Ponoka County

Part of the North Saskatchewan and South Saskatchewan River Basins
Tp 041 to 044, R 22 to 28, W4M & Tp 041 to 045, R 01 to 05, W5M
Regional Groundwater Assessment

Prepared for Ponoka County

In conjunction with

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

Canada

Prepared by
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Our File No.: **02-191**

September 2003

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HYDROGEOLOGICAL CONSULTANTS LTD.
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Geologists and Geophysicists of Alberta

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Acknowledgements

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

Mr. Terry Dash – AAFC-PFRA
Mr. Glen Brandt – AAFC-PFRA
Mr. Robert Zimmer – Ponoka County

For additional copies of the report/CD-ROM, please contact the following:

- 1-800-GEO-WELL
- The Groundwater Centre/Regional Groundwater Assessment

http://www.groundwatercentre.com/m_info_rgwa.asp

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 Ponoka 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 Ponoka County prepared by Hydrogeological Consultants Ltd. (HCL) with financial and technical assistance from the Prairie Farm Rehabilitation Administration branch of Agriculture and Agri-Food Canada (AAFC-PFRA) and Ponoka County. The project study area includes Ponoka County and the Samson and Montana First Nations lands (herein referred to as Ponoka County or the County). 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 used in the regional groundwater assessment for Ponoka County.

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[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 Ponoka 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 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 shown in this report, plus additional maps, figures and cross-sections, are available on the CD-ROM. In order to avoid map-edge effects, all maps are based on an analysis of hydrogeological data from townships 041 to 045, ranges 22 to 28, W4M townships 041 to 045, ranges 01 to 05, W5M, plus a buffer area of 5,000 metres; this buffer area includes parts of the Ermineskin and Louis Bull First Nations lands. 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. A plastic County map outline is provided to overlay the maps, and contains information such as towns, main rivers, etc.

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 *Water Act*
3) interpretation of chemical analysis of drinking water
4) 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 *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.

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[3] See glossary

2 INTRODUCTION

2.1 Setting

Ponoka County is situated in south-central Alberta. The County is within the North Saskatchewan River and the South Saskatchewan River basins; the three sub-basins are the Red Deer River, the North Saskatchewan River, and the Battle River (see CD-ROM); a part of the County's northeastern boundary is the Battle River. The other County boundaries follow township or section lines, which include parts of the area bounded by townships 041 to 044, ranges 22 to 28, W4M and townships 041 to 045, ranges 01 to 05, W5M, as shown on page A-3.

Regionally, the topographic surface varies between 750 and 1,050 metres above mean sea level (AMSL). The lowest elevations occur mainly in the northeastern parts of the County in that portion of the Battle River that borders the Samson First Nation lands, and in Samson Lake and Red Deer Lake; the highest elevations are in the western parts of the County as shown on Figure 1 and page A-4. The area is well drained by the Medicine River, the Blindman River and the Battle River.

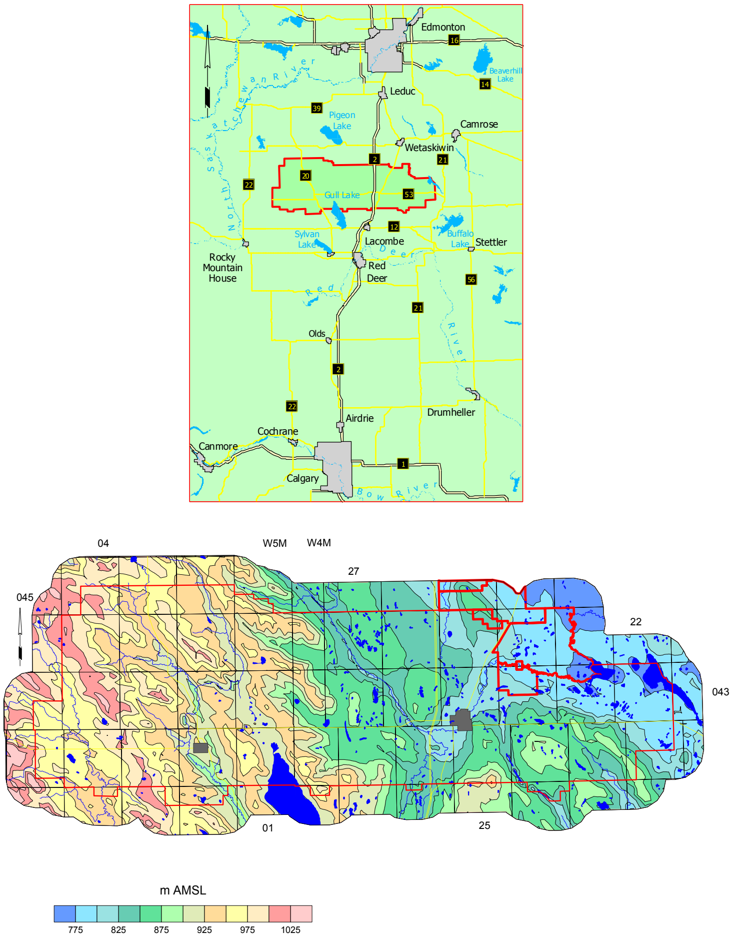

Figure 1. Index Map

2.2 Climate

Ponoka 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 Leggat, 1981) shows that the County is located mainly in the Aspen Parkland region and the Low Boreal Mixedwood region; a small portion in the northwestern part of the County is in the Lower Boreal Cordilleran region. Increased precipitation and cooler temperatures, resulting in additional moisture availability, influence these vegetation changes.

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 three meteorological stations within the County measured 509 millimetres (mm), based on data from 1957 to 1993. The mean annual temperature averaged 2.2° C, with the mean monthly temperature reaching a high of 15.5° C in July, and dropping to a low of -12.2° C in January. The calculated annual potential evapotranspiration is 482 millimetres.

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[4] See glossary

2.3 Background Information

2.3.1 Number, Type and Depth of Water Wells

There are currently 10,014 records in the groundwater database for the County, of which 7,839 are water wells[5]. Of the 10,014 records in the groundwater database for the County, 1,380 are within the Samson First Nation lands and 189 are within the Montana First Nation lands. Of the 7,839 water wells, 6,629 are for domestic/stock purposes. The remaining 1,210 water wells were completed for a variety of uses, including industrial, municipal, observation, agricultural, irrigation, investigation, dewatering, injection and monitoring; 759 of the 1,210 water wells have an “unknown” purpose, and 124 water wells are not in use. Based on a rural population of 8,852 (Phinney, 2003), there are three domestic/stock water wells per family of four. There are 5,881 domestic or stock water wells with a completed depth, of which 4,200 (71%) are completed at depths of less than 60 metres below ground surface. Details for lithology[6] are available for 5,782 water wells.

2.3.2 Number of Water Wells in Surficial and Bedrock Aquifers

There are 4,940 water wells with completion interval and lithologic information, such that the aquifer in which the water wells are completed can be identified. 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 4,940 water wells for which aquifers could be defined, 135 are completed in surficial aquifers, with 109 (80%) having a completion depth of less than 50 metres below ground surface. 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, and in the areas around, east and south of the Town of Ponoka.

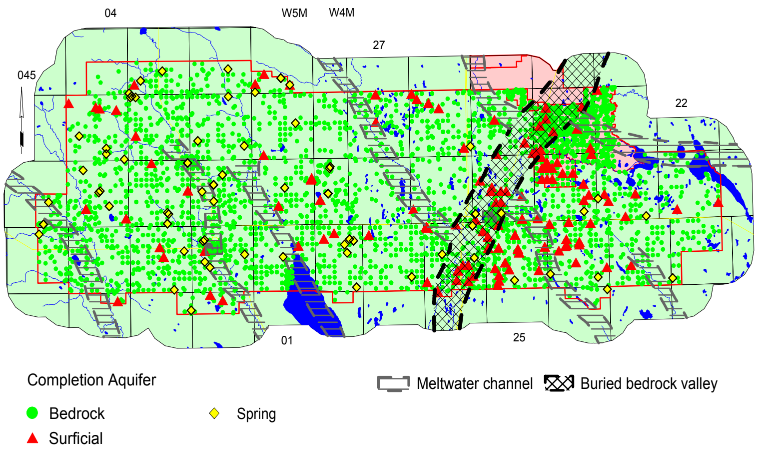

Figure 2. Location of Water Wells and Springs

The data for 4,805 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. From Figure 2 (also see page A-6), it can be seen that water wells completed in bedrock aquifers occur throughout the County.

Within Ponoka County, there are currently records for 71 springs in the groundwater database, including three springs that were documented by Borneuf (1983). There are 38 springs having at least one total dissolved solids (TDS) value, with 75% having a TDS of less than 500 milligrams per litre (mg/L). There are two springs in the groundwater database with flow rates/test rates of 36.4 and 90.9 litres per minute (lpm), respectively. In addition to the two springs having flow rates/test rates, there is the Paetkau (Lick) Spring that Mow-Tech Ltd.[7] monitored from 1989 to 1998. A detailed discussion regarding the Paetkau (Lick) Spring is on pages 40 and 41 in Section 6.0 (Groundwater Budget) of this report.

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[5] See glossary

[6] See glossary

[7] Mow-Tech Ltd. 1-800-GEO-WELL

2.3.3 Casing Diameter and Type

Data for casing diameters are available for 5,722 water wells, with 5,711 (99.8%) indicated as having a diameter of less than 275 mm and 11 (0.2%) having a 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 mainly drilled water wells. The groundwater database suggests that the 11 above-mentioned water wells in the County were bored, hand dug, or dug by backhoe. The complete water well database for the County suggests that 98 of the water wells in the County were bored or hand dug.

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. Within the County, casing-diameter information is available for 133 of the 135 water wells completed in the surficial deposits, of which 131 surficial water wells have a casing diameter of less than 275 millimetres and are assumed to be drilled water wells. Within the County, casing-diameter information is available for 4,780 of the 4,805 water wells completed below the top of bedrock, of which 4,778 have a surface casing diameter of less than 275 mm and have been mainly completed with either a perforated liner or as open hole; there are 20 bedrock water wells completed with a water well screen.

Where the casing material is known, steel surface casing materials have been used in 80.3% of the drilled water wells over the last 50 years. For the remaining drilled water wells with known surface casing material, 10.4% were completed with galvanized steel casing, 9.1% with plastic casing, and 0.2% with wood, concrete or other surface casing materials (used mostly in the 1960s and 1970s). Prior to the mid-1960s, the type of surface casing used in drilled water wells was mainly undocumented. Steel casing was in use in the 1950s and is still used in 75% of the water wells being drilled in the County. Steel and galvanized steel were the main casing types until the start of the 1990s, at which time plastic casing started to replace the use of galvanized steel casing.

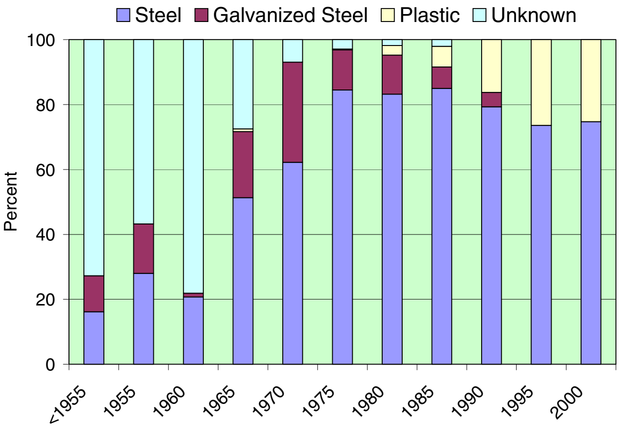

Figure 3. Surface Casing Types Used in Drilled Water Wells

Steel casing has been dominant in the County probably because it has resisted corrosion and also because water well drillers may be reluctant to use plastic (PVC) casing if there have been no documented problems with steel casing in the area.

2.3.4 Dry Water Test Holes

In the County, there are 10,014 records in the groundwater database. Of these 10,014 records, 19 are indicated as being dry or abandoned with “insufficient water”[8]. Also included in these dry test holes is any record that includes comments that state the water well goes dry in dry years. Of the 19 “dry” water test holes, 11 are completed in bedrock aquifers; the remaining eight “dry” water test holes are completed in surficial deposits. This is a remarkably low rate of dry or unsuccessful test holes or water wells. Only about 7% of all water wells with apparent yield estimates were judged to yield less than 6.5 m³/day (1 igpm).

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[8] “dry” can be due to a variety of reasons: skill of driller, type of drilling rig/method used, the geology

2.3.5 Requirements for Licensing

Water well diversion starting after 01 Jan 1999 must have a non-exempt authorization to divert and use groundwater unless (1) the diversion is for household use in excess of 3.4 cubic metres per day (1,250 cubic metres per year) [m^3/year] or 750 imperial gallons per day[9]), (2) the diversion is from saline groundwaters with total dissolved solids in excess of 4,000 mg/L, or (3) the diversion of groundwater is from a manually pumped water well. A person diverting groundwater for agricultural purposes before 01 Jan 1999 to a maximum of 6,250 m^3/year can continue to divert the groundwater without a licence or a registration as long as the person continues to own or occupy the land. The diversion of groundwater under this exemption has no priority, the right is non-transferable and the exemption ceases when the person no longer owns or occupies the land.

In the last update from the Alberta Environment (AENV) groundwater database in January 2003, 1,270 groundwater allocations were shown to be within the County, with the most recent groundwater user being authorized in November 2002. Of the 1,270 authorized non-exempt groundwater users (licences and registrations), 892 are registrations for traditional agriculture use under the *Water Act*. These 892 users will continue to have an industry activity code of ‘registration’ but the groundwater will be used for stock and/or crop spraying. Typically, the groundwater diversion for crop spraying is less than one m^3/day. Of the 892 registrations, only 208 (23%) could be linked to the AENV groundwater database. Of the remaining 378 from the 1,270 authorized non-exempt groundwater users, 315 are for agricultural purposes (mainly stock watering), 35 are for municipal purposes (mainly urban), 16 are for industrial purposes (mainly oil injection), five are for commercial purposes, four are recreation purposes, two are dewatering purposes, and the remaining one is for exploration purposes. Of these 378 licensed groundwater users in the County, 221 (58%) could be linked to the AENV groundwater database. The total maximum authorized diversion from the water wells associated with these licences and registrations is 19,650 m^3/day, although actual use could be less. Of the 19,650 m^3/day, 7,180 m^3/day (36.5%) is authorized for municipal purposes, 4,488 m^3/day (22.8%) is for industrial purposes, 3,984 m^3/day (20.3%) is authorized for agricultural purposes, 2,817 m^3/day (14.3%) is for registrations, 824 m^3/day (4.2%) is authorized for dewatering purposes, 286 m^3/day (1.5%) is authorized for commercial purposes, 41 m^3/day (0.2%) is authorized for exploration, and the remaining 30 m^3/day is allotted for recreation use (0.2%), as shown below in Table 1. A figure showing the locations of the authorized non-exempt groundwater users is in Appendix A (page A-7) and on the CD-ROM. Table 1 also shows a breakdown of the 1,270 groundwater allocations by the aquifer in which the water well is completed. Approximately fifty-seven percent of the total authorized groundwater allocations are in the Dalehurst and Upper Scollard aquifers. The 59 users where an aquifer cannot be determined is because there is no completion information available.

Aquifer **	No. of Diversions	Registrations (m^3/day)	Licensed Groundwater Users* (m^3/day)							Authorized Non-Exempt Total	Percentage
			Agricultural	Municipal	Industrial	Commercial	Recreation	Dewatering	Exploration		
Multiple Surficial Completions	1	3	0	0	0	0	0	0	0	3	0.0
Upper Sand and Gravel	2	5	0	0	0	0	0	0	0	5	0.0
Lower Sand and Gravel	15	27	54	11	0	74	0	0	0	166	0.8
Multiple Bedrock Completions	168	404	602	970	531	94	0	657	0	3,258	16.6
Dalehurst	595	1,312	1,221	1,027	2,882	0	10	167	41	6,660	33.9
Upper Lacombe	110	277	362	0	602	0	0	0	0	1,241	6.3
Lower Lacombe	46	131	97	0	0	0	0	0	0	228	1.2
Haynes	63	102	653	0	0	0	20	0	0	775	3.9
Upper Scollard	104	225	675	3,501	0	118	0	0	0	4,519	23.0
Lower Scollard	30	50	131	0	0	0	0	0	0	181	0.9
Battle and Whitemud	5	6	7	0	0	0	0	0	0	13	0.1
Upper Horseshoe Canyon	70	156	112	1,173	0	0	0	0	0	1,441	7.3
Middle Horseshoe Canyon	1	0	0	0	0	0	0	0	0	0	0.0
Saline	1	0	0	0	473	0	0	0	0	473	2.4
Unknown	59	119	70	498	0	0	0	0	0	687	3.5
Total	1,270	2,817	3,984	7,180	4,488	286	30	824	41	19,650	100
Percentage		14.3	20.3	36.5	22.8	1.5	0.2	4.2	0.2	100	

* - data from AENV ** - Aquifer identified by HCL

Table 1. Authorized Non-Exempt Groundwater Diversions

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[9] see conversion table on page 64

Based on the 2001 Agriculture Census (Statistics Canada), the calculated water requirement for 956,153 livestock for the County (including the First Nation lands) is in the order of 30,000 m^3/day. This value includes intensive livestock use but not domestic animals and is based on an estimate of water use per livestock type. Of the 30,000 m^3/day average calculated livestock use, AENV has authorized a groundwater diversion of 6,801 m^3/day (agricultural and registration) (23%) and licensed a surface-water diversion based on consumptive use of 197 m^3/day (<1%). the remaining 76% of the calculated livestock use would have to be mainly from unlicensed sources.

2.3.6 Groundwater Chemistry and Base of Groundwater Protection

Groundwaters from an aquifer in the surficial deposits can be expected to be chemically hard, having a total 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. High nitrate + nitrite (as N) concentrations were evident in 2% of the available chemical data for the surficial aquifers and fewer than 1% of the available chemical data for the upper bedrock aquifer(s); a plot of nitrate + 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 from less than 500 to more than 1,500 mg/L (page A-31). 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 20 percent of the chemical analyses for upper bedrock water wells indicate a fluoride concentration above 1.5 mg/L, with most of the exceedances occurring in the northeastern part of the County (page A-33).

Constituent	No. of Analyses	Range for County in mg/L Minimum	Maximum	Median	Recommended Maximum Concentration SGCDWQ
Total Dissolved Solids	1,600	0	4,537	629	500
Sodium	1,330	0	31,510	239	200
Sulfate	1,599	0	2,812	52	500
Chloride	1,587	0	205	3	250
Fluoride	1,464	0	8.8	0.3	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)

SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality
Federal-Provincial-Territorial Committee on Drinking Water, April 2002

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

The minimum, maximum and median[10] 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 Summary of Guidelines for Canadian Drinking Water Quality (SGCDWQ) in Table 2. Of the five constituents compared to the SGCDWQ, median concentrations of TDS and sodium exceed the guidelines.

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[10] see glossary

In general, 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[11] 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 the Base of Groundwater Protection ranges from less than 50 metres in the northeastern part of the County and along parts of the Battle River, to more than 490 metres in the western parts of the County, as shown on Figure 4, on some cross-sections presented in Appendix A, and on the CD-ROM.

There are 7,180 water wells with completed depth data, of which 113 are completed below the Base of Groundwater Protection. Most of these water wells are located within or adjacent to the Buried Red Deer Valley or meltwater channels and in other areas where the depth to Base of Groundwater Protection is less than 150 metres. Of the 113 water wells completed below the Base of Groundwater Protection, 13 are/were used for industrial purposes, and two water wells do not have a proposed use. Chemistry data are available for 18 of the 113 water wells, which provided groundwaters with TDS concentrations of less than 1,200 mg/L.

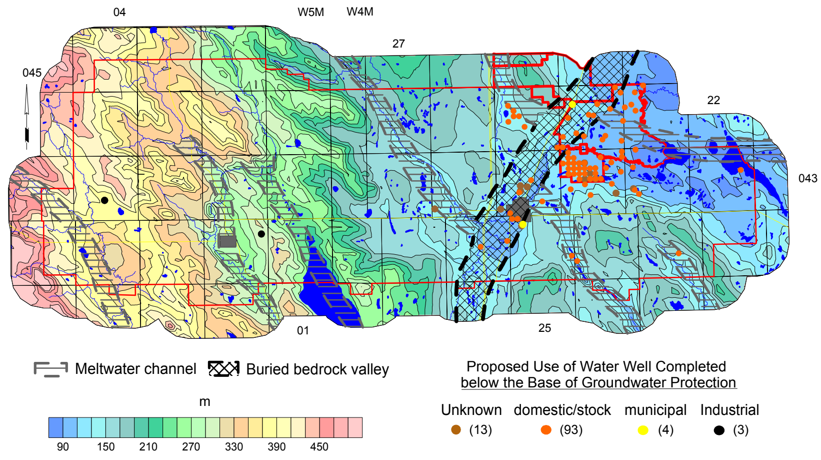

Figure 4. Depth to Base of Groundwater Protection (after EUB, 1995)

Proper management of the groundwater resource requires water-level data. These data are often collected from observation water wells. At the present time, there are three AENV-operated observation water wells (within the County (see page A-57 for observation water well locations). Additional data can be obtained from some of the authorized non-exempt groundwater diversions. In the past, the data for authorized diversions have been difficult to obtain from AENV, in part because of the failure of the applicant to provide the data.

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, as has been the case in the Wildrose Country Ground Water Monitoring Association and Flagstaff County.

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[11] See glossary

3 TERMS

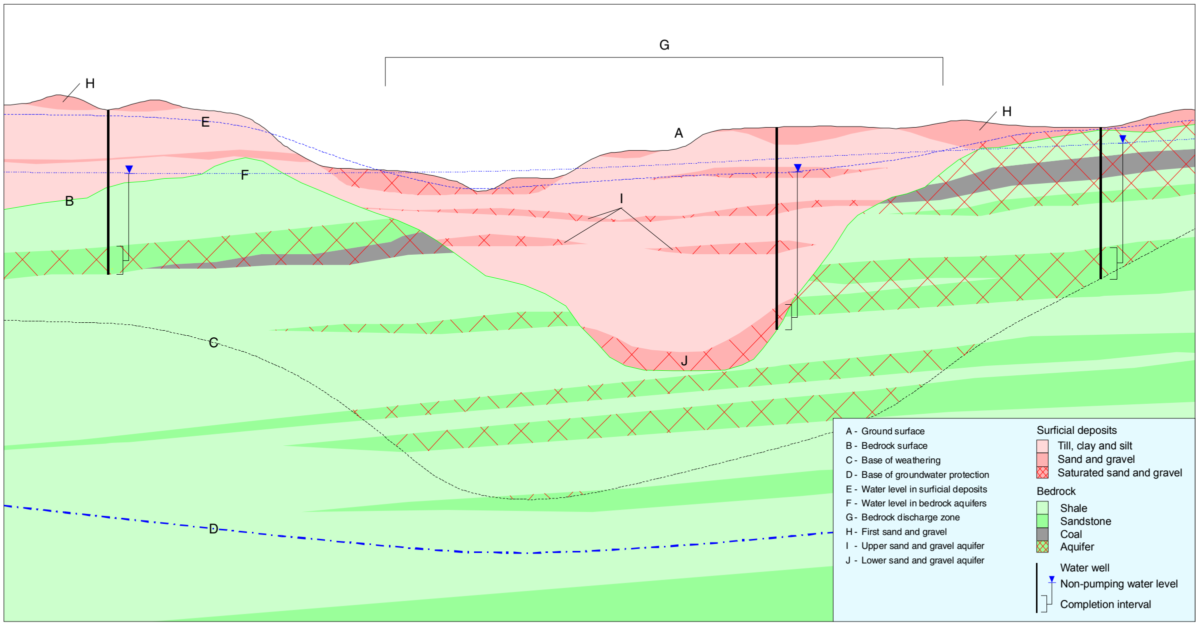
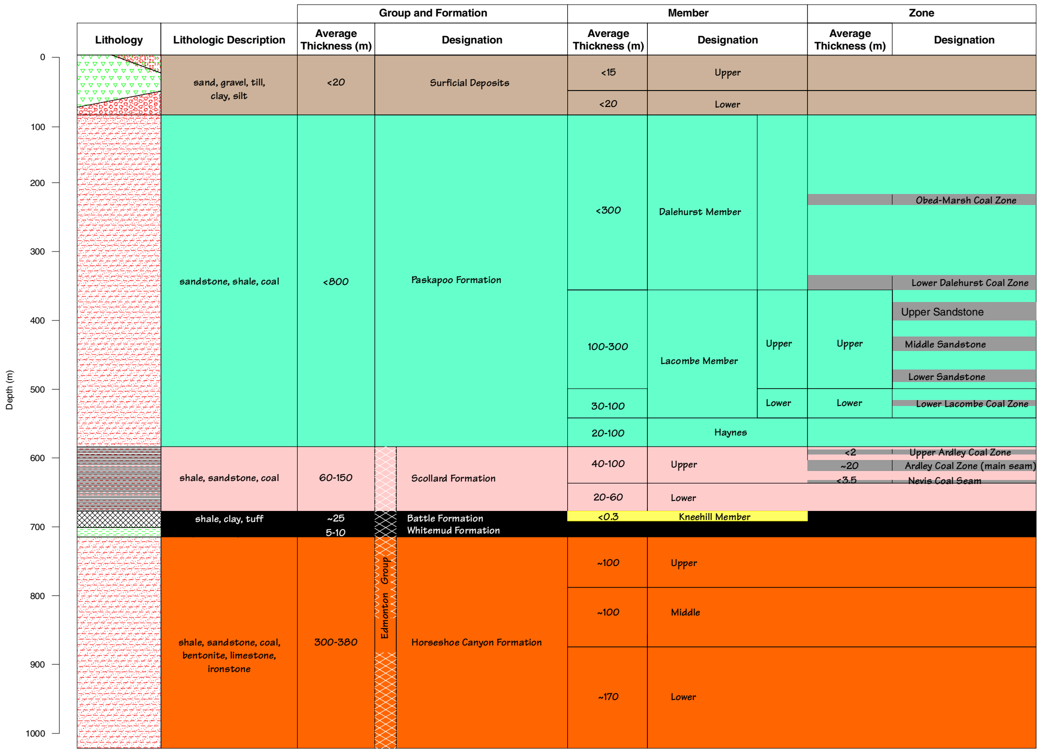


Figure 5. Generalized Cross-Section (for terminology only)

(for larger version, see page A-9)



Lithology	Lithologic Description	Group and Formation			Member			Zone	
		Average Thickness (m)		Designation	Average Thickness (m)	Designation		Average Thickness (m)	Designation
	sand, gravel, till, clay, silt	<20		Surficial Deposits	<15	Upper			
					<20	Lower			
	sandstone, shale, coal	<800		Paskapoo Formation	<300	Dalehurst Member			Obed-Marsh Coal Zone Lower Dalehurst Coal Zone
					100-300	Lacombe Member	Upper	Upper	Upper Sandstone Middle Sandstone Lower Sandstone
					30-100		Lower	Lower	Lower Lacombe Coal Zone
					20-100	Haynes			
	shale, sandstone, coal	60-150	Edmonton Group	Scollard Formation	40-100	Upper		<2	Upper Ardley Coal Zone
								~20	Ardley Coal Zone (main seam)
								<3.5	Nevis Coal Seam
					20-60	Lower			
	shale, clay, tuff	~25		Battle Formation	<0.3	Kneehill Member			
		5-10		Whitemud Formation					
	shale, sandstone, coal, bentonite, limestone, ironstone	300-380		Horseshoe Canyon Formation	~100	Upper			
					~100	Middle			
					~170	Lower			

Figure 6. Geologic Column

(for larger version, see page A-10)

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) locations for some water wells determined during water well surveys
5) chemical analyses for some groundwaters[12]
6) location of some flowing shot holes
7) location of some structure test holes
8) a variety of data related to the groundwater resource.

The main disadvantage to the database is the reliability of the information entered into the database. 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 an area-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 based on the NAD27 datum. This means that a record for the NE ¼ of section 18, township 044, range 24, W4M would have a horizontal coordinate with an Easting of 103,344 metres and a Northing of 5,848,510 metres, the centre of the quarter section. If the water well has been repositioned by AAFC-PFRA using orthorectified aerial photographs, 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.

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[12] Since 1986, Alberta Health and Wellness has restricted access to chemical analysis data, and hence the database includes only limited amounts of chemical data after 1986.

Where possible, determinations are made from individual records in order to assign water wells to aquifers and to obtain values for the following:

1) depth to bedrock
2) total thickness of sand and gravel below 15 metres
3) total thickness of saturated sand and gravel
4) depth to the top and bottom of completion intervals[13].

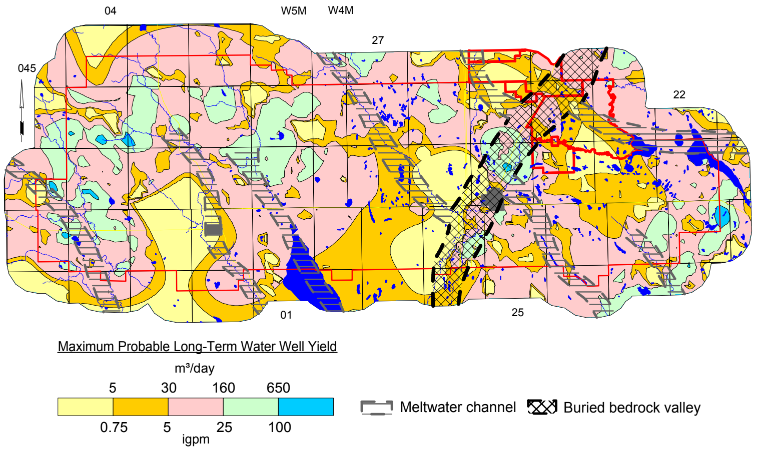

Figure 7. Hydrogeological Map

Also, where sufficient information is available, values for apparent transmissivity[14] and apparent yield[15] 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 maps covering at least a part of the County were published in 1971 (Tokarsky, 1971; LeBreton, 1971), 2,790 values for apparent transmissivity and 2,375 values for apparent yield have been added to the groundwater database. The median apparent yield of the water wells with apparent yield values is 62 m³/day. Approximately 11% of the apparent yield values for these water wells are less than ten m³/day. With the addition of the apparent yield values, including a 0.1-m³/day value assigned to "dry" water wells and water test holes, a hydrogeological map has been prepared to help illustrate the general groundwater availability across the County (Figure 7 and page A-11). The map is based on groundwater being obtained from all aquifers and has been prepared to allow direct comparison with the results provided on the Alberta Research Council (ARC) hydrogeological maps. In general, the ARC map shows higher estimated long-term yields. The differences between the two maps may be a result of fewer apparent yield values and the gridding method employed by ARC.

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 and apparent yield 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.

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[13] See glossary
[14] For definitions of Transmissivity, see glossary
[15] For definitions of Yield, see glossary

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.

4.2 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 depth of a water well cannot be established, 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. The NPWL given on the water well record is usually the water level recorded when the water well was drilled, measured prior to the initial aquifer test. In areas where groundwater levels have since fallen, the NPWL may now be lower and accordingly, potential apparent yield would be reduced. The total dissolved solids, sulfate and chloride concentrations from the chemical analyses of the groundwaters 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).

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. The representative data set included using the available data from townships 041 to 044, ranges 22 to 28, W4M and township 041 to 045, ranges 01 to 05, W5M, plus a buffer area of at least 5,000 metres. 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; for the maps, the areas with little or no data are identified.

On some maps, values are posted as a way of showing anomalies to the underlying grid or as a means of emphasizing either the lack of sufficient data or areas where there is concentrated hydrogeological data control.

4.3 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. For the upper bedrock aquifer(s) where areas of sufficient data are not available from the groundwater database, prepared maps have been masked with a solid faded pink color to indicate these areas. These masks have been added to the Lacombe, Scollard and Upper Horseshoe Canyon 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 non-pumping water levels. 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. Eight cross-sections are presented in Appendix A of this report and as poster-size drawings forwarded with this report; only two (G-G’ and H-H’) are included in the text of this report. The cross-sections are also included on the CD-ROM; page-size maps of the poster-size cross-sections are included in Appendix D of this report.

4.4 Software

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

- Acrobat 5.0
- ArcView 3.2
- AutoCAD 2002
- CorelDraw! 11.0
- Microsoft Office XP
- Surfer 8

5 AQUIFERS

5.1 Background

An aquifer is a permeable rock unit that is saturated. In this context, rock refers to subsurface materials, such as sand, gravel, sandstone and coal. If the NPWL is above the top of the rock unit, this type of aquifer is a confined or artesian aquifer. If the rock unit is not entirely saturated and the water level is below the top of the rock unit, this type of aquifer is a water-table or unconfined 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 sediments 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.

5.2 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[16] and lacustrine[17] deposits. The lacustrine deposits include clay, silt and fine-grained sand. The *upper surficial deposits* include the traditional glacial sediments of till[18] and ice-contact deposits. Pre-glacial materials are expected to be mainly present in association with linear bedrock lows. Meltwater channels are associated with glaciation.

5.2.1 Geological Characteristics of Surficial Deposits

While the surficial deposits are treated as one hydrogeologic unit, they consist of three hydraulic units. The first unit is the sand and gravel deposits of the lower surficial deposits, when present. These deposits are mainly saturated. 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 9 and to page A-9. While the unsaturated deposits are not technically an aquifer, they are significant as they provide a pathway for soluble contaminants to move downward into the groundwater.

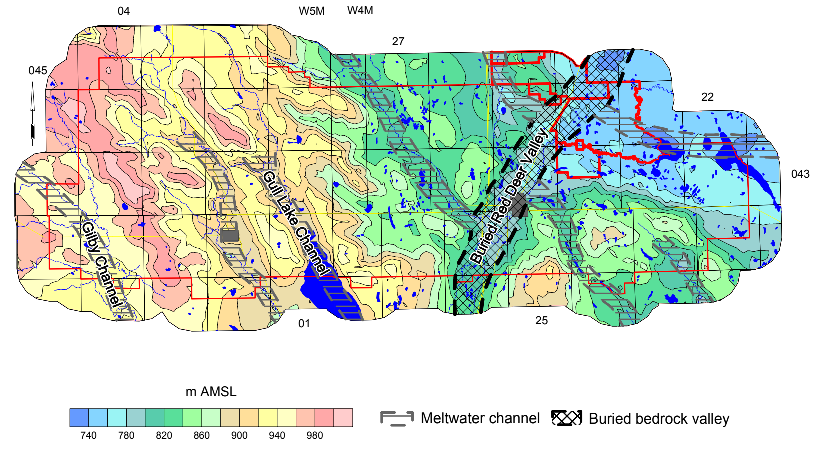

Figure 8. Bedrock Topography

The base of the surficial deposits is the bedrock surface, represented by the bedrock topography as shown on the adjacent map. Regionally, the bedrock surface varies between 720 and 1,060 metres AMSL. The lowest elevations occur mainly in the northeastern part of the County, as shown on Figure 8 and page A-20.

Over the majority of the County, the surficial deposits are less than 30 metres thick (see CD-ROM). The exceptions are mainly in association with areas where buried bedrock

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[16] See glossary

[17] See glossary

[18] See glossary

valleys and meltwater channels are present, where the deposits can have a thickness of more than 40 metres. The main southwest-northeast-trending linear bedrock low in the County is the Buried Red Deer Valley.

The Buried Red Deer Valley is present in the east-central part of the County, and extends northeast from the County border through the Town of Ponoka and the Montana, Samson and Ermineskin First Nations lands to the northern County border. The Valley is approximately nine kilometres wide, with local bedrock relief being less than 60 metres. Sand and gravel deposits can be expected in association with the bedrock low, but the thickness of the sand and gravel deposits is expected to be mainly less than ten metres.

The lower surficial deposits are composed mostly of fluvial and lacustrine deposits. Lower surficial deposits occur over of the County, but mainly in linear bedrock lows. The total thickness of the lower surficial deposits is mainly less than 30 metres, but can be more than 35 metres in the linear bedrock lows (see CD-ROM). The lowest part of the lower surficial deposits includes pre-glacial sand and gravel deposits. These deposits would generally overlie the bedrock surface in the Buried Red Deer Valley. The lowest sand and gravel deposits are of fluvial origin, are usually less than five metres thick and may be discontinuous (see CD-ROM).

In the County, there are numerous 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 parts of the meltwater channels, it is possible that the meltwater channels were originally tributaries to the Buried Red Deer Valley (see CD-ROM). The three significant surface-water bodies in the County, Gull Lake, Samson Lake and Red Deer Lake, appear to be associated with meltwater channels.

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 25 metres. Upper surficial deposits are present mainly in the western part of the County and are absent from the buried bedrock valleys (see CD-ROM). Because the meltwater channels are mainly an erosional feature, the sand and gravel deposits associated with these features are considered not to be significant aquifers. The upper sand and gravel deposits are usually less than two metres thick (see CD-ROM). Upper sand and gravel deposits are present mainly in the southwestern part of the County and are absent from the buried bedrock valleys (see CD-ROM).

The west-east cross-section G-G’, Figure 9 shown below and page A-18, passes across the Buried Red Deer Valley and shows the surficial deposits being in the order of 30 to 60 metres thick (locally up to 100 metres) in the Buried Red Deer Valley and east to the County border.

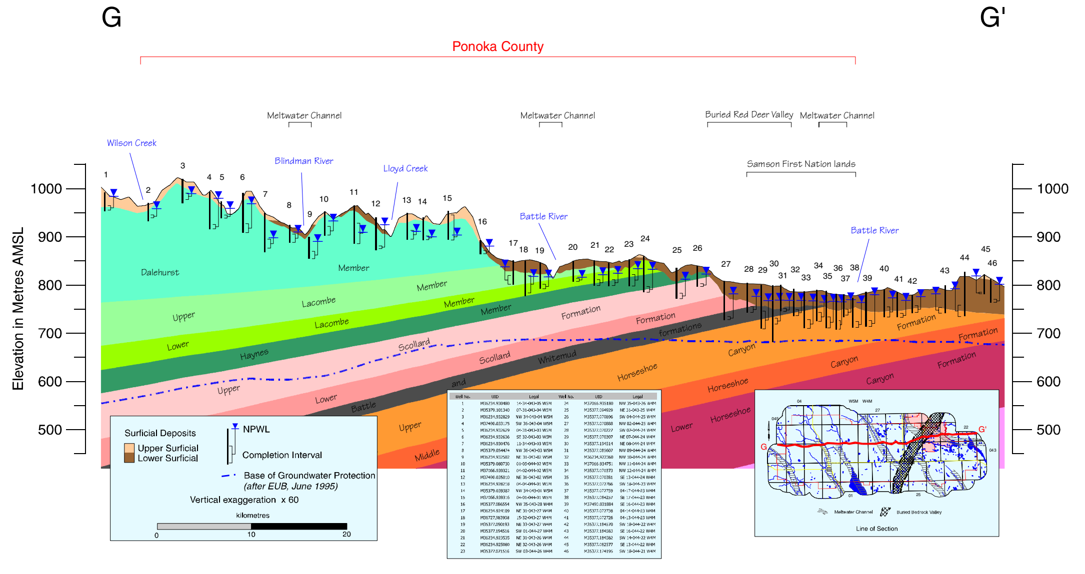

Figure 9. Cross-Section G - G’

Sand and gravel deposits (Figure 10) can occur throughout the surficial deposits. The total thickness of sand and gravel deposits is generally less than two metres but can be more than five metres in association with the linear bedrock lows.

The combined thickness of all sand and gravel deposits has been determined as a function of the total thickness of the surficial deposits. Over approximately 5% of the County where sand and gravel deposits are present, the sand and gravel deposits are more than 30% of the total thickness of the surficial deposits (page A-23). The areas where sand and gravel deposits constitute more than 30% of the total thickness of the surficial deposits are mainly associated with linear bedrock lows.

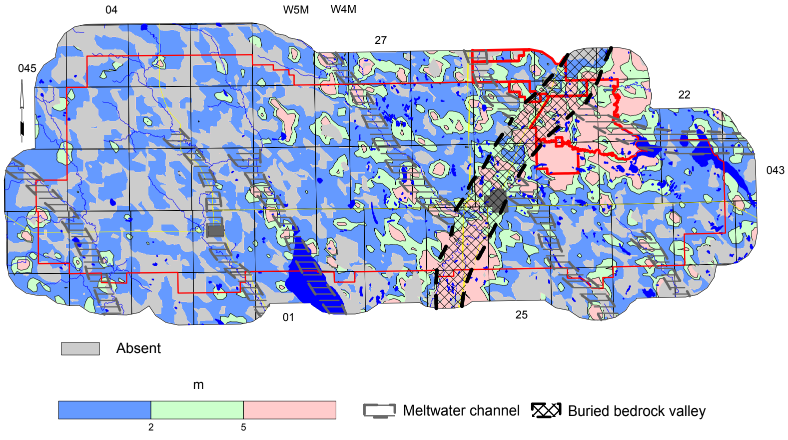

Figure 10. Thickness of Sand and Gravel Deposits

5.2.2 Sand and Gravel Aquifer(s)

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 non-pumping water level in water wells that are less than 20 metres deep. The base of the surficial deposits is the bedrock surface.

Since the Sand and Gravel Aquifer(s) are not present everywhere, the actual aquifer that is developed at a given location is usually dictated by the aquifer that is present. Over approximately 40% of the County, the sand and gravel deposits are not present, or if present, are not saturated; these areas are designated as grey on the adjacent map. In the County, the thickness of the Sand and Gravel Aquifer(s) is generally less than five metres, but can be more than five metres mainly in areas of, or near, linear bedrock lows, as shown in Figure 11, in Appendix A and on the CD-ROM.

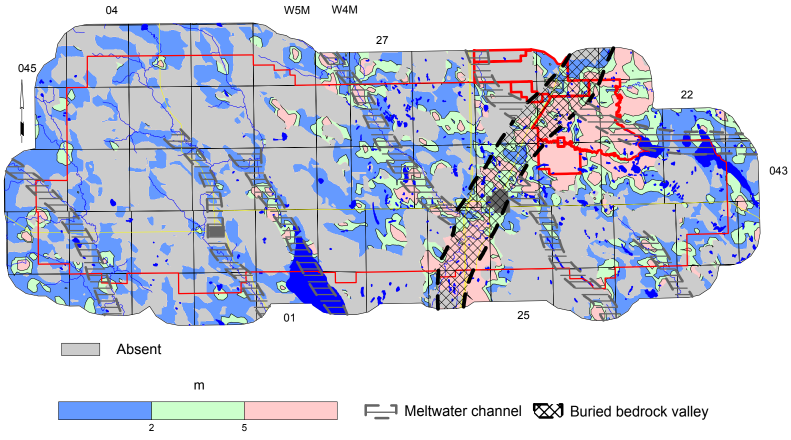

Figure 11. Thickness of Sand and Gravel Aquifer(s)

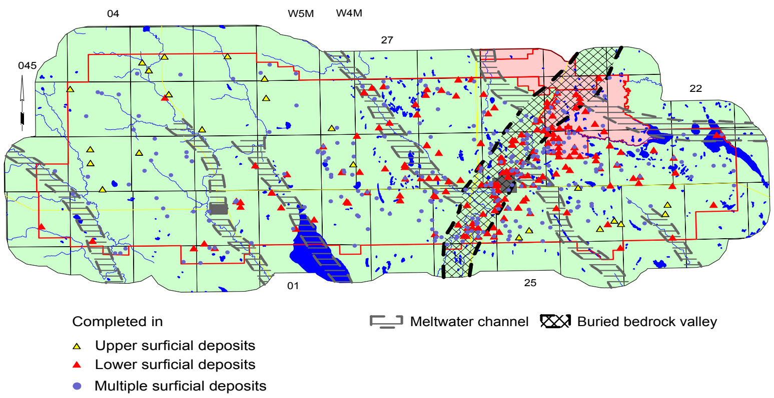

Figure 12. Water Wells Completed Surficial Deposits

Of the 7,839 water wells in the database, 135 were defined as being completed in surficial aquifers, based on lithologic information and water well completion details. From the present hydrogeological analysis, 541 water wells are completed in aquifers in the surficial deposits. Of the 541 water wells, 25 are completed in aquifers in the upper surficial deposits, 223 are completed in aquifers in the lower surficial deposits, and 293 water wells are completed in multiple surficial aquifers. This number of water wells (541) is four times the number (135) 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 are mainly not in association with linear bedrock lows, as shown on Figure 12. A large number of water wells completed in the lower surficial deposits are located along the Buried Red Deer Valley.

	No. of Water Wells with Values for	Number of Water Wells with Apparent Yields		
Aquifer	Apparent Yield (*)	<10 m^3/day	10 to 100 m^3/day	>100 m^3/day
Upper Surficial	3	0	2	1
Lower Surficial	32	9	12	11
Multiple Completions	49	8	26	15
Totals	84	17	40	27

Table 3. Apparent Yields of Sand and Gravel Aquifer(s)

In the County, there are 84 records for surficial water wells with apparent yield data, which is 16% of the 541 surficial water wells. Of the 84 water well records with apparent yield values, 35 have been assigned to aquifers associated with specific geologic units. Twenty percent (17) of the 84 water wells completed in the Sand and Gravel Aquifer(s) have apparent yields that are less than ten m^3/day, 48% (40) have apparent yield values that range from 10 to 100 m^3/day, and 32% (27) have apparent yields that are greater than 100 m^3/day, as shown in Table 3. In addition to the 84 records for surficial water wells, there are eight records that indicate that the water well is dry. In order to depict a more accurate yield map, an apparent yield of 0.1 m^3/day was assigned to each of the eight dry holes prior to gridding. All of the dry holes are in multiple surficial completions.

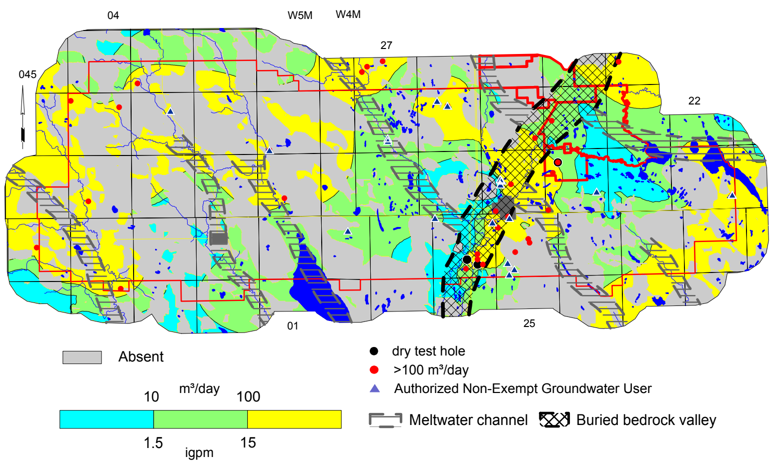

Figure 13. Apparent Yield for Water Wells Completed in Sand and Gravel Aquifer(s)

The adjacent map shows expected yields 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 m^3/day from the Sand and Gravel Aquifer(s) can be expected in 60% of the County where the Sand and Gravel Aquifer(s) are present. The most notable areas where yields of more than 100 m^3/day are expected are in association with the Buried Red Deer Valley and the Gilby and Gull Lake meltwater channels. The higher yields in the extreme eastern part of the County could be a result of the gridding procedure used to process a limited number of data points.

In the County, there are eighteen authorized non-exempt water wells that are completed in the Sand and Gravel Aquifer(s), for a total authorized diversion of 174 m^3/day (Table 1, page 6). Five of the eighteen water wells are in the vicinity of the Town of Ponoka and are completed in the sand and gravel deposits in association with the Buried Red Deer Valley, as shown above in Figure 13. The highest allocation is for the Ponoka Golf Course, which is authorized to divert 74 m^3/day for irrigation purposes.

5.2.2.1 Chemical Quality of Groundwater from Surficial Deposits

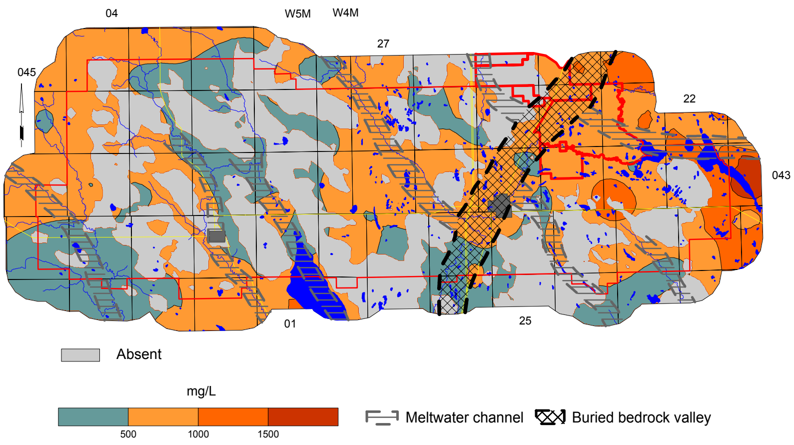

Figure 14. Total Dissolved Solids in Groundwater from Surficial Deposits

The chemical analyses results of groundwaters from the surficial deposits indicate the groundwaters are generally chemically hard and high in dissolved iron. In Ponoka County, groundwaters from the surficial aquifers mainly have a chemical hardness of greater than 200 and less than 400 mg/L (see CD-ROM).

The Piper tri-linear diagram [19] for surficial deposits (page A-29) shows that the groundwaters from the surficial deposits are mainly calcium-magnesium-bicarbonate or sodium-bicarbonate-type waters. Sixty-two percent of the groundwaters from the surficial deposits have a TDS concentration of more than 500 mg/L. Groundwaters having TDS concentrations of less than 500 mg/L mainly occur in association with several of the meltwater channels, and in association with the southern part of the Buried Red Deer Valley. Sixty-seven percent of the groundwaters from the surficial deposits are reported to have dissolved iron concentrations of less than or equal to the aesthetic objective (AO) of 0.3 mg/L. However, many iron analyses results are questionable due to varying sampling and analytical methodologies.

In some areas, the groundwater chemistry of the surficial aquifers is such that sulfate is the major anion[20]. 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 90% of the samples analyzed for surficial deposits in the County, the chloride ion concentration is less than 20 mg/L (see CD-ROM).

Constituent	No. of Analyses	Range for County in mg/L Minimum	 Maximum	 Median	Recommended Maximum Concentration SGCDWQ
Total Dissolved Solids	114	25	1,776	542	500
Sodium	96	3	5,589	143	200
Sulfate	116	0	840	52	500
Chloride	115	0	79	3	250
Nitrate + Nitrite (as N)	92	0	336	0.0	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)
SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality Federal-Provincial-Territorial Committee on Drinking Water, April 2002

Table 4. Concentrations of Constituents in Groundwaters from Surficial Deposits

In the County, the nitrate + nitrite (as N) concentrations in the groundwaters from the surficial deposits exceed the maximum acceptable concentrations (MAC) of ten mg/L in three of the 92 groundwater samples analyzed (up to about 1986).

The minimum, maximum and median 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 SGCDWQ in the adjacent table. Of the five constituents that have been compared to the SGCDWQ, the median value of TDS concentrations exceeds the guidelines.

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[19] See glossary

[20] 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 in the upper surficial deposits are not usually continuous over large areas but are expected over approximately 15% 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 the depth to the top of the lower surficial deposits when present. In the County, the thickness of the Upper Sand and Gravel Aquifer is generally less than two metres.

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 long-term yields of the water wells are expected to be less than the apparent yields.

Where the Upper Sand and Gravel Aquifer is absent and where the yields are low, the shallow sand and gravel aquifers can be more susceptible to drought, and the development of water wells for the domestic needs of single families may not be possible from this Aquifer. Construction of a water supply well into the underlying bedrock may be the only alternative, provided that yields and quality of groundwater from the bedrock aquifer(s) are suitable.

In the County, there are only three apparent yield values available for water wells completed through the Upper Sand and Gravel Aquifer (Table 3, page 17).

In the County, there are two authorized non-exempt water wells that are completed through the Upper Sand and Gravel Aquifer, for a total authorized diversion of five m^3/day (Table 1, page 6). The two non-exempt authorizations are for registrations for traditional agriculture use under the *Water Act*. One of the two authorized non-exempt water wells completed through the Upper Sand and Gravel Aquifer could be linked to a water well in the AENV groundwater database.

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 deeper part of the linear bedrock lows. The top of the lower surficial deposits is based on more than 1,000 control points across Alberta.

5.2.4.1 Aquifer Thickness

The thickness of the Lower Sand and Gravel deposits is mainly less than five metres, but can be up to ten metres in the linear bedrock lows (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 m^3/day to more than 100 m^3/day. The most notable areas where yields of more than 100 m^3/day are expected are mainly in association with the Buried Red Deer Valley. In the County, there are no dry water test holes completed in the Lower Sand and Gravel Aquifer.

In the County, there are 15 non-exempt authorizations for water wells that are completed through the Lower Sand and Gravel Aquifer, for a total authorized diversion of 166 m^3/day.

Of the 15 water wells, seven have been licensed for agricultural purposes, five are for registrations and are expected to be used for stock and/or crop spraying purposes, two are for municipal purposes and one is for commercial purpose. The highest groundwater allocation of 74 m^3/day is for the Town of Ponoka Golf Course, licensed to divert groundwater for commercial purposes. This use occurs in the summer irrigation season and the groundwater would be diverted at much higher daily rates.

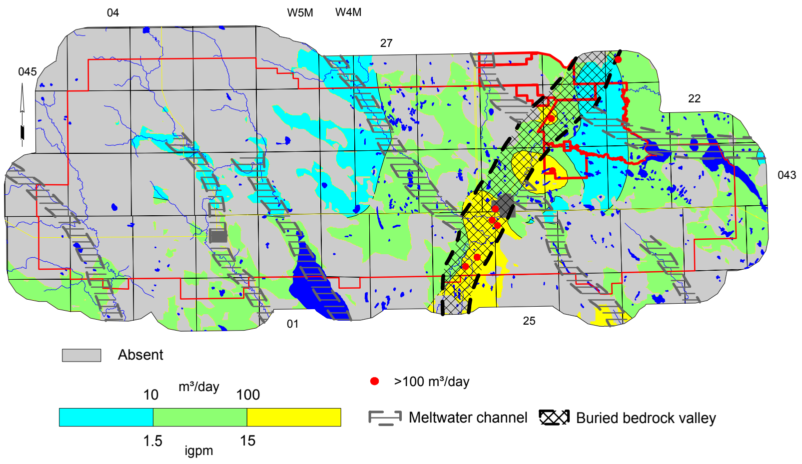


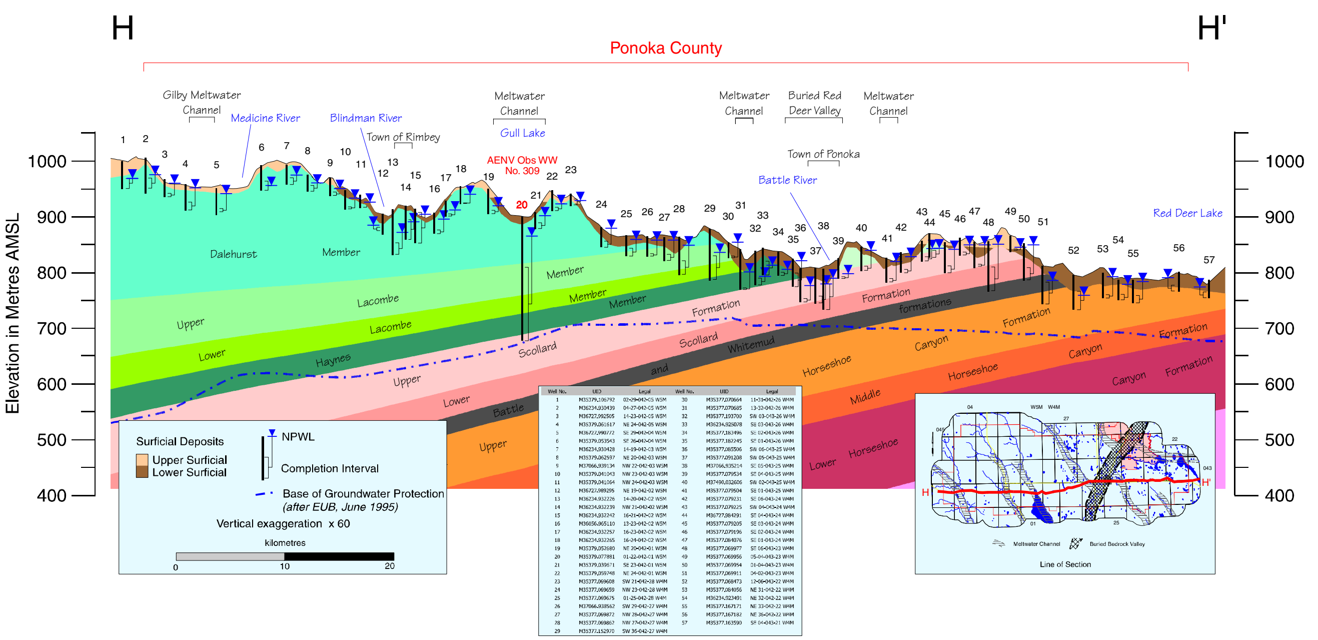
Figure 15. Apparent Yield for Water Wells Completed through Lower Sand and Gravel Aquifer

There are no chemistry data available in the groundwater database for the Town of Ponoka Golf Course water supply well.

5.3 Bedrock

5.3.1 Bedrock Aquifers

The upper bedrock includes formations that are generally less than 200 metres below the bedrock surface. In the County, the upper bedrock includes the Paskapoo Formation (Dalehurst, Upper and Lower Lacombe, and Haynes members), as well as the Scollard, Battle and Whitemud and Horseshoe Canyon formations, as shown below on cross-section H-H' (see page A-19). 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[21] and water well screens are a necessity.



Well No.	UID	Legal	Well No.	UID	Legal
1	M35379.106792	02-29-042-05 W5M	30	M35377.070664	11-31-042-26 W4M
2	M36234.930439	04-27-042-05 W5M	31	M35377.070685	13-32-042-26 W4M
3	M36727.992505	14-23-042-05 W5M	32	M35377.193700	SW 03-043-26 W4M
4	M35379.061617	NE 24-042-05 W5M	33	M36234.925078	SE 03-043-26 W4M
5	M36727.990772	SE 29-042-04 W5M	34	M35377.183496	SE 02-043-26 W4M
6	M35379.053543	SE 26-042-04 W5M	35	M35377.182245	SE 01-043-26 W4M
7	M36234.930428	14-19-042-03 W5M	36	M35377.085506	SW 06-043-25 W4M
8	M35379.062597	NE 20-042-03 W5M	37	M35377.091208	SW 05-043-25 W4M
9	M37066.939134	NW 22-042-03 W5M	38	M37066.935214	SE 05-043-25 W4M
10	M35379.041043	NW 23-042-03 W5M	39	M35377.079534	SE 04-043-25 W4M
11	M35379.041064	NW 24-042-03 W5M	40	M37490.032606	SW 02-043-25 W4M
12	M36727.989295	NE 19-042-02 W5M	41	M35377.079504	SE 01-043-25 W4M
13	M36234.932226	14-20-042-02 W5M	42	M35377.079231	SE 06-043-24 W4M
14	M36234.932239	NW 21-042-02 W5M	43	M35377.079225	SW 04-043-24 W4M
15	M36234.932242	16-21-042-02 W5M	44	M36727.984291	SE 04-043-24 W4M
16	M36056.965110	13-23-042-02 W5M	45	M35377.079205	SE 03-043-24 W4M
17	M36234.932257	16-23-042-02 W5M	46	M35377.079196	SE 02-043-24 W4M
18	M36234.932265	16-24-042-02 W5M	47	M35377.084076	SE 01-043-24 W4M
19	M35379.052680	NE 20-042-01 W5M	48	M35377.069977	SE 06-043-23 W4M
20	M35379.077881	01-22-042-01 W5M	49	M35377.069956	05-04-043-23 W4M
21	M35379.039671	SE 23-042-01 W5M	50	M35377.069954	01-04-043-23 W4M
22	M35379.059748	NE 24-042-01 W5M	51	M35377.069911	04-02-043-23 W4M
23	M35377.069608	SW 21-042-28 W4M	52	M35377.068473	12-06-043-22 W4M
24	M35377.069659	NW 23-042-28 W4M	53	M35377.084056	NE 31-042-22 W4M
25	M35377.069675	01-25-042-28 W4M	54	M36234.923491	NE 32-042-22 W4M
26	M37066.938562	SW 29-042-27 W4M	55	M35377.167171	NE 33-042-22 W4M
27	M35377.069872	NW 28-042-27 W4M	56	M35377.167182	NE 36-042-22 W4M
28	M35377.069862	NW 27-042-27 W4M	57	M35377.163590	SE 04-043-21 W4M
29	M35377.152970	SW 36-042-27 W4M			

Figure 16. Cross-Section H - H'

In the western part of County, the Base of Groundwater Protection is mainly below the Haynes Member. On the eastern edge of the County, the Middle Horseshoe Canyon Formation is above the Base of Groundwater Protection. A map showing the depth to the Base of Groundwater Protection is given on page 8 of this report, in Appendix A, and on the CD-ROM.

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[21] See glossary

5.3.2 Geological Characteristics

The Paskapoo Formation in central Alberta consists of the Dalehurst, Lacombe and Haynes members (Demchuk and Hills, 1991). The Edmonton Group underlies the Paskapoo Formation. The Edmonton Group includes the Scollard, Battle, Whitemud and Horseshoe Canyon formations. A generalized geologic column is illustrated in Figure 6, in Appendix A, and on the CD-ROM.

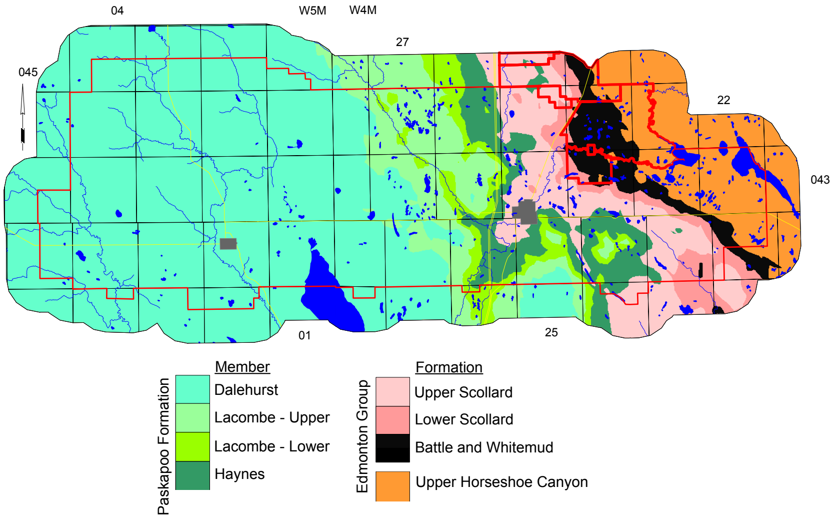

Figure 17. Bedrock Geology

The Paskapoo Formation is the upper bedrock and subcrops mainly west of range 25, W4M in the County. The Paskapoo Formation consists of cycles of thick, tabular sandstone, siltstone and mudstone layers (Glass, 1990). The maximum thickness of the Paskapoo Formation is generally less than 800 metres; in the County, the thickness is less than 500 metres.

The Dalehurst Member is the upper bedrock and subcrops in the western half of the County. This Member has a maximum thickness of 220 metres within the County and is mostly composed of shale and siltstone with sandstone, bentonite and coal seams or zones. Two prominent coal zones within the Dalehurst are the Obed-Marsh Coal (up to 30 metres thick) and the Lower Dalehurst Coal (up to 50 metres thick). The bottom of the Lower Dalehurst Coal is the border between the Dalehurst and Lacombe members (Demchuck and Hills, 1991). In the County, the coal seams are not well developed. If the coal seams are not fractured, they are impermeable.

The Lacombe Member underlies the Dalehurst Member and has a maximum thickness of 245 metres in the County. The upper part of the Lacombe Member is mostly composed of shale interbedded with sandstone and has a maximum thickness of 130 metres. The lower part of the Lacombe Member is composed of sandstone and coal layers. In the middle of the lower part of the Lacombe Member there is a coal zone, which can be up to five metres thick. In the County, the Lower Lacombe Member has a maximum thickness of 115 metres.

The Haynes Member underlies the Lacombe Member and is composed mainly of sandstone with some siltstone, shale and coal. In other parts of Alberta, the Haynes Member has a maximum thickness of 100 metres; in the County, the Haynes Member has a maximum thickness of 50 metres.

The Scollard Formation underlies the Haynes Member, generally has a maximum thickness of 160 metres and has two separate designations: Upper and Lower. The Upper Scollard consists mainly of sandstone, siltstone, shale and coal seams or zones. The Lower Scollard is composed mainly of shale and sandstone. In the County, the Scollard Formation has a maximum thickness of 170 metres.

Beneath the Scollard Formation are two formations having a maximum thickness of 30 metres; the two are the Battle and Whitemud formations. The Battle Formation is composed mainly of claystone, tuff, shale and bentonite, and includes the Kneehills Member, a 2.5- to 30-cm-thick tuff bed. The Whitemud Formation is composed mainly of shale, siltstone, sandstone and bentonite. The Battle and Whitemud formations are significant geologic markers, and were used in the preparation of various geological surfaces within the bedrock. Because of the ubiquitous nature of the bentonite in the Battle and Whitemud formations, there is very little significant permeability within these two formations and there will be no direct review of the Battle and Whitemud formations.

The Horseshoe Canyon Formation is the lower part of the Edmonton Group and is the upper bedrock in the extreme northeastern parts of the County. In the County, the Horseshoe Canyon Formation has a maximum thickness of 380 metres and has three separate designations: Upper, Middle and Lower. In Ponoka County, the Upper Horseshoe Canyon has a maximum thickness of 100 metres; the Middle Horseshoe Canyon has a maximum thickness of 80 metres, and the Lower Horseshoe Canyon has a maximum thickness of 200 metres.

The Horseshoe Canyon Formation consists of deltaic[22] 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 sandstones, when present, tend 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.

There will be no direct review of the Middle or Lower Horseshoe Canyon formations in the text of this report; there are insufficient or no hydrogeological data within the study area to prepare meaningful maps; the only maps associated with these formations to be included on the CD-ROM will be structure-contour maps.

5.3.3 Upper Bedrock Completion Aquifer(s)

Of the 7,839 water wells in the database, 4,805 were defined as being completed below the top of bedrock, based on lithologic information and water well completion details. However, at least a reported completion depth is available for 6,537 water wells completed below the bedrock surface. Of these 6,537 water wells, four are completed below the upper bedrock in saline formations, giving a total of 6,533 water wells completed in upper bedrock aquifer(s). Assigning a water well to a specific geologic unit 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 the top of the completion interval was 80% of the total completed depth of a water well. With this assumption, it has been possible to designate the specific bedrock aquifer of completion for an additional 319 bedrock water wells, giving a total of 5,124 water wells. The remaining 1,409 of the total 6,533 bedrock water wells are identified as being completed in more than one bedrock aquifer, as shown in Table 5. The bedrock water wells are mainly completed in the Dalehurst and Upper Horseshoe Canyon aquifers.

Geologic Unit	No. of Bedrock Water Wells
Dalehurst	2,726
Upper Lacombe	278
Lower Lacombe	116
Haynes	363
Battle and Whitemud	29
Upper Scollard	503
Lower Scollard	174
Upper Horseshoe Canyon	935
Multiple Completions	1,409
Total	6,533

Table 5. Completion Aquifer for Upper Bedrock Water Wells

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[22] See glossary

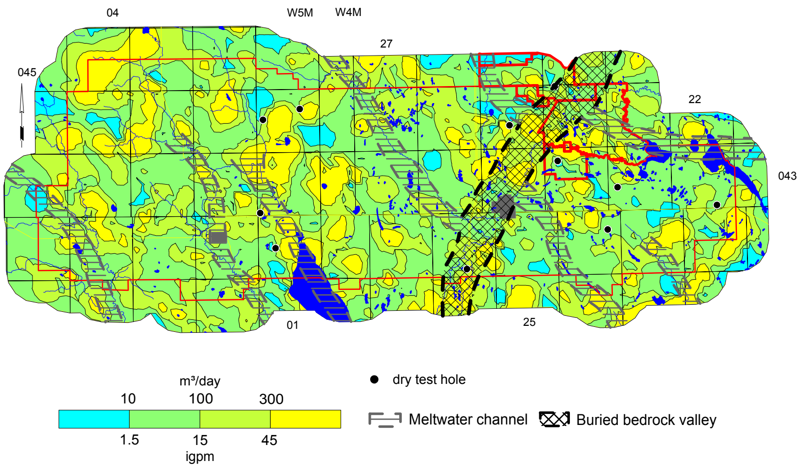

Figure 18. Apparent Yield for Water Wells Completed in Upper Bedrock Aquifer(s)

There are 2,718 records for bedrock water wells that have apparent yield values, which is 42% of the 6,533 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 and have a median apparent yield of more than 60 m³/day. Some of the areas with yields of more than 300 m³/day indicated on the adjacent figure are in the vicinity of linear bedrock lows. These higher yield areas may identify locations of increased permeability resulting from the weathering process. In addition to the 6,533 records for bedrock water wells, there are 11 records that indicate that the water well/water test hole is 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 water test holes prior to gridding.

Of the 2,718 water well records with apparent yield values, 2,096 have been assigned to aquifers associated with specific geologic units. Eleven percent (296) of the 2,718 water wells completed in bedrock aquifers have apparent yields that are less than ten m³/day, 52% (1,422) have apparent yield values that range from 10 to 100 m³/day, 23% (611) have apparent yield values that range from 100 to 300 m³/day, and 14% (389) have apparent yields that are greater than 300 m³/day, as shown in Table 6. The water well records completed in the Battle and Whitemud aquifers showing apparent yield values that are greater than ten m³/day are suspect. In the Haynes Aquifer, nearly 50% of the apparent yield values are greater than 100 m³/day.

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 to 300 m³/day	>300 m³/day
Dalehurst	1,026	79	555	221	171
Upper Lacombe	118	6	69	22	21
Lower Lacombe	27	3	18	5	1
Haynes	115	8	52	37	18
Battle and Whitemud	7	2	5	0	0
Upper Scollard	166	18	98	33	17
Lower Scollard	63	12	37	6	8
Upper Horseshoe Canyon	574	48	290	165	71
Multiple Completions	622	120	298	122	82
Totals	2,718	296	1,422	611	389

* - does not include dry test holes

Table 6. Apparent Yields of Bedrock Aquifers

5.3.4 Chemical Quality of Groundwater

The Piper tri-linear diagram for bedrock aquifers (page A-29) shows that all chemical types of groundwater occur in the bedrock aquifers. However, the majority of the groundwaters are sodium-bicarbonate types.

The TDS concentrations in the groundwaters from the upper bedrock aquifer(s) range from less than 500 mg/L to more than 1,500 mg/L, with most of the groundwaters with lower TDS concentrations occurring in the western half of County. The lower TDS concentrations may be a result of more active flow systems and shorter flow paths.

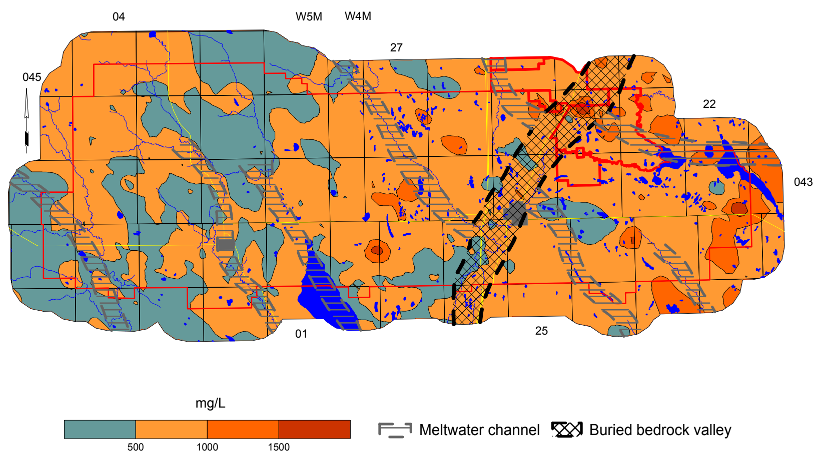

Figure 19. Total Dissolved Solids in Groundwater from Upper Bedrock Aquifer(s)

The relationship between TDS and sulfate concentrations shows that when TDS values in the groundwaters from the upper bedrock aquifer(s) exceed 1,100 mg/L, the sulfate concentrations exceed 400 mg/L. The sulfate concentrations in groundwaters from the upper bedrock aquifer(s) were compared to the distance of completion depth from the top of the Upper Lacombe Member. The maximum sulfate concentrations generally increase with depth, as shown below in Figure 20.

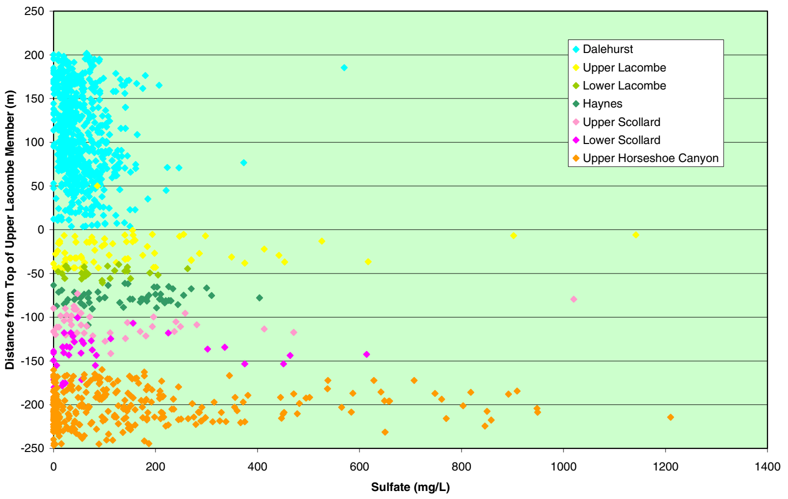

Figure 20. Distance from Top of Upper Lacombe Member vs Sulfate in Groundwaters from Upper Bedrock Aquifer(s)

In the County, nearly 95% of the chloride concentrations in the groundwaters from the upper bedrock aquifer(s) are less than 50 mg/L. Chloride concentrations of greater than 50 mg/L are mainly associated with groundwaters from the Upper Horseshoe Canyon Aquifer.

The nitrate + nitrite (as N) concentrations are less than 0.1 mg/L in 84% of the chemical analyses for upper bedrock water wells. Approximately 70% of the total hardness values in the groundwaters from the upper bedrock aquifer(s) are less than 200 mg/L.

In the County, approximately 65% 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 15% of the groundwater samples from the entire County are between 0.5 and 1.5 mg/L and approximately 20% exceed the maximum acceptable concentration for fluoride of 1.5 mg/L. Fluoride concentrations of greater than 1.5 mg/L are mainly associated with groundwaters from the Upper Horseshoe Canyon Aquifer.

5.3.5 Dalehurst Aquifer

The Dalehurst Aquifer comprises the permeable parts of the Dalehurst Member, as defined for the present program. The Dalehurst Member subcrops under the surficial deposits in the western half of the County. The thickness of the Dalehurst Member varies from less than two metres at the eastern edge of the subcrop to 220 metres in the western part of the County. The regional groundwater flow direction in the Dalehurst Aquifer is toward the Blindman and Battle rivers (see CD-ROM).

5.3.5.1 Depth to Top

The depth to the top of the Dalehurst Member is mainly less than 30 metres and is a reflection of the thickness of the surficial deposits.

5.3.5.2 Apparent Yield

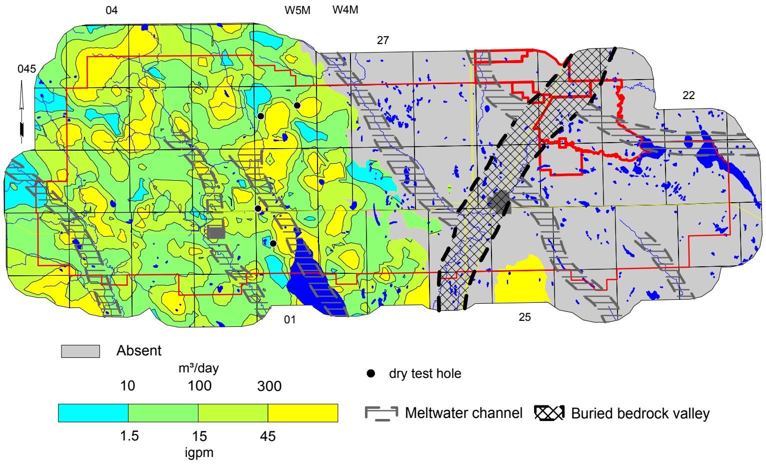

Figure 21. Apparent Yield for Water Wells Completed through Dalehurst Aquifer

The apparent yields for individual water wells completed through the Dalehurst Aquifer are mainly in the range of 10 to 100 m³/day. The higher yielding areas appear to be random, as shown on Figure 21.

Shown on the adjacent map are the locations of the four dry water test holes.

There are 595 non-exempt groundwater users that have water wells completed through the Dalehurst Aquifer, for a total groundwater diversion of 6,660 m³/day.

The highest non-exempt groundwater use is for seven authorizations that allow Gulf Canada Resources Inc. to divert up to 2,747 m³/day for industrial purposes in sections 5 and 6, township 044, range 01, W5M. The Town of Rimbey has five authorizations to divert up to 1,027 m³/day from water supply wells for municipal purposes.

Of the 595 non-exempt authorizations, 178 could be linked to water wells in the AENV groundwater database.

An extended aquifer test conducted with a Town of Rimbey water supply well completed in the Dalehurst Aquifer in August 1972 indicated a long-term yield of 210 m³/day based on an effective transmissivity of approximately 22.5 metres squared per day (m²/day) (Winner and Tokarsky, 1977).

5.3.5.3 Quality

The groundwaters from the Dalehurst Aquifer are mainly a bicarbonate type, with no dominant cation (see Piper diagram on CD-ROM), with 40% of the groundwater samples having TDS concentrations of less than 500 mg/L (page A-36). Ninety-nine percent of the sulfate concentrations in groundwaters from the Dalehurst Aquifer are less than 200 mg/L. Nearly 90% of the chloride concentrations from the Dalehurst Aquifer are less than ten mg/L.

A chemical analysis of a groundwater sample collected in February 1988 from the PanCanadian Petroleum Limited Battery Domestic Water Well in 01-23-043-28 W4M indicates the groundwater is a sodium-bicarbonate type, with a TDS concentration of 518 mg/L, a sulfate concentration of 43 mg/L, a chloride concentration of less than 1 mg/L, and a fluoride concentration of 0.09 mg/L (HCL, November 1989).

Of the five constituents that have been compared to the SGCDWQ, the median value of TDS exceeds the guidelines. The median concentrations in the Dalehurst Aquifer are all below the median concentrations from water wells completed in all upper bedrock aquifer(s).

Constituent	No. of Analyses	Range for County in mg/L Minimum	Maximum	Median	All Bedrock Median	Recommended Maximum Concentration SGCDWQ
Total Dissolved Solids	750	7	1,218	532	629	500
Sodium	585	0	3,059	153	239	200
Sulfate	748	0	570	41	52	500
Chloride	735	0	200	1	3	250
Fluoride	675	0	9	0.2	0.3	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)
SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality Federal-Provincial Subcommittee on Drinking Water, April 2002

Table 7. Apparent Concentrations of Constituents in Groundwaters from Dalehurst Aquifer

5.3.6 Upper Lacombe Aquifer

The Upper Lacombe Aquifer comprises the permeable parts of the Upper Lacombe Member, as defined for the present program. Structure contours have been prepared for the top of the Upper Lacombe Member. The structure contours show that the Upper Lacombe Member ranges in elevation from less than 760 to more than 880 metres AMSL and has a maximum thickness of 130 metres. The non-pumping water level in the Upper Lacombe Aquifer is downgradient to the northeast toward the Battle River (see CD-ROM).

5.3.6.1 Depth to Top

The depth to the top of the Upper Lacombe Member ranges from less than ten metres to more than 200 metres in the western part of the County (page A-37).

5.3.6.2 Apparent Yield

The apparent yields for individual water wells completed through the Upper Lacombe Aquifer are mainly in the range of 10 to 100 m^3/day. There are no dry water test holes that are completed in the Upper Lacombe Aquifer. The areas showing water wells with yields of greater than 300 m^3/day are expected are mainly in the areas between the Gull Lake meltwater channel and the Buried Red Deer Valley.

There are 110 non-exempt groundwater users that have water wells completed through the Upper Lacombe Aquifer, for a total authorized groundwater diversion of 1,241 m^3/day.

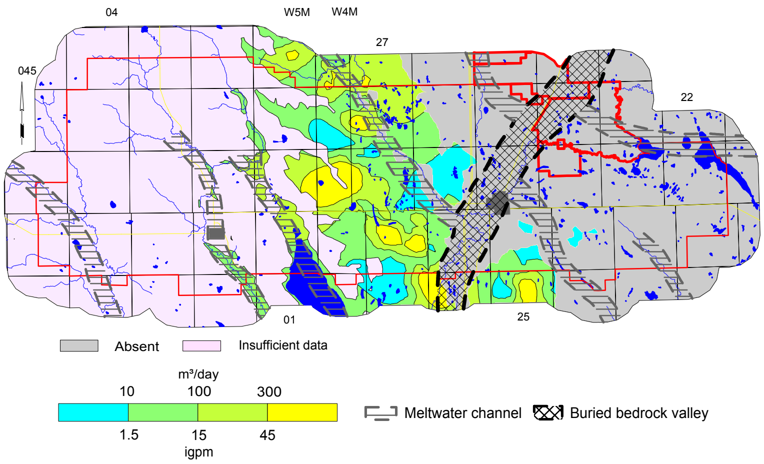

Figure 22. Apparent Yield for Water Wells Completed through Upper Lacombe Aquifer

Of the 110 non-exempt authorizations, 44 could be linked to water wells in the AENV groundwater database.

The highest non-exempt groundwater use is for an authorization that allows PanCanadian Petroleum Limited to divert up to 500 m^3/day for industrial injection purposes in SE 23-043-28 W4M.

Two PanCanadian Petroleum Limited water source wells in SE 23-043-28 W4M are authorized to divert a total of 600 m^3/day (HCL, 2002). The water source wells are completed in the Upper Lacombe Aquifer. Long-term rmonitoring of the two water source wells and ten observation water wells indicated an effective transmissivity of 40 m^2/day and corresponding storativity of 0.0008. In addition to the long-term monitoring of the water source wells and the observation water wells, the flow rate from the Paetkau (Lick) Spring, an outcrop of the Upper Lacombe Member, in NW 14-043-28 W4M was monitored from 1989 to 1998.

5.3.6.3 Quality

The groundwaters from the Upper Lacombe Aquifer are mainly a sodium-bicarbonate type (see Piper diagram on CD-ROM), with nearly 80% of the groundwater samples having TDS concentrations ranging from 500 to 1,000 mg/L (page A-39). The sulfate concentrations in groundwaters from the Upper Lacombe Aquifer are mainly less than 250 mg/L. The chloride concentrations from the Upper Lacombe Aquifer are mainly less than ten mg/L. Nearly 75% of the groundwater samples have fluoride concentrations that are less than 1.5 mg/L.

A chemical analysis of a groundwater sample collected in February 1988 from one of the PanCanadian Petroleum Limited water source wells in SE 23-043-28 W4M indicates the groundwater is a sodium-bicarbonate type, with a TDS concentration of 582 mg/L, a sulfate concentration of 10 mg/L, a chloride concentration of less than 10 mg/L, and a fluoride concentration of 2.42 mg/L (HCL, Nov-1989).

Of the five constituents that have been compared to the SGCDWQ, the median values of TDS and sodium exceed the guidelines. The median concentrations of TDS, sulfate and fluoride from water wells completed in the Upper Lacombe Aquifer are greater than the median concentrations from water wells completed in all upper bedrock aquifer(s).

Constituent	No. of Analyses	Range for County in mg/L Minimum	Maximum	Median	All Bedrock Median	Recommended Maximum Concentration SGCDWQ
Total Dissolved Solids	83	241	2,452	655	629	500
Sodium	74	0.5	8,855	225	239	200
Sulfate	82	0	1142	92	52	500
Chloride	82	0	30	3	3	250
Fluoride	80	0	3	0.4	0.3	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)

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Table 8. Apparent Concentrations of Constituents in Groundwaters from Upper Lacombe Aquifer

5.3.7 Lower Lacombe Aquifer

The Lower Lacombe Aquifer comprises the permeable parts of the Lower Lacombe Member, as defined for the present program. Structure contours have been prepared for the top of the Lower Lacombe Member. The structure contours show that the Lower Lacombe Member ranges in elevation from less than 660 to more than 880 metres AMSL and has a maximum thickness of 115 metres. The non-pumping water level in the Lower Lacombe Aquifer is downgradient to the northeast and southwest toward the Battle River (see CD-ROM).

5.3.7.1 Depth to Top

The depth to the top of the Lower Lacombe Member ranges from less than 20 metres below ground level where the Member subcrops to more than 300 metres at the western edge of the County (page A-40).

5.3.7.2 Apparent Yield

The apparent yields for individual water wells completed through the Lower Lacombe Aquifer are mainly in the range of 10 to 100 m³/day. There are no dry water test holes that are completed in the Lower Lacombe Aquifer. The areas showing water wells with yields of greater than 300 m³/day are expected to be mainly between the Gull Lake meltwater channel and the Buried Red Deer Valley.

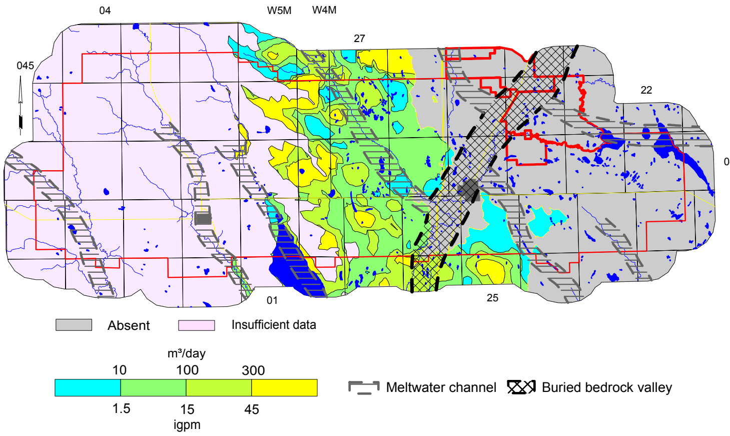

Figure 23. Apparent Yield for Water Wells Completed through Lower Lacombe Aquifer

There are 46 non-exempt groundwater users that have water wells completed through the Upper Lacombe Aquifer, for a total authorized groundwater diversion of 228 m³/day. The highest single allocation is 32 m³/day for a water well in 04-10-043-26 W4M licensed to divert groundwater for agricultural purposes. Of the 46 non-exempt authorizations, seven could be linked to water wells in the AENV groundwater database.

5.3.7.3 Quality

The groundwaters from the Lower Lacombe Aquifer are mainly a sodium-bicarbonate type (see Piper diagram on CD-ROM), with more than 80% of the groundwater samples having TDS concentrations ranging from 500 to 1,000 mg/L (page A-42). The sulfate concentrations in groundwaters from the Lower Lacombe Aquifer are mainly less than 200 mg/L. The chloride concentrations from the Lower Lacombe Aquifer are mainly less than ten mg/L. There is only one analysis where the fluoride concentration exceeds 1.5 mg/L.

Constituent	No. of Analyses	Range for County in mg/L Minimum	Maximum	Median	All Bedrock Median	Recommended Maximum Concentration SGCDWQ
Total Dissolved Solids	29	354	1,189	703	629	500
Sodium	22	38	6,210	255	239	200
Sulfate	29	9	500	96	52	500
Chloride	29	0	18	1	3	250
Fluoride	24	0	2	0.3	0.3	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)

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Table 9. Apparent Concentrations of Constituents in Groundwaters from Lower Lacombe Aquifer

Of the five constituents that have been compared to the SGCDWQ, the median values of TDS and sodium exceed the guidelines The median concentrations of TDS, sodium, and sulfate from water wells completed in the Lower Lacombe Aquifer are greater than the median concentrations from water wells completed in all upper bedrock aquifer(s).

5.3.8 Haynes Aquifer

The Haynes Aquifer comprises the permeable parts of the Haynes Member, as defined for the present program. Structure contours have been prepared for the top of the Haynes Member. The structure contours show that the Haynes Member ranges in elevation from less than 600 to more than 880 metres AMSL and has a maximum thickness of 50 metres.

5.3.8.1 Depth to Top

The depth to the top of the Haynes Member ranges from less than 20 metres below ground surface at the eastern extent to more than 400 metres in the western part of the County (page A-43). The non-pumping water level in the Haynes Aquifer is downgradient to the northeast and southwest toward the Battle River (see CD-ROM).

5.3.8.2 Apparent Yield

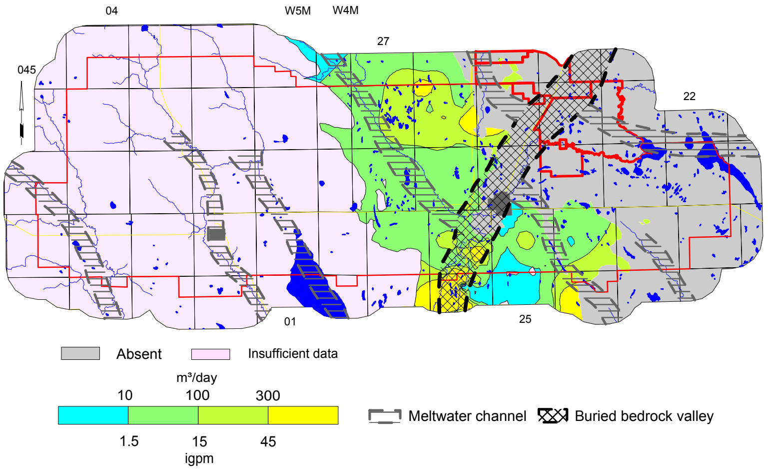

Figure 24. Apparent Yield for Water Wells Completed through Haynes Aquifer

The apparent yields for individual water wells completed through the Haynes Aquifer are mainly in the range of 10 to 100 m^3/day. Nearly 50% (55) of the 115 water wells completed in the Haynes Aquifer have apparent yield values that are greater than 100 m^3/day. There are no dry water test holes that are completed in the Haynes Aquifer.

There are 63 non-exempt groundwater users that have water wells completed through the Haynes Aquifer, for a total authorized groundwater diversion of 775 m^3/day.

The highest allocations total 226 m^3/day for two water source wells in NW 10-044-26 W4M licensed to divert groundwater for agricultural purposes. Of the 63 non-exempt authorizations, 35 could be linked to water wells in the AENV groundwater database.

An extended aquifer test conducted with a water source well completed in the Haynes Aquifer in NE 28-043-26 W4M indicated a long-term yield of 200 m^3/day, based on an effective transmissivity of 41.3 m^2/day and a corresponding storativity of 0.0001 (HCL, Jun-2002).

5.3.8.3 Quality

The groundwaters from the Haynes Aquifer are mainly a sodium-bicarbonate type (see Piper diagram on CD-ROM), with 75% of the values having TDS concentrations ranging from 500 to 1,000 mg/L (page A-45). The sulfate concentrations in groundwaters from the Haynes Aquifer are mainly less than 250 mg/L. The chloride concentrations from the Haynes Aquifer are mainly less than ten mg/L. There is only one analysis where the fluoride concentration exceeds 1.5 mg/L.

A chemical analysis of a groundwater sample collected in June 2002 from a water supply well completed in the Haynes Aquifer for a hog operation indicated the groundwater is a sodium-bicarbonate type, with a TDS concentration of 916 mg/L, a sulfate concentration of 234 mg/L, a chloride concentration of 7.1 mg/L, and a fluoride concentration of 1.1 mg/L (HCL, Jun-2002).

Of the five constituents that have been compared to the SGCDWQ, the median value of TDS exceeds the guidelines. The median concentrations of TDS and sulfate from water wells completed in the Haynes Aquifer are greater than the median concentrations from water wells completed in all upper bedrock aquifer(s).

		Range for County in mg/L				
Constituent	No. of Analyses	Minimum	Maximum	Median	All Bedrock Median	Recommended Maximum Concentration SGCDWQ
Total Dissolved Solids	9	240	1,677	729	629	500
Sodium	8	16	601	164	239	200
Sulfate	67	0	404	170	52	500
Chloride	52	0	4	2	3	250
Fluoride	60	0	3	0.2	0.3	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)

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Federal-Provincial Subcommittee on Drinking Water, April 2002

Table 10. Apparent Concentrations of Constituents in Groundwaters from Haynes Aquifer

5.3.9 Upper Scollard Aquifer

The Upper Scollard Aquifer comprises the permeable parts of the Upper Scollard Formation that underlie the Haynes Member. Structure contours have been prepared for the top of the Formation. The structure contours show that the Upper Scollard Formation ranges in elevation from less than 540 to more than 880 metres AMSL and has a thickness of in the order of 130 metres. The non-pumping water level in the Upper Scollard Aquifer slopes toward the Battle River and toward Maskwa Creek in the areas north of the Battle River.

5.3.9.1 Depth to Top

The depth to the top of the Upper Scollard Formation ranges from less than 20 metres below ground surface at the eastern extent to more than 400 metres in the western part of the County (page A-46).

5.3.9.2 Apparent Yield

The apparent yields for individual water wells completed through the Upper Scollard Aquifer are mainly in the range of 10 to 100 m^3/day. There are two dry water test holes that are completed in the Upper Scollard Aquifer.

There are 104 non-exempt groundwater users that have water wells completed through the Upper Scollard Aquifer, for a total authorized groundwater diversion of 4,519 m^3/day.

The Town of Ponoka operates eight water supply wells that are completed in the Upper Scollard Aquifer, having a total authorized diversion of 3,054 m^3/day. Three of these eight water wells could be linked to water wells in the AENV groundwater database.

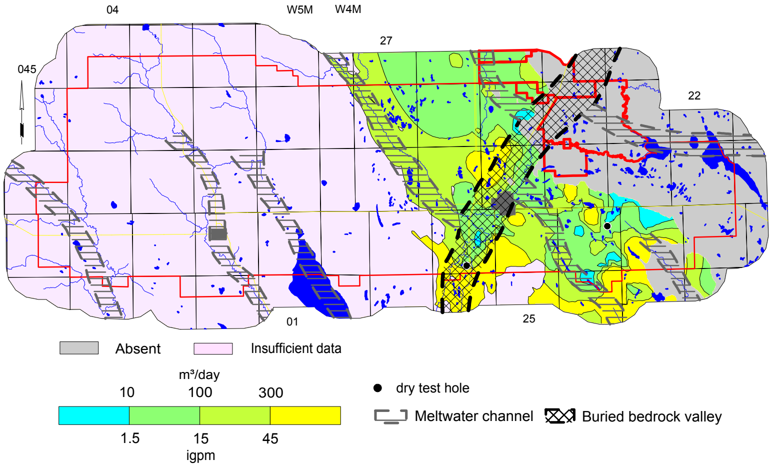

Figure 25. Apparent Yield for Water Wells Completed through Upper Scollard Aquifer

Of the 104 non-exempt authorizations, 47 could be linked to water wells in the AENV groundwater database.

Extended aquifer tests were conducted with two water test holes drilled for the Town of Ponoka and completed in the Upper Scollard Aquifer. The extended aquifer test with Water Test Hole (WTH) No. 1-79 in 14-05-043-25 W4M indicated a long-term yield of 655 m^3/day, and the aquifer test with WTH No. 2-79 in 12-05-043-25 W4M indicated a long-term yield of 125 m^3/day based on an effective transmissivity of 105 m^2/day and a corresponding storativity of 1.7 x 10^{-4} (HCL, June 2002). These long-term yields are based on the premise that the water supply wells would be pumped simultaneously. If the water supply wells were pumped individually the long-term yields would be greater than 1,300 m^3/day for each of the water supply wells.

5.3.9.3 Quality

The groundwaters from the Upper Scollard Aquifer are mainly a sodium-bicarbonate type (see Piper diagram on CD-ROM), with nearly 60% of the groundwater samples having TDS concentrations ranging from 500 to 1,000 mg/L (page A-48). The sulfate concentrations are mainly less than 200 mg/L. The chloride concentrations from the water wells completed in the Upper Scollard Aquifer are mainly less than 10 mg/L. There are only two analyses where fluoride concentrations exceed 1.5 mg/L.

A chemical analysis of a groundwater sample collected during the aquifer test with WTH No. 1-79 in July 1979 indicated the groundwater is a sodium-bicarbonate type, with a TDS concentration of 863 mg/L, a sulfate concentration of 188 mg/L, a chloride concentration of 6 mg/L, a fluoride concentration of 0.23 mg/L, and a total hardness of 324 mg/L. A chemical analysis of a groundwater sample collected during the aquifer test with WTH No. 2-79 in July 1979 indicated the groundwater is also a sodium-bicarbonate type, with a TDS concentration of 631 mg/L, a sulfate concentration of 5 mg/L, a chloride concentration of 33 mg/L, a fluoride concentration of 0.94 mg/L, and a total hardness of 12 mg/L (HCL, Apr-1980).

The total hardness value in WTH No. 1-79 varies significantly from the total hardness value in WTH No. 2-79. It was apparent during the aquifer test with WTH No. 1-79 that the groundwater was a mixture of the Upper Scollard Aquifer groundwater and water leaking through the fractured shale from the surficial deposits (HCL, Apr-1980).

Of the five constituents that have been compared to the SGCDWQ, the median value of TDS exceeds the guidelines. The median concentrations of TDS and sulfate from water wells completed in the Upper Scollard Aquifer are greater than the median concentrations from water wells completed in all upper bedrock aquifer(s).

Constituent	No. of Analyses	Range for County in mg/L Minimum	Maximum	Median	All Bedrock Median	Recommended Maximum Concentration SGCDWQ
Total Dissolved Solids	50	283	2,557	632	629	500
Sodium	37	11.5	5,290	153	239	200
Sulfate	48	0	1,431	53	52	500
Chloride	50	0	98	2	3	250
Fluoride	43	0	3	0.2	0.3	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)

SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality
Federal-Provincial Subcommittee on Drinking Water, April 2002

Table 11. Apparent Concentrations of Constituents in Groundwaters from Upper Scollard Aquifer

5.3.10 Lower Scollard Aquifer

The Lower Scollard Aquifer comprises the porous and permeable parts of the Lower Scollard Formation that underlie the Upper Scollard Formation. Structure contours have been prepared for the top of the Formation. The structure contours show that the Lower Scollard Formation ranges in elevation from less than 450 to more than 840 metres AMSL and has a maximum thickness of 40 metres. The non-pumping water level in the Lower Scollard Aquifer is mainly downgradient to the northwest toward the Battle River and toward Maskwa Creek in the areas north of the Battle River.

5.3.10.1 Depth to Top

The depth to the top of the Lower Scollard Formation ranges from less than 20 metres below ground surface at the eastern extent to more than 500 metres in the western part of the County (page A-49).

5.3.10.2 Apparent Yield

The apparent yields for individual water wells completed through the Lower Scollard Aquifer range mainly from 10 to 100 m³/day. There are two dry water test holes that are completed in the Lower Scollard Aquifer. The areas showing water wells with yields of greater than 300 m³/day are expected mainly in the linear bedrock lows.

In the County, there are 30 non-exempt groundwater users that have water wells that are completed in the Lower Scollard Aquifer, for a total authorized diversion of 181 m³/day. Of the 30 authorizations, 18 are new registrations and 12 are for agricultural purposes. The highest single allocation of 50 m³/day is for a water supply well in 13-22-043-25 W4M licensed to divert groundwater for agricultural purposes. Thirteen of the 30 authorized non-exempt water wells could be linked to a water well in the AENV groundwater database.

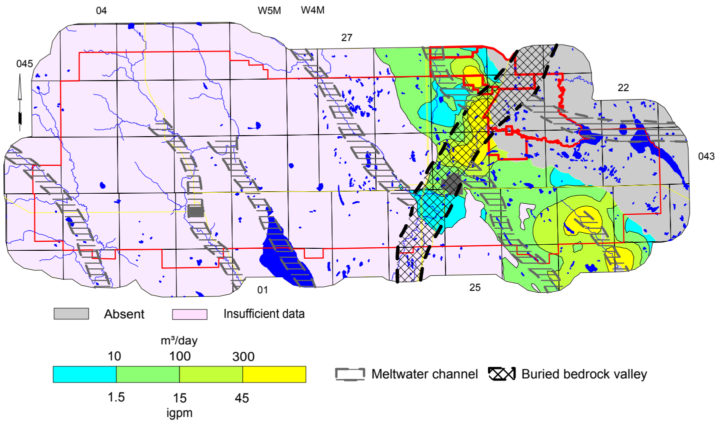

Figure 26. Apparent Yield for Water Wells Completed through Lower Scollard Aquifer

5.3.10.3 Quality

Constituent	No. of Analyses	Range for County in mg/L Minimum	Maximum	Median	All Bedrock Median	Recommended Maximum Concentration SGCDWQ
Total Dissolved Solids	37	407	4,537	780	629	500
Sodium	28	24.4	31,510	286	239	200
Sulfate	40	0	2,812	44	52	500
Chloride	40	0	58	6	3	250
Fluoride	32	0	3	0.9	0.3	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)
SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality
Federal-Provincial Subcommittee on Drinking Water, April 2002

Table 12. Apparent Concentrations of Constituents in Groundwaters from Lower Scollard Aquifer

The groundwaters from the Lower Scollard Aquifer are mainly a sodium-bicarbonate type (see Piper diagram on CD-ROM), with more than 75% of the groundwater samples having TDS concentrations ranging from 500 to 1,000 mg/L (page A-51). The sulfate concentrations are mainly less than 100 mg/L. The chloride concentrations from the water wells completed in the Upper Scollard Aquifer are mainly less than 50 mg/L. There are eight analyses where fluoride concentrations exceed 1.5 mg/L.

Of the five constituents that have been compared to the SGCDWQ, the median values of TDS and sodium exceed the guidelines. The median concentrations of TDS, sodium, chloride and fluoride from water wells completed in the Lower Scollard Aquifer are greater than the median concentrations from water wells completed in all upper bedrock aquifer(s).

5.3.11 Upper Horseshoe Canyon Aquifer

The Upper Horseshoe Canyon Aquifer comprises the permeable parts of the Upper Horseshoe Canyon Formation that underlie the Lower Scollard Formation. The Upper Horseshoe Canyon Formation subcrops under the surficial deposits in the eastern third of the County. Structure contours have been prepared for the top of the Formation. The structure contours show that the Upper Horseshoe Canyon Formation ranges in elevation from less than 360 to more than 760 metres AMSL and has a thickness of up to 100 metres. The non-pumping water level in the Upper Horseshoe Canyon Aquifer is downgradient to the northwest and downgradient to the southeast toward the Battle River.

5.3.11.1 Depth to Top

The depth to the top of the Upper Horseshoe Canyon Formation is variable, ranging from less than 20 metres at the eastern extent to more than 600 metres in the western part of the County (page A-52).

5.3.11.2 Apparent Yield

The apparent yields for individual water wells completed through the Upper Horseshoe Canyon Aquifer range mainly from 10 to 100 m³/day. There are three dry water test holes that are completed in the Upper Horseshoe Canyon Aquifer. The areas showing water wells with yields of greater than 300 m³/day are expected mainly in the linear bedrock lows.

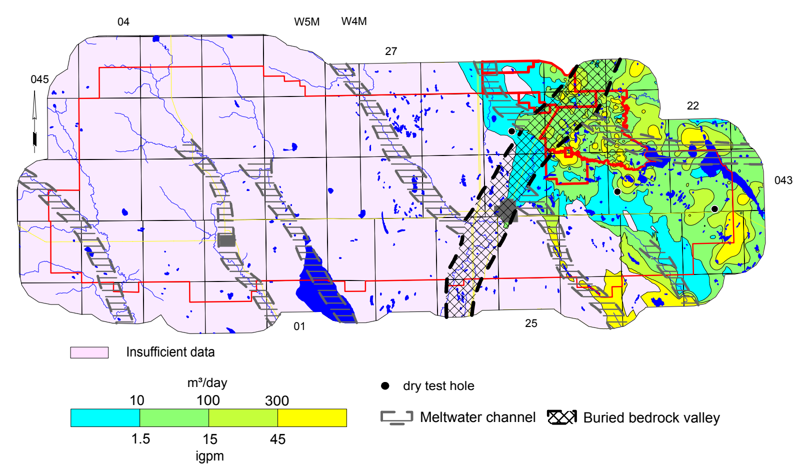

Figure 27. Apparent Yield for Water Wells Completed through Upper Horseshoe Canyon Aquifer

In the County, there are 70 non-exempt groundwater users that have water wells that are completed in the Upper Horseshoe Aquifer, for a total authorized diversion of 1,441 m³/day. Of the 1,441 m³/day, the Samson First Nations are licensed to divert 1,159 m³/day for municipal purposes, of which the highest allocation of 450 m³/day is for a water supply well in 08-17-044-24 W4M. Twenty-six of the 70 authorized non-exempt water wells could be linked to a water well in the AENV groundwater database.

Between 1971 and 1995, extended aquifer tests have been conducted by Mow-Tech Ltd. for Samson First Nations with eleven water supply wells and numerous domestic water wells completed in the Upper Horseshoe Canyon Aquifer in township 044, range 24, W4M. The results of the aquifer tests have indicated long-term yields that range from less than ten to more than 3,000 m³/day.

5.3.11.3 Quality

The groundwaters from the Upper Horseshoe Canyon Aquifer are mainly a bicarbonate-to-sulfate type, with sodium as the main cation (see Piper diagram on CD-ROM). Total dissolved solids concentrations range from less than 500 to more than 1,000 mg/L (page A-54), with more than 80% of the groundwater values having TDS concentrations of less than 1,000 mg/L. The sulfate concentrations range from less than 100 to more than 500 mg/L, with 90% of the groundwater samples having sulfate concentrations of less than 500 mg/L. The chloride concentrations range from less than ten to more than 100 mg/L, with 85% of the groundwater samples having chloride concentrations of less than 50 mg/L. One hundred seventy-one (55%) of the 309 fluoride analyses for water wells completed in the Upper Horseshoe Canyon Aquifer exceed the MAC of 1.5 mg/L; 150 of the 171 analyses are from water wells that were part of a field-verified water well survey conducted by Mow-Tech Ltd.[23] in July and August 2002 within the Samson First Nations land (see CD-ROM).

Constituent	No. of Analyses	Range for County in mg/L Minimum	Maximum	Median	All Bedrock Median	Recommended Maximum Concentration SGCDWQ
Total Dissolved Solids	321	570	2,435	748	629	500
Sodium	302	1	762	291	239	200
Sulfate	323	0	1,210	73	52	500
Chloride	323	0	205	24	3	250
Fluoride	309	0	3	1.7	0.3	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)

SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality Federal-Provincial Subcommittee on Drinking Water, April 2002

Table 13. Apparent Concentrations of Constituents in Groundwaters from Upper Horseshoe Canyon Aquifer

A chemical analysis of a groundwater sample collected during the aquifer test with a water supply well in 08-17-044-24 W4M in October 1995 indicated the groundwater is a sodium-bicarbonate type, with a TDS concentration of 826 mg/L, a sulfate concentration of 66 mg/L, a chloride concentration of 25 mg/L, and a fluoride concentration of 0.64 mg/L (HCL, Revised Mar-1996).

Of the five constituents that have been compared to the SGCDWQ, the median values of TDS, sodium and fluoride exceed the guidelines. The median concentrations of all five consitituents from water wells completed in the Upper Horseshoe Canyon Aquifer are greater than the median concentrations from water wells completed in all upper bedrock aquifer(s).

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[23] Mow-Tech Ltd. 1-800-GEO-WELL

6 GROUNDWATER BUDGET

6.1 Hydrographs

In the County, there are three observation water wells that are part of the AENV regional groundwater monitoring network. These are locations where water levels are being measured and recorded as a function of time: AENV Obs Water Well Ponoka 60-2 (AENV Ponoka Obs WW) in 02-08-043-25 W4M, AENV Obs Water Well Crestomere Lake North Obs No. 1 (AENV Crestomere Lake Obs WW) in 01-34-043-28 W4M and AENV Obs Water Well Gull Lake (AENV Gull Lake Obs WW) in 01-22-042-01 W5M. The water level in AENV Ponoka Obs WW has been measured since January 1964, the water level in AENV Crestomere Lake Obs WW has been measured since December 1990, and the water level in AENV Gull Lake Obs WW has been measured since December 1964 (see page A-57).

The AENV Ponoka Obs WW is completed from 31.4 to 68.0 metres below ground surface mainly in the Upper Scollard Aquifer. The hydrograph shows that the water levels in AENV Ponoka Obs WW have declined in the order of 24 metres since 1973 (see page A-57). The water-level fluctuations in AENV Ponoka Obs WW have been compared to the available monthly precipitation measured at the Ponoka South weather station.

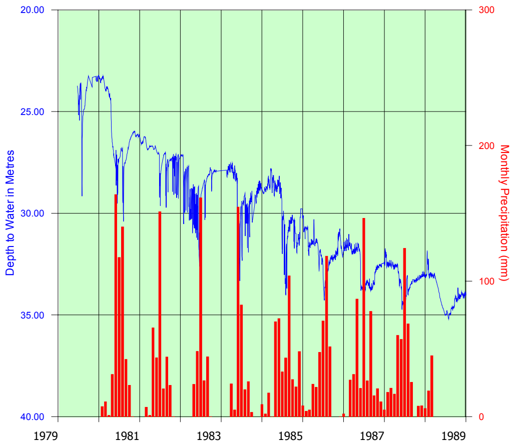

Figure 28. Monthly Precipitation vs Water Levels in AENV Ponoka Obs WW

In an area where there are no pronounced seasonal uses of groundwater, the highest water level will usually occur in late spring/early summer and the lowest water level will be in late winter/early spring. In the adjacent figure, it was noted that the highest water levels occur in late winter/early spring and the lowest water levels are mainly during summer. This situation is a result of increased groundwater use by the Town of Ponoka during the summer months. The Town of Ponoka is authorized to divert more than 4,000 m³/day of groundwater for municipal purposes. The Town of Ponoka diverts groundwater from 11 water supply wells, of which eight are completed in the Upper Scollard Aquifer. The remaining three water supply wells are completed in multiple bedrock aquifers.

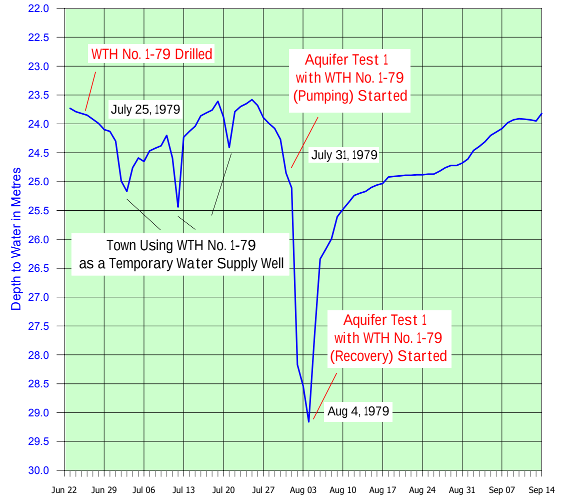

Figure 29. Comparison between AENV Ponoka Obs WW Water Levels and Groundwater Production

In 1979, WTH No. 1-79 was drilled for the Town of Ponoka to augment the Town's water supply. An extended aquifer test commenced on July 31, 1979 and consisted of a 6285-minute pumping interval followed by a 22,800-minute recovery interval. The average pumping rate during the test was 2,070 litres per minute. The water level in AENV Ponoka Obs WW was monitored during the aquifer test. The adjacent figure illustrates the direct hydraulic relationship between the water level in AENV Ponoka Obs WW and the groundwater production from WTH No. 1-79 (HCL, Apr-1980).

During the pumping interval of the aquifer test with WTH No. 1-79, the water level in AENV Ponoka Obs WW declined more than four metres. The water level in AENV Ponoka Obs WW recovered to its pre-aquifer-test water level by Aug 17, 1979 (page A-59).

A second example illustrating the impact groundwater production has on water levels is with AENV Crestomere Lake Obs WW in 01-34-043-28 W4M. In SE 23-043-28 W4M, PanCanadian Petroleum Limited is licensed to divert 600 m³/day from two water source wells completed in the Upper Lacombe Aquifer in the Crestomere area. From 1991 to 1999, PanCanadian diverted an average of 345 m³/day from WSW Nos. 1-88 and 1-89 (HCL, Jan-2000). From 1991 to 1999, the water levels were monitored in WSW Nos. 1-88 and 1-89 and ten privately owned water wells in the area that were used as observation water wells by Pan Canadian.

The Engelen SE 18 Stock WW in SE 18-043-27 W4M is one of the observation water wells that was monitored as part of the PanCanadian Petroleum Limited groundwater monitoring program. The Engelen SE 18 Stock WW is completed from 48.8 to 67.1 metres below ground surface in the Upper Lacombe Aquifer and is 3,300 metres southeast of the two water source wells. In order to determine if water-level fluctuations in the Engelen SE 18 Stock WW were in response to the groundwater production from WSW Nos. 1-88 and 1-89, a mathematical simulation using a model aquifer was completed. The model aquifer was used to calculate the water levels in the Engelen SE Stock WW based on the PanCanadian production since 1991, with an aquifer transmissivity of 40 m²/day and a corresponding storativity of 0.0008. The model aquifer has a boundary 500 metres west of the water source wells. The calculations are based on an aquifer that is homogeneous and isotropic. No allowance has been made for aquifer recharge. Therefore, if there were a decrease in recharge to the groundwater, a water-level decline could occur and the simulation would not account for the change. There is a reasonable match between the measured and the calculated water levels in the Engelen SE 18 Stock WW (see page A-60).

The above parameters were used to calculate the water levels in AENV Crestomere Lake Obs WW, as shown in Figure 30 and page A-61. The AENV Crestomere Lake Obs WW is 3,800 metres northwest of the two PanCanadian water source wells and is completed from 107 to 134.7 metres below ground surface in the Upper Lacombe Aquifer. From the comparison between the calculated water level and the measured water level in AENV Crestomere Lake Obs WW, it can be determined that the groundwater production from WSW Nos. 1-88 and 1-89 has influenced the water-level fluctuations in AENV Crestomere Lake Obs WW.

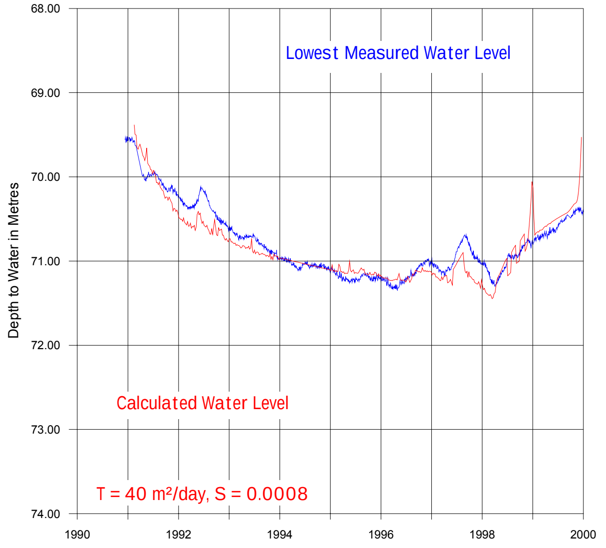

Figure 30. Water-Level Comparison - AENV Crestomere Lake Obs WW

The flow rate of the Paetkau (Lick) Spring in NW 14-043-28 W4M was measured weekly from 1989 to April 1995 and monthly from May 1995 to 1998 as part of the PanCanadian Petroleum Limited groundwater monitoring program. The measured discharge in the Paekau (Lick) Spring ranged from a low of 63.7 lpm on January 3, 1997 to a high of 563 lpm on January 27, 1992.

The changes in flow rates measured from 1989 to 1998 were compared to precipitation measured at the Dakota West weather station. The comparison shows that the flow-rate fluctuations of the Paetkau (Lick) Spring reflect the changes in precipitation. For example, from June 10 to June 12, 1990, a total of 88 millimetres of precipitation was measured, and in response, the flow rate increased from 230 to 260 litres per minute. Following this major recharge event, 141 mm of precipitation was measured on July 2, 1990. This single-day precipitation is the highest amount that was recorded during the 1989 to 1998 monitoring program. In response, the flow rate measured at the Paetkau (Lick) Spring increased to 379 lpm.

In addition to precipitation, the flow rate measured at the Paetkau (Lick) Spring is influenced by changes in ambient temperature. The adjacent graph shows that in every year when the mean monthly temperature recorded at the Dakota West weather station rose above zero, mainly in April, the flow rate at the Paetkau (Lick) Spring increased. After this initial increase in flow rate in April, the flow rate would decrease until May. In order for the flow rate in the Paetkau (Lick) Spring to continue to increase during seasonal recharge, the June precipitation would need to be in the order of at least 115 mm as shown during the years of 1990, 1991 and 1997 in the adjacent figure. If the June precipitation was below 115 mm, the flow rate generally declined throughout the remainder of the year as shown during the years from 1992 to 1996. The exception that occurred in 1998 may be a result of the day during the month of July when the flow rate was measured at the Paetkau (Lick) Spring (page A-62).

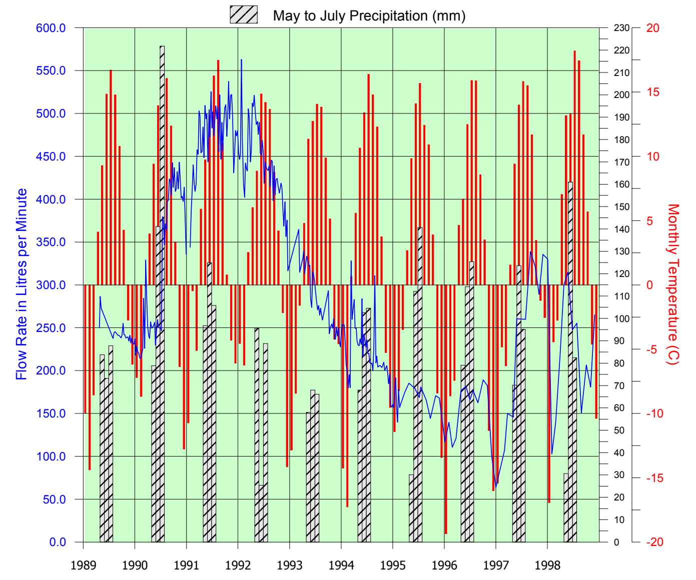

Figure 31. Monthly Temperature and May to July Precipitation vs Flow Rate in Paetkau (Lick) Spring

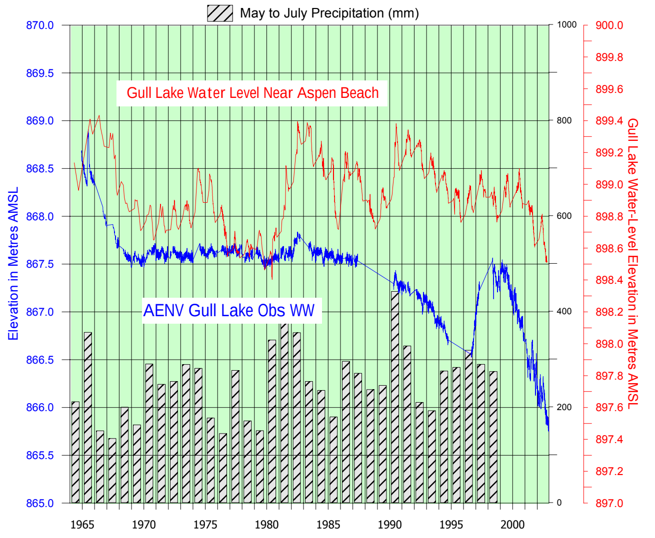

Figure 32. Comparison of Water Levels in AENV Gull Lake Obs WW to Precipitation and Gull Lake Water Level

AENV Gull Lake Obs WW in 01-22-042-01 W5M is completed open hole from 91.4 to 223.5 metres below ground surface in multiple bedrock aquifers.

From 1964 to 2002, the water level in AENV Gull Lake Obs WW has declined 2.5 metres. In order to determine if there is a hydraulic relationship with Gull Lake, the water levels in AENV Gull Lake Obs WW were compared to the total May to July precipitation measured at the Dakota West weather station and to the Gull Lake surface water level recorded near Aspen Beach from 1964 to 2002.

In the mid-1960s, there appears to be a relationship between the water level in AENV Gull Lake Obs WW, the Gull Lake surface water level and the precipitation measured at the Dakota West weather station. However, in subsequent years there are not sufficient AENV Gull Lake Obs WW monitoring data to establish a consistent relationship. The apparent relationship between the lake surface water levels and the AENV Gull Lake Obs WW in the mid-1960s may be because the Obs WW is completed in multiple bedrock aquifers and it took five years for the groundwater elevation to reach a new equilibrium.

Within a 5,000-metre radius of AENV Gull Lake Obs WW, there are a total of 32 authorized non-exempt water wells, the closest being 1,000 metres from AENV Gull Lake Obs WW, which is authorized to divert 0.7 m³/day. The highest authorization is for a water well in 16-08-042-28 W4M, licensed to divert 16.9 m³/day for agricultural purposes. It does not appear that groundwater diversion from authorized non-exempt water wells is having an effect on the water-level fluctuations in AENV Gull Lake Obs WW.

6.2 Estimated Groundwater Use in Ponoka County

An estimate of the quantity of groundwater removed from each geologic unit in Ponoka County must include both the authorized non-exempt and the exempt groundwater diversions. As stated previously on page 6 of this report, the daily water requirement for livestock for the County based on the 2001 census is estimated to be 29,945 cubic metres. As of January 2003, AENV has licensed the use of 6,998 m^3/day for livestock, which includes both surface water (based on consumptive use) 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 22,947 m^3/day of water required for livestock watering is obtained from unauthorized groundwater use.

In the groundwater database for the County, there are records for domestic (4,227), domestic/stock (1,277) and stock (1,125) purposes.

Groundwater for household use requires a non-exempt authorization if the use is more than 1,250 m^3/year. Under the *Water Act*, a residence is protected for up to 3.4 m^3/day. However, the standard groundwater use for household purposes (a family of four) is 1.1 m^3/day. Since there are 5,504 domestic water wells in Ponoka County serving a population of 8,852, the domestic use per water well is 0.4 m^3/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	0.4 m^3/day
Stock	14.3 m^3/day
Domestic/stock	14.7 m^3/day

Because of the limitations of the data, no attempt has been made to compensate for dugouts, springs or inactive water wells.

Based on using all available domestic, domestic/stock, and stock water wells and corresponding calculations, the following table was prepared. Table 14 shows a breakdown of the 6,629 unauthorized and authorized non-exempt 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 Table 14 indicate that most of the 29,742 m^3/day, estimated to be diverted from unlicensed domestic, stock, or domestic/stock water wells, is from the Dalehurst Aquifer or multiple bedrock completions.

	Unauthorized and Authorized Non-Exempt Groundwater Diversions							***Authorized Non-Exempt Groundwater Diversions***	***Unauthorized Groundwater Diversions***
Aquifer Designation	Number of Domestic	Daily Use (0.4 m^3/day)	Number of Stock	Daily Use (14.3 m^3/day)	Number of Domestic and Stock	Daily Use (14.7 m^3/day)	Totals m^3/day	Totals (m^3/day)	Totals m^3/day
Multiple Surficial Completions	132	53	52	743	58	852	1649	3	1646
Upper Sand/Gravel	8	3	7	100	8	118	221	5	216
Lower Sand/Gravel	92	37	30	429	33	485	951	81	870
Multiple Bedrock Completions	738	297	214	3,058	211	3,100	6,456	1,006	5,450
Dalehurst	1,440	579	516	7375	528	7758	15,712	2,533	13,179
Upper Lacombe	80	32	66	943	53	779	1,754	639	1,115
Lower Lacombe	31	12	28	400	23	338	751	228	523
Haynes	170	68	57	815	69	1,014	1,897	755	1,142
Upper Scollard	211	85	69	986	114	1675	2,746	900	1,846
Lower Scollard	59	24	24	343	37	544	910	181	729
Battle and Whitemud	14	6	5	71	7	103	180	13	167
Upper Horseshoe Canyon	703	283	49	700	97	1,425	2,408	268	2,140
Unknown	549	221	8	114	39	573	908	189	719
Totals (1)	4,227	1,700	1,125	16,079	1,277	18,764	36,543	6,801	29,742

(1) The values given in the table have been rounded and, therefore, the columns and rows may not add up equally

Table 14. Total Groundwater Diversions by Aquifer

By assigning 0.4 m³/day for domestic use, 14.3 m³/day for stock use and 14.7 m³/day for domestic/stock use, and using the total maximum authorized diversion associated with any non-exempt water well, a map has been prepared that shows the estimated groundwater use in terms of volume per section per day for the County (not including springs).

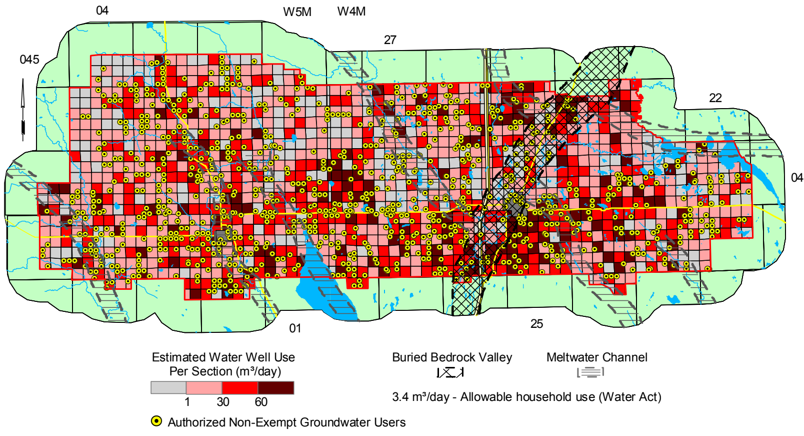

Figure 33. Estimated Water Well Use Per Section

There are 1,274 sections in the County. In 15% (197) of the sections in the County, there is no domestic, stock or authorized non-exempt groundwater user. The range in groundwater use for the remaining 1,077 sections is from 0.2 m³/day to 1,065 m³/day (municipal), with an average use per section of 38 m³/day (5.8 igpm). The estimated water well use per section can be more than 60 m³/day in 157 of the 1,274 sections. There are 317 of the total 1,270 authorized non-exempt groundwater users in areas of greater than 60 m³/day. The most notable areas where water well use of more than 60 m³/day is expected to occur is in township 043, range 28, W4M; township 044, range 25, W4M; and the Town of Ponoka and the areas south of the Town in range 25, W4M, as shown on Figure 33.

Groundwater Use within Ponoka County (m³/day)		%
Domestic/Stock (including agriculture and registrations)	35,887	74
Municipal (licensed)	7,180	15
Commercial/Dewatering/Industrial et al (licensed)	5,669	12
Total	48,736	100

Table 15. Total Groundwater Diversions

In summary, the estimated total groundwater use within Ponoka County is 48,736 m³/day, with the breakdown as shown in the adjacent table. An estimated 48,238 m³/day is being withdrawn from a specific aquifer. The remaining 498 m³/day or 1% is being withdrawn from unknown aquifer units. Of the 48,736 m³/day, 96% is being diverted from bedrock aquifers and 3% from surficial aquifers. Approximately 40% of the total estimated groundwater use is from authorized non-exempt 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 various parts of individual aquifers within the County.

Aquifer/Area	Trans (m^2/day)	Gradient (m/m)	Width (m)	Flow (m^3/day)	Aquifer Flow (m^3/day)	Authorized Non-Exempt Diversion (m^3/day)	Exempted Diversion (m^3/day)	Total (m^3/day)
Surficial					5,087	3	1,677	1,680
Southwest								
east	10.3	0.004	20,000	916				
Northwest								
east	10.3	0.008	10,000	773				
Central								
east	10.3	0.005	18,000	927				
Northeast								
northeast	10.3	0.004	64,000	2472				
Lower Sand and Gravel					201	81	871	952
Red Deer Valley								
northeast	12.9	0.001	6,000	103				
North Central								
southeast	12.9	0.0016	2,000	41				
Gull Lake								
south	12.9	0.0013	2,000	32				
Hobbema								
east	12.9	0.0005	4,000	24				
Dalehurst					35,771	2,533	13,301	15,834
West1								
east	13.2	0.003	23,000	949				
West 2								
east	13.2	0.008	40,000	3960				
west	13.2	0.006	44,000	3485				
West 2a								
east	13.2	0.011	11,000	1659				
west	13.2	0.010	11,000	1452				
West 3								
east	13.2	0.008	18,000	1782				
west	13.2	0.010	44,000	5808				
West 3a								
east	13.2	0.007	44,000	3872				
west	13.2	0.007	44,000	3872				
West 4								
east	13.2	0.010	25,000	3300				
west	13.2	0.007	32,000	2,816				
West 4a								
northeast	13.2	0.017	8,000	1,760				
southwest	13.2	0.01	8,000	1,056				
Upper Lacombe					1,141	639	1,130	1,769
Battle Basin								
east	8.3	0.003	55,000	1141				
Lower Lacombe					4,921	228	523	751
Battle Basin								
west	8.7	0.003	25,000	580				
east	8.7	0.010	25,000	2175				
north	8.7	0.005	15,000	653				
Battle South								
north	8.7	0.004	18,000	626				
south (1)	8.7	0.002	15,000	261				
south (2)	8.7	0.004	6,000	209				
Morningside								
north	8.7	0.006	8,000					

Aquifer/Area	Trans (m^2/day)	Gradient (m/m)	Width (m)	Flow (m^3/day)	Aquifer Flow (m^3/day)	Authorized Non-Exempt Diversion (m^3/day)	Exempted Diversion (m^3/day)
Haynes					4,761	755	1,142
Battle Basin							
northeast	7.8	0.007	40000	2,080			
southwest	7.8	0.007	25000	1,300			
Ponoka South							
northeast	7.8	0.005	16000	624			
northwest	7.8	0.005	13000	507			
Morningside							
southeast	7.8	0.004	8000	250			
Upper Scollard					5,960	900	1,863
South Central							
north	8.4	0.004	25,000	840			
Ponoka							
northwest	8.4	0.006	15,000	756			
southeast	8.4	0.004	15,000	504			
southeast (2)	8.4	0.002	15,000	252			
North Central							
northeast	8.4	0.003	20,000	504			
northwest	8.4	0.006	15,000	756			
Bearhills							
southeast	8.4	0.005	12,000	504			
Southeast							
northeast	8.4	0.007	13,000	728			
southwest	8.4	0.007	13,000	780			
northwest	8.4	0.005	8,000	336			
Lower Scollard					1,733	181	744
Bearhills							
southwest	3.1	0.006	13,000	242			
northeast	3.1	0.010	13,000	403			
Northcentral							
northeast	3.1	0.006	25,000	465			
Ponoka							
southwest	3.1	0.005	20,000	310			
west	3.1	0.003	11,000	107			
east	3.1	0.003	20,000	207			
Upper Horseshoe Canyon					3,189	268	2,144
South central							
northwest	7	0.006	18,000	756			
northeast	7	0.01	25,000	1,750			
Ponoka west							
southeast	7	0.004	26,000	683			

Table 16. Groundwater Budget

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 has been summarized in Table 16.

Table 16 indicates that there is more groundwater flowing through the aquifers than has been authorized to be diverted from the individual aquifers, except for the Lower Sand and Gravel Aquifer and the Upper Lacombe Aquifer. However, even where use is less than the calculated aquifer flow, there can still be local impacts on water levels. The calculations of flow through individual aquifers as presented in Table 16 are very approximate and are intended only as a guide; more detailed investigations are needed to better understand the groundwater flow.

6.3.1 Quantity of Groundwater

An estimate of the volume of groundwater stored in the surficial deposits is 0.6 to 3.6 cubic kilometres. This volume is based on an areal extent of 2,400 square kilometres and a saturated thickness of five metres. The variation in the total volume is based on the value of porosity that is used for the surficial deposits. 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 to depths of less than 20 metres 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 (indicated by grey areas on the map). The water-level map for the surficial deposits shows a flow direction northeast toward the Battle River.

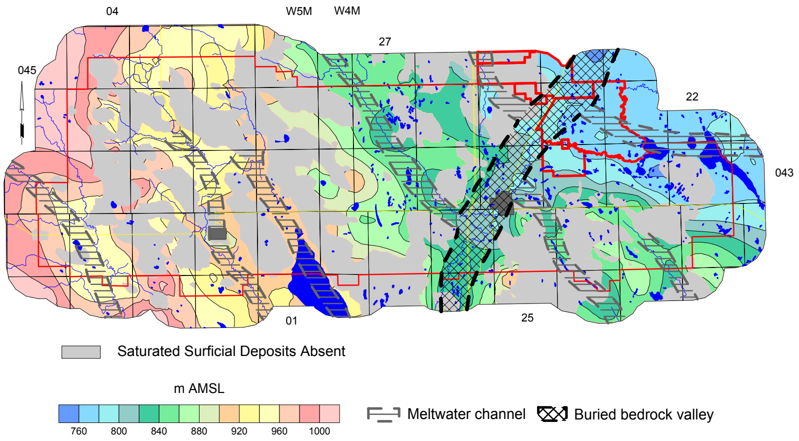

Figure 34. Non-Pumping Water-Level Surface in Surficial Deposits Based on Water Wells Less than 20 Metres Deep

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 hydraulic unit. 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 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. 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.

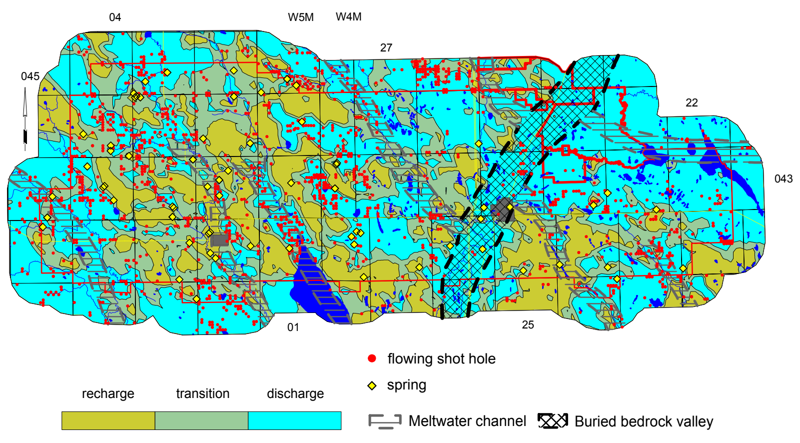

Figure 35. Bedrock Recharge/Discharge Areas

In the absence of sufficient water-level data in the surficial deposits, a reasonable hydraulic gradient between the surficial deposits and the upper bedrock aquifer(s) could not be determined. Therefore, an alternative approach has been used to establish approximate recharge and discharge areas. The first objective was to determine the location of springs, flowing shot holes and any water wells that had a water level measurement depth of less than 0.1 metres. These locations would reflect where there is an upward hydraulic gradient from the bedrock to the surficial deposits (i. e. discharge). The depth to water level for water wells completed in the upper bedrock aquifer(s) has been determined by subtracting the non-pumping water-level surface associated with all water wells completed in the upper bedrock aquifer(s) from the bedrock surface. This resulting depth to water level grid was contoured to reflect the positioning of springs, flowing shot holes and flowing water wells (i. e. discharge). The recharge classification is used where the water level in the upper bedrock aquifer(s) is more than two metres below bedrock surface. The discharge areas are where the water level in the upper bedrock aquifer(s) is more than ten metres above the bedrock surface. When the depth to water level in the upper bedrock aquifer(s) is between two metres below the bedrock surface and ten metres above the bedrock surface, the area is classified as a transition, that is, no recharge and no discharge.

Figure 35 shows that, in more than 30% of the County, there is a downward hydraulic gradient from the bedrock surface toward the upper bedrock aquifer(s) (i. e. recharge). These areas tend to be mainly at higher elevations. Areas where there is an upward hydraulic gradient from the bedrock to the bedrock surface (i. e. discharge) are mainly in the vicinity of linear bedrock lows. The remaining parts of the County are areas where there is a transition condition.

Because of the paucity of data, recharge/discharge maps for the individual bedrock aquifers have not been attempted.

With 30% of the County land area being one of recharge to the bedrock, and the average precipitation being 522 mm per year, three percent of the annual precipitation is sufficient to provide the total calculated quantity of groundwater flowing through the upper bedrock aquifer(s).

6.4 Areas of Groundwater Decline

In order to determine the areas of possible water-level decline in the sand and gravel aquifer(s) and in the upper bedrock aquifer(s), the following approach was attempted. The available non-pumping water-level elevation for each water well was first sorted by location, and then by date of water-level measurement. The dates of measurements were required to differ by at least 365 days. Only the earliest and latest control points at a given location were used. The method of calculating changes in water levels is at best an estimate. Additional data would be needed to verify water-level change.

With the absence of sufficient non-pumping water-level data at a given location for water wells completed in the surficial deposits, the areas of groundwater decline in the sand and gravel aquifer(s) have been calculated by determining the frequency of non-pumping water level control points per five-year period. Of the 275 surficial water wells with a non-pumping water level and date in the County and buffer area, 121 are from water wells completed before 1975 and 130 are from water wells completed after 1975.

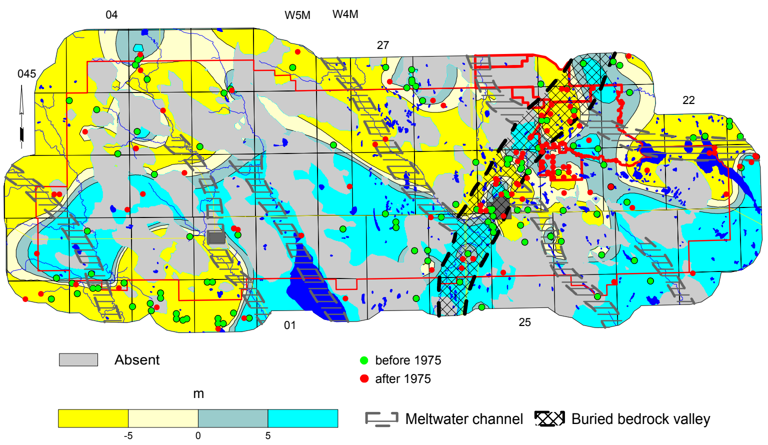

Figure 36. Changes in Water Levels in Surficial Deposits

Where the earliest water level (before 1975) is at a higher elevation than the latest water level (after 1975), there is the possibility that some groundwater decline has occurred. The interpretation of the adjacent map should be limited to areas where both earliest and latest water-level control points are present. Most of the areas in which the map suggests that there has been a decline in NPWL may reflect the nature of gridding a limited number of control points. The adjacent map, where sufficient control exists, indicates that there may have been a decline in the NPWL in the Buried Red Deer Valley north of the Town of Ponoka, and in parts of the southwestern portions of the County, as shown in Figure 36 and on page A-66.

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 surficial aquifer. Of the 18 groundwater users completed in surficial aquifers that are authorized to divert groundwater, most occur in areas where insufficient control exists.

Estimated Water Well Use Per Section (m³/day)	*% of Area with More than a 10 Metre Projected Decline*
no use	*12*
<30	*44*
30 to 60	*28*
>60	*16*

Table 17. Water-Level Decline of More than 10 Metres in Sand and Gravel Aquifer(s)

Figure 36 indicates that in 51% of the County where surficial deposits are present, it is possible that the non-pumping water level has declined. The areas of groundwater decline in the sand and gravel aquifer(s) where there is no estimated water well use suggest that groundwater diversion is not having an impact and that the decline may be due to variations in recharge to the aquifer or because the water wells are not on file with Alberta Environment.

In areas where a water-level decline of more than ten metres is indicated, 12% of the areas has no estimated water well use; 44% of the use is less than 30 m³/day; 28% of the use is between 30 and 60 m³/day per section; and the remaining 16% of the declines occurred where the estimated groundwater use per section is greater than 60 m³/day, as shown above in Table 17.

The available non-pumping water-level elevation for each water well completed in upper bedrock aquifer(s) was first sorted by location, and then by date of water-level measurement. The dates of measurements were required to differ by at least 365 days. Only the earliest and latest control points at a given location were used. Of the 5,676 bedrock water wells with a non-pumping water level and date in the County and buffer area, there are 2,783 water wells with sufficient control to prepare the adjacent map.

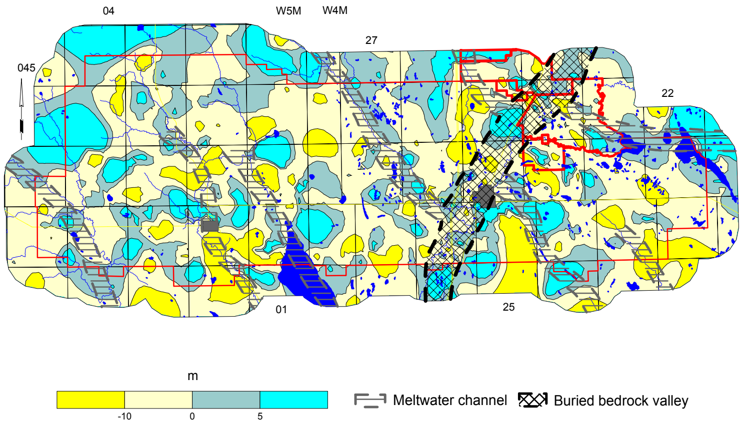

Figure 37. Areas of Potential Groundwater Depletion - Upper Bedrock Aquifer(s)

The adjacent map indicates that in nearly 65% of the County, it is possible that the NPWL has declined. The NPWL decline shown by the AENV Ponoka Obs WW hydrograph and by the AENV Gull Lake Obs WW hydrograph occur in these areas.

In areas where a water-level decline of more than ten metres is indicated, 7% of the area has no estimated water well use; 33% is less than 30 m³/day; 48% is between 30 and 60 m³/day per section; and the remaining 12% of the declines occurred where the estimated groundwater use per section is greater than 60 m³/day, as shown below in Table 18.

Estimated Water Well Use Per Section (m³/day)	*% of Area with More than a 10 Metre Projected Decline*
no use	*7*
<30	*33*
30 to 60	*48*
>60	*12*

Table 18. Water-Level Decline of More than 10 Metres in Upper Bedrock Aquifer(s)

The areas of groundwater decline in the upper bedrock aquifer(s) where there is no estimated water well use suggest that groundwater production is not having an impact and that the decline may be due to variations in recharge to the aquifer or because the water wells are not on file with Alberta Environment.

6.5 Discussion of Specific Study Areas

As per the Request for Proposal, Ponoka County requested that comments be made, where possible, on the following three study areas and issues. The issue is stated at the beginning of each of the following sections. Figure 38 shows the three specific study areas in the County; in Figure 39, the three specific study areas have been color outlined on the bedrock geology map; Figure 40 shows the apparent yield for water wells completed in the Sand and Gravel Aquifer(s); and Figure 41 shows the apparent yield for water wells completed in the Upper Bedrock Aquifer(s).

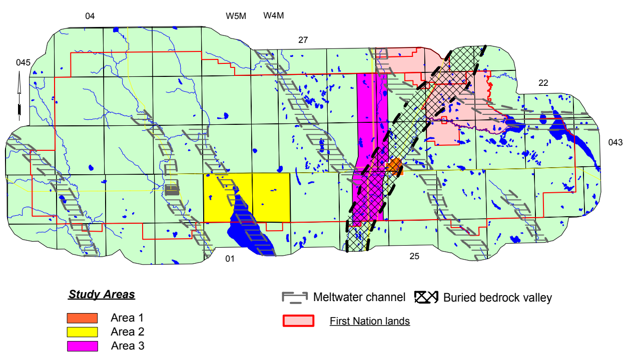

Figure 38. Specific Study Areas

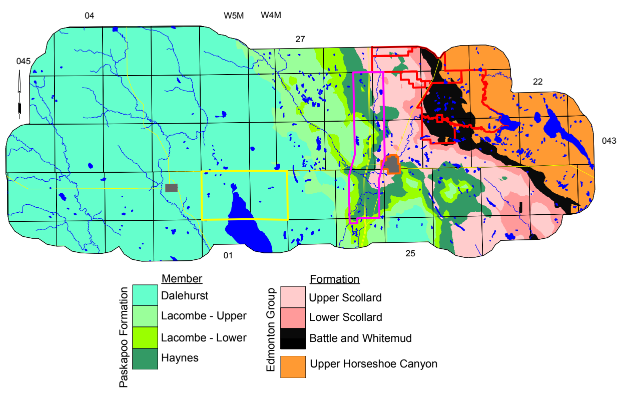

Figure 39. Bedrock Geology of Specific Study Areas

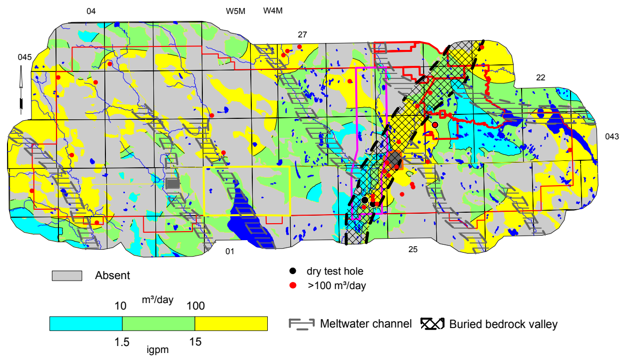

Figure 40. Apparent Yield for Water Wells Completed in Sand and Gravel Aquifer(s) - Specific Study Areas

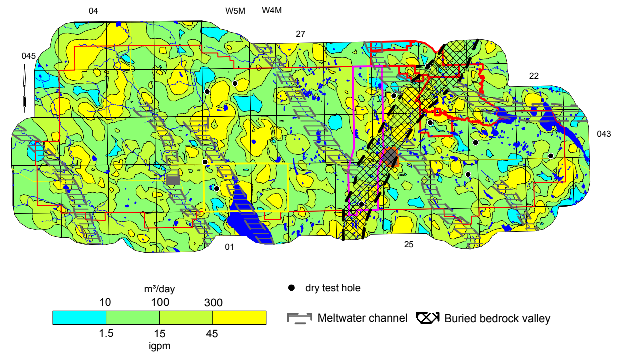

Figure 41. Apparent Yield for Water Wells Completed in Upper Bedrock Aquifer(s) - Specific Study Areas

6.5.1 Area 1 – Town of Ponoka

What is the approximate extent and potential (yield and water quality) of the aquifers in this area? What comments can be made regarding the apparent water-level decline in the aquifer supplying the Town of Ponoka?

The Town of Ponoka requires additional water for their municipal water system. The population of the Town of Ponoka has been growing at a rate of more than 2% per year. Based on the current population of 6,330 (Phinney, 2003), the Town of Ponoka requires an average groundwater supply of 1,520 m^3/day. The eight existing water supply wells are mainly completed in the Upper Scollard Aquifer and are authorized to divert up to 4,015 m^3/day for municipal purposes, as shown in the adjacent figure. Of the eight water supply wells, four could be linked to water wells in the AENV groundwater database; aquifer test data were available for two of the water supply wells.

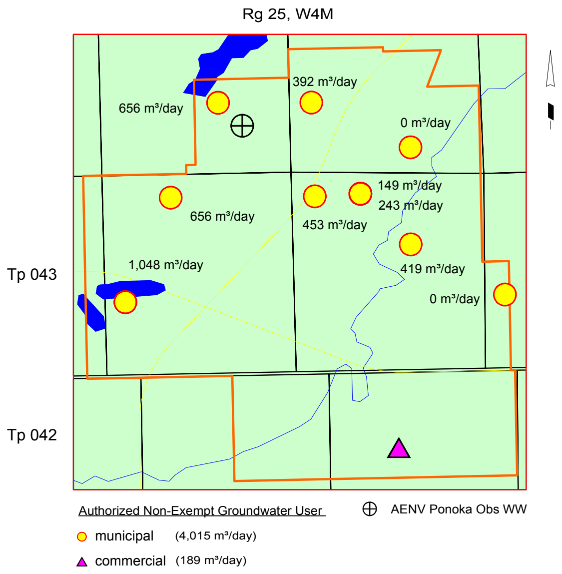

Figure 42. Authorized Non-Exempt Groundwater Water Wells – Area 1

There are indications that there has been a continual decline of more than ten metres in the water-level surface in the Upper Scollard Aquifer, as shown by the AENV Ponoka Obs WW hydrograph (see page A-57).

Water-level monitoring data from the Town of Ponoka water supply wells would need to be provided by the Town in order to determine the extent of the water-level decline.

It was indicated in the 1979 groundwater program conducted by HCL for the Town of Ponoka that once the two 1979 water supply wells completed in the Upper Scollard Aquifer in 12-05 and 14-05-043-25 W4M are put into production, the groundwater available from the Aquifer within the Town boundaries would be at or near the maximum. Since 1979, an additional 656 m^3/day has been authorized to be diverted from a water supply well completed in the Upper Scollard Aquifer in 07-08-043-25 W4M.

It was recommended in the 1979 report, that in the event that groundwater production from the water supply wells in 12-05 and 14-05 could not be increased above the total recommended rates of 1,570 m^3/day, and if groundwater production from the Buried Red Deer Valley deposits is not feasible, additional groundwater supplies would have to be developed from sites outside the Town boundaries, possibly in sections 35 and 36, township 042, range 26, W4M. It is not known if the Town has conducted any groundwater investigations at sites outside the Town boundaries.

Before the Town of Ponoka can be helped, there is a need for meaningful management of the groundwater resource and a need for the Town to consider developing additional groundwater supplies from outside the Town's corporate limits.

6.5.2 Area 2 – Gull Lake

What is the approximate extent and potential (yield and water quality) of the aquifers in this area?

The Sand and Gravel Aquifer(s) is present over 50% of Area 2. The saturated sand and gravel deposits are expected to be mainly less than five metres thick. In Area 2, the apparent yields for water wells completed through the Lower Sand and Gravel Aquifer are expected to be less than 50 m³/day. In Area 2, there are no apparent yield data for water wells completed in the Sand and Gravel Aquifer(s). The closest water well to Area 2 with apparent yield data is a water well completed in the Lower Sand and Gravel Aquifer in 16-28-042-27 W4M, which has an apparent yield of 27 m³/day.

Groundwaters from water wells completed in Area 2 in the surficial deposits are expected to have TDS concentrations that are less than 1,000 mg/L.

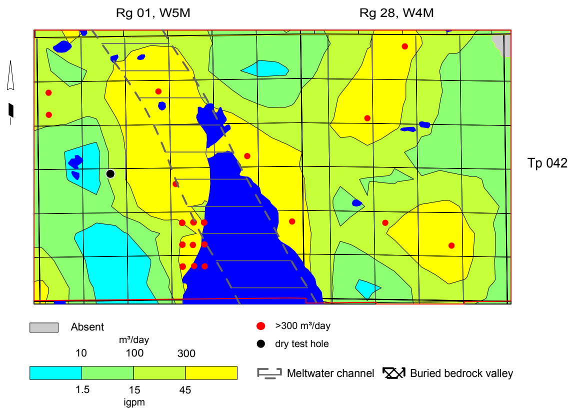

Figure 43. Apparent Yield for Water Wells Completed in Dalehurst Aquifer – Area 2

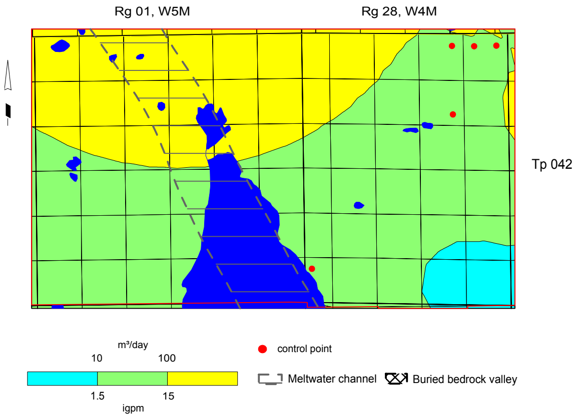

Figure 44. Apparent Yield for Water Wells Completed in Upper Lacombe Aquifer – Area 2

The upper bedrock in Area 2 is the Dalehurst Member. In approximately 60% of Area 2, the apparent yields for water wells completed through the Dalehurst Aquifer are expected to be greater than 100 m³/day, as shown above in Figure 43. The water wells that are shown in Gull Lake are the result of having an available legal location only to the nearest half section.

In Area 2, the depth to the top of the Upper Lacombe ranges from less than 30 metres in the extreme northeastern part of Area 2 to greater than 100 metres in the western part of Area 2. In Area 2, there are five water wells completed in the Upper Lacombe Aquifer with apparent yield data. The completed depths of the water wells range from 36 to 50 metres below ground surface. The apparent yields for water wells completed in the Upper Lacombe Aquifer are expected to be mainly greater than 30 m³/day.

Groundwaters from water wells completed in the Dalehurst Aquifer in Area 2 are expected to have TDS concentrations that are mainly less than 1,000 mg/L, sulfate concentrations that are less than 200 mg/L, chloride concentrations that are less than ten mg/L, and fluoride concentrations that are less than one mg/L.

In Area 2, there are two water wells completed in the Upper Lacombe Aquifer that have chemistry data for TDS, sulfate and chloride concentrations as shown in the adjacent table. One water well in SE 26-042-28 W4M indicates a fluoride concentration that significantly exceeds the SGDWQ.

Based on the available data in Area 2, apparent yields are expected to be the highest in the Dalehurst Aquifer.

Constituent	Legal Description	Results mg/L	Analysis Date	Recommended Maximum Concentration SGCDWQ
TDS	NE 24-042-28 W4M	2,452	22-Aug-60	500
		2,042	22-Aug-60	
	SE 26-042-28 W4M	528	10-Dec-86	
Sulfate	NE 24-042-28 W4M	1,142	22-Aug-60	200
		902	22-Aug-60	
	SE 26-042-28 W4M	10	10-Dec-86	
Chloride	NE 24-042-28 W4M	4	22-Aug-60	250
		4	22-Aug-60	
	SE 26-042-28 W4M	30	10-Dec-86	
Fluoride	SE 26-042-28 W4M	10	10-Dec-86	1.5

Note: indicated concentrations are for Aesthetic Objectives except for Fluoride, which is for Maximum Acceptable Concentration (MAC)

SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality Federal-Provincial-Territorial Committee on Drinking Water, April 2002

Table 19. Concentrations of TDS, Sulfate and Fluoride for Water Wells in Upper Lacombe Aquifer – Area 2

6.5.3 Area 3 – Highway 2 Corridor

What is the approximate extent and potential (yield and water quality) of the aquifers in this area?

There are aquifers in six separate geological units in Area 3. The hydrogeological data for each aquifer is summarized below in Table 20.

Geologic Unit	Number of Water Wells	*Water Well Use (m³/day)	Elevation to Bottom (m AMSL)		% of Area Aquifer Present	Range in Apparent Yield (m³/day)		Chemical Quality (mg/L)		
			Maximum	Minimum		Low	High	Hardness	TDS	Fluoride
Lower Sand and Gravel	27	80	860	760	65	>10	<300	<400	<1,000	---
Upper Lacombe	3	---	850	790	15	<10	<100	<200	<1,000	<0.5
Lower Lacombe	12	76	840	780	35	<10	<100	<400	<1,000	<1.0
Haynes	182	900	810	760	80	<10	>300	<400	<1,000	<1.0
Upper Scollard	104	730	780	700	100	<10	>300	<200	<1,500	<1.0
Lower Scollard	11	60	740	660	100	<10	<100	<200	<1,500	<2.0

*Estimated 2003 groundwater use based on criteria in section 6.2 of this report

Table 20. Summary of Aquifers in Area 3

The Lower Sand and Gravel Aquifer is present in approximately 65% of Area 3. The apparent yields for water wells completed in the Lower Sand and Gravel Aquifer range from ten m³/day to 300 m³/day, with higher yields in the Buried Red Deer Valley (see page A-76).

Groundwaters from water wells completed in Area 3 in the surficial deposits are expected to have TDS concentrations that are less than 1,000 mg/L,

The upper bedrock over most of Area 3 is the Paskapoo Formation and the Scollard formations (see page A-77).

The apparent yields for water wells completed through the upper bedrock aquifer(s) are expected to range between ten and 300 m³/day, with the highest yielding water wells being completed in the Haynes and Upper Scollard aquifers (see pages A-78 and A-89).

Groundwaters from water wells completed in the upper bedrock aquifer(s) are expected to have TDS concentrations that range between 500 and 1,000 mg/L (see page A-77).

Figure 45 shows the main areas where apparent yields for bedrock water wells are expected to be greater than 300 m³/day and where TDS concentrations in the groundwaters are expected to be less than 500 mg/L.

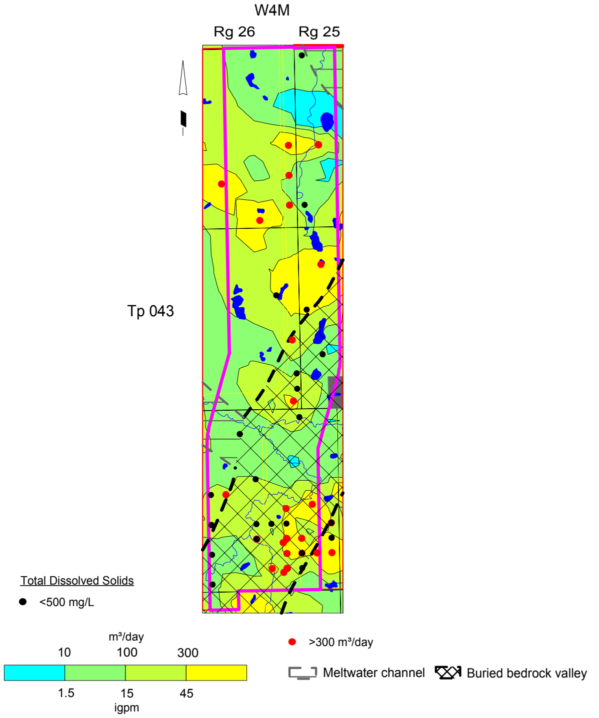

Figure 45. Apparent Yield and Total Dissolved Solids in Groundwater for Water Wells Completed in Upper Bedrock Aquifer(s) – Area 3

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 240 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. There are 13 water wells for which the County has responsibility; the County-operated water wells are included in Appendix E. It is recommended that the County-operated water wells plus the 240 water wells be field-verified, water levels be measured, a water sample be collected for analysis, and a short aquifer test be conducted. An attempt to update the quality of the entire database is not recommended.

The most notable areas where surficial water wells are completed are the sand and gravel aquifer(s) that are in association with the linear bedrock lows. There are 37 surficial water wells with an apparent yield value completed in the Sand and Gravel Aquifer(s) that are in association with the Buried Red Deer Valley and meltwater channels. The median apparent yield value from these 37 water wells is 65 m³/day (10 igpm).

The results of the present study indicate that the main source of groundwater in the County is aquifers in the upper bedrock aquifer(s). The median apparent yield value from all water wells completed in the upper bedrock aquifer(s) is in the order of 60 m³/day (9 igpm). More than 35% of the water wells completed in the upper bedrock aquifer(s) have an apparent yield of greater than 100 m³/day.

Before an attempt is made to provide a major upgrade to the level of interpretation provided in this report, the accompanying maps and the groundwater query, it is recommended that the 240 water wells listed in Appendix E for which water well drilling reports are available, plus the 13 County–operated water wells, 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.

This additional information would provide a baseline to be used for comparison to either existing chemical analyses or aquifer tests, or to determine if future monitoring would be necessary if significant changes in the aquifer parameters had occurred.

A list of the 253 water wells that could be considered for the above program is given in Appendix E and on the CD-ROM.

An attempt to link the AENV groundwater and licensing databases was 35% successful in this study (see CD-ROM); sixty-five percent of authorized non-exempt 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 authorized non-exempt water wells are completed.

While there are a few areas where water-level data are available at different times, 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 were being provided with a tax credit if they accurately measured 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 (Buchanan, Bob (editor). Alberta Agriculture, Food and Rural Development, 1996).

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.

Communities that are concerned about apparent water-level declines in the aquifers in which their water supply wells are completed should implement a conscientious groundwater monitoring program.

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.

In summary, for the next level of study, the database needs updating. The updating of information for existing water wells requires more details for the water wells listed in Appendix E; the additional information for new water wells is mainly better spatial control.

Groundwater is a renewable resource and it must be managed.

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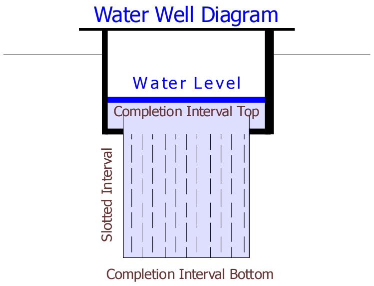
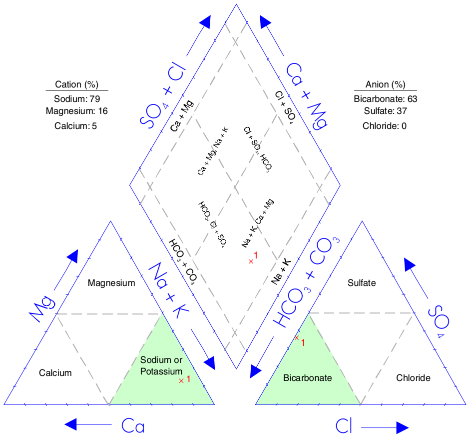
9 GLOSSARY

Anion	negatively charged ion
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
Completion Interval	see diagram
Deltaic	a depositional environment in standing water near the mouth of a river
Dewatering	the removal of groundwater from an aquifer for purposes other than use
Dfb	one of the Köppen climate classifications; a Dfb climate consists of warm to cool summers, severe winters, and no dry season. The mean monthly temperature drops below -3° C in the coolest month, and exceeds 10° C in the warmest month.
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



Completion Interval

mm	millimetres
m²/day	metres squared per day
m³	cubic metres
m³/day	cubic metres per day
mg/L	milligrams per litre
Median	the value at the centre of an ordered range of numbers
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
AAFC-PFRA	Prairie Farm Rehabilitation Administration Branch of Agriculture and Agri-Food Canada
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
IAAM	*Infinite Aquifer Artesian Model.* The mathematical model is used to calculate water levels at a given location. The model has been used for more than 17 years by HCL for several hundred groundwater monitoring projects. The model aquifer is based on a solution of the well function equation. The simulation calculates drawdown by solving the well function equation using standard approximation methods. The drawdown at any given point at any given time uses the method of superposition.
NPWL	non-pumping water level
TDS	Total Dissolved Solids
WSW	Water Source Well or Water Supply Well

10 CONVERSIONS

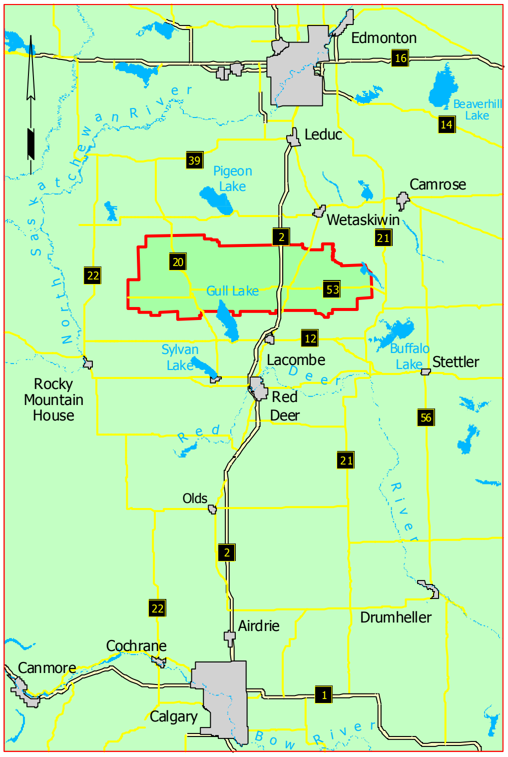
Multiply	by	To Obtain
Length/Area		
feet	0.304 785	metres
metres	3.281 000	feet
hectares	2.471 054	acres
centimetre	0.032 808	feet
centimetre	0.393 701	inches
acres	0.404 686	hectares
inchs	25.400 000	millimetres
miles	1.609 344	kilometres
kilometer	0.621 370	miles (statute)
square feet (ft^2)	0.092 903	metres (m^2)
metres (m^2)	10.763 910	square feet (ft^2)
metres (m^2)	0.000 001	kilometres (km^2)
Concentration		
grains/gallon (UK)	14.270 050	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	0.219 974	ipgm
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 (m	0.152 759	igpm
Pressure		
psi	6.894 757	kpa
kpa	0.145 038	psi
Miscellaneous		
Celsius	F° = 9/5 (C° + 32)	Fahrenheit
Fahrenheit	C° = (F°- 32) * 5/9	Celsius
degrees	0.017 453	radians

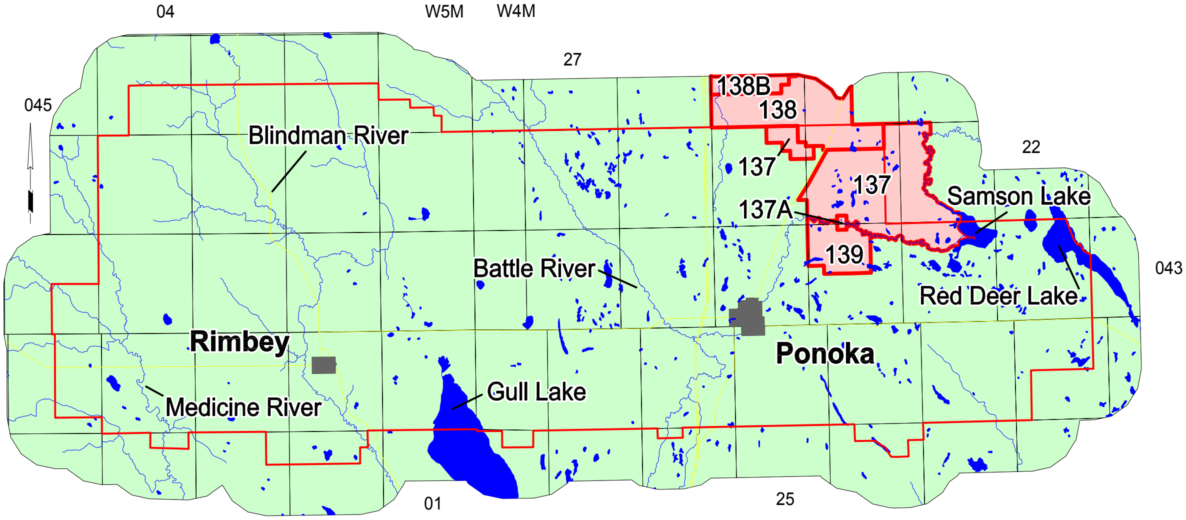
PONOKA COUNTY

Appendix A

HYDROGEOLOGICAL MAPS AND FIGURES

Index Map/County Details





🟥 <u>First Nation lands</u>

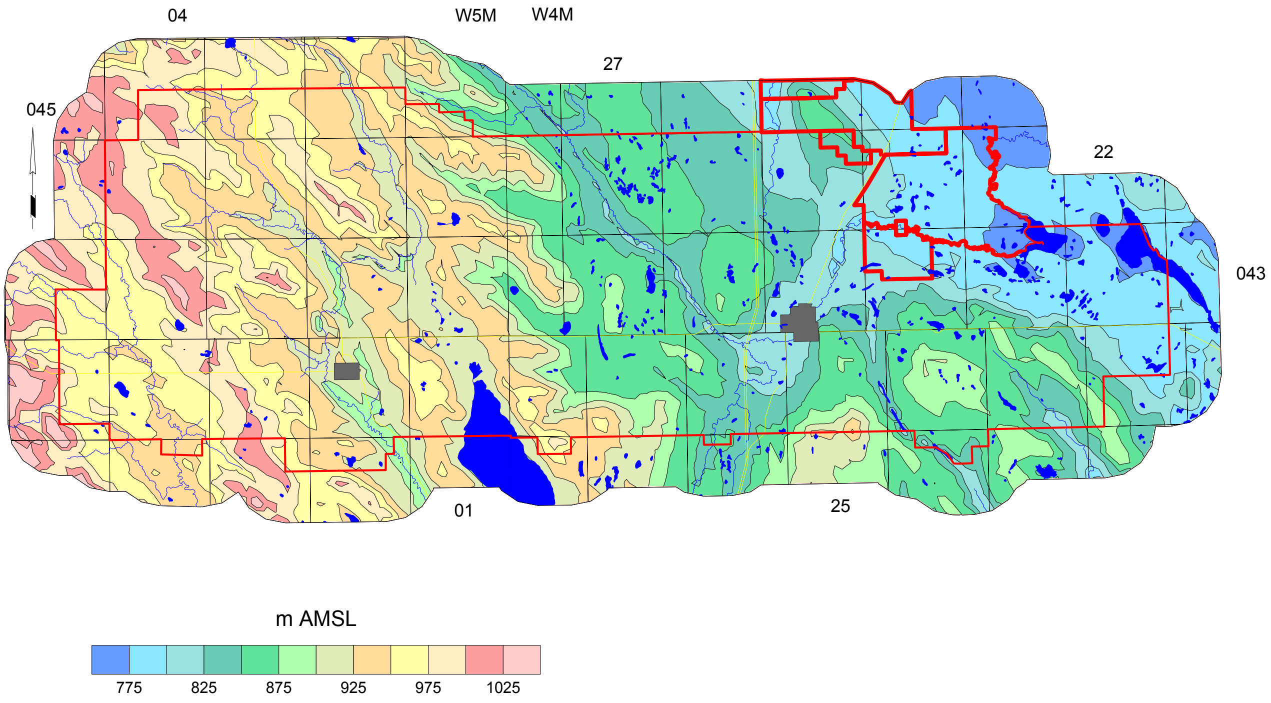
Samson Cree - 137, 137A

Ermineskin - 138

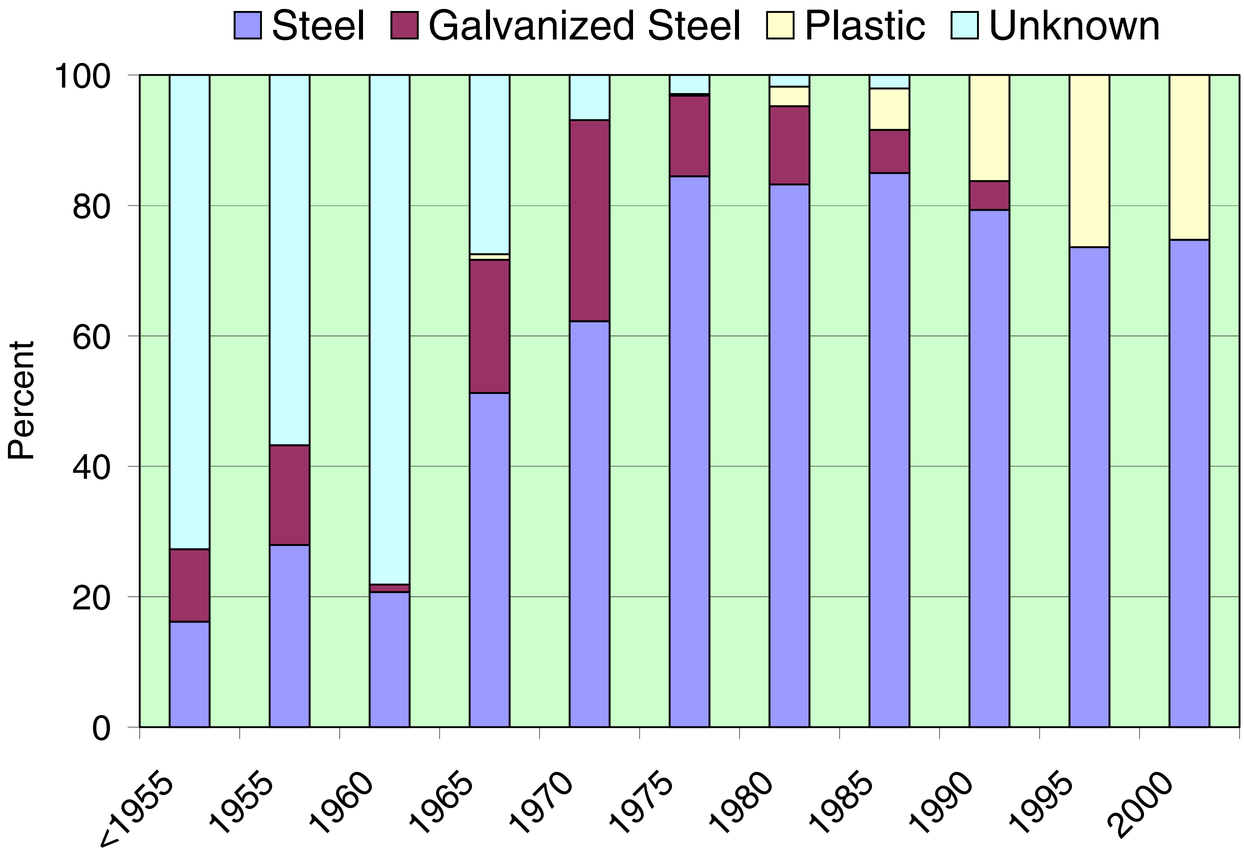
Louis Bull - 138B

Montana - 139

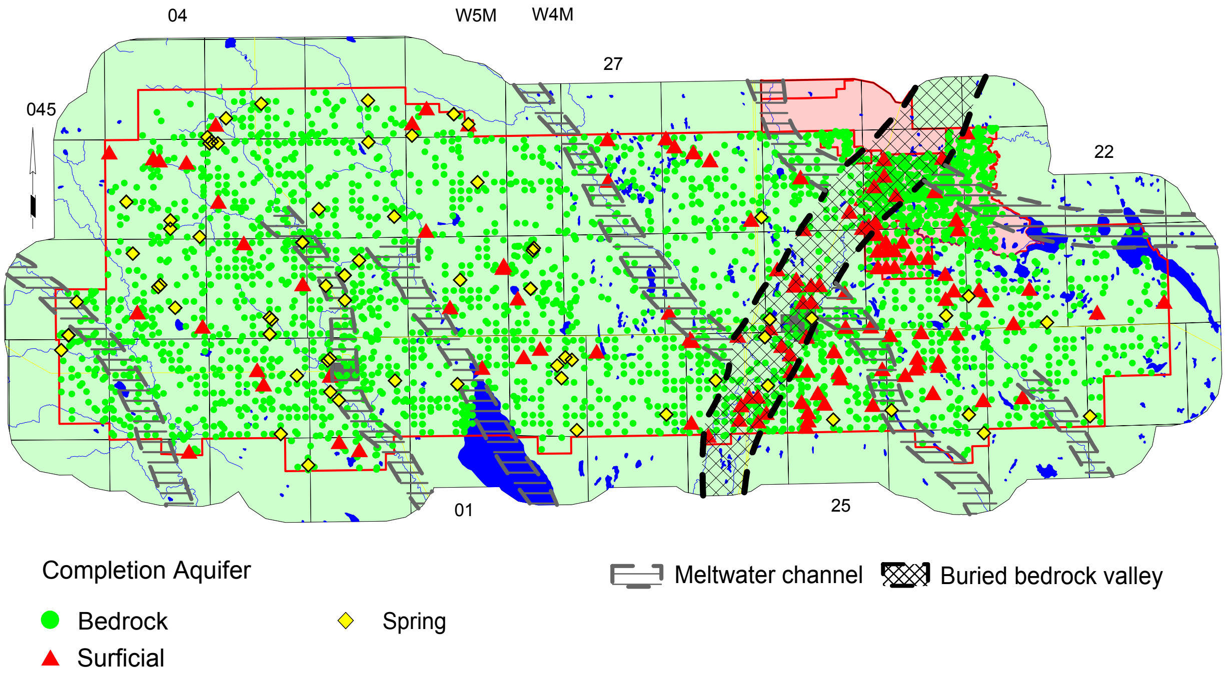
Surface Topography



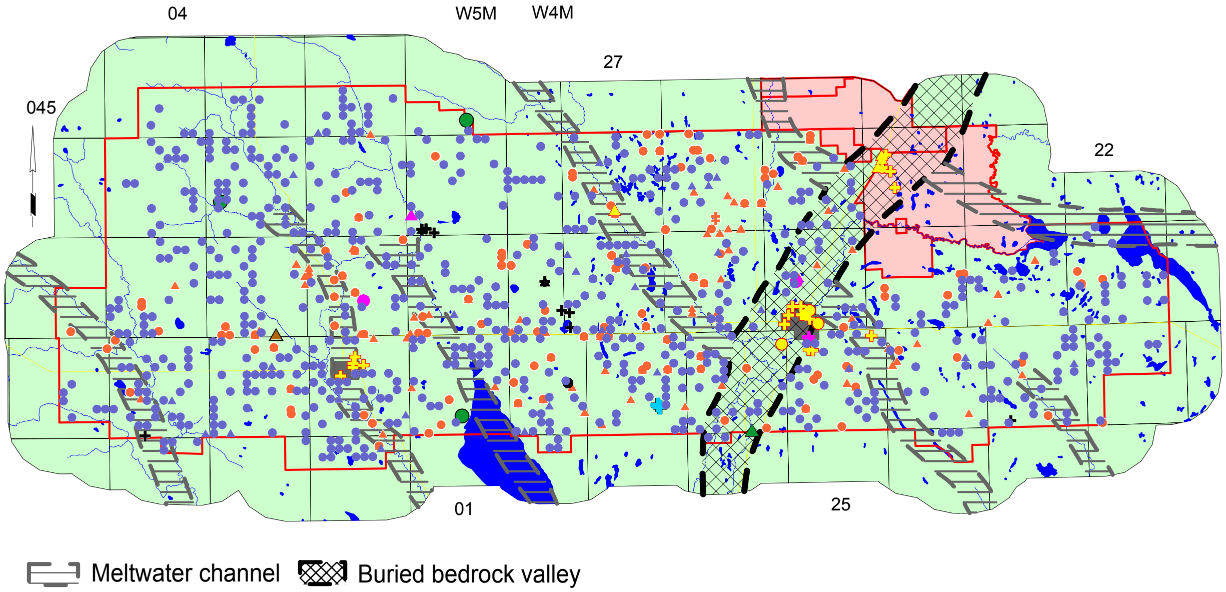
Surface Casing Types Used in Drilled Water Wells



Location of Water Wells and Springs



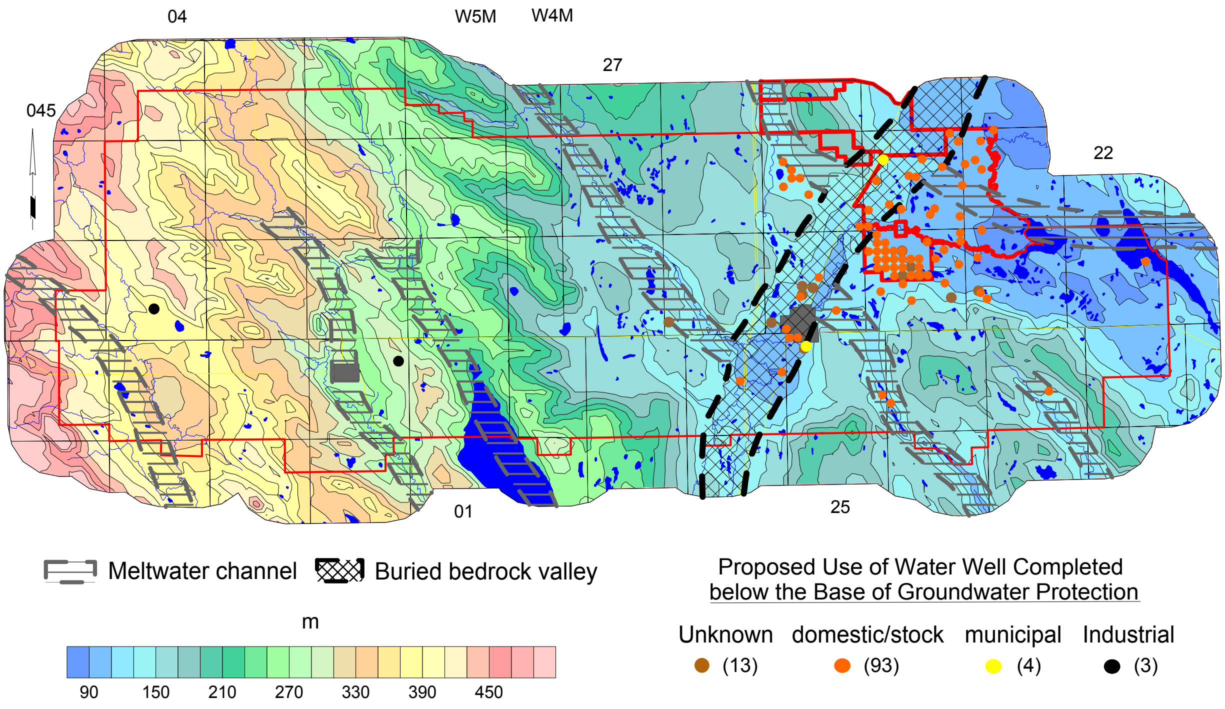
Authorized Non-Exempt Groundwater Water Wells



m³/day	registration	agricultural	municipal	industrial	commercial	recreation	dewatering	exploration
< 10	● (857)	● (169)	○ (4)	● (1)	● (2)	● (3)	● (0)	● (0)
10 to 100	▲ (35)	▲ (144)	△ (8)	▲ (3)	▲ (2)	▲ (1)	▲ (0)	▲ (1)
> 100	✚ (0)	✚ (2)	✚ (23)	✚ (12)	✚ (1)	✚ (0)	✚ (2)	✚ (0)

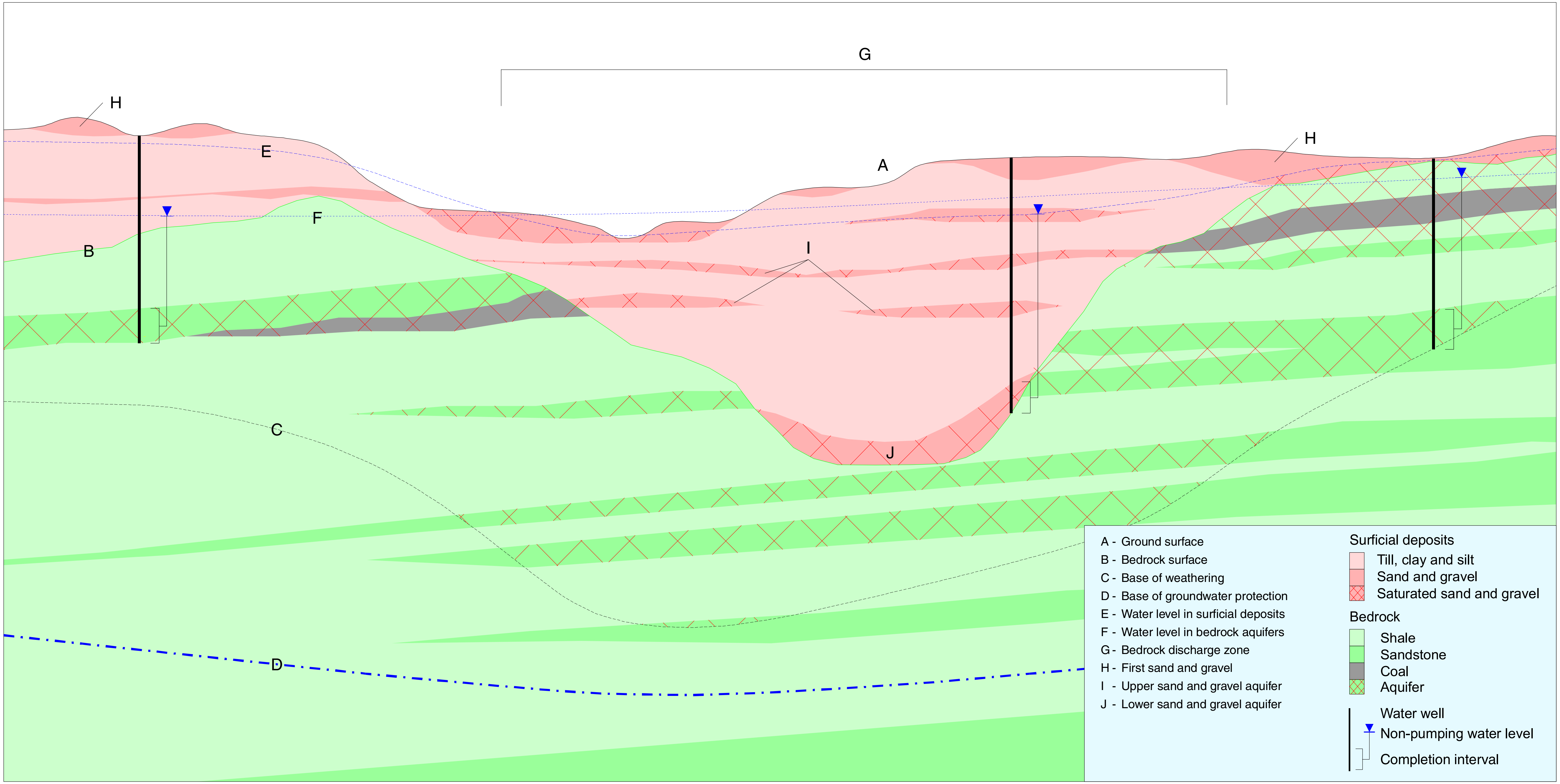
Depth to Base of Groundwater Protection

(modified after EUB, 1995)

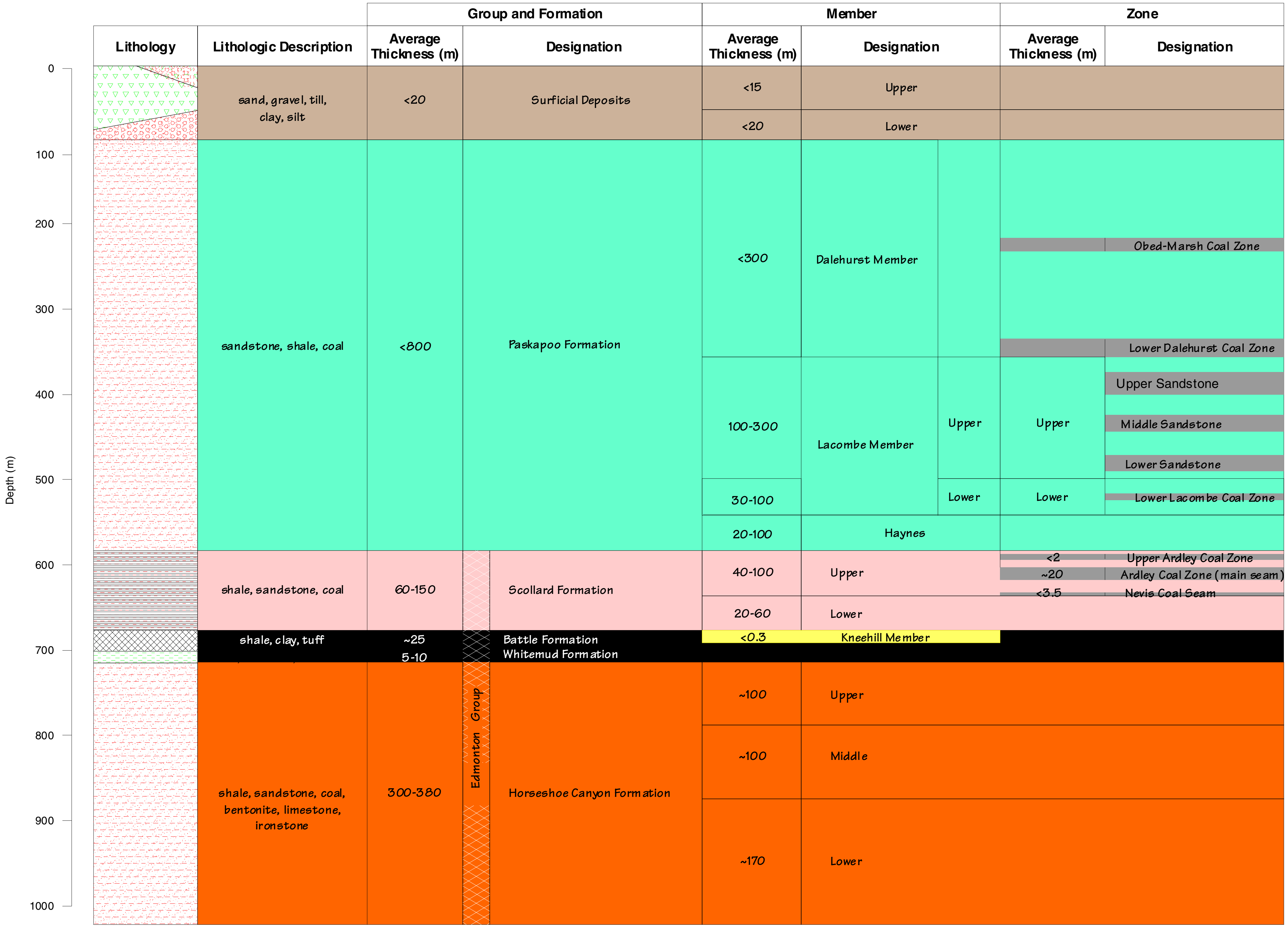


Generalized Cross-Section

(for terminology only)



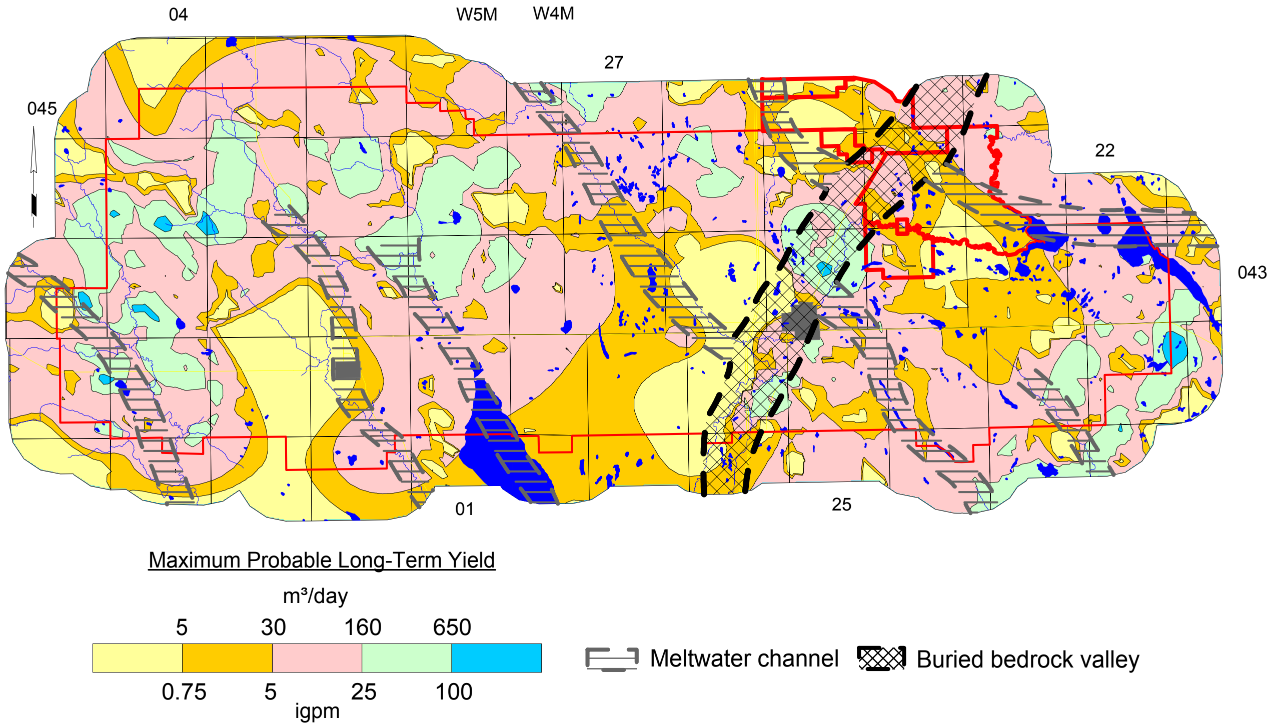
Geologic Column



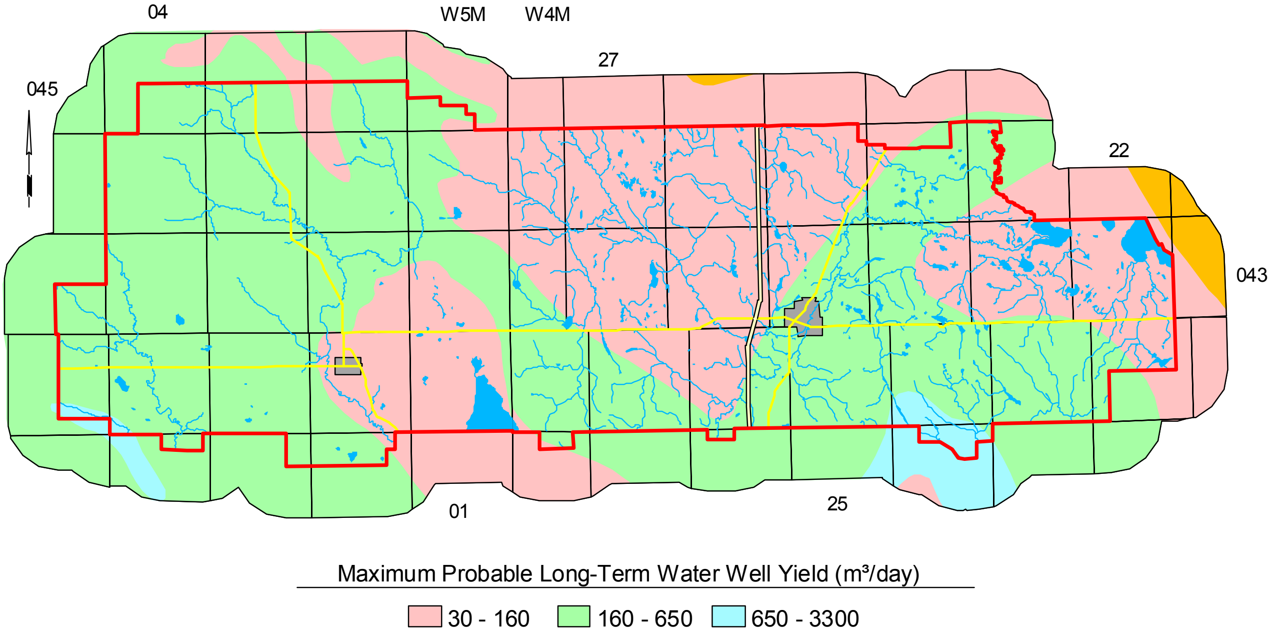
Lithology	Lithologic Description	Group and Formation: Average Thickness (m)		Group and Formation: Designation	Member: Average Thickness (m)	Member: Designation		Zone: Average Thickness (m)	Zone: Designation
	sand, gravel, till, clay, silt	<20		Surficial Deposits	<15	Upper			
					<20	Lower			
	sandstone, shale, coal	<800		Paskapoo Formation	<300	Dalehurst Member			Obed-Marsh Coal Zone
									Lower Dalehurst Coal Zone
					100-300	Lacombe Member	Upper	Upper	Upper Sandstone Middle Sandstone Lower Sandstone
					30-100		Lower	Lower	Lower Lacombe Coal Zone
					20-100	Haynes			
	shale, sandstone, coal	60-150	Edmonton Group	Scollard Formation	40-100	Upper		<2	Upper Ardley Coal Zone
								~20	Ardley Coal Zone (main seam)
								<3.5	Nevis Coal Seam
					20-60	Lower			
	shale, clay, tuff	~25		Battle Formation	<0.3	Kneehill Member			
		5-10		Whitemud Formation					
	shale, sandstone, coal, bentonite, limestone, ironstone	300-380		Horseshoe Canyon Formation	~100	Upper			
					~100	Middle			
					~170	Lower			

]

Hydrogeological Maps

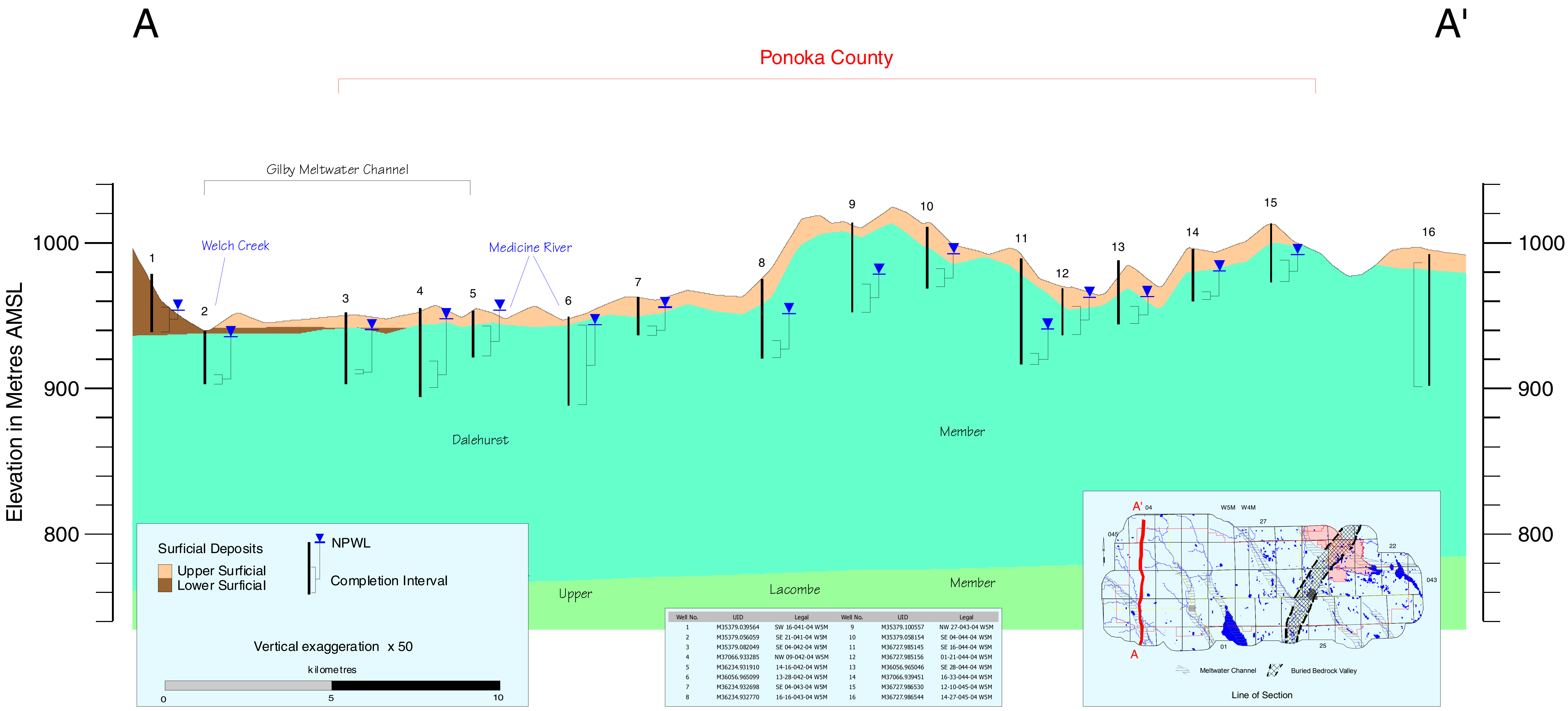


2003 HCL



1971 Alberta Research Council

Cross-Section A - A'



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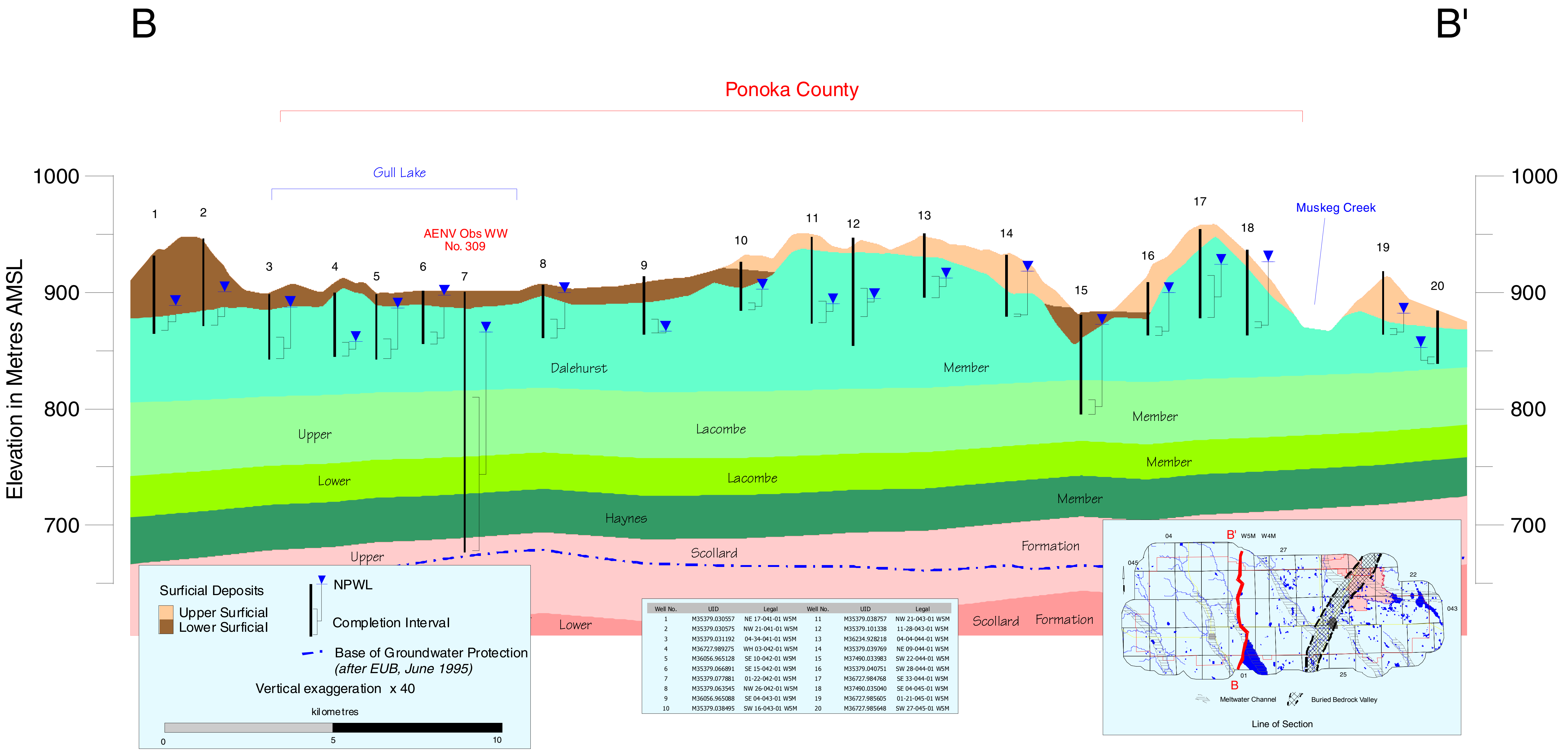
4	M37066.933285	NW 09-042-04 W5M	12	M36727.985156	01-21-044-04 W5M
5	M36234.931910	14-16-042-04 W5M	13	M36056.965046	SE 28-044-04 W5M
6	M36056.965099	13-28-042-04 W5M	14	M37066.939451	16-33-044-04 W5M
7	M36234.932698	SE 04-043-04 W5M	15	M36727.986530	12-10-045-04 W5M
8	M36234.932770	16-16-043-04 W5M	16	M36727.986544	14-27-045-04 W5M

Cross-Section B - B'



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4	M36727.989275	WH 03-042-01 W5M	14	M35379.039769	NE 09-044-01 W5M
5	M36056.965128	SE 10-042-01 W5M	15	M37490.033983	SW 22-044-01 W5M
6	M35379.066891	SE 15-042-01 W5M	16	M35379.040751	SW 28-044-01 W5M
7	M35379.077881	01-22-042-01 W5M	17	M36727.984768	SE 33-044-01 W5M
8	M35379.063545	NW 26-042-01 W5M	18	M37490.035040	SE 04-045-01 W5M
9	M36056.965088	SE 04-043-01 W5M	19	M36727.985605	01-21-045-01 W5M
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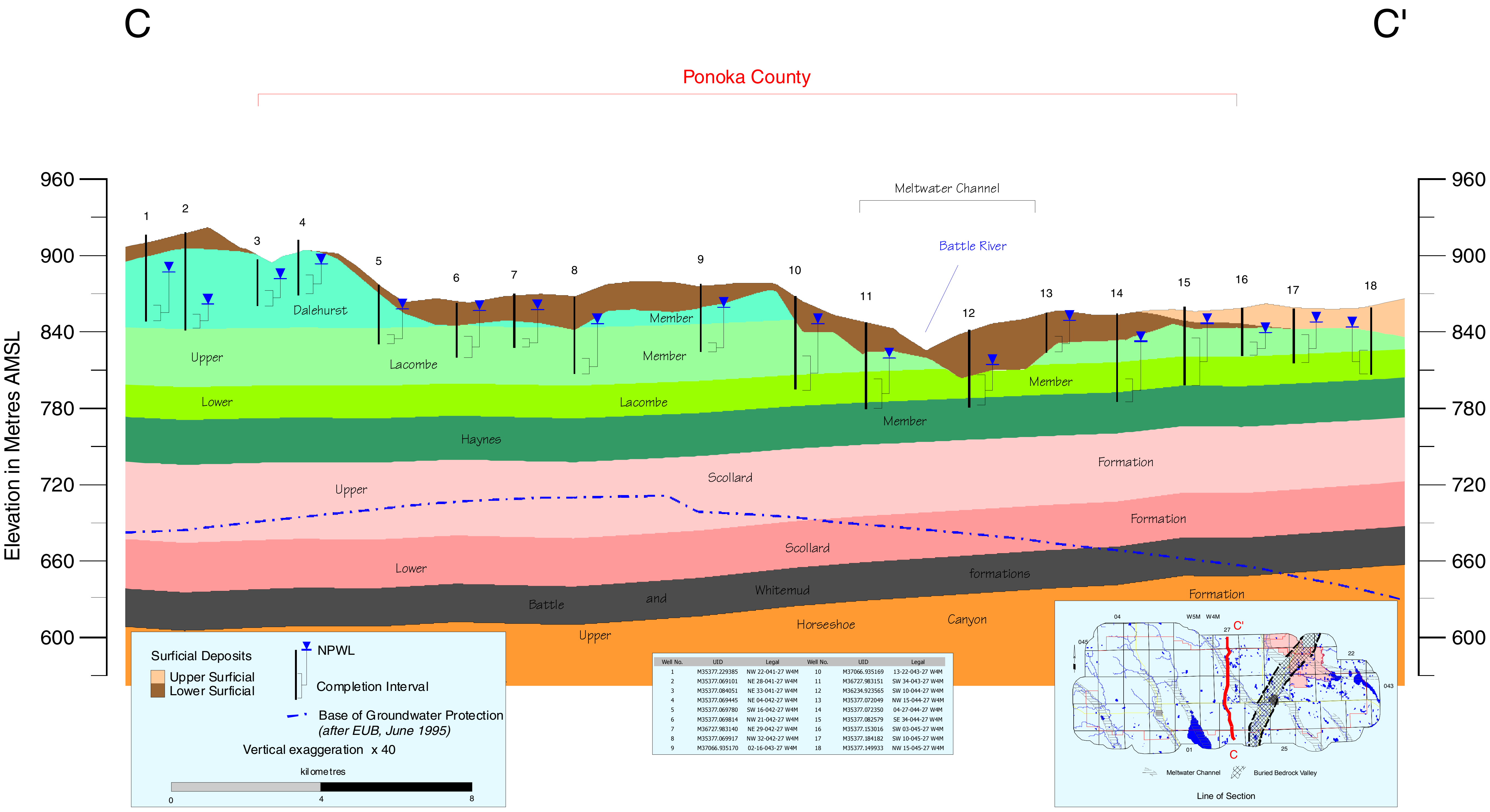
Cross-Section C - C'



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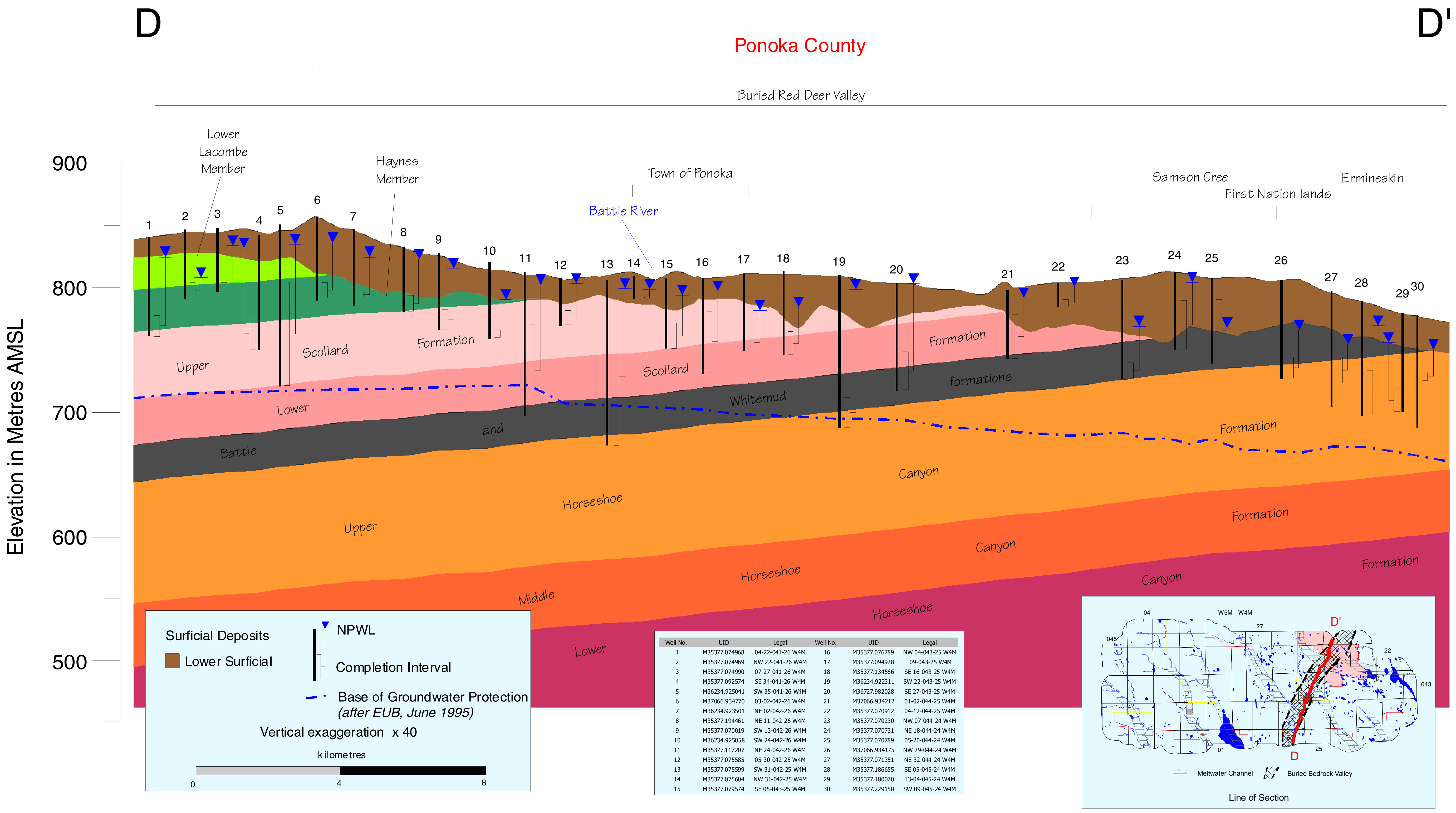
4	M35377.069445	NE 04-042-27 W4M	13	M35377.072049	NW 15-044-27 W4M
5	M35377.069780	SW 16-042-27 W4M	14	M35377.072350	04-27-044-27 W4M
6	M35377.069814	NW 21-042-27 W4M	15	M35377.082579	SE 34-044-27 W4M
7	M36727.983140	NE 29-042-27 W4M	16	M35377.153016	SW 03-045-27 W4M
8	M35377.069917	NW 32-042-27 W4M	17	M35377.184182	SW 10-045-27 W4M
9	M37066.935170	02-16-043-27 W4M	18	M35377.149933	NW 15-045-27 W4M

Cross-Section D - D'



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5	M36234.925041	SW 35-041-26 W4M	20	M36727.982028	SE 27-043-25 W4M
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12	M35377.075585	05-30-042-25 W4M	27	M35377.071351	NE 32-044-24 W4M
13	M35377.075599	SW 31-042-25 W4M	28	M35377.186655	SE 05-045-24 W4M
14	M35377.075604	NW 31-042-25 W4M	29	M35377.180070	13-04-045-24 W4M
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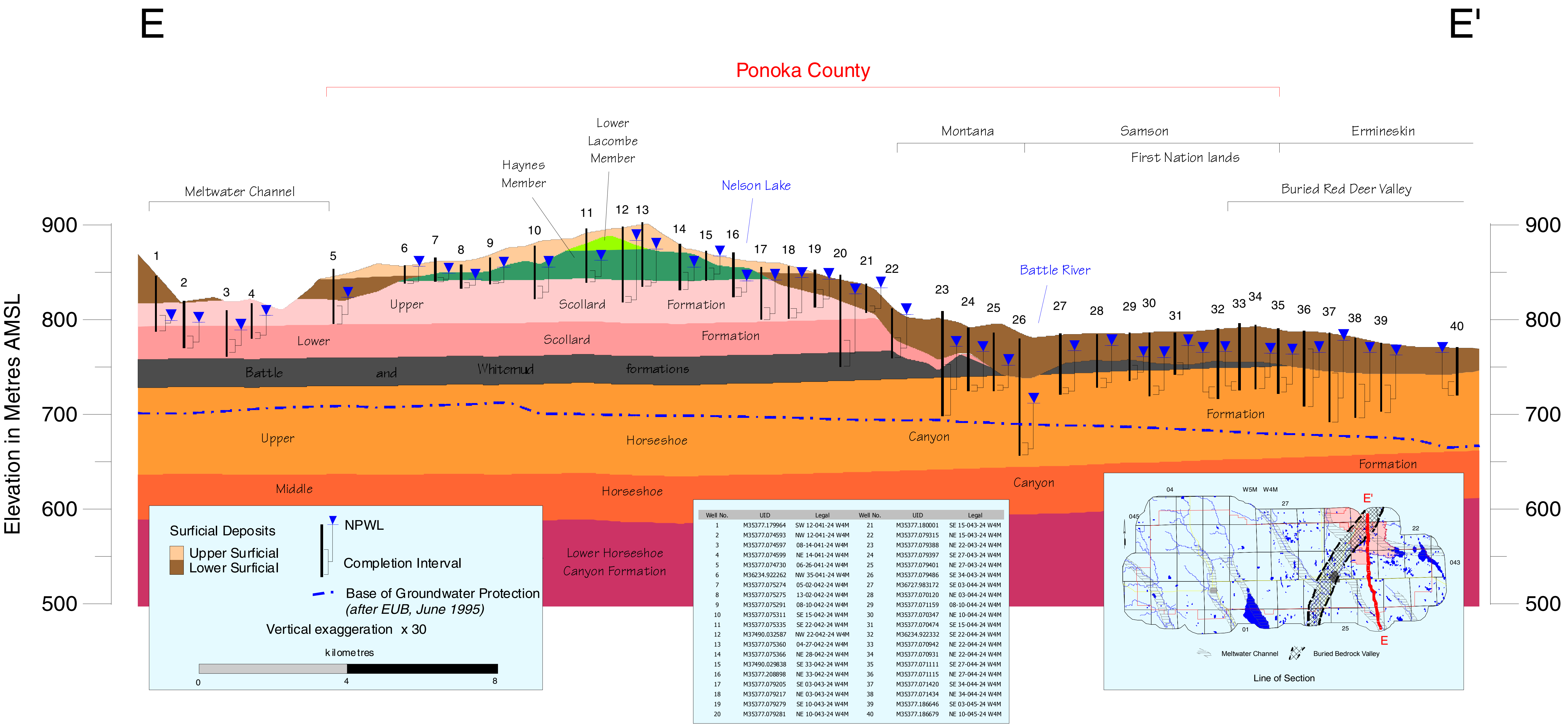
Cross-Section E - E'



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4	M35377.074599	NE 14-041-24 W4M	24	M35377.079397	SE 27-043-24 W4M
5	M35377.074730	06-26-041-24 W4M	25	M35377.079401	NE 27-043-24 W4M
6	M36234.922262	NW 35-041-24 W4M	26	M35377.079486	SE 34-043-24 W4M
7	M35377.075274	05-02-042-24 W4M	27	M36727.983172	SE 03-044-24 W4M
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9	M35377.075291	08-10-042-24 W4M	29	M35377.071159	08-10-044-24 W4M
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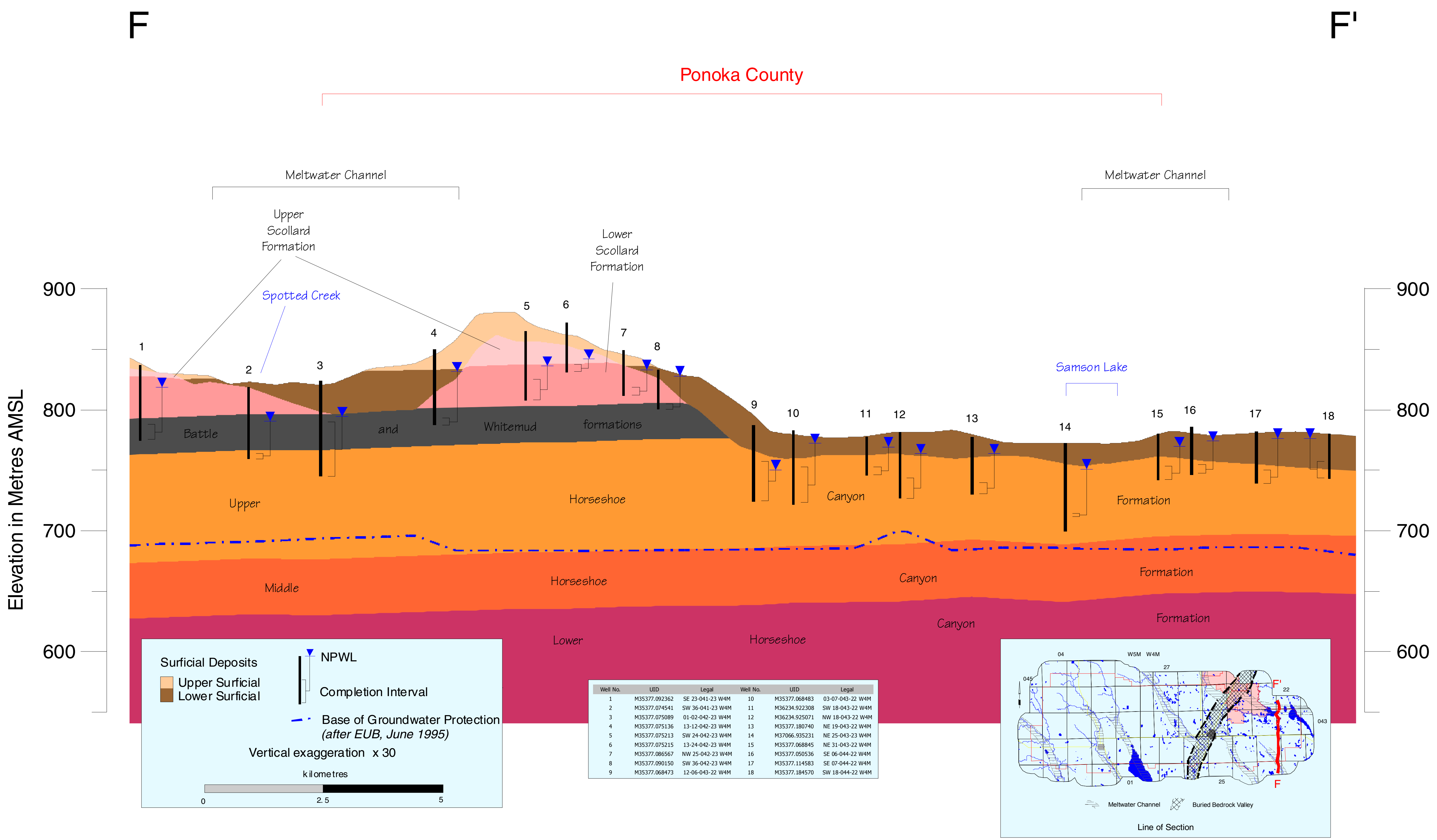
Cross-Section F - F'



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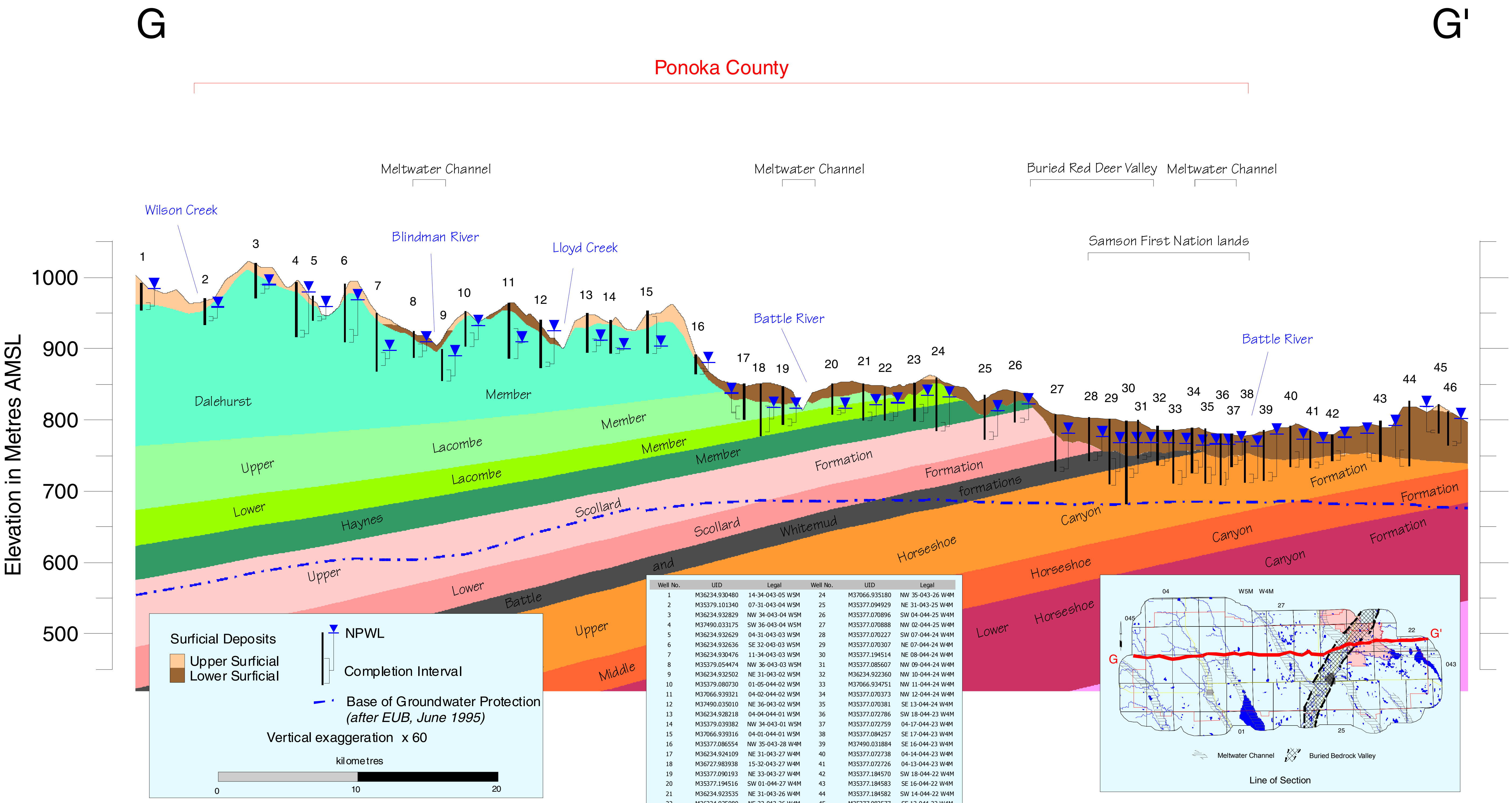
Cross-Section G -G'



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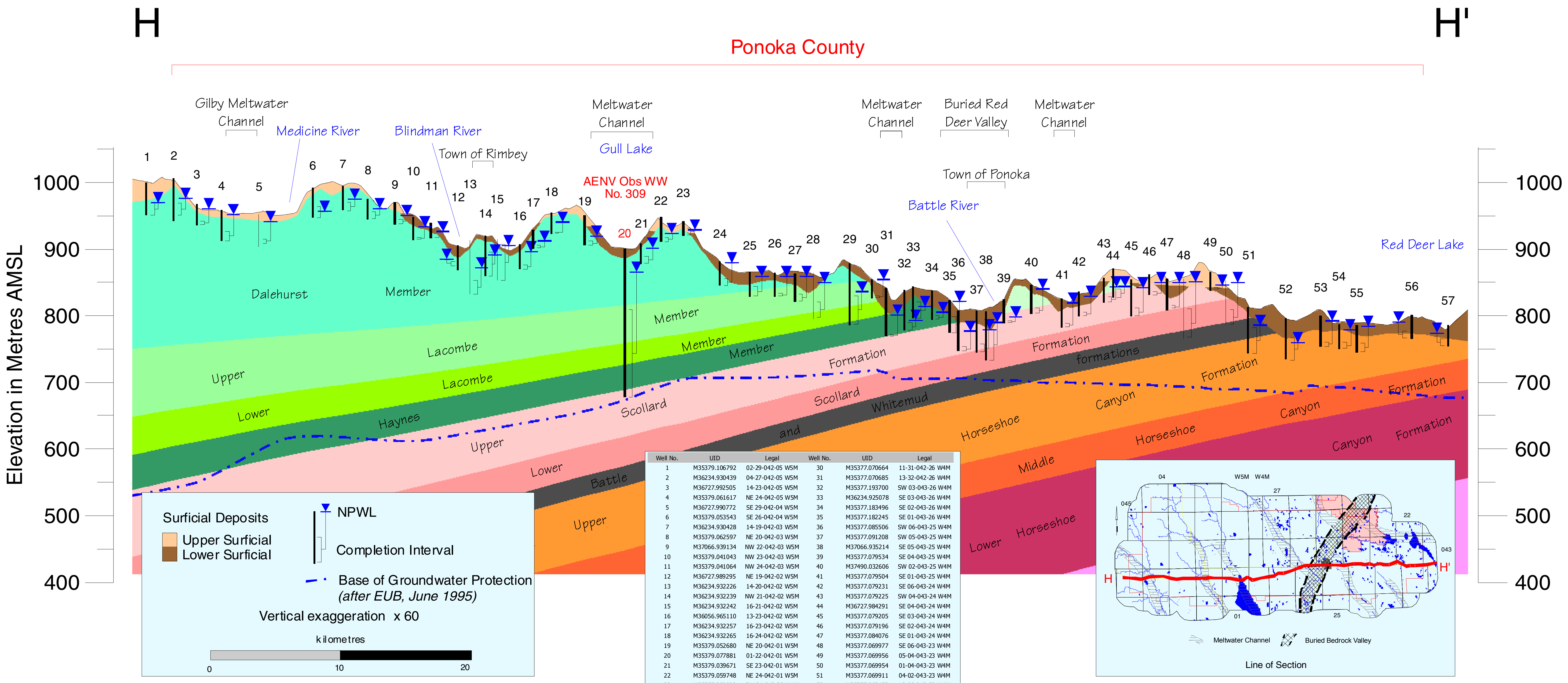
Cross-Section H -H'



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28	M35377.069862	NW 27-042-27 W4M	57	M35377.163590	SE 04-043-21 W4M
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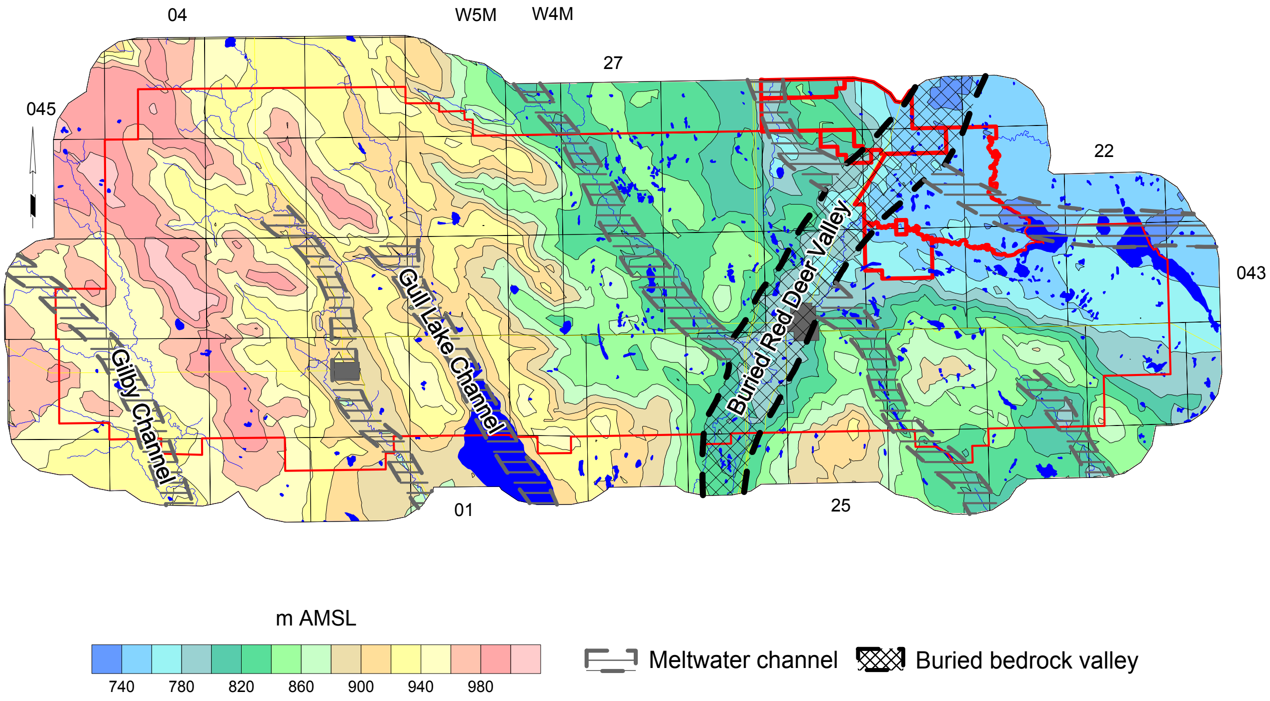
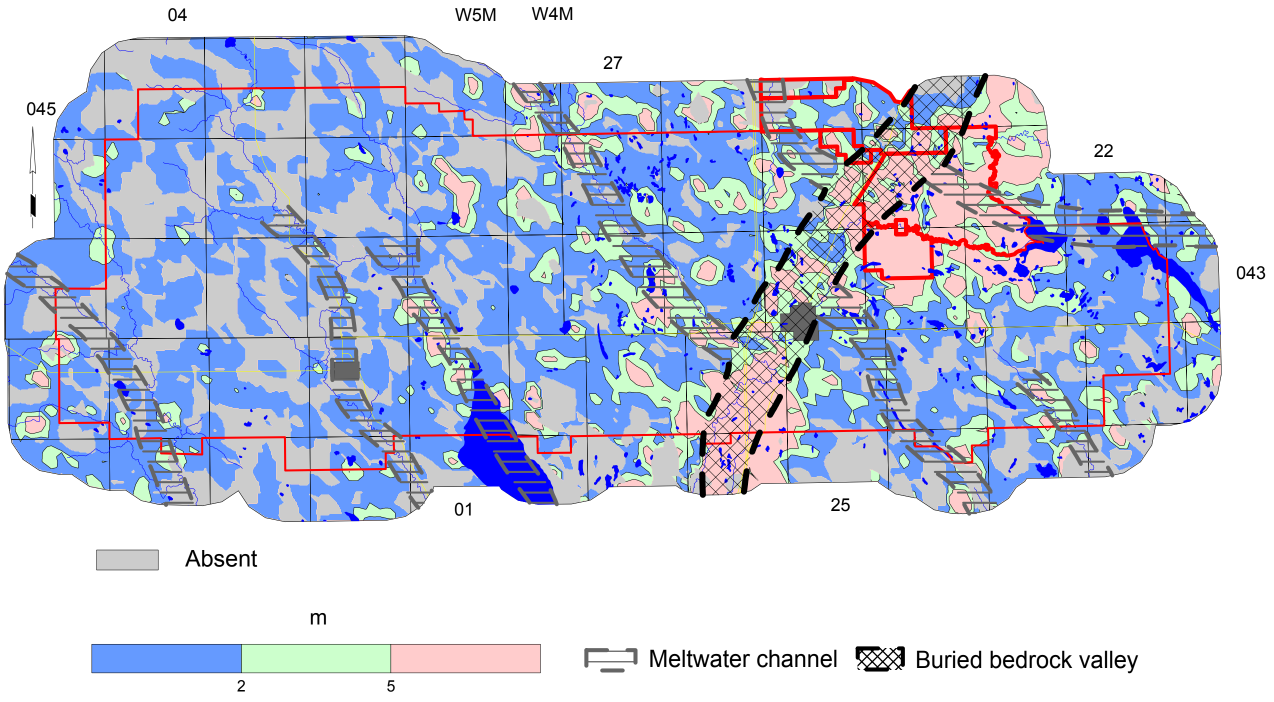
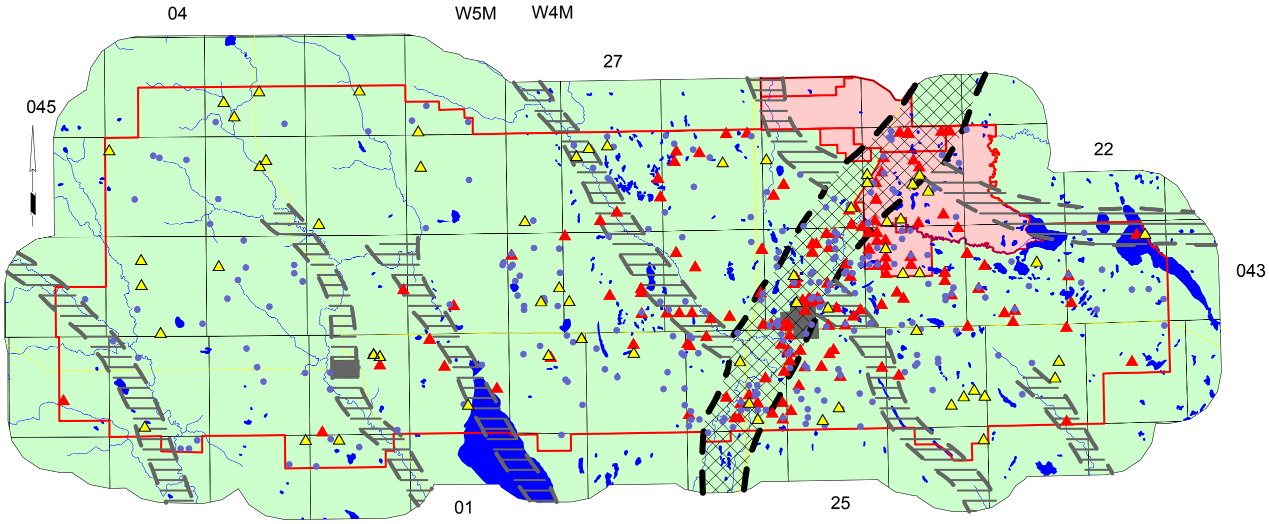
Bedrock Topography



Thickness of Sand and Gravel Deposits



Water Wells Completed in Surficial Deposits

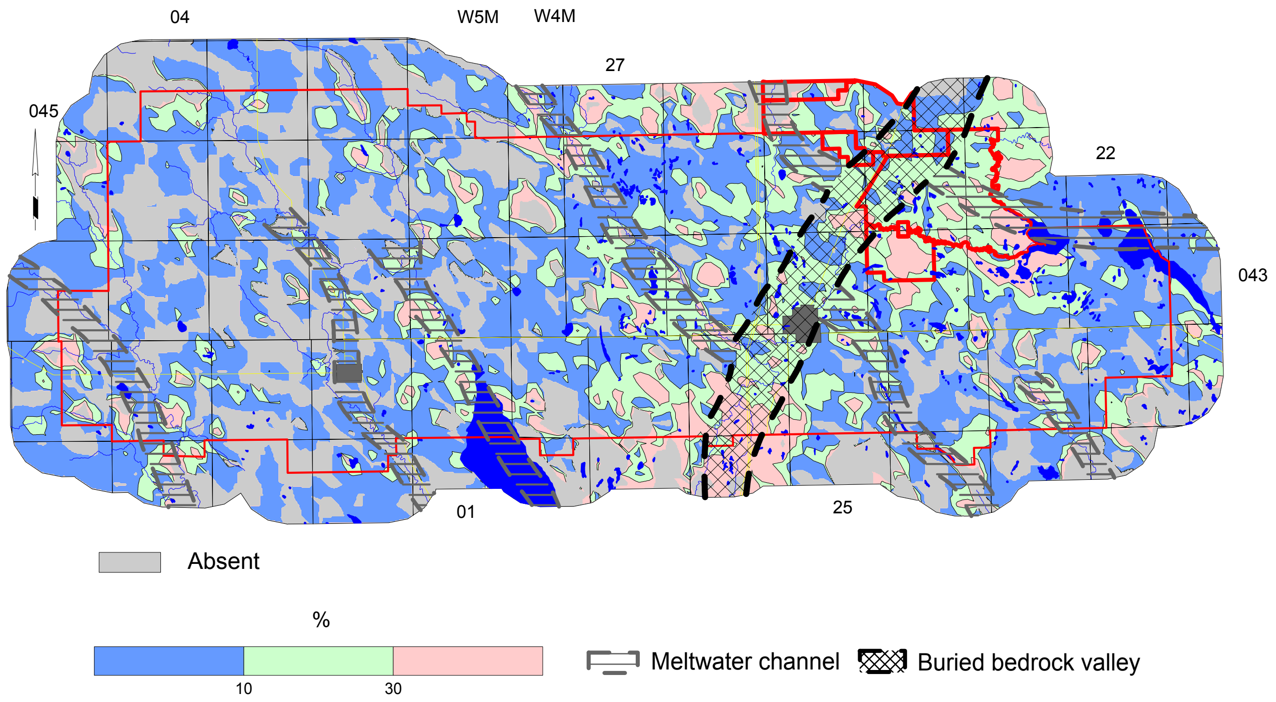


Completed in

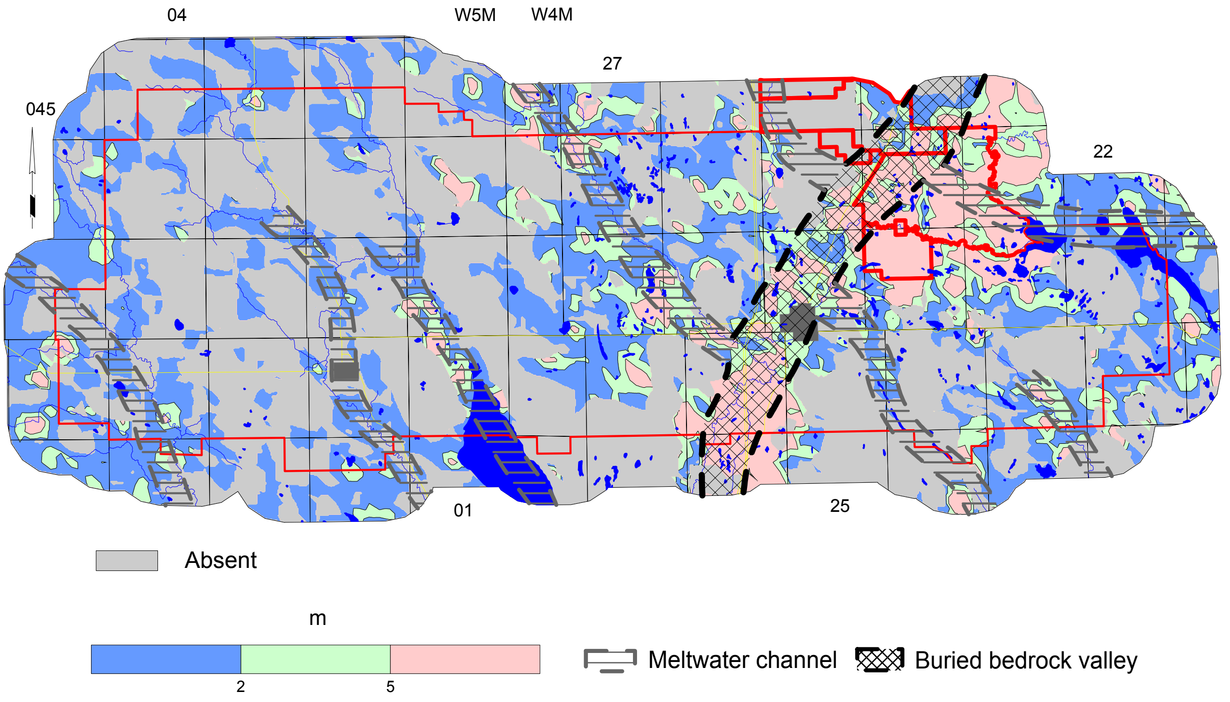
- △ Upper surficial deposits
- ▲ Lower surficial deposits
- ● Multiple surficial deposits

▭ Meltwater channel ▨ Buried bedrock valley

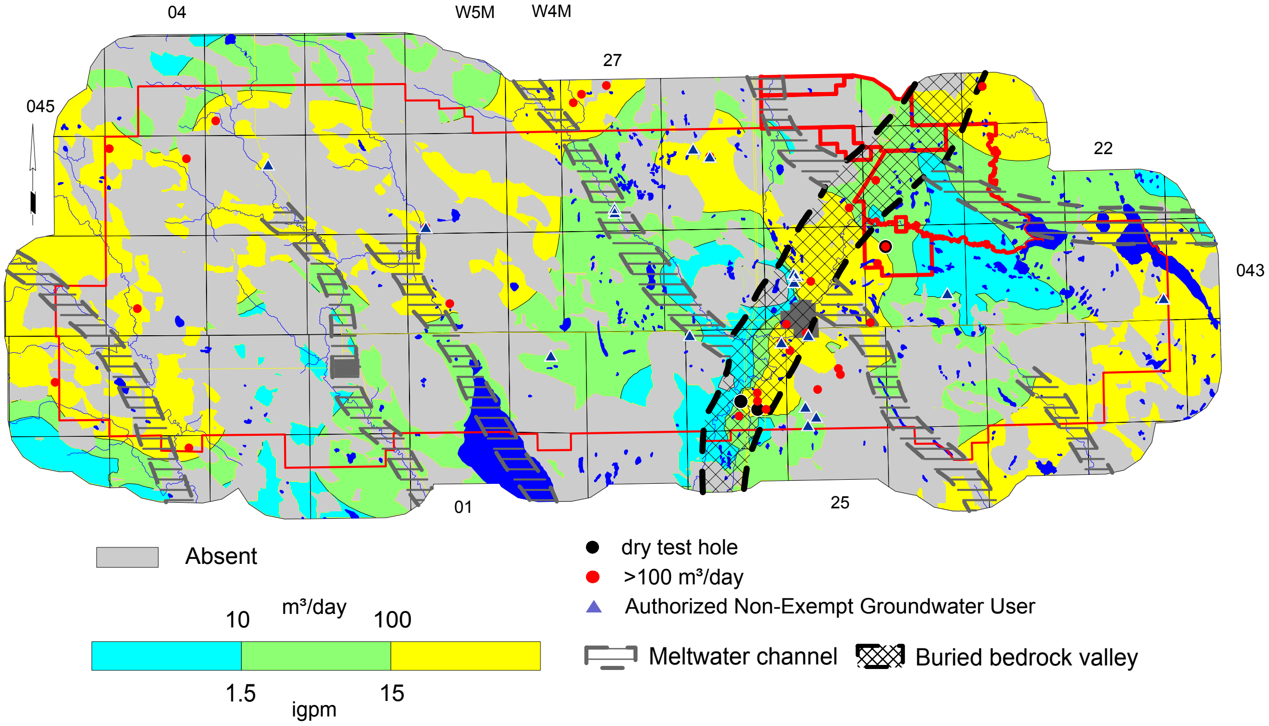
Amount of Sand and Gravel in Surficial Deposits



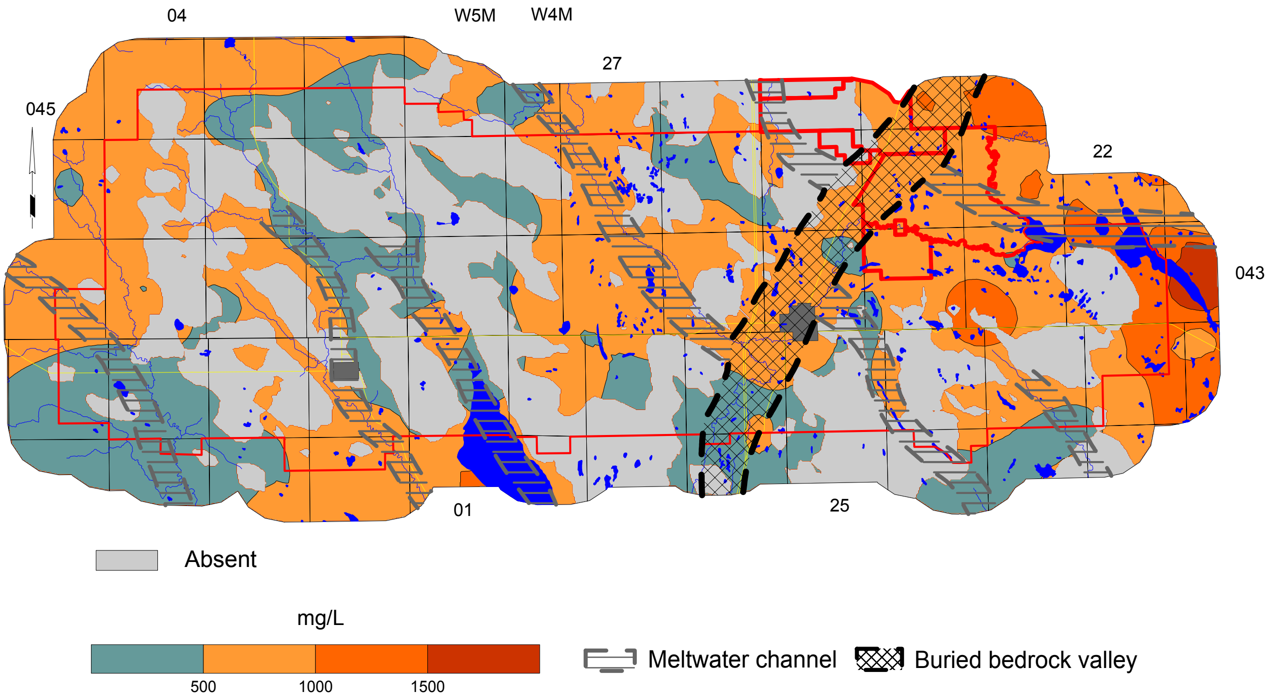
Thickness of Sand and Gravel Aquifer(s)



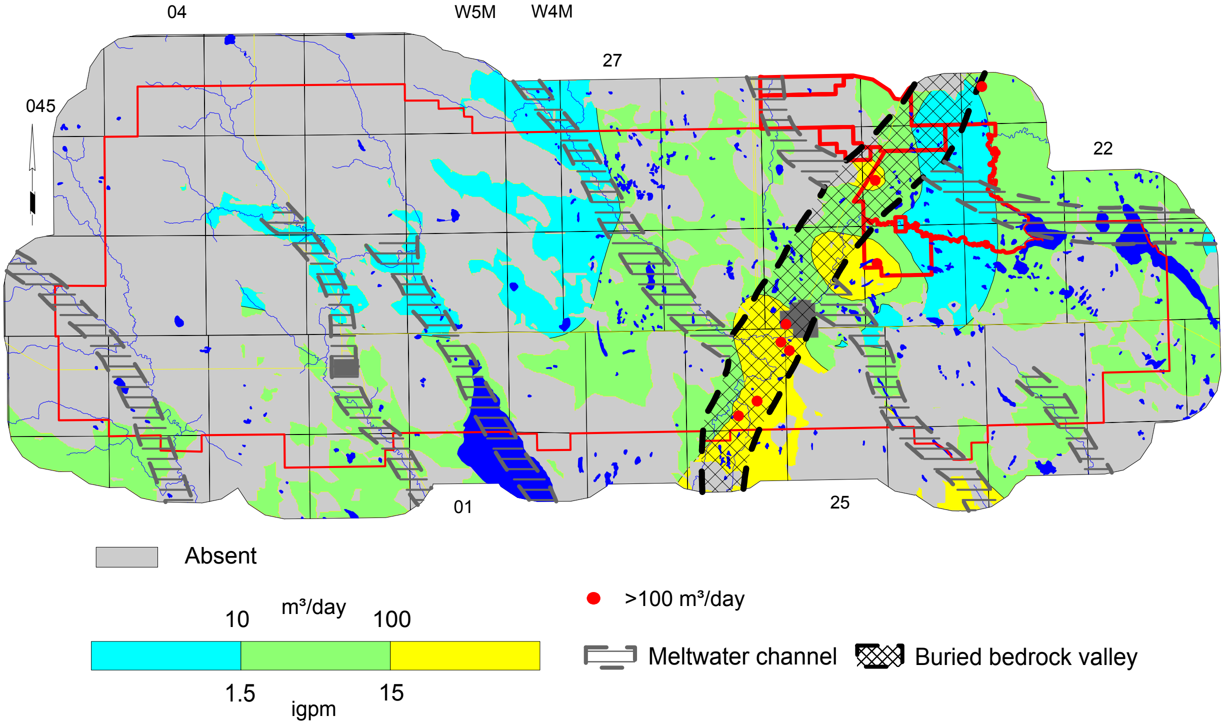
Apparent Yield for Water Wells Completed in Sand and Gravel Aquifer(s)



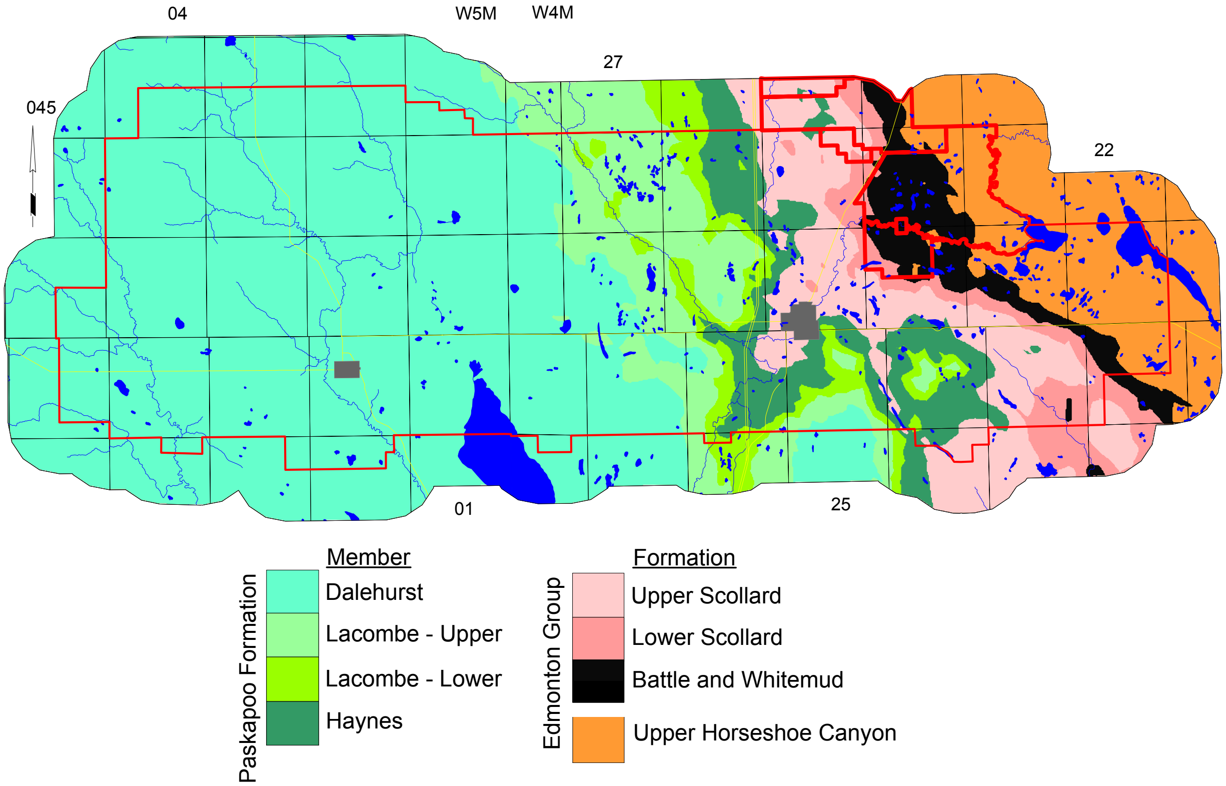
Total Dissolved Solids in Groundwater from Surficial Deposits



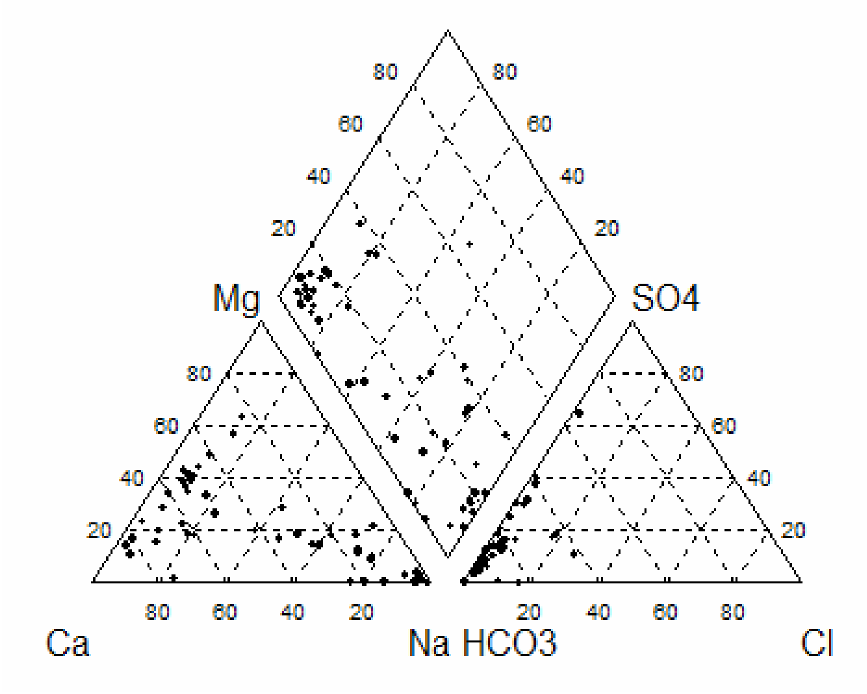
Apparent Yield for Water Wells Completed through Lower Sand and Gravel Aquifer



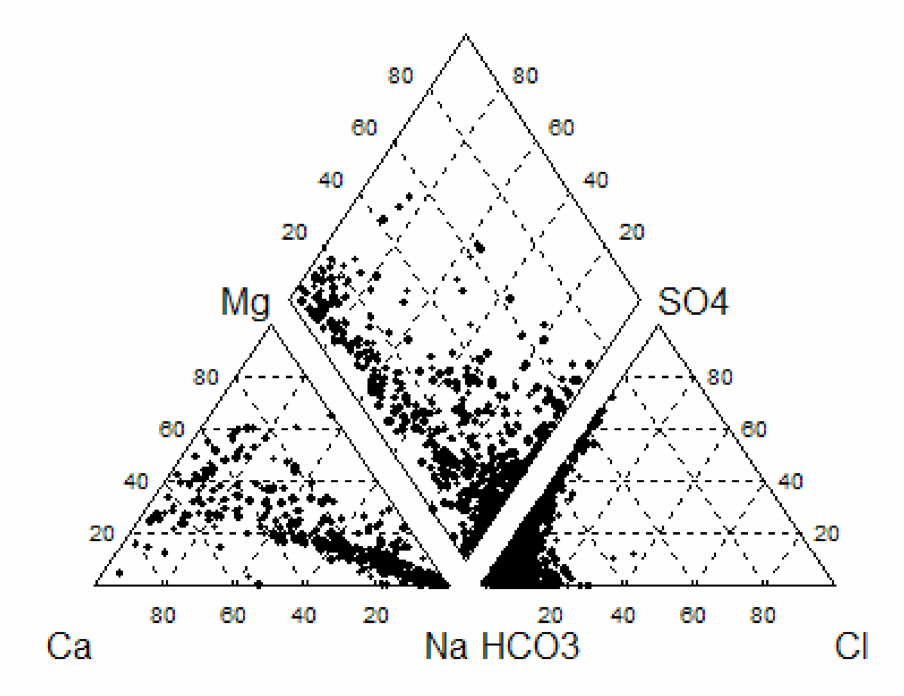
Bedrock Geology



Piper Diagrams

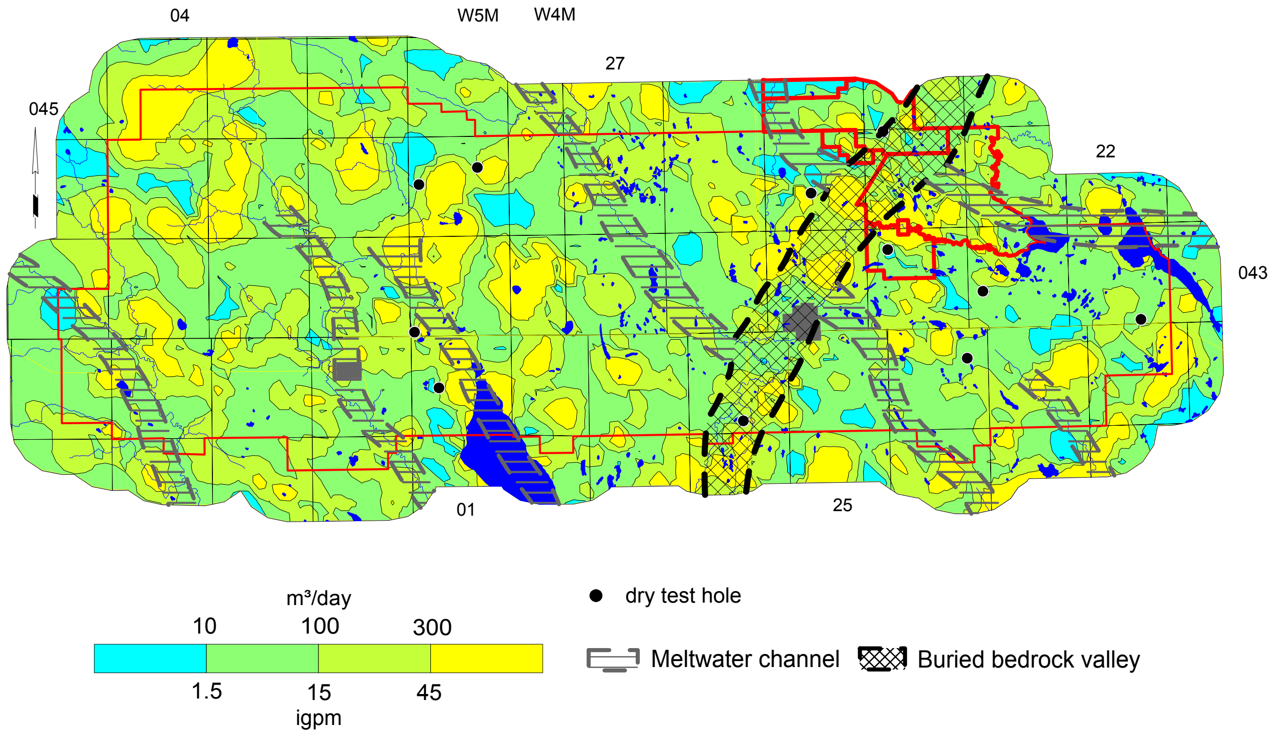


Surficial Deposits

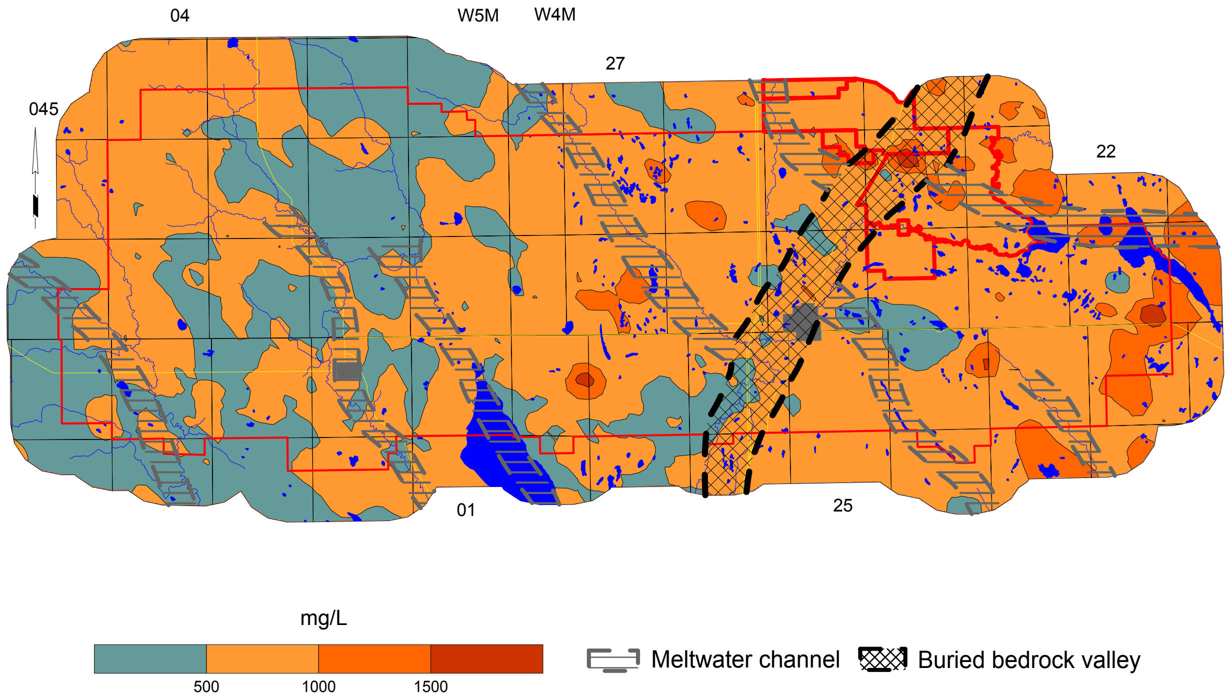


Bedrock Aquifers

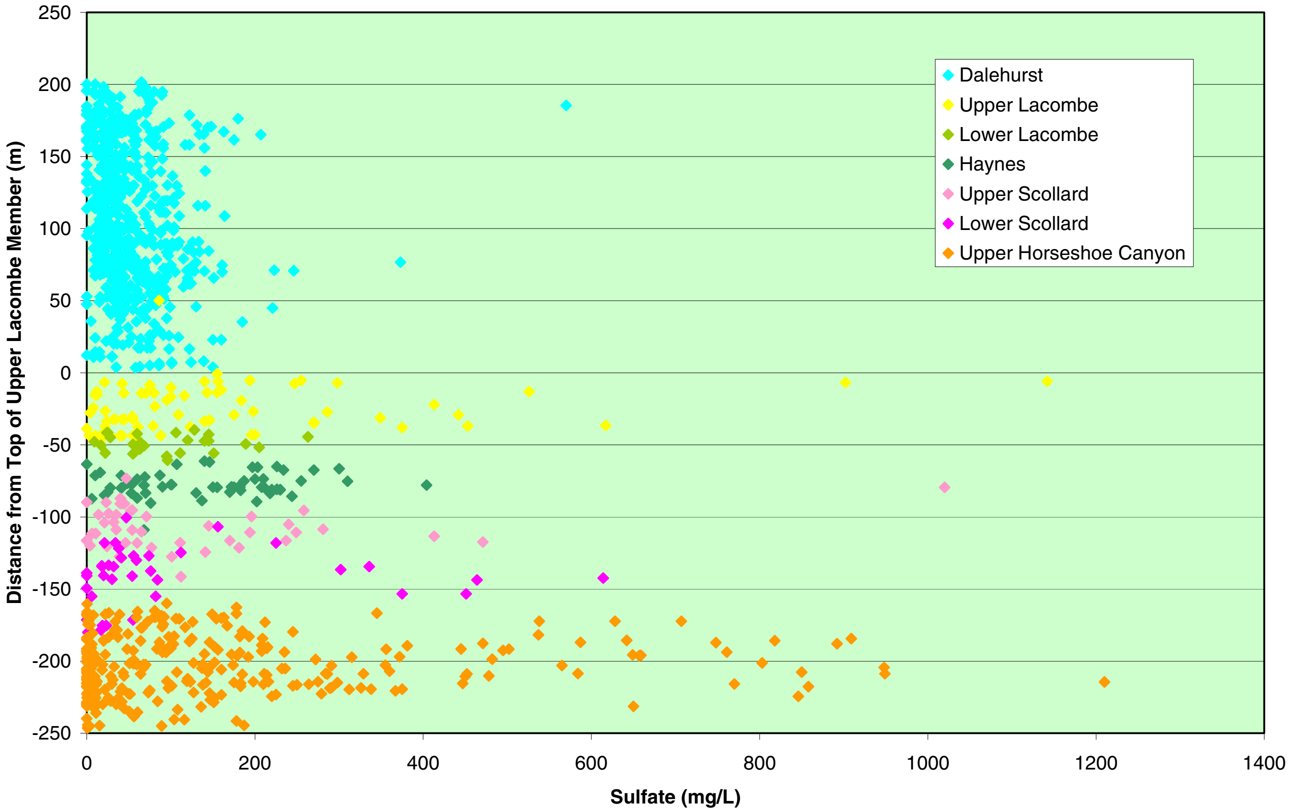
Apparent Yield for Water Wells Completed in Upper Bedrock Aquifer(s)



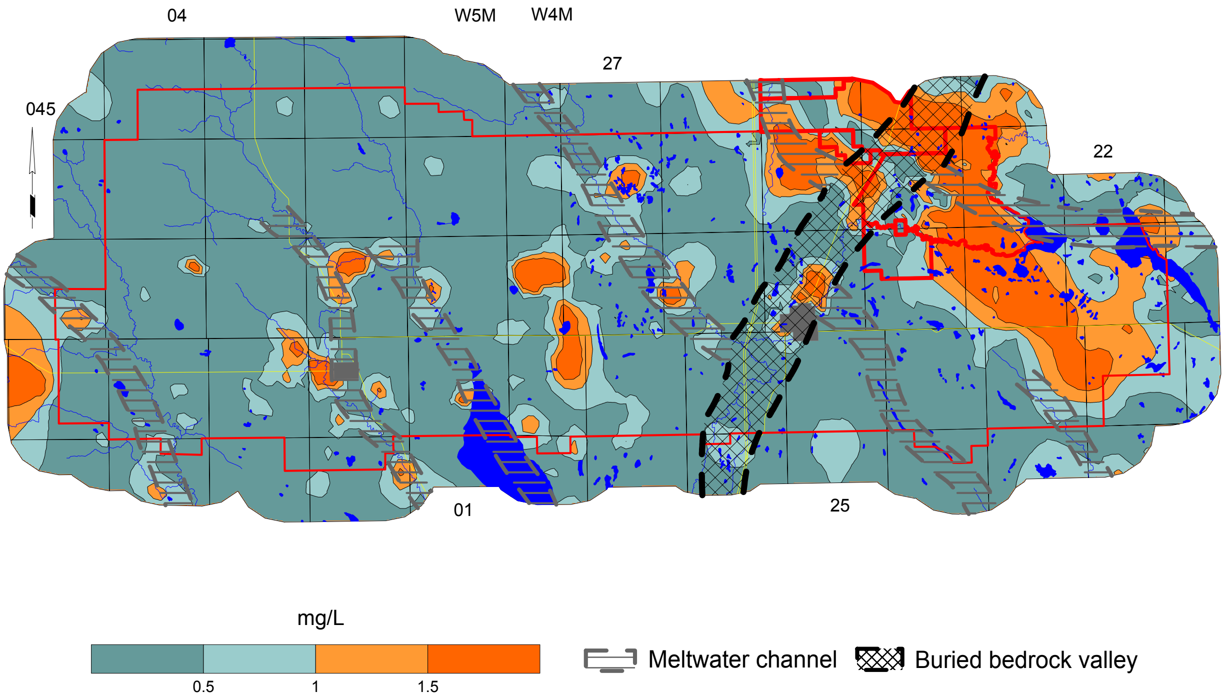
Total Dissolved Solids in Groundwater from Upper Bedrock Aquifer(s)



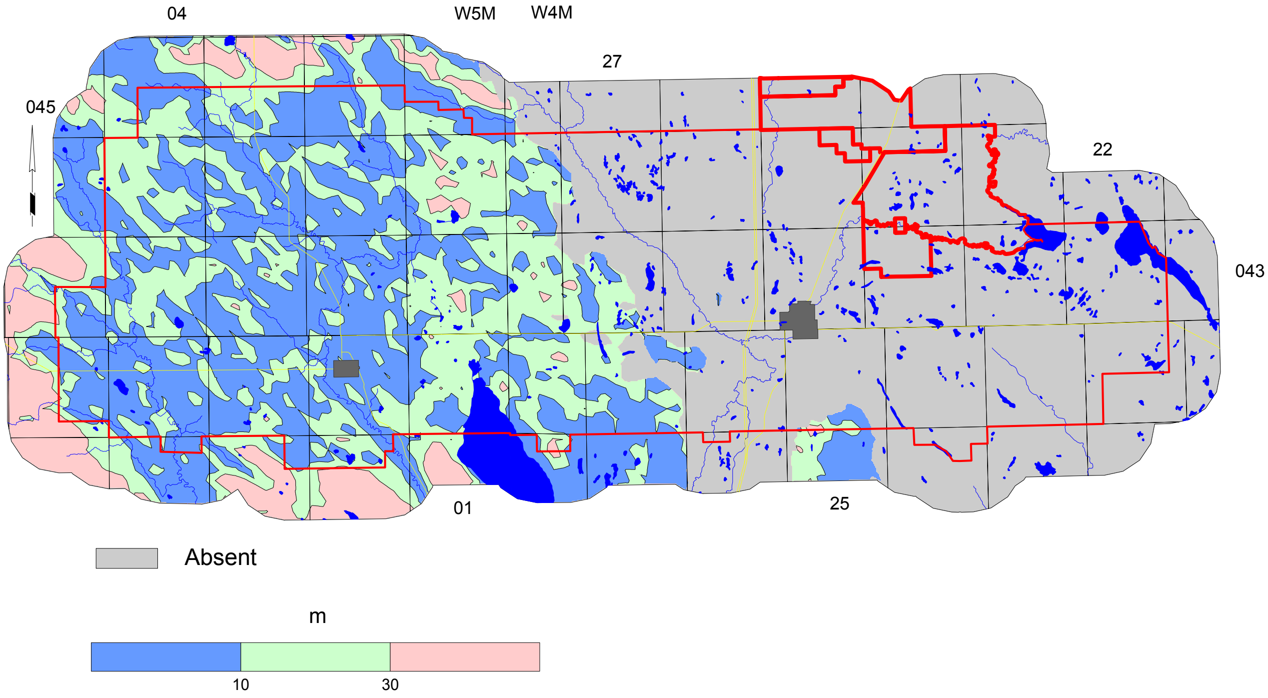
Distance from Top of Upper Lacombe Member vs. Sulfate in Groundwater from Upper Bedrock Aquifer(s)



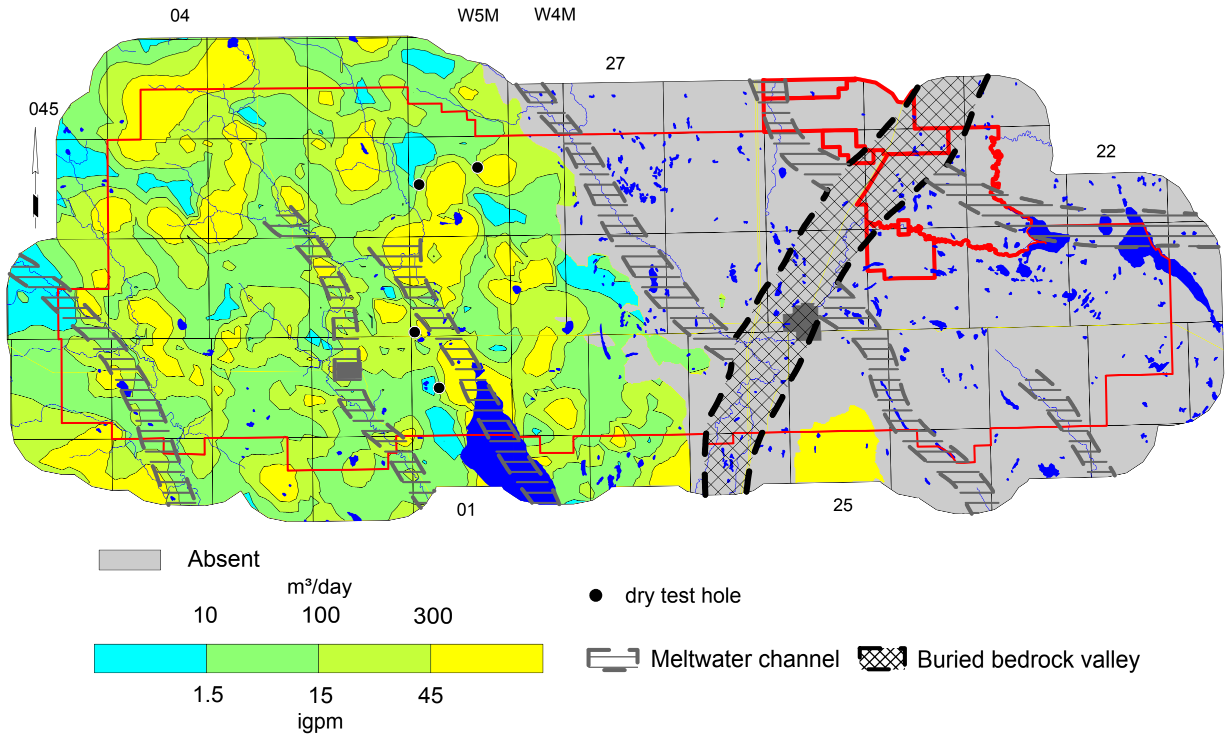
Fluoride in Groundwater from Upper Bedrock Aquifer(s)



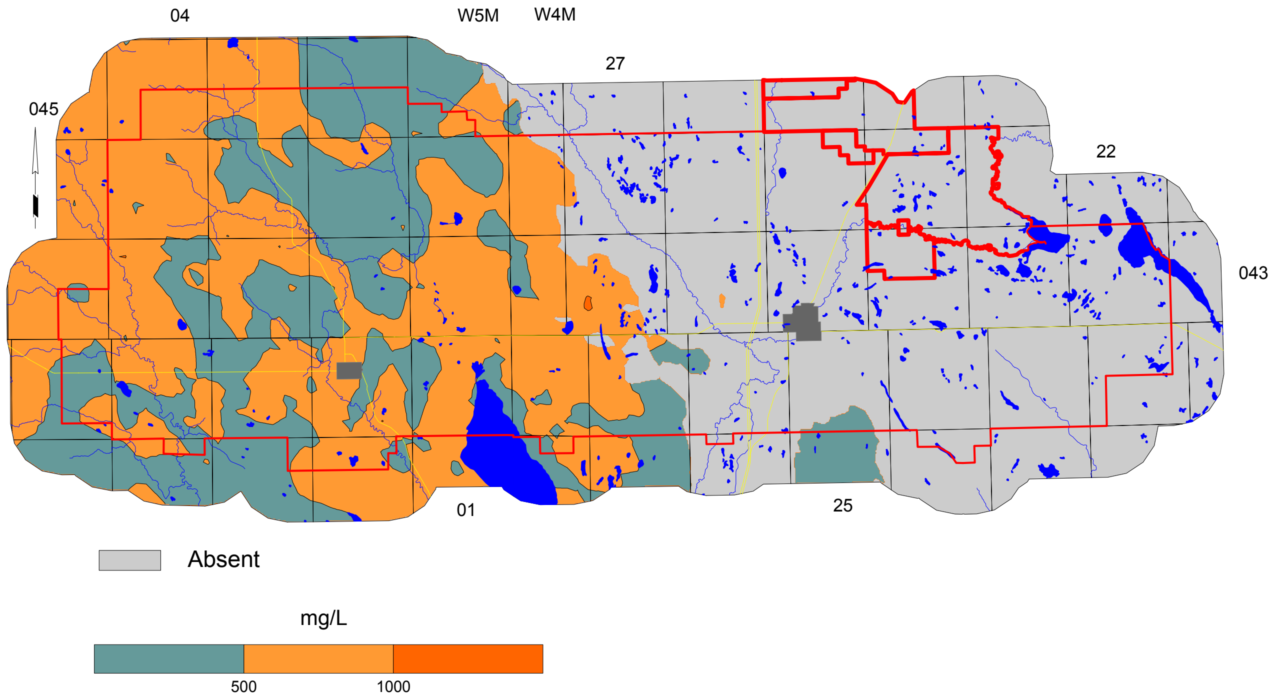
Depth to Top of Dalehurst Member



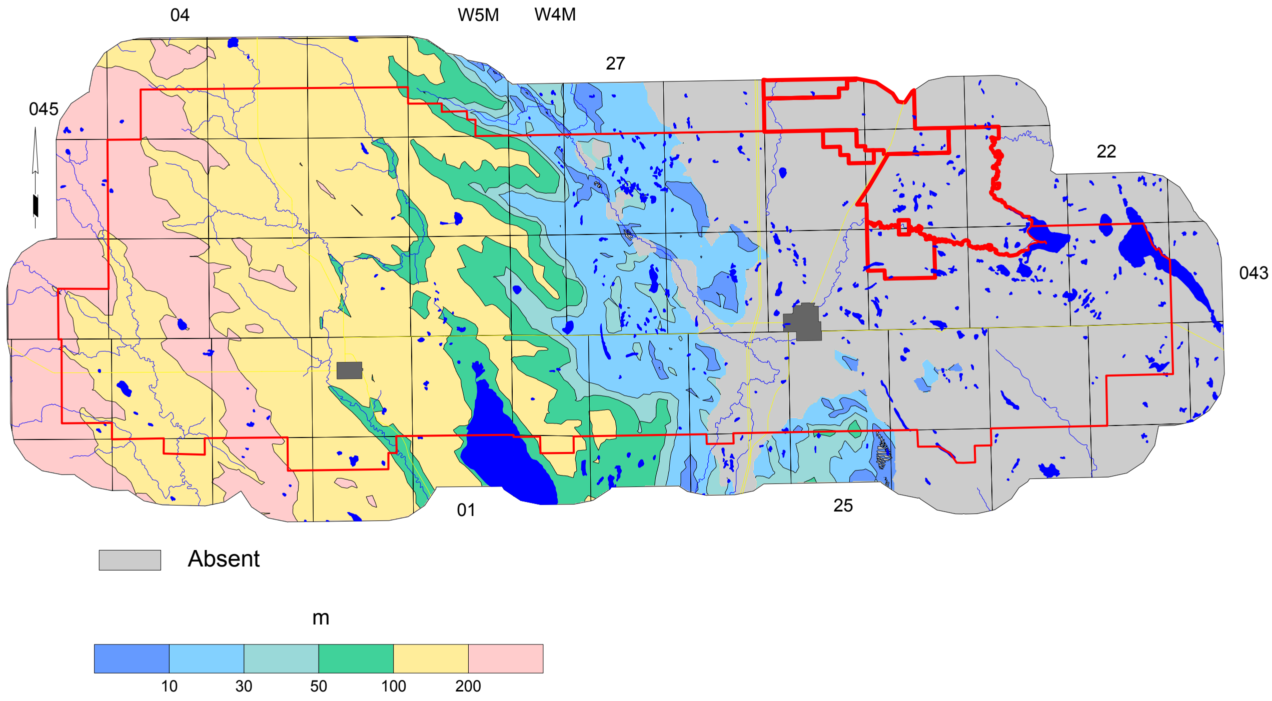
Apparent Yield for Water Wells Completed through Dalehurst Aquifer



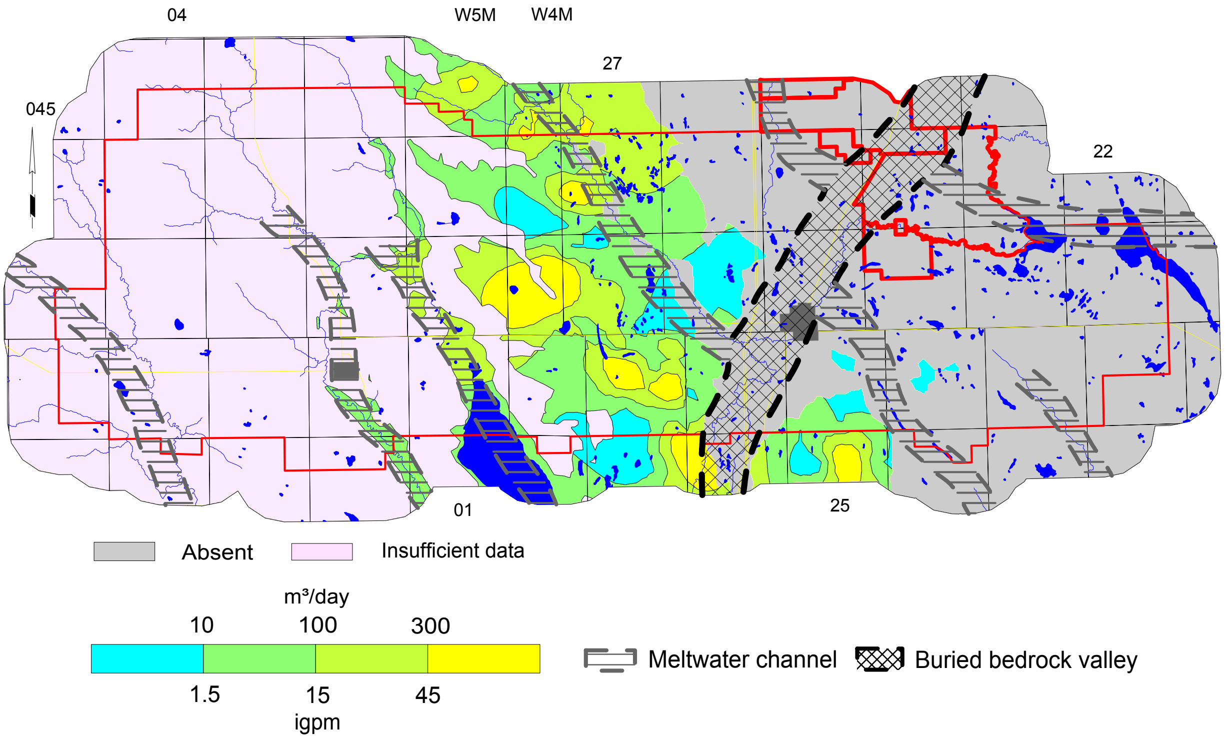
Total Dissolved Solids in Groundwater from Dalehurst Aquifer



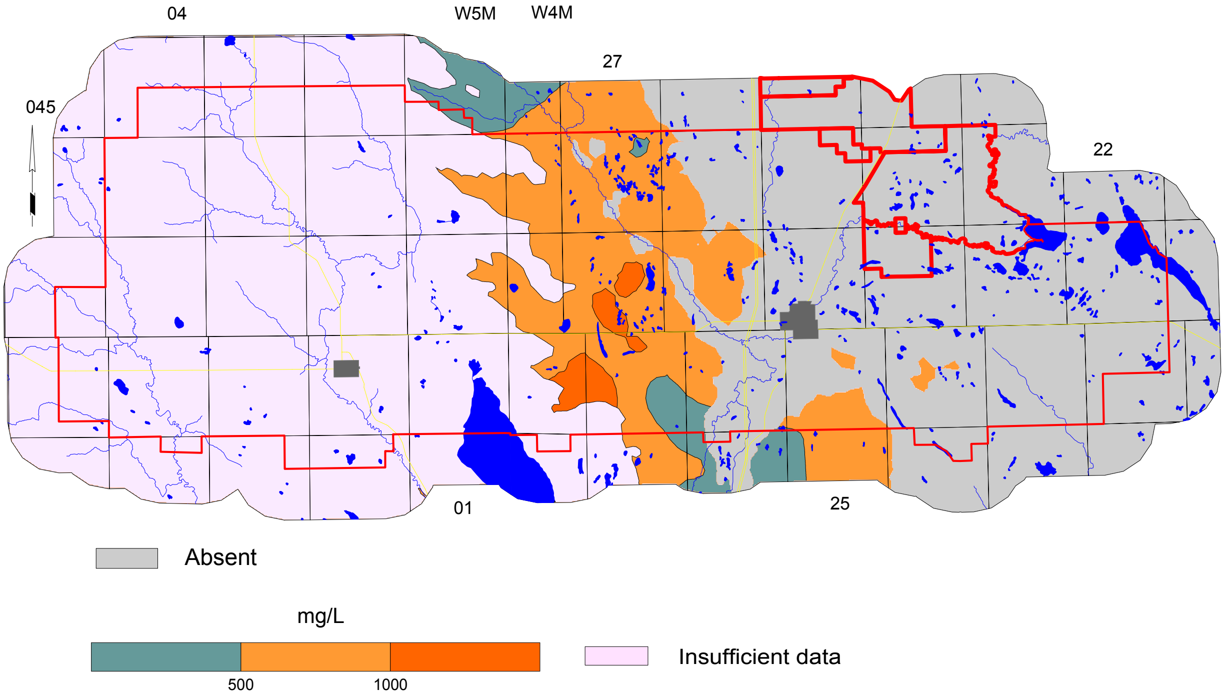
Depth to Top of Upper Lacombe Member



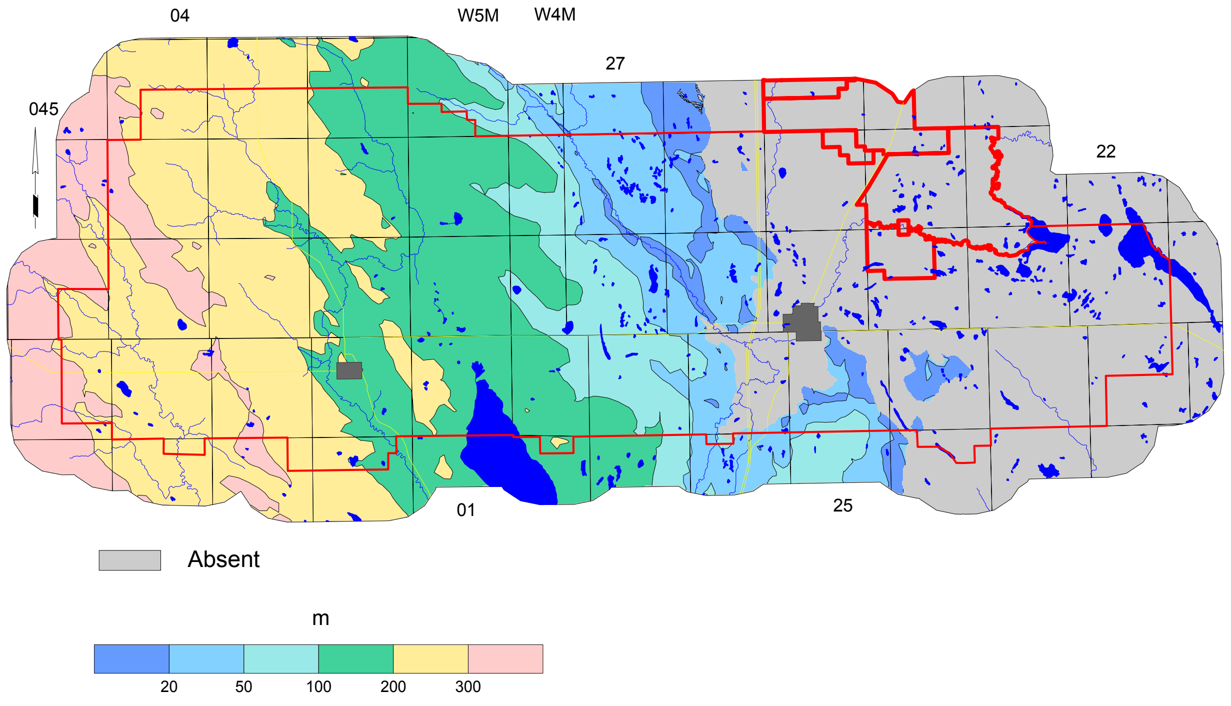
Apparent Yield for Water Wells Completed through Upper Lacombe Aquifer



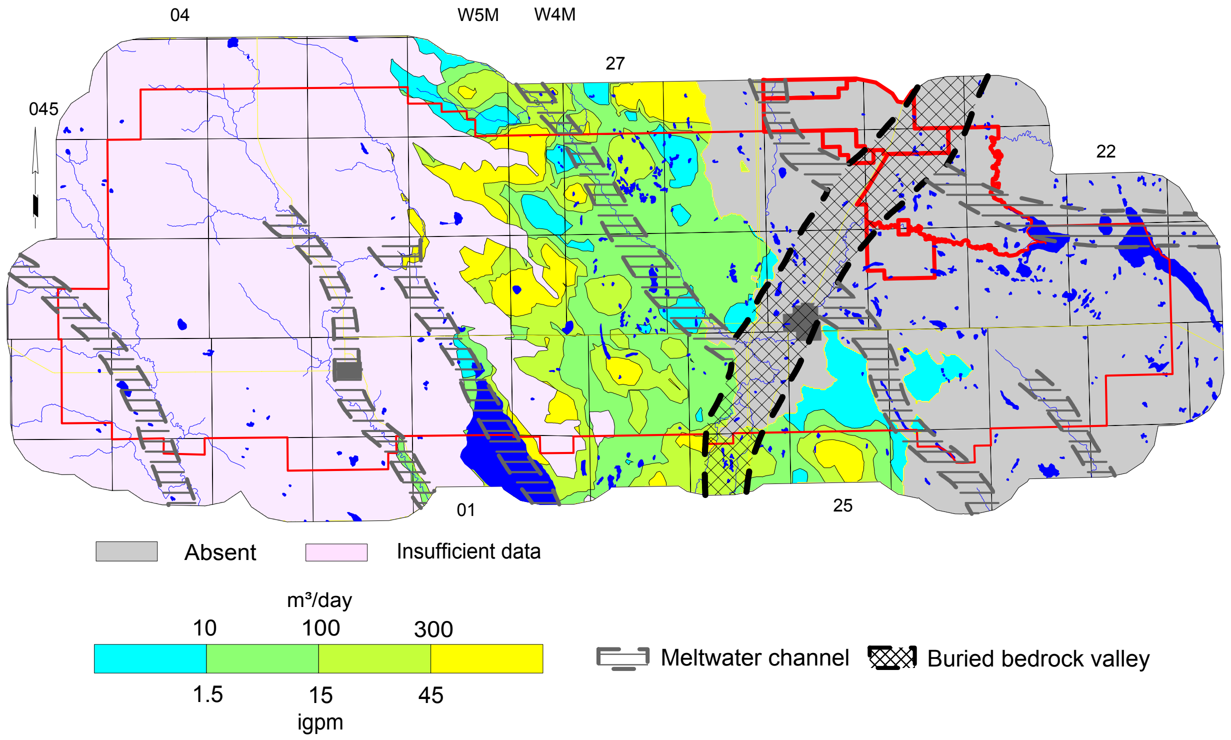
Total Dissolved Solids in Groundwater from Upper Lacombe Aquifer



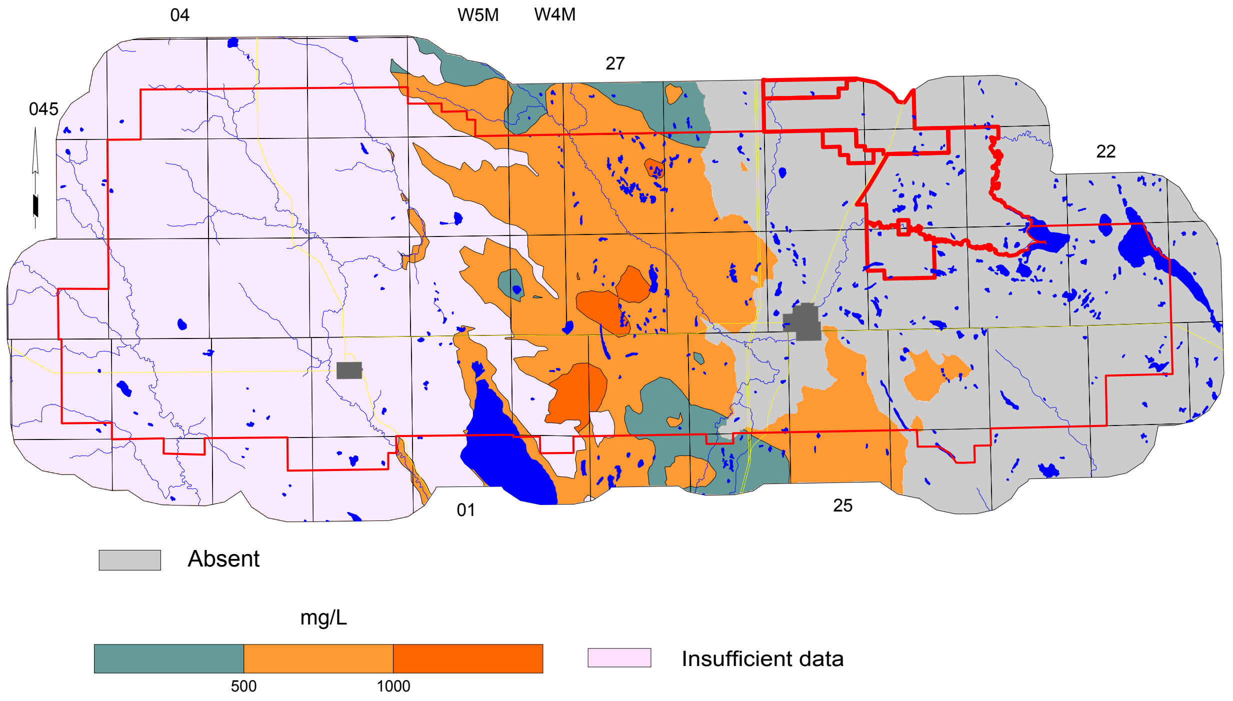
Depth to Top of Lower Lacombe Member



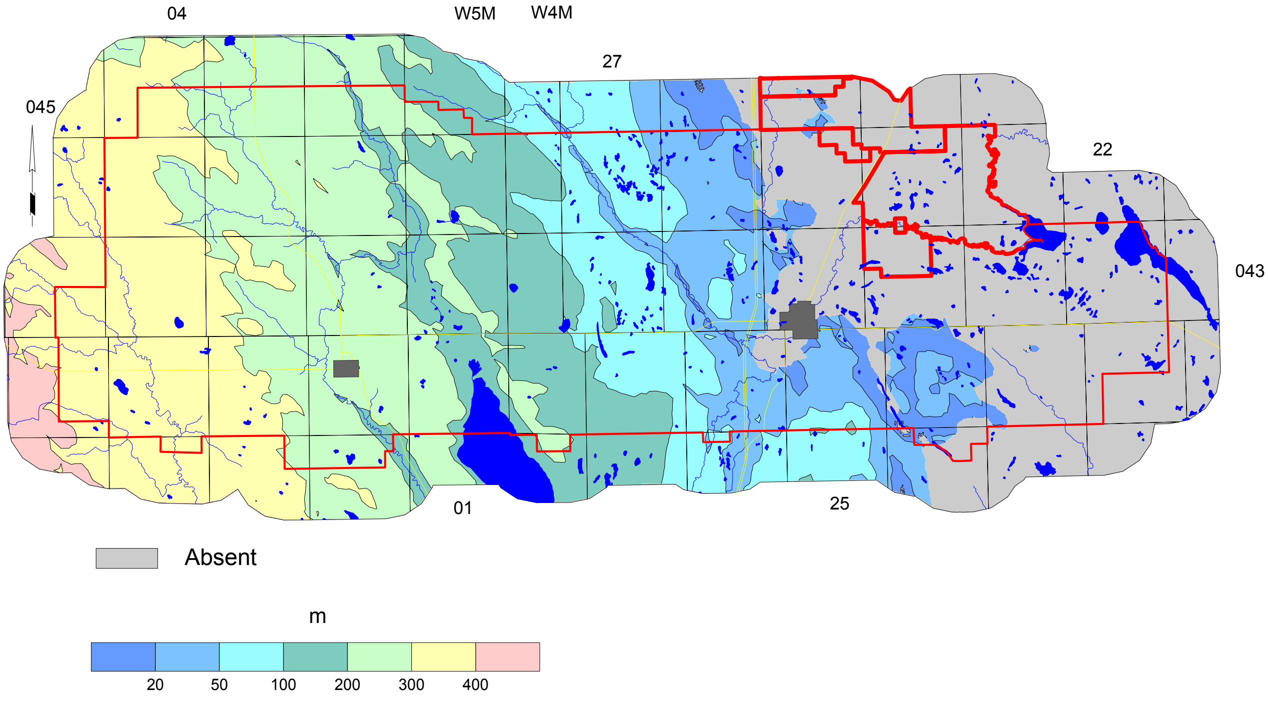
Apparent Yield for Water Wells Completed through Lower Lacombe Aquifer



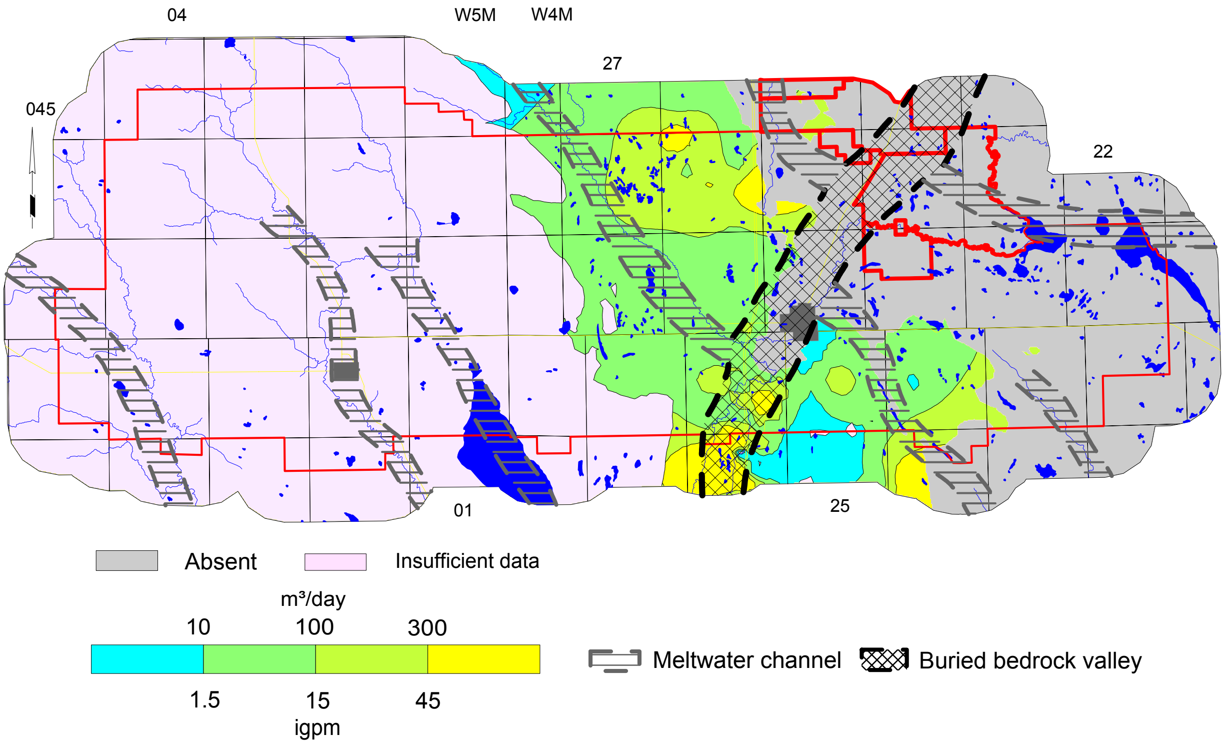
Total Dissolved Solids in Groundwater from Lower Lacombe Aquifer



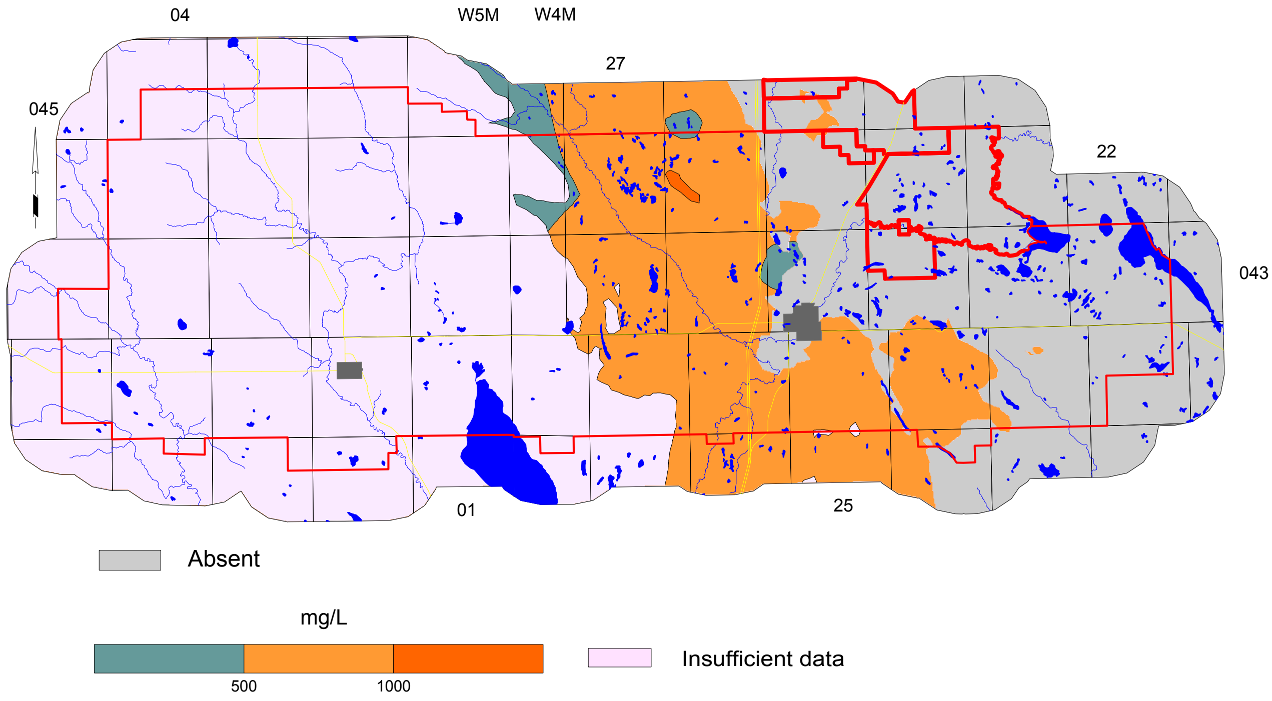
Depth to Top of Haynes Member



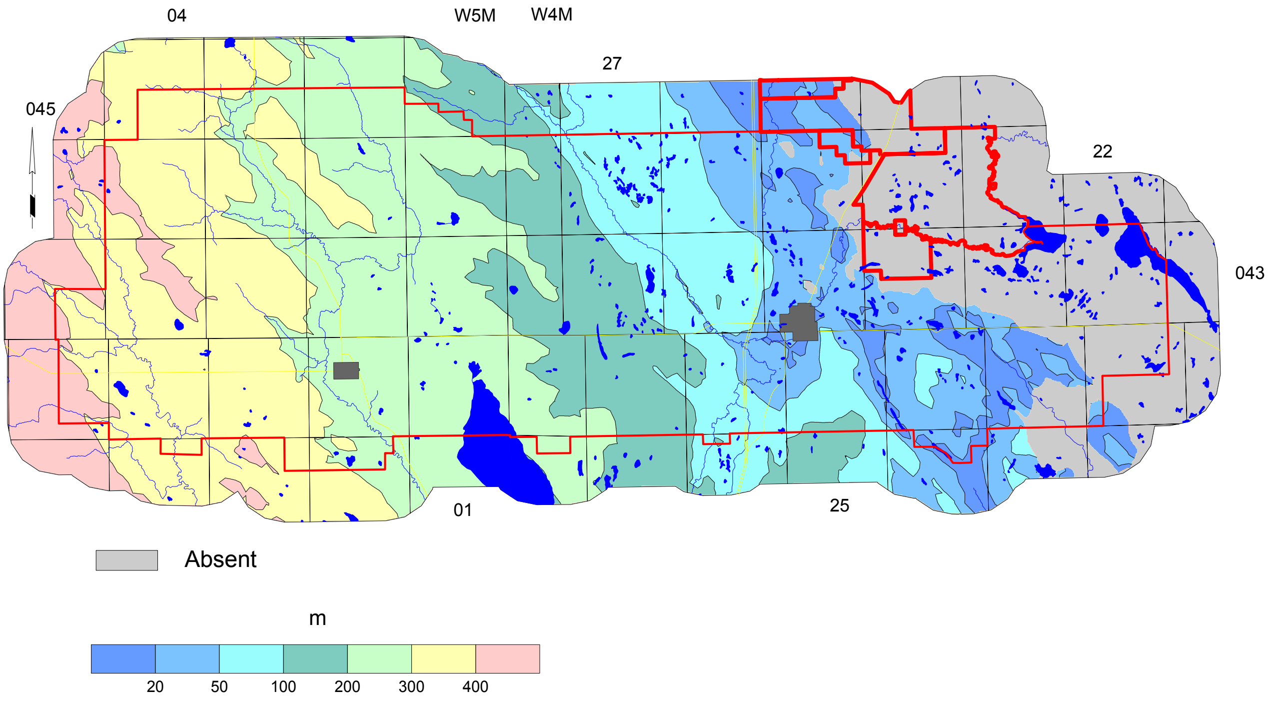
Apparent Yield for Water Wells Completed through Haynes Aquifer



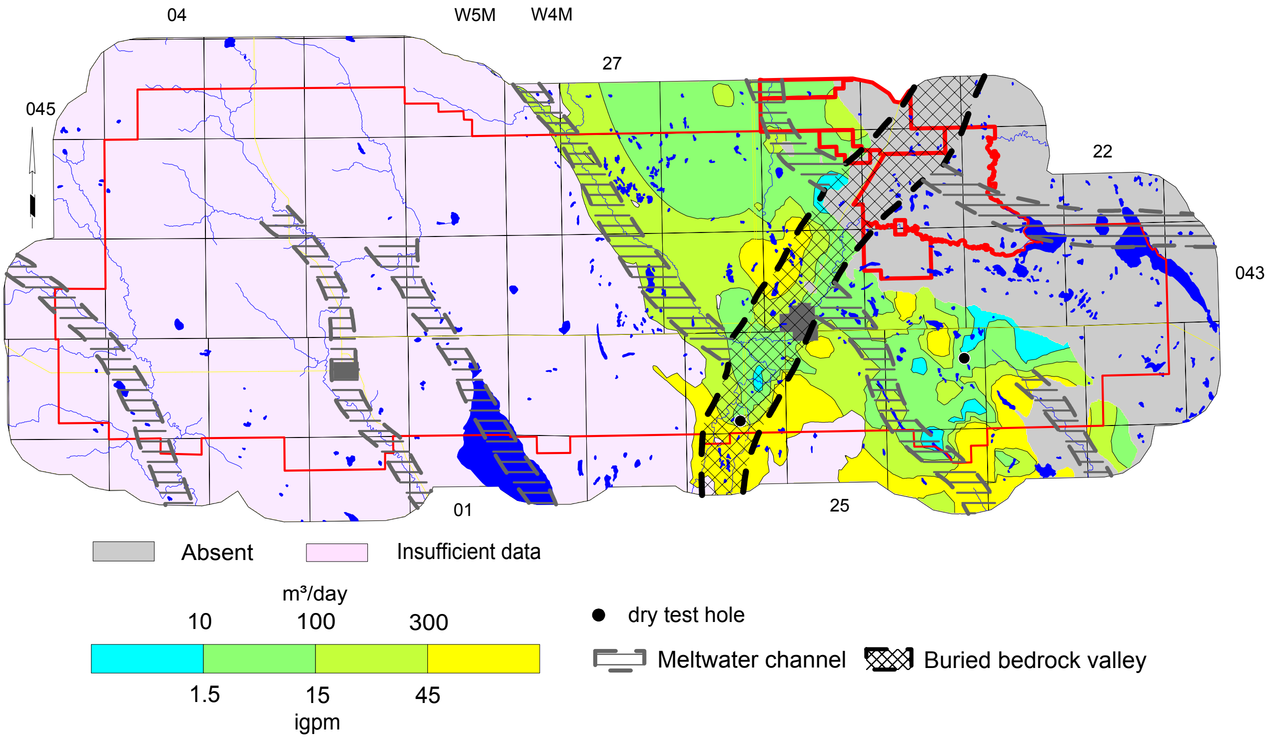
Total Dissolved Solids in Groundwater from Haynes Aquifer



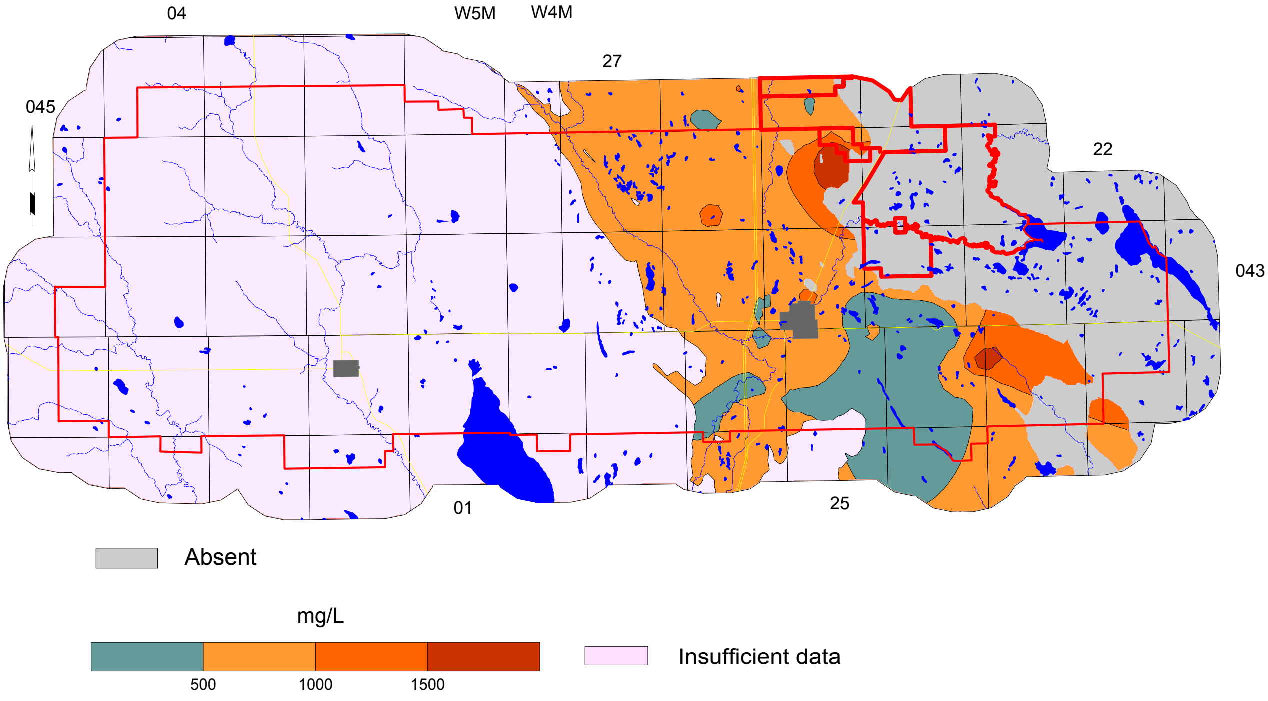
Depth to Top of Upper Scollard Formation



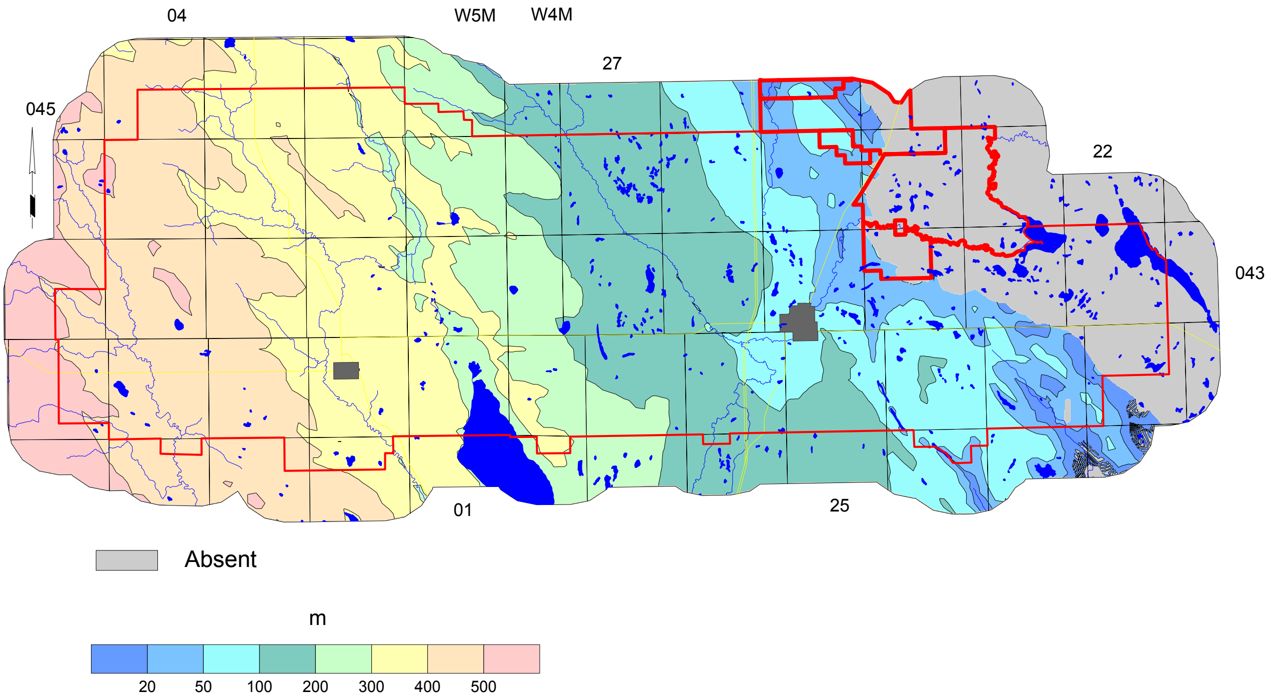
Apparent Yield for Water Wells Completed through Upper Scollard Aquifer



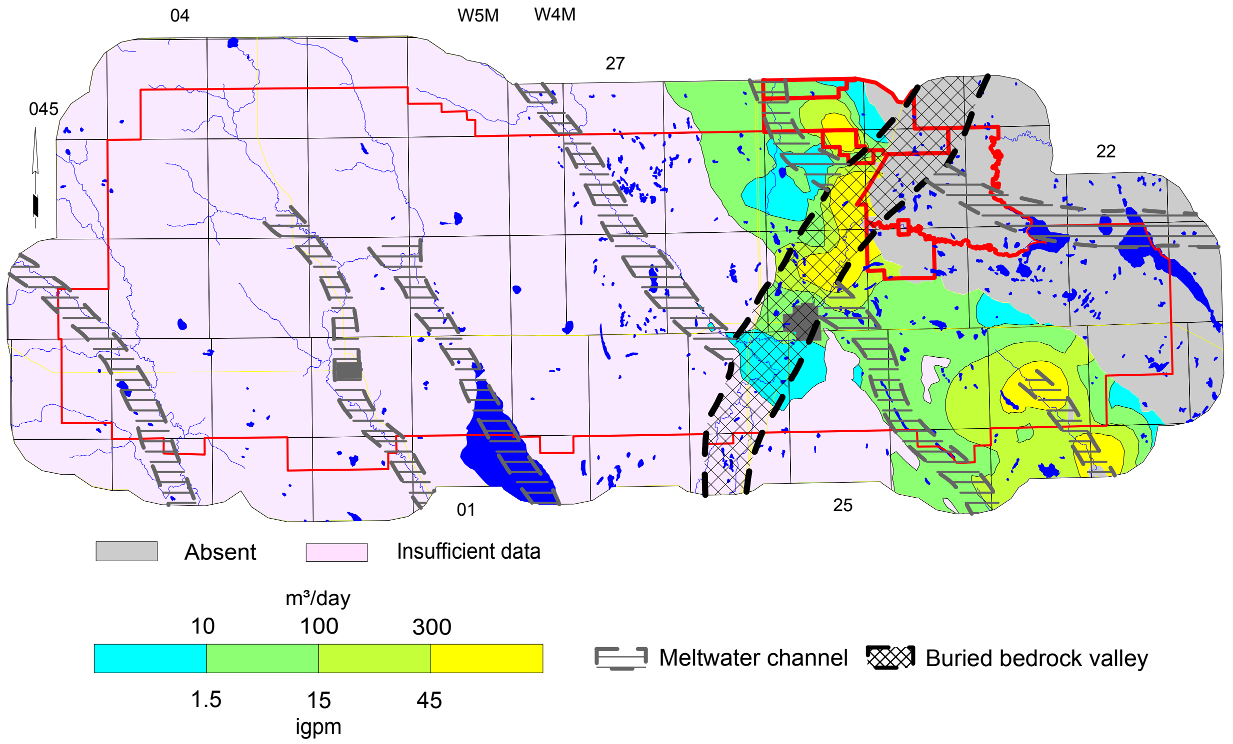
Total Dissolved Solids in Groundwater from Upper Scollard Aquifer



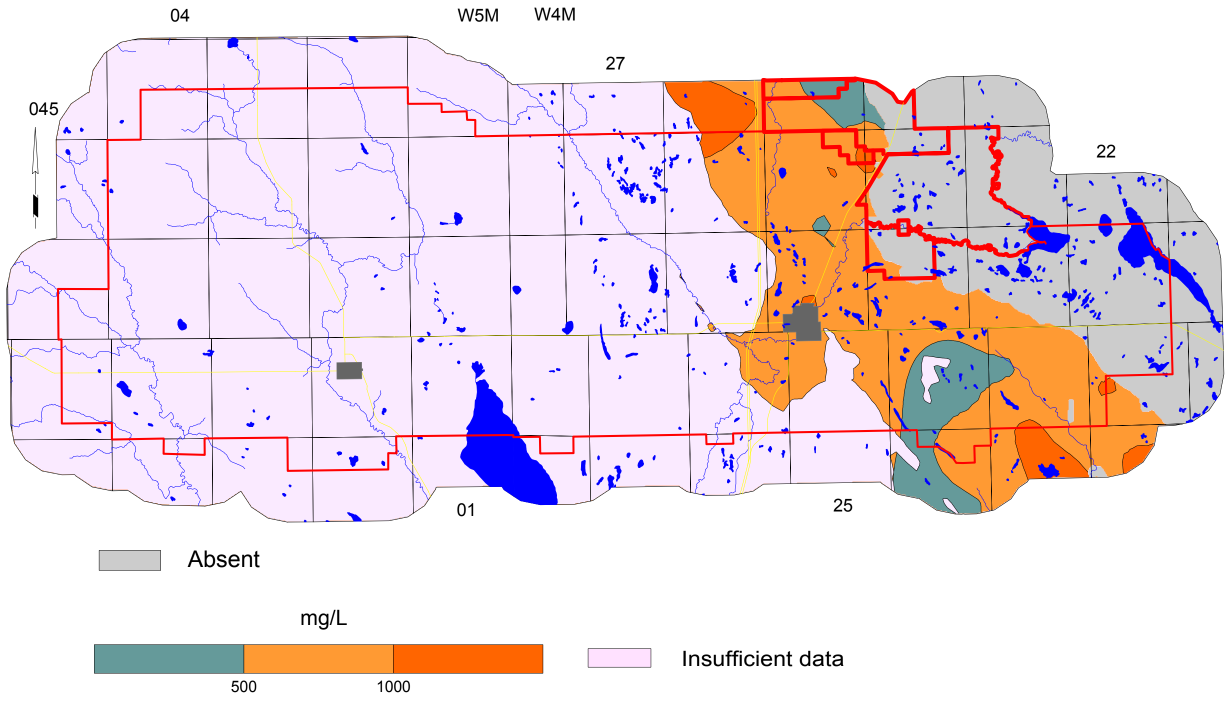
Depth to Top of Lower Scollard Formation



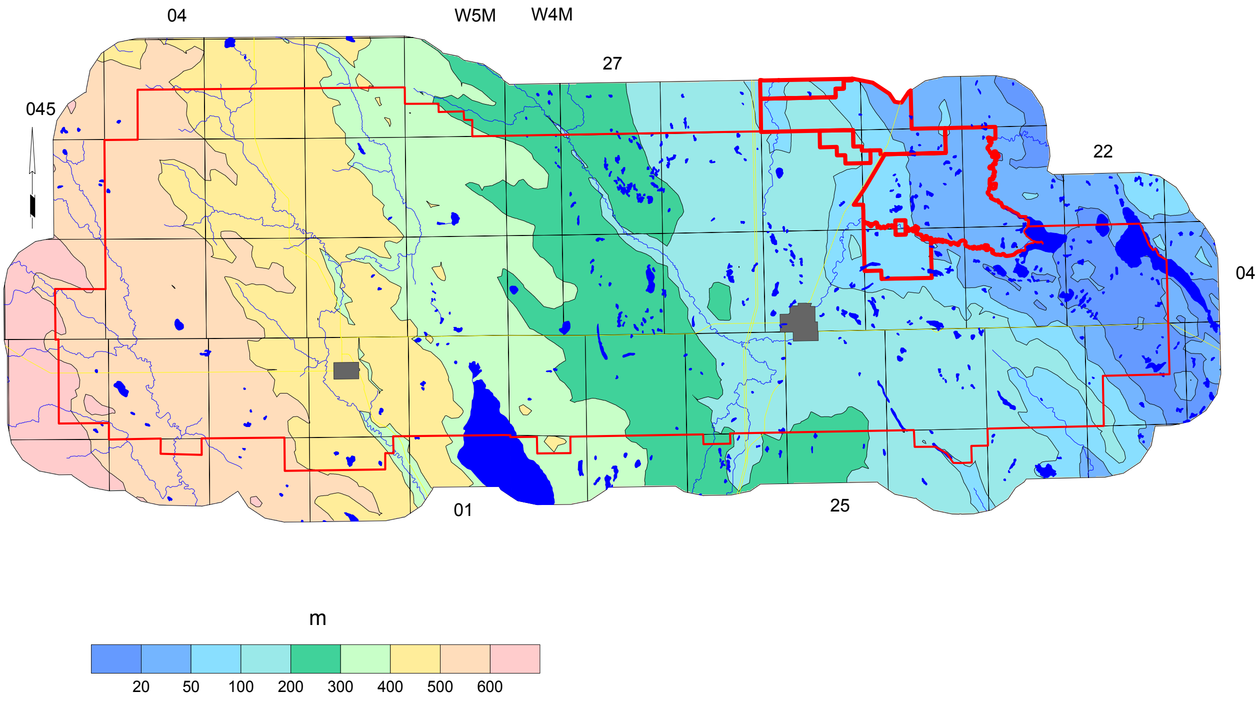
Apparent Yield for Water Wells Completed through Lower Scollard Aquifer



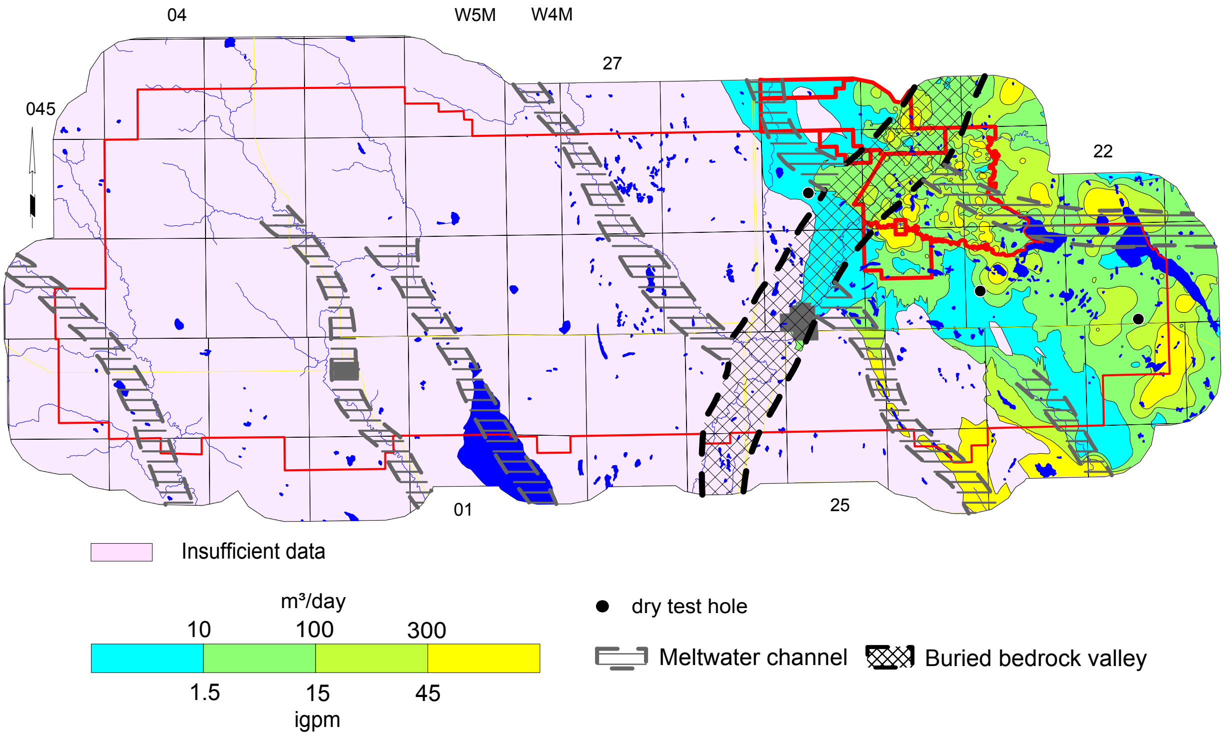
Total Dissolved Solids in Groundwater from Lower Scollard Aquifer



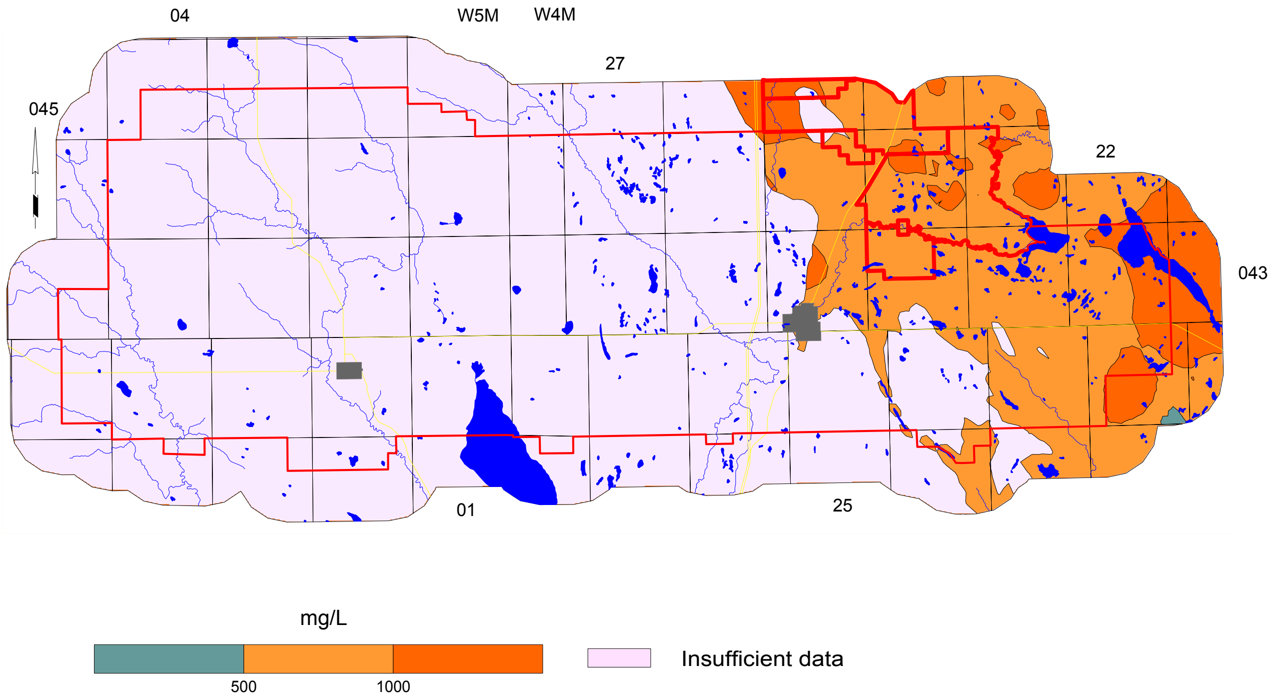
Depth to Top of Upper Horseshoe Canyon Formation



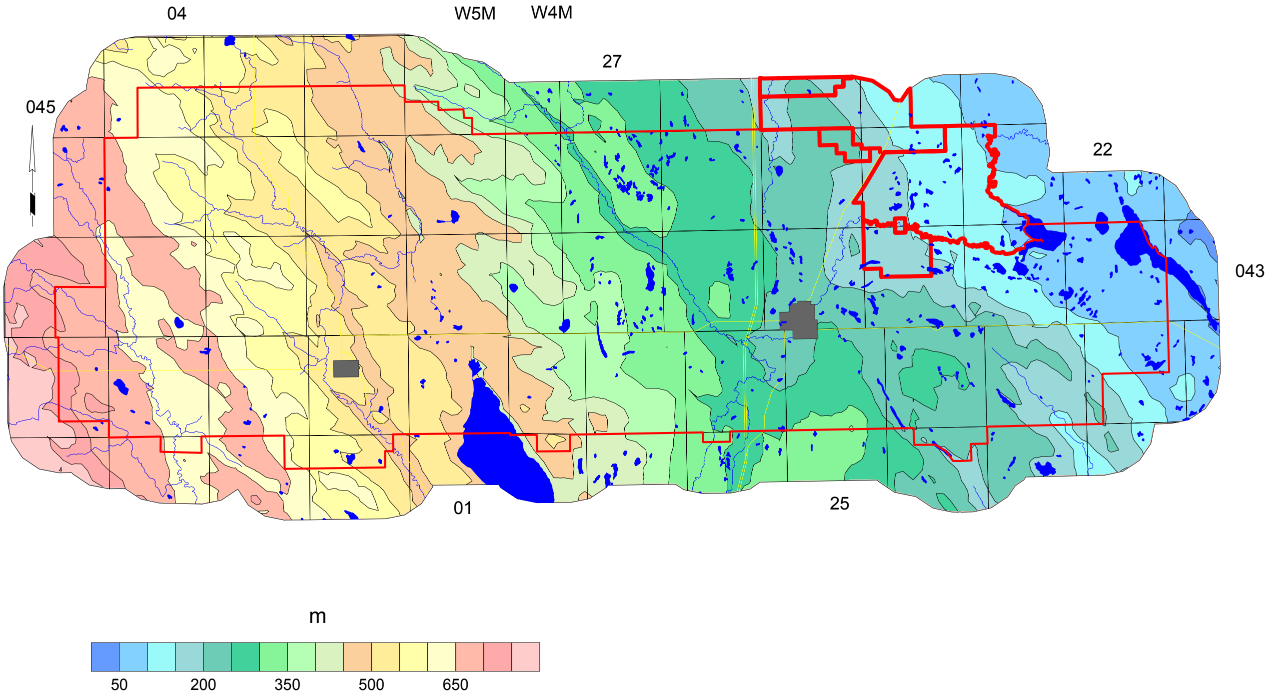
Apparent Yield for Water Wells Completed through Upper Horseshoe Canyon Aquifer



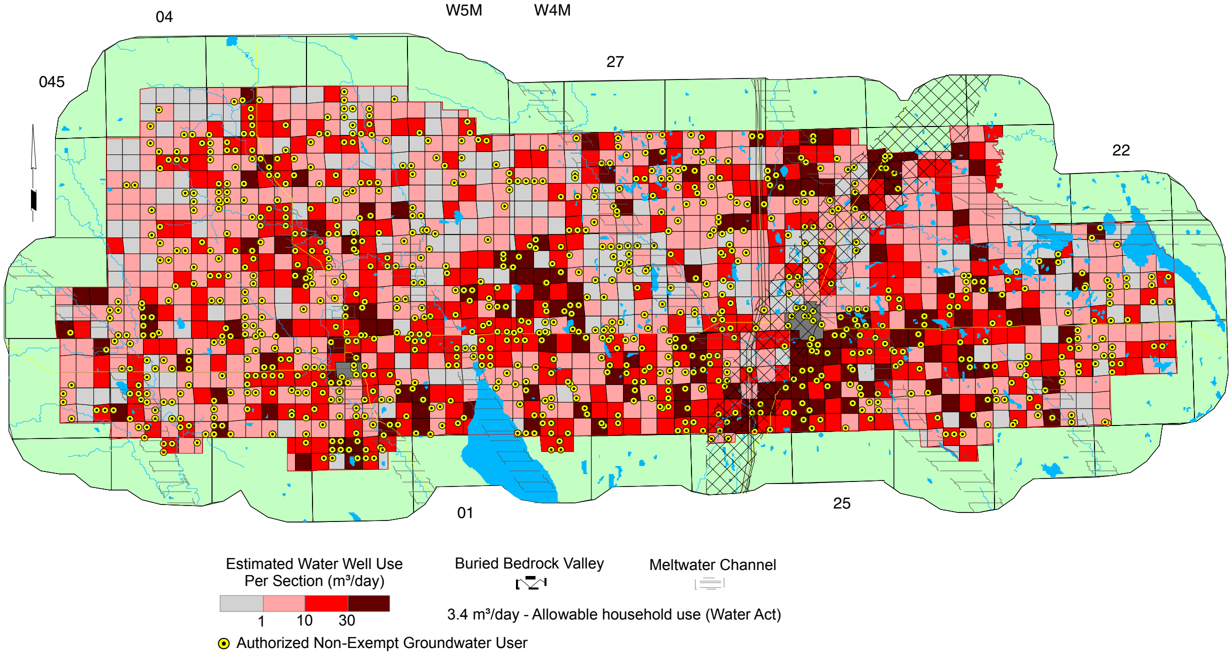
Total Dissolved Solids in Groundwater from Upper Horseshoe Canyon Aquifer



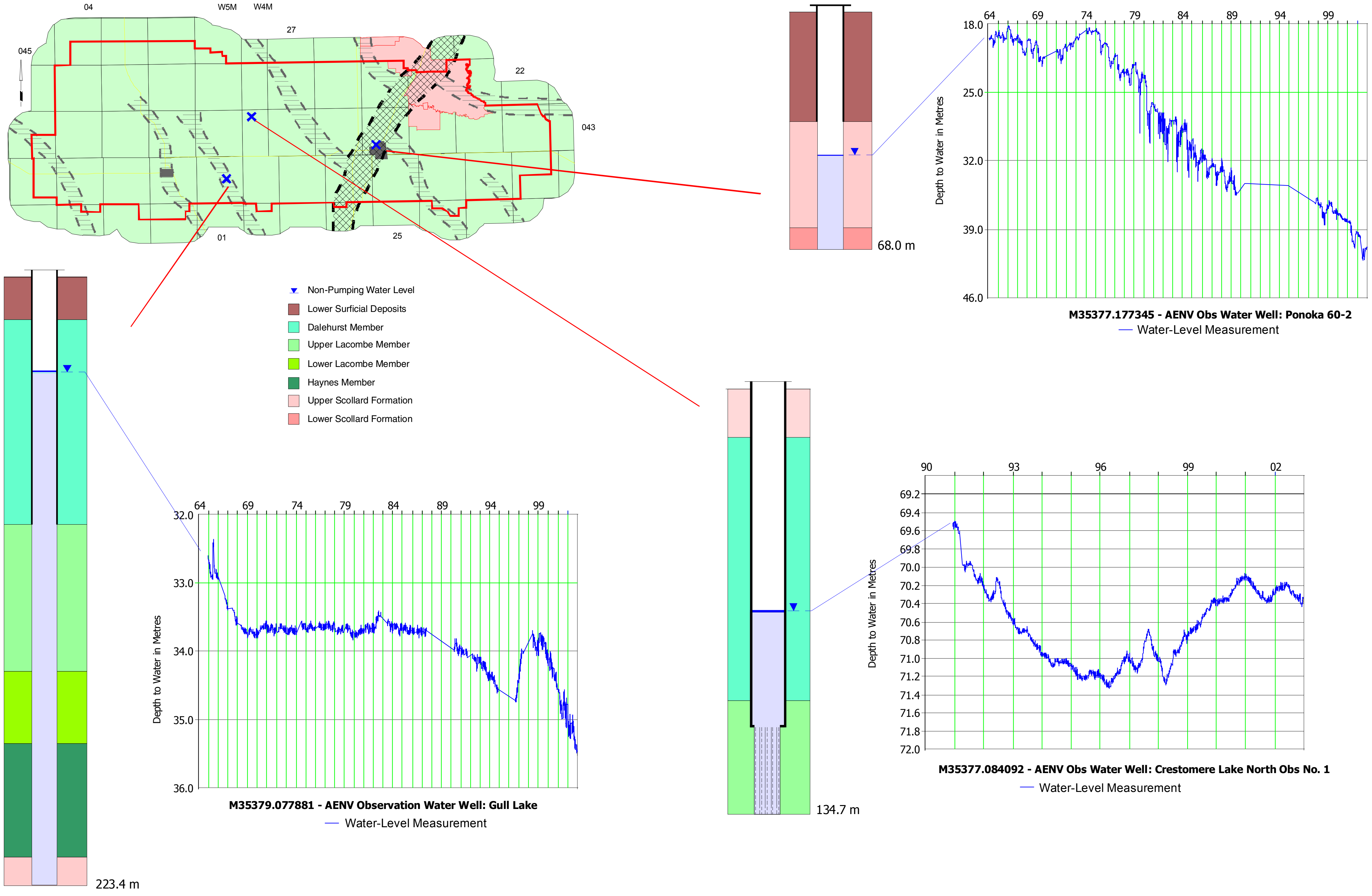
Depth to Top of Middle Horseshoe Canyon Formation



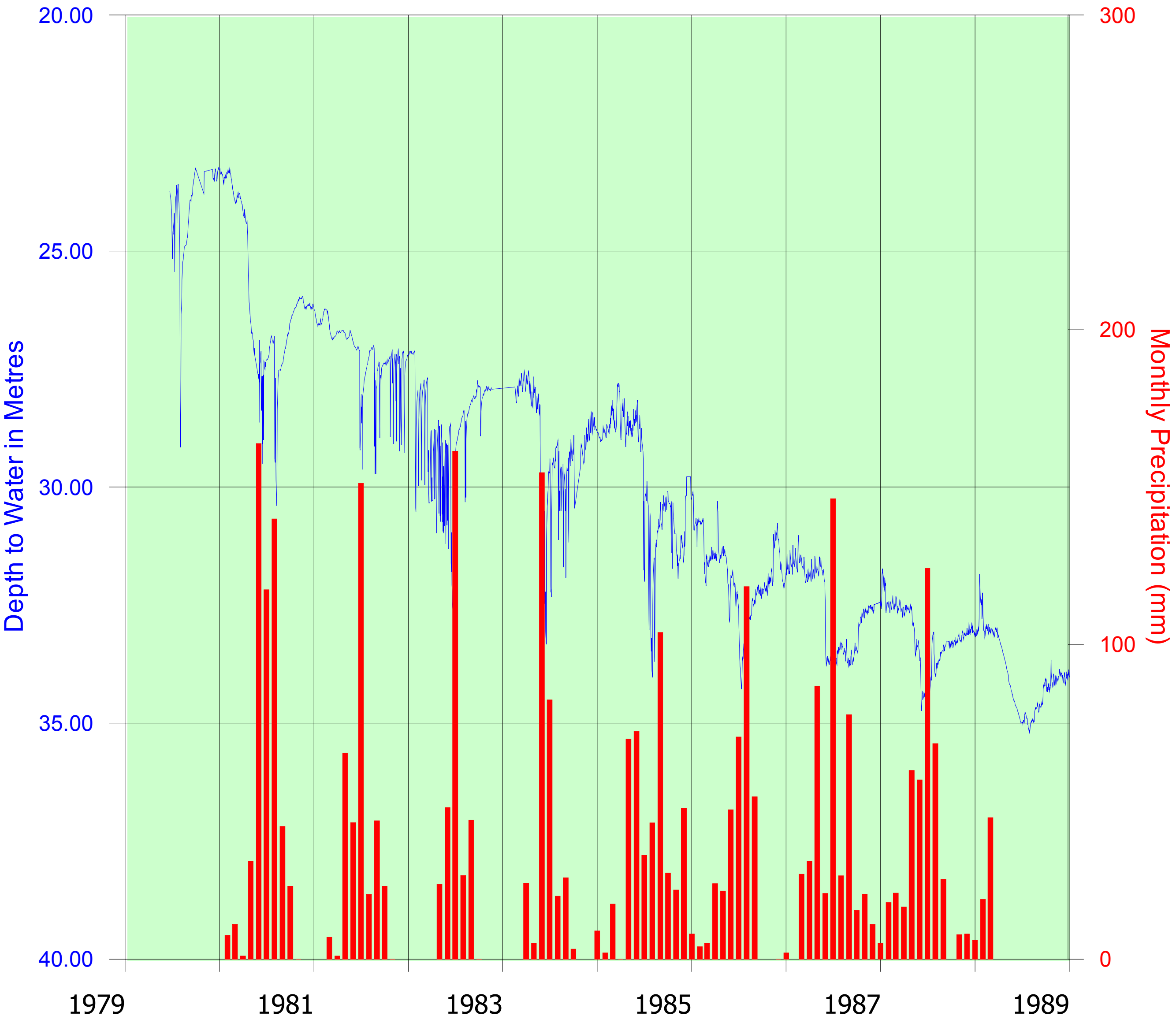
Estimated Water Well Use per Section



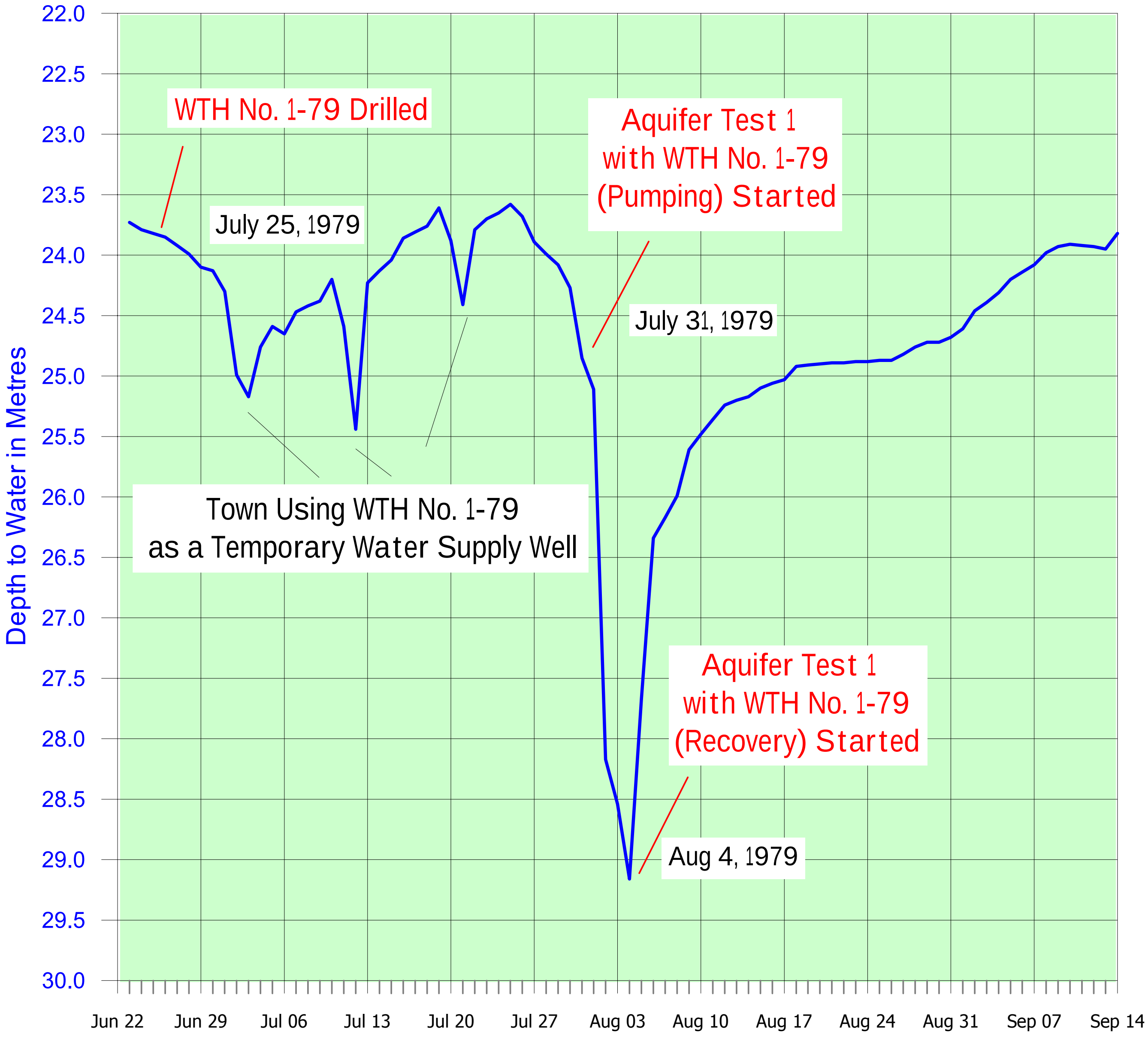
Hydrographs



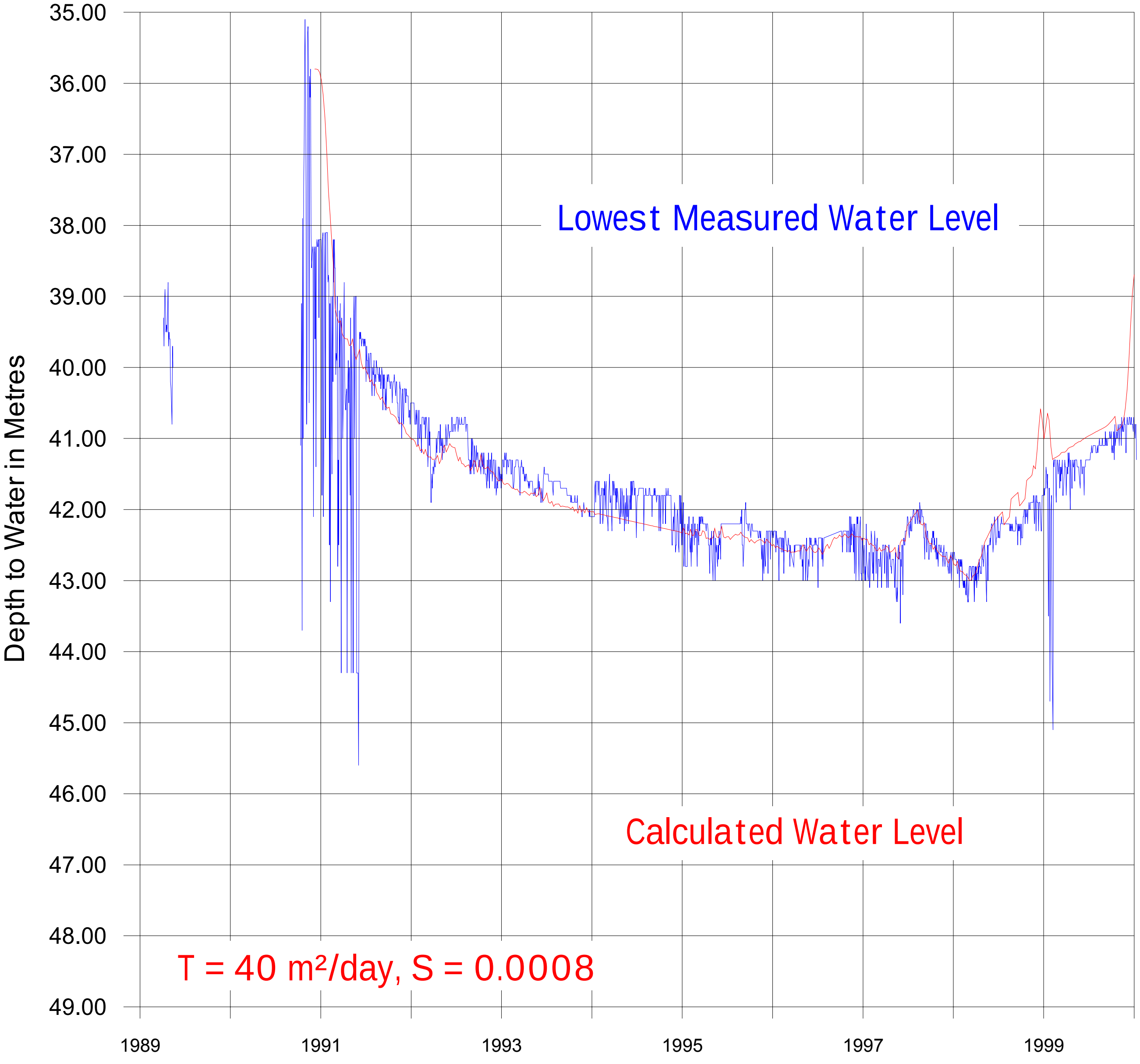
Monthly Precipitation vs. Water Levels in AENV Ponoka Obs WW



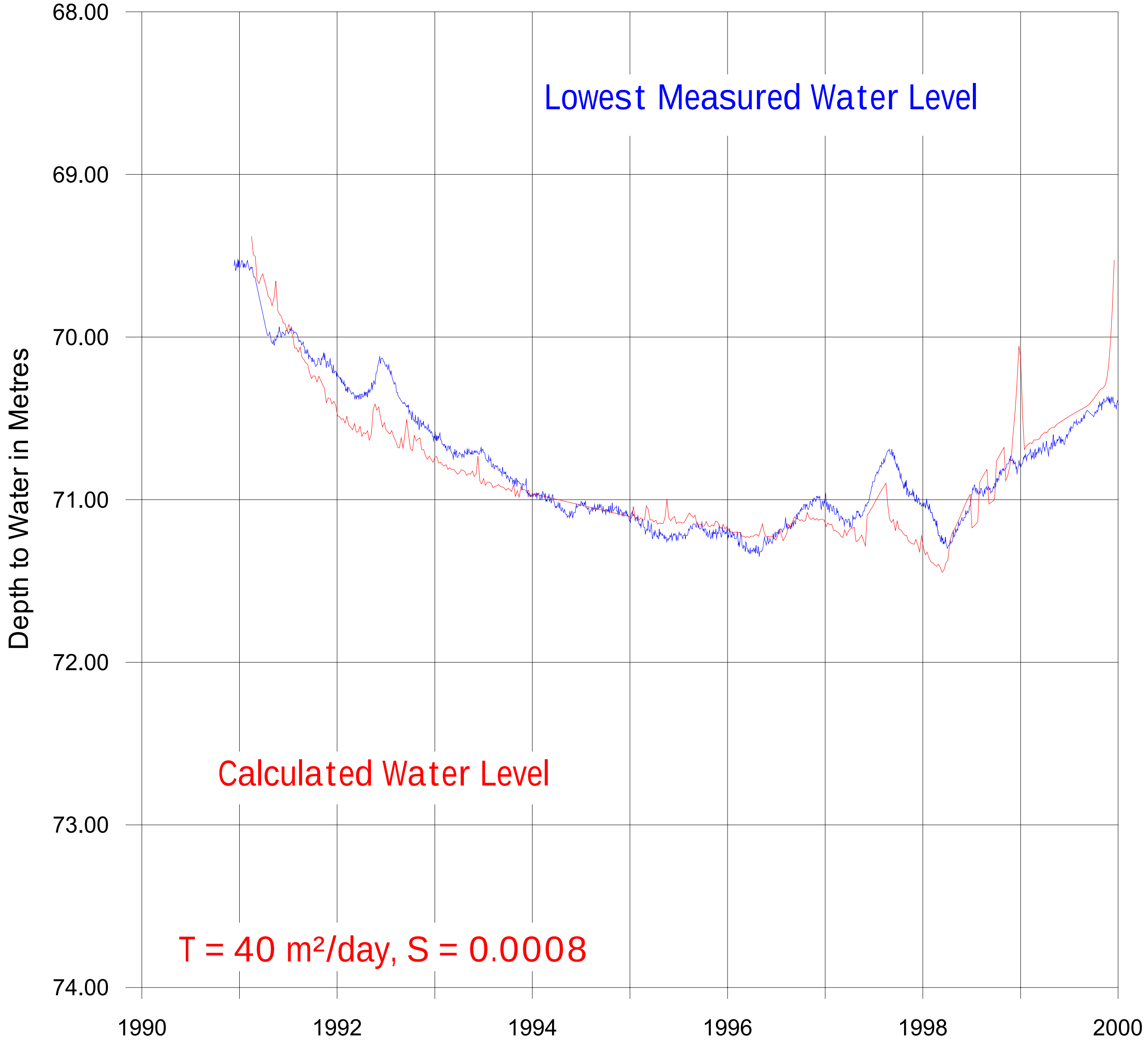
Comparison between AENV Ponoka Obs WW Water Levels and Groundwater Production



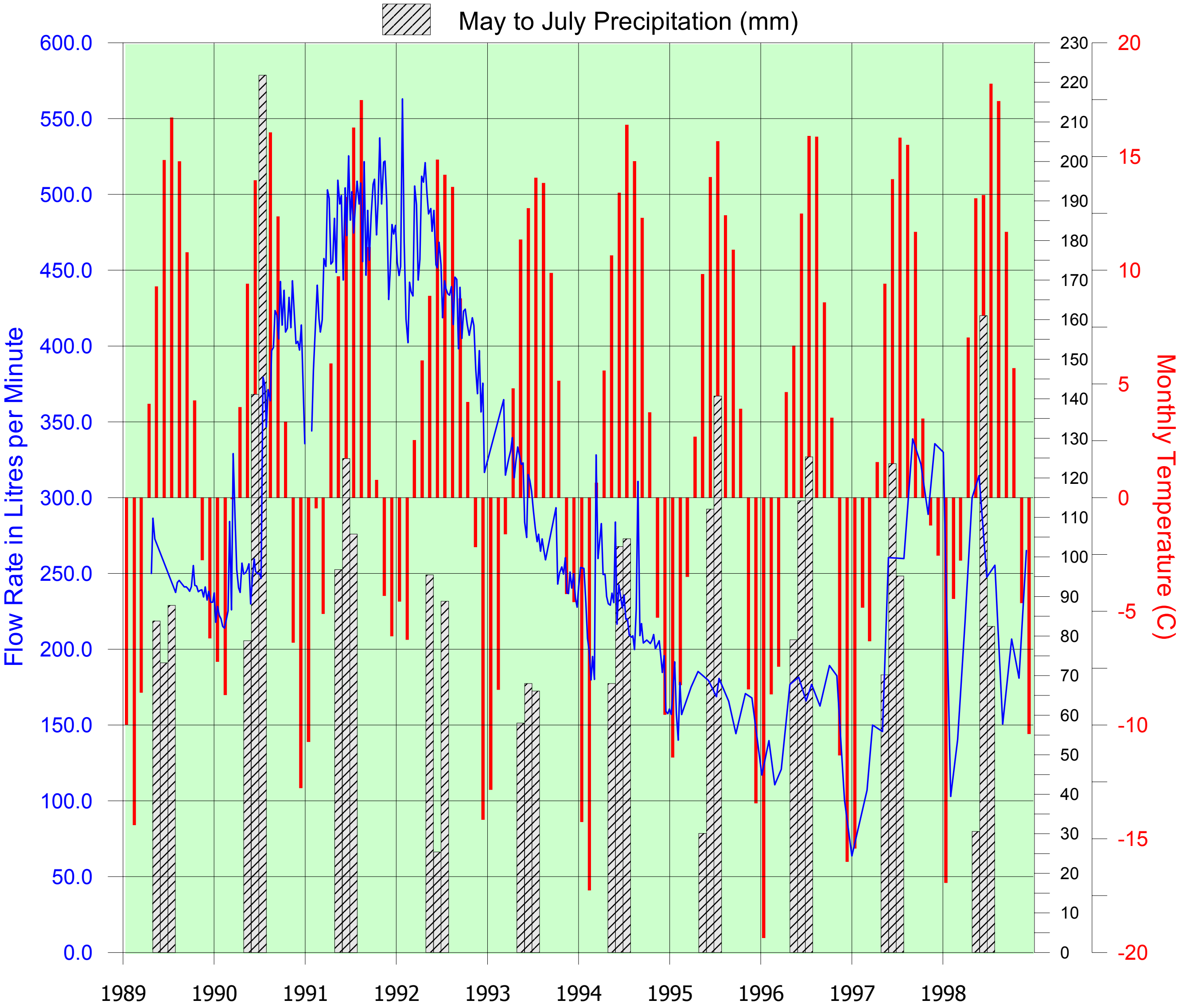
Water-Level Comparison - Engelen SE 18 Stock WW



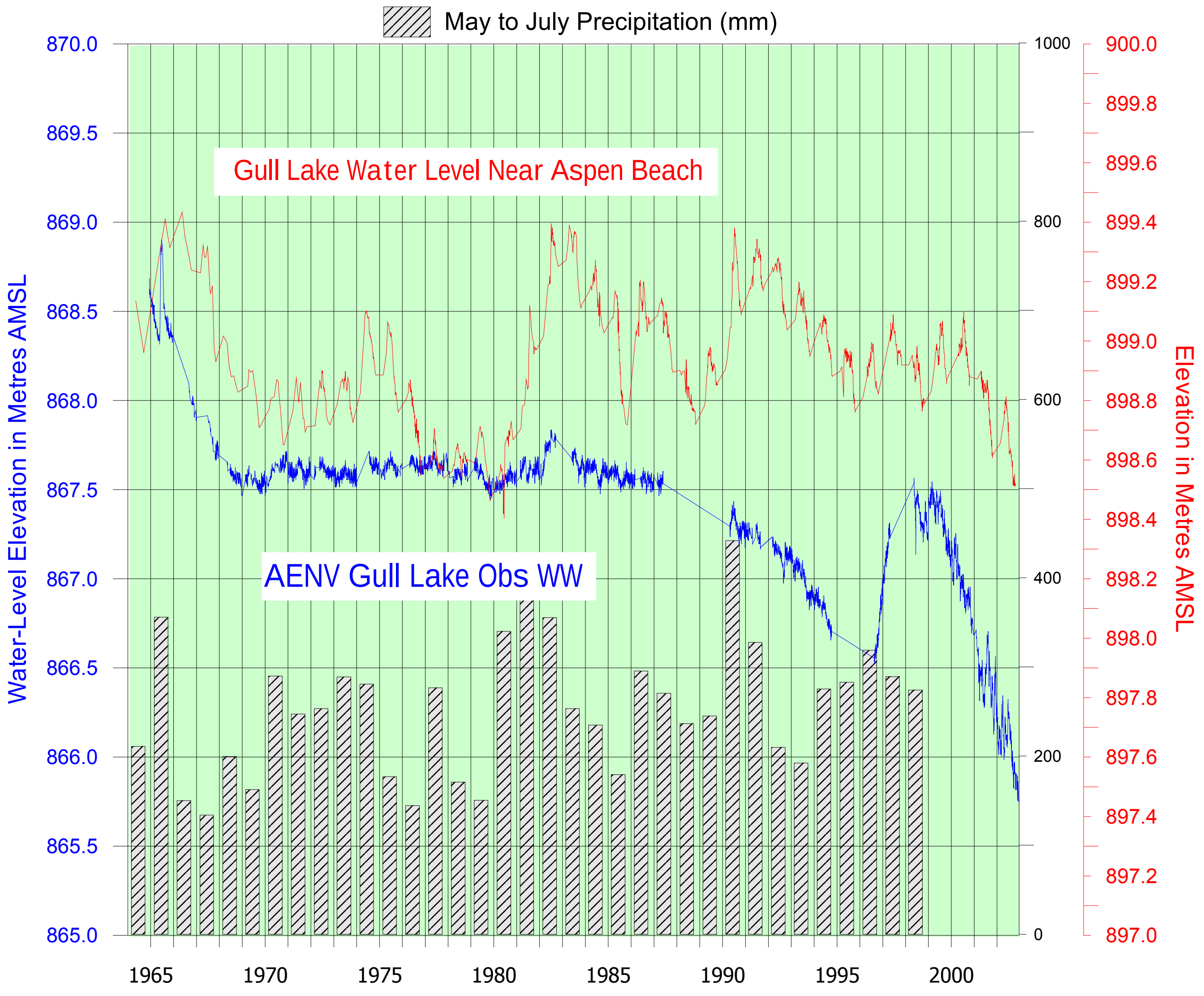
Water-Level Comparison - AENV Crestomere Obs WW



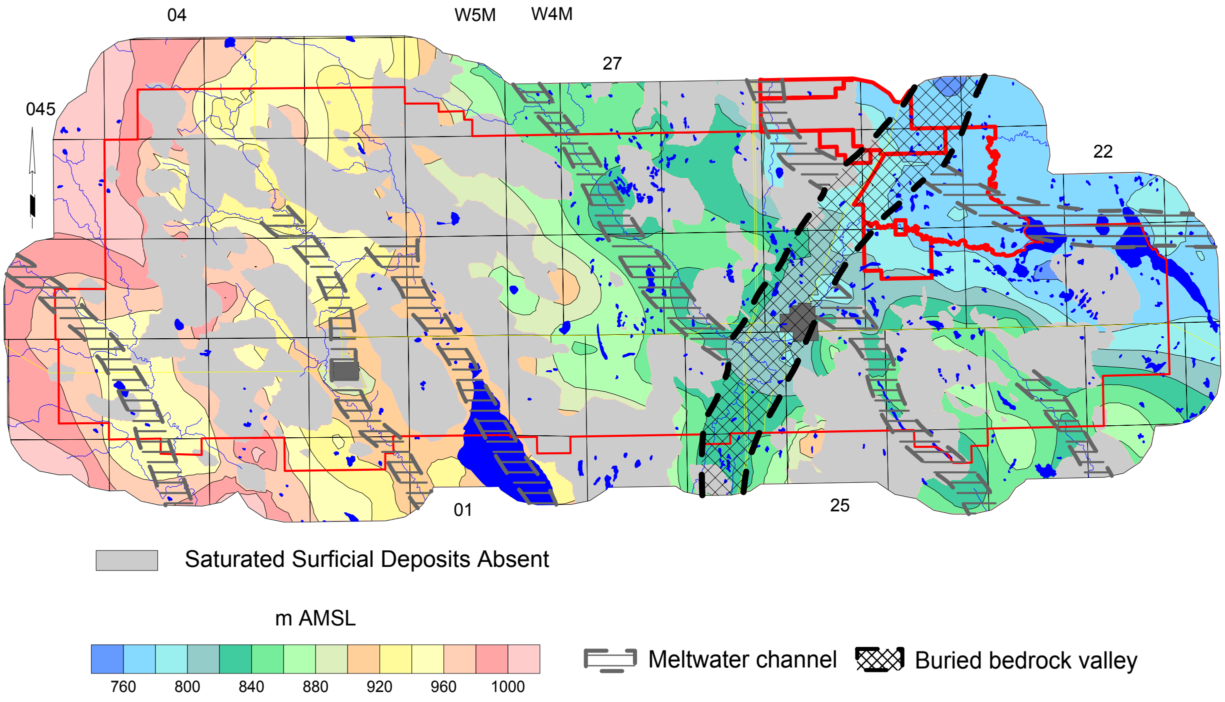
Monthly Temperature and May to July Precipitation vs. Flow Rate in the Paetkau (Lick) Spring



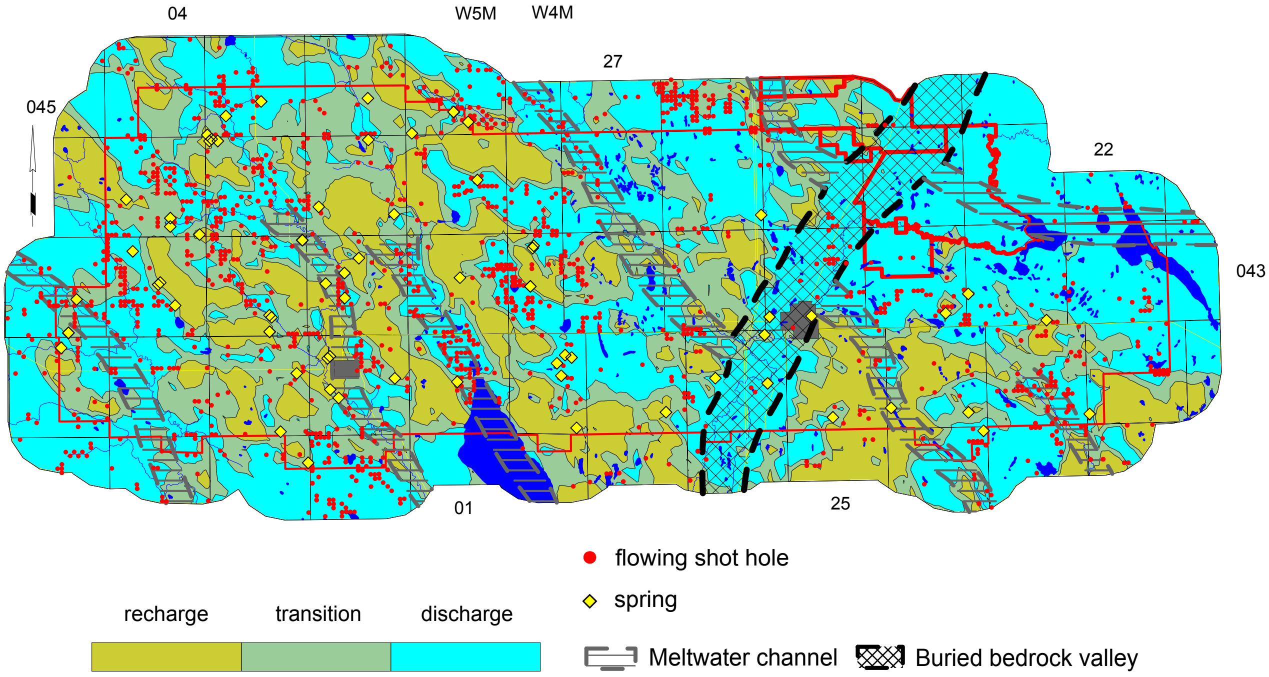
AENV Gull Lake Obs WW vs. Annual Precipitation and Gull Lake Water Levels



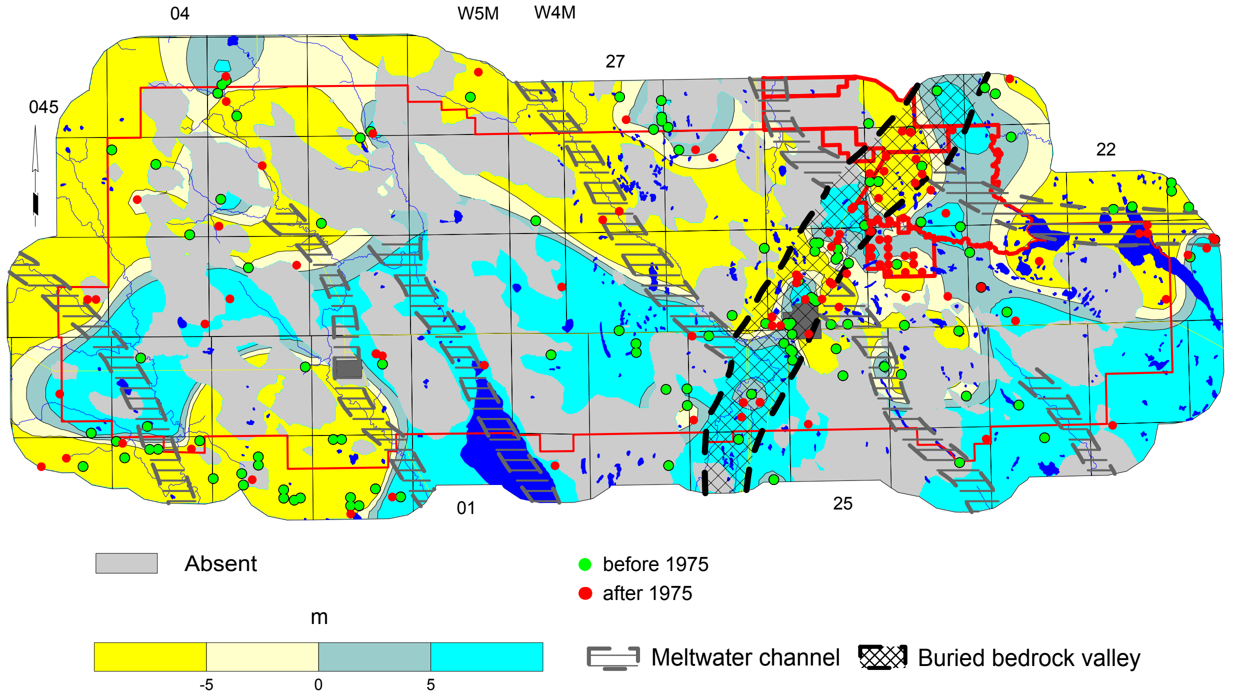
Non-Pumping Water-Level Surface in Surficial Deposits Based on Water Wells Less than 20 Metres Deep



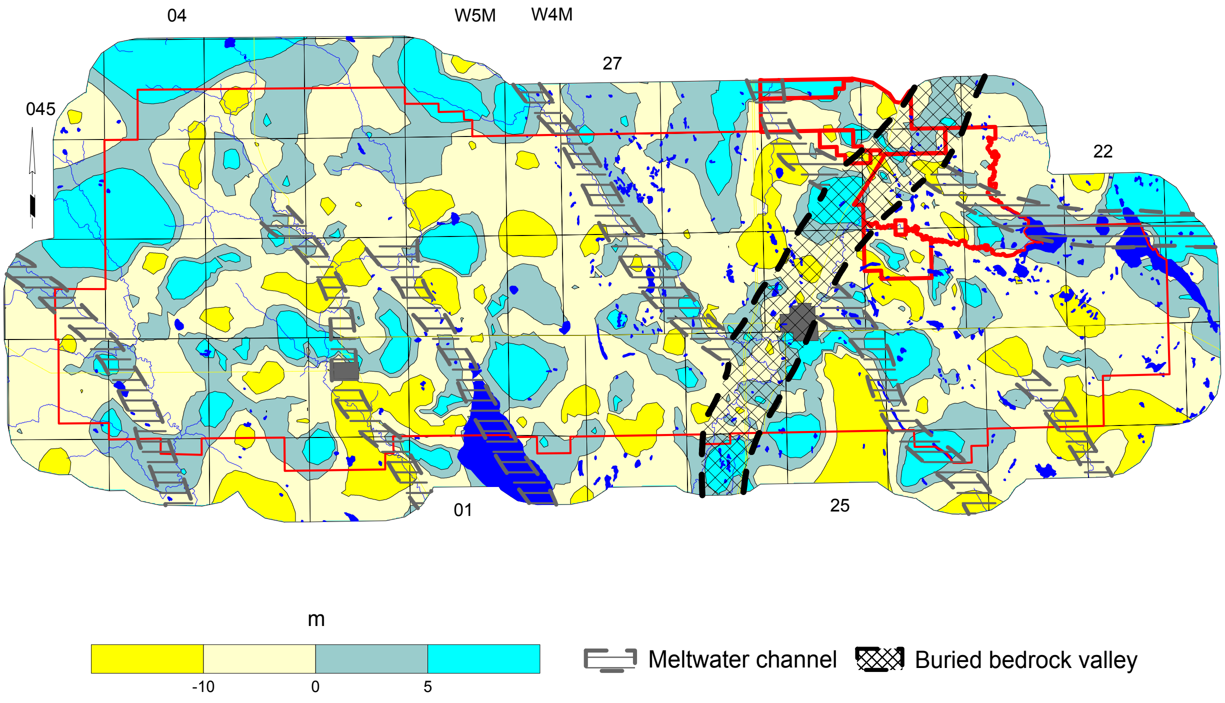
Bedrock Recharge/Discharge Areas



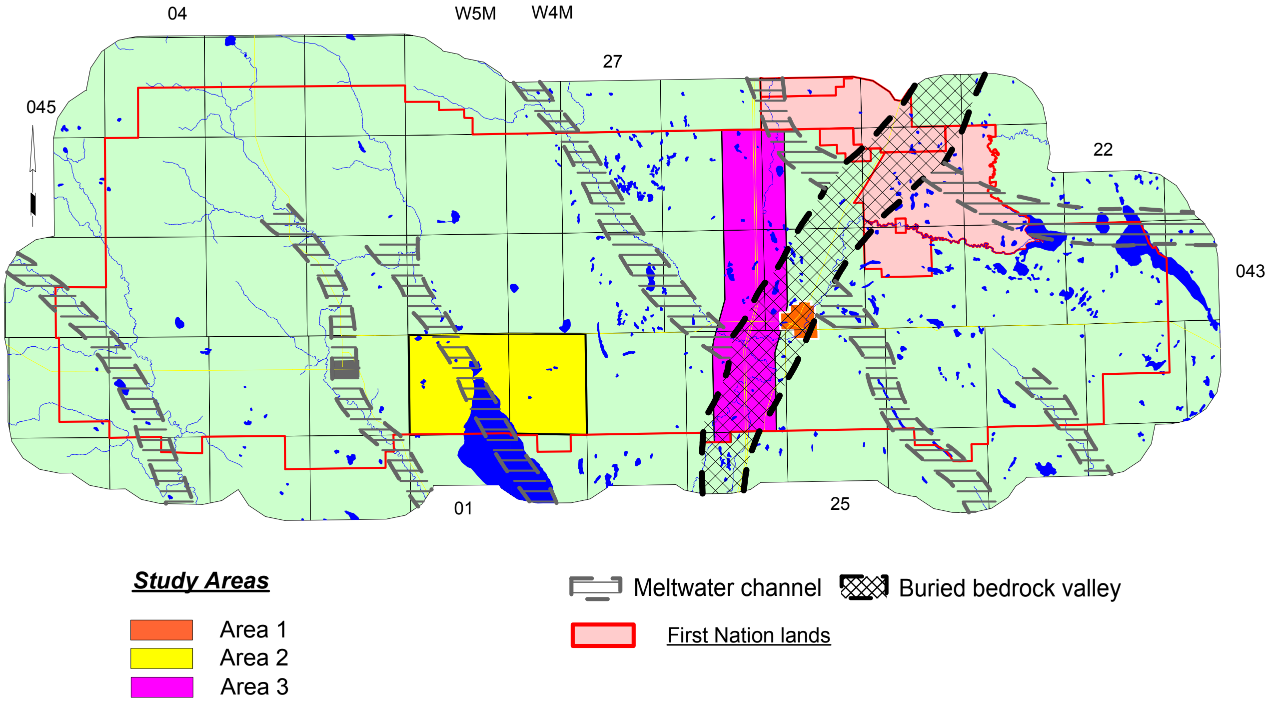
Changes in Water Levels in Surficial Deposits



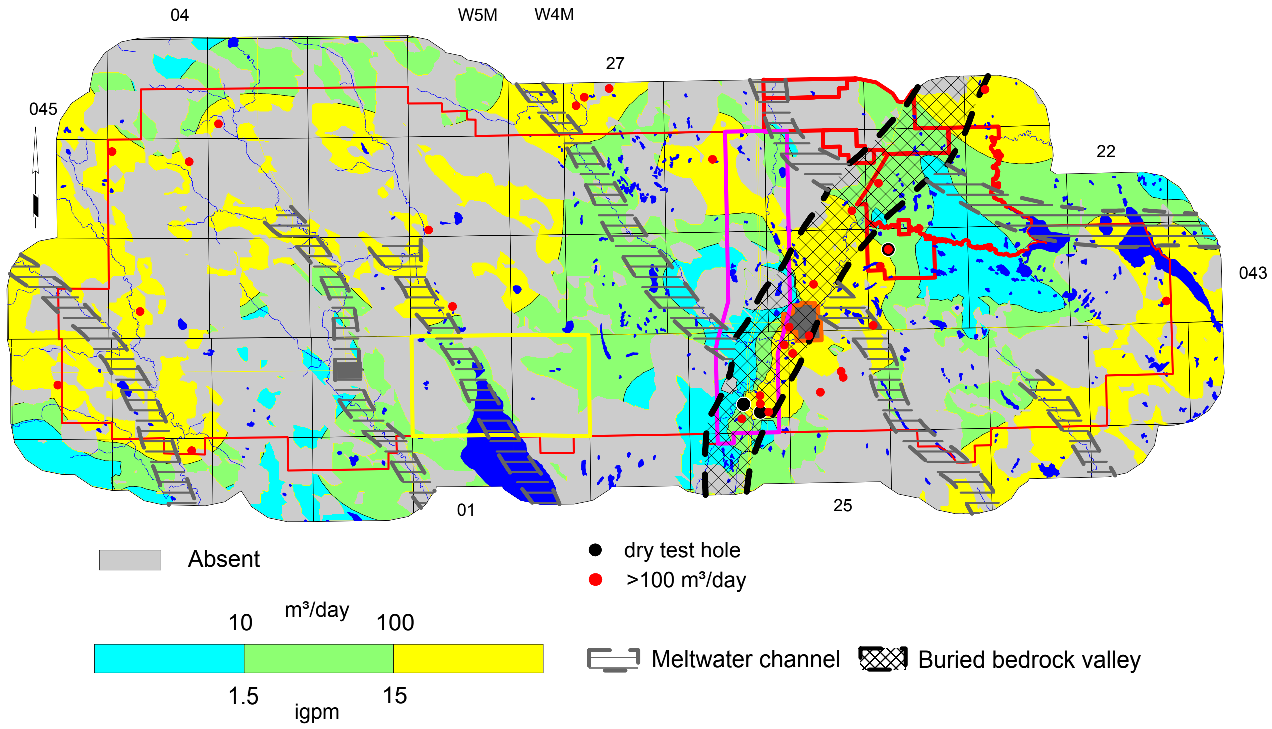
Areas of Potential Groundwater Depletion - Upper Bedrock Aquifer(s)



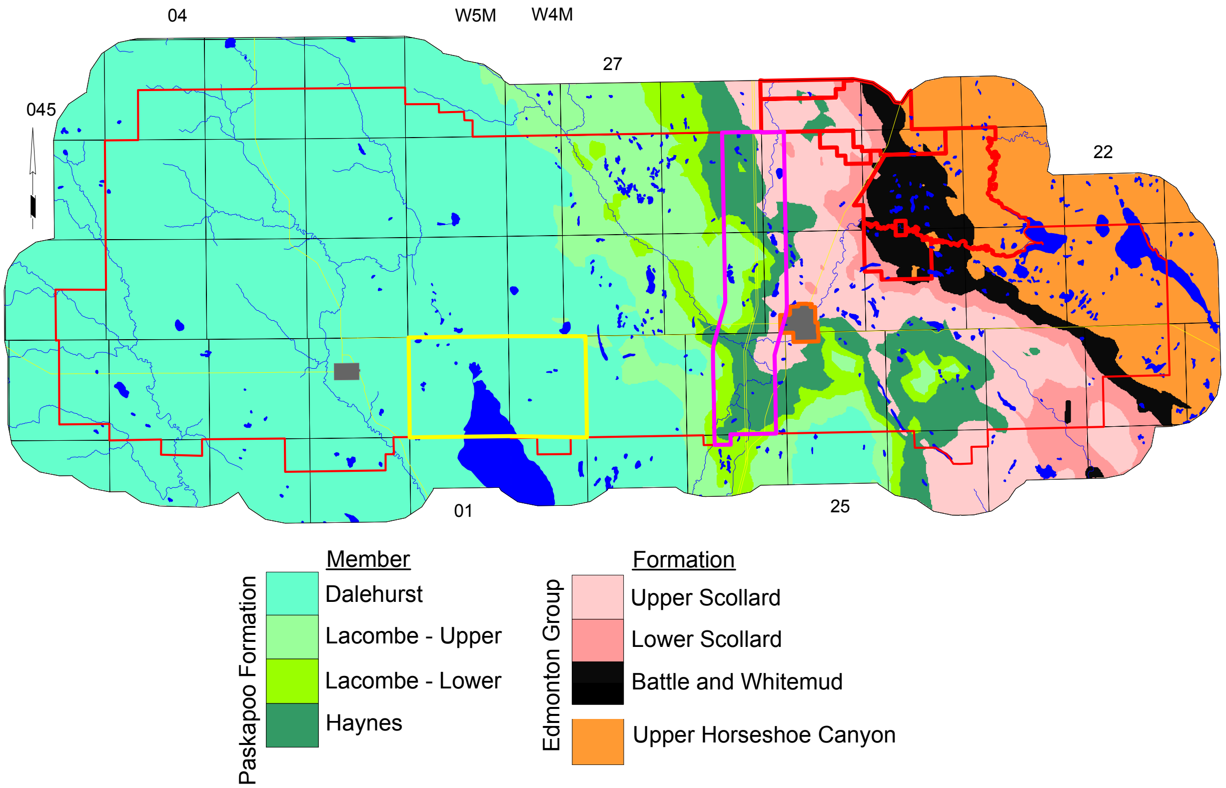
Specific Study Areas



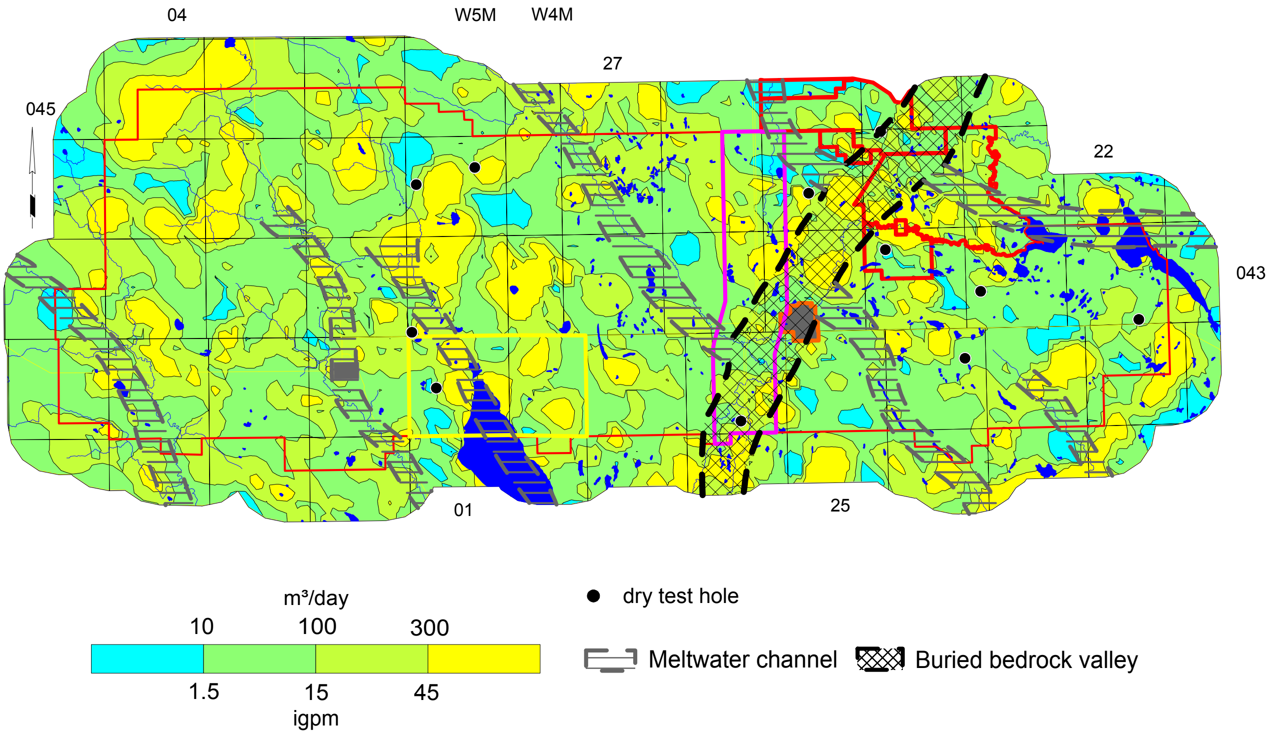
Apparent Yield for Water Wells Completed in Sand and Gravel Aquifer(s) - Specific Study Areas



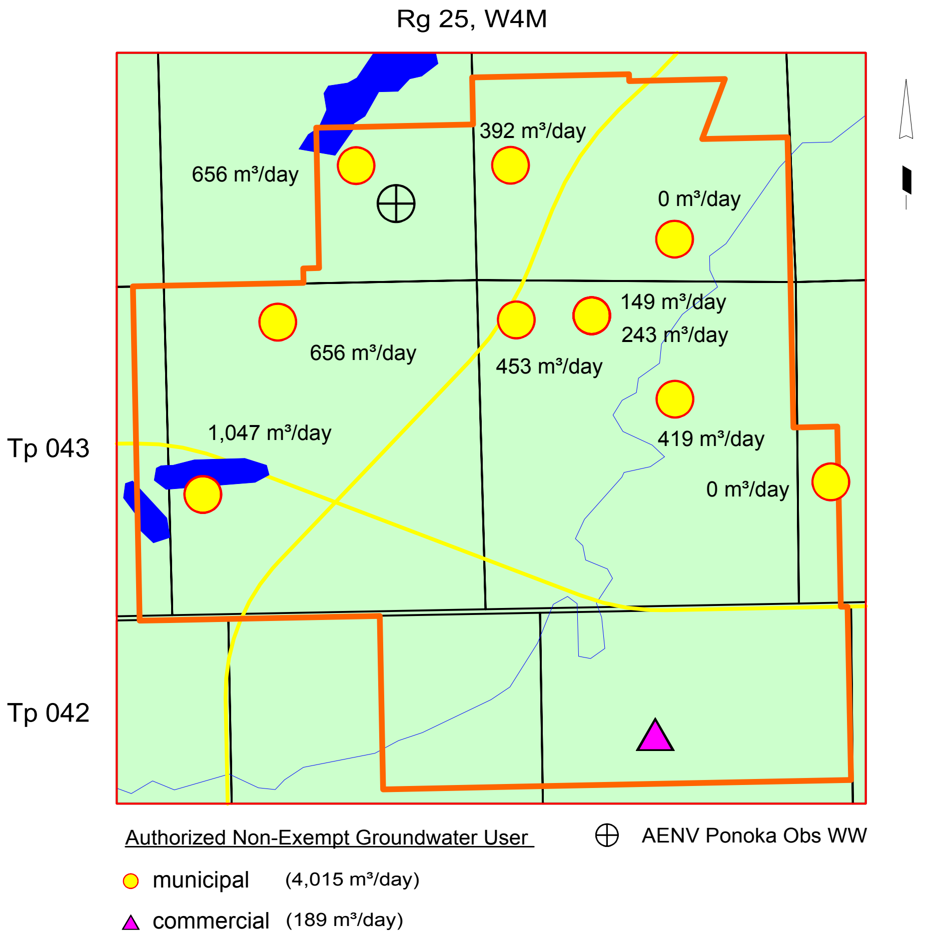
Bedrock Geology of Specific Study Areas



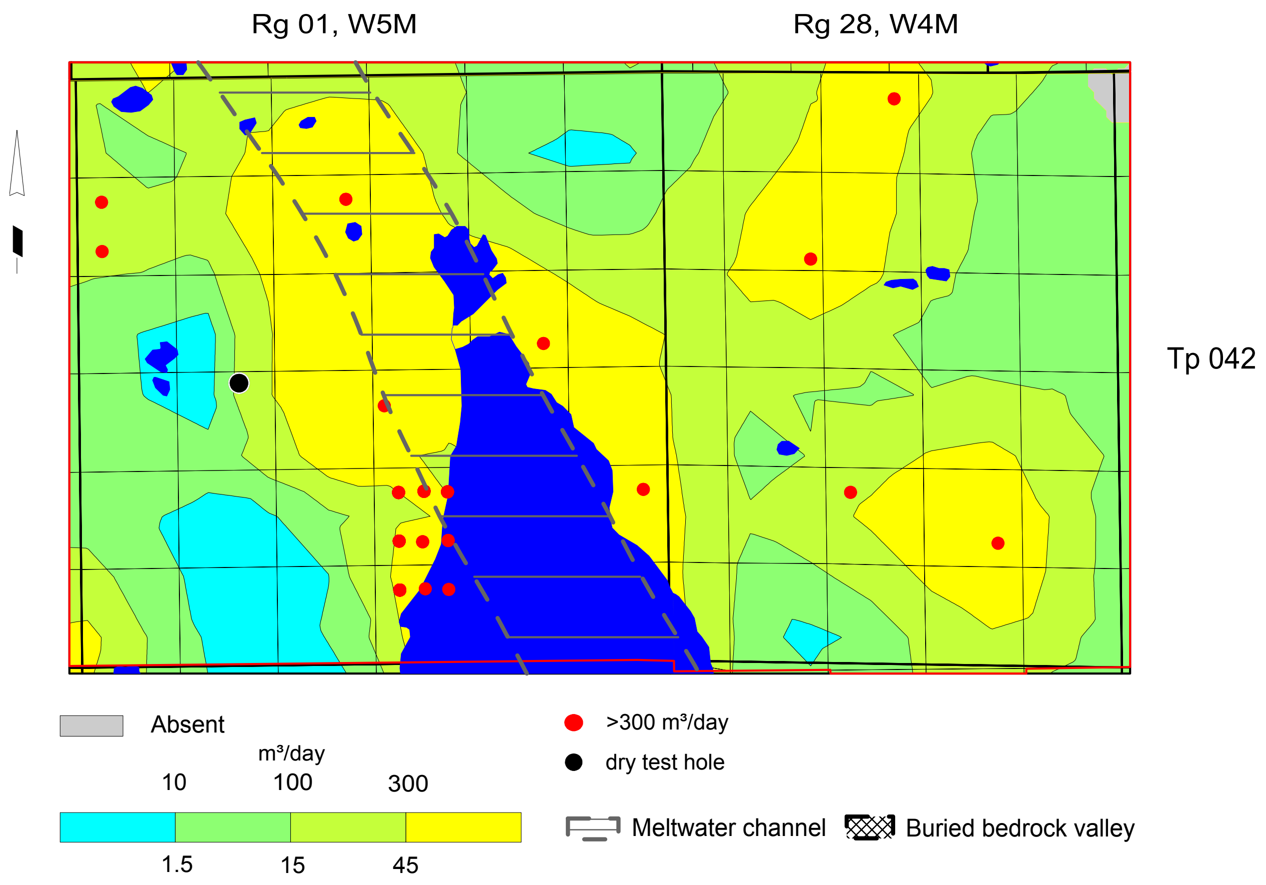
Apparent Yield for Water Wells Completed in Upper Bedrock Aquifer(s) - Specific Study Areas



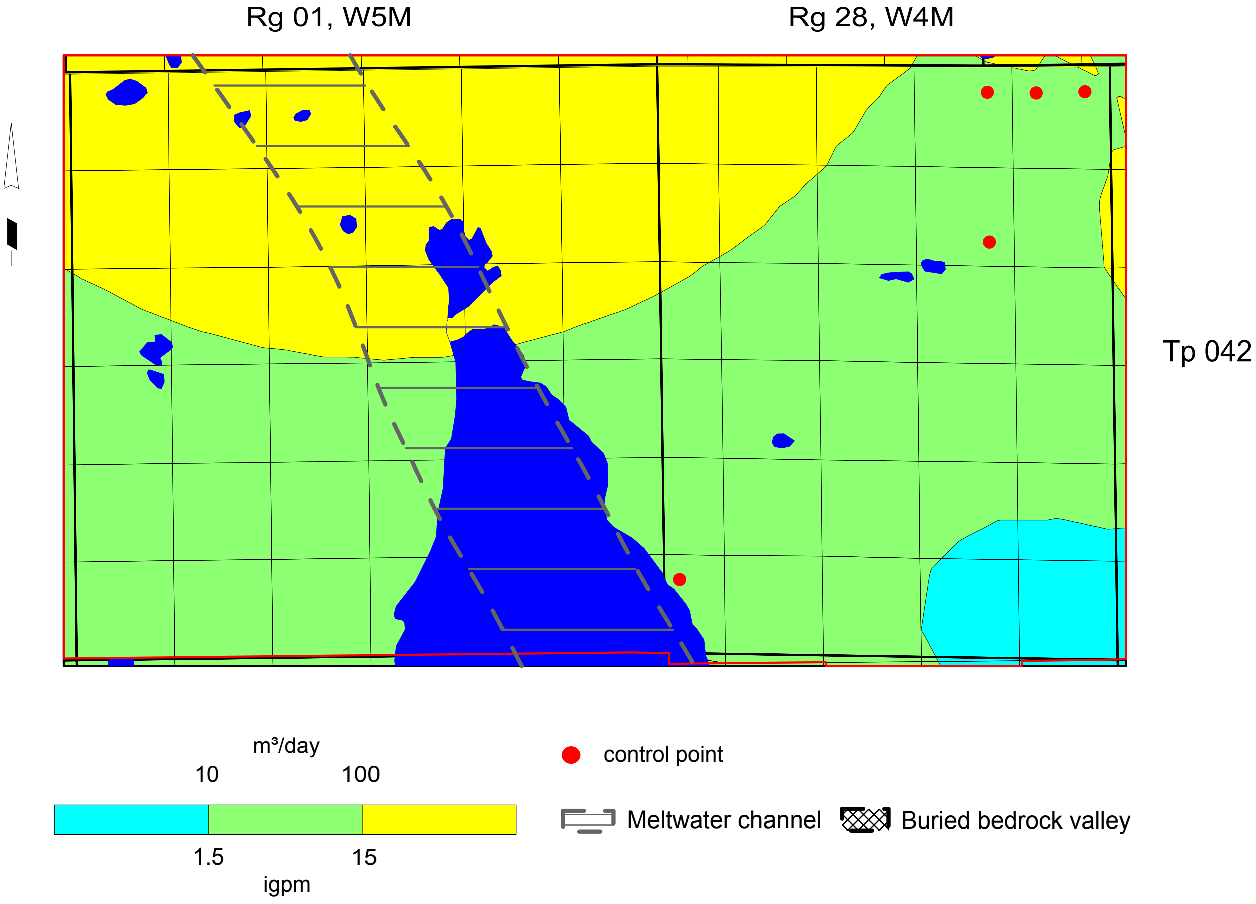
Authorized Non-Exempt Groundwater Water Wells – Area 1



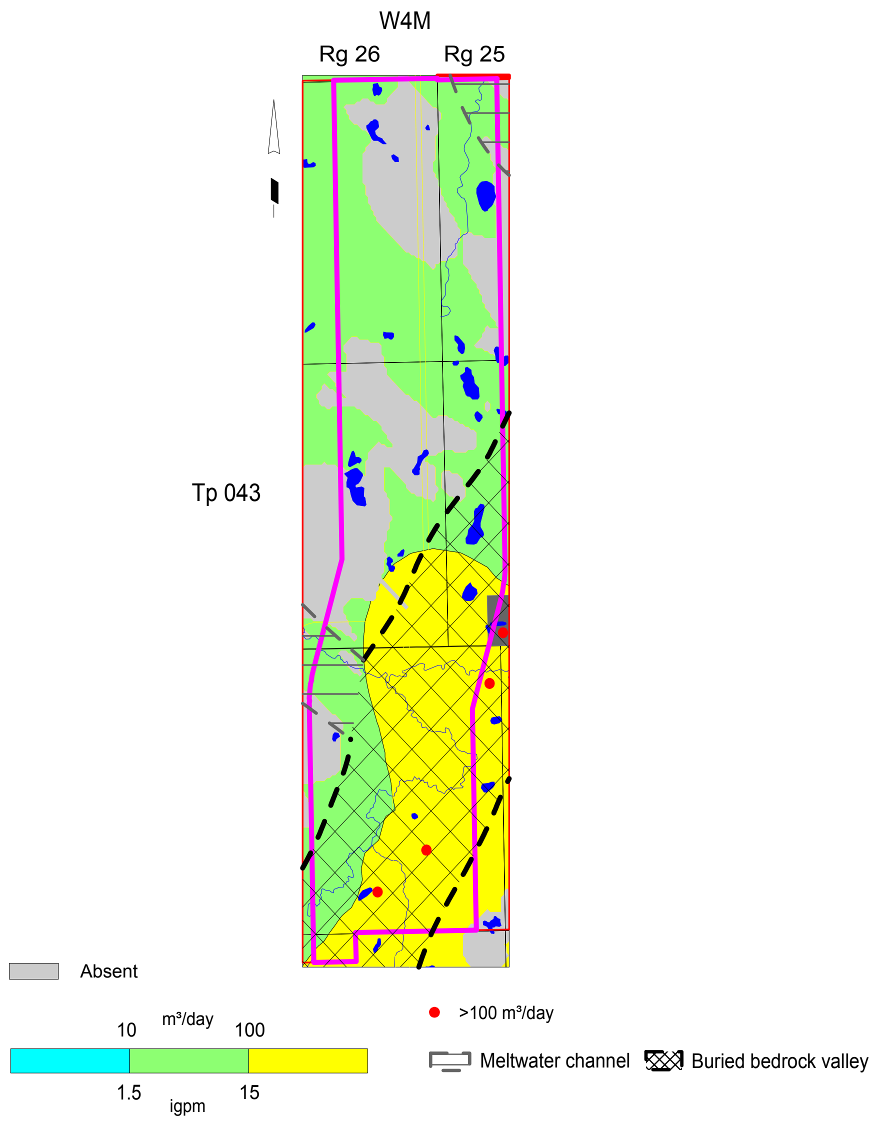
Apparent Yield for Water Wells Completed through Dalehurst Aquifer – Area 2



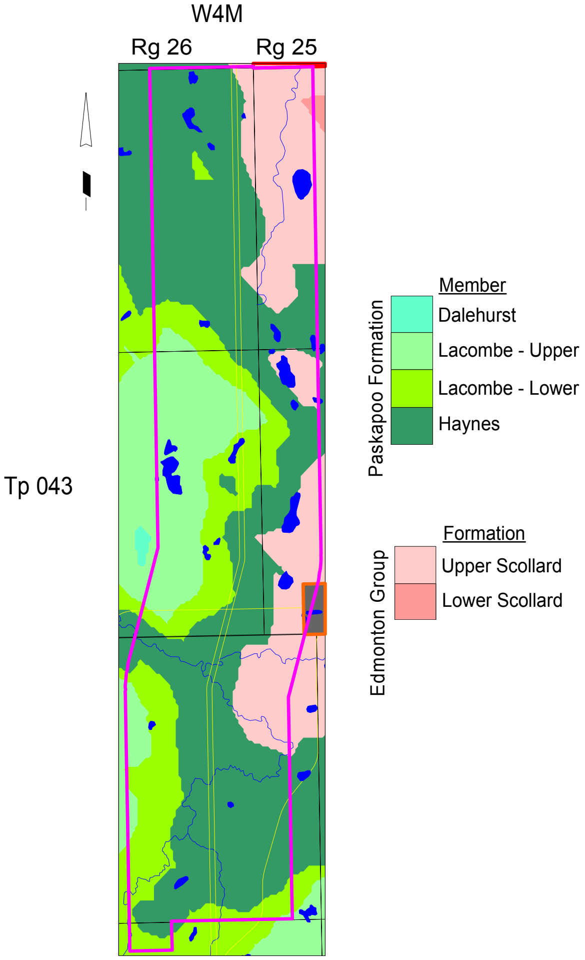
Apparent Yield for Water Wells Completed through Upper Lacombe Aquifer – Area 2



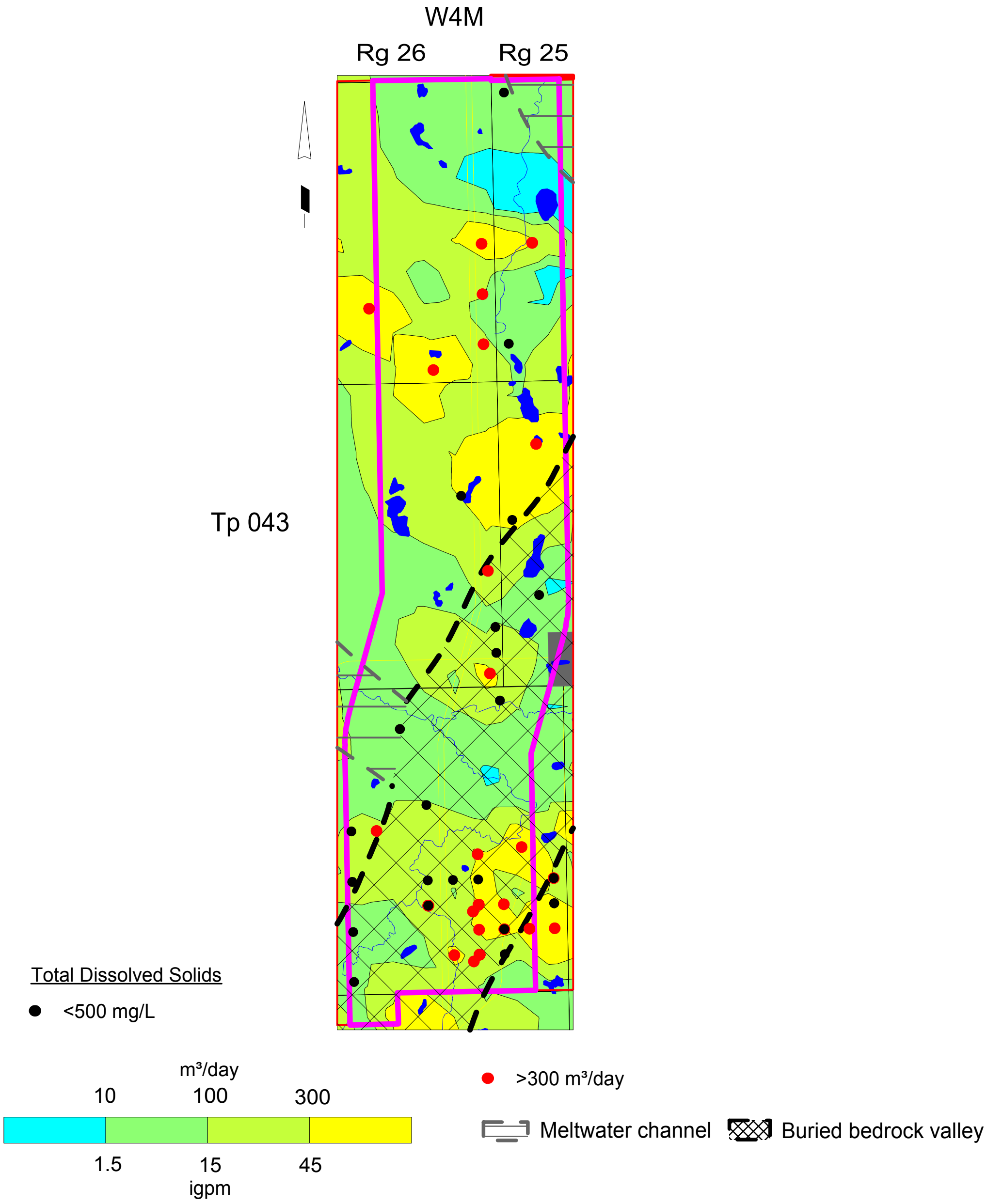
Apparent Yield for Water Wells Completed through Lower Sand and Gravel Aquifer – Area 3



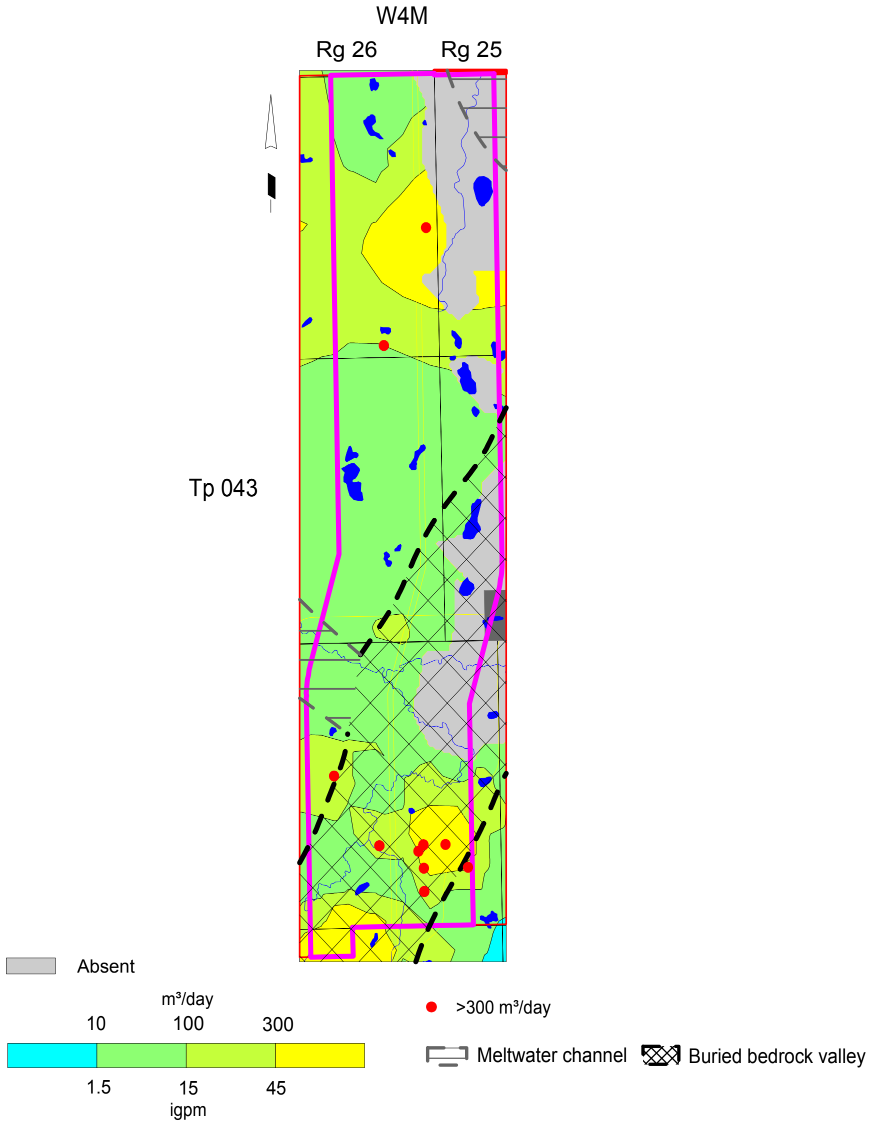
Bedrock Geology – Area 3



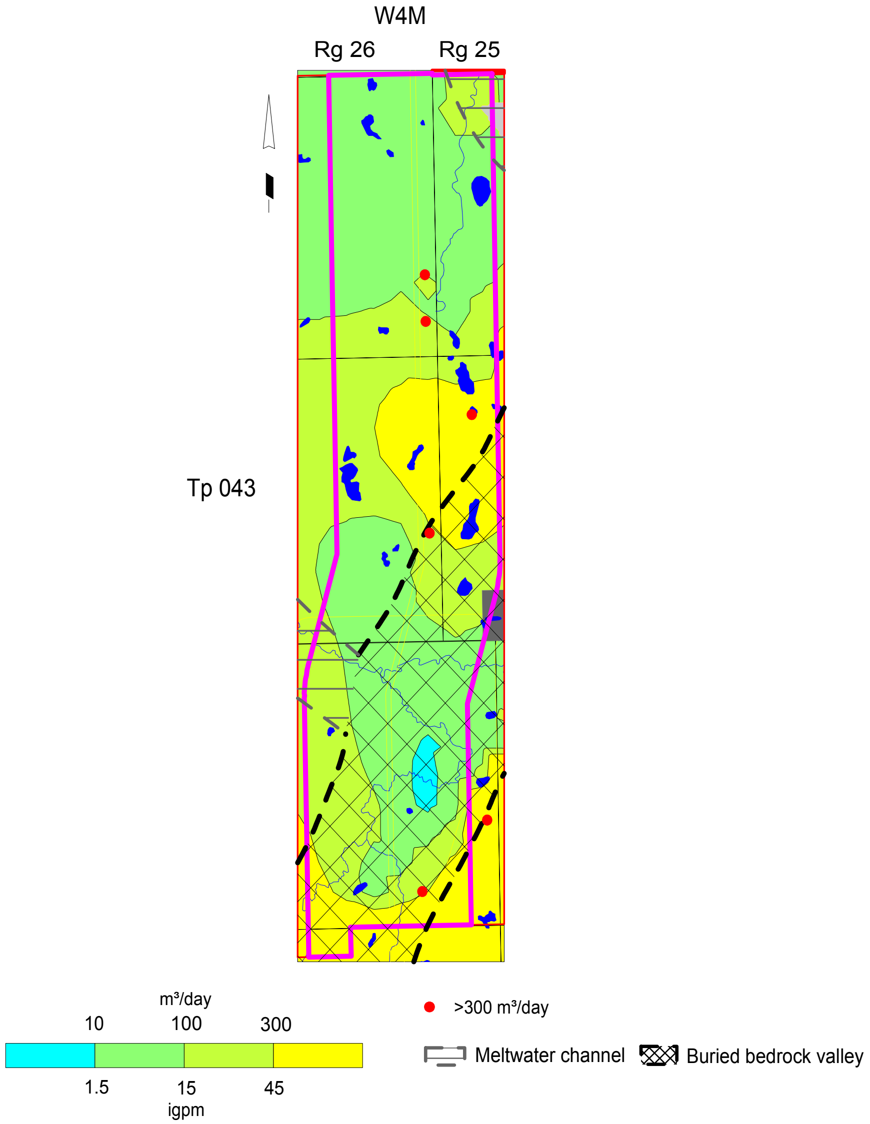
Apparent Yield and Total Dissolved Solids in Groundwater for Water Wells Completed in Upper Bedrock Aquifer(s) – Area 3



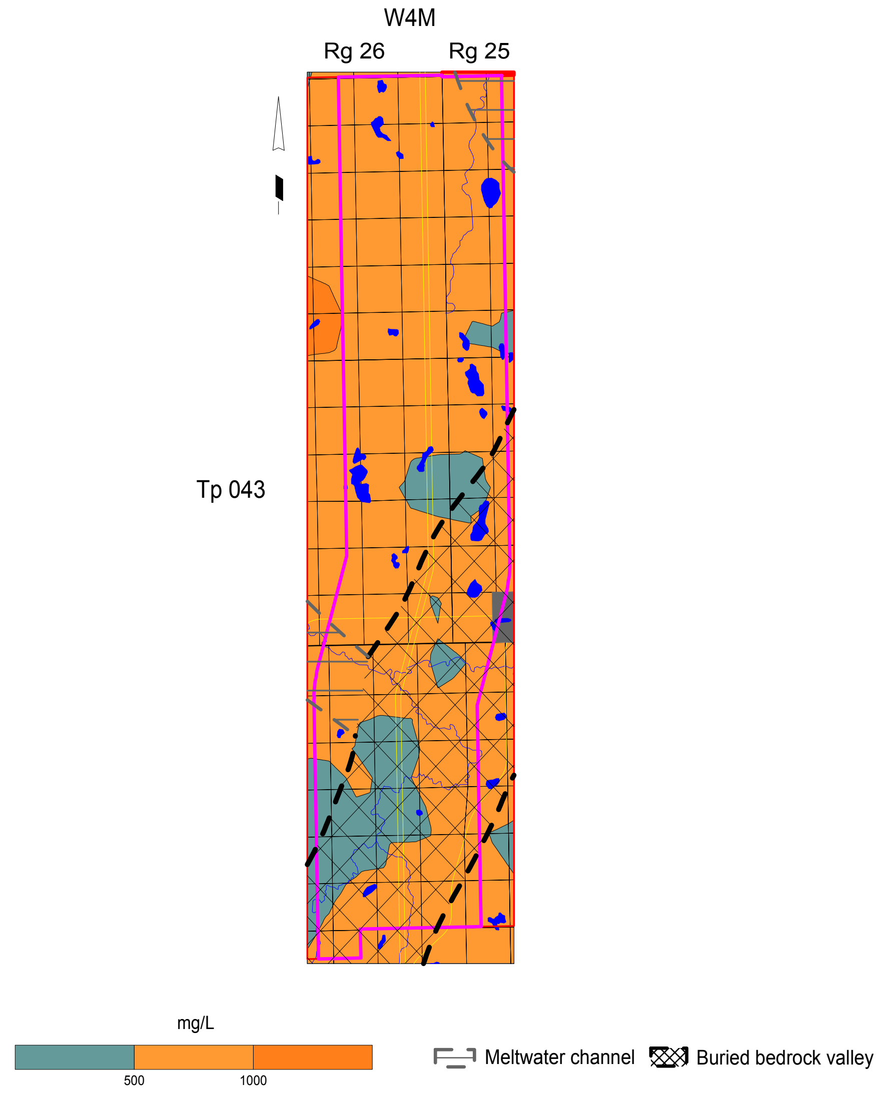
Apparent Yield for Water Wells Completed through Haynes Aquifer – Area 3



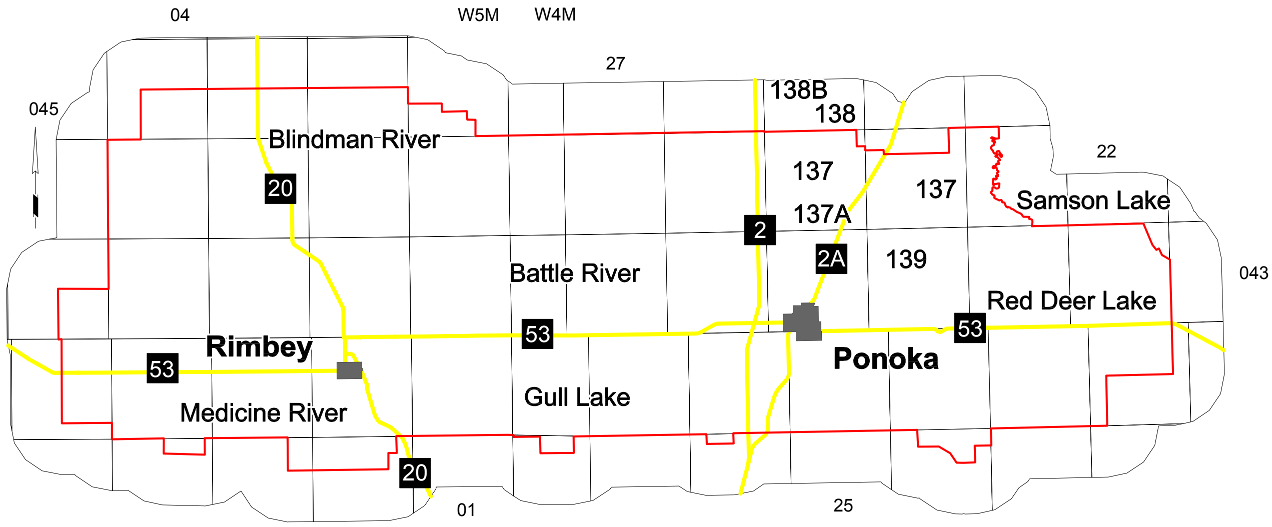
Apparent Yield for Water Wells Completed through Upper Scollard Aquifer – Area 3



Total Dissolved Solids in Groundwater from Upper Bedrock Aquifer(s) – Area 3



Overlay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W5M
W4M
27
045
138B
138
Blindman River
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137
137
22
Samson Lake
2
137A
2A
139
043
Battle River
Red Deer Lake
53
53
Rimbey
Ponoka
53
Gull Lake
Medicine River
20
01
25

PONOKA COUNTY

Appendix B

Maps and Figures on CD-ROM

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A04	Surface Casing Types Used in Drilled Water Wells
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A07	Maximum Depth of Existing Water Wells
A08	Difference Between the Maximum and Minimum Depth of Existing Water Wells
A09	Depth to Base of Groundwater Protection
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A11	Generalized Cross-Section (for terminology only)
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A13	Cross-Section A - A'
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A20	Cross-Section H - H'
A21	Bedrock Topography
A22	Bedrock Geology
A23	Relative Permeability
A24	Authorized Non-Exempt Groundwater Water Wells
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b) Dalehurst Member

c) Upper Lacombe Member

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e) Haynes Member

f) Upper Scollard Formation

PONOKA 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 ± 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 ±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

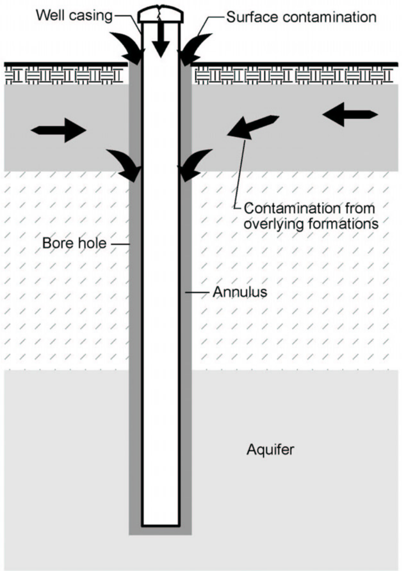
A water sample must be collected between the 4- and 6-minute water-level measurements, whenever there is an observed physical change in the groundwater being pumped, and 10 minutes before the end of the planned pumping interval. Additional water samples must be collected if it is expected that pumping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

Plugging Abandoned Wells

Adapted from Water Wells that Last Generations (PFRA 2000)

For more information refer to the Water Wells That Last video series Part II — Managing and Maintaining.

Figure 1 Well Contamination



Wells that are no longer being used should be plugged. They are a serious public safety and environmental hazard.

Plugging Abandoned Wells

When a well is no longer being used or maintained for future use, it is considered abandoned. Abandoned wells pose a serious threat to the preservation of groundwater quality. They are also a serious safety hazard for children and animals.

There are approximately 59,000 farmsteads in Alberta and most of these have at least one well. In addition there are a great number of non-farming rural residents that rely on water wells. The exact number of abandoned wells in Alberta is unknown but is estimated to be in the tens of thousands. Plugging an abandoned well prevents:

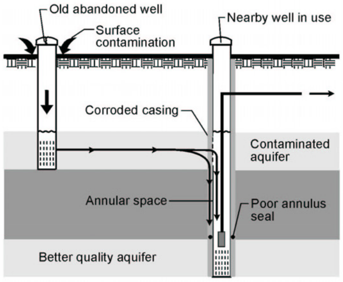
- Downward movement of water in the well or well annulus
- Surface contamination from reaching aquifers
- Intermixing of water between aquifers of different water quality
- Serious accidents from happening.

Unfortunately, groundwater contamination and its effects are usually not recognized until groundwater quality is seriously affected and nearby wells have been contaminated. Surface contaminants can enter a well several ways:

- Directly through the surface opening if the cap is loose, cracked or missing
- Through unsealed spaces along the outside of the casing (see Figure 1, Well Contamination).

When the steel casing of an abandoned well starts to corrode, holes will develop. When this takes place, surface contaminants or poor quality water from shallow aquifers may migrate into the deeper aquifers of nearby operating wells (see Figure 2, Contamination From an Abandoned Well).

Figure 2 Contamination From an Abandoned Well



Who is Responsible?

In Alberta, responsibility for plugging a water well is defined by legislation. The well owner is responsible for plugging the well when:

- The well is no longer being used as a water supply
- The well is in a poor state of repair and the pumping equipment has been removed or cannot be repaired or replaced
- The well produces water that is unsuitable for drinking.

The drilling contractor is legally responsible for immediately plugging a well when it is not completed due to construction problems or inadequate yield. Before you sign a contract with a driller, ask questions about what materials are going to be used to plug the well and associated costs.

It is generally best to hire a drilling contractor to complete the plugging of your well. This person has the expertise and equipment to do a proper job. Unless you use the right plugging materials and have them properly placed in the well, you will end up with a poorly sealed well that will continue to allow contaminants to enter into the groundwater. When a replacement well is drilled, your old well should be immediately plugged.

Process of Plugging a Well

There are several steps to take before actually plugging the well. Some steps you will be able to do yourself and others you may want to consult with, or hire, a drilling contractor to complete.

Preparation

For information on how to take a non-pumping water level measurement, see Module 5 "Monitoring Your Water Well."

To know exactly how much plugging material is needed, measure the total depth and diameter of the well, plus the non-pumping water level (the depth to the standing water in the well). If possible, compare these measurements to the information on the drilling report from when the well was originally constructed. The only time you should even consider plugging a well yourself is when the well is open to its original depth.

Ideally the casing should be removed from the well before the plugging process begins. Often only the liner casing is removed and the surface casing is left intact because it is more difficult to remove and it could separate down hole. The older the well, the more difficult it will be to successfully remove the casing. If the casing is left in place, it should be perforated, particularly if there is evidence of water movement in the annulus of the well. Any casing left in place must be cut off 0.5 m (20 in.) below ground surface after the well is plugged.

Materials

Materials that are used to plug a well must be uncontaminated and impervious. They must prevent any movement of water. See the chart below for acceptable and unacceptable materials.

Cement grout and concrete may shrink after setting so may not create as good a seal as bentonite.

Sand and gravel are not acceptable materials. They are not impervious materials because water can easily move through them.

Acceptable Materials	Unacceptable Materials
• grout - neat cement (cement mixed with water) - sand cement (cement, sand and water)	sand
• concrete (cement, sand and aggregate mixed with water)	gravel
• manufactured high yield bentonite products	drilling mud or fluid
• clean, uncontaminated clay (for large diameter wells)	

High yield bentonite is a special type of clay that swells when wet to provide a very effective impervious seal. It comes in a powder that when mixed with water produces a slurry that can be pumped into the well. It is also manufactured in pellet or granular form that is designed to pour into the well. This type of bentonite when mixed with water will actually swell to about eight times its original size and will form a water-tight plug.

It is important to understand that bentonite cannot be used as a plugging material in some situations. When the chloride level in the well water is greater than 4000 mg/L, or the calcium level is greater than 700 mg/L, bentonite will not swell properly, so then it is best to use a cement grout.

Large diameter or bored wells pose special problems because of their size and volume of material required to fill them. A lower cost alternative for the plugging material is clean, uncontaminated clay that can be shovelled into the well until it is filled. This must be done carefully, however, to ensure the clay reaches the bottom of the well and seals off all empty space. The cribbing must be cut off below ground surface and the well topped up with high yield bentonite to make a water-tight seal.

Method

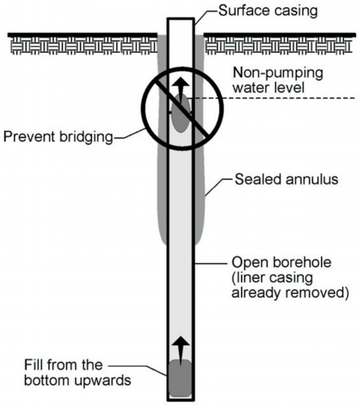
Aside from choosing the appropriate plugging material, the method of placing material into the well is most critical. Regulation requires that the plugging material must be introduced from the bottom of the well and placed progressively upward to ground surface.

If the plugging material is cement grout, concrete or bentonite slurry, special equipment is needed. The material must be placed into the well through a tremie pipe that is usually about 3 in. in diameter. At all times this pipe must be kept below the surface of the plugging material to prevent it from diluting or separating. It is recommended that you hire a drilling contractor when a slurry is chosen as the plugging material because the drilling contractor will have the proper equipment and experience to do the job correctly.

When bentonite pellets are chosen for the plugging material, they can be poured into the well from the ground surface. These pellets have a weight material added to help them sink to the bottom of the hole. They are also coated to prevent immediate swelling on contact with water. When poured slowly, they should reach the bottom of the well before swelling. If you are not careful, however, these pellets will bridge off down hole and the well will be only partially plugged (see Figure 3, Bridging).

Before you pour in the pellets, you can determine how many feet of well casing can be filled with the size of pellets you have chosen. As the well is being filled, measure the depth to the top of the plugging material quite frequently. Then you will know if the plug is rising faster than expected indicating a bridge has formed. If this happens, be sure to break it up before adding more material to the well.

Figure 3 Bridging



Steps to Plugging a Well

By regulation, a well must be filled full length with impervious material. That material must be introduced into the well at the bottom and be placed progressively upward to ground surface.

Step 1 Remove all pumping equipment from the well. Thoroughly flush out the well using a bailer or air compressor.

Step 2 Measure the total depth of the well, the diameter and the non-pumping water level. If possible, compare these figures with the information on the original drilling report. Confirm whether the well is open to its original depth.

Step 3 Use these figures to decide which plugging material is appropriate and how much you will need. A drilling contractor can help you decide. Whether or not the casing can be successfully pulled out will also determine which material to use and what method is appropriate for placing it into the well. If the casing cannot be removed, choose a slurry that can be pumped under pressure into the well so that any space around the outside of the casing will also get filled in.

Step 4 Disinfect the well. Add enough chlorine to bring the water standing in the well to a chlorine concentration of 200 mg/L. For every 450 L (100 gal.) of water in the well, add 2 L (.4 gal.) of household bleach (5.25% chlorine). See Module 6 "Shock Chlorination—Well Maintenance" to calculate how much water is in your well. Leave this chlorine in your well.

Step 5 If possible, remove the well casing.

Step 6 Place the plugging material into the well. It must be introduced at the bottom of the well and placed progressively upwards to ground surface. The only exception to this rule is when the plugging material being used is a bentonite pellet that has been designed and manufactured for pouring into the well from the ground surface.

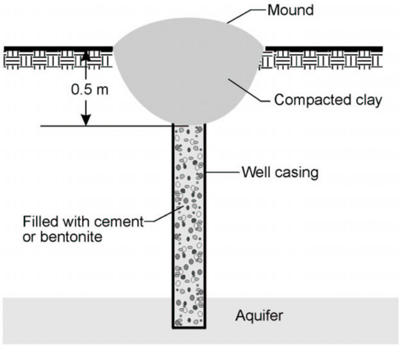
Step 7 If the casing was not already removed, dig around it and cut it off a minimum of 0.5 m (20 in.) below the ground surface (see Figure 4, Cutting Off the Casing and Mounding the Clay).

Step 8 Backfill and mound this portion of the hole with material appropriate for intended use of the land (i.e., clay) (see Figure 4, Cutting Off the Casing and Mounding the Clay).

Step 9 Use the worksheet at the end of this module to record the details of your well plugging. Include the well owner name, location, total depth, casing diameter, type and amount of plugging material used, date and method of placing material into the well. Send a copy of this record to:

Alberta Environment
Groundwater Information Centre
10th Floor, Oxbridge Place
Edmonton, Alberta T5K 2J6

Figure 4 Cutting Off the Casing and Mounding the Clay



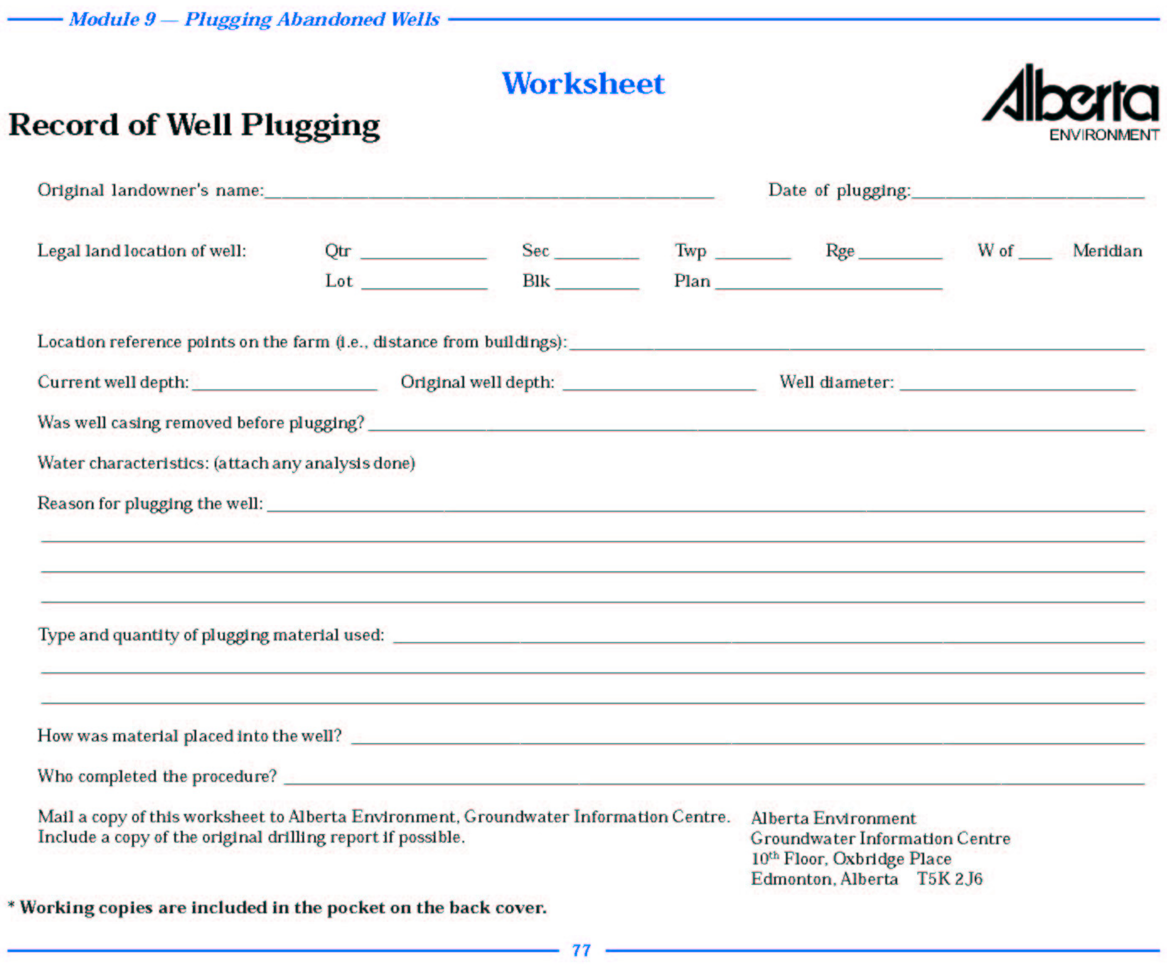
Special Problems

Flowing wells present special problems for plugging. It is highly recommended that you use the services of a drilling contractor. Before a flowing well can be plugged, the flow must be controlled. Several methods can be used.

- Reduce the flow by pouring high specific gravity fluids such as drilling mud or cement into the well.
- If there is a nearby well that is tapped into the same aquifer as the flowing well being plugged, pump it to create a drawdown in the well being plugged.
- Where practical, extend the well casing high enough above the ground surface to stop the flow.

Worksheet

For future reference, use the "Record of Well Plugging" worksheet to record the date of plugging, materials and procedures used. Also mark or map the location of this plugged well for future reference. A sample copy is included at the back of this module. Working copies are included in the pocket on the back cover. Keep the worksheet in the back pocket.



Module 9 — Plugging Abandoned Wells

Worksheet

Record of Well Plugging

Alberta
ENVIRONMENT

Original landowner's name: __________ Date of plugging: __________

Legal land location of well: Qtr ______ Sec ______ Twp ______ Rge ______ W of ____ Meridian
Lot ______ Blk ______ Plan __________

Location reference points on the farm (i.e., distance from buildings): __________

Current well depth: __________ Original well depth: __________ Well diameter: __________

Was well casing removed before plugging? __________

Water characteristics: (attach any analysis done)

Reason for plugging the well: __________

Type and quantity of plugging material used: __________

How was material placed into the well? __________

Who completed the procedure? __________

Mail a copy of this worksheet to Alberta Environment, Groundwater Information Centre. Include a copy of the original drilling report if possible.

Alberta Environment
Groundwater Information Centre
10th Floor, Oxbridge Place
Edmonton, Alberta T5K 2J6

*** Working copies are included in the pocket on the back cover.**

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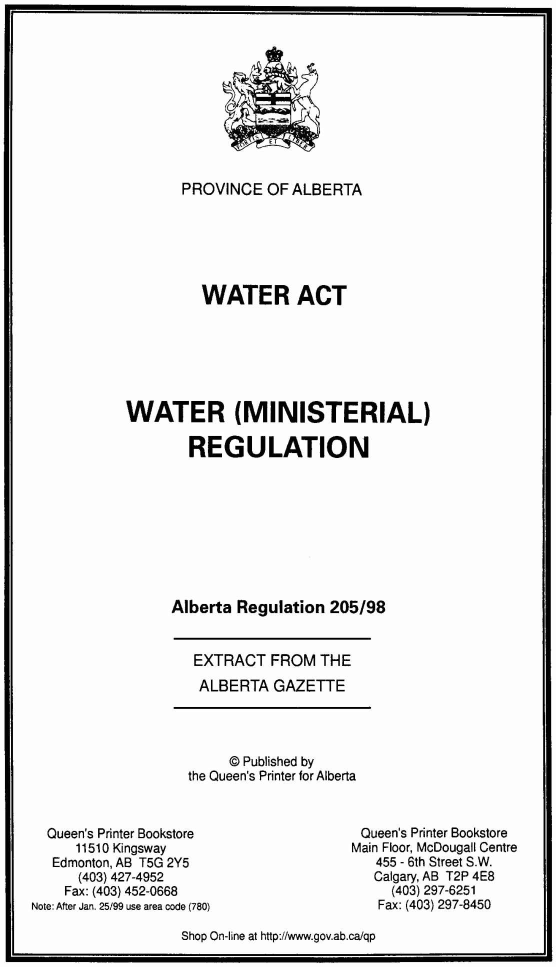
Water Act - Water (Ministerial) Regulation



PROVINCE OF ALBERTA

WATER ACT

WATER (MINISTERIAL) REGULATION

Alberta Regulation 205/98

EXTRACT FROM THE
ALBERTA GAZETTE

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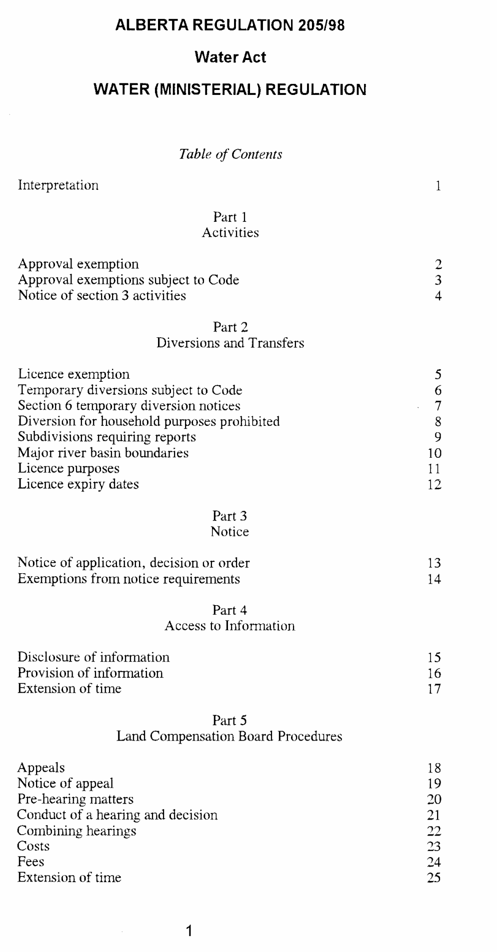

ALBERTA REGULATION 205/98

Water Act

WATER (MINISTERIAL) REGULATION

Table of Contents

1

Chemical Analysis of Farm Water Supplies

Adapted from Agdex 716 (D04) Published April 1991

A routine chemical analysis tests the water for 15 chemical parameters. It will reveal the hardness and iron concentration as well as the presence of other chemicals such as chlorides, sulphates, nitrates and nitrites. Chemicals, other than those listed below, can be tested but arrangements should be made with the lab before the sample is submitted. These special requests' must be clearly specified on the request form. Your farm water supply should be analyzed whenever a new water source is constructed, or when a change in water quality is noticed.

Your local health unit can provide you with the necessary water sample containers. Water samples specifically for human consumption must be submitted to the health unit.

The water sample you take should be representative. Choose an outlet as close to the source as possible. For most domestic samples, allow the water to run through the faucet for about five minutes and then fill the sample container.

Once you have obtained a good water sample, take it to your local health unit for forwarding to the appropriate laboratory. After the laboratory analysis is completed, the health inspector or technologist will receive a copy of the analysis and will be able to help you interpret the results.

Water Quality Criteria
It is not essential for private supplies to meet these guidelines. People have different reactions and tolerances to different minerals. If any chemical in your water exceeds drinking water limits consult you family doctor or local health unit.

All levels listed below (except pH) are listed in parts per million (ppm). Many labs report results in milligrams/Litre (mg/L), which is equivalent to ppm.

Sodium
Sodium is not considered a toxic metal, and 5,000 to 10,000 milligrams per day are consumed by normal adults without adverse effects. The average intake of sodium from water is only a small fraction of that consumed in a normal diet.

Persons suffering from certain medical conditions such as hypertension may require a sodium restricted diet, in which case the intake of sodium from drinking water could become significant. Sodium levels as low as 20 ppm are sometimes a concern to them. A maximum level of 300 (200*) ppm sodium has traditionally been used as a guideline but the "Guidelines for Canadian Drinking Water Quality" list no maximum acceptable concentration.

Sodium is a significant factor in assessing water for irrigation and plant watering. High sodium levels affect soil structure and a plant's ability to take up water.

Potassium
Potassium is usually only found in quantities of a few ppm in water. There is no recommended limit for potassium but levels over 2,000 ppm may be harmful to human nervous systems. Alberta water supplies rarely contain more than 20 ppm.

Calcium

Calcium is one cause of "hardness" in water. Calcium is not a hazard to health but is undesirable because it may be detrimental for domestic uses such as washing, bathing and laundering. It also tends to cause encrustations in kettles, coffee makers and water heaters. 200 ppm is often considered an acceptable limit.

Magnesium

Magnesium is another constituent causing "hardness" in water. A suggested limit of 150 ppm is used because of taste considerations.

Iron

Iron levels as low as 0.2 to 0.3 ppm will usually cause the staining of laundry and plumbing fixtures. The presence of iron bacteria in water supplies will often cause these symptoms at even lower levels. Iron gives water a metallic taste that may be objectionable to some persons at one to two ppm. Most water contains less that five ppm iron but occasionally levels over 30 ppm are found. Iron and iron bacteria are not considered a health concern.

Sulphate (SO4)

Sulphate concentrations over 500 ppm can be laxative to some humans and livestock. Sulphate levels over 500 ppm may be a concern for livestock on marginal intakes of certain trace minerals. Very high levels of sulphates have been associated with some brain disorders in cattle and pigs.

Chloride

Due to taste considerations the suggested maximum level for chloride is 250 ppm. Most water in Alberta contains less than 20 ppm chloride, although chloride in the 2,000 ppm range can be found.

NO2 Nitrogen (Nitrite)

Due to its toxicity, the maximum acceptable concentration of nitrite in drinking water is one ppm. Nitrite is usually an indicator of very direct contamination by sewage or manure because nitrites are unstable and quickly become nitrates.

The concentration in livestock water should not exceed 10 ppm.

NO3 Nitrogen (Nitrate)

Nitrates are also an indicator of contamination by human or livestock wastes, excessive fertilization or seepage from dump sites. The maximum acceptable concentration in drinking water is 10 ppm. The figure is based on the potential for the nitrate poisoning of infants. Adults can tolerate higher levels but high nitrate levels may cause irritation of the stomach and bladder. The suggested maximum for livestock use is 1,000 ppm.

Fluoride

Fluorides occur naturally in most well waters and are desirable since they help prevent dental cavities. Between one and 1.5 ppm is desirable. As fluoride levels increase above this amount there is an increase in the tendency to cause tooth mottling.

Fluoride levels less than four ppm are not considered a problem for livestock.

TDS Inorganic (Total Dissolved Solids)

This is a measure of the inorganic minerals dissolved in the water. As a general rule less than 1,000 (500*) ppm TDS is considered satisfactory. Levels higher than this are not necessarily a problem; it depends on the specific minerals present.

The suitability for livestock deteriorates as TDS exceeds the 2,000 to 3,000 ppm range.

Conductivity

Conductivity is measured in micro Siemens per centimetre. It can be used to estimate the total dissolved solids in the water. Multiplying the conductivity by 0.65 will give a good approximation of the total dissolved solids. Conductivity tests are often used to assess water suitability for irrigation.

pH

pH is a measure of how acidic or basic the water is. The pH scale goes from zero (acidic) to 14 (basic) with seven being neutral. The generally accepted range for pH is 6.5 to 8.5 with an upper limit of 9.5.

Hardness

The harder the water is the greater its ability to neutralize soap suds. Hardness is caused primarily by calcium and magnesium, but is expressed as ppm equivalent of calcium carbonate. Hard water causes soap curd which makes bathroom fixtures difficult to keep clean and causes greying of laundry.

Hard water will also tend to form scale in hot water tanks, kettles, piping systems, etc.

Type of Water	**Amount of Hardness**	
	ppm	**grains per gallon**
Soft	0- 50	0-3
Moderately Soft	50 - 100	3-6
Moderately Hard	100 - 200	6-12
Hard	200 - 400	12- 23
Very Hard	400 - 600	23 - 35
Extremely Hard	Over 600	Over 35

Alkalinity

Alkalinity is not a specific substance but rather a combined effect of several substances. It is a measure of the resistance of a water to a change in pH. The alkalinity of most Alberta waters is in the range of 100 - 500 ppm, which is considered acceptable. Water with higher levels is often used. Alkalinity is a factor in corrosion or scale deposition and may affect some livestock when over 1,000 ppm.

Water Treatment

Water treatment equipment can often improve water quality significantly. Each type of water treatment equipment has its limitations and thus should be selected carefully. For more information on water treatment please refer to the Agdex 71 6 D series of fact sheets.

Helpful Conversions

1 ppm (part per million) = 1 mg/L (milligram per litre)
1 gpg (grain per gallon) = 17.1 ppm (parts per million)

References

Guidelines for Canadian Drinking Water Quality (1987) Health and Welfare Canada

*Federal-Provincial Subcommittee on Drinking Water of the Federal-Provincial-Territorial Committee on Environment and Occupational Health. March 2001. Summary of Guidelines for Canadian Drinking Water Quality.

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);
http://www.agric.gov.ab.ca/water/wells/index.html
Quality Farm Dugouts - http://www.agric.gov.ab.ca/esb/dugout.html

ALBERTA ENVIRONMENT

WATER - http://www3.gov.ab.ca/env/water.cfm

GROUNDWATER INFORMATION SYSTEM - http://www.telusgeomatics.com/tgpub/ag_water/

WATER WELL INSPECTORS
Jennifer McPherson (Edmonton: 780-427-6429)

WATER WELL LICENSING
Rob George (Edmonton: 780-427-6429) - http://www3.gov.ab.ca/env/regions/central/

GEOPHYSICAL INSPECTION SERVICE
Edmonton: 780-427-3932

COMPLAINT INVESTIGATIONS
Jerry Riddell (Edmonton: 780-422-4851)
Claude Eckert (Calgary: 403-297-6649)
Ian Franks (Lethbridge: 403-381-5998)

GENERAL LICENSING INQUIRIES
Lethbridge: 403-381-5392

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
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WILDROSE COUNTRY GROUND WATER MONITORING ASSOCIATION
Dave Andrews (Irricana: 403-935-4478)

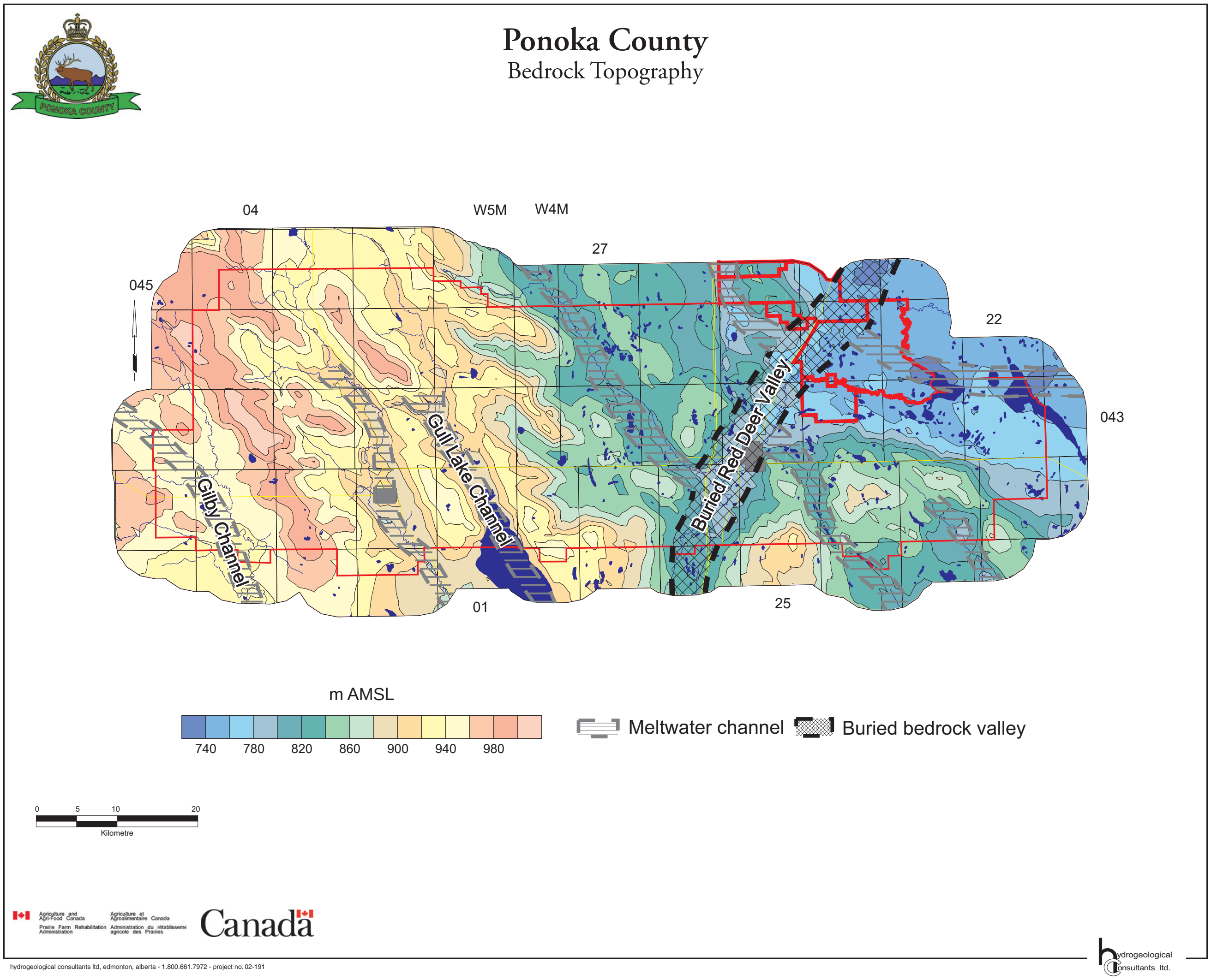
LOCAL HEALTH DEPARTMENTS

PONOKA COUNTY

Appendix D

Maps and Figures Included as Large Plots

Bedrock Topography



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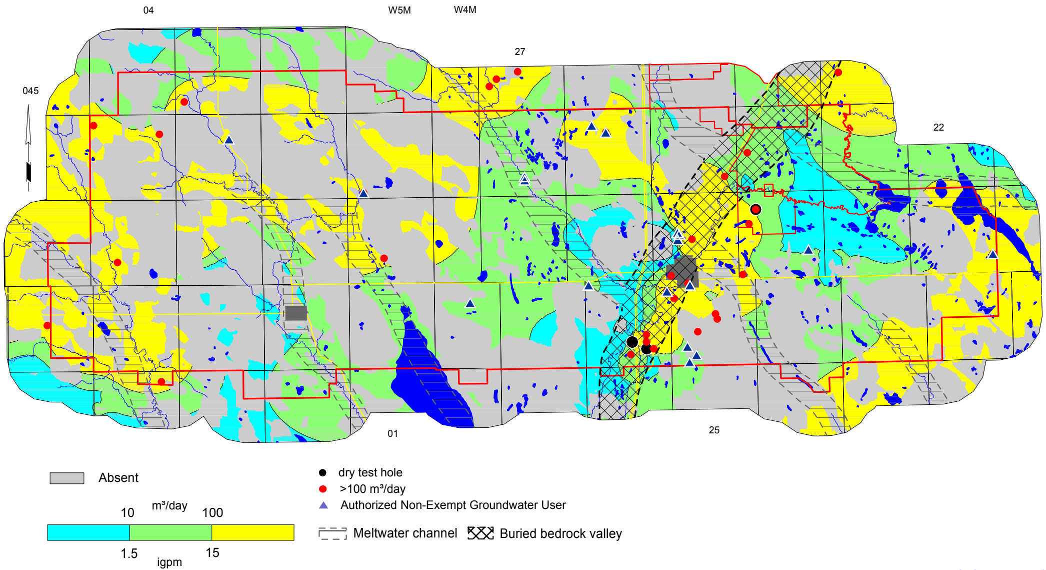
Apparent Yield for Water Wells Completed in Sand and Gravel Aquifer(s)

Ponoka County

Apparent Yield for Water Wells Completed in Sand and Gravel 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

0 5 10 20
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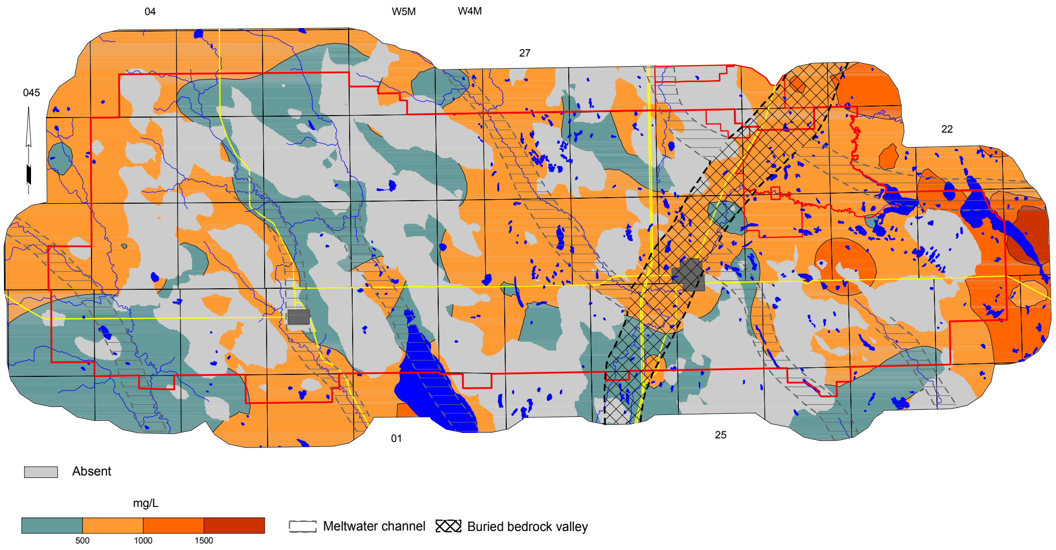
Total Dissolved Solids in Groundwater from Surficial Deposits

Ponoka 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

0 5 10 20
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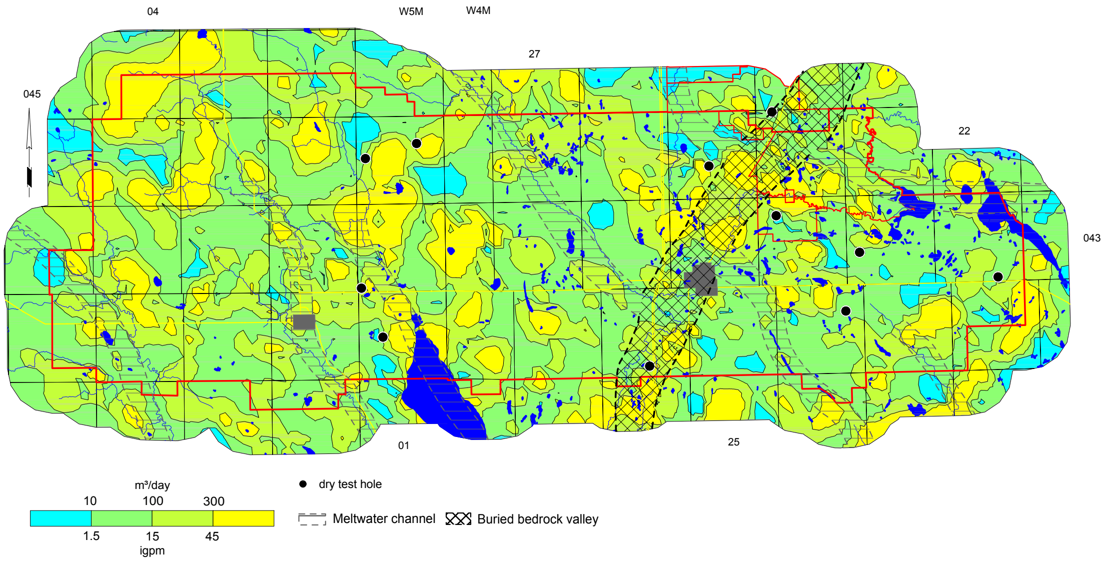
Apparent Yield for Water Wells Completed in Upper Bedrock Aquifer(s)

Ponoka 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

0 5 10 20
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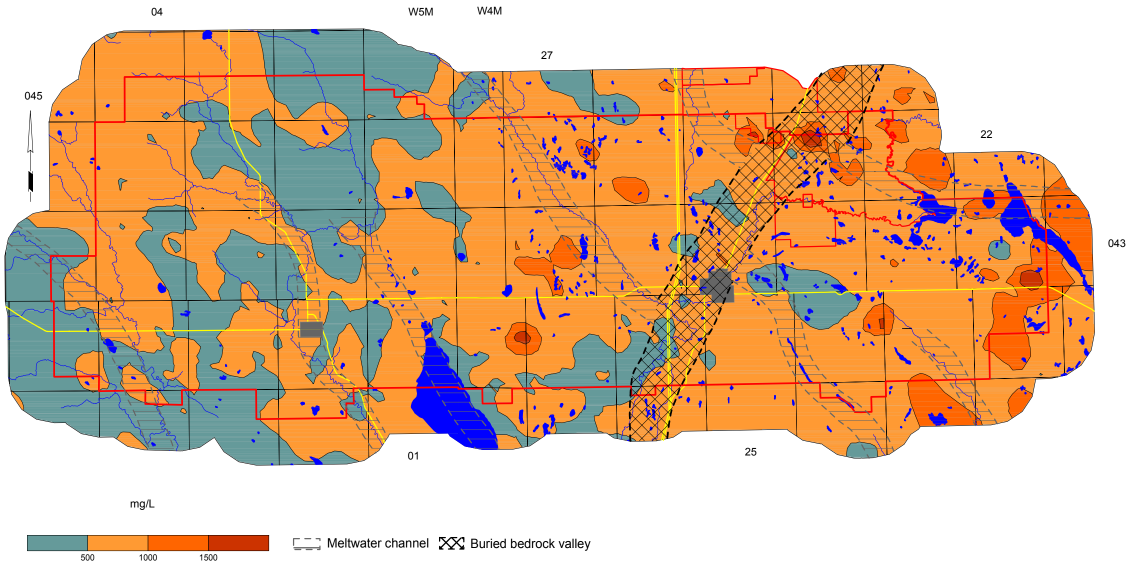
Total Dissolved Solids in Groundwater from Upper Bedrock Aquifer(s)

Ponoka County

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



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

0 5 10 20
Kilometre

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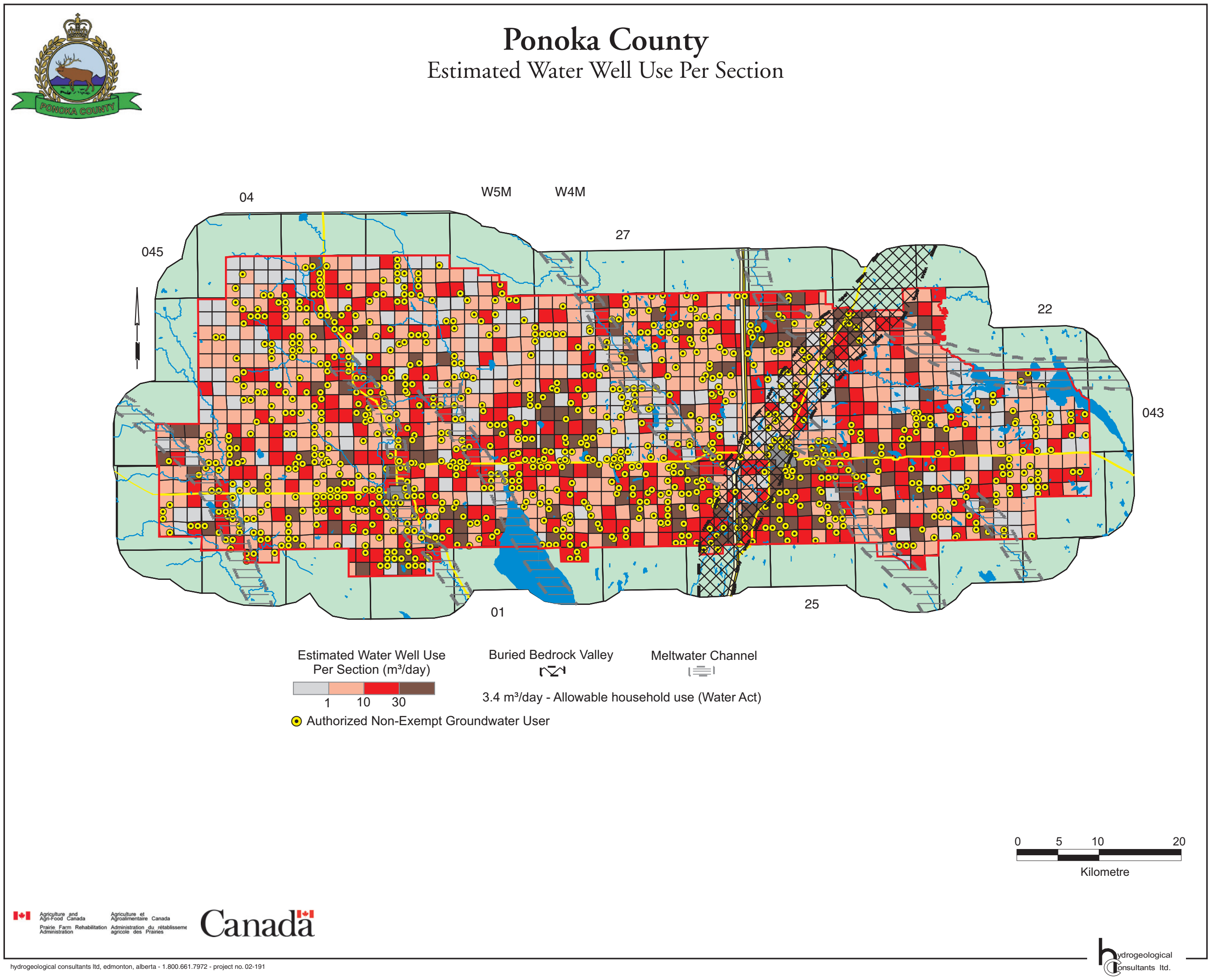
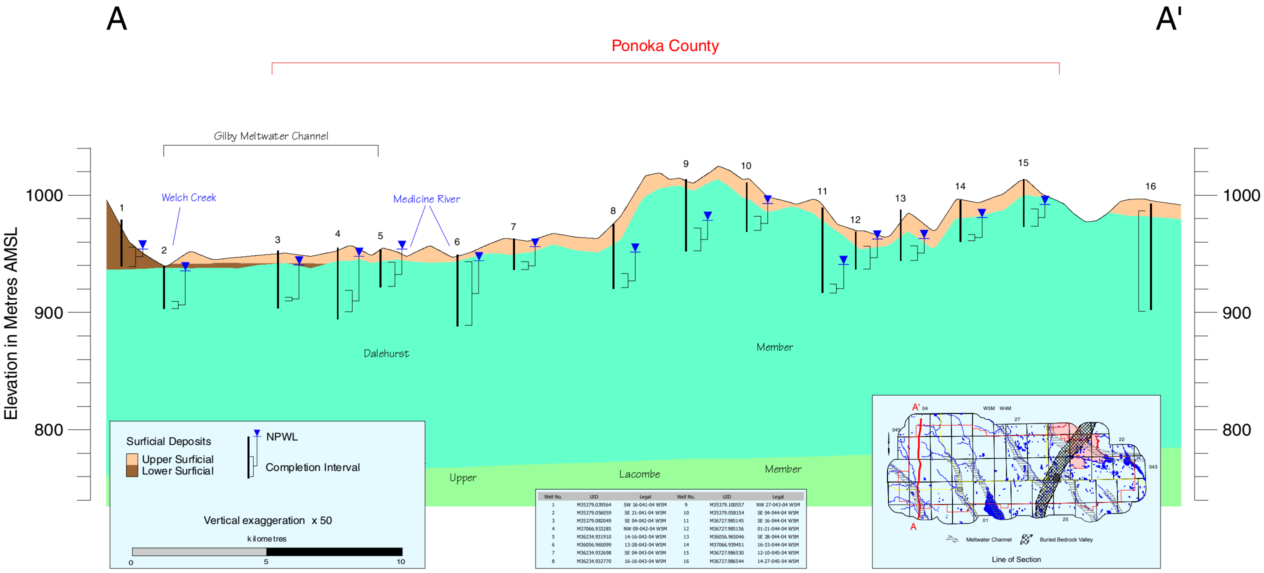
Estimated Water Well Use Per Section



Cross-Section A - A'

Ponoka County
Cross-Section A - A'



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3	M35379.082049	SE 04-042-04 W5M	11	M36727.985145	SE 16-044-04 W5M
4	M37066.933285	NW 09-042-04 W5M	12	M36727.985156	01-21-044-04 W5M
5	M36234.931910	14-16-042-04 W5M	13	M36056.965046	SE 28-044-04 W5M
6	M36056.965099	13-28-042-04 W5M	14	M37066.939451	16-33-044-04 W5M
7	M36234.932698	SE 04-043-04 W5M	15	M36727.986530	12-10-045-04 W5M
8	M36234.932770	16-16-043-04 W5M	16	M36727.986544	14-27-045-04 W5M

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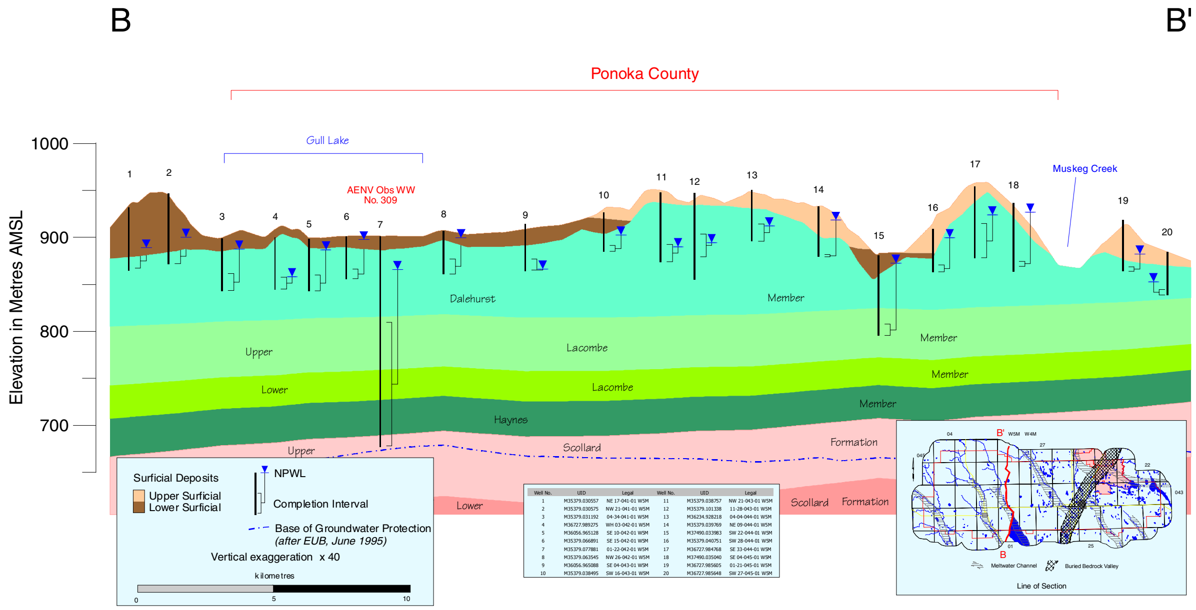
Cross-Section B - B’

Ponoka County

Cross-Section B - B'



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4	M36727.989275	WH 03-042-01 W5M	14	M35379.039769	NE 09-044-01 W5M
5	M36056.965128	SE 10-042-01 W5M	15	M37490.033983	SW 22-044-01 W5M
6	M35379.066891	SE 15-042-01 W5M	16	M35379.040751	SW 28-044-01 W5M
7	M35379.077881	01-22-042-01 W5M	17	M36727.984768	SE 33-044-01 W5M
8	M35379.063545	NW 26-042-01 W5M	18	M37490.035040	SE 04-045-01 W5M
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10	M35379.038495	SW 16-043-01 W5M	20	M36727.985648	SW 27-045-01 W5M

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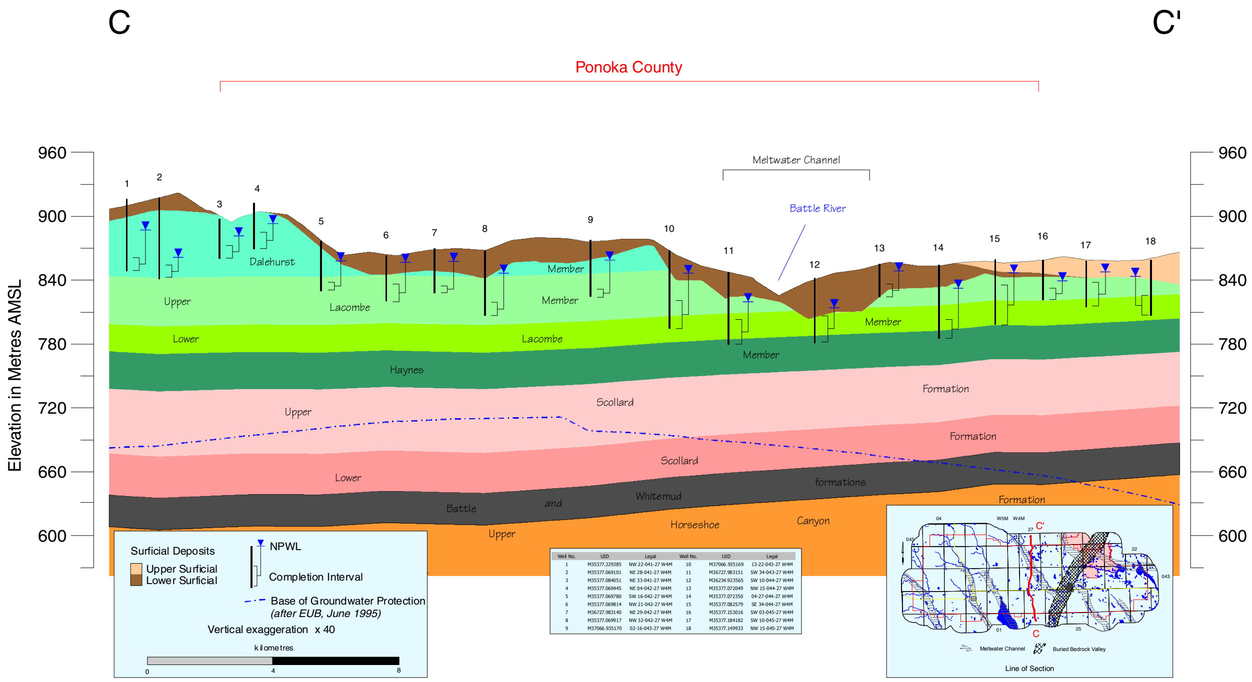
Cross-Section C - C'

Ponoka County
Cross-Section C - C'



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4	M35377.069445	NE 04-042-27 W4M	13	M35377.072049	NW 15-044-27 W4M
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8	M35377.069917	NW 32-042-27 W4M	17	M35377.184182	SW 10-045-27 W4M
9	M37066.935170	02-16-043-27 W4M	18	M35377.149933	NW 15-045-27 W4M

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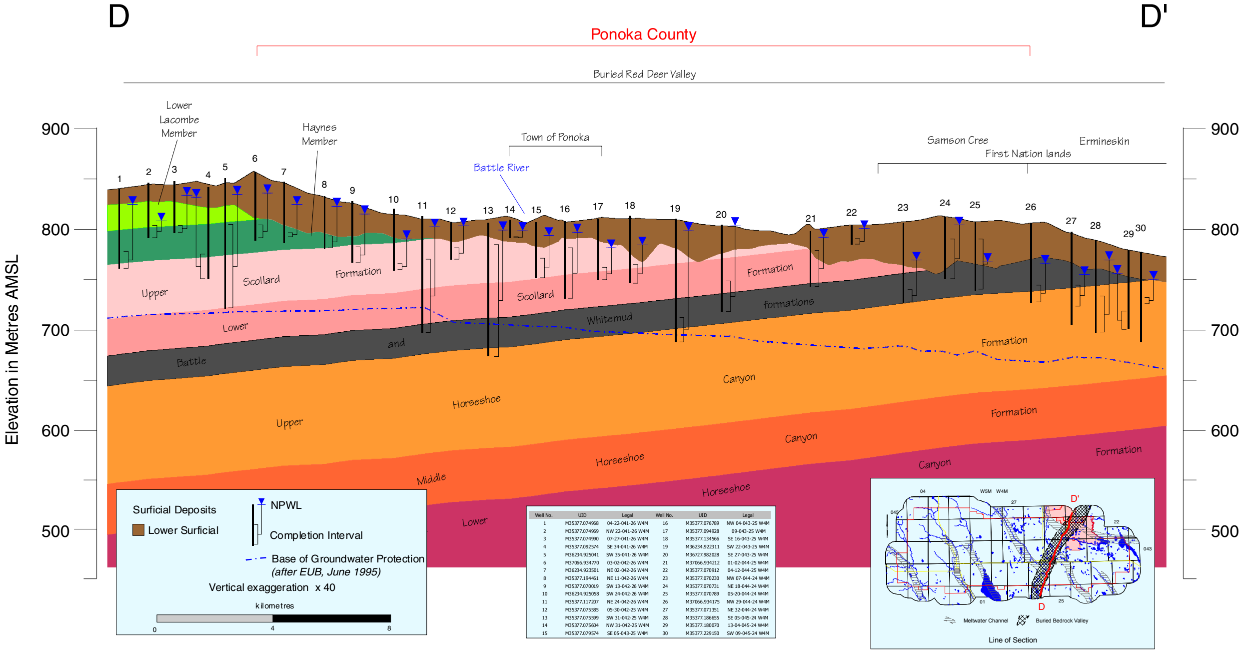
Cross-Section D - D’

Ponoka County
Cross-Section D - D'



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4	M35377.092574	SE 34-041-26 W4M	19	M36234.922311	SW 22-043-25 W4M
5	M36234.925041	SW 35-041-26 W4M	20	M36727.982028	SE 27-043-25 W4M
6	M37066.934770	03-02-042-26 W4M	21	M37066.934212	01-02-044-25 W4M
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8	M35377.194461	NE 11-042-26 W4M	23	M35377.070230	NW 07-044-24 W4M
9	M35377.070019	SW 13-042-26 W4M	24	M35377.070731	NE 18-044-24 W4M
10	M36234.925058	SW 24-042-26 W4M	25	M35377.070789	05-20-044-24 W4M
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12	M35377.075585	05-30-042-25 W4M	27	M35377.071351	NE 32-044-24 W4M
13	M35377.075599	SW 31-042-25 W4M	28	M35377.186655	SE 05-045-24 W4M
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15	M35377.079574	SE 05-043-25 W4M	30	M35377.229150	SW 09-045-24 W4M

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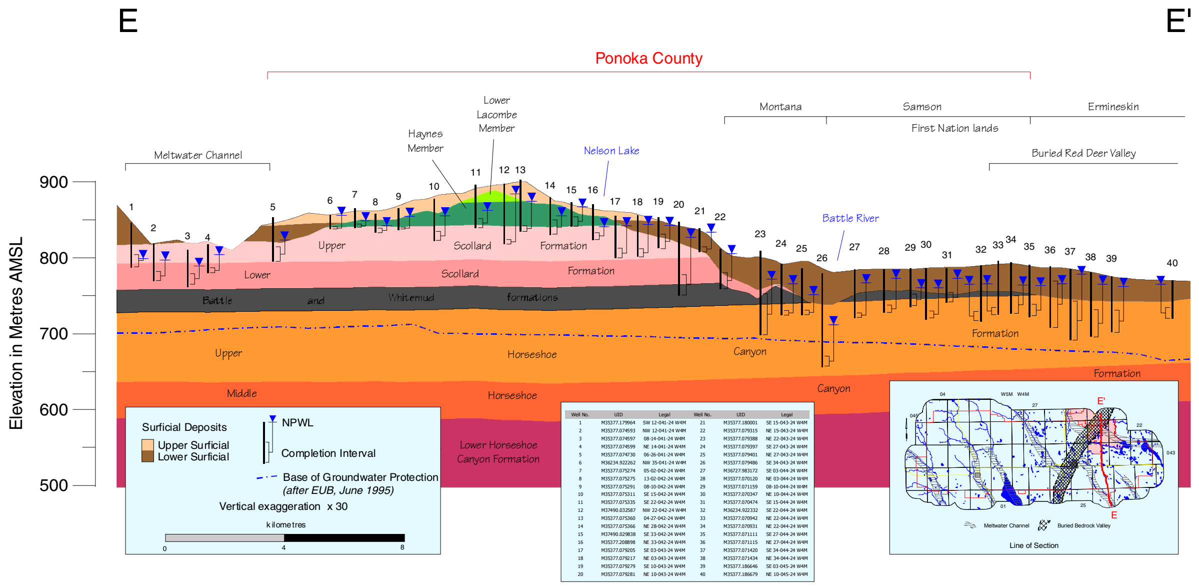
Cross-Section E - E'

Ponoka County

Cross-Section E - E'



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3	M35377.074597	08-14-041-24 W4M	23	M35377.079388	NE 22-043-24 W4M
4	M35377.074599	NE 14-041-24 W4M	24	M35377.079397	SE 27-043-24 W4M
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7	M35377.075274	05-02-042-24 W4M	27	M36727.983172	SE 03-044-24 W4M
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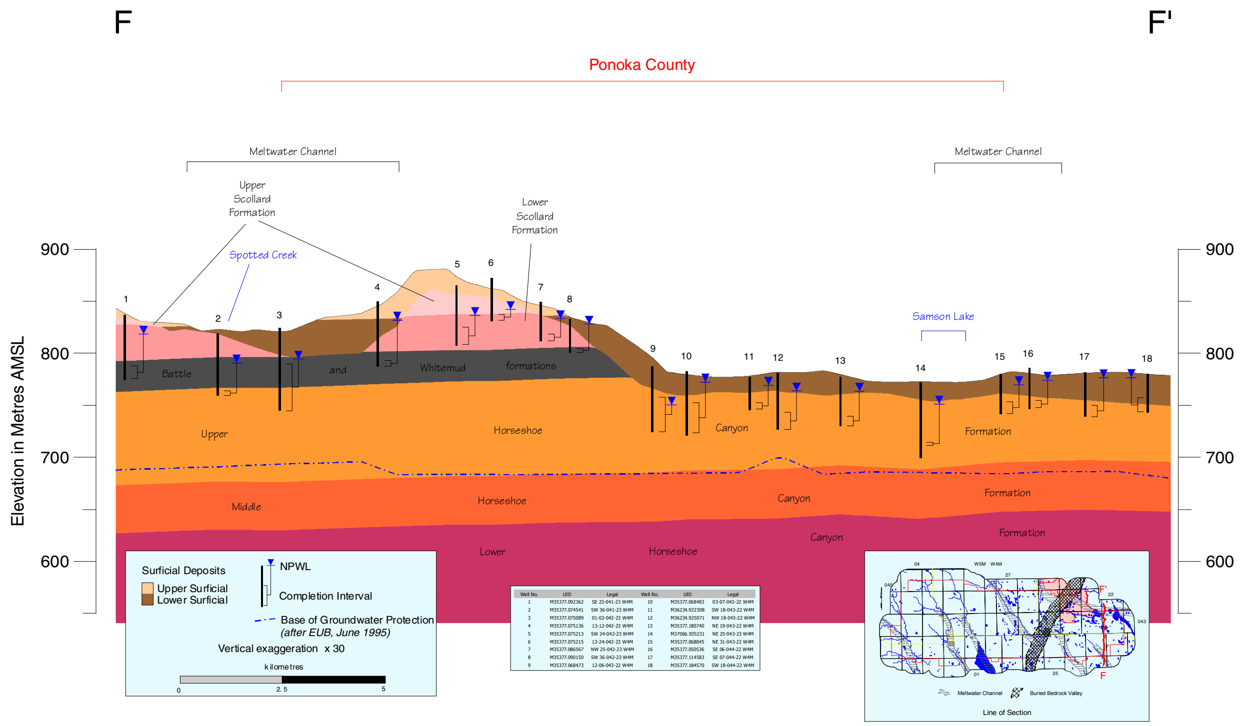
Cross-Section F - F'

Ponoka County
Cross-Section F - F'



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3	M35377.075089	01-02-042-23 W4M	12	M36234.925071	NW 18-043-22 W4M
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5	M35377.075213	SW 24-042-23 W4M	14	M37066.935231	NE 25-043-23 W4M
6	M35377.075215	13-24-042-23 W4M	15	M35377.068845	NE 31-043-22 W4M
7	M35377.086567	NW 25-042-23 W4M	16	M35377.050536	SE 06-044-22 W4M
8	M35377.090150	SW 36-042-23 W4M	17	M35377.114583	SE 07-044-22 W4M
9	M35377.068473	12-06-043-22 W4M	18	M35377.184570	SW 18-044-22 W4M

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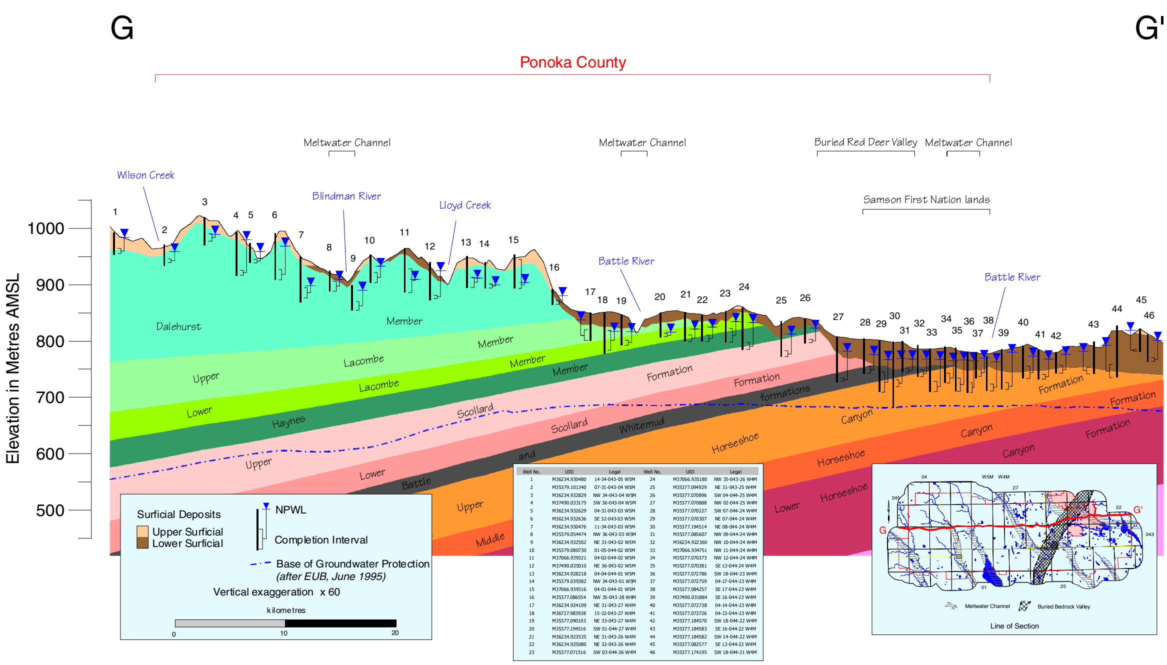
Cross-Section G - G'

Ponoka County

Cross-Section G - G'



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4	M37490.033175	SW 36-043-04 W5M	27	M35377.070888	NW 02-044-25 W4M
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23	M35377.071516	SW 03-044-26 W4M	46	M35377.174195	SW 18-044-21 W4M

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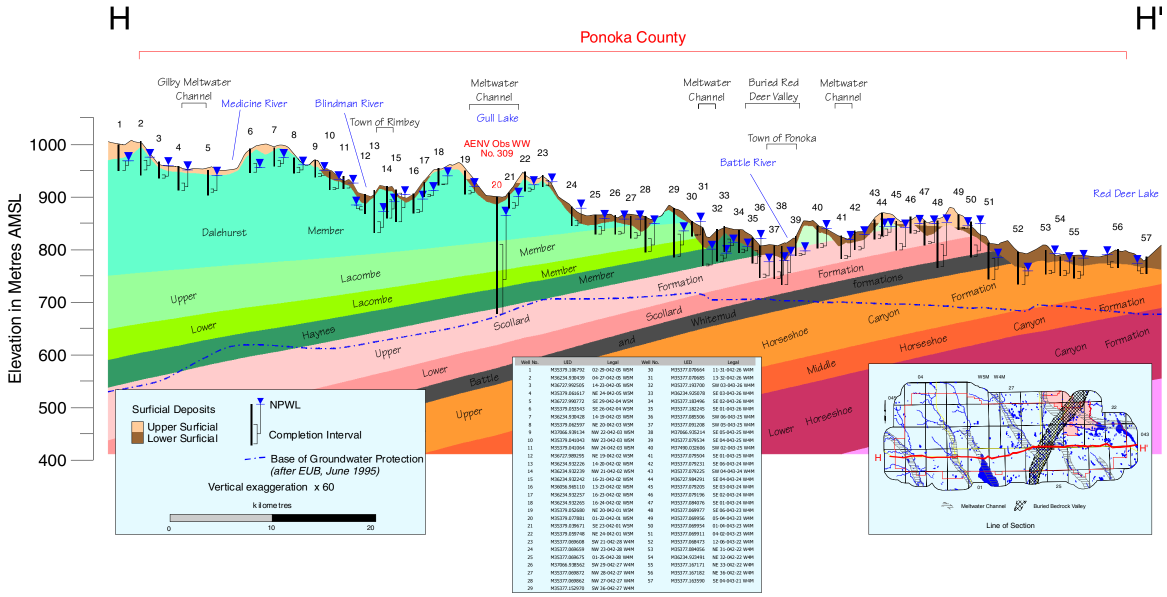
Cross-Section H - H'

Ponoka County

Cross-Section H - H'



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5	M36727.990772	SE 29-042-04 W5M	34	M35377.183496	SE 02-043-26 W4M
6	M35379.053543	SE 26-042-04 W5M	35	M35377.182245	SE 01-043-26 W4M
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23	M35377.069608	SW 21-042-28 W4M	52	M35377.068473	12-06-043-22 W4M
24	M35377.069659	NW 23-042-28 W4M	53	M35377.084056	NE 31-042-22 W4M
25	M35377.069675	01-25-042-28 W4M	54	M36234.923491	NE 32-042-22 W4M
26	M37066.938562	SW 29-042-27 W4M	55	M35377.167171	NE 33-042-22 W4M
27	M35377.069872	NW 28-042-27 W4M	56	M35377.167182	NE 36-042-22 W4M
28	M35377.069862	NW 27-042-27 W4M	57	M35377.163590	SE 04-043-21 W4M
29	M35377.152970	SW 36-042-27 W4M			

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PONOKA COUNTY

Appendix E

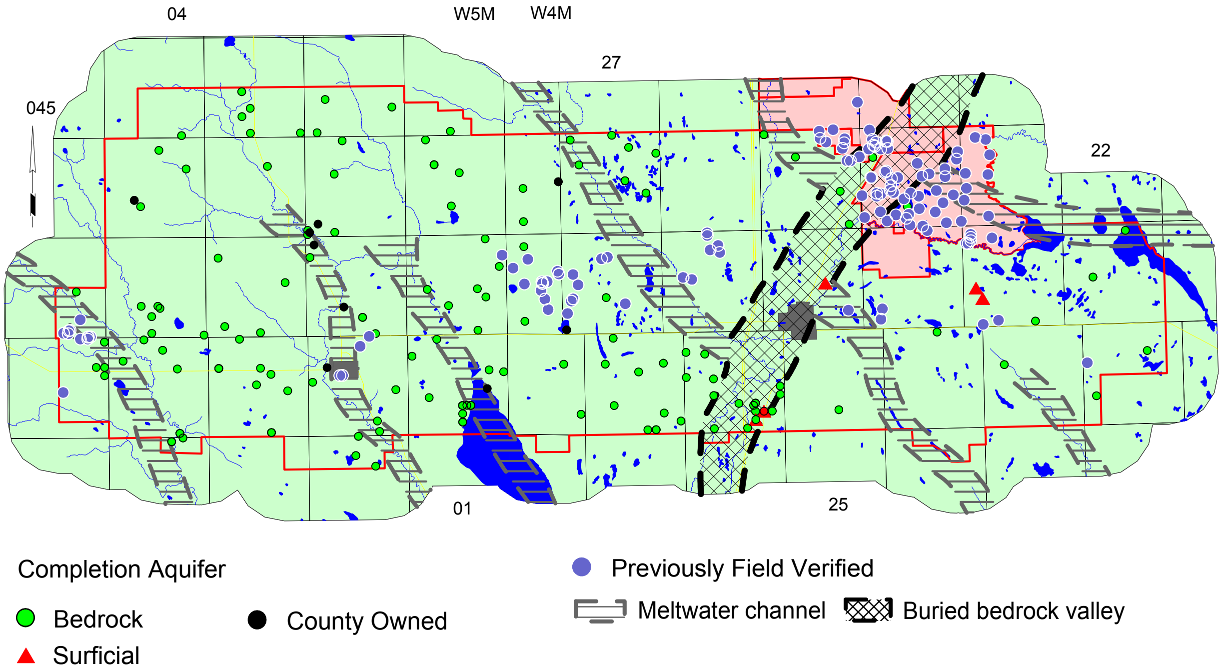
Water Wells Recommended for Field Verification

and

County-Operated Water Wells

Water Wells Recommended for Field Verification

(details on following pages)



WATER WELLS RECOMMENDED FOR FIELD VERIFICATION

		Aquifer	Date Water	Completed Depth		NPWL			
Owner	Location	Name	Well Drilled	Metres	Feet	Metres	Feet	UID	Field Checked
Adams, John and Joy	15-11-043-28 W4M	Dalehurst	12-Nov-83	36.6	120.1	5.8	19.0	M36076.566387	27-Mar-03
Adcock, Miles	NW 22-042-27 W4M	Upper Lacombe	17-May-84	29.0	95.0	7.01	23.0	M35377.069820	
Allen, Bill	SE 11-042-27 W4M	Dalehurst	23-Jun-78	29.3	96.0	16.8	55.0	M35377.069506	
Anastasi, Arthur	SE 14-044-25 W4M	Lower Scollard	01-Aug-74	51.5	169.0	3.7	12.0	M35377.070920	
Anderson, Gary	SE 13-042-26 W4M	Upper Scollard	01-May-79	48.8	160.0	24.7	81.0	M35377.070014	
Applegarth, Helen	NW 07-044-24 W4M	Upper Horseshoe Canyon	21-Jul-77	67.1	220.0	29.6	97.0	M35377.070298*	24-Jun-02
Applegarth, Myron / Samson Band	NW 07-044-24 W4M	Upper Horseshoe Canyon	24-Apr-00	71.6	235.0	37.2	122.0	M37066.938602*	24-Jun-02
Arnold, Mervin	SE 30-044-24 W4M	Upper Horseshoe Canyon	26-May-84	68.6	225.0	5.2	17.0	M35377.071231	
Baines, Howard	SE 01-045-03 W5M	Dalehurst	10-Sep-75	15.9	52.0	7.9	26.0	M36727.985787	
Bartesko, D.L.	SE 03-042-03 W5M	Dalehurst	01-Jun-73	27.4	90.0	12.2	40.0	M35379.037937	
Bartesko, D.L.	SE 03-042-03 W5M	Dalehurst	01-Jun-73	27.4	90.0	12.2	40.0	M35379.037937	
Bauer, Donald	SE 02-043-05 W5M	Dalehurst	23-Apr-81	15.2	50.0	3.1	10.0	M35379.076454	14-May-97
Bauer, Donald	01-02-043-05 W5M	Dalehurst	30-Sep-83	22.9	75.0	9.1	30.0	M36234.932842	14-Sep-97
Bauer, Donald	02-02-043-05 W5M	Dalehurst	06-Oct-83	25.9	85.0	6.1	20.0	M36234.932843	14-May-97
Becker, Doug	01-01-043-04 W5M	Dalehurst	17-Sep-81	19.5	64.0	3.7	12.0	M36234.932691	
Beekman, Walter	12-05-043-03 W5M	Dalehurst	03-Aug-79	64.0	210.0	24.4	80.0	M36234.932536	
Beierbach, Les	04-26-042-04 W5M	Dalehurst	23-Jun-81	18.3	60.0	9.1	30.0	M36234.931936	
Bell, Terry	NW 11-042-26 W4M	Haynes	17-Sep-79	48.8	160.0	12.5	41.0	M35377.069752	
Bennik, J.	NE 14-042-03 W5M	Dalehurst	03-May-71	29.6	97.0	9.5	31.0	M37066.939188	
Boorman, George	NE 10-042-01 W5M	Dalehurst	12-Jun-79	24.4	80.0	4.0	13.2	M35379.039162	
Braeburn Stock Farms	SW 01-044-25 W4M	Upper Horseshoe Canyon	01-Jan-72	64.0	210.0	20.7	68.0	M35377.070885	
Brewster, John	SW 17-045-02 W5M	Dalehurst	16-Feb-82	16.5	54.0	5.8	19.0	M36727.985739	
Briedis, Olie	NE 03-043-28 W4M	Dalehurst	01-Sep-74	24.4	80.0	0.6	2.0	M35377.071350	
Brittain, K.M.	NW 10-042-01 W5M	Dalehurst	26-Apr-76	46.0	151.0	15.2	50.0	M35379.038261	
Broadbent, Jeff	SE 05-042-26 W4M	Haynes	14-Jul-81	73.2	240.0	14.6	48.0	M35377.069400	
Brooks, Russell	NW 03-042-01 W5M	Dalehurst	01-May-81	24.4	80.0	4.6	15.0	M35379.032080	
Bruno Jr., Leo / Samson Band	NW 24-044-24 W4M	Upper Horseshoe Canyon	08-Oct-98	76.2	250.0	24.0	78.7	M36727.982041*	26-Jul-02
Bruno, Brenda / Samson Band	SE 03-044-24 W4M	Upper Horseshoe Canyon	10-Nov-98	64.0	210.0	17.4	57.0	M36727.983172*	05-Jul-02
Bruno, Fred	SE 03-044-24 W4M	Upper Horseshoe Canyon	28-Jul-77	43.0	141.0	17.4	57.0	M35377.070110*	05-Jul-02
Bruno, Tina / Samson Band	NE 11-044-24 W4M	Upper Horseshoe Canyon	19-Oct-92	88.4	290.0	33.5	110.0	M35377.118367*	17-Jul-02
Buffalo, Danny / Samson Band	NW 14-044-24 W4M	Upper Horseshoe Canyon	15-Oct-96	73.2	240.0	38.1	125.0	M36234.921494*	18-Jul-02
Buffalo, Elesha / Samson Band	NE 36-043-24 W4M	Upper Horseshoe Canyon	25-Sep-98	79.2	260.0	15.2	50.0	M36234.925074*	22-Jul-02
Buffalo, Frank	NE 36-043-24 W4M	Lower Surficial	29-Dec-67	21.3	70.0	10.7	35.0	M35377.079500*	22-Jul-02
Buffalo, Karen	SE 19-044-23 W4M	Upper Horseshoe Canyon	16-Oct-79	49.4	162.0	9.1	30.0	M35377.070746*	31-Jul-02
Buffalo, Phyllis / Samson Band	SE 21-044-24 W4M	Upper Horseshoe Canyon	18-Sep-98	64.0	210.0	23.7	77.7	M36234.925096*	03-Jul-02
Buffalo, Rod	NE 13-044-24 W4M	Upper Horseshoe Canyon	21-Feb-81	64.0	210.0	27.1	89.0	M35377.070400*	25-Jul-02
Buffalo, Wanda / Samson Band	NW 18-044-23 W4M	Upper Horseshoe Canyon	15-Sep-99	68.6	225.0	17.4	57.0	M36727.984303*	02-Aug-02
Burkart, Helmut	NE 24-042-05 W5M	Dalehurst	15-Nov-74	30.5	100.0	6.1	20.0	M35379.041654	
Burkinshaw, Earl	NW 10-042-01 W5M	Dalehurst	13-Jul-81	40.5	133.0	13.4	44.0	M35379.038276	
Burns, R W	NW 22-044-01 W5M	Dalehurst	16-Apr-64	21.3	70.0	9.8	32.0	M35379.040535	
Burton, J.W.	16-23-042-01 W5M	Dalehurst	18-May-63	11.3	37.0	2.7	9.0	M35379.039676	
Buss, Robert	NE 17-043-22 W4M	Upper Horseshoe Canyon	26-Aug-77	34.8	114.0	7.3	24.0	M35377.068588	
Carby, Robert	SW 11-042-26 W4M	Haynes	29-Jul-81	58.5	192.0	14.6	48.0	M35377.069743	
Carr, W.	NW 33-044-02 W5M	Dalehurst	01-Jan-67	36.6	120.0	24.4	80.0	M36727.984894	
Christensen, G/T	NE 09-044-01 W5M	Dalehurst	17-Jul-85	61.0	200.0	15.9	52.0	M35379.040065	
Christenson, Merv	SW 10-044-02 W5M	Dalehurst	11-Aug-69	42.7	140.0	34.4	113.0	M36727.984824	
Christiansen, Terry	NE 01-042-27 W4M	Upper Lacombe	04-Jul-75	36.6	120.0	9.1	30.0	M35377.069418	
Clark, Ken	SW 02-042-04 W5M	Dalehurst	25-Jun-82	11.6	38.0	3.4	11.0	M36234.931864	
Clovechok, Ross	SW 29-042-27 W4M	Upper Lacombe	12-Sep-80	29.0	95.0	3.7	12.0	M35377.069879	
Coninx, Matthew	NE 36-042-05 W5M	Dalehurst	03-Nov-75	18.3	60.0	3.1	10.0	M35379.041107	
Cosby, Rioux	SW 03-043-03 W5M	Dalehurst	26-Apr-78	80.8	265.0	71.6	235.0	M36234.932531	

WATER WELLS RECOMMENDED FOR FIELD VERIFICATION (continued)

Owner	Location	Aquifer Name	Date Water Well Drilled	Completed Depth Metres	Completed Depth Feet	NPWL Metres	NPWL Feet	UID	Field Checked
Crane, John	SE 18-044-24 W4M	Upper Horseshoe Canyon	06-Sep-95	67.1	220.0	18.29	60.0	M35377.221720	
Crane, Mary	SW 18-044-24 W4M	Upper Horseshoe Canyon	27-Jul-84	70.1	230.0	42.67	140.0	M35377.186444	
Crane, Richard / Samson Band	SW 07-044-24 W4M	Upper Horseshoe Canyon	17-Aug-92	64.0	210.0	13.72	45.0	M35377.165077	
Crane, Tracy / Samson Band	NW 06-044-24 W4M	Upper Horseshoe Canyon	31-Mar-92	61.0	200.0	16.76	55.0	M35377.204119	
Crane, Virginia	SW 18-044-24 W4M	Upper Horseshoe Canyon	03-Oct-79	67.7	222.0	7.01	23.0	M35377.223587	
Crane, Wayne	NE 07-044-24 W4M	Upper Horseshoe Canyon	12-Nov-79	67.7	222.0	21.33	70.0	M35377.222338	
Cross, Harold	SW 06-044-02 W5M	Dalehurst	23-May-66	21.3	70.0	16.76	55.0	M35377.222389	
Curtis, Rance	02-02-045-04 W5M	Dalehurst	13-Oct-73	25.3	83.0	7.62	25.0	M35377.206326	
Cutknife, Ben / Samson Band	NW 24-044-24 W4M	Upper Horseshoe Canyon	12-Mar-99	77.7	255.0	4.66	15.3	M35377.223149	
Cutknife, Clark	SE 25-044-24 W4M	Upper Horseshoe Canyon	01-Nov-78	42.7	140.0	4.57	15.0	M35377.222905	
Cutknife, Craig / Samson Band	SE 25-044-24 W4M	Upper Horseshoe Canyon	28-Sep-98	70.1	230.0	4.57	15.0	M35377.221851	
Cutknife, Kristen	SE 04-044-24 W4M	Upper Horseshoe Canyon	14-Sep-82	64.0	210.0	22.86	75.0	M35377.206436	
Damer, R.	16-33-041-02 W5M	Dalehurst	10-Nov-83	54.9	180.0	12.19	40.0	M35377.222649	
Dayton, W.	NH 10-042-01 W5M	Dalehurst	26-Apr-79	36.6	120.0	6.1	20.0	M35377.221724	
De Atley, Larry	03-14-043-28 W4M	Dalehurst	23-Dec-79	31.1	102.0	2.68	8.8	M35377.221606	
Denoudsten, Peter	SE 12-042-28 W4M	Dalehurst	27-Sep-80	27.4	90.0	18.29	60.0	M35377.223826	
Dick Lake Gas Plant	05-05-044-01 W5M	Surficial	01-Jan-60	29.3	96.0	19.81	65.0	M35377.203944	
Doran, W.	09-28-044-27 W4M	Lower Lacombe	01-Jan-66	39.9	131.0	15.24	50.0	M35377.222717	
Dowling, Edward	SE 20-042-26 W4M	Lower Lacombe	30-Nov-82	48.8	160.0	10.06	33.0	M35377.206286	
Dube, Aurele	05-06-044-02 W5M	Dalehurst	16-Nov-78	27.4	90.0	15.85	52.0	M35377.092252	
Eagle, Frankie / Samson Band	SE 10-044-24 W4M	Upper Horseshoe Canyon	26-Mar-99	79.2	260.0	10.36	34.0	M35377.206135	
Eisenbarth, A.	SW 34-044-04 W5M	Dalehurst	08-Dec-81	25.9	85.0	3.96	13.0	M35377.221836	
Everden, Ted	NE 22-042-03 W5M	Dalehurst	29-Sep-78	42.7	140.0	6.71	22.0	M35377.221527	
Fehr, Oswald	NW 35-042-05 W5M	Dalehurst	23-May-89	30.5	100.0	18.9	62.0	M35377.204018	
Feitsma, Johan	NE 28-043-26 W4M	Haynes	05-Mar-02	53.3	175.0	4.11	13.5	M35377.221372	
Fenske, Clifford	05-28-044-25 W4M	Lower Scollard	09-Nov-77	88.4	290.0	6.1	20.0	M35377.207417	
Ferries, W.	NE 20-044-02 W5M	Dalehurst	01-Jun-71	25.0	82.0	19.81	65.0	M35377.222635	
Firingstone	SW 13-044-24 W4M	Upper Horseshoe Canyon	05-Mar-68	49.7	163.0	15.24	50.0	M35377.206493	
Fitzimmons, L	NH 09-043-01 W5M	Dalehurst	02-Jul-84	36.6	120.0	36.57	120.0	M35377.128768	
Frandsen, Eric	13-34-044-27 W4M	Lower Lacombe	01-Jun-76	48.8	160.0	37.79	124.0	M35377.128754	
Fulton, B.	14-24-044-02 W5M	Dalehurst	15-Nov-61	15.5	51.0	25.91	85.0	M35377.177346	
Ganson, Leo	NW 11-042-26 W4M	Haynes	12-Aug-80	50.3	165.0	24.08	79.0	M35377.219523	
Gartner, Rod(Well C)	NE 25-044-27 W4M	Lower Lacombe	29-Oct-77	33.2	109.0	34.14	112.0	M35377.206418	
Goings, Glen	13-02-042-02 W5M	Dalehurst	19-May-72	30.5	100.0	2.13	7.0	M35377.206311	
Gooch, Phil	SW 10-042-25 W4M	Upper Lacombe	08-Nov-56	15.9	52.0	16.76	55.0	M35377.222570	
Green, Francis / Samson Band	SW 09-044-24 W4M	Upper Horseshoe Canyon	07-Jul-97	64.0	210.0	7.86	25.8	M35377.222569	
Grutterink, John	02-30-042-03 W5M	Dalehurst	29-Jul-77	27.4	90.0	6.4	21.0	M35377.222543	
Grutterink, John	02-30-042-03 W5M	Dalehurst	29-Jul-77	27.4	90.0	8.47	27.8	M35377.130449	
Hagemann, Elmer	NE 13-042-26 W4M	Haynes	02-Dec-77	27.4	90.0	9.14	30.0	M35377.223171	
Hagemann, Stanley	12-13-043-01 W5M	Dalehurst	01-Jan-62	19.2	63.0	30.02	98.5	M35377.186538	
Hanneman, A.	SE 05-044-02 W5M	Dalehurst	19-Oct-77	32.0	105.0	24.38	80.0	M35377.206182	
Hardie, Charles	01-28-042-28 W4M	Dalehurst	27-Sep-62	25.9	85.0	13.72	45.0	M35377.206322	
Hartman, T.	08-34-043-28 W4M	Dalehurst	20-May-78	24.7	81.0	35.36	116.0	M35377.080315	
Hartman, Tony	SE 34-043-28 W4M	Dalehurst	20-May-78	24.7	81.0	6.1	20.0	M35377.223183	
Hawkins, Brian	01-27-041-02 W5M	Dalehurst	04-Oct-78	32.0	105.0	27.43	90.0	M35377.207246	
Heilmaun, N.	NE 28-041-02 W5M	Dalehurst	19-Jul-82	29.6	97.0	42.91	140.8	M35377.222129	
Hirsche, J.	NW 12-045-02 W5M	Dalehurst	06-Nov-83	22.6	74.0	42.67	140.0	M35377.206380	
Hoar, W.	NE 32-042-27 W4M	Upper Lacombe	03-Oct-84	30.5	100.0	8.84	29.0	M35377.221880	
Hodges, L.	NW 29-042-26 W4M	Haynes	23-Apr-66	67.1	220.0	9.45	31.0	M35377.206422	
Holzer, Fred	NW 16-045-03 W5M	Dalehurst	15-Jul-73	28.4	93.0	9.45	31.0	M35377.206423	
Hull, John	SW 17-042-01 W5M	Dalehurst	07-Dec-71	31.1	102.0	9.45	31.0	M35377.205967	
Hutchinson, John & Brenda	NW 03-042-01 W5M	Dalehurst	20-May-82	39.6	130.0	12.8	42.0	M35377.186555	
Jansen, Hank	SE 18-043-23 W4M	Lower Surficial	26-Nov-83	17.7	58.0	14.72	48.3	M35377.148099	

WATER WELLS RECOMMENDED FOR FIELD VERIFICATION (continued)

Owner	Location	Aquifer Name	Date Water Well Drilled	Completed Depth		NPWL		UID	Field Checked
				Metres	Feet	Metres	Feet		
Jehn, Gus	NE 24-042-05 W5M	Dalehurst	27-Apr-72	27.1	89.0	6.4	21.0	M35379.040943	
Jenson, T.	SE 04-043-04 W5M	Dalehurst	18-Nov-74	26.2	86.0	7.0	23.0	M36234.932698	
Johns, E.	NW 30-043-02 W5M	Dalehurst	24-Aug-84	32.0	105.0	11.6	38.0	M36234.932488	
Johnson, B.	NE 30-042-27 W4M	Upper Lacombe	08-Aug-61	33.8	111.0	9.5	31.0	M35377.069896	
Johnson, Bernard	SE 27-043-02 W5M	Dalehurst	01-Oct-66	27.4	90.0	9.1	30.0	M36234.932475	
Johnson, Johnny	SE 11-044-24 W4M	Upper Horseshoe Canyon	01-Jun-78	33.5	110.0	13.7	45.0	M35377.070352*	17-Jul-02
Johnston, Leslie	09-30-042-04 W5M	Dalehurst	10-May-63	15.2	50.0	7.6	25.0	M36234.931952	
Johnston, Roy	SW 25-042-05 W5M	Dalehurst	12-Jul-78	27.4	90.0	10.7	35.0	M35379.040988	
Jones, D.	NE 33-042-26 W4M	Upper Scollard	31-Aug-67	48.8	160.0	29.0	95.0	M35377.070694	
Jonust Farms Ltd	12-08-043-23 W4M	Surficial	05-Jun-81	27.1	89.0	7.6	25.0	M35377.070001	
Kay, Dale	NW 02-042-26 W4M	Upper Scollard	14-May-79	89.6	294.0	26.3	86.3	M35377.069335	
Keeton, Darwin	NE 13-043-03 W5M	Dalehurst	28-May-62	27.4	90.0	12.5	41.0	M36234.932560	
Key, Ray	NE 08-042-27 W4M	Dalehurst	20-Sep-78	30.5	100.0	13.7	45.0	M35377.069483	
Kikel, Richard	08-27-042-22 W4M	Upper Horseshoe Canyon	19-Feb-83	21.3	70.0	2.1	7.0	M35377.167151	
Kindleman, E.H.	SW 10-042-01 W5M	Dalehurst	04-May-84	30.8	101.0	4.4	14.5	M35379.032627	
Kleckner, Randy	NW 11-042-26 W4M	Haynes	21-Nov-80	48.8	160.0	6.4	21.0	M35377.069771	
Kowalzik, John	NW 31-042-01 W5M	Dalehurst	06-Jul-61	14.9	49.0	4.6	15.0	M35379.031866	
Krause, Don	SE 11-042-26 W4M	Surficial	27-Oct-81	46.6	153.0	12.2	40.0	M35377.069689	
Kreil, R	NW 14-043-01 W5M	Dalehurst	01-Nov-81	43.3	142.0	29.9	98.0	M35379.038425	
Lave, Peter	EH 34-043-22 W4M	Upper Horseshoe Canyon	01-Jun-82	35.1	115.0	15.2	50.0	M35377.068931	
Ledergerber, Marcel	NE 10-042-01 W5M	Dalehurst	03-Sep-80	26.8	88.0	3.7	12.0	M35379.039171	
Lee, Mike	SW 11-043-05 W5M	Dalehurst	16-Sep-93	27.7	91.0	3.1	10.0	M35379.073848	16-Sep-93
Lee, Terry	SE 17-042-26 W4M	Lower Lacombe	27-Jun-76	45.7	150.0	18.3	60.0	M35377.070263	
Leedale Community Centre	SW 02-042-04 W5M	Dalehurst	30-May-80	15.2	50.0	2.5	8.3	M35379.042493	
Leedale Curling Club	NW 35-041-04 W5M	Dalehurst	18-Aug-81	14.6	48.0	2.4	8.0	M36056.963843	
Lind, Hjalmar	SE 04-045-01 W5M	Dalehurst	26-May-62	64.0	210.0	34.1	112.0	M36727.985519	
Lockhart, A.	SE 29-044-01 W5M	Dalehurst	17-Aug-74	56.7	186.0	8.2	27.0	M36727.984757	
Lohmann, B.	SE 27-044-03 W5M	Dalehurst	28-Nov-83	24.4	80.0	11.9	39.0	M36727.985037	
Louis, Barbara / Sampson Band	NE 19-044-23 W4M	Upper Horseshoe Canyon	01-Mar-79	54.9	180.0	13.7	45.0	M35377.072881*	01-Aug-02
Louis, Kelsey / Samson Band	SE 32-043-23 W4M	Upper Horseshoe Canyon	24-Sep-98	73.2	240.0	6.7	22.0	M36234.925095*	07-Aug-02
Louis, Margaret	NE 06-044-24 W4M	Lower Surficial	05-Jul-78	35.7	117.0	1.8	6.0	M35377.070193*	26-Jun-02
Louis, Marlow / Samson Band	16-19-044-23 W4M	Upper Horseshoe Canyon	07-Sep-82	64.0	210.0	23.8	78.0	M35377.072884*	01-Aug-02
Mannix, Lee	NE 34-041-04 W5M	Dalehurst	29-Jun-79	48.8	160.0	3.8	12.5	M36056.963847	
Mannix, R. L.	NE 34-041-04 W5M	Dalehurst	10-Oct-74	39.0	128.0	3.9	12.7	M36056.963846	
Manson, Mildred	04-02-043-02 W5M	Dalehurst	09-Mar-76	54.9	180.0	39.6	130.0	M36234.932353	
Maron, George	NE 35-042-05 W5M	Dalehurst	01-Sep-83	18.3	60.0	8.4	27.5	M35379.041093	15-May-97
Matschke, Lyle	SE 04-045-03 W5M	Dalehurst	07-Nov-75	21.3	70.0	5.2	17.0	M36727.985804	
Mcintosh, Jim	NE 32-042-01 W5M	Dalehurst	05-Dec-79	47.2	155.0	16.8	55.0	M37066.939175	
Mclarty, Keith	14-12-043-05 W5M	Dalehurst	26-Apr-68	25.3	83.0	14.6	48.0	M36234.932873	
McWade, Bob	SE 26-042-27 W4M	Upper Lacombe	02-Apr-81	27.4	90.0	9.8	32.0	M35377.069856	
Meseck, Hans	NW 10-042-01 W5M	Dalehurst	04-Apr-77	23.5	77.0	3.7	12.0	M35379.038100	
Milner, Roy	NE 10-042-01 W5M	Dalehurst	10-Apr-84	40.5	133.0	5.8	19.0	M35379.041649	
Misner, Victor	13-33-042-04 W5M	Dalehurst	27-Aug-83	18.3	60.0	6.4	21.0	M36234.931965	
Moline, Leo A.	NW 02-042-26 W4M	Surficial	30-May-79	47.9	157.0	22.9	75.0	M35377.069332	
Montour, Ursula	13-17-044-23 W4M	Upper Horseshoe Canyon	01-Jul-57	70.1	230.0	10.7	35.0	M35377.072764*	09-Aug-02
Nachtegaele, Victor	13-09-044-04 W5M	Dalehurst		38.1	125.0	25.9	85.0	M36727.985112	
Naegeli, E.	SE 06-045-02 W5M	Dalehurst	10-Aug-64	18.3	60.0	8.8	29.0	M35379.042509	
Naegeli, Ernest	NE 09-045-03 W5M	Dalehurst	20-Sep-76	25.6	84.0	7.3	24.0	M36727.985838	
Nagy, William	SW 09-045-03 W5M	Dalehurst	03-Aug-81	20.1	66.0	5.2	17.0	M36727.985834	
Nelson Lake Campsite Well	NW 34-042-24 W4M	Upper Scollard	01-Aug-73	23.5	77.0	4.7	15.3	M35377.183412	
Jansen, Hank	SE 18-043-23 W4M	Lower Surficial	26-Nov-83	17.7	58.0	14.7	48.3	M35377.148099	

WATER WELLS RECOMMENDED FOR FIELD VERIFICATION (continued)

Owner	Location	Aquifer Name	Date Water Well Drilled	Completed Depth		NPWL		UID	Field Checked
				Metres	Feet	Metres	Feet		
Nepoose, Florence	NE 06-044-24 W4M	Upper Horseshoe Canyon	12-Sep-84	61.0	200.0	27.4	90.0	M35377.070200*	26-Jun-02
Nepoose, Levi / Samson Band	NE 18-044-24 W4M	Upper Horseshoe Canyon	25-Nov-98	80.8	265.0	36.2	118.7	M36727.983181*	21-Jun-02
Nepoose, Melvin	NE 06-044-24 W4M	Upper Horseshoe Canyon	04-Oct-84	67.1	220.0	27.4	90.0	M35377.070202*	14-Aug-02
Nickoriuk, Bob	SE 09-043-04 W5M	Dalehurst	20-Aug-80	29.6	97.0	4.3	14.0	M36234.932737	
Noble, Jim & Donna	NE 24-042-01 W5M	Dalehurst	08-Jun-89	36.6	120.0	24.2	79.4	M35379.059748	
Northwest, Winston	NE 22-044-24 W4M	Upper Horseshoe Canyon	19-Aug-85	68.6	225.0	27.4	90.0	M35377.070942*	12-Jul-02
Nystrom, Arvid A.	SE 25-042-05 W5M	Dalehurst	18-Oct-77	33.5	110.0	5.3	17.3	M35379.040957	
Okeymon, Tandra / Samson Band	NW 36-043-24 W4M	Upper Horseshoe Canyon	07-Jun-99	73.2	240.0	21.9	72.0	M36727.983149*	22-Jul-02
Okeymow, Dennis	NW 10-044-24 W4M	Upper Horseshoe Canyon	27-Sep-82	64.0	210.0	24.7	81.0	M35377.070339*	10-Jul-02
Okeymow, Michael / Samson Banc	NW 36-043-24 W4M	Upper Horseshoe Canyon	04-Aug-99	73.2	240.0	22.2	72.8	M36727.984294*	22-Jul-02
Omeasa, Dennis / Samson Band	SE 27-044-24 W4M	Upper Horseshoe Canyon	29-May-97	115.8	380.0	27.3	89.5	M36234.922335*	12-Jul-02
Ormberg, Murray	NW 13-042-02 W5M	Dalehurst	01-Jan-76	22.6	74.0	3.1	10.0	M36234.932180	
Pastell, Roy	01-26-044-04 W5M	Dalehurst	11-May-76	27.4	90.0	6.1	20.0	M36727.985187	
Polushin, M.	03-10-043-02 W5M	Dalehurst	23-Jul-62	35.1	115.0	25.9	85.0	M37066.939262	
Potts, Geo	SE 09-044-24 W4M	Upper Horseshoe Canyon	03-Sep-82	67.1	220.0	29.9	98.0	M35377.070321*	
Prediger, J.	01-22-044-27 W4M	Lower Lacombe	26-Oct-84	42.7	140.0	10.7	35.0	M35377.072103	
Prediger, Ron	NE 15-043-25 W4M	Lower Surficial	17-Jul-87	24.4	80.0	1.8	6.0	M35377.115758	
Prins, J.	SW 02-042-27 W4M	Dalehurst	04-Jun-84	50.6	166.0	8.5	28.0	M35377.069420	
Quaife, Blair	01-21-042-03 W5M	Dalehurst	01-Nov-83	30.5	100.0	7.0	23.0	M35379.040975	
Rain, Bonnie / Samson Band	SE 15-044-24 W4M	Upper Horseshoe Canyon	10-Oct-96	67.1	220.0	21.9	72.0	M36234.921495*	10-Jul-02
Rain, Leanne / Samson Band	NW 22-044-24 W4M	Upper Horseshoe Canyon	03-Oct-97	70.1	230.0	26.4	86.6	M36234.922333*	11-Jul-02
Rallison, C.	13-10-043-04 W5M	Dalehurst	18-Sep-80	27.4	90.0	3.4	11.0	M36234.932750	
Rallison, Charlie	NW 10-043-04 W5M	Dalehurst	12-Dec-77	18.3	60.0	0.9	3.0	M36234.932747	
Rallison, Chuck	SW 34-042-04 W5M	Dalehurst	19-Oct-83	25.9	85.0	9.1	30.0	M35379.055639	
Redcrow, John	SE 23-044-24 W4M	Upper Horseshoe Canyon	16-Dec-82	67.1	220.0	36.3	119.0	M35377.070947*	18-Jul-02
Redcrow, Maggie	SE 23-044-24 W4M	Upper Horseshoe Canyon	06-Jun-84	73.2	240.0	53.6	176.0	M35377.070467*	18-Jul-02
Rederow, Sandy / Samson Band	SE 23-044-24 W4M	Upper Horseshoe Canyon	17-Oct-96	83.8	275.0	20.7	68.0	M36234.921498*	18-Jul-02
Reid, Clint/Mclaren, Brian	NW 20-042-23 W4M	Upper Scollard	16-Sep-76	32.0	105.0	22.9	75.0	M35377.117206	
Reiser, Doug	SE 23-043-03 W5M	Dalehurst	30-May-86	82.3	270.0	75.6	248.0	M36234.932593	
Renauld, Rene	SE 17-044-04 W5M	Dalehurst	26-Oct-79	32.0	105.0	15.2	49.9	M37066.939455	
Resta, S.J.	16-32-042-03 W5M	Dalehurst	13-Nov-73	30.5	100.0	18.3	60.0	M35379.041671	
Riley, D.E.	NE 26-042-01 W5M	Dalehurst	23-Jun-67	25.6	84.0	6.3	20.5	M35379.039878	
Robins, Cliff	10-31-044-27 W4M	Lower Lacombe	20-Apr-66	37.5	123.0	18.6	61.0	M35377.072384	
Rohwer, H.	NW 10-042-26 W4M	Haynes	30-Jul-80	51.8	170.0	18.3	60.0	M35377.069609	
Saddleback, Leonard	NW 25-044-24 W4M	Upper Horseshoe Canyon	06-Dec-84	48.8	160.0	24.4	80.0	M35377.071095*	26-Jul-02
Saddleback, Leroy / Samson Band	NW 06-044-23 W4M	Upper Horseshoe Canyon	19-Apr-97	76.2	250.0	16.8	55.0	M36234.921481*	02-Aug-02
Saddleback, Roy	SW 21-044-24 W4M	Upper Horseshoe Canyon	07-Dec-82	67.1	220.0	48.8	160.0	M35377.070804*	03-Jul-02
Samson Gas Department	NW 09-044-24 W4M	Upper Horseshoe Canyon	24-Oct-90	54.9	180.0	22.9	75.0	M35377.085607*	02-Jul-02
Samson, Harvey / Samson Band	13-30-044-23 W4M	Upper Horseshoe Canyon	03-May-69	53.3	175.0	12.5	41.0	M35377.073024*	30-Jul-02
Sandin, Victor	NE 07-042-22 W4M	Lower Scollard	10-Jun-83	54.9	180.0	17.4	57.0	M35377.167067	
Saskatchewan, Albert	12-07-044-23 W4M	Upper Horseshoe Canyon	04-Apr-68	76.2	250.0	36.6	120.0	M35377.072596*	02-Aug-02
Schell, Art	NW 30-042-01 W5M	Dalehurst	15-Nov-77	41.2	135.0	21.3	70.0	M35379.031831	
Schickerowski, Dan	SE 26-042-28 W4M	Upper Lacombe	24-Jul-86	50.3	165.0	13.7	45.0	M35377.069684	
Schmidt, Alex	NW 03-042-01 W5M	Dalehurst	22-Jun-81	35.1	115.0	9.5	31.0	M35379.032077	
Schofer, Tim	SW 12-042-26 W4M	Haynes	29-Mar-80	42.7	140.0	7.9	26.0	M35377.069997	
Scott, J.	SW 10-044-03 W5M	Dalehurst	08-Sep-67	25.9	85.0	3.1	10.0	M36727.984953	
SDA Church	12-11-042-26 W4M	Haynes	02-Apr-81	44.2	145.0	13.4	44.0	M35377.069770	
Seidel, H.	NW 33-043-03 W5M	Dalehurst	24-Nov-65	24.4	80.0	12.2	40.0	M36234.932646	
Shelinsky, Edwin	02-16-043-27 W4M	Upper Lacombe	10-Aug-76	53.3	175.0	18.3	60.0	M37066.935170	
Simon, E.	13-04-044-24 W4M	Upper Horseshoe Canyon	16-May-69	59.7	196.0	23.8	78.0	M35377.071153*	

WATER WELLS RECOMMENDED FOR FIELD VERIFICATION (continued)

Owner	Location	Aquifer Name	Date Water Well Drilled	Completed Depth		NPWL		UID	Field Checked
				Metres	Feet	Metres	Feet		
Simon, Hubert / Samson Band	NW 04-044-24 W4M	Upper Horseshoe Canyon	18-Mar-96	56.4	185.0	29.6	97.0	M35377.076766*	04-Jul-02
Simon, Lewis	NW 04-044-24 W4M	Upper Horseshoe Canyon	21-Oct-77	59.4	195.0	24.7	81.0	M35377.070138*	04-Jul-02
Simpson, Charles	SW 02-042-02 W5M	Upper Lacombe	11-Aug-83	35.7	117.0	4.6	15.0	M36234.932109	
Smith, Levi	01-07-042-02 W5M	Dalehurst	08-May-62	37.2	122.0	18.9	62.0	M36234.932144	
Soosay, Chris	SE 17-044-24 W4M	Surficial	07-Oct-97	61.0	200.0	26.4	86.6	M36234.923557*	20-Jun-02
Soosay, Louis / Samson Band	SE 17-044-24 W4M	Upper Horseshoe Canyon	31-Oct-96	61.0	200.0	30.8	101.0	M36234.921497*	08-Jul-02
Soosay, Reggie	SE 16-044-24 W4M	Upper Horseshoe Canyon	06-Apr-87	67.1	220.0	27.4	90.0	M35377.070504*	02-Jul-02
Stearn, Norman	NW 32-043-03 W5M	Dalehurst		22.9	75.0	10.7	35.0	M36234.932638	
Stout, Tom	NE 30-043-03 W5M	Dalehurst	04-Oct-79	27.4	90.0	15.2	50.0	M35379.057704	
Strellaeff, Jerry	04-27-042-03 W5M	Dalehurst	28-May-81	30.5	100.0	21.3	70.0	M35379.041411	
Stutheit, Ted	SW 19-042-02 W5M	Dalehurst	09-Jul-75	51.8	170.0	29.0	95.0	M36234.932217	
Sutton, L	SE 14-043-01 W5M	Dalehurst	26-Jun-79	27.4	90.0	9.1	30.0	M35379.038406	
Swampy, Christine	SE 20-044-24 W4M	Upper Horseshoe Canyon	12-Aug-82	80.8	265.0	42.4	139.0	M35377.070777*	19-Jun-02
Synkowski, Art	SW 02-043-23 W4M	Upper Horseshoe Canyon	08-Sep-82	64.0	210.0	6.1	20.0	M35377.069908	
T&J Holdings	NW 17-043-01 W5M	Dalehurst	14-Aug-81	63.4	208.0	19.8	65.0	M35379.038526	
Tatlow, J.D.	05-13-044-27 W4M	Haynes	01-Sep-76	88.4	290.0	18.3	60.0	M35377.071971	
Taylor, Ed	04-35-044-27 W4M	Upper Lacombe	07-Sep-79	32.6	107.0	15.2	50.0	M35377.072541	
Teeuwsen, Joe	NE 03-044-28 W4M	Dalehurst	19-Jul-77	42.7	140.0	18.5	60.6	M35377.071708	
Thom, Lorna (Samson)	NE 04-044-24 W4M	Upper Horseshoe Canyon	07-Jun-73	50.6	166.0	18.3	60.0	M35377.070147*	02-Oct-95
Thom, Mina	NE 04-044-24 W4M	Upper Horseshoe Canyon	29-Sep-82	64.0	210.0	25.0	82.0	M35377.070151*	02-Oct-95
Thom, Mina	NE 04-044-24 W4M	Upper Horseshoe Canyon	29-Sep-82	64.0	210.0	24.1	79.0	M35377.070151*	02-Oct-95
Thul, B	SW 02-043-01 W5M	Dalehurst	18-May-82	46.9	154.0	18.3	60.0	M35379.037958	
Tompkins, Clarence	04-29-044-27 W4M	Lower Lacombe	14-Mar-81	30.5	100.0	13.7	45.0	M35377.072366	
Tyndall, Howard	NE 15-044-28 W4M	Dalehurst	25-Feb-81	36.6	120.0	8.2	27.0	M35377.071773	
Vetsch, L.	13-09-043-04 W5M	Dalehurst	01-Jun-73	32.0	105.0	6.4	21.0	M36234.932740	
Wagner, Stan	NW 31-044-25 W4M	Upper Scollard	12-May-82	36.6	120.0	10.7	35.0	M35377.071239	
Warwa Bros	NW 10-042-26 W4M	Surficial	01-Apr-79	21.0	69.0	8.1	26.5	M35377.069587	
Wettstein, Emil	NW 14-043-05 W5M	Dalehurst	15-Oct-82	22.9	75.0	11.0	36.0	M36234.932878	
Wilson, E	NE 35-043-01 W5M	Dalehurst	06-Apr-81	26.2	86.0	17.7	58.0	M35379.039396	
Wilson, L.	SE 03-042-27 W4M	Dalehurst	04-Apr-81	25.0	82.0	7.0	23.0	M35377.069429	
Wolf Creek Golf Course	SE 03-042-26 W4M	Haynes	03-Apr-83	48.8	160.0	9.1	30.0	M35377.069351	
Wollmann, Ben	SE 11-042-26 W4M	Haynes	23-Jun-82	48.8	160.0	14.6	48.0	M35377.069693	
Wright, R.	NW 32-044-01 W5M	Dalehurst	13-Jun-84	45.7	150.0	27.7	91.0	M35379.042507	
Wyering, Gerald	13-30-042-26 W4M	Upper Lacombe	21-Jun-82	25.9	85.0	13.1	43.0	M35377.070616	
Yellowbird, Carter	SW 23-044-24 W4M	Upper Horseshoe Canyon	18-Nov-97	79.2	260.0	25.0	82.0	M36234.923559*	19-Jul-02
Zerbe, A.	05-19-042-26 W4M	Upper Lacombe	22-Jun-80	27.4	90.0	17.7	58.0	M35377.070281	
	02-25-043-01 W5M	Dalehurst	07-Sep-74	20.4	66.9	-0.3	-1.0	M36076.565586	

* Water wells located on First Nations lands

PONOKA COUNTY-OPERATED WATER WELLS

Owner	Location	Aquifer Name	Date Water Well Drilled	Completed Depth		NPWL		UID	Field checked
				Metres	Feet	Metres	Feet		
County of Ponoka 13	01-24-044-28 W4M	Dalehurst	29-Oct-59	36.57	120.0	25.91	85.0	M35377.071854	
County of Ponoka 3	01-24-044-28 W4M	Bedrock	02-Jan-62	150.87	495.0	39.62	130.0	M35377.071862	
County No 3 (Div 4) Campsite	NE 14-042-01 W5M	Dalehurst	27-Jun-64	15.24	50.0		0.0	M35379.059333	
COUNTY OF PONOKA (SCHOOL)	SW 06-043-27 W4M	Upper Lacombe		35.05	115.0	6.1	20.0	M36056.977785	
County of Ponoka	NW 09-043-02 W5M	Dalehurst	16-Jun-81	28.95	95.0	3.35	11.0	M36234.932384	
County of Ponoka	---31-043-02 W5M	Dalehurst	01-Oct-61	33.53	110.0	8.84	29.0	M36234.932504	
County of Ponoka	SW 06-044-02 W5M	Dalehurst	03-Jun-68	30.48	100.0	13.11	43.0	M36727.984809	
County of Ponoka	SE 17-044-04 W5M	Dalehurst	06-Jun-72	43.58	143.0	31.09	102.0	M36727.985148	
County of Ponoka	04-29-042-02 W5M	Dalehurst	27-Apr-62	39.32	129.0	18.6	61.0	M37066.930166	
County of Ponoka	NE 06-044-02 W5M	Dalehurst	07-Oct-99	36.57	120.0	18.47	60.6	M37066.932469	
Ponoka County	SE 33-042-02 W5M	Dalehurst	19-Dec-02	19.81	65.0			M37671.708507	06-Jan-03
Ponoka County	SE 06-043-23 W4M	unknown	11-Mar-03	23.47	77.0	9.16	30.1	M37694.666667	11-Mar-03
Ponoka County	01-23-043-28 W4M	unknown	11-Apr-03	146.3	480.0			M37711.542269	27-Mar-03