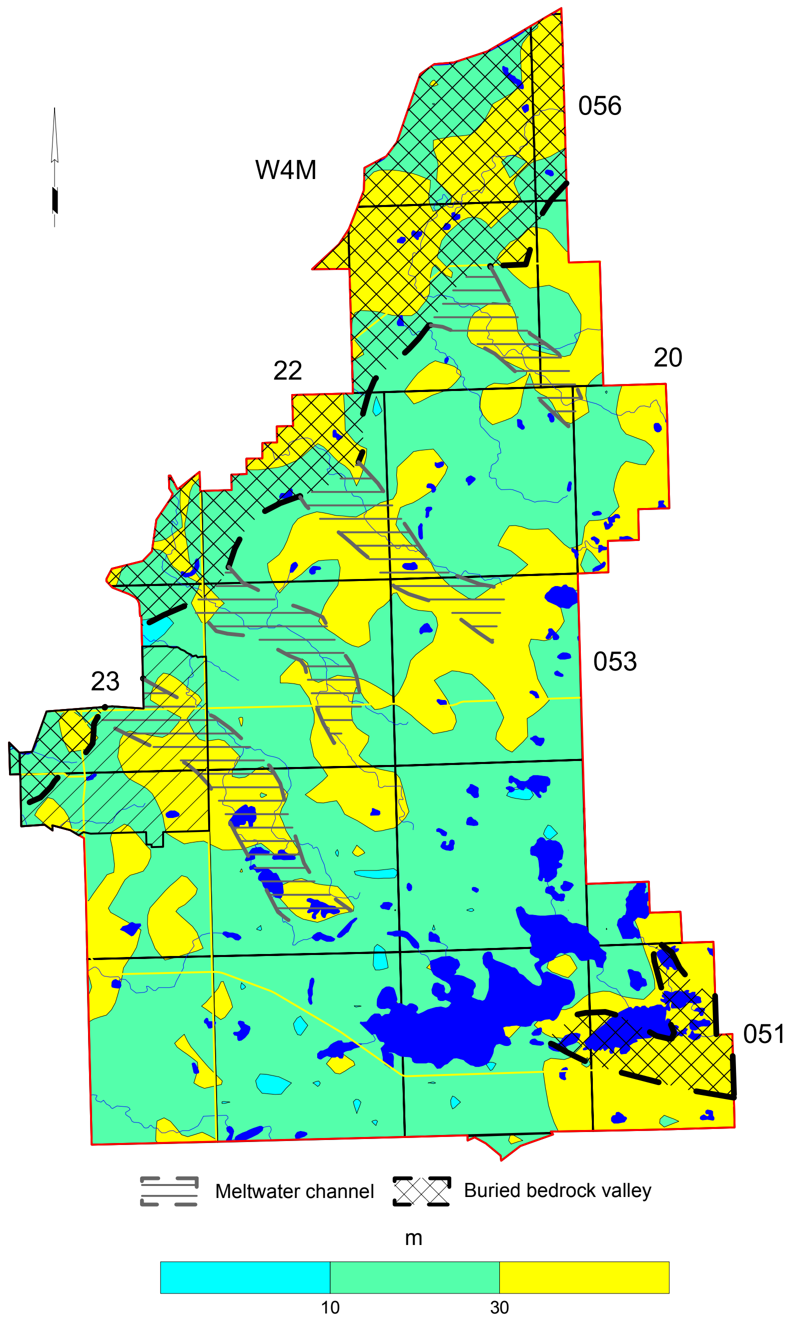
Cross-Section C - C'



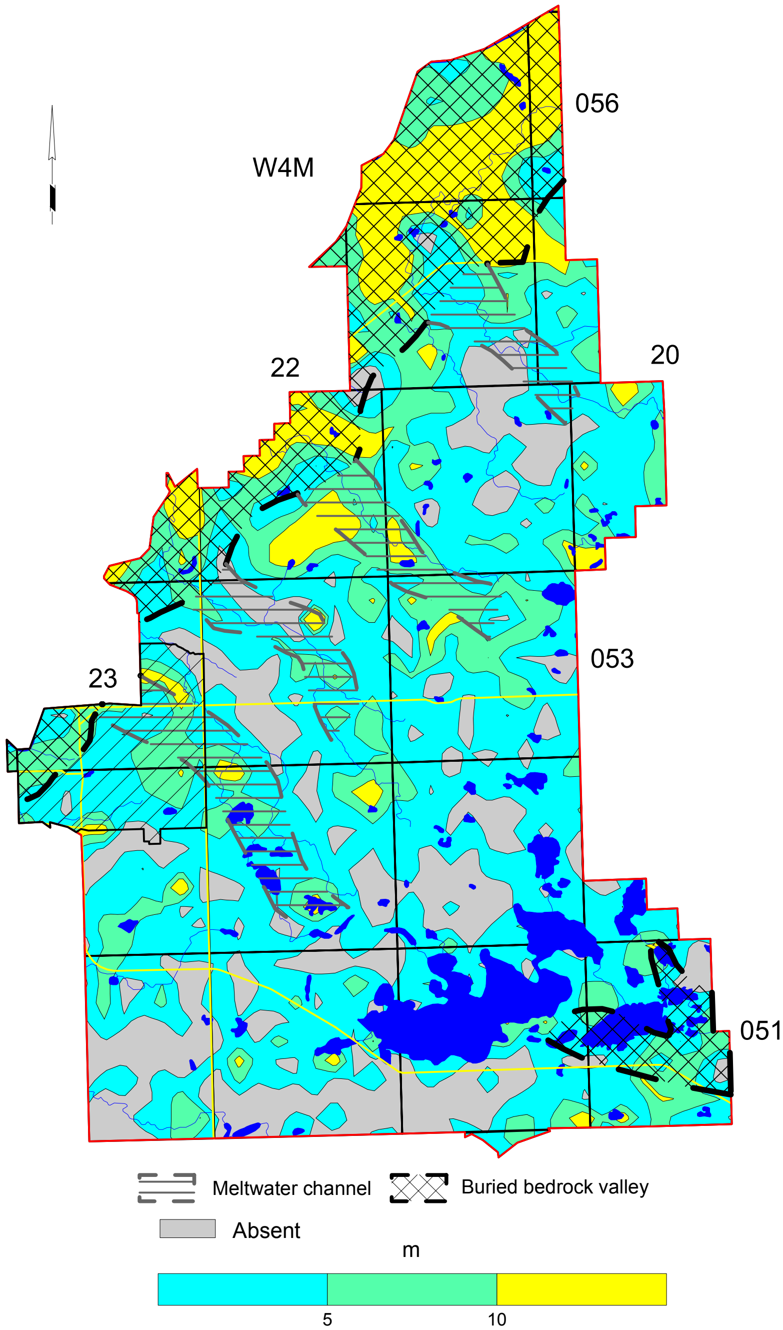
Bedrock Topography



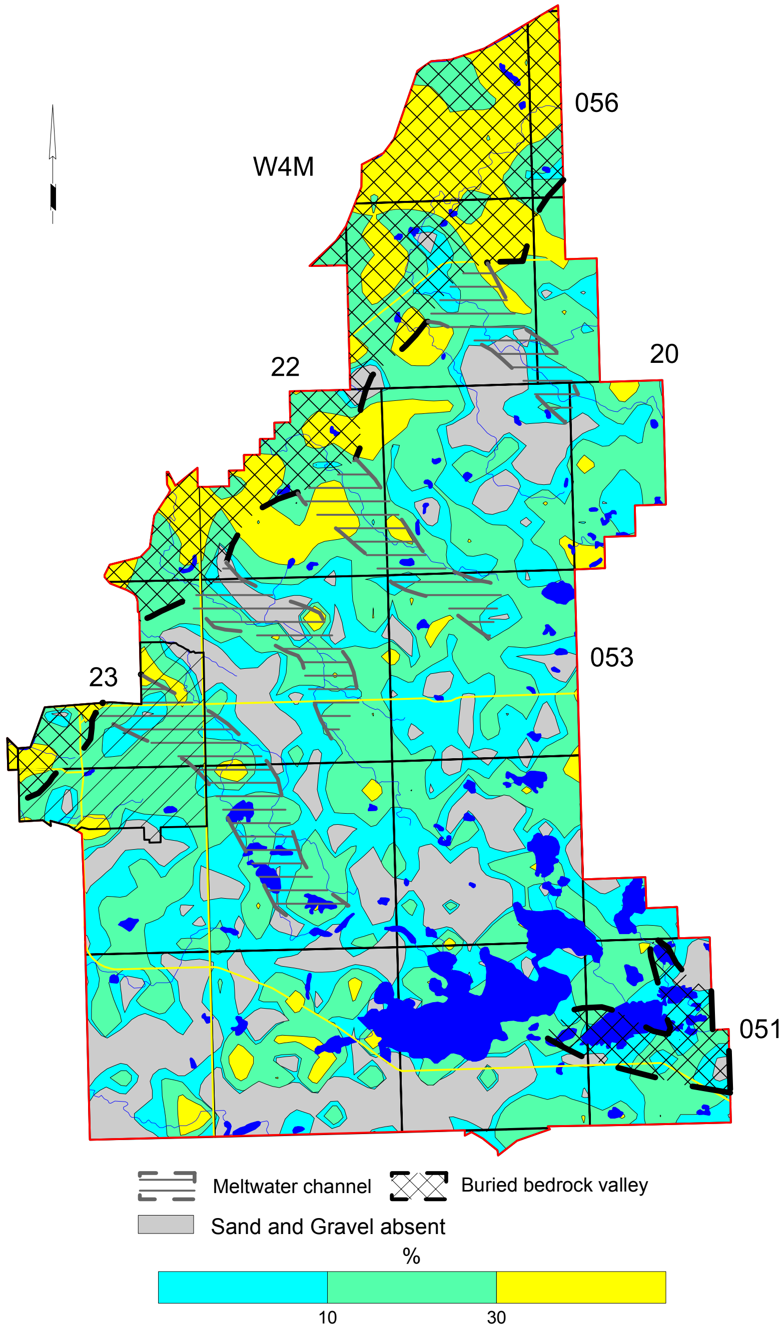
Thickness of Surficial Deposits



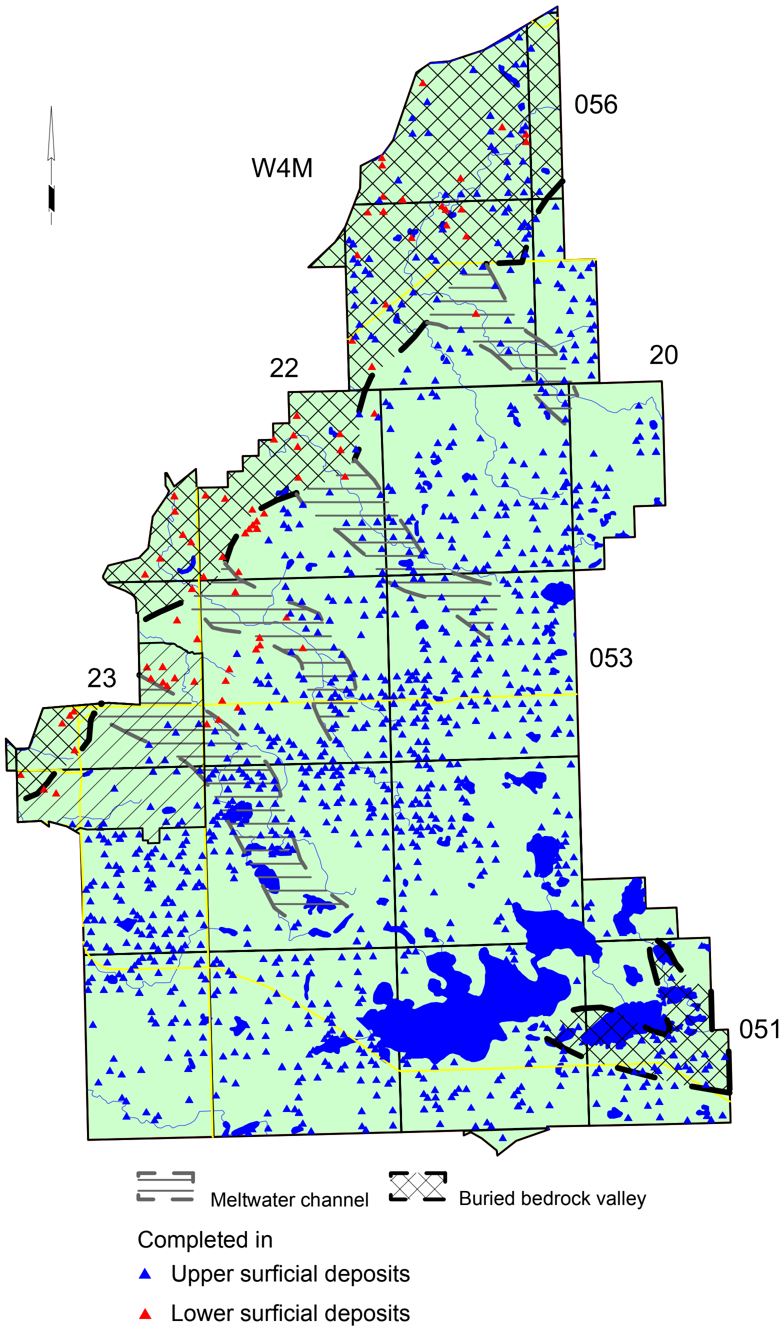
Thickness of Sand and Gravel Deposits



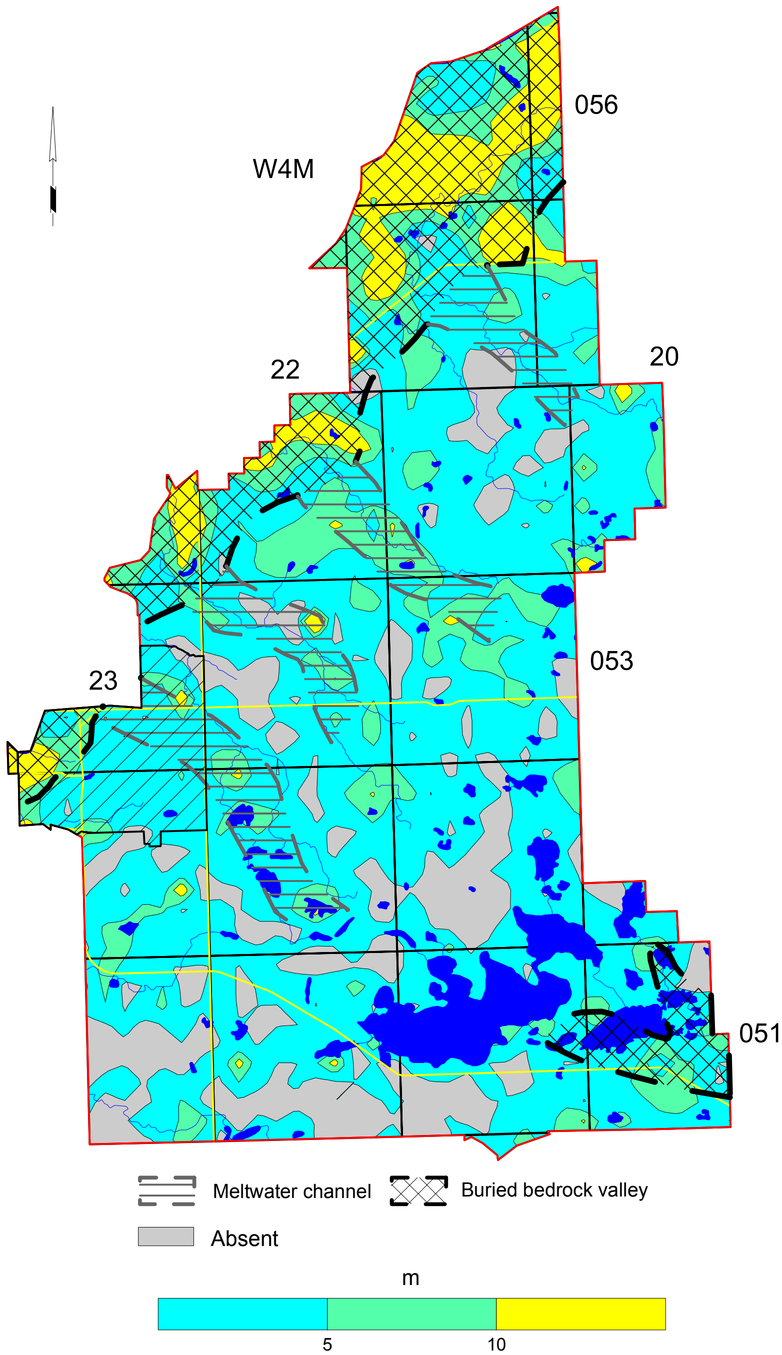
Amount of Sand and Gravel in Surficial Deposits



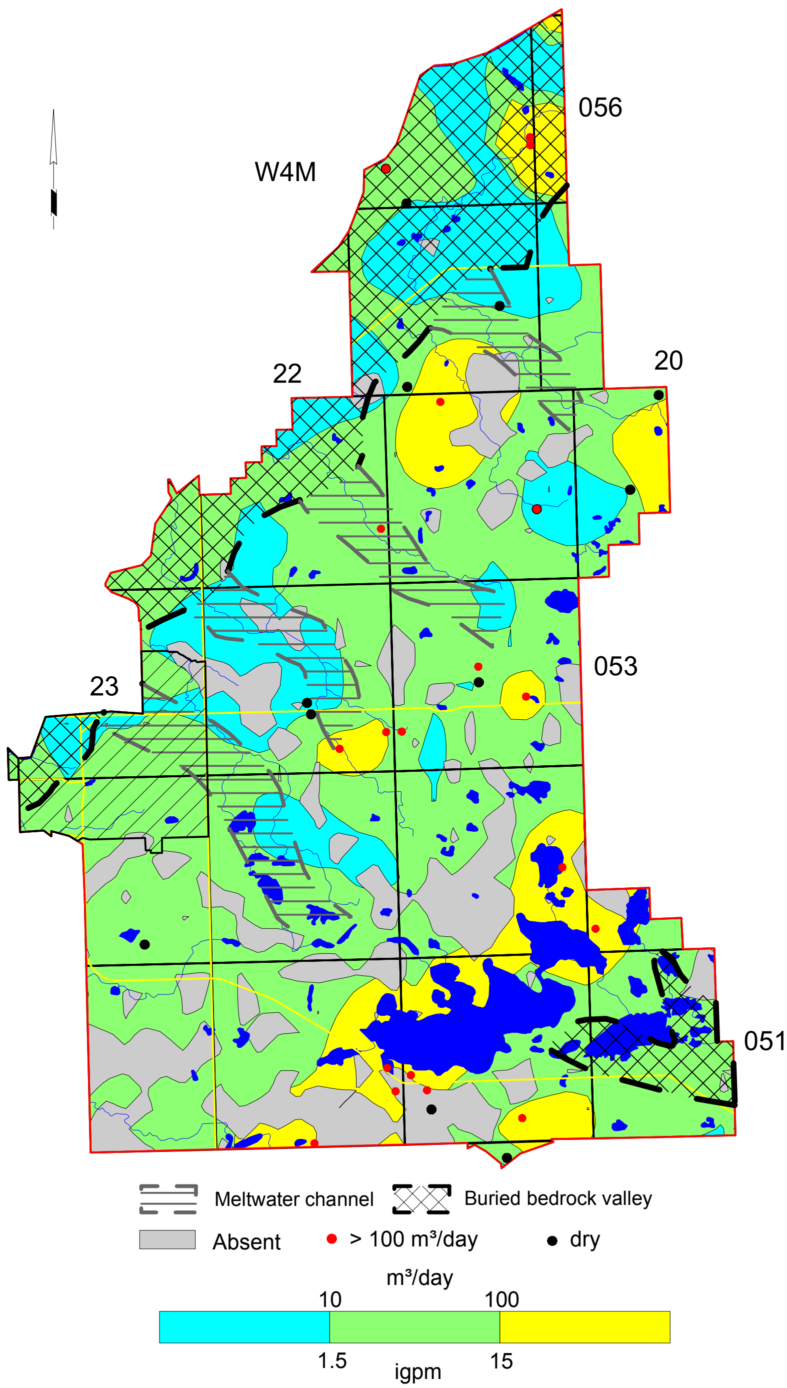
Water Wells Completed In Surficial Deposits



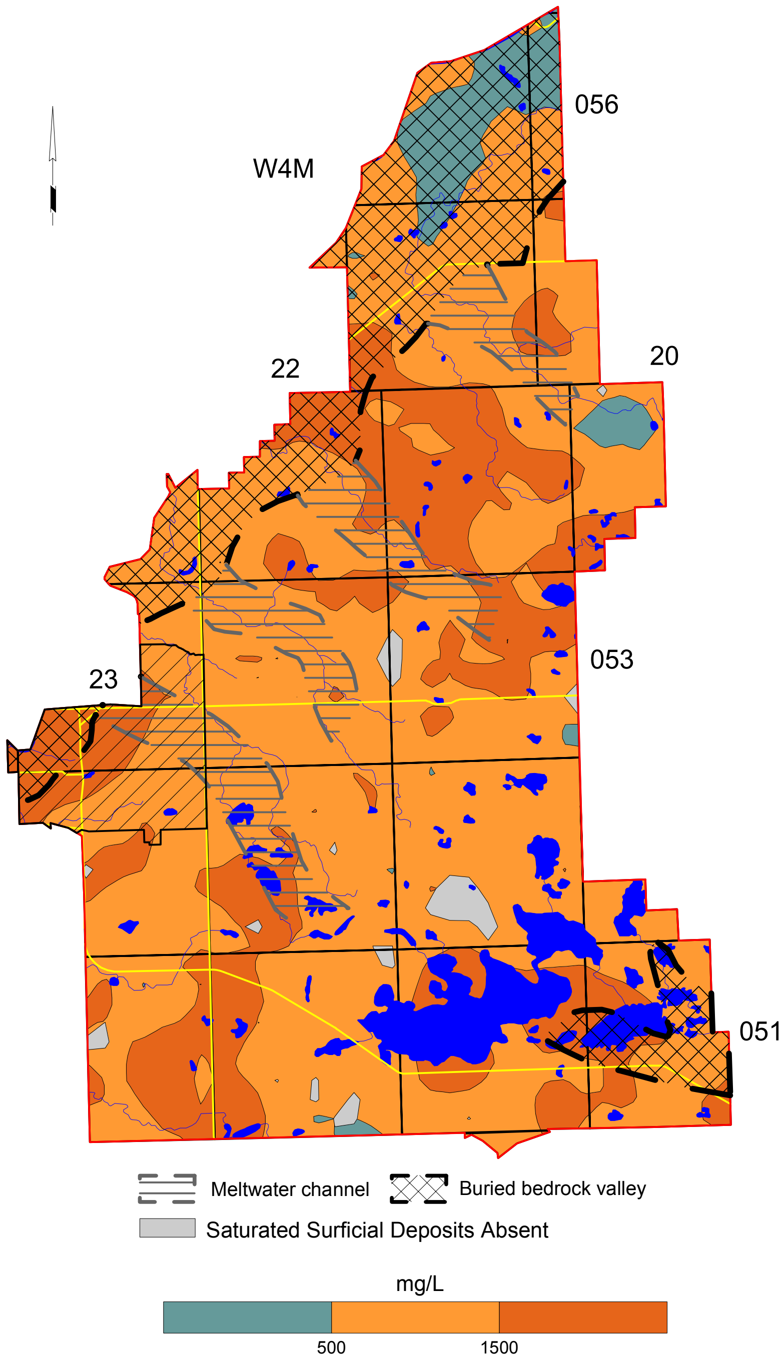
Thickness of Sand and Gravel Aquifer(s)



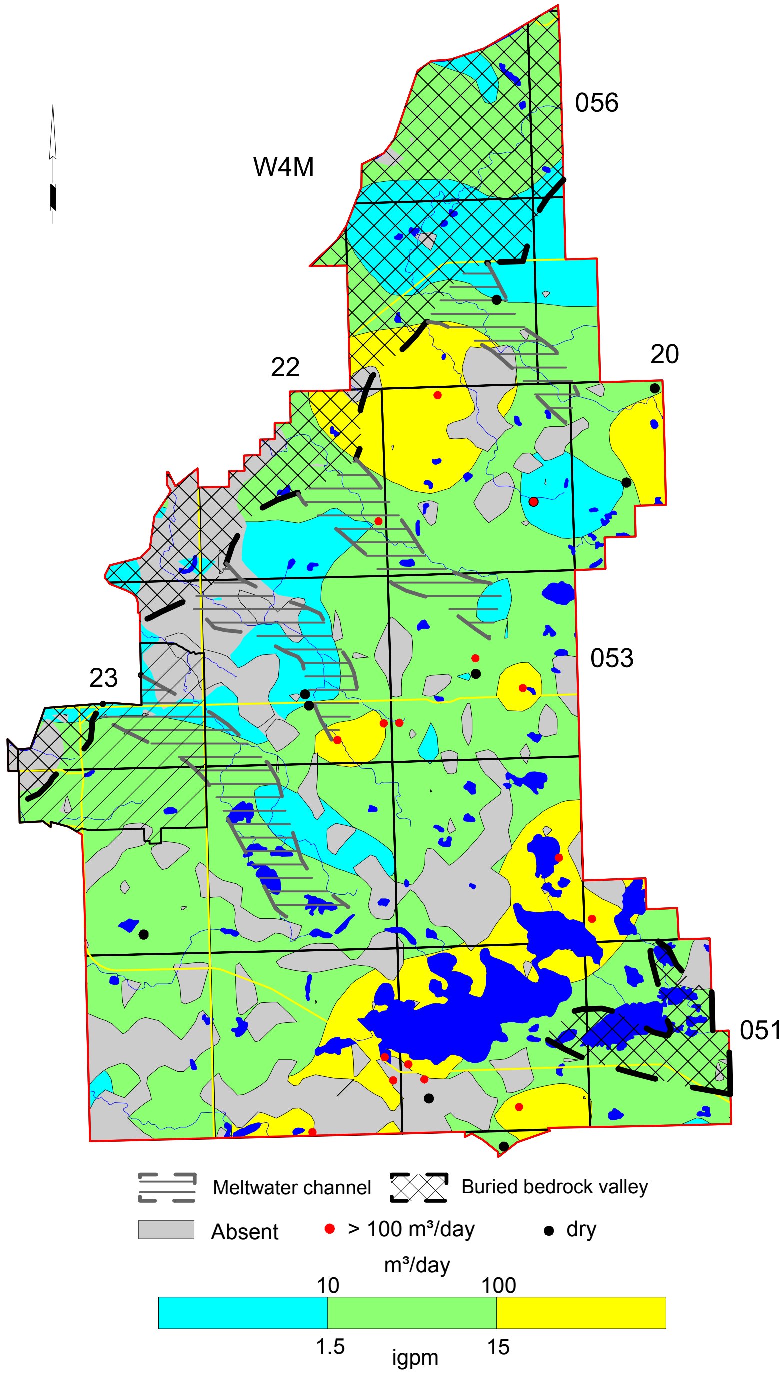
Apparent Yield for Water Wells Completed in Sand and Gravel Aquifer(s)



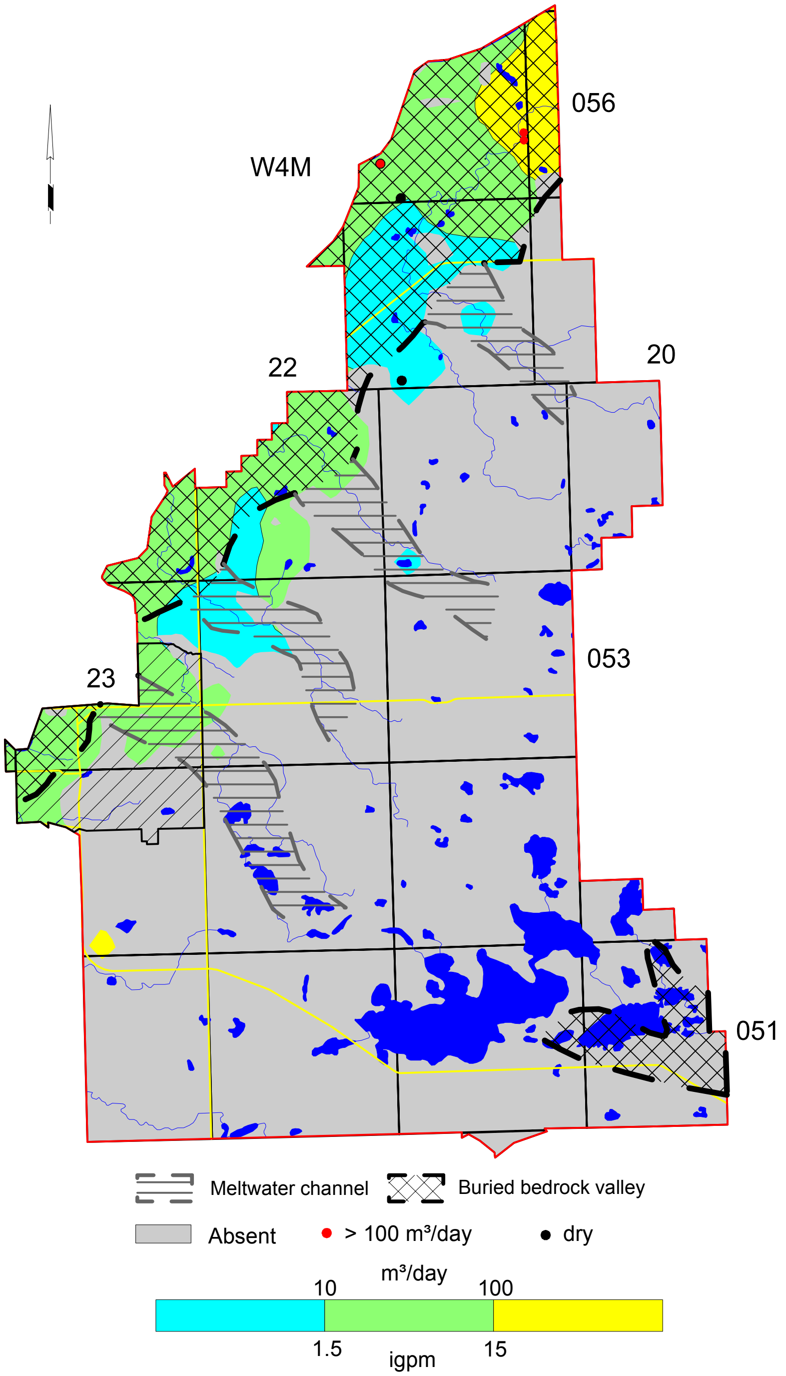
Total Dissolved Solids in Groundwater from Surficial Deposits



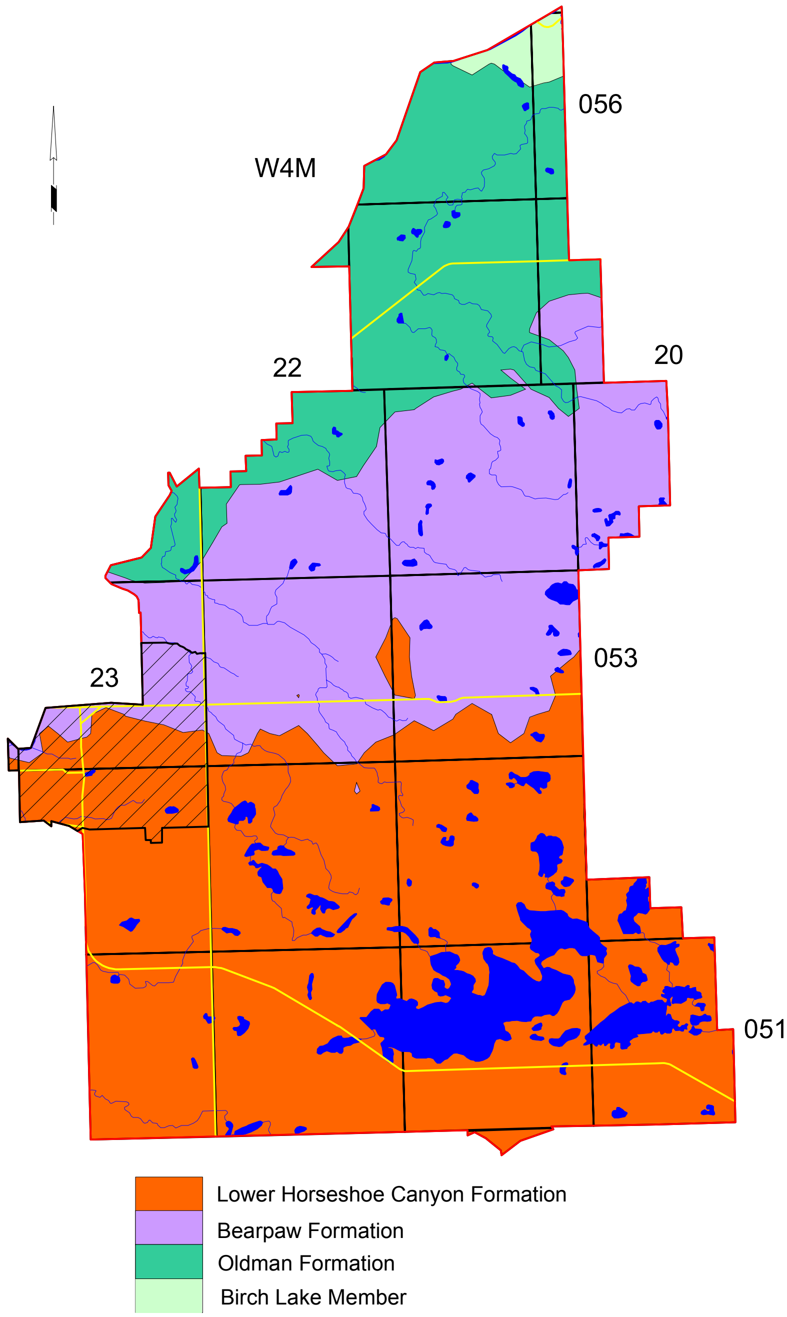
Apparent Yield for Water Wells Completed through Upper Sand and Gravel Aquifer



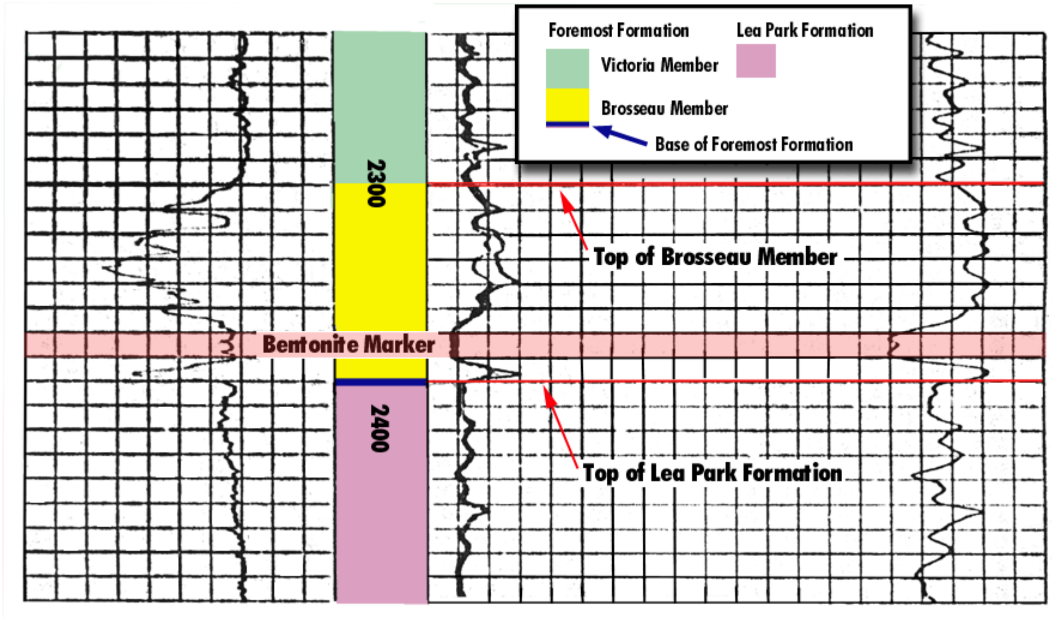
Apparent Yield for Water Wells Completed through Lower Sand and Gravel Aquifer



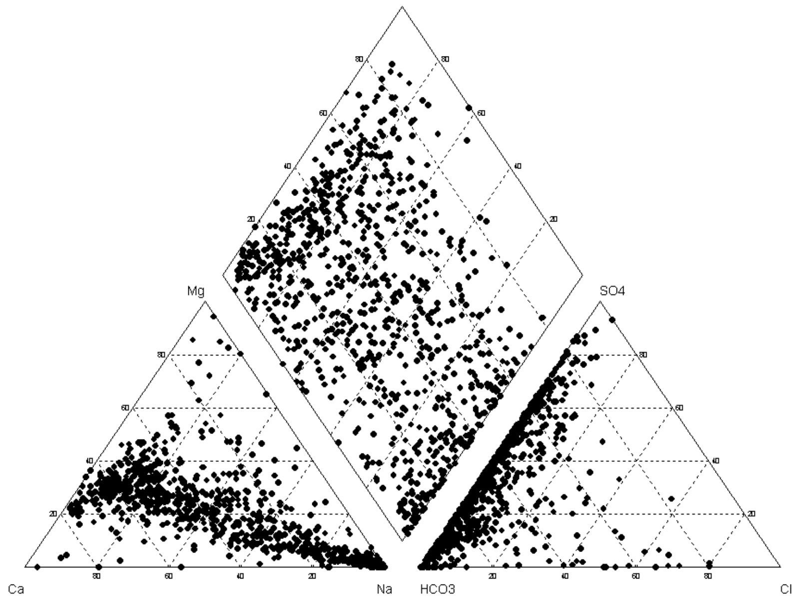
Bedrock Geology



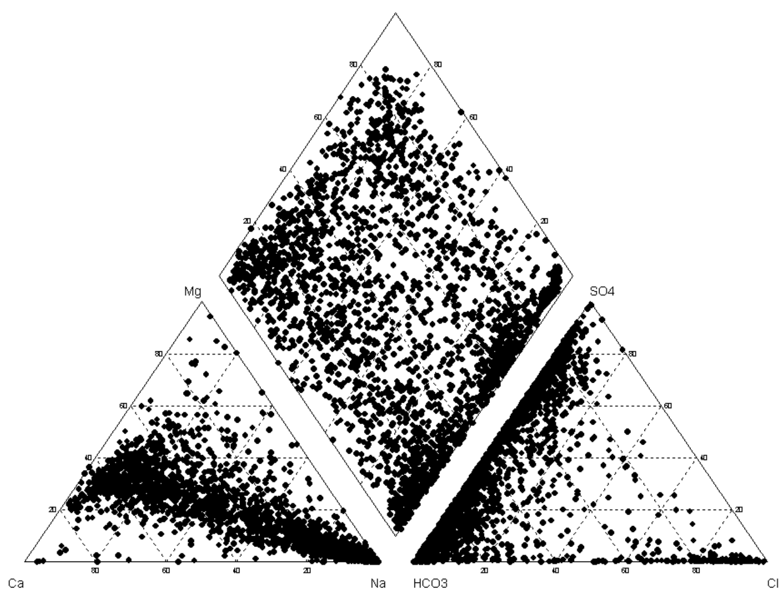
Elog Showing Base of Foremost Formation



Piper Diagrams

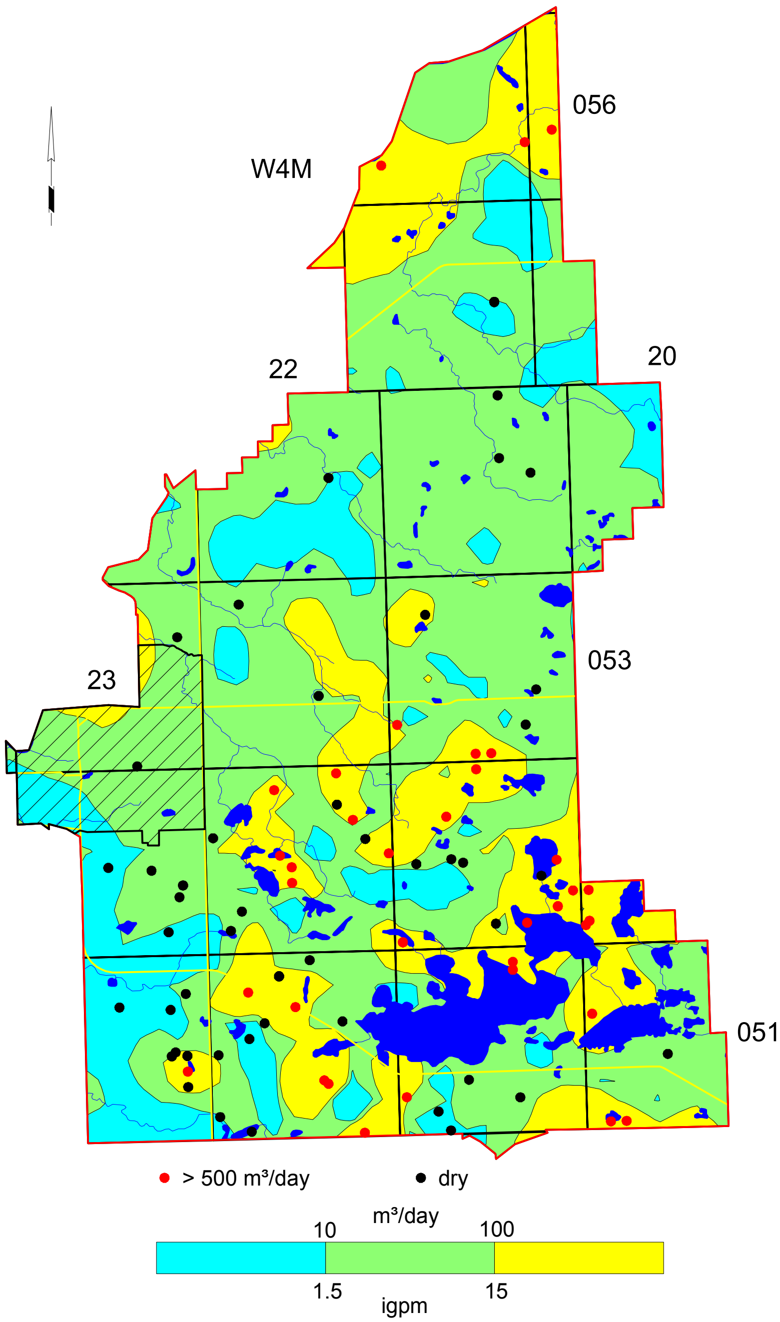


Surficial Deposits

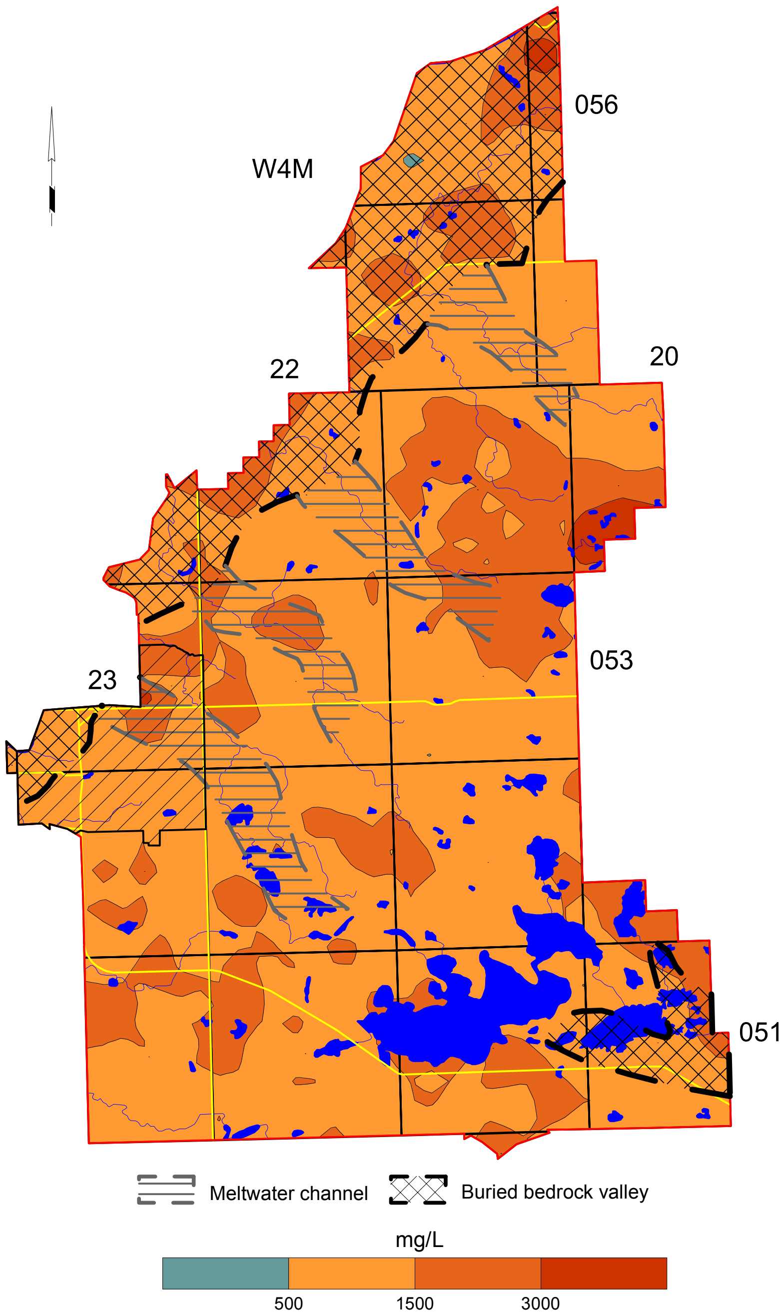


Bedrock Aquifers

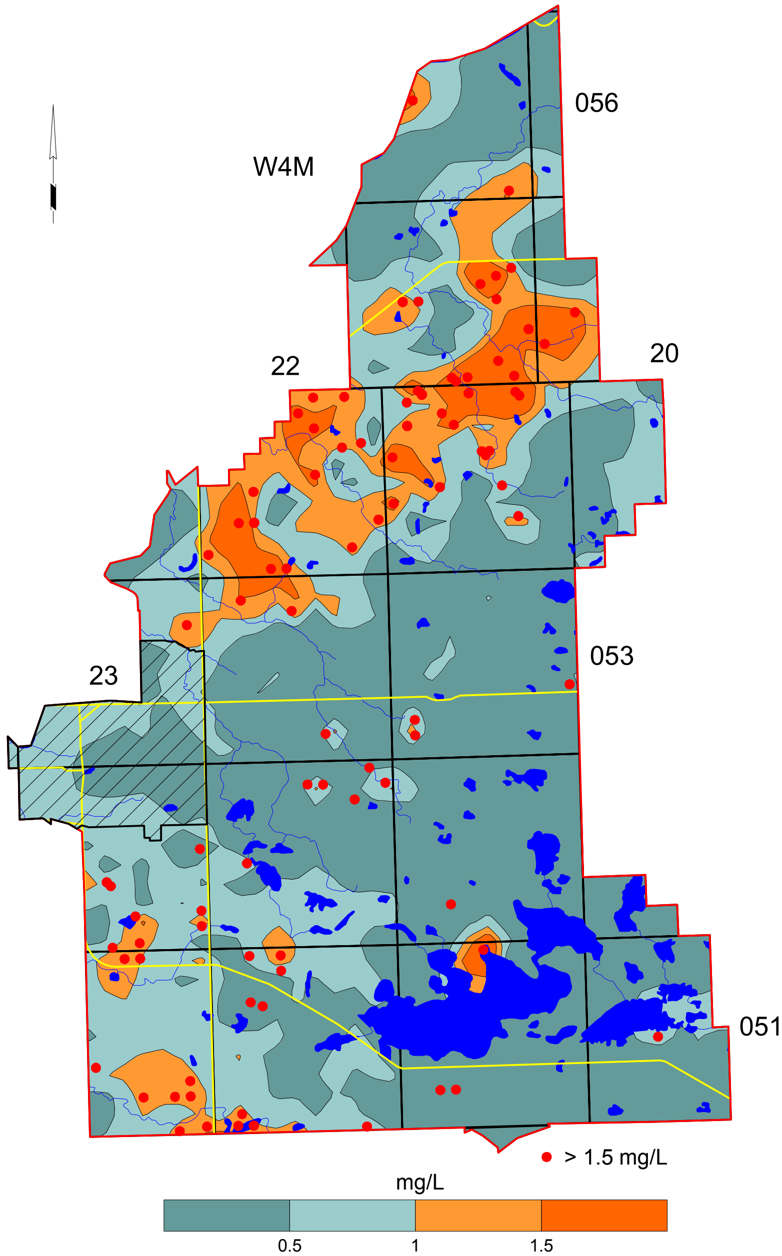
Apparent Yield for Water Wells Completed in Upper Bedrock Aquifer(s)



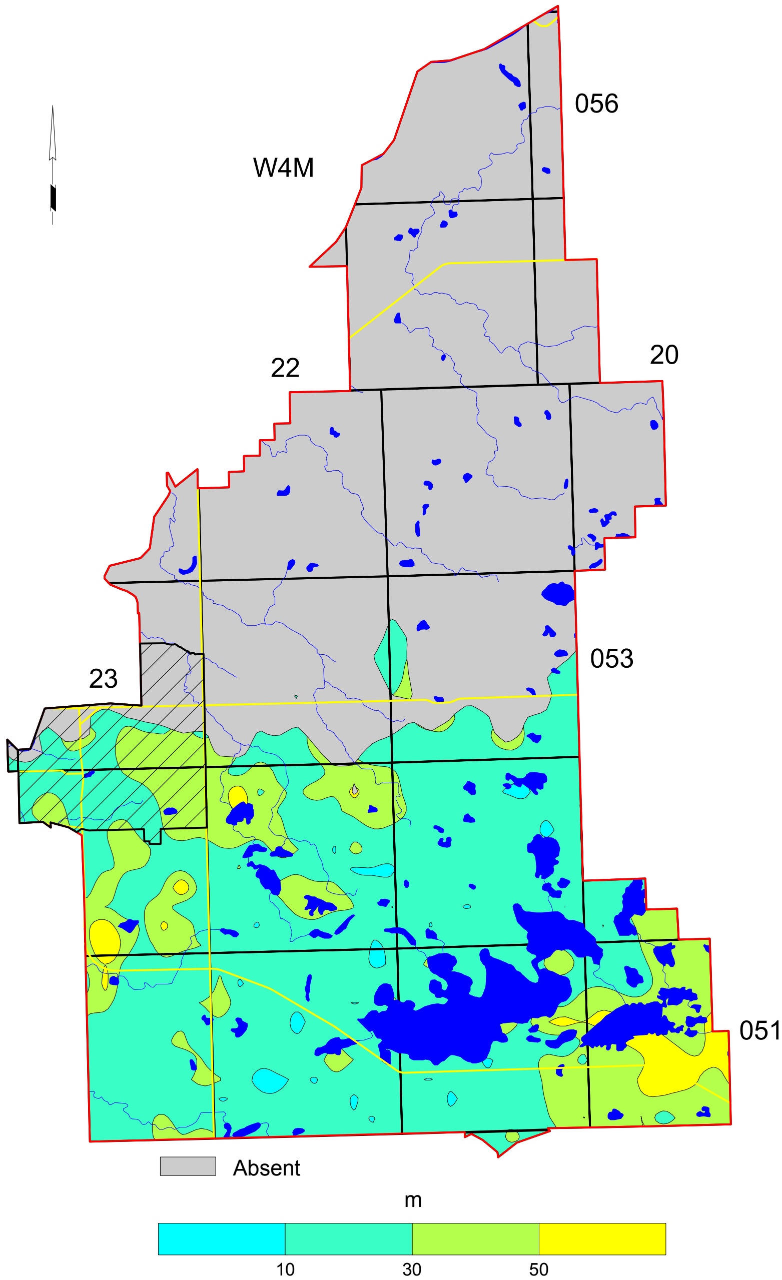
Total Dissolved Solids in Groundwater from Upper Bedrock Aquifer(s)



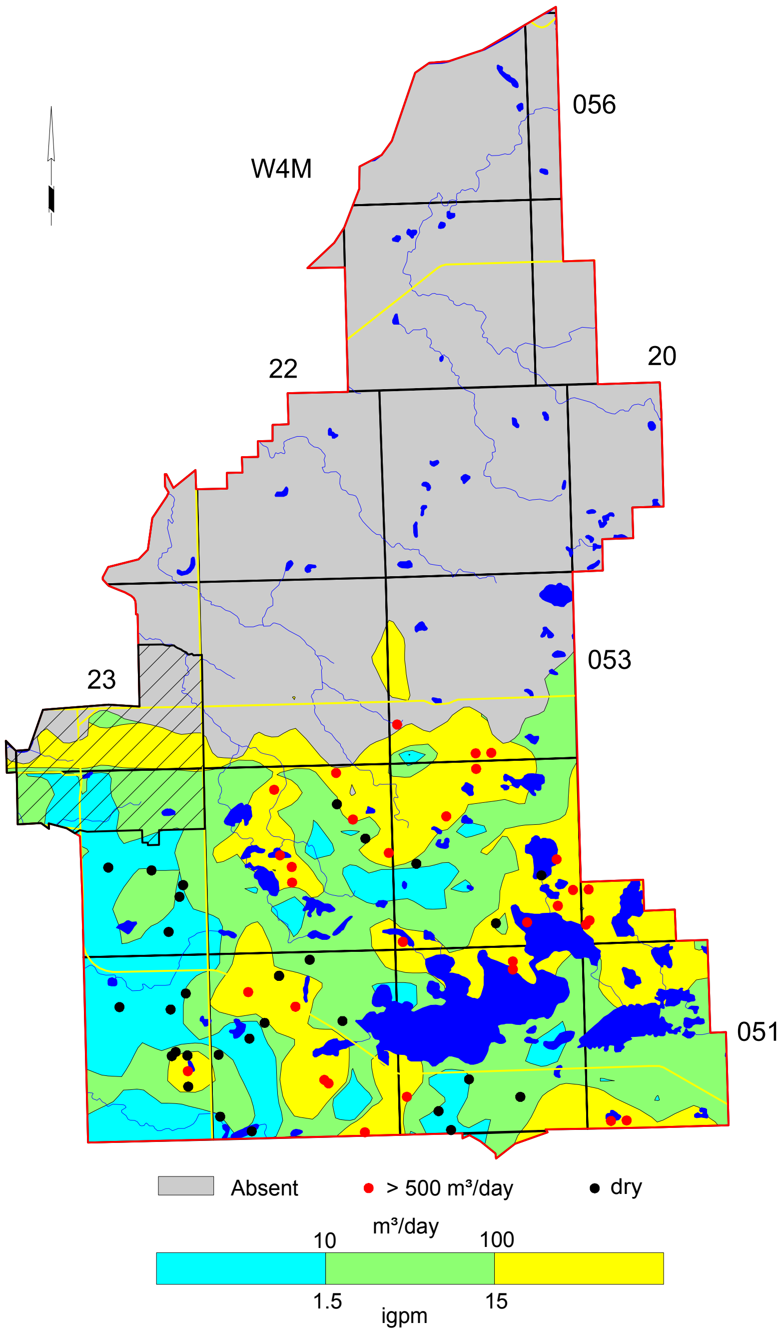
Fluoride in Groundwater from Upper Bedrock Aquifer(s)



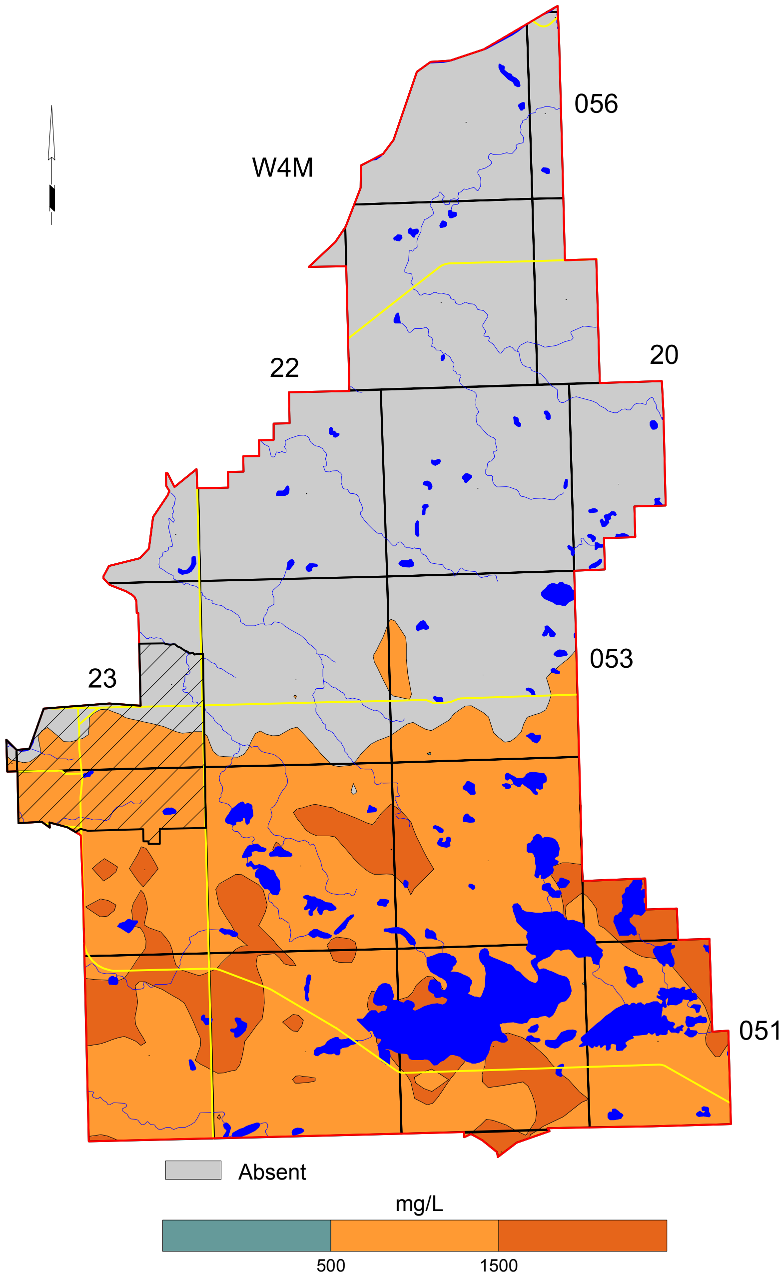
Depth to Top of Lower Horseshoe Canyon Formation



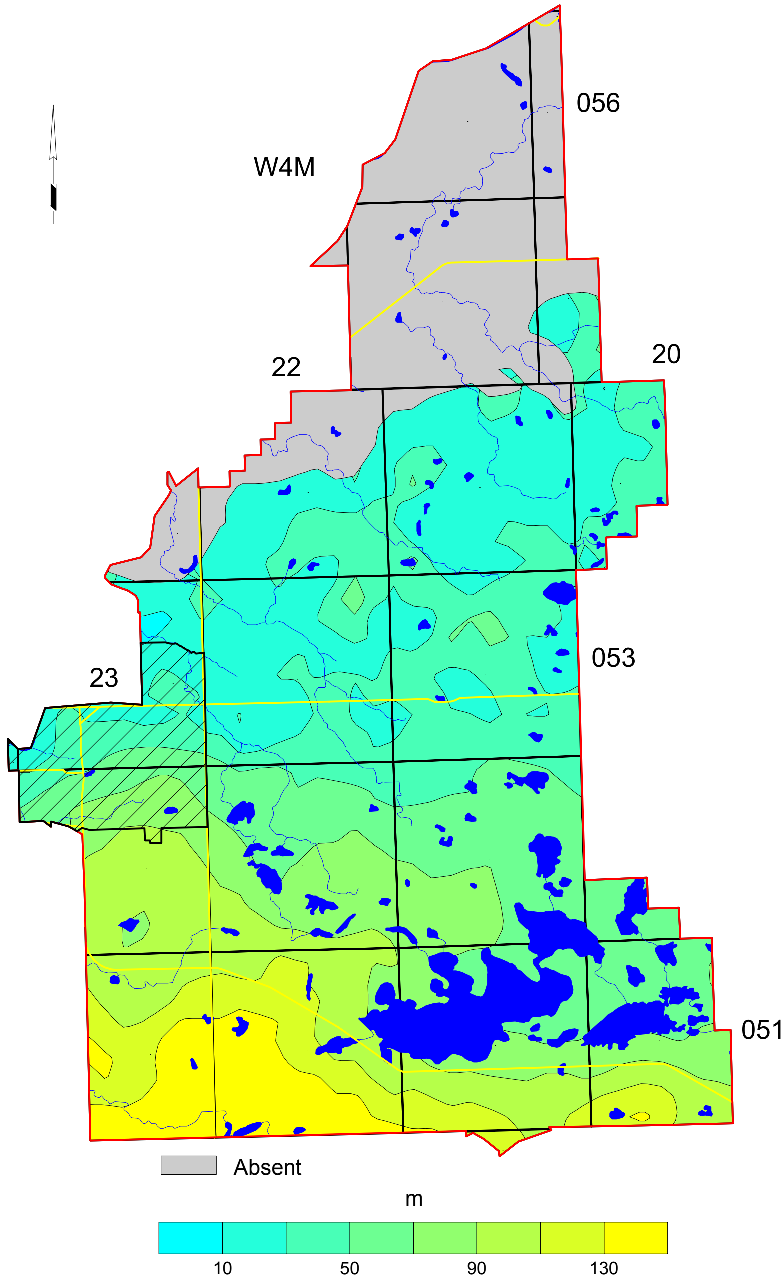
Apparent Yield for Water Wells Completed through Lower Horseshoe Canyon Aquifer



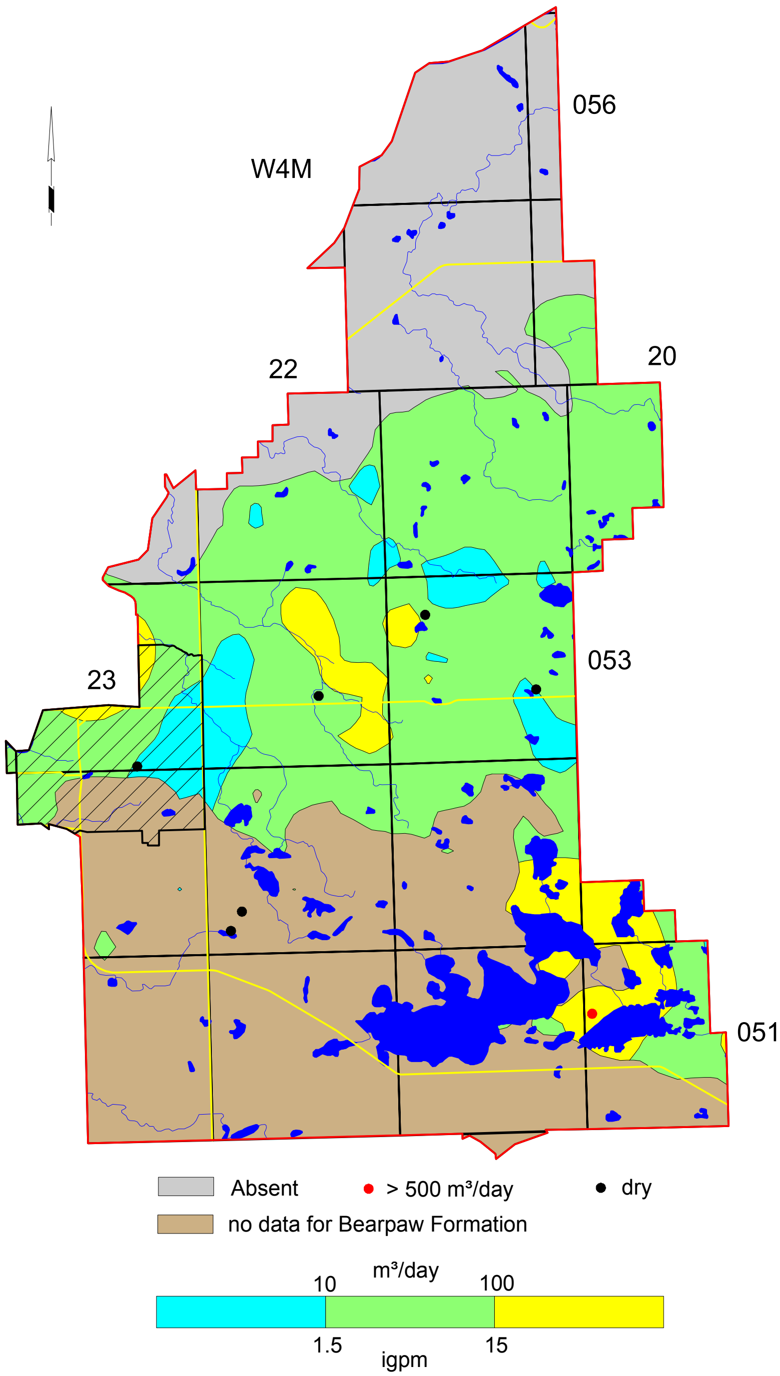
Total Dissolved Solids in Groundwater from Lower Horseshoe Canyon Aquifer



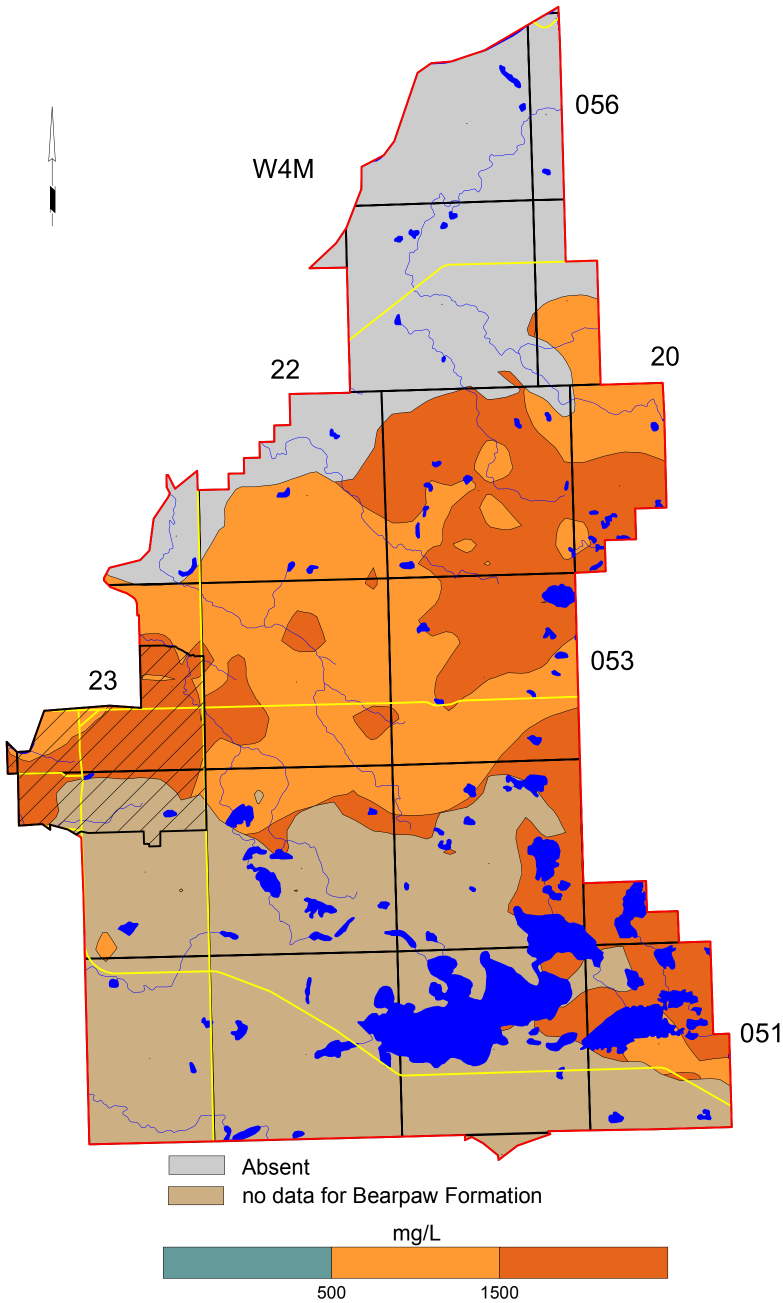
Depth to Top of Bearpaw Formation



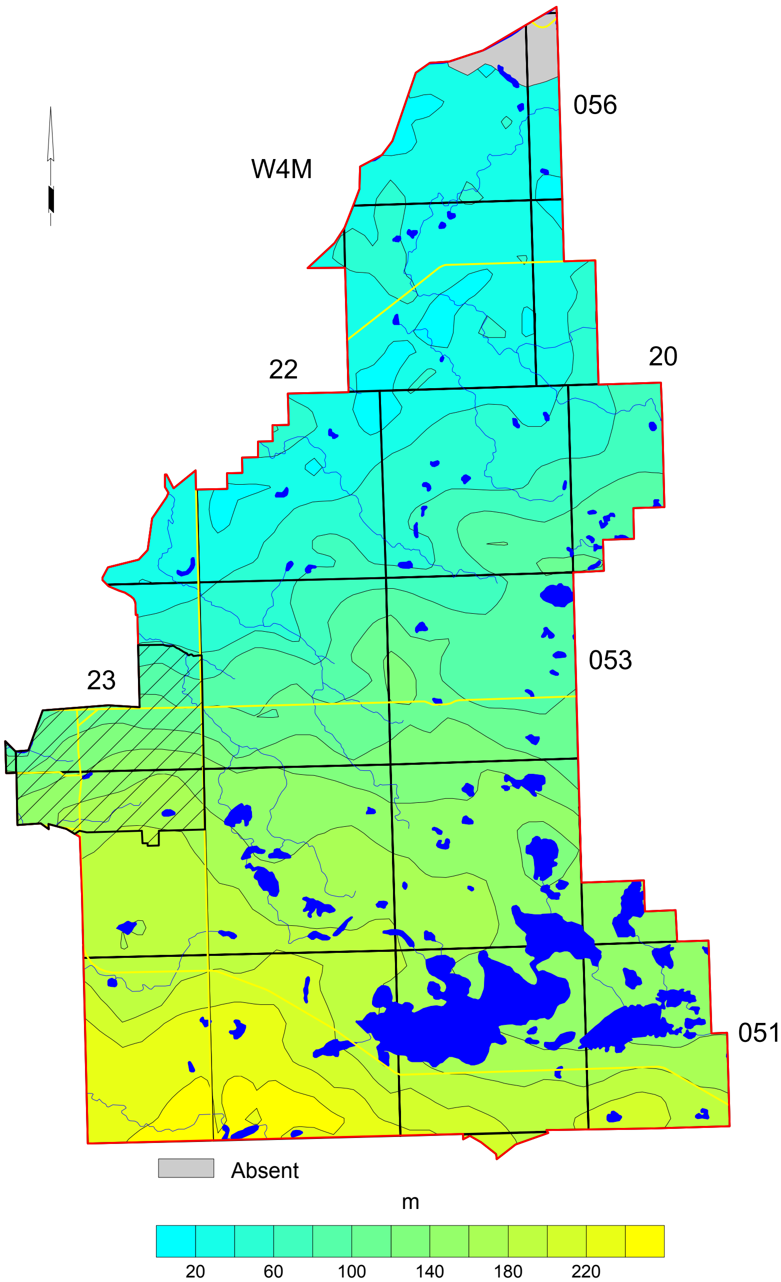
Apparent Yield for Water Wells Completed through Bearpaw Aquifer



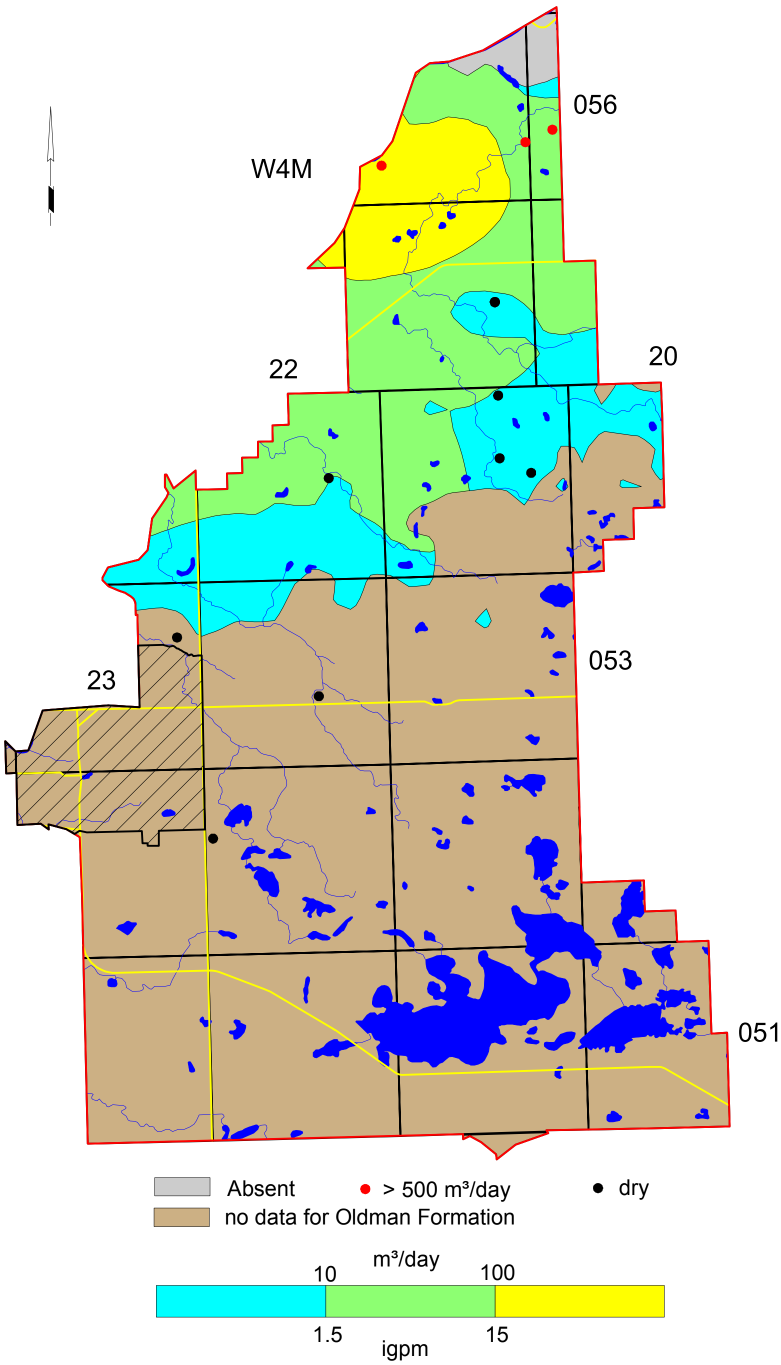
Total Dissolved Solids in Groundwater from Bearpaw Aquifer



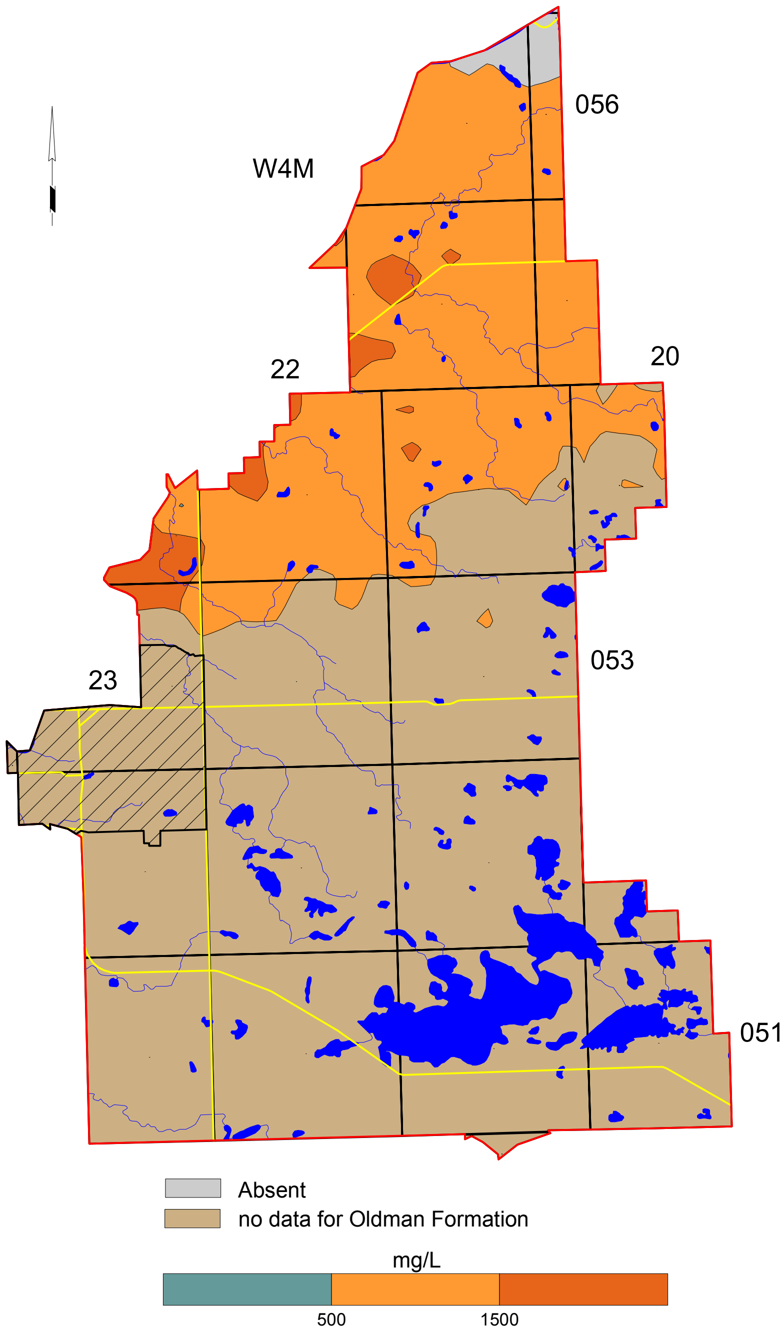
Depth to Top of Oldman Formation

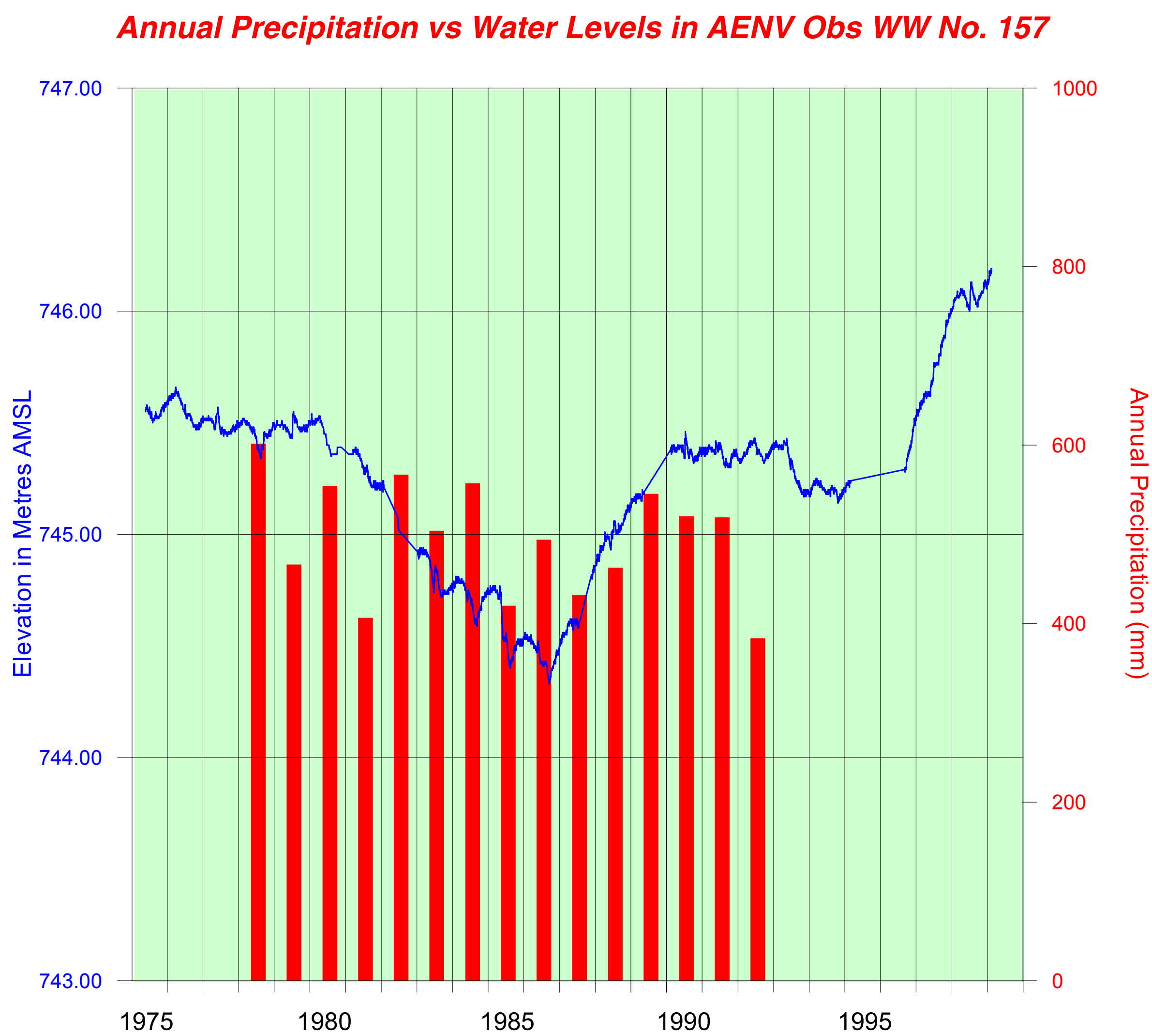


Apparent Yield for Water Wells Completed through Oldman Aquifer

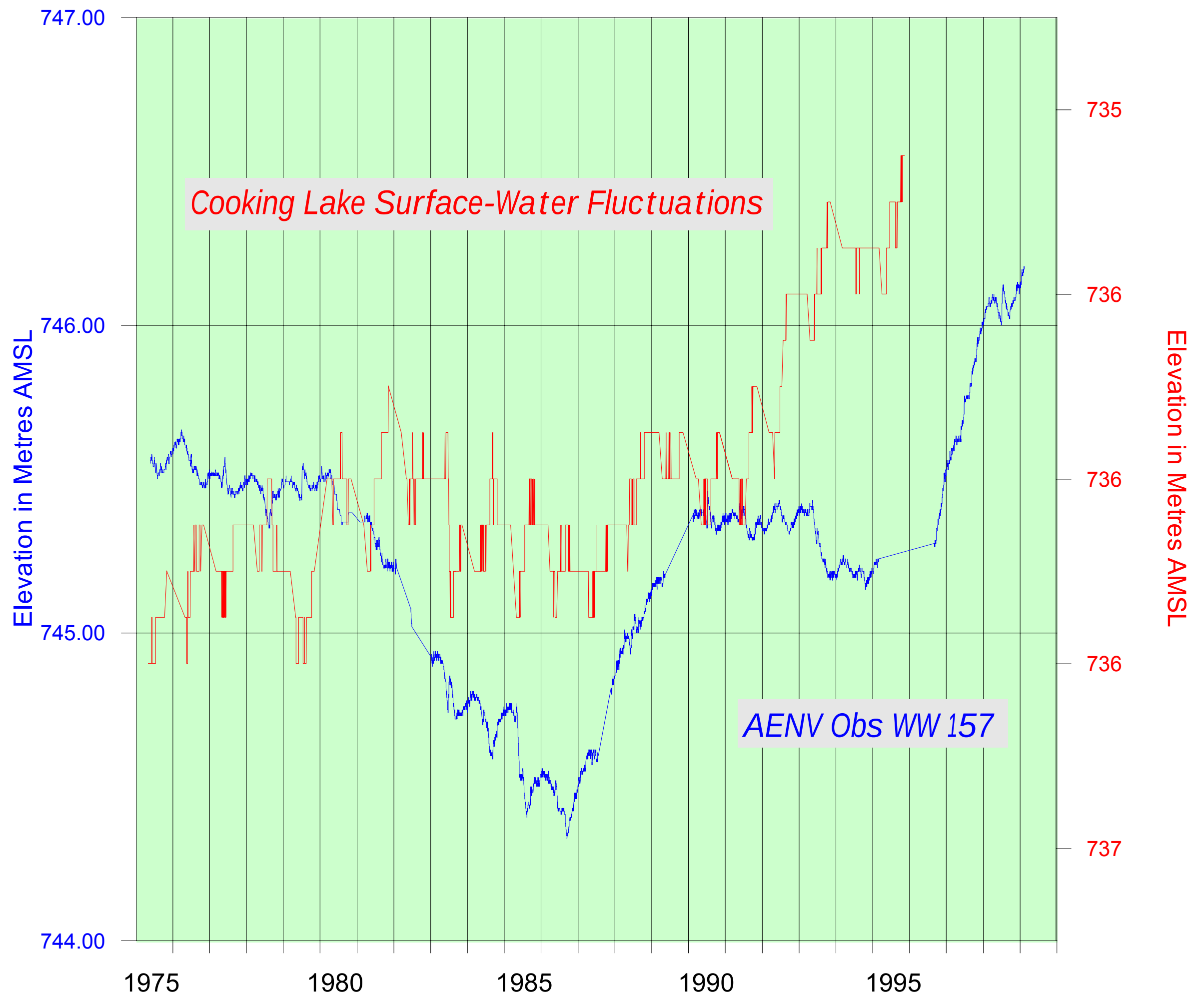


Total Dissolved Solids in Groundwater from Oldman Aquifer

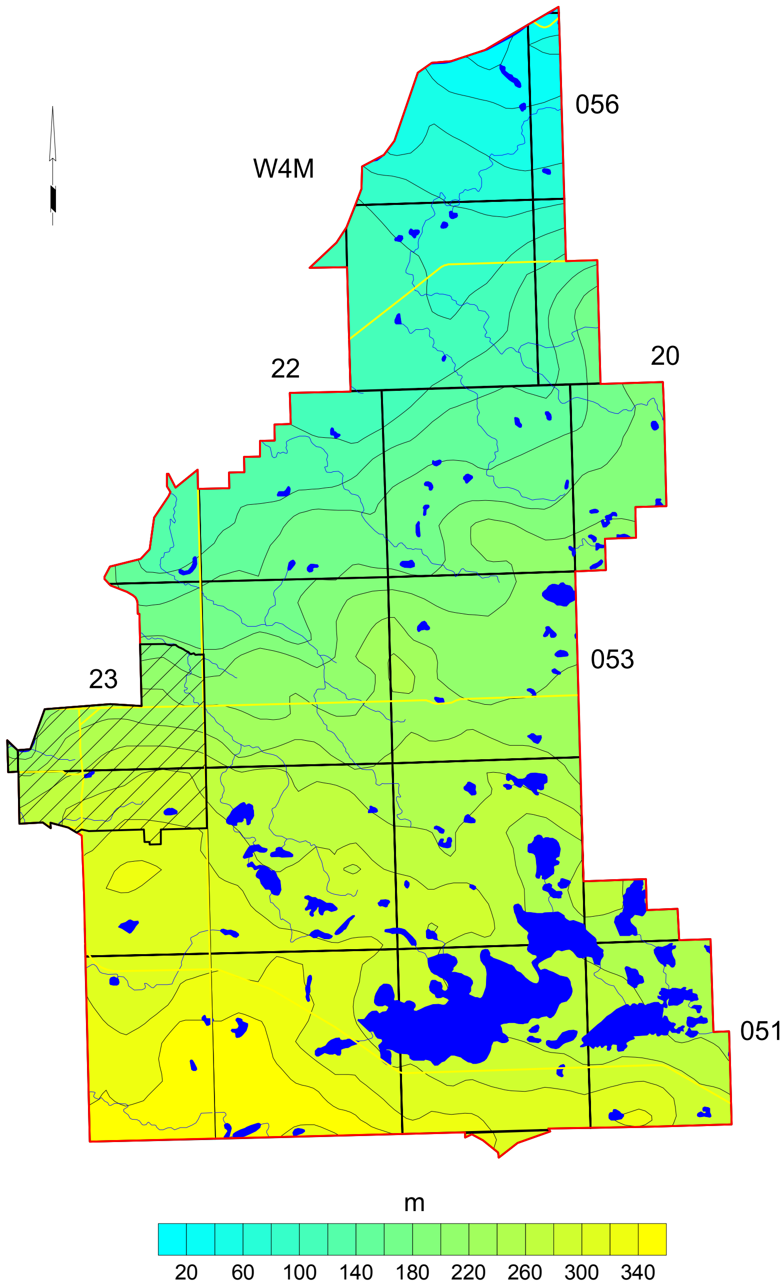



Annual Precipitation vs Water Levels in AENV Obs WW No. 157
747.00
746.00
745.00
744.00
743.00
Elevation in Metres AMSL
1000
800
600
400
200
0
Annual Precipitation (mm)
1975
1980
1985
1990
1995

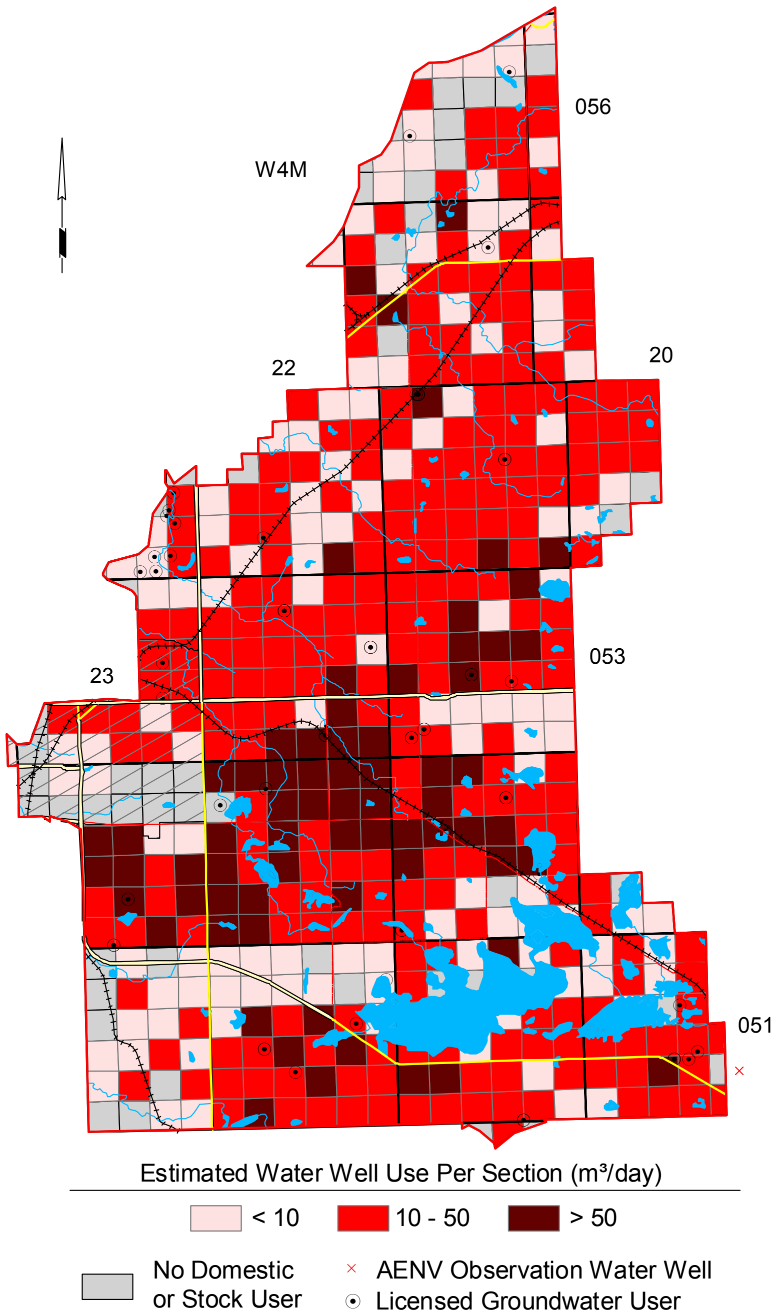
AENV Obs WW No. 157 vs Cooking Lake Water-Level Fluctuations



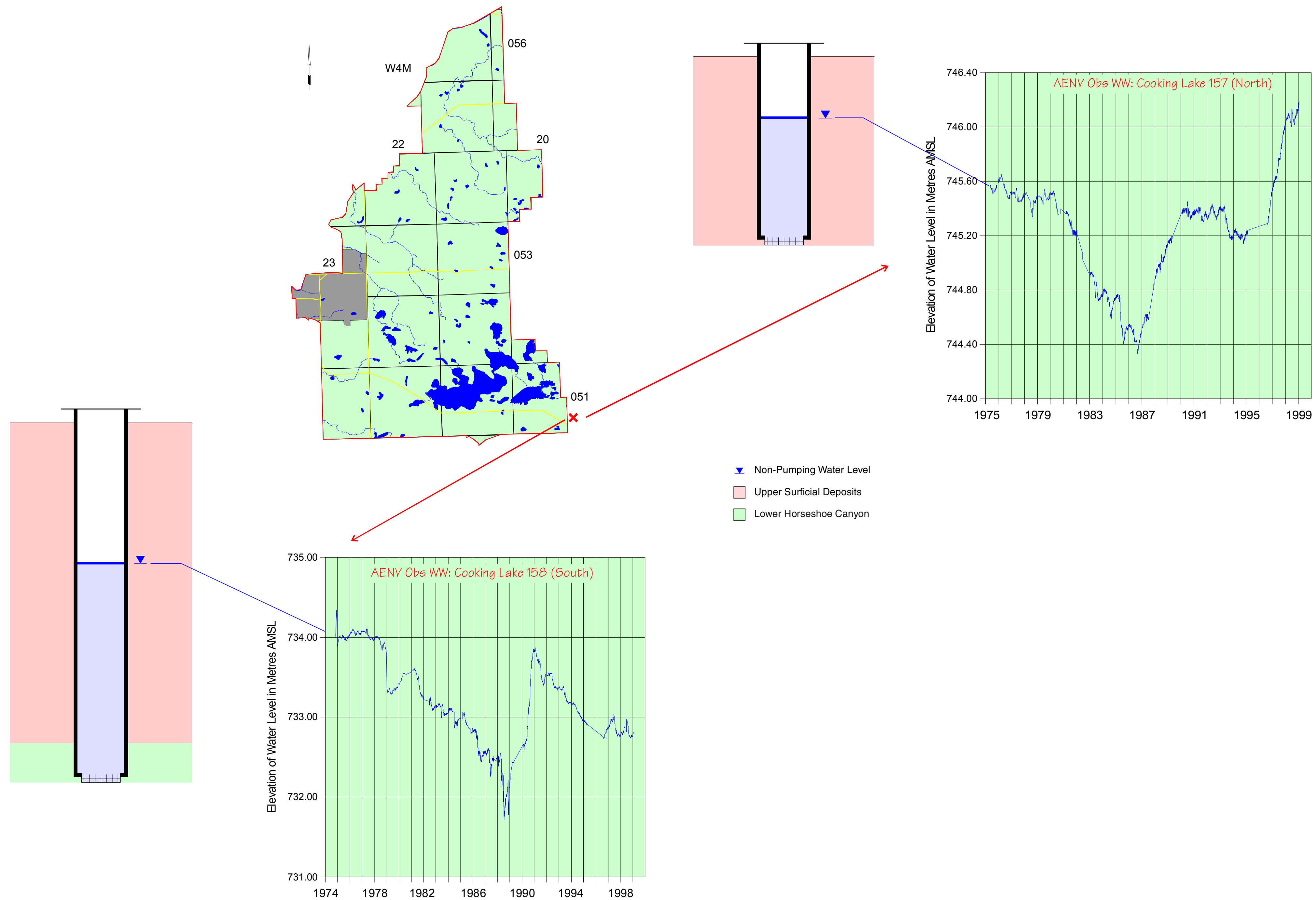
Depth to Top of Birch Lake Member



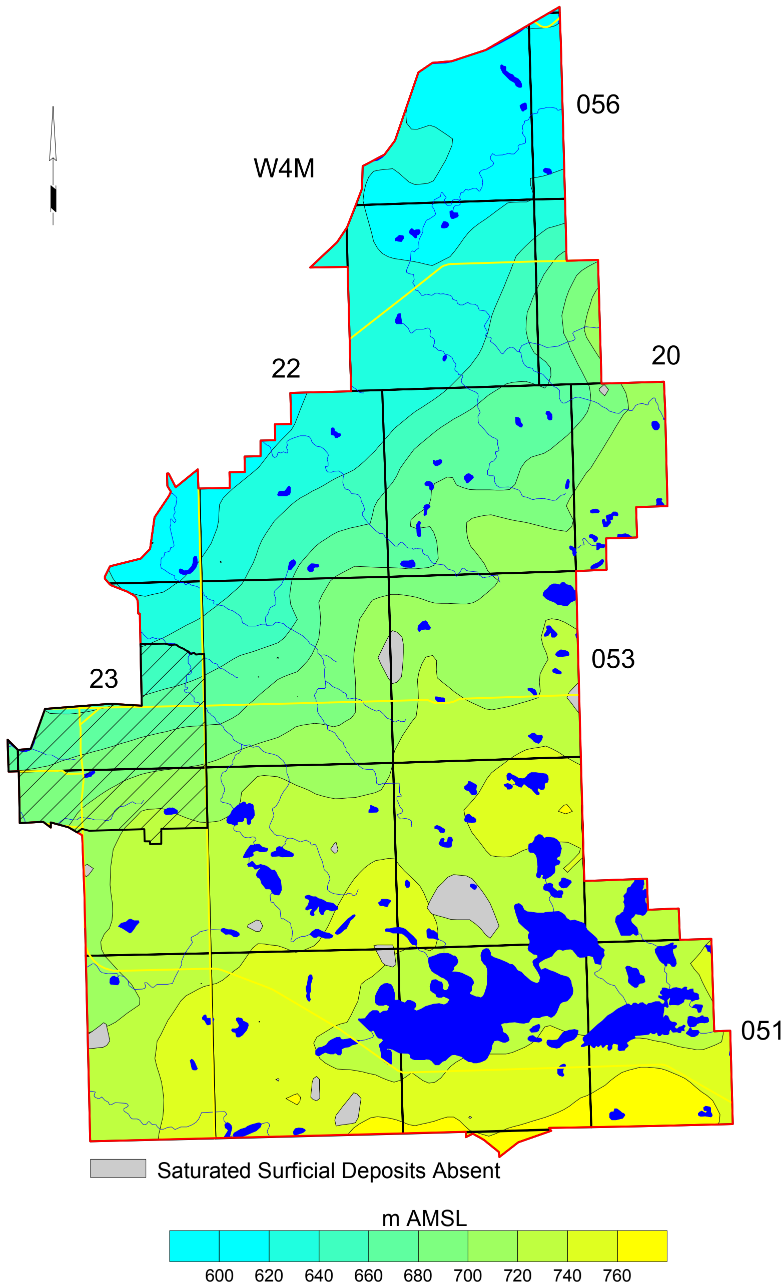
Estimated Water Well Use Per Section



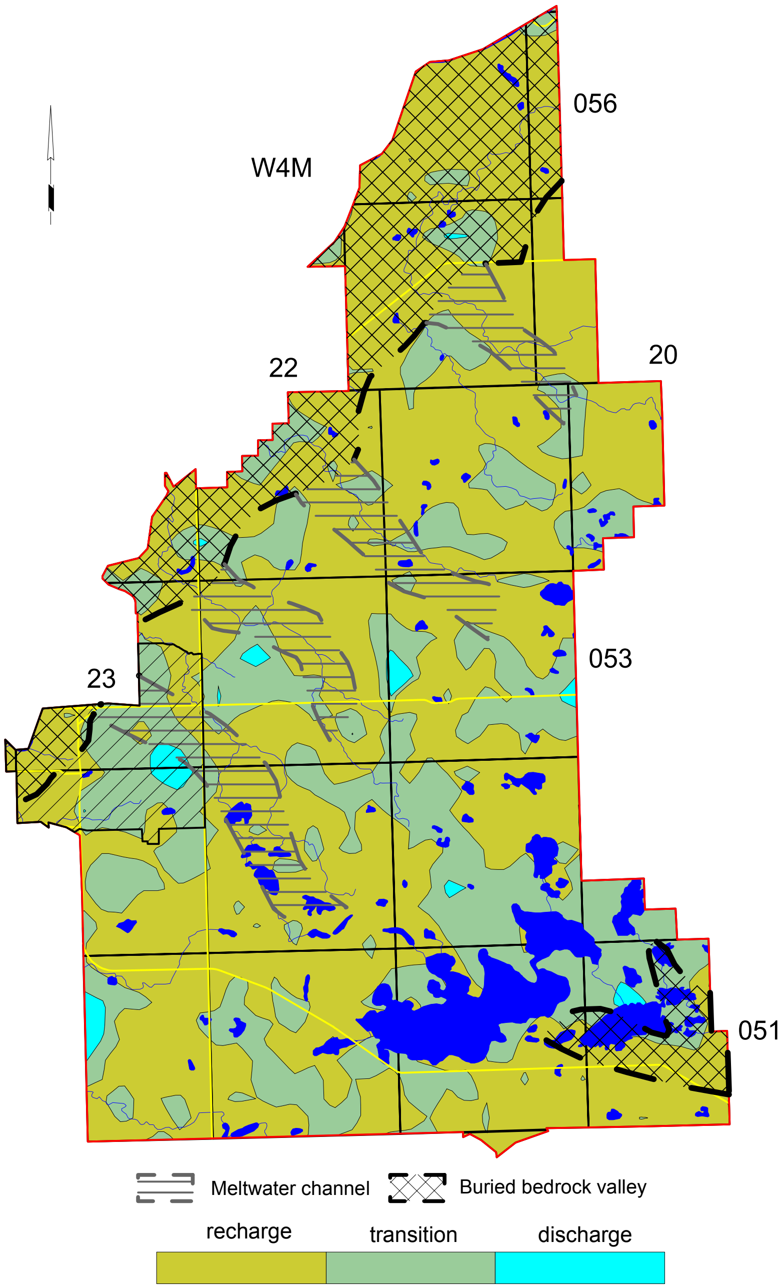
Hydrographs – AENV Observation Water Wells



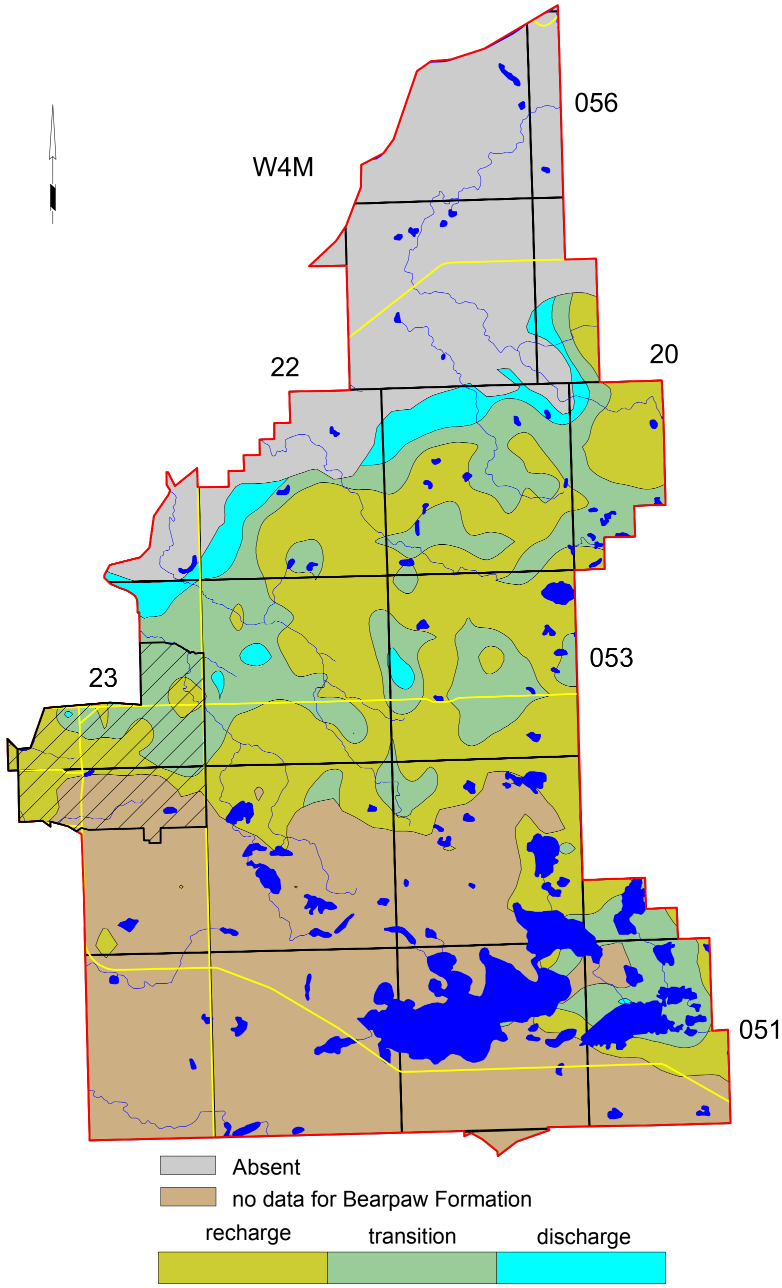
Non-Pumping Water-Level Surface in Surficial Deposits Based on Water Wells Less than 20 Metres Deep



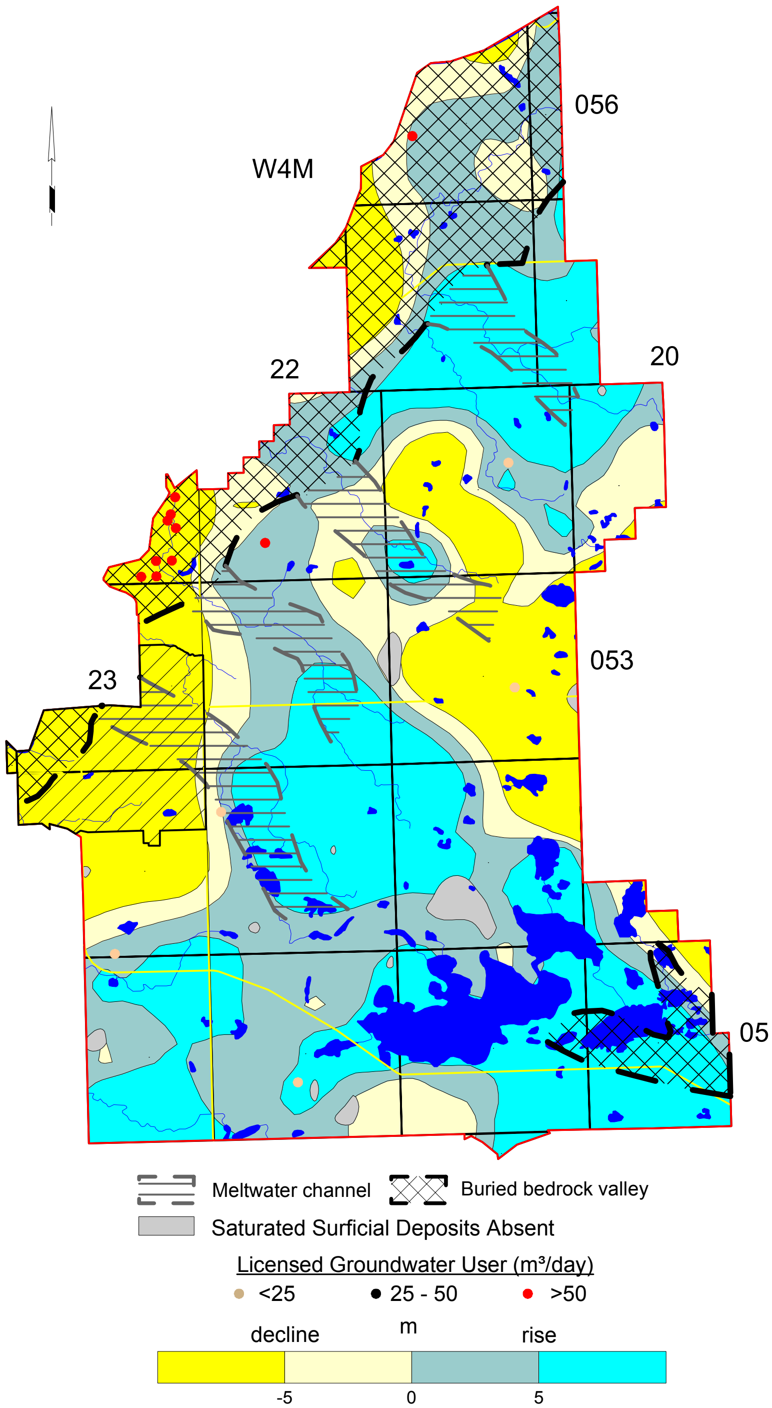
Recharge/Discharge Areas between Surficial Deposits and Upper Bedrock Aquifer(s)



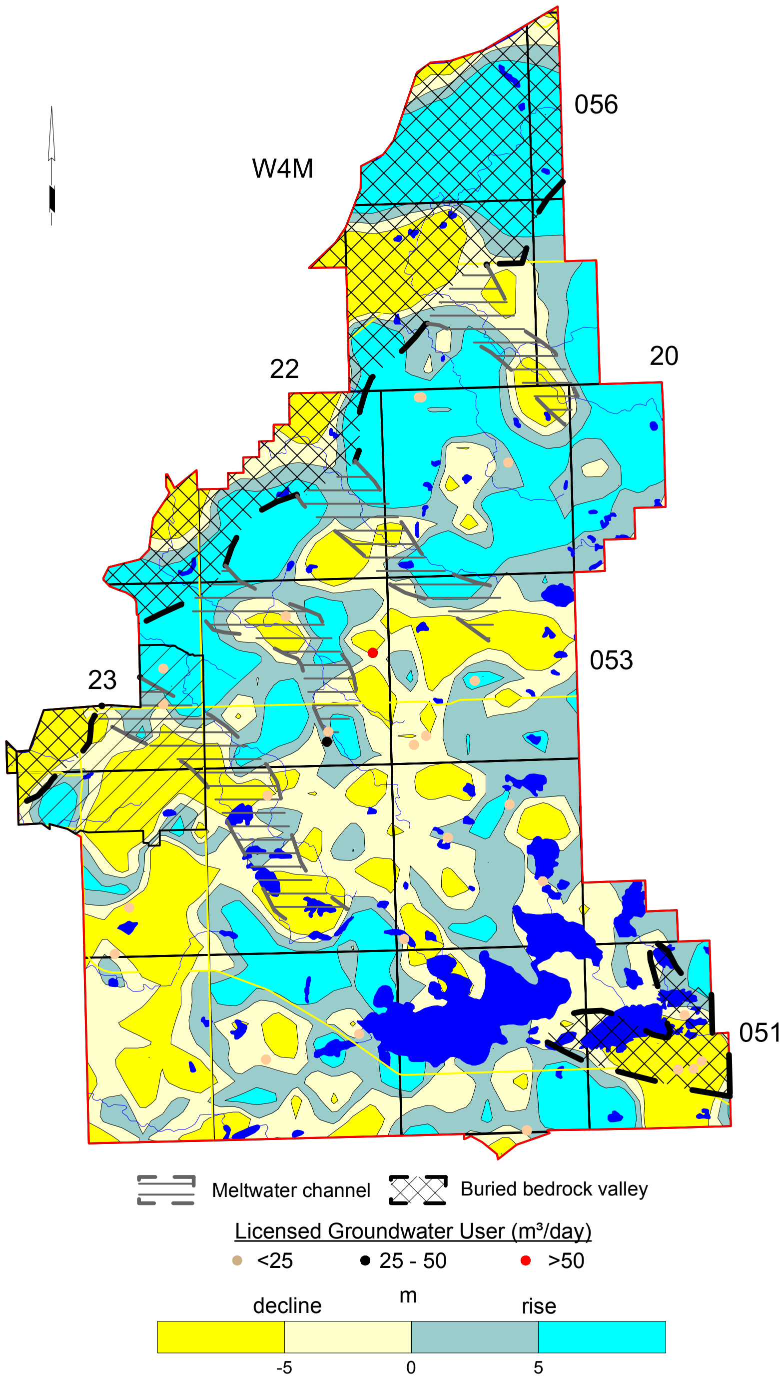
Recharge/Discharge Areas between Surficial Deposits and Bearpaw Aquifer



Changes in Water Levels in Sand and Gravel Aquifer(s) Based on Water Wells Less than 20 Metres Deep



Changes in Water Levels in Upper Bedrock Aquifer(s)



STRATHCONA COUNTY

Appendix B

Maps and Figures on CD-ROM

STRATHCONA COUNTY
Appendix C

General Water Well Information

Domestic Water Well Testing

Purpose and Requirements

The purpose of the testing of domestic water wells is to obtain background data related to:

1) the non-pumping water level for the aquifer - Has there been any lowering of the level since the last measurement?
2) the specific capacity of the water well, which indicates the type of contact the water well has with the aquifer;
3) the transmissivity of the aquifer and hence an estimate of the projected long-term yield for the water well;
4) the chemical, bacteriological and physical quality of the groundwater from the water well.

The testing procedure involves conducting an aquifer test and collecting of groundwater samples for analysis by an accredited laboratory. The date and time of the testing are to be recorded on all data collection sheets. A sketch showing the location of the water well relative to surrounding features is required. The sketch should answer the question, "If this water well is tested in the future, how will the person doing the testing know this is the water well I tested?"

The water well should be taken out of service as long as possible before the start of the aquifer test, preferably not less than 30 minutes before the start of pumping. The non-pumping water level is to be measured 30, 10, and 5 minutes before the start of pumping and immediately before the start of pumping which is to be designated as time 0 for the test. All water levels must be from the same designated reference, usually the top of the casing. Water levels are to be measured during the pumping interval and during the recovery interval after the pump has been turned off; all water measurements are to be with an accuracy of $\pm$ 0.01 metres.

During the pumping and recovery intervals, the water level is to be measured at the appropriate times. An example of the time schedule for a four-hour test is as follows, measured in minutes after the pump is turned on and again after the pump is turned off:

1,2,3,4,6,8,10,13,16,20,25,32,40,50,64,80,100,120.

For a four-hour test, the reading after 120 minutes of pumping will be the same as the 0 minutes of recovery. Under no circumstance will the recovery interval be less than the pumping interval.

Flow rate during the aquifer test should be measured and recorded with the maximum accuracy possible. Ideally, a water meter with an accuracy of better than $\pm$1% displaying instantaneous and total flow should be used. If a water meter is not available, then the time required to completely fill a container of known volume should be recorded, noting the time to the nearest 0.5 seconds or better. Flow rate should be determined and recorded often to ensure a constant pumping rate.

Groundwater samples should be collected as soon as possible after the start of pumping and within 10 minutes of the end of pumping. Initially only the groundwater samples collected near the end of the pumping interval need to be submitted to the accredited laboratory for analysis. All samples must be properly stored for transportation to the laboratory and, in the case of the bacteriological analysis, there is a maximum time allowed between the time the sample is collected and the time the sample is delivered to the laboratory. The first samples collected are only analyzed if there is a problem or a concern with the first samples submitted to the laboratory.

Procedure

Site Diagrams

These diagrams are a map showing the distance to nearby significant features. This would include things like a corner of a building (house, barn, garage etc.) or the distance to the half-mile or mile fence. The description should allow anyone not familiar with the site to be able to unequivocally identify the water well that was tested. In lieu of a map, UTM coordinates accurate to within five metres would be acceptable. If a hand-held GPS is used, the post-processing correction details must be provided.

Surface Details

The type of surface completion must be noted. This will include such things as a pitless adapter, well pit, pump house, in basement, etc. Also, the reference point used for measuring water levels needs to be noted. This would include top of casing (TOC) XX metres above ground level; well pit lid, XX metres above TOC; TOC in well pit XX metres below ground level.

Groundwater Discharge Point

Where was the flow of groundwater discharge regulated? For example was the discharge through a hydrant downstream from the pressure tank; discharged directly to ground either by connecting directly above the well seal or by pulling the pump up out of the pitless adapter; from a tap on the house downstream from the pressure tank? Also note must be made if any action was taken to ensure the pump would operate continuously during the pumping interval and whether the groundwater was passing through any water-treatment equipment before the discharge point.

Water-Level Measurements

How were the water-level measurements obtained? If obtained using a contact gauge, what type of cable was on the tape, graduated tape or a tape with tags? If a tape with tags, when was the last time the tags were calibrated? If a graduated tape, what is the serial number of the tape and is the tape shorter than its original length (i.e. is any tape missing)?

If water levels are obtained using a transducer and data logger, the serial numbers of both transducer and data logger are needed and a copy of the calibration sheet. The additional information required is the depth the transducer was set and the length of time between when the transducer was installed and when the calibration water level was measured, plus the length of time between the installation of the transducer and the start of the aquifer test. All water levels must be measured at least to the nearest 0.01 metres.

Discharge Measurements

Type of water meter used. This could include such things as a turbine or positive displacement meter. How were the readings obtained from the meter? Were the readings visually noted and recorded or were they recorded using a data logger?

Water Samples

A water sample must be collected between the 4- and 6-minute water-level measurements, whenever there is an observed physical change in the groundwater being pumped, and 10 minutes before the end of the planned pumping interval. Additional water samples must be collected if it is expected that pumping will be terminated before the planned pumping interval.

Water Act - Water (Ministerial) Regulation

PROVINCE OF ALBERTA

WATER ACT

WATER (MINISTERIAL) REGULATION

Alberta Regulation 205/98

EXTRACT FROM THE
ALBERTA GAZETTE

© Published by
the Queen's Printer for Alberta

Queen's Printer Bookstore
11510 Kingsway
Edmonton, AB T5G 2Y5
(403) 427-4952
Fax: (403) 452-0668
Note: After Jan. 25/99 use area code (780)

Queen's Printer Bookstore
Main Floor, McDougall Centre
455 - 6th Street S.W.
Calgary, AB T2P 4E8
(403) 297-6251
Fax: (403) 297-8450

Shop On-line at http://www.gov.ab.ca/qp

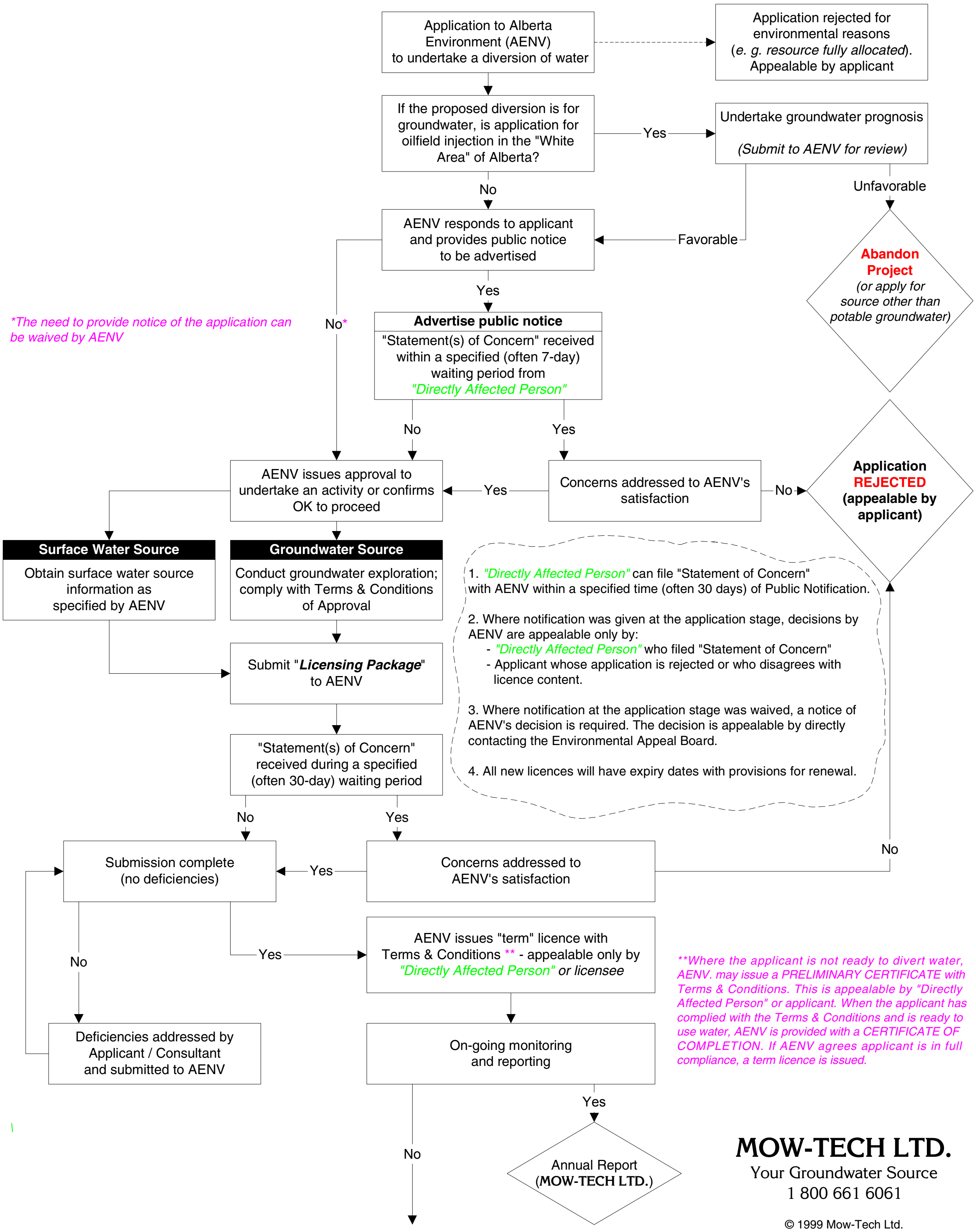
ALBERTA REGULATION 205/98

Water Act

WATER (MINISTERIAL) REGULATION

Table of Contents

Water Act – Flowchart



*This flow chart was developed by Mow-Tech Ltd. and is provided as a guide **only** to Alberta's new **Water Act.** Mow-Tech Ltd. accepts no responsibility for the information provided.*

Interpretation of Chemical Analysis of Drinking Water

Stony Plain - Lac Ste. Anne Health Unit

HEAD OFFICE
P.O. Box 210
Stony Plain, Alberta
Canada T0E 2G0
Telephone: 963-2206
Fax: 963-7612

SUB-OFFICES
Box 4323
Spruce Grove, Alberta
T7X 3B5
Telephone: 962-4072

163 Provincial Bldg.
Whitecourt, Alberta
T0E 2L0
Telephone: 778-5555
Fax: 778-3852

Box 430
Fox Creek, Alberta
T0H 1P0
Telephone: 622-3730

HOME CARE:
Box 210
Stony Plain, Alberta
T0E 2G0
Telephone: 963-3366

INTERPRETATION OF CHEMICAL ANALYSIS OF DRINKING WATER

1. TOTAL DISSOLVED SOLIDS (TDS) - The recommended limit is 1000 mg/L for untreated and 500 mg/L for treated waters. TDS indicates the approximate organic and inorganic substances in the water. It will be high if other components of the analysis are high.

2. IRON - Amounts over 0.3 mg/L, usually stain laundry and plumbing fixtures and cause undesirable tastes. Iron filtration can be utilized. Iron bacteria may also be the cause of increased iron content.

3. CALCIUM - This is a constituent of hardness. Excessive calcium in drinking water may be a factor in disorders of the kidneys, bladder and urinary system.

4. MAGNESIUM - This is a constituent of hardness.

5. HARDNESS - A maximum acceptable concentration has not been established. Hardness is caused mainly by calcium and magnesium. Levels between 80 and 100 mg/L are satisfactory: 100 to 200 mg/L are less acceptable: more than 200 mg/L are considered to be poor and in excess of 500 mg/L are unacceptable for most domestic purposes. Softening can be helpful in given circumstances.

6. SODIUM - Ideally, there should be no more than 200mg/L. The average intake of sodium from water is only a small fraction of that consumed in a normal diet. Persons suffering from hypertension or congestive heart failure may require a sodium-restricted diet, in which case the intake of sodium from drinking water could become significant. Your physician should be informed of the sodium content.

7. NITRITE-NITROGEN & NITRATE-NITROGEN (NO2 + NO3) - The maximum acceptable concentration is 10 mg/L. Any amount over that may be harmful to children up to 12 months of age, causing a condition known as methaemoglobinaemia. Presence may indicate a contaminating source although other instances, e.g. fertilizer and decomposing vegetation can cause an elevated figure.

8. NITRITE-NITROGEN - The maximum acceptable concentration is 1.0 Mg/L. Nitrite is unstable in water and converts to nitrate. An elevated figure may indicate a pollution problem.

9. FLUORIDE - Approximately 1 mg/L of fluoride is recommended in drinking water in order to give developing teeth some protection against decay. If the fluoride is higher than 1.5 mg/L you should talk to the dental staff of the Health Unit about the possibility of mottled enamel; if the fluoride is lower than 0.7 mg/L please ask about fluoride supplements for your children.

10. SULPHATE - The maximum acceptable concentration is 500 mg/L. Taste becomes noticeable between 250 and 600 mg/L and a laxative effect may be noticed by new users when sulphate combines with sodium or magnesium.

11. CHLORIDE - The recommended limit is 250 mg/L. Chloride content is usually low and an increase may indicate a nearby source of pollution (particularly if NO2 and NO3 and nitrite are high). Some wells contain naturally occurring chlorides. A salty taste may be evident.

12. ALKALINITY T (Total) - Alkalinity below 500 mg/L is generally accepted. Excessive alkalinity may result in incrustations on utensils, service pipes and water heaters.

13. BICARBONATE _ Upper limit not established. Relates to alkalinity as bicarbonate of sodium, calcium and magnesium.

NOTE: mg/L = milligrams per litre.

The preceding notes and standards are for your guidance only based on an intake of 2 litres of water per day. The figures may be interpreted in a variety of ways and the public health inspector for your area can be contacted for further advice.
Telephone: Stony Plain - 963-2206; Spruce Grove - 962-4072; Whitecourt - 778-5555.

For stock water and other agricultural uses the requirements are not necessarily the same as for domestic use. Please consult your District Agriculturalist for that kind of advice.

Additional Information

VIDEOS

Will the Well Go Dry Tomorrow? (Mow-Tech Ltd.: 1-800 GEO WELL)
Water Wells that Last (PFRA – Edmonton Office: 780-495-3307)
Ground Water and the Rural Community (Ontario Ground Water Association)

BOOKLET

Water Wells that Last (PFRA – Edmonton Office: 780-495-3307)

ALBERTA ENVIRONMENT

WATER WELL INSPECTORS

Jennifer McPherson (Edmonton: 780-427-6429)

GEOPHYSICAL INSPECTION SERVICE

Edmonton: 780-427-3932

COMPLAINT INVESTIGATIONS

Blair Stone (Red Deer: 403-340-5310)

UNIVERSITY OF ALBERTA – Department of Earth and Atmospheric Sciences - Hydrogeology

Carl Mendoza (Edmonton: 780-492-2664)

UNIVERSITY OF CALGARY – Department of Geology and Geophysics - Hydrogeology

Larry Bentley (Calgary: 403-220-4512)

FARMERS ADVOCATE

Paul Vasseur (Edmonton: 780-427-2433)

PRAIRIE FARM REHABILITATION ADMINISTRATION

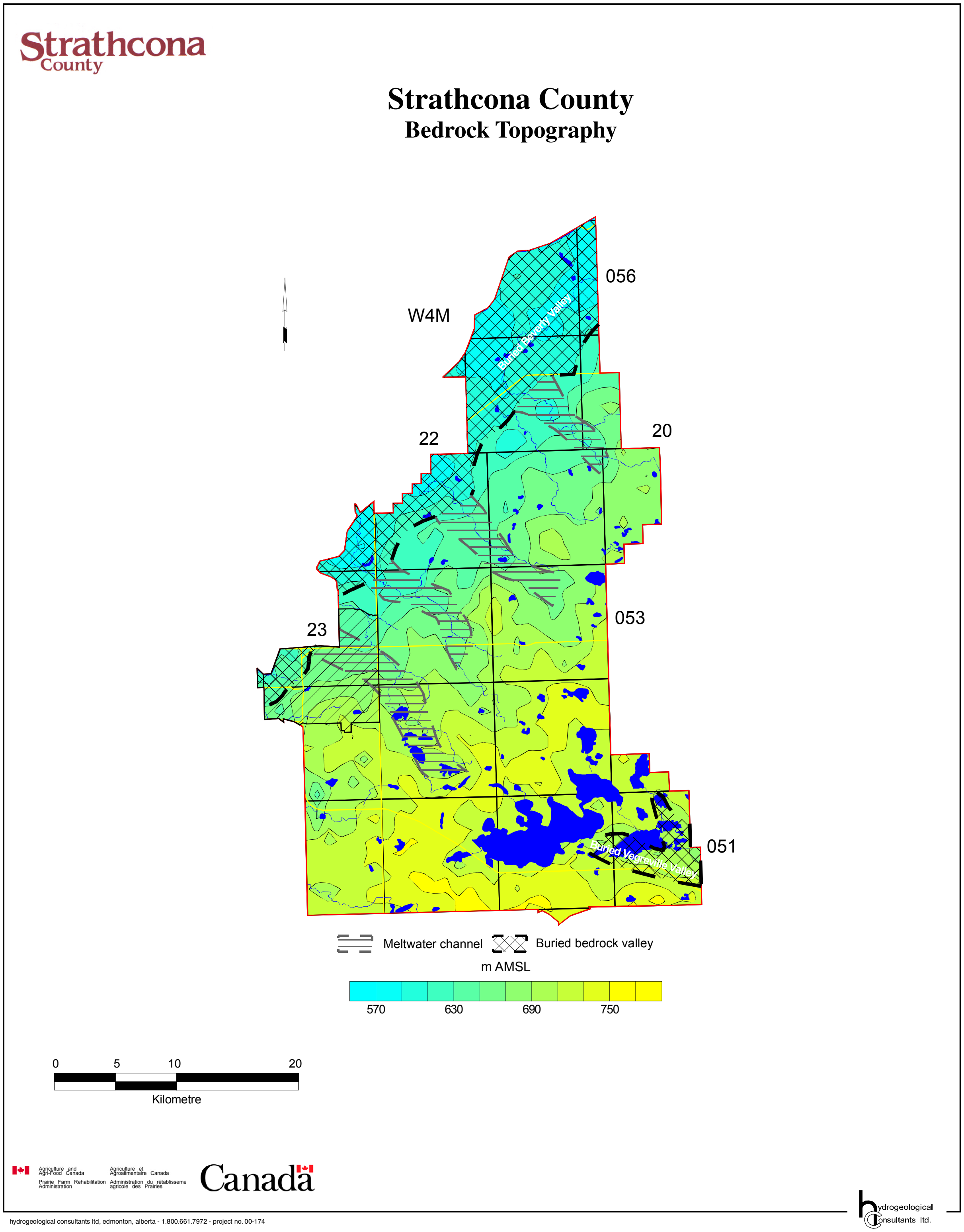
Tony Cowen (Edmonton: 780-495-4911)
Keith Schick (Vegreville: 780-632-2919)

LOCAL HEALTH DEPARTMENTS

STRATHCONA COUNTY
Appendix D

Maps and Figures Included as Large Plots

Bedrock Topography

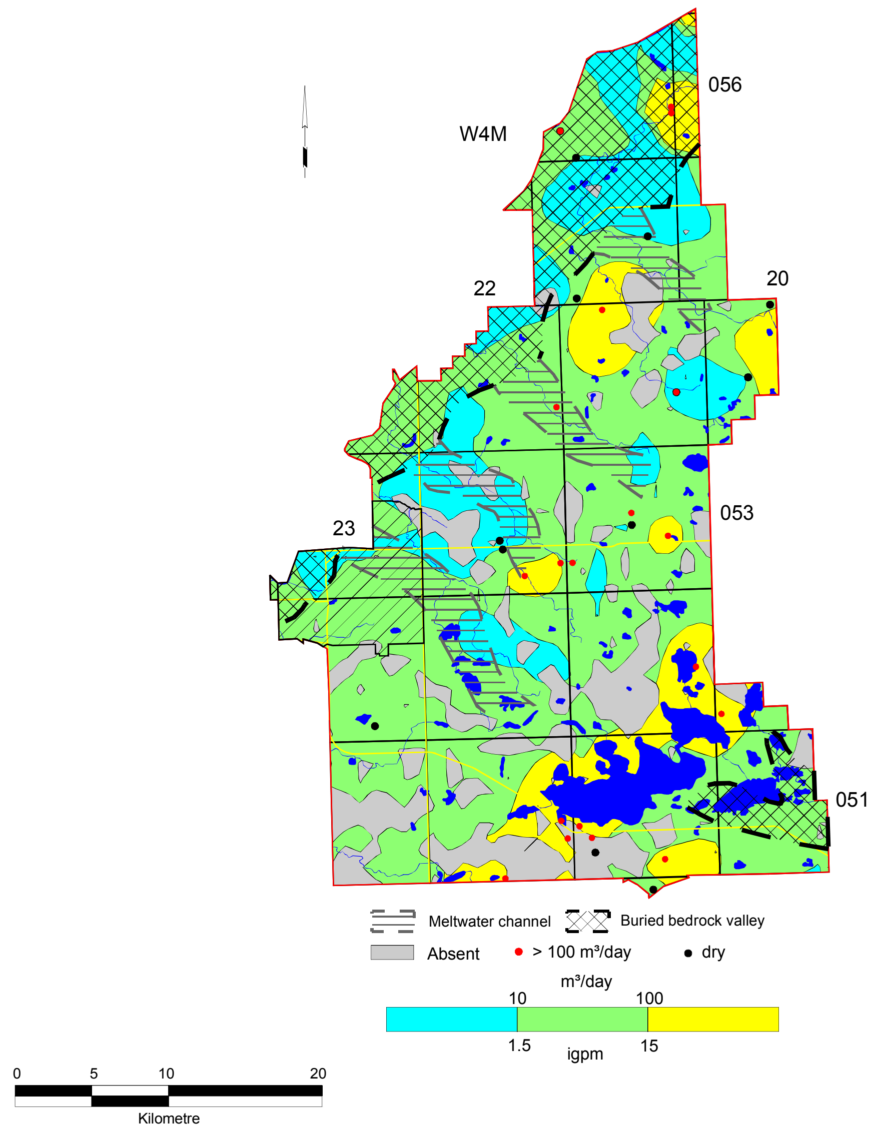


Apparent Yield for Water Wells Completed in Sand and Gravel Aquifer(s)

Strathcona County

Strathcona County

Apparent Yield for Water Wells Completed through Sand and Gravel Aquifer



GROUNDWATER CONSUMPTION

Groundwater Purpose[(3)]	Lower Limit (m³/day)	Upper Limit (m³/day)
Residential[(1)]	1.1	3.4
Multi Parcel[(1)]	1.1	3.4
Commercial	1	max. available
Light Industrial	1	max. available
Agricultural[(2)]	17.1	max. available

(1) per household
(2) traditional agricultural use as defined in the Water Act
(3) all non-household groundwater use must be licensed

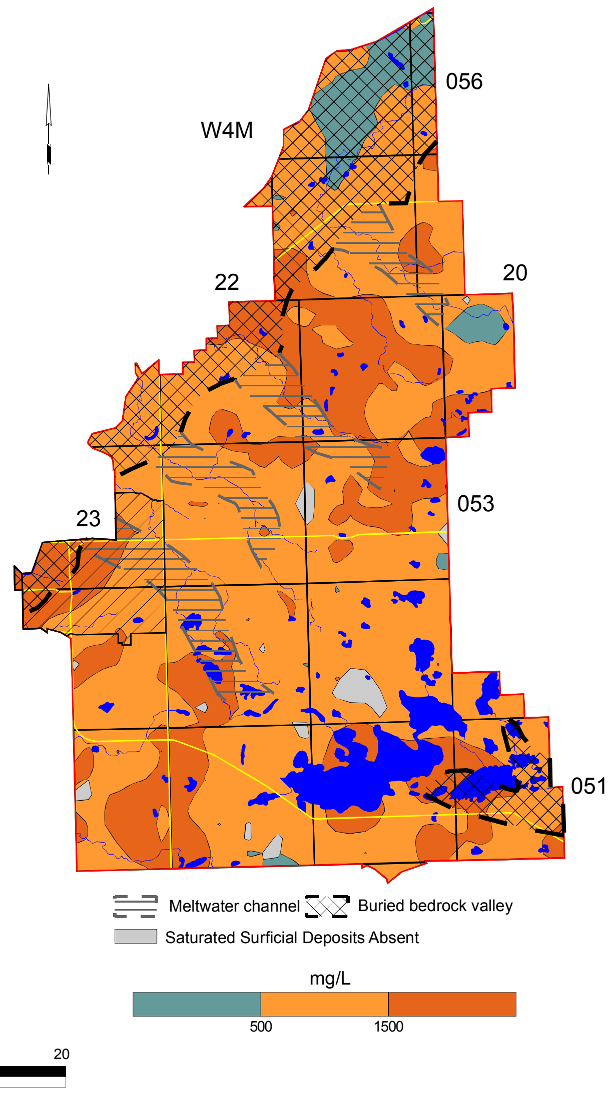
Agriculture and Agri-Food Canada — Agriculture et Agroalimentaire Canada
Prairie Farm Rehabilitation Administration — Administration du rétablissement agricole des Prairies
Canada

hydrogeological consultants ltd.

Total Dissolved Solids in Groundwater from Surficial Deposits

Strathcona County

Strathcona County
Total Dissolved Solids in Groundwater from Surficial Deposits



MAXIMUM LIMIT
TOTAL DISSOLVED SOLIDS

Use	mg/L
Residential	500
Livestock	3,000
Irrigation	500 - 3,500
Commercial	Depends on Purpose
Industrial	Depends on Purpose

from: Canadian Water Quality Guidelines, 1992

Agriculture and Agri-Food Canada — Agriculture et Agroalimentaire Canada
Prairie Farm Rehabilitation Administration — Administration du rétablisseme agricole des Prairies
Canada

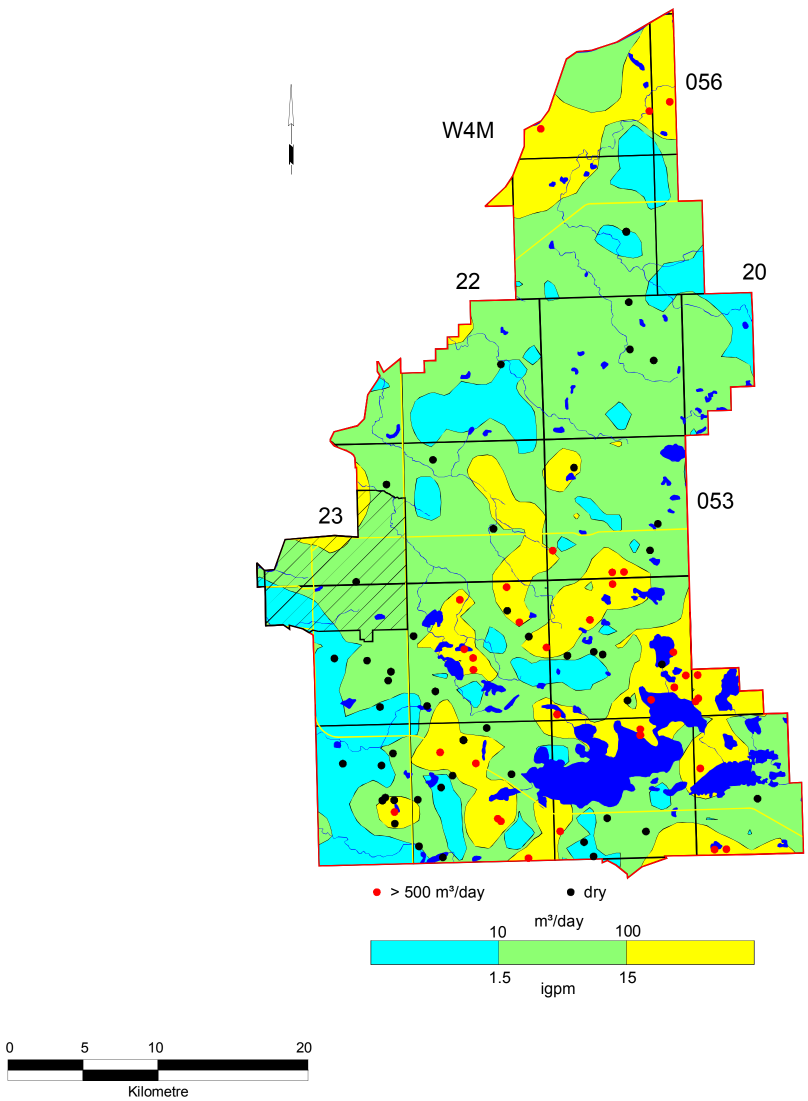
hydrogeological consultants ltd.

Apparent Yield for Water Wells Completed in Upper Bedrock Aquifer(s)

Strathcona County

Strathcona County

Apparent Yield for Water Wells Completed in Upper Bedrock Aquifer(s)



GROUNDWATER CONSUMPTION

Groundwater Purpose(3)	Lower Limit (m³/day)	Upper Limit (m³/day)
Residential(1)	1.1	3.4
Multi Parcel(1)	1.1	3.4
Commercial	1	max. available
Light Industrial	1	max. available
Agricultural(2)	17.1	max. available

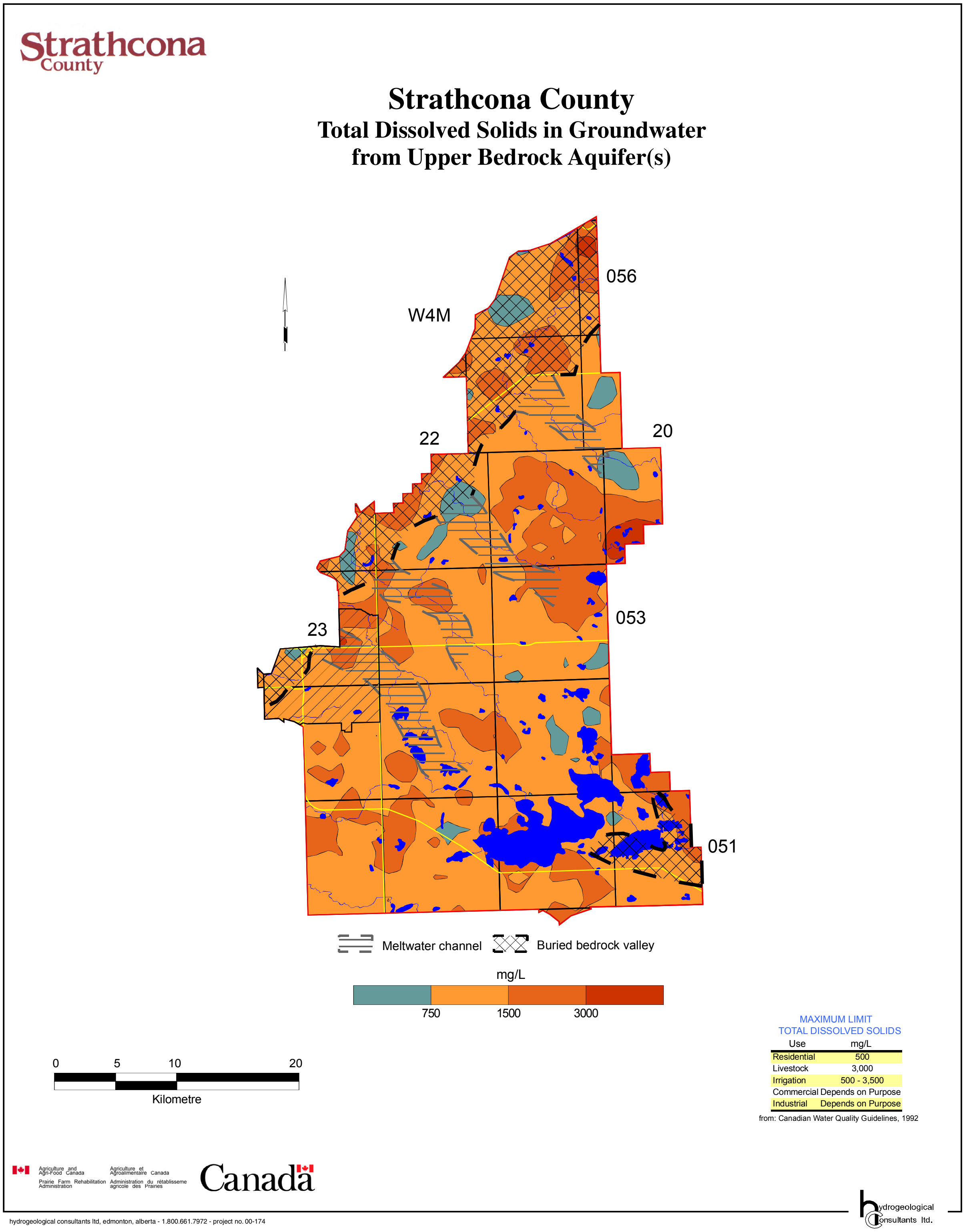
(1) per household
(2) traditional agricultural use as defined in the Water Act
(3) all non-household groundwater use must be licensed

Agriculture and Agri-Food Canada / Agriculture et Agroalimentaire Canada
Prairie Farm Rehabilitation Administration / Administration du rétablissement agricole des Prairies
Canada

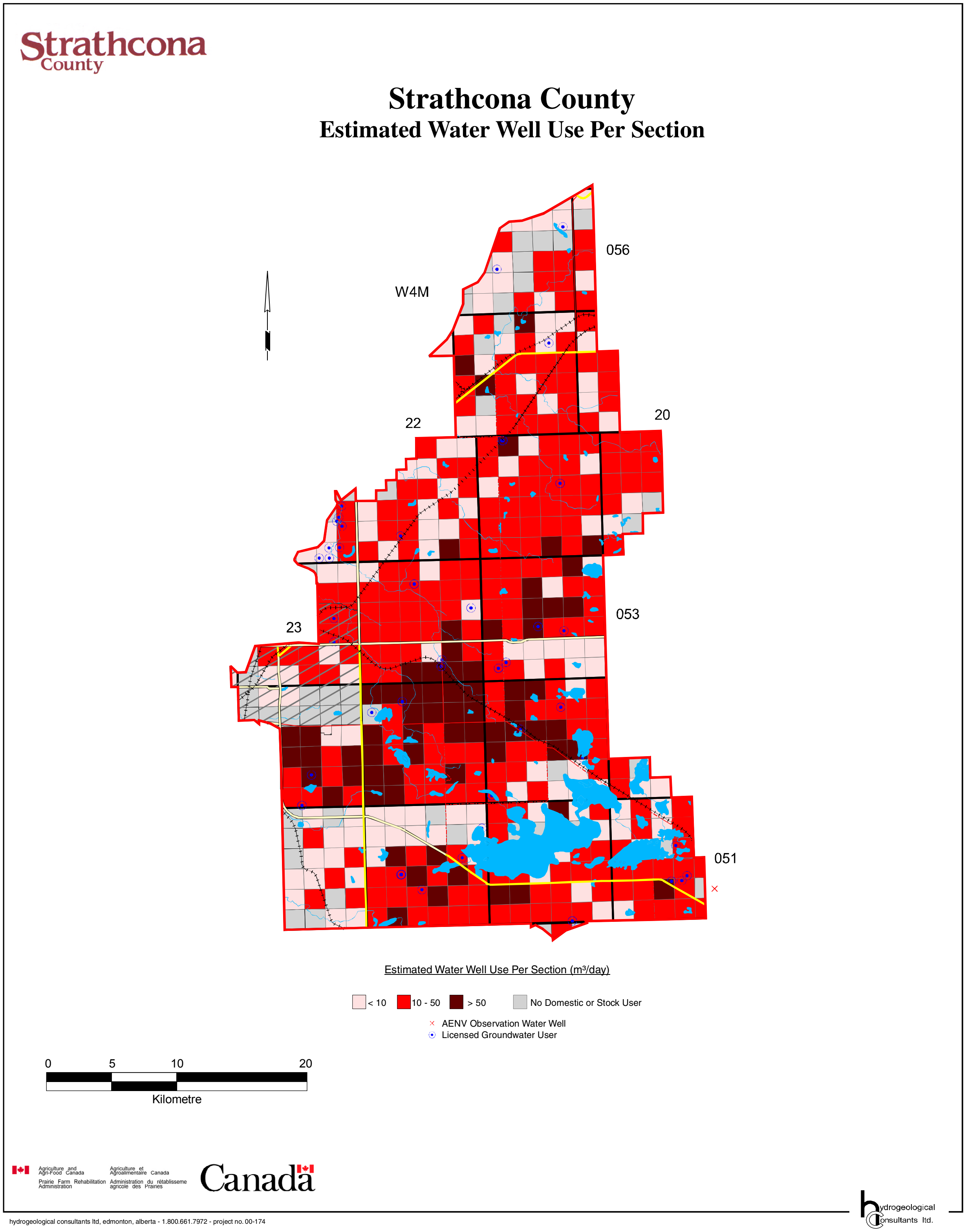
hydrogeological consultants ltd.

hydrogeological consultants ltd, edmonton, alberta - 1.800.661.7972 - project no. 00-174

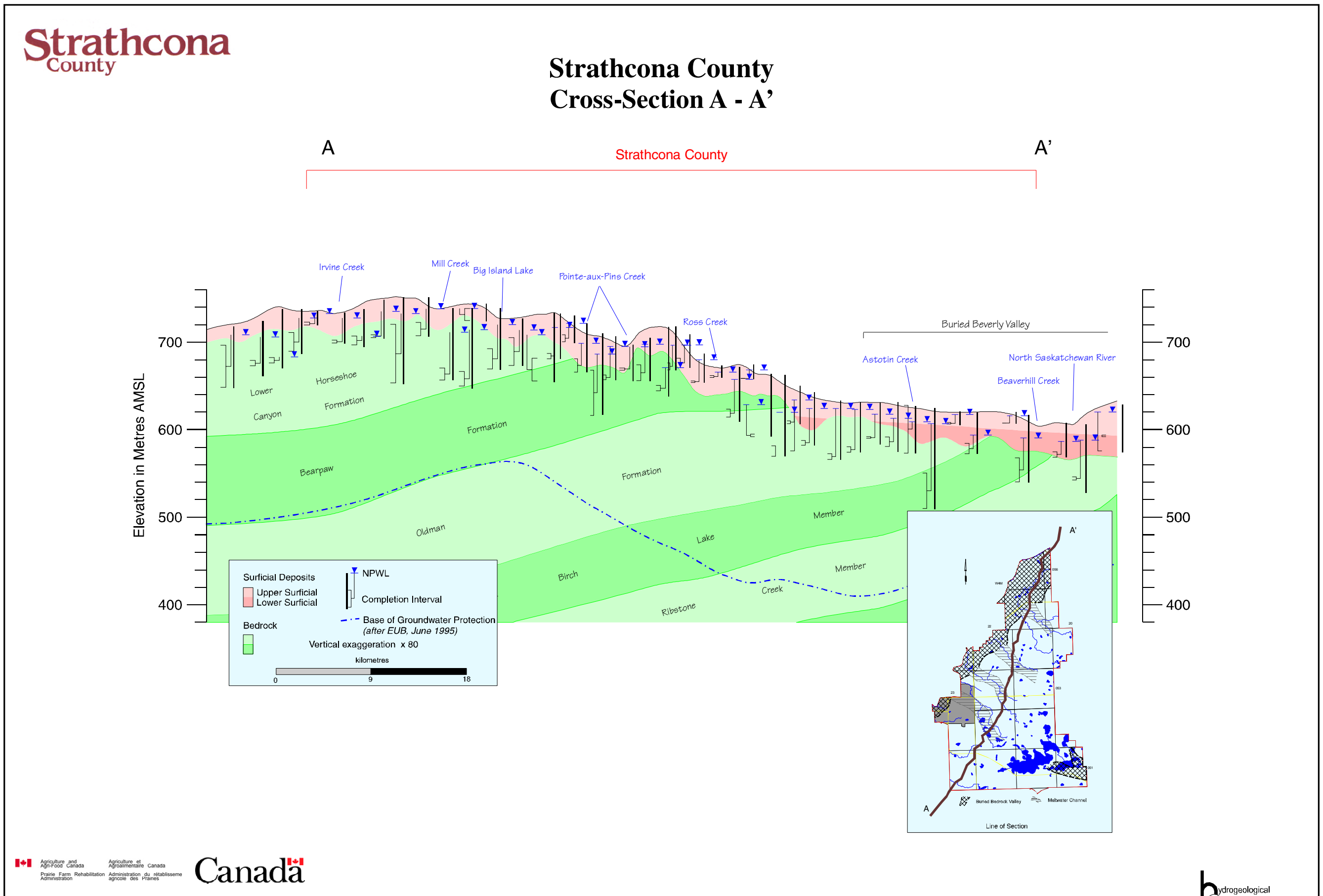
Total Dissolved Solids in Groundwater from Upper Bedrock Aquifer(s)



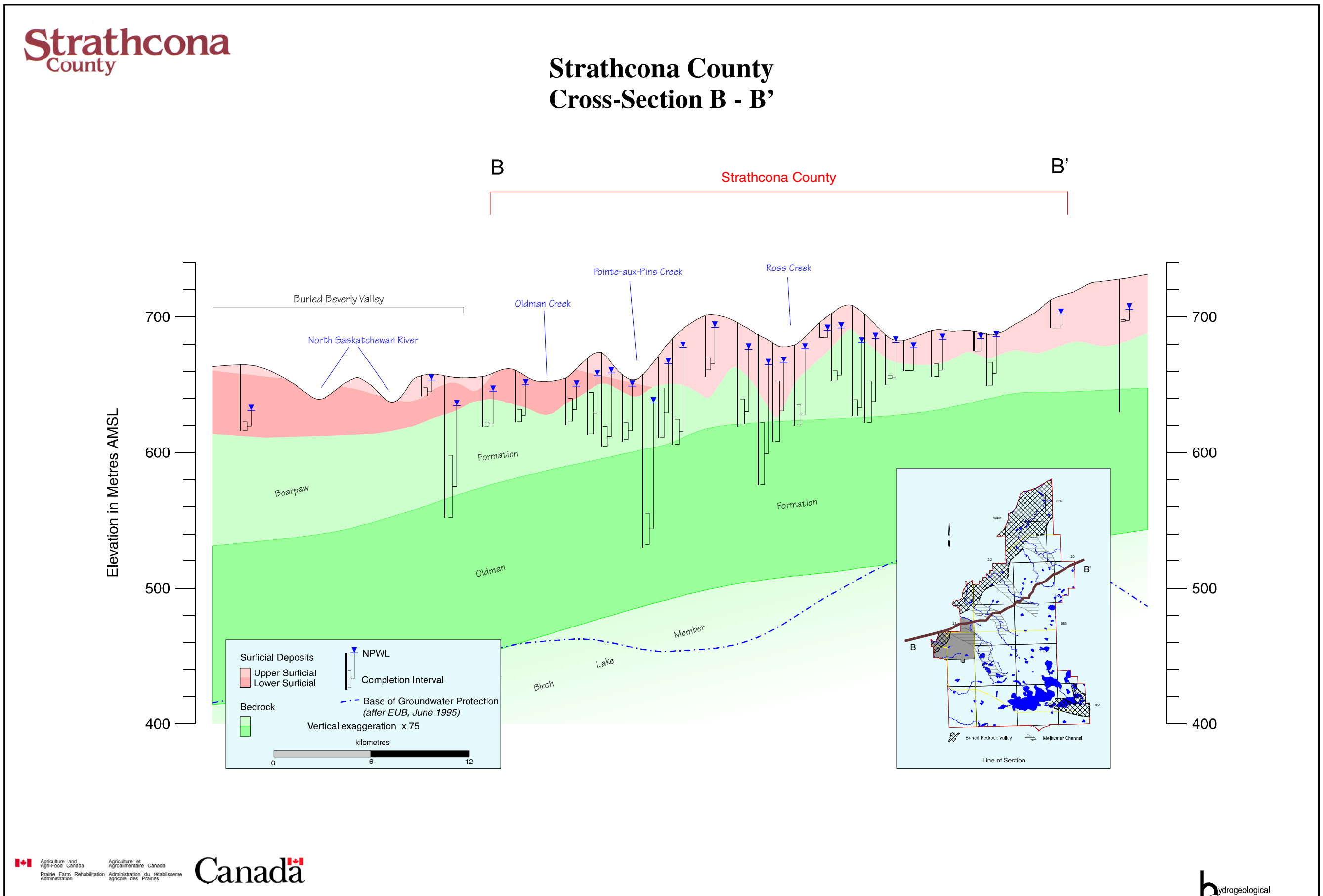
Estimated Water Well Use Per Section



Cross-Section A - A'

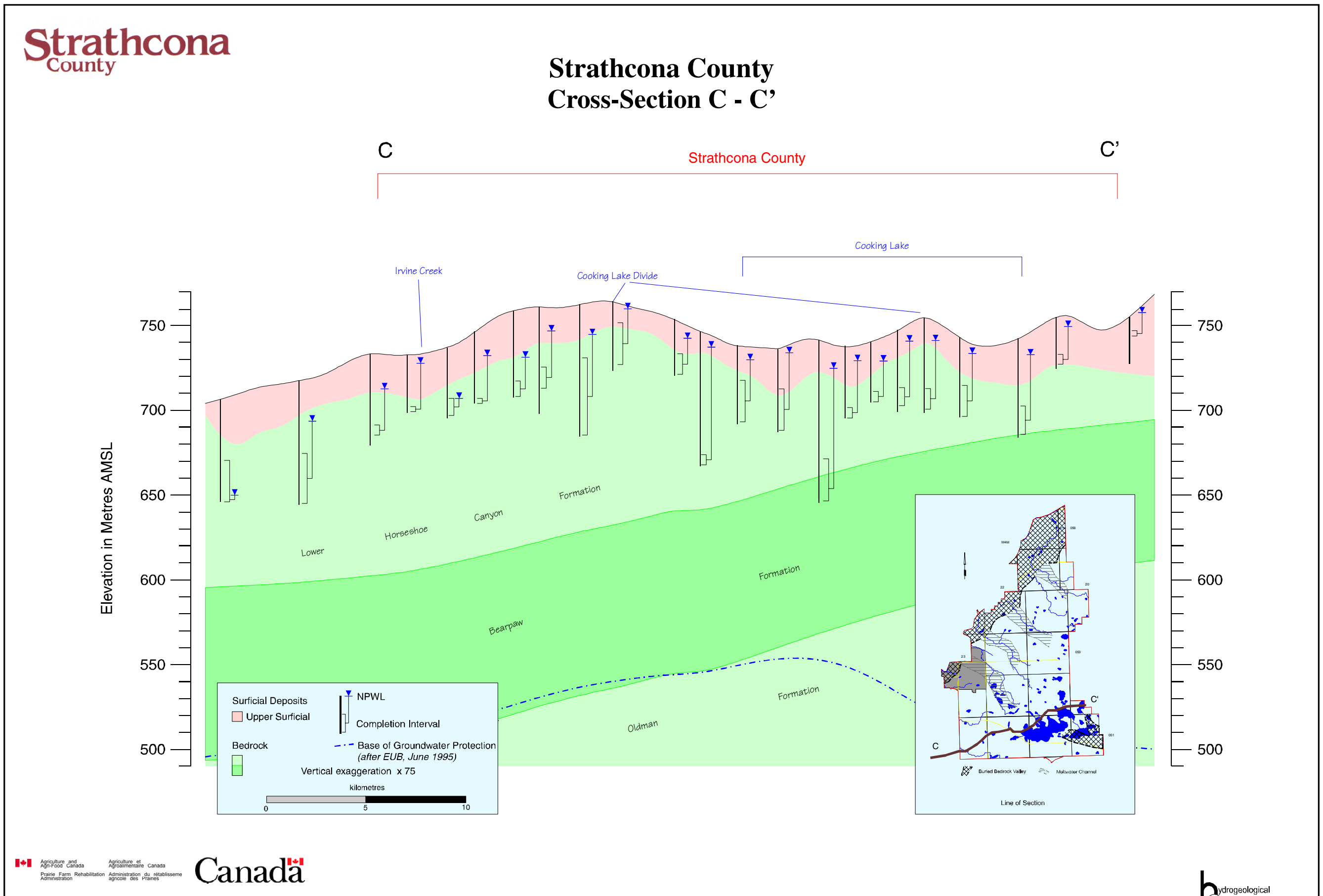


Cross-Section B - B'



hydrogeological consultants ltd, edmonton, alberta - 1.800.661.7972 - project no. 00-179

Cross-Section C - C'



hydrogeological consultants ltd, edmonton, alberta - 1.800.661.7972 - project no. 00-179

STRATHCONA COUNTY

Appendix E

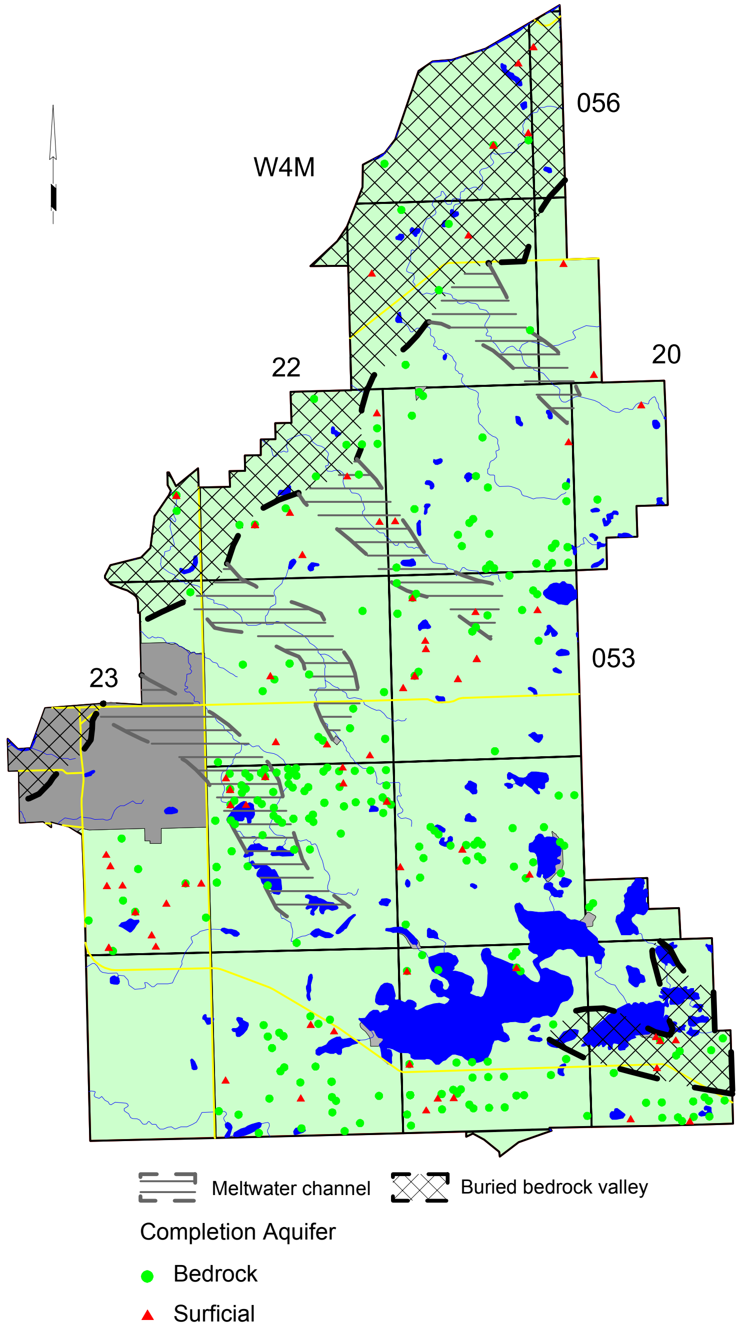
Water Wells Recommended for Field Verification

and

County-Operated Water Wells

Water Wells Recommended for Field Verification

(details on following pages)



WATER WELLS RECOMMENDED FOR FIELD VERIFICATION

Owner	Location	Aquifer Name	Date Water Well Drilled	Completed Depth Metres	Completed Depth Feet	NPWL Metres	NPWL Feet	UID
Adamson, Marvin	01-04-051-20 W4M	Lower Horseshoe Canyon	12-May-76	45.7	150.0	18.3	60.0	M36234.940377
Akley Design	NE 06-051-21 W4M	Upper Surficial	01-Sep-79	18.9	62.0	15.9	52.0	M36234.939995
Alberta Department of Highways	NE 11-053-22 W4M	Bearpaw	01-May-62	28.7	94.0	4.4	14.5	M36234.938124
Alberta Environment	13-30-056-20 W4M	Upper Surficial	27-Mar-85	10.1	33.0	5.8	19.0	M35377.173265
Alberta Environment	13-30-056-20 W4M	Upper Surficial	27-Mar-85	10.1	33.0	5.8	19.0	M35377.173275
Alberta Government Services	SE 21-052-23 W4M	Upper Surficial	10-Mar-81	25.0	82.0	6.4	21.0	M36234.942005
Andruchow, E	NE 11-056-21 W4M	Lower Surficial	17-Aug-84	42.4	139.0	29.0	95.0	M35377.055095
Arndt, Gerald	SE 21-052-22 W4M	Lower Horseshoe Canyon	04-Dec-80	41.2	135.0	12.2	40.0	M36234.938478
Baker, Gerald	09-25-052-22 W4M	Bearpaw	17-Jul-80	56.4	185.0	8.5	28.0	M36234.938641
Baldt, Henry	SW 18-052-22 W4M	Lower Horseshoe Canyon	18-May-73	75.3	247.0	9.1	30.0	M36234.938308
Barrow, Dale	NW 23-052-22 W4M	Lower Horseshoe Canyon	24-Jul-79	61.0	200.0	22.9	75.0	M36234.938568
Bartel, Richard	NE 34-054-22 W4M	Oldman	21-Nov-88	42.7	140.0	24.4	80.0	M35377.231871
Basaraba, Maria	NW 30-053-21 W4M	Bearpaw	29-May-82	39.0	128.0	21.9	72.0	M36234.943452
Bath, R.	16-16-052-23 W4M	Upper Surficial	17-Mar-77	27.4	90.0	11.0	36.0	M36234.941890
Berg, Roy	08-01-051-21 W4M	Lower Horseshoe Canyon	24-Mar-81	61.0	200.0	27.7	91.0	M36234.939904
Berg, Ted	05-27-054-21 W4M	Bearpaw	31-Jul-71	34.4	113.0	6.7	22.0	M36234.945119
Berlin, Bernard	10-20-051-22 W4M	Lower Horseshoe Canyon	09-Aug-78	22.9	75.0	4.6	15.0	M36234.939476
Berry, Peter	NW 01-054-21 W4M	Bearpaw	28-Jun-76	51.8	170.0	13.7	45.0	M36234.944805
Best, Everett	SE 02-054-21 W4M	Bearpaw	13-Sep-75	57.9	190.0	15.2	50.0	M36234.944828
Beter, Paul	13-16-053-22 W4M	Upper Surficial	13-Jun-84	17.1	56.0	6.1	20.0	M36234.938225
Beutler, Otto	SE 08-051-22 W4M	Lower Horseshoe Canyon	08-Jun-81	14.6	48.0	4.9	16.0	M36234.939686
Biffert, R.	NE 01-053-22 W4M	Bearpaw	09-May-79	27.4	90.0	1.8	6.0	M36234.937888
Birch Bay Ranch	SW 32-051-21 W4M	Lower Horseshoe Canyon	30-Mar-84	39.6	130.0	5.8	19.0	M36234.940244
Bitter, M.	06-35-052-22 W4M	Upper Surficial	01-Jun-79	32.0	105.0	11.6	38.0	M36234.941606
Bjornson, John	NW 09-051-21 W4M	Lower Horseshoe Canyon	10-May-82	18.3	60.0	4.6	15.0	M36234.940080
Black, Leonard	SE 30-052-22 W4M	Bearpaw	09-Jun-72	67.1	220.0	13.7	45.0	M36234.943547
Blair, Doug	07-02-051-22 W4M	Lower Horseshoe Canyon	11-Jul-79	36.6	120.0	12.8	42.0	M36234.939578
Boisvert, Emile	16-30-052-22 W4M	Lower Horseshoe Canyon	21-Jun-79	67.1	220.0	22.9	75.0	M36234.943629
Bonowicz, Joe	01-16-054-22 W4M	Upper Surficial		9.1	30.0	1.5	5.0	M35377.231598
Bonowicz, Joe	SE 16-054-22 W4M	Oldman	03-Nov-88	61.0	200.0	10.7	35.0	M35377.231601
Booth, Terry	NW 03-051-21 W4M	Lower Horseshoe Canyon	21-May-80	21.3	70.0	13.7	45.0	M36234.939915
Bowerman, B.	NW 10-051-21 W4M	Lower Horseshoe Canyon	13-Mar-62	42.7	140.0	13.7	45.0	M36234.940100
Bowls, D.	01-10-051-22 W4M	Lower Horseshoe Canyon	02-Aug-79	46.3	152.0	9.1	30.0	M36234.939198
Briggs, G.	SW 02-052-23 W4M	Upper Surficial	01-May-78	22.9	75.0	3.1	10.0	M36234.941467
Brown, Cameron	15-16-052-21 W4M	Lower Horseshoe Canyon	29-Oct-80	39.6	130.0	9.1	30.0	M36234.946041
Buchko, Richard	NE 04-051-21 W4M	Lower Horseshoe Canyon	12-Jun-85	21.3	70.0	1.8	6.0	M36234.939955
Budjak, Michael N.	NE 34-052-22 W4M	Lower Horseshoe Canyon	14-Aug-80	32.0	105.0	6.7	22.0	M36234.941587
Buksa, Elvira	03-24-052-21 W4M	Bearpaw	08-Oct-82	61.0	200.0	2.4	8.0	M36234.946259
Bunnage, Judd	NE 33-052-22 W4M	Lower Horseshoe Canyon	06-Jun-77	32.0	105.0	4.6	15.0	M36234.941513
Burghoff, Karl	SW 13-052-23 W4M	Upper Surficial	24-Jun-77	42.7	140.0	13.7	45.0	M36234.941741
Burnett, Bill	NW 26-053-21 W4M	Bearpaw	30-Sep-81	48.8	160.0	14.6	48.0	M36234.943315
Burns, Marie	NE 36-052-22 W4M	Lower Horseshoe Canyon	24-Feb-77	41.2	135.0	6.4	21.0	M36234.941713
Burton, John	SE 31-052-22 W4M	Upper Surficial	18-Oct-72	47.2	155.0	12.8	42.0	M36234.943656
Butler, Bill	12-02-052-23 W4M	Upper Surficial	29-May-81	9.8	32.0	2.1	7.0	M36234.941471

WATER WELLS RECOMMENDED FOR FIELD VERIFICATION

Owner	Location	Aquifer Name	Date Water Well Drilled	Completed Depth Metres	Completed Depth Feet	NPWL Metres	NPWL Feet	UID
Bykewteh, Orest	NE 30-052-22 W4M	Upper Surficial	14-Sep-81	14.6	48.0	6.1	20.0	M36234.943635
Campbell Town Baptist Chruch	03-06-053-22 W4M	Bearpaw	19-Jul-79	61.6	202.0	24.7	81.0	M36234.938022
Carlson Realty Ltd.	SW 34-052-22 W4M	Bearpaw	2-Nov-74	53.3	175.0	10.7	35.0	M36234.941558
Chesnich, Alex	SW 05-051-20 W4M	Upper Surficial	1-Jul-72	21.0	69.0	6.1	20.0	M36234.940396
Chimera, Walter	NW 08-054-22 W4M	Oldman	22-Sep-83	61.0	200.0	18.3	60.0	M35377.231466
Chisholm, Bruce	NE 34-051-21 W4M	Lower Horseshoe Canyon	10-Jun-78	27.4	90.0	3.1	10.0	M36234.940284
Chrenek Developments	SW 15-052-23 W4M	Upper Surficial	26-Nov-79	24.4	80.0	5.9	19.5	M36234.941801
Christensen, Bob	SW 03-051-20 W4M	Lower Horseshoe Canyon	15-Jun-76	45.7	150.0	17.1	56.0	M36234.940366
Churchill, Beverley	07-35-053-21 W4M	Bearpaw	22-Jun-77	59.4	195.0	18.3	60.0	M36234.943496
Clarke, James	NW 16-051-20 W4M	Lower Horseshoe Canyon	4-Sep-79	63.1	207.0	6.1	20.0	M36234.940571
Clyne, Jim & Jean	12-16-053-21 W4M	Upper Surficial	27-Oct-81	19.5	64.0	4.6	15.0	M36234.943105
Colvin, Jim	13-16-051-20 W4M	Upper Surficial	25-Nov-80	30.5	100.0	7.6	25.0	M36234.940574
Conley Const	04-03-054-21 W4M	Bearpaw	5-Jun-79	48.8	160.0	4.9	16.0	M36234.944856
Cooke, John	SW 21-052-21 W4M	Lower Horseshoe Canyon	2-Aug-79	42.7	140.0	4.3	14.0	M36234.946176
County of Strathcona	13-32-054-21 W4M	Oldman	26-Mar-74	61.0	200.0	18.9	62.0	M36234.945163
County of Strathcona	SE 04-052-22 W4M	Lower Horseshoe Canyon	25-Aug-75	70.1	230.0	13.7	45.0	M36234.947612
Crakim Holdings Ltd.	SE 35-053-21 W4M	Bearpaw		53.3	175.0	11.8	38.7	M36234.943502
Crowell, Keith	NE 10-051-22 W4M	Lower Horseshoe Canyon	25-Apr-80	39.6	130.0	15.2	50.0	M36234.939240
Crummer, D.	NW 16-053-22 W4M	Bearpaw	5-Jun-75	70.1	230.0	10.7	35.0	M36234.938224
Daily, Rocky	NE 01-054-21 W4M	Bearpaw	26-Nov-73	56.4	185.0	17.7	58.0	M36234.944819
Daly, Ethel	NE 31-052-22 W4M	Bearpaw	15-Jun-65	67.1	220.0	14.0	46.0	M36234.943708
Dannacker, Keith	NE 10-051-22 W4M	Lower Horseshoe Canyon	5-Jul-76	21.3	70.0	11.6	38.0	M36234.939216
Davis, Dick	16-34-052-22 W4M	Lower Horseshoe Canyon	6-Apr-78	33.5	110.0	9.8	32.0	M36234.941583
Davis, Fred	SW 13-052-21 W4M	Lower Horseshoe Canyon	8-Jun-78	27.4	90.0	4.6	15.0	M35377.076635
Davison, Herb	NW 18-052-22 W4M	Lower Horseshoe Canyon	10-Oct-79	38.1	125.0	6.1	20.0	M36234.938340
Davy, Robert	NW 18-052-22 W4M	Lower Horseshoe Canyon	6-Oct-77	64.0	210.0	20.7	68.0	M36234.938336
Dekleyne, Harry	SE 21-052-21 W4M	Lower Horseshoe Canyon	17-Mar-83	30.5	100.0	7.3	24.0	M36234.946158
Diehl, David	11-32-052-22 W4M	Bearpaw	10-Oct-84	73.5	241.0	29.0	95.0	M36234.943774
Dilworth, Jack	15-29-052-22 W4M	Lower Horseshoe Canyon	3-Dec-75	45.7	150.0	19.8	65.0	M36234.943519
Dimitroff, Paul	SE 31-052-22 W4M	Bearpaw	19-Apr-72	73.2	240.0	15.2	50.0	M36234.943661
Dionne, Raymond	05-32-052-22 W4M	Lower Horseshoe Canyon	14-Mar-72	68.6	225.0	22.9	75.0	M36234.943736
Dittrich, Leo	16-34-053-21 W4M	Bearpaw	19-Jun-75	42.7	140.0	3.7	12.0	M36234.943490
Dmytriw, Marvin	NW 25-052-22 W4M	Lower Horseshoe Canyon	5-Dec-73	50.3	165.0	19.8	65.0	M36234.938627
Doll, Rita	NW 04-051-21 W4M	Lower Horseshoe Canyon	5-Jun-81	39.6	130.0	9.8	32.0	M36234.939951
Dougall, S.	05-28-052-22 W4M	Lower Horseshoe Canyon	8-Nov-78	34.4	113.0	10.4	34.0	M36234.942463
Dubyk, J.	NE 03-053-22 W4M	Bearpaw	23-Jul-74	39.0	128.0	1.4	4.6	M36234.937951
Duff, Don	16-19-055-20 W4M	Upper Surficial	1-Nov-73	30.5	100.0	12.5	41.0	M36234.945547
Dunlop, Al	NW 20-052-21 W4M	Lower Horseshoe Canyon	8-Jun-76	44.2	145.0	1.5	5.0	M36234.946137
Dutchack, Bill	10-31-052-22 W4M	Upper Surficial	15-May-75	31.7	104.0	9.1	30.0	M36234.943699
Dykstra, A.	SE 18-052-21 W4M	Lower Horseshoe Canyon	1-Aug-69	47.2	155.0	16.8	55.0	M36234.946051
Eastman, John	NE 13-054-21 W4M	Bearpaw	9-Jul-85	30.5	100.0	6.4	21.0	M36234.944999
Ebony Homes Ltd.	12-18-052-21 W4M	Upper Surficial	18-Jun-80	19.8	65.0	4.9	16.0	M35377.050334
Ebony Homes Ltd.	NE 33-052-22 W4M	Lower Horseshoe Canyon	4-May-78	30.5	100.0	7.6	25.0	M36234.941530
Ede, William	NE 19-055-21 W4M	Lower Surficial	23-Jul-75	38.1	125.0	34.8	114.0	M36234.945816
Esso Resource Canada Ltd.	07-25-056-21 W4M	Upper Surficial	20-Aug-84	14.6	48.0	6.1	20.0	M35377.055711
Ewanchuk, Alvin	14-15-053-22 W4M	Bearpaw	14-Jun-76	33.5	110.0	8.2	27.0	M36234.938215

WATER WELLS RECOMMENDED FOR FIELD VERIFICATION

Owner	Location	Aquifer Name	Date Water Well Drilled	Completed Depth Metres	Completed Depth Feet	NPWL Metres	NPWL Feet	UID
Fairbanks, Richard	SW 21-051-22 W4M	Lower Horseshoe Canyon	23-Jul-77	48.8	160.0	12.2	40.0	M36234.939495
Fairweather, B	NE 11-056-21 W4M	Lower Surficial	1-Aug-73	37.2	122.0	35.1	115.0	M35377.055072
Falkenberg, Arron	04-33-052-22 W4M	Lower Horseshoe Canyon	2-Nov-78	36.6	120.0	7.3	24.0	M36234.941496
Falkner, Max	01-21-054-21 W4M	Bearpaw		27.7	91.0	6.1	20.0	M36234.945068
Fenna, Donald	NW 04-051-20 W4M	Lower Horseshoe Canyon	8-Dec-76	54.9	180.0	36.6	120.0	M36234.940387
Field, Dick	NE 31-051-21 W4M	Lower Horseshoe Canyon	8-Jun-73	45.7	150.0	13.7	45.0	M36234.940235
Field, Joanne	NW 35-052-22 W4M	Bearpaw	26-Sep-79	50.3	165.0	6.7	22.0	M36234.941638
Fink, Garry	SW 27-052-22 W4M	Lower Horseshoe Canyon	14-Jul-77	48.8	160.0	15.2	50.0	M36234.942391
Fischer, Alice	10-09-054-21 W4M	Bearpaw	14-Jun-83	64.0	210.0	18.3	60.0	M36234.944950
Flemming, R. & A.	SW 10-054-21 W4M	Bearpaw	16-Jun-83	64.6	212.0	15.2	50.0	M36234.944959
Follack, Val	06-27-052-22 W4M	Lower Horseshoe Canyon	30-Oct-79	53.3	175.0	18.3	60.0	M36234.942396
Fowler, Ray	10-34-051-21 W4M	Lower Horseshoe Canyon	23-Sep-79	32.0	105.0	4.3	14.0	M36234.940272
Frigon, A.	NW 04-053-22 W4M	Upper Surficial	1-Jun-72	12.2	40.0	5.5	18.0	M36234.937994
Gabert, J.	NE 12-055-21 W4M	Oldman	27-May-76	68.6	225.0	24.4	80.0	M36234.945768
Gallant, Ron	NE 03-051-20 W4M	Lower Horseshoe Canyon	14-May-85	59.4	195.0	18.3	60.0	M36234.940374
Gallant, Ron	NW 16-051-20 W4M	Upper Surficial	18-Jul-80	38.4	126.0	5.5	18.0	M36234.940573
Galloway, Don	15-33-052-22 W4M	Bearpaw	28-Jul-78	43.9	144.0	6.1	20.0	M36234.941526
Gaulhofer, Konrad	05-21-051-22 W4M	Lower Horseshoe Canyon	9-Aug-85	36.6	120.0	17.4	57.0	M36234.939512
Gauthier, H.	12-06-051-21 W4M	Lower Horseshoe Canyon	9-Mar-78	29.9	98.0	12.8	42.0	M36234.939988
Geisler, Harvey	NW 18-052-22 W4M	Lower Horseshoe Canyon	8-Sep-77	79.2	260.0	16.8	55.0	M36234.938329
Gibbs, Dwayne	NE 18-053-21 W4M	Upper Surficial	7-Sep-82	38.1	125.0	22.9	75.0	M36234.943165
Gibson, Brent	SW 18-051-21 W4M	Upper Surficial	13-Jun-78	12.2	40.0	3.7	12.2	M36234.940169
Gillespie	NE 27-052-22 W4M	Lower Horseshoe Canyon	28-Jun-85	54.9	180.0	17.7	58.0	M36234.942434
Ginther, Neil	01-25-054-21 W4M	Upper Surficial	30-Jun-80	14.9	49.0	6.1	20.0	M36234.945108
Gleeson, Andrew	SE 09-051-22 W4M	Upper Surficial	10-May-72	21.3	70.0	9.1	30.0	M36234.939169
Glowatsky, Wilbert	09-33-052-22 W4M	Lower Horseshoe Canyon	1-Mar-77	32.0	105.0	0.3	1.0	M36234.941524
Goebel, B	NW 06-052-21 W4M	Lower Horseshoe Canyon	16-Mar-81	54.9	180.0	20.7	68.0	M35377.069425
Goertz, Abe	NW 02-051-20 W4M	Lower Horseshoe Canyon	1-Jun-69	67.4	221.0	21.3	70.0	M36234.940358
Goodchild, Tom	SE 18-054-20 W4M	Bearpaw	28-Apr-83	42.7	140.0	9.1	30.0	M35377.074318
Grabowski, Jack	SE 16-051-20 W4M	Lower Horseshoe Canyon	18-Oct-79	56.4	185.0	7.0	23.0	M36234.940555
Grabowski, Tom	08-16-051-20 W4M	Lower Horseshoe Canyon	7-Jun-85	61.0	200.0	11.6	38.0	M36234.940561
Gray, Reg	07-10-052-23 W4M	Upper Surficial	24-Jun-80	12.2	40.0	3.1	10.0	M36234.942255
Grey, R.	07-10-052-23 W4M	Lower Horseshoe Canyon	18-Nov-78	78.0	256.0	18.9	62.0	M36234.942254
Grier, Don	SW 25-054-22 W4M	Oldman	1-Jun-73	63.1	207.0	14.6	48.0	M35377.056401
Grobben, G.	16-33-052-22 W4M	Lower Horseshoe Canyon	26-Nov-77	30.5	100.0	10.4	34.0	M36234.941517
Guzyk, Bill	07-25-052-22 W4M	Lower Horseshoe Canyon	3-Jul-80	48.8	160.0	4.0	13.0	M36234.938618
Hagan & Schaaf	12-20-053-21 W4M	Upper Surficial	22-Jun-79	38.4	126.0	18.0	59.0	M36234.943198
Hall, Gordon	NE 20-052-22 W4M	Lower Horseshoe Canyon	1-Nov-73	44.8	147.0	6.1	20.0	M36234.938463
Hamle of Josephburg	NW 32-054-21 W4M	Oldman	26-Aug-69	58.2	191.0	17.7	58.0	M36234.945155
Hangartner, Thomas	SH 21-052-21 W4M	Lower Horseshoe Canyon	6-May-80	27.4	90.0	9.1	30.0	M36234.946155
Hankinson, L. V.	NE 11-051-21 W4M	Lower Horseshoe Canyon	1-Oct-86	39.6	130.0	10.7	35.0	M36234.940110
Hanlan, Harv	SE 21-053-22 W4M	Bearpaw	14-Aug-79	70.1	230.0	29.6	97.0	M36234.938265
Hanlan, Harv	SE 21-053-22 W4M	Bearpaw	24-Mar-76	39.6	130.0	25.9	85.0	M36234.938266
Hanneman, Carl	SE 05-055-20 W4M	Upper Surficial	17-Sep-81	15.9	52.0	6.7	22.0	M36234.945466
Harke, Gordon	01-04-052-23 W4M	Lower Horseshoe Canyon	13-Jul-79	80.8	265.0	21.3	70.0	M36234.942180

WATER WELLS RECOMMENDED FOR FIELD VERIFICATION

Owner	Location	Aquifer Name	Date Water Well Drilled	Completed Depth Metres	Completed Depth Feet	NPWL Metres	NPWL Feet	UID
Harkness, J. W.	15-03-053-22 W4M	Bearpaw	18-May-84	54.9	180.0	16.8	55.0	M36234.937959
Harms, Art	02-10-051-21 W4M	Lower Horseshoe Canyon	1-Feb-78	22.9	75.0	4.1	13.4	M36234.940094
Harrison, John E.	SE 31-052-22 W4M	Upper Surficial	28-Jul-73	51.8	170.0	19.8	65.0	M36234.943658
Harter, Alvin	SW 01-053-22 W4M	Upper Surficial	5-Oct-84	19.2	63.0	6.1	20.0	M36234.937841
Hayduk, A.	NE 34-052-22 W4M	Lower Horseshoe Canyon	14-Sep-83	35.7	117.0	9.5	31.0	M36234.941591
Hdrwood, J. W.	NE 18-053-21 W4M	Upper Surficial	8-Sep-72	33.5	110.0	25.9	85.0	M36234.943138
Heinrichs, Ed	16-27-055-21 W4M	Lower Surficial	5-Jul-74	26.8	88.0	17.7	58.0	M36234.945871
Helsey, Stan	14-07-051-22 W4M	Upper Surficial	23-Feb-83	19.8	65.0	3.7	12.0	M36234.939680
Henry, Dwayne	SE 03-051-20 W4M	Lower Horseshoe Canyon	28-Sep-82	68.6	225.0	18.3	60.0	M35377.074458
Herbert, Licht	NE 06-051-22 W4M	Lower Horseshoe Canyon	27-Apr-78	47.2	155.0	4.6	15.0	M36234.939664
Heske, Gerry	NE 08-054-22 W4M	Lower Surficial	28-May-86	11.9	39.0	3.1	10.0	M35377.231489
Hillmer, Ken	SE 21-052-22 W4M	Lower Horseshoe Canyon	26-Aug-76	51.8	170.0	15.2	50.0	M36234.938493
Hisey, Gorden	SE 31-053-21 W4M	Bearpaw	2-Sep-81	54.9	180.0	19.8	65.0	M36234.943459
Hisey, Gordon	SE 31-053-21 W4M	Upper Surficial	4-Sep-78	22.9	75.0	12.2	40.0	M36234.943457
Hitchcock, Jack	SW 06-054-21 W4M	Bearpaw	24-Aug-76	48.8	160.0	21.3	70.0	M36234.944919
Hodder, Ed	NE 16-052-21 W4M	Lower Horseshoe Canyon	24-Apr-80	35.1	115.0	12.2	40.0	M36234.946039
Holewoch, Water	NE 28-053-21 W4M	Upper Surficial	30-May-84	34.4	113.0	4.6	15.0	M36234.943416
Holowaychuk, Bob	NE 33-052-22 W4M	Lower Horseshoe Canyon	12-Sep-77	33.5	110.0	2.1	7.0	M36234.941518
Hopp, Edith	NE 32-052-22 W4M	Lower Horseshoe Canyon	4-Jan-85	57.9	190.0	20.7	68.0	M36234.943765
House Proud	NE 34-051-21 W4M	Lower Horseshoe Canyon	18-Nov-77	30.5	100.0	1.8	6.0	M36234.940289
Hubbard, Dave & /Linda	SW 12-051-22 W4M	Lower Horseshoe Canyon	10-Jun-83	35.1	115.0	16.2	53.0	M36234.939271
Hugell, Florence	09-32-052-22 W4M	Bearpaw	28-Oct-78	77.7	255.0	20.4	67.0	M36234.943775
Huley, James	SE 04-051-22 W4M	Lower Horseshoe Canyon	26-May-74	48.8	160.0	10.7	35.0	M36234.939598
Humphreys, Wayne	SE 04-052-23 W4M	Upper Surficial	21-Nov-77	47.9	157.0	21.3	70.0	M36234.942179
Hutton, Stan	NE 18-053-21 W4M	Upper Surficial	4-Aug-78	36.6	120.0	7.0	23.0	M36234.943149
Inkster, R.	NE 01-054-21 W4M	Bearpaw	1-Nov-74	44.2	145.0	11.3	37.0	M36234.944817
Inscho, A.	09-03-053-22 W4M	Upper Surficial	7-Oct-81	14.6	48.0	4.3	14.0	M36234.937946
Iozzo, Joseph	13-20-053-21 W4M	Upper Surficial	10-Aug-80	18.3	60.0	13.4	44.0	M36234.943195
J.S.H. Holdings Ltd.	15-25-052-22 W4M	Bearpaw	9-Jun-83	53.3	175.0	7.0	23.0	M36234.938636
Jacques, Reg	12-27-053-21 W4M	Bearpaw	23-Mar-78	64.0	210.0	21.3	70.0	M36234.943331
Jamison, Dennis	NW 29-052-22 W4M	Upper Surficial	2-Dec-85	41.8	137.0	15.2	50.0	M36234.942508
Jantz, Albert	13-20-052-21 W4M	Lower Horseshoe Canyon	1-Nov-75	36.6	120.0	4.9	16.0	M36234.946121
Johnson, Art	NE 03-053-22 W4M	Bearpaw	26-Sep-84	54.9	180.0	21.3	70.0	M36234.937958
Johnson, Oran	16-17-051-22 W4M	Lower Horseshoe Canyon	12-Oct-84	39.6	130.0	12.2	40.0	M36234.939394
Jones, Brinley	SE 28-053-21 W4M	Bearpaw	13-Nov-78	56.1	184.0	9.1	30.0	M36234.943376
Jones, Jeff	16-32-052-22 W4M	Bearpaw	6-Jul-76	67.1	220.0	21.9	72.0	M36234.943770
Joslin, Rodney	NE 18-053-21 W4M	Upper Surficial	20-Feb-79	33.5	110.0	16.5	54.0	M36234.943150
Kalf, Dirk	04-01-054-21 W4M	Bearpaw	5-Sep-79	65.5	215.0	25.9	85.0	M36234.944795
Kaplin, Greg	NE 25-052-22 W4M	Upper Surficial	27-May-83	36.6	120.0	7.9	26.0	M36234.938634
Kehlert, S.	SW 09-054-21 W4M	Bearpaw	26-Mar-74	35.1	115.0	9.1	30.0	M36234.944944
Keith, Younger	07-33-052-22 W4M	Lower Horseshoe Canyon	8-Mar-78	32.0	105.0	7.3	24.0	M36234.941145
Kempf, A.	08-15-051-20 W4M	Lower Horseshoe Canyon	1-Jan-65	79.2	260.0	33.5	110.0	M36234.940544
Kendale, John	NE 34-051-21 W4M	Lower Horseshoe Canyon	2-Jul-79	27.4	90.0	2.7	9.0	M36234.940283
Kennedy, Ken	NE 08-054-22 W4M	Bearpaw	11-Jun-79	14.9	49.0	3.1	10.0	M35377.056377
Kershaw, Peter	13-09-051-20 W4M	Upper Surficial	12-Jul-82	22.3	73.0	10.7	35.0	M36234.940459

WATER WELLS RECOMMENDED FOR FIELD VERIFICATION

Owner	Location	Aquifer Name	Date Water Well Drilled	Completed Depth Metres	Completed Depth Feet	NPWL Metres	NPWL Feet	UID
Kiel, Rudy	NW 13-054-23 W4M	Oldman	29-May-79	32.0	105.0	23.8	78.0	M35377.049473
Kinasewich, Ron	SW 03-054-21 W4M	Bearpaw	12-Oct-80	41.2	135.0	13.7	45.0	M36234.944848
Kiss, Sandy	NE 12-054-22 W4M	Upper Surficial	15-Nov-74	25.9	85.0	17.4	57.0	M35377.231523
Kleespies, A.	NE 27-052-22 W4M	Lower Horseshoe Canyon	8-Nov-73	49.4	162.0	22.9	75.0	M36234.942413
Kofluk, D	SW 08-056-21 W4M	Oldman	1-Apr-73	48.8	160.0	29.9	98.0	M35377.055023
Kohut, Rosalind	SW 32-052-22 W4M	Bearpaw	28-Jun-83	70.1	230.0	29.3	96.0	M36234.943733
Komm, Dr. Kenneth	SE 28-052-22 W4M	Lower Horseshoe Canyon	28-Jun-73	56.4	185.0	5.5	18.0	M36234.942443
Kopala, Ray	SE 13-054-21 W4M	Bearpaw	19-Sep-81	36.6	120.0	13.7	45.0	M36234.944981
Kostyk, Larry S.	NE 33-052-22 W4M	Lower Horseshoe Canyon	23-Jul-79	31.7	104.0	9.1	30.0	M36234.941534
Koydrowski, Mike	NE 26-053-21 W4M	Upper Surficial		48.8	160.0	14.0	46.0	M36234.943321
Krampitz, Walter	NE 30-052-22 W4M	Lower Horseshoe Canyon	27-Jun-72	54.9	180.0	12.2	40.0	M36234.943621
Kreamer, Wes	SW 22-052-22 W4M	Lower Horseshoe Canyon	1-Oct-70	48.8	160.0	15.2	50.0	M36234.938543
Kribs, Robert	01-21-055-21 W4M	Oldman	3-Apr-80	36.6	120.0	16.2	53.0	M36234.945831
Kroenting, Greg	NE 08-054-22 W4M	Lower Surficial	27-Oct-80	9.1	30.0	1.8	6.0	M35377.231483
Kumpula, Ellis	SW 13-054-23 W4M	Oldman	4-Nov-77	31.1	102.0	24.7	81.0	M35377.049382
La Fontain, Pierre	SE 17-051-21 W4M	Lower Horseshoe Canyon	25-Nov-77	32.0	105.0	9.1	30.0	M36234.940162
La Trace, Darlene	SE 22-054-22 W4M	Oldman	29-Nov-88	37.2	122.0	6.1	20.0	M35377.231626
Lamberecth, Norman	NW 30-053-21 W4M	Bearpaw	26-May-76	52.4	172.0	10.7	35.0	M36234.943434
Lambert, Lawrence	SW 08-051-21 W4M	Lower Horseshoe Canyon	8-Nov-80	21.3	70.0	7.6	25.0	M36234.940069
Lavoie, Dennis	SE 01-054-21 W4M	Bearpaw	30-Aug-76	70.1	230.0	16.8	55.0	M35377.064031
Lawrie, George	16-18-053-21 W4M	Bearpaw	6-Jun-78	45.7	150.0	28.7	94.0	M36234.943141
Lehbauer, Edward	NE 25-052-21 W4M	Bearpaw	18-May-83	67.1	220.0	8.5	28.0	M36234.946290
Lemay, Marie	SW 07-051-21 W4M	Lower Horseshoe Canyon	12-Apr-82	26.5	87.0	9.1	30.0	M36234.940013
Lengert, Cy	01-12-052-23 W4M	Lower Horseshoe Canyon	13-Sep-83	29.6	97.0	18.3	60.0	M36234.942311
Lengwieler, Francois	NE 10-051-22 W4M	Lower Horseshoe Canyon	10-Jul-80	21.3	70.0	11.9	39.0	M36234.939217
Leversedge, Dan	NE 08-054-22 W4M	Lower Surficial	8-Jun-79	13.1	43.0	4.6	15.0	M35377.056370
Lien, P.	SW 14-052-21 W4M	Upper Surficial	1-Oct-69	24.4	80.0	8.2	27.0	M36234.945961
Litke, J.	16-33-052-22 W4M	Lower Horseshoe Canyon	15-Jun-77	32.0	105.0	4.6	15.0	M36234.941523
Locker, Brian	NE 10-051-22 W4M	Lower Horseshoe Canyon	16-Nov-82	33.5	110.0	17.4	57.0	M36234.939229
Machushyk, Michael	SE 10-051-22 W4M	Lower Horseshoe Canyon	30-Jul-85	42.7	140.0	12.8	42.0	M36234.939192
Macleod, C.	SW 08-051-21 W4M	Lower Horseshoe Canyon	25-Jun-84	54.9	180.0	11.6	38.0	M36234.940056
Madu, Lyle	04-08-051-21 W4M	Upper Surficial	25-May-84	16.8	55.0	7.6	25.0	M36234.940072
Mair, Diek	SE 19-052-22 W4M	Lower Horseshoe Canyon	28-Mar-77	54.9	180.0	13.7	45.0	M36234.938373
Malcolm, Gerald	SW 04-051-20 W4M	Lower Horseshoe Canyon	1-Jun-77	64.0	210.0	12.2	40.0	M36234.940382
Maloney, John & Karen	NE 18-053-21 W4M	Bearpaw	7-Aug-78	48.8	160.0	19.8	65.0	M36234.943153
Manning, Ken	NW 36-052-22 W4M	Bearpaw	14-Nov-75	39.6	130.0	6.7	22.0	M36234.941666
Marcotte, Rollin	SW 21-052-21 W4M	Lower Horseshoe Canyon	21-Sep-76	29.6	97.0	7.6	25.0	M36234.946165
Marshall, Breat	SE 04-052-23 W4M	Upper Surficial		16.5	54.0	6.1	20.0	M36234.942178
Marsolais, Henry	SW 30-052-22 W4M	Lower Horseshoe Canyon	28-Jul-74	56.4	185.0	13.7	45.0	M36234.943565
Mason, L	NE 07-051-20 W4M	Lower Horseshoe Canyon	14-Mar-77	54.9	180.0	27.4	90.0	M35377.069126
Mathiew, Jean	SE 21-053-21 W4M	Upper Surficial	20-Jul-78	23.2	76.0	7.3	24.0	M36234.943213
May, Tom	SW 13-051-21 W4M	Lower Horseshoe Canyon	24-Oct-83	36.6	120.0	6.1	20.0	M36234.940126
McAlpine, Joan/David	01-34-051-21 W4M	Lower Horseshoe Canyon	2-May-86	24.4	80.0	3.0	9.7	M36234.940261
McBride, Bob	NE 05-051-20 W4M	Lower Horseshoe Canyon	23-Jul-83	70.1	230.0	20.7	68.0	M36234.940413
McCue, Pat	04-14-052-21 W4M	Lower Horseshoe Canyon	24-May-85	32.3	106.0	5.5	18.0	M36234.945984

WATER WELLS RECOMMENDED FOR FIELD VERIFICATION

		Aquifer	Date Water	Completed Depth		NPWL		
Owner	Location	Name	Well Drilled	Metres	Feet	Metres	Feet	UID
McDonald, Hector	11-26-052-22 W4M	Lower Horseshoe Canyon	30-Jun-77	45.1	148.0	9.8	32.0	M36234.942347
McDonald, Howard	NE 23-052-21 W4M	Lower Horseshoe Canyon	18-Jul-79	12.2	40.0	11.3	37.0	M36234.946246
McFall, Earl E.	NE 16-051-20 W4M	Upper Surficial	18-Sep-77	18.9	62.0	7.6	25.0	M36234.940578
McGrandle, Jim	SW 07-051-21 W4M	Lower Horseshoe Canyon	4-Oct-83	30.5	100.0	6.4	21.0	M36234.940018
McLaren, Gordon	NE 22-051-22 W4M	Lower Horseshoe Canyon	8-May-81	25.9	85.0	9.5	31.0	M36234.939549
McLaughlin, Dennis	NE 18-053-21 W4M	Upper Surficial	23-Aug-82	36.6	120.0	18.0	59.0	M36234.943164
McLleane, Ron	02-08-051-21 W4M	Upper Surficial	13-Jun-79	6.1	20.0	-0.6	-2.0	M36234.940035
Meheriuk, Bill	SE 02-054-21 W4M	Bearpaw	17-Sep-75	64.0	210.0	15.2	50.0	M36234.944827
Miller, Gary	NE 06-051-22 W4M	Lower Horseshoe Canyon	29-Jun-77	30.5	100.0	3.1	10.0	M36234.939663
Miller, W.	NW 10-052-23 W4M	Lower Horseshoe Canyon	16-Oct-72	54.9	180.0	7.6	25.0	M36234.942266
Milligan, R.W.	NE 03-053-22 W4M	Bearpaw	16-May-73	39.9	131.0	1.2	4.0	M36234.937971
Ministik Highway Campground	SE 16-051-21 W4M	Lower Horseshoe Canyon	13-Apr-61	27.4	90.0	3.4	11.0	M36234.940150
Mitchinson, Vern	01-10-051-21 W4M	Lower Horseshoe Canyon	12-Dec-87	17.7	58.0	7.9	26.0	M36234.940097
Moen, Dave	NE 10-051-22 W4M	Lower Horseshoe Canyon	3-Jun-76	33.5	110.0	8.5	28.0	M36234.939233
Mohr, Miles	NE 25-054-22 W4M	Oldman	24-Apr-80	56.4	185.0	7.9	26.0	M35377.231644
Mohr, Reg	SE 36-054-22 W4M	Lower Surficial	22-Jul-74	36.6	120.0	3.1	10.0	M35377.231880
Moore, Dale	SW 03-054-21 W4M	Bearpaw	31-May-80	32.0	105.0	2.4	8.0	M36234.944843
Much, Peter	14-04-054-21 W4M	Bearpaw	30-May-75	48.8	160.0	12.8	42.0	M36234.944893
Mules, G.	NW 14-051-20 W4M	Bearpaw	6-Sep-86	96.0	315.0	15.2	50.0	M36234.940538
Mumby, Brian	01-17-052-22 W4M	Lower Horseshoe Canyon	5-Jul-83	53.3	175.0	7.6	25.0	M36234.938290
Murphy, Don	04-21-052-21 W4M	Upper Surficial	15-Oct-81	19.5	64.0	10.7	35.0	M36234.946177
Murray, Arch	07-08-051-21 W4M	Lower Horseshoe Canyon	17-May-80	16.8	55.0	7.9	26.0	M36234.940066
Muzylowski, Fred	SE 19-052-21 W4M	Lower Horseshoe Canyon	1-Mar-73	50.3	165.0	4.5	14.9	M35377.092175
Napora, Terry	SW 35-052-22 W4M	Lower Horseshoe Canyon	3-Jul-86	41.2	135.0	23.8	78.0	M36234.941617
Nelson, Lary	SW 03-053-21 W4M	Lower Horseshoe Canyon	6-Dec-79	42.7	140.0	21.2	69.5	M36239.965069
Nelson-Zutter, Guy	SW 07-051-21 W4M	Lower Horseshoe Canyon	25-Jul-80	47.2	155.0	22.9	75.0	M36234.940007
Nickolay, C.	03-28-052-22 W4M	Lower Horseshoe Canyon	1-Jan-72	50.3	165.0	11.6	38.0	M36234.942477
Nikolay, Karl	11-26-052-22 W4M	Lower Horseshoe Canyon	24-Nov-80	48.8	160.0	24.1	79.0	M36234.942353
Nordstrom, Joey	NE 34-051-21 W4M	Lower Horseshoe Canyon	8-Jul-76	32.0	105.0	5.5	18.0	M36234.940268
Norman, Norman	11-22-051-22 W4M	Lower Horseshoe Canyon	11-Jun-81	15.2	50.0	9.1	30.0	M36234.939538
Norman, Norman C.	13-22-051-22 W4M	Lower Horseshoe Canyon	16-Jul-83	18.3	60.0	12.2	40.0	M36234.939539
Nouta, R.	SW 21-051-22 W4M	Lower Horseshoe Canyon	29-Oct-75	25.6	84.0	8.5	28.0	M36234.939498
Obradovich, Vuksan	NW 13-054-23 W4M	Lower Surficial	1-Oct-77	31.7	104.0	21.6	71.0	M35377.049408
Osbaldeston, Grant	01-18-054-21 W4M	Bearpaw	31-Aug-83	39.6	130.0	11.6	38.0	M36234.945049
Osborne Brothers	SE 28-053-21 W4M	Bearpaw	25-Sep-72	54.9	180.0	39.6	130.0	M36234.943384
Ostasheski, Bill	SW 28-052-22 W4M	Lower Horseshoe Canyon	14-Nov-73	62.5	205.0	18.3	60.0	M36234.942460
Ottewell, Garnet	08-17-053-22 W4M	Bearpaw	23-Sep-75	30.5	100.0	7.3	24.0	M36234.938232
Otto, Donald	NE 29-052-22 W4M	Lower Horseshoe Canyon	2-Apr-76	59.4	195.0	24.4	80.0	M36234.943524
Packer, Stephen	SW 18-051-21 W4M	Lower Horseshoe Canyon	15-Feb-83	61.0	200.0	3.7	12.0	M36234.940171
Parkway Design Homes Ltd.	SW 08-051-21 W4M	Lower Horseshoe Canyon	25-Oct-79	19.8	65.0	5.2	17.0	M36234.940059
Partas, Thomas	NW 16-052-21 W4M	Lower Horseshoe Canyon	1-Jul-73	22.9	75.0	5.5	18.0	M36234.946030
PCL Braun Simons Ltd.	NE 32-055-21 W4M	Oldman	9-Oct-81	41.2	135.0	29.0	95.0	M36234.945906
Pelletier, Raymond	NE 25-052-22 W4M	Bearpaw	1-May-72	55.8	183.0	16.8	55.0	M36234.938637
Pelz, Carey	SW 16-051-22 W4M	Lower Horseshoe Canyon	20-Jun-73	22.9	75.0	8.5	28.0	M36234.939359
Pelz, Ray	04-16-051-22 W4M	Lower Horseshoe Canyon	5-Jun-76	30.5	100.0	7.6	25.0	M36234.939366

WATER WELLS RECOMMENDED FOR FIELD VERIFICATION

Owner	Location	Aquifer Name	Date Water Well Drilled	Completed Depth Metres	Completed Depth Feet	NPWL Metres	NPWL Feet	UID
Perry, Al	01-31-054-21 W4M	Oldman	1-Apr-74	42.7	140.0	15.9	52.0	M36234.945141
Pesklevis, Albert	NW 13-054-23 W4M	Oldman	23-Mar-78	31.4	103.0	24.4	80.0	M35377.049452
Pettican, Alan	NW 03-051-20 W4M	Lower Horseshoe Canyon	18-Oct-78	53.3	175.0	18.3	60.0	M36234.940372
Pettit, Doug	04-07-052-20 W4M	Lower Horseshoe Canyon	15-May-85	36.0	118.0	26.2	86.0	M36234.947970
Pickett, J	NE 05-055-21 W4M	Oldman	5-Sep-78	41.2	135.0	3.7	12.0	M35377.069127
Popke, Helmut	NW 25-052-21 W4M	Lower Horseshoe Canyon	15-Jul-74	54.9	180.0	21.9	72.0	M36234.946282
Prochnau, Len	SW 16-051-21 W4M	Lower Horseshoe Canyon	12-Jul-82	27.4	90.0	6.7	22.0	M36234.940155
Quinton, James	NE 01-053-22 W4M	Bearpaw	4-Sep-82	41.2	135.0	4.6	15.0	M36234.937860
Radke, Ben	SW 34-055-21 W4M	Birch Lake	28-Sep-77	94.5	310.0	10.7	35.0	M36234.945917
Radloff, Denys	SE 28-052-22 W4M	Lower Horseshoe Canyon	6-Oct-77	42.7	140.0	9.5	31.0	M36234.942451
Rankin, Doug	NE 01-054-21 W4M	Bearpaw	24-May-76	55.2	181.0	15.2	50.0	M36234.944816
Raulin, Eric	03-05-051-22 W4M	Lower Horseshoe Canyon	5-Sep-78	51.8	170.0	10.4	34.0	M36234.939640
Remin, M.	SE 13-053-22 W4M	Bearpaw	5-Jun-72	77.7	255.0	24.4	80.0	M36234.938145
Reynolds, Edson	04-34-052-22 W4M	Lower Horseshoe Canyon	28-Jul-76	30.5	100.0	12.5	41.0	M36234.941574
Robbins, E.	02-11-053-22 W4M	Bearpaw	2-Nov-76	42.7	140.0	7.3	24.0	M36234.938089
Robinson, Cara	SE 34-051-21 W4M	Upper Surficial	21-Sep-83	17.1	56.0	3.1	10.0	M36234.940258
Rogier, Terry	SE 08-051-21 W4M	Lower Horseshoe Canyon	16-Jun-82	16.8	55.0	7.9	26.0	M36234.940034
Rogier, Terry	SE 08-051-21 W4M	Lower Horseshoe Canyon	16-Jun-82	16.8	55.0	7.9	26.0	M36234.940042
Rowlan, Russell	NE 09-051-21 W4M	Lower Horseshoe Canyon	6-Jul-76	39.6	130.0	9.8	32.0	M36234.940088
Rozema, Martin	SW 07-051-21 W4M	Lower Horseshoe Canyon	22-Aug-83	21.3	70.0	6.7	22.0	M36234.940017
Rozema, Paul	SW 06-051-21 W4M	Lower Horseshoe Canyon	15-Jan-75	62.5	205.0	4.6	15.0	M36234.939978
Russ, Dyson	NW 05-051-21 W4M	Lower Horseshoe Canyon	15-Dec-80	22.3	73.0	13.7	45.0	M36234.939971
Santarosa, Geo.	SE 33-052-22 W4M	Lower Horseshoe Canyon	18-May-83	48.8	160.0	3.7	12.0	M36234.941487
Schilman, Eric	SW 33-054-20 W4M	Upper Surficial	12-Jun-81	19.5	64.0	9.1	30.0	M35377.074471
Schmidt, Herb	13-04-051-21 W4M	Lower Horseshoe Canyon	28-Mar-77	24.4	80.0	11.3	37.0	M36234.939947
Schneider, Rob	SE 04-051-20 W4M	Lower Horseshoe Canyon	31-Jul-80	51.8	170.0	12.2	40.0	M36234.940378
Scholz, R.	SE 20-052-21 W4M	Lower Horseshoe Canyon	4-Jul-83	41.2	135.0	6.1	20.0	M36234.946103
Schumacher, Joe	SW 24-052-21 W4M	Lower Horseshoe Canyon	26-Sep-78	18.3	60.0	4.3	14.0	M36234.946257
Scott, Murray	03-03-054-21 W4M	Bearpaw	9-Jun-80	44.2	145.0	2.1	7.0	M36234.944853
Sears, Verden	08-08-051-21 W4M	Lower Horseshoe Canyon	23-Apr-77	15.2	50.0	7.3	24.0	M36234.940046
Shastak, Orest	SW 03-054-21 W4M	Bearpaw	17-Sep-81	36.6	120.0	10.1	33.0	M36234.944844
Shaw, James R.	04-09-052-23 W4M	Lower Horseshoe Canyon	19-Mar-84	56.4	185.0	18.0	59.0	M36234.942243
Shell Canada Resources Ltd.	NW 22-052-23 W4M	Lower Horseshoe Canyon	7-Aug-68	57.0	187.0	23.2	76.0	M36234.942084
Shewchuk, John	NE 22-052-21 W4M	Lower Horseshoe Canyon	25-Feb-83	39.6	130.0	9.8	32.0	M36234.946238
Shillingford, Al	NE 33-052-22 W4M	Lower Horseshoe Canyon	19-Aug-77	27.4	90.0	7.6	25.0	M36234.941514
Shimek, Jerry	SW 20-053-22 W4M	Bearpaw	27-May-85	30.5	100.0	6.4	21.0	M36234.938256
Shmidt, Ron	SW 30-052-22 W4M	Lower Horseshoe Canyon	1-Jun-76	59.4	195.0	18.9	62.0	M36234.943600
Shostak Construction Ltd.	09-32-052-22 W4M	Upper Surficial	21-Sep-77	39.6	130.0	11.6	38.0	M36234.943755
Shulba, Pete	08-22-051-22 W4M	Upper Surficial	3-Aug-78	10.7	35.0	3.1	10.0	M36234.939530
Sigurdson, Howard	NW 13-054-23 W4M	Lower Surficial	4-Jul-79	31.7	104.0	22.9	75.0	M35377.049482
Silvester, Raymon	04-32-052-22 W4M	Bearpaw	29-Nov-78	70.1	230.0	23.8	78.0	M36234.943729
Sime, George	10-36-053-23 W4M	Oldman	3-Jul-86	79.2	260.0	13.7	45.0	M36234.942858
Simoneau, Flarence	NW 33-052-22 W4M	Lower Horseshoe Canyon	10-Aug-83	54.9	180.0	21.3	70.0	M36234.941506
Slater, Buck	SE 26-054-22 W4M	Oldman	1-Sep-73	61.0	200.0	15.2	50.0	M35377.231645
Slater, Don	NE 35-052-22 W4M	Bearpaw	22-Jul-81	70.1	230.0	9.1	30.0	M36234.941644

WATER WELLS RECOMMENDED FOR FIELD VERIFICATION

Owner	Location	Aquifer Name	Date Water Well Drilled	Completed Depth Metres	Completed Depth Feet	NPWL Metres	NPWL Feet	UID
Smart, William	SE 02-054-21 W4M	Bearpaw	25-Jun-74	41.8	137.0	15.1	49.5	M36234.944826
Smith, Forrest	14-35-052-22 W4M	Upper Surficial	22-Aug-79	27.4	90.0	11.6	38.0	M36234.941624
Smith, Jim	05-24-054-22 W4M	Oldman	1-Jun-73	57.6	189.0	21.9	72.0	M35377.231640
Smith, Ken	01-30-052-22 W4M	Lower Horseshoe Canyon	15-Oct-77	48.8	160.0	11.6	38.0	M36234.943550
Smith, Ralph	SE 25-054-22 W4M	Oldman	31-Oct-81	61.0	200.0	27.4	90.0	M35377.231642
Sonnenberg, Leo	NE 09-051-22 W4M	Lower Horseshoe Canyon	14-Aug-75	44.2	145.0	6.1	20.0	M36234.939182
Soulman, Norm	SW 01-054-21 W4M	Bearpaw	12-Feb-85	62.5	205.0	10.7	35.0	M36234.944800
Spiker, Syd	16-18-052-21 W4M	Lower Horseshoe Canyon	24-May-79	38.4	126.0	15.2	50.0	M36234.946064
Sproule, Lorraine	SE 20-051-22 W4M	Lower Horseshoe Canyon	25-May-82	44.8	147.0	5.5	18.0	M36234.939428
Squire, Gordon	SE 31-052-22 W4M	Lower Horseshoe Canyon	1-Jul-73	70.1	230.0	7.6	25.0	M36234.943659
Stallknecht, Kurt	04-03-051-20 W4M	Upper Surficial	21-Jun-77	51.8	170.0	12.8	42.0	M36234.940368
Stasiewich, Bill	01-30-052-22 W4M	Lower Horseshoe Canyon	14-Oct-77	45.7	150.0	10.4	34.0	M36234.943551
Steadman, G.	12-22-051-22 W4M	Upper Surficial	5-Sep-64	9.8	32.0	2.1	7.0	M36234.939544
Stehn, Karen	NW 18-052-22 W4M	Lower Horseshoe Canyon	19-Sep-78	76.2	250.0	16.8	55.0	M36234.938337
Steinbrener, H.	NE 32-052-22 W4M	Lower Horseshoe Canyon	17-May-83	61.0	200.0	21.3	70.0	M36234.943766
Steiner, M.Y.	07-21-052-21 W4M	Lower Horseshoe Canyon	22-Oct-80	24.4	80.0	13.7	45.0	M36234.946154
Stewart, Dan J.	12-28-052-22 W4M	Lower Horseshoe Canyon	19-Aug-82	54.9	180.0	10.7	35.0	M36234.942483
Storie, R.E.	NW 31-053-21 W4M	Bearpaw	24-Jun-75	38.4	126.0	4.6	15.0	M36234.943464
Storozuk, Martin	NW 32-052-22 W4M	Lower Horseshoe Canyon	18-Apr-78	45.7	150.0	13.7	45.0	M36234.943743
Strocki, Nick	02-28-053-21 W4M	Bearpaw	1-Mar-73	61.0	200.0	14.2	46.5	M36234.943408
Stushnoff, William	SE 31-052-22 W4M	Upper Surficial	24-Sep-74	39.6	130.0	4.6	15.0	M36234.943660
Sutter, Ron	SE 13-052-23 W4M	Upper Surficial	17-Feb-77	18.3	60.0	5.5	18.0	M36234.941733
Swabey, R. G.	08-23-051-21 W4M	Lower Horseshoe Canyon	1-Jul-73	76.2	250.0	13.7	45.0	M36234.940192
Swanson 21 Svc	13-06-051-22 W4M	Lower Horseshoe Canyon	11-Oct-61	36.6	120.0	2.1	7.0	M36234.939659
Swonek, Ken	08-31-053-21 W4M	Bearpaw	2-May-80	51.8	170.0	7.0	23.0	M36234.943458
Taylor, G. J.	NE 11-056-21 W4M	Oldman		36.6	120.0	31.1	102.0	M35377.055056
Taylor, H.	SE 31-052-22 W4M	Bearpaw	1-Apr-73	76.2	250.0	21.3	70.0	M36234.943672
Temchuak, Geo	13-25-053-22 W4M	Bearpaw	23-Nov-76	59.4	195.0	24.7	81.0	M36234.942525
Thomas, Warren	NW 15-054-21 W4M	Bearpaw	31-Mar-86	33.5	110.0	3.1	10.0	M36234.945020
Thomlinson, M.	SE 36-052-22 W4M	Lower Horseshoe Canyon	26-May-73	39.6	130.0	5.5	18.0	M36234.941653
Todhunter, R.J.	SW 31-051-21 W4M	Lower Horseshoe Canyon	12-Aug-83	73.2	240.0	19.8	65.0	M36234.940223
Todhunter, Roy	SW 31-051-21 W4M	Upper Surficial	10-Dec-84	47.2	155.0	6.1	20.0	M36234.940218
Toman, Earl	14-01-054-21 W4M	Bearpaw	1-Jun-76	54.9	180.0	13.7	45.0	M36234.944804
Tomplins, D.	NE 08-054-22 W4M	Lower Surficial	28-Aug-78	9.1	30.0	2.4	8.0	M35377.231477
Torium Realty Ltd.	SE 08-051-21 W4M	Lower Horseshoe Canyon	26-Jul-80	19.8	65.0	1.5	5.0	M36234.940047
Town of Bruderheim	16-12-056-21 W4M	Oldman	4-Nov-75	37.2	122.0	24.5	80.2	M35377.055185
Town of Bruderheim	01-13-056-21 W4M	Lower Surficial	16-Jul-75	38.4	126.0	24.8	81.5	M35377.055218
Townsend, Ernie	SW 28-052-22 W4M	Lower Horseshoe Canyon	1-May-73	41.2	135.0	7.3	24.0	M36234.942468
Underschultz, Doreen	SW 13-051-21 W4M	Lower Horseshoe Canyon	14-Oct-76	50.6	166.0	24.7	81.0	M36234.940129
Unguran, Wayne	SW 15-051-22 W4M	Lower Horseshoe Canyon	15-Apr-86	30.5	100.0	11.6	38.0	M36234.939345
Unican Homes	SE 16-052-23 W4M	Upper Surficial	10-Jul-76	21.3	70.0	9.1	30.0	M36234.941849
Van De Griend, Martin	NE 03-051-22 W4M	Lower Horseshoe Canyon	28-Dec-74	41.2	135.0	10.7	35.0	M36234.939595
Van Hooren, Paul	06-18-053-21 W4M	Upper Surficial	27-Jun-79	37.5	123.0	15.2	50.0	M36234.943152
Vanderbos, Peter	NE 15-052-23 W4M	Lower Horseshoe Canyon	2-Jun-75	85.3	280.0	6.1	20.0	M36234.941843
Vanderdonk, John	10-11-052-23 W4M	Upper Surficial	15-Jun-76	9.1	30.0	2.4	8.0	M36234.942280

WATER WELLS RECOMMENDED FOR FIELD VERIFICATION

Owner	Location	Aquifer Name	Date Water Well Drilled	Completed Depth Metres	Completed Depth Feet	NPWL Metres	NPWL Feet	UID
Vanhollen, H.G.	SW 18-052-22 W4M	Lower Horseshoe Canyon	11-Oct-78	79.2	260.0	22.9	75.0	M36234.938318
Venables, R.	SW 13-052-23 W4M	Lower Horseshoe Canyon	31-Mar-79	89.9	295.0	33.2	109.0	M36234.941744
Venables, R.	SE 21-053-21 W4M	Upper Surficial	22-Apr-77	33.5	110.0	2.1	7.0	M36234.943215
Verbitsky, J.	SE 34-051-21 W4M	Lower Horseshoe Canyon	21-Oct-78	22.9	75.0	5.5	18.0	M36234.940253
Viket Farms Ltd.	NW 03-054-22 W4M	Lower Surficial	19-Dec-78	38.4	126.0	32.9	108.0	M35377.231450
Volrath, Wayne	11-14-052-21 W4M	Lower Horseshoe Canyon	30-Sep-76	36.6	120.0	3.7	12.0	M36234.945949
Vopat, Richard	NW 17-052-22 W4M	Lower Horseshoe Canyon	1-Aug-73	57.9	190.0	13.7	45.0	M36234.938300
Wait, Vern	10-33-052-22 W4M	Lower Horseshoe Canyon	13-Aug-76	36.6	120.0	9.1	30.0	M36234.941521
Walker, Earl	NW 07-054-21 W4M	Upper Surficial	24-Feb-77	23.2	76.0	4.0	13.0	M36234.944929
Warren, Glen	11-20-052-21 W4M	Lower Horseshoe Canyon	24-Mar-78	37.8	124.0	2.4	8.0	M36234.946131
Weir, Ken	04-02-051-22 W4M	Lower Horseshoe Canyon	31-Jul-82	42.7	140.0	29.0	95.0	M36234.939579
Wetmore, H.R.	SW 07-051-21 W4M	Lower Horseshoe Canyon	29-May-84	30.5	100.0	11.6	38.0	M36234.940019
Whale, Tim	NE 09-054-21 W4M	Bearpaw	31-May-79	50.3	165.0	15.2	50.0	M36234.944951
Wibrowski, V.	SE 19-052-22 W4M	Lower Horseshoe Canyon	27-Apr-77	47.2	155.0	10.4	34.0	M36234.938374
Widmer, Irvin	NE 26-052-22 W4M	Lower Horseshoe Canyon	7-Sep-83	48.8	160.0	10.4	34.0	M36234.942372
Wild, Calvin	SW 07-051-21 W4M	Lower Horseshoe Canyon	20-Jul-81	24.4	80.0	5.5	18.0	M36234.940002
Wildman, Ron	SW 07-052-20 W4M	Lower Horseshoe Canyon	30-Oct-82	33.5	110.0	20.4	67.0	M35377.074419
Wilson, Grant	15-03-051-20 W4M	Lower Horseshoe Canyon	13-Aug-84	59.4	195.0	16.2	53.0	M36234.940373
Wings Construction Ltd.	NE 23-053-21 W4M	Bearpaw	1-Aug-77	62.5	205.0	12.5	41.0	M36234.943257
Wisemaz, Raymond	03-27-052-22 W4M	Lower Horseshoe Canyon	31-May-79	53.3	175.0	14.0	46.0	M36234.942393
Woolsey, Ross	SE 21-052-22 W4M	Lower Horseshoe Canyon	23-Aug-74	48.8	160.0	4.0	13.0	M36234.938489
Wright, Karl	SE 23-054-22 W4M	Lower Surficial	16-Dec-77	24.7	81.0	10.8	35.5	M35377.231629
Youngman, Doug	EH 15-052-21 W4M	Lower Horseshoe Canyon	7-Aug-74	25.6	84.0	9.1	30.0	M36234.946000
Yurkiw, Zane	NE 10-051-22 W4M	Lower Horseshoe Canyon	27-Jul-76	33.5	110.0	18.6	61.0	M36234.939232

STRATHCONA COUNTY-OPERATED WATER WELLS

Owner	Location	Aquifer Name	Date Water Well Drilled	Completed Depth Metres	Completed Depth Feet	NPWL Metres	NPWL Feet	UID
County of Strathcona	SE 04-052-22 W4M	Lower Horseshoe Canyon	25-Aug-75	70.1	230.0	13.7	45.0	M36234.947612
County of Strathcona	13-32-054-21 W4M	Oldman	26-Mar-74	61.0	200.0	18.9	62.0	M36234.945163