

MGV Energy Inc - Proposed NGC Development Groundwater Newsletter - Penhold Area

Introduction

This newsletter contains information related to the groundwater resources in the area of the proposed MGV Energy Inc. (MGV) Natural Gas in Coal (NGC) exploration in parts of townships 035 to 037, within range 27, west of the fourth Meridian, and has been prepared by Hydrogeological Consultants Ltd. (HCL). This study was undertaken to assist MGV in understanding and managing the groundwater resource during exploration for NGC deposits. NGC is also commonly referred to as coalbed methane (CBM). The newsletter is based on information available from the Groundwater Centre database, which is

an enhanced version of the Alberta Environment (AENV) database. Geological surfaces are from a geological-surfaces database maintained by the Groundwater Centre, which is used for regional groundwater assessments and is based on similar surfaces developed by the Alberta Geological Survey.

The area of interest (AOI) covers an area of 129 square kilometres in central Alberta, 140 kilometres south of Edmonton. The topographic elevation in the AOI ranges from over 1,060 metres above mean sea level (AMSL) in the southern part to about 860 metres AMSL in the northern part.

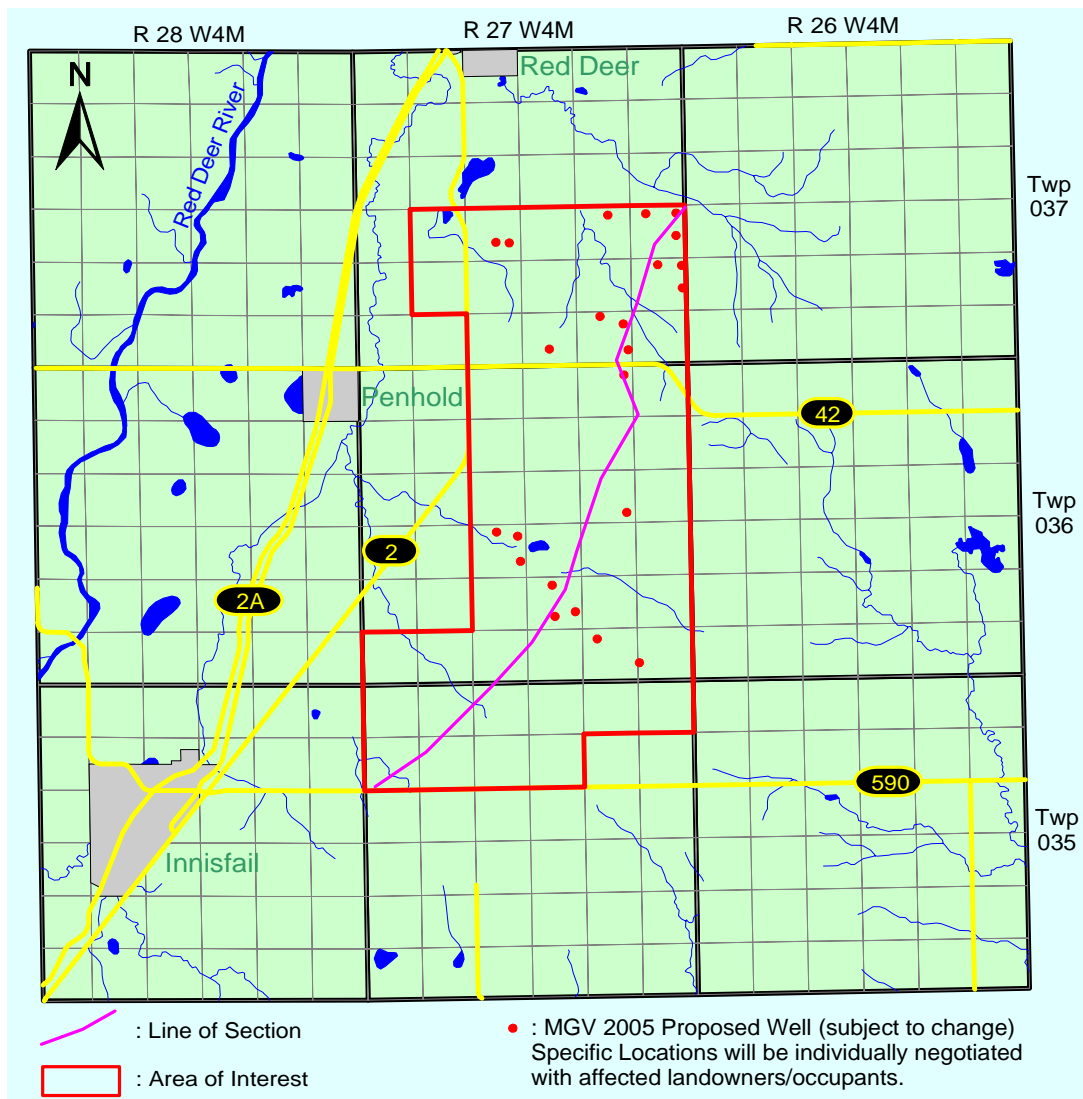


Figure 1. Index Map

Geology

The bedrock that subcrops in the study area is the Dalehurst Member of the Paskapoo Formation. The Dalehurst Member is between approximately 25 and 200 metres thick in the study area (Figure 2). The thickest part of the Dalehurst Member underlies the higher topographic area in the east-central part of the AOI.

The Lacombe Member underlies the Dalehurst Member and the Lacombe Member has been divided into upper and lower parts. The upper part of the Lacombe Member is approximately 100 metres thick in the AOI.

The southwest-northeast cross-section (the line of section is provided on Figure 2) shows that the Dalehurst Member of the Paskapoo Formation is the uppermost bedrock along the line of the cross-section. As the bedrock has been eroded to the north, the Dalehurst Member becomes progressively thinner and the Upper Lacombe Member becomes shallower. The cross-section shows the geological units in the bedrock dipping to the southwest at approximately one and one-half metres per kilometre.

The Base of Groundwater Protection is located within the upper part of the Scollard Formation along the majority of the southwest-northeast cross-section; close to the northeast end of the cross-section, the Base of Groundwater Protection declines into the lower part of the Scollard Formation; this abrupt decline is a result of a

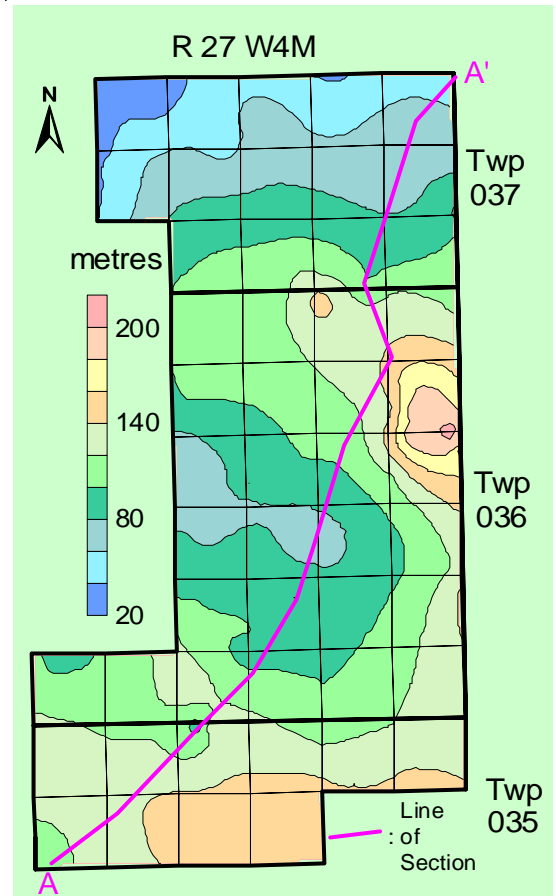


Figure 2. Dalehurst Member Thickness

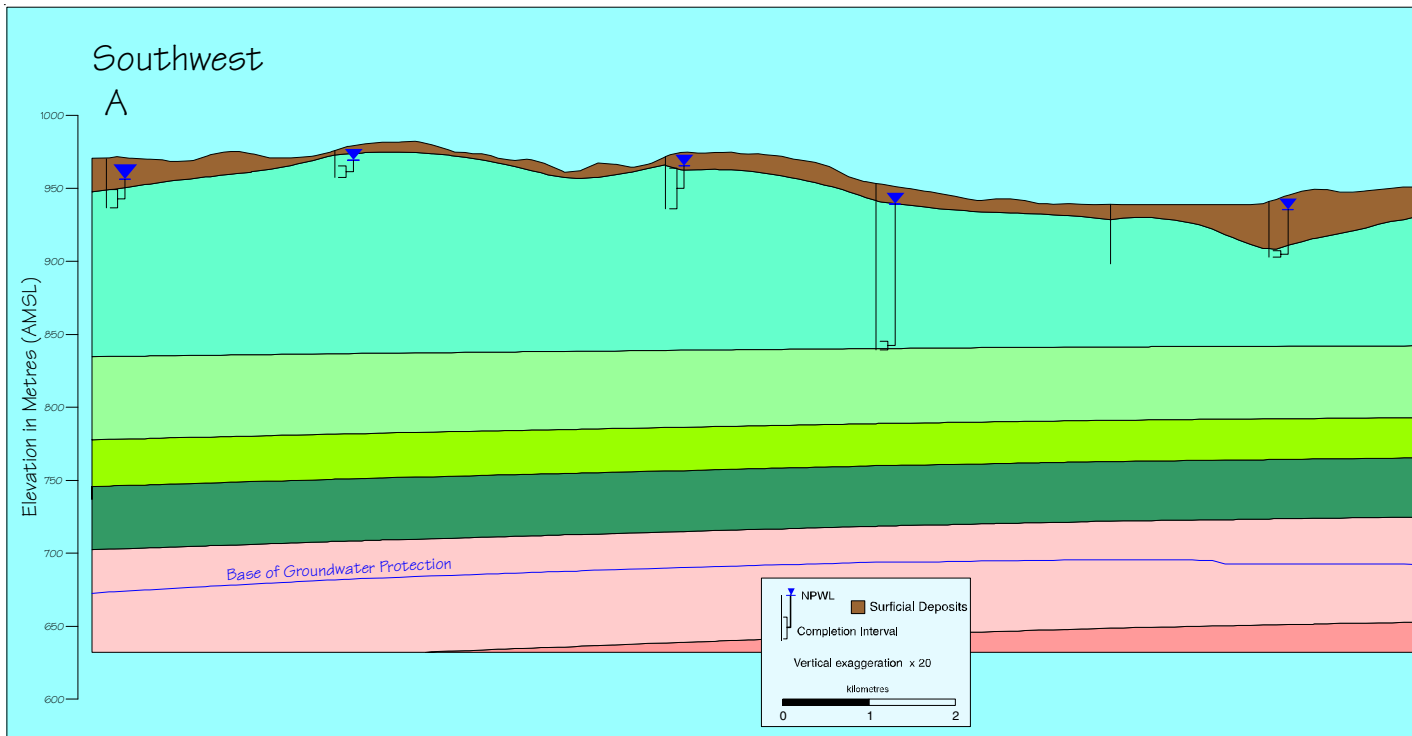


Figure 3. Southwest-Northeast Cross-Section

limited amount of data being available. The Base of Groundwater Protection is between 660 and 695 metres AMSL, between 225 and 305 metres below ground level. The Base of Groundwater Protection, determined by the Alberta Energy and Utilities Board (EUB), is the depth below which groundwater is expected to have a total dissolved solids (TDS) concentration of more than 4,000 milligrams per litre (mg/L).

The bedrock surface is the upper limit of the consolidated sediments, sediments which have, over time, been compacted and cemented. The sediments in the bedrock are at least 50 million years old. Above the bedrock and below the land surface are the unconsolidated sediments. The unconsolidated sediments are mainly derived from glacial activities and are usually less than one million years old. Aquifers in the unconsolidated sediments are deposits of sand or gravel that may have been derived from melting ice.

The bedrock surface varies between 860 and 1,050 metres AMSL and is highest in the east-central part of the AOI. From the highest bedrock elevation, a bedrock ridge extends for a distance of approximately five kilometres to the northwest. The bedrock is also at a higher elevation along most of the southern edge and the southern half of the AOI. The bedrock surface is lowest in the northern part of the AOI and there is a second significant bedrock low in the central part of the AOI. Another bedrock high is a linear extension from the west-central edge eastward through most of the AOI.

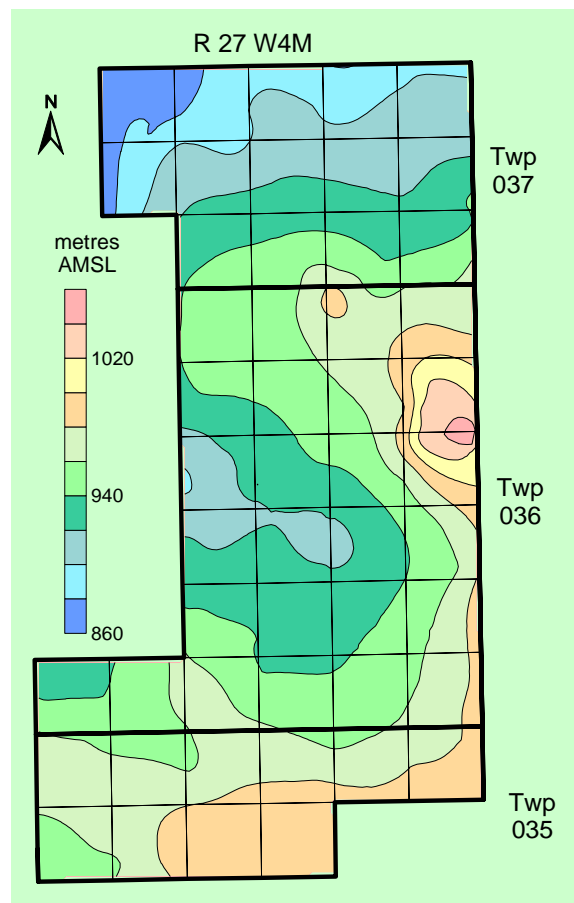
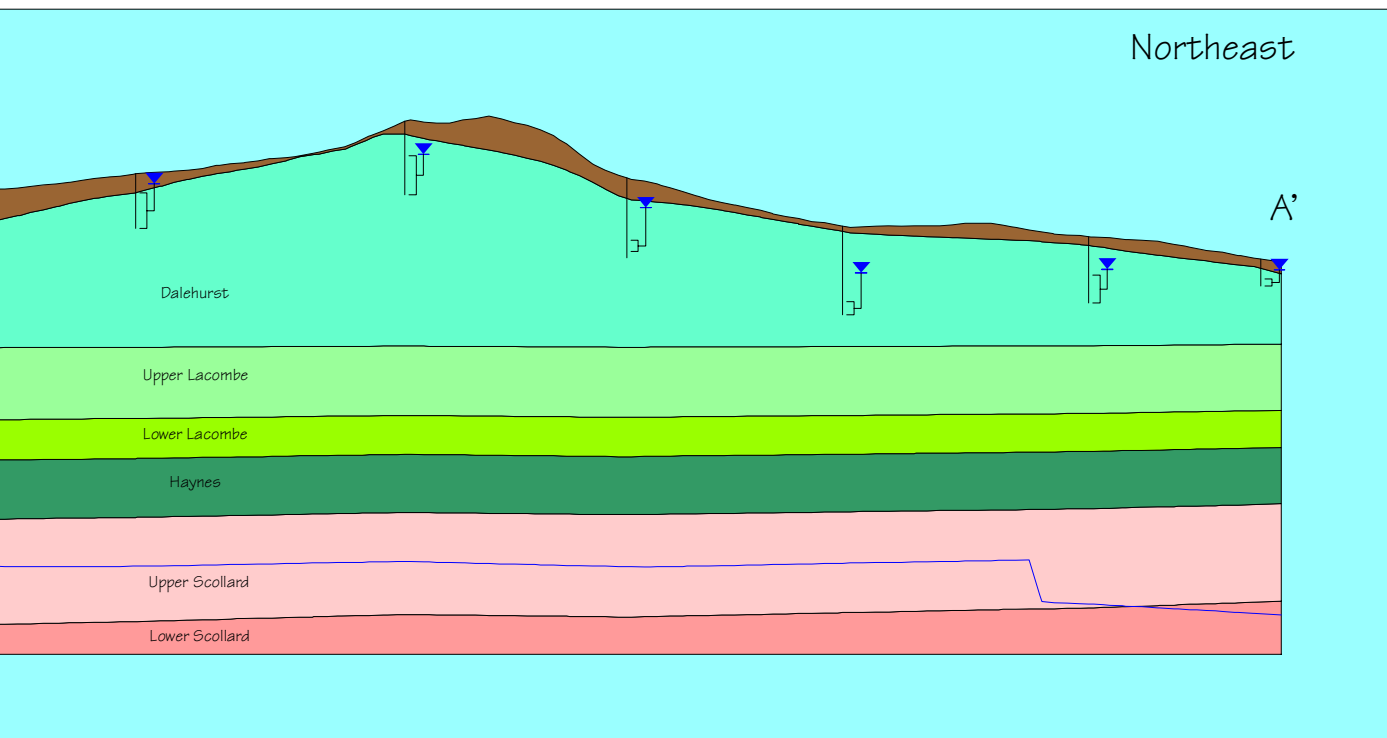


Figure 4. Bedrock Topography



Northeast Cross-Section

Water Well Use

There are currently records for 343 water wells in the groundwater database for the AOI. Of the 343 water wells, 293 (85%) are for domestic, stock, domestic/stock or domestic/industrial purposes; 25 (7%) are for industrial purposes; two are for irrigation purposes; and one is for investigative purposes, as shown in Figure 5. The proposed use of the remaining 22 water wells is not available. The water wells vary in depth from less than five metres to more than 150 metres, with 91% (313) being less than 150 metres deep; 168 water well records have sufficient information to determine the geological unit in which the water wells are completed. Seven percent (24) of the records did not have an associated depth drilled.

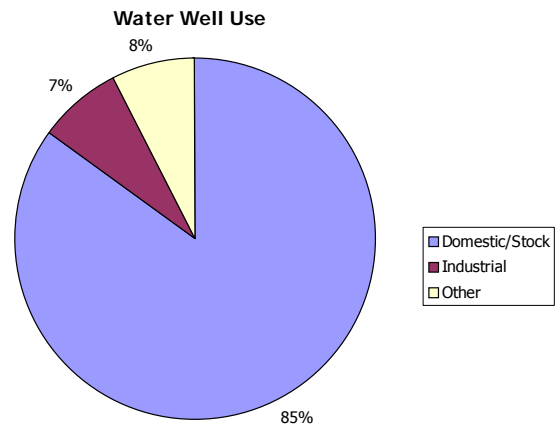


Figure 5. Water Well Use

The database includes results of 134 chemical and no microbiological analyses. The 134 chemical analyses are available from 105 water wells, with more than one chemical analysis available from 23 water wells.

Authorized Groundwater Diversions

Data from AENV indicate that there are 67 licences and registrations for groundwater use in the AOI. The total groundwater diversion allowed under these approvals is 287 cubic metres per day (m³/day). Of the 287 m³/day that is approved, 157 m³/day (55%) is for agricultural use and 130 m³/day (45%) is approved for water well registrations, as shown in Figure 6. The maximum single groundwater allocation is 25.3 m³/day for agricultural use.

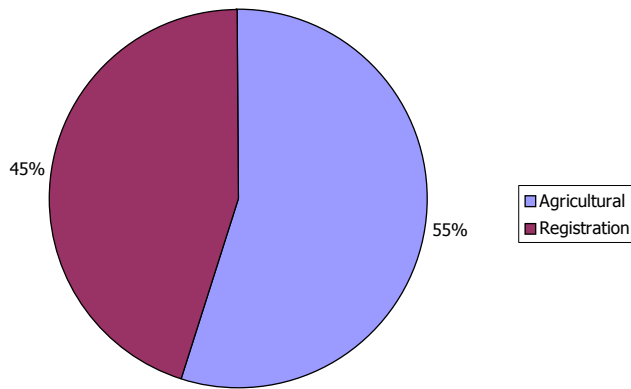


Figure 6. Authorized Groundwater Diversion

Water Well Yields

The groundwater database includes summary results for aquifer tests. These tests are performed after completion of each water well. The tests are now required under the *Water Act* but in the past were used to pump the water well clean of sediment created by the drilling of the water

well. These summary results are used to calculate an apparent transmissivity value for each aquifer in which the water wells are completed. The apparent transmissivity values are then used to calculate an apparent long-term yield for each water well. Values for apparent yield vary from less than one to more than 1,100 m³/day, with 73% of the values being less than 50 m³/day. Figure 7 is a frequency-distribution graph showing the number of apparent yield values within five groups. The graph shows that the maximum number of values (37) is in the five to 50 m³/day range.

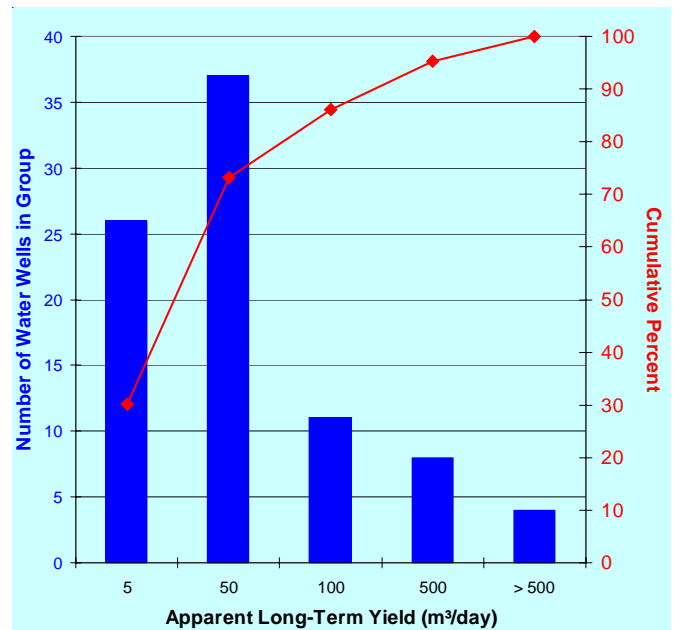


Figure 7. Apparent Water Well Yields

Apparent yields for water wells vary significantly over the study area both with location and with depth. As Figure 8 shows, most apparent yields are less than 80 m³/day and most water wells are less than 70 metres deep. There is only one apparent yield that exceeds 40 m³/day in water

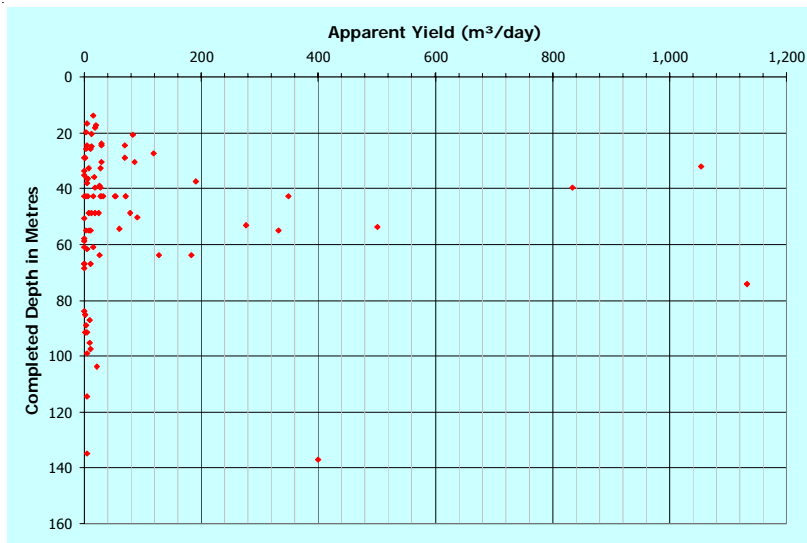


Figure 8. Water Well Yield vs Depth

wells with a depth that is greater than 70 metres. To a depth of 70 metres, there is generally a decrease in apparent yield with increased depth.

When the apparent yields are plotted on a map and contoured (Figure 9), in a total of 28% of the AOI, water wells are expected to have yields of less than ten m³/day. This volume is approximately three times the quantity of water that is protected for household use under the *Water Act*. The main areas where yields are expected to be less than ten m³/day are in the southern and central parts of the AOI.

Figure 9 indicates that approximately 4% of the study area has apparent water well yields that are greater than 500 m³/day. The areas of higher apparent yields are located in the northern portion and part of the central region of the AOI.

Water Levels

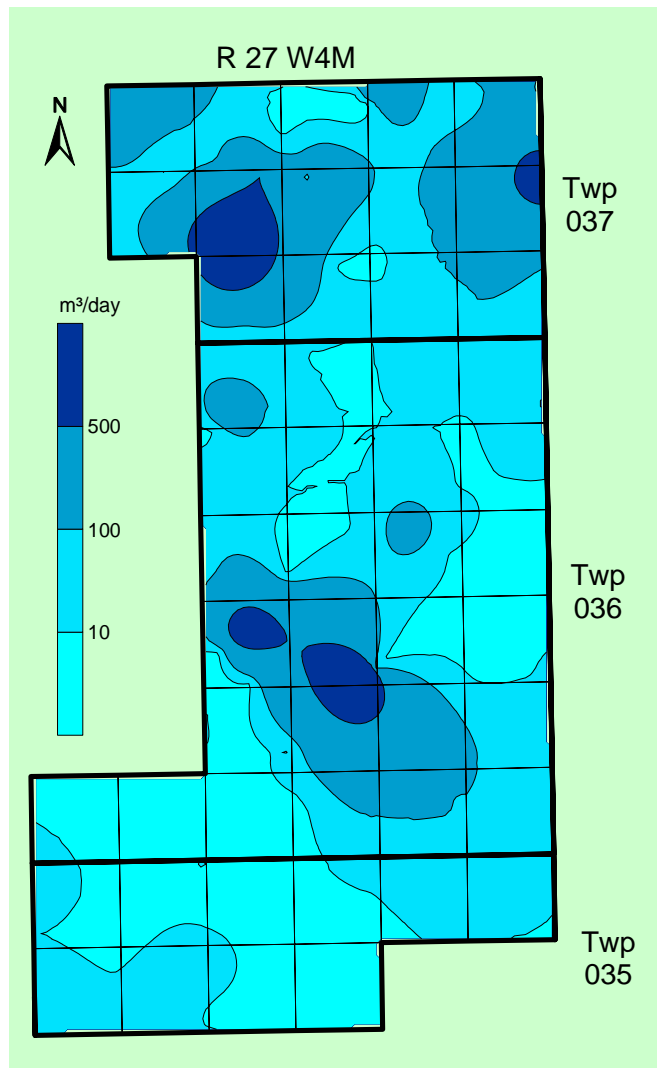


Figure 9. Apparent Yield Map - Upper Bedrock

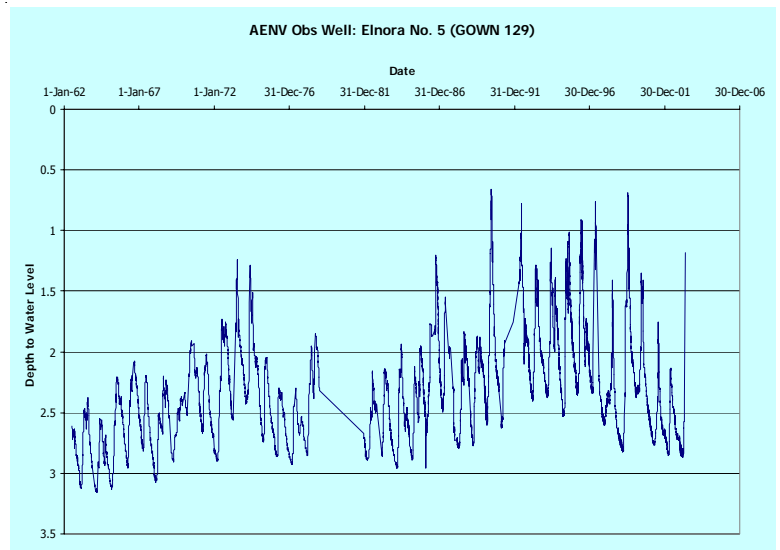


Figure 10. Obs Water Well Hydrograph

The water level in an aquifer fluctuates with time. The fluctuations can be natural, such as a response to increased or decreased annual precipitation, or the fluctuation can be a result of groundwater being pumped from an aquifer. If groundwater is removed from an aquifer, the water level in the aquifer will decline; if the groundwater diversion stops, the water level in the aquifer will rise. Because groundwater is a renewable resource, it must be managed to ensure that the quantity of groundwater pumped from the aquifers does not exceed the sustainable yield. The only method to manage the groundwater resource is to measure the water levels in the aquifer and record the quantity of groundwater removed from the aquifers. The hydrograph in Figure 10 is from an AENV observation water well (Obs WW) in the Elnora area.

Safe Drinking Water

The Guidelines for Canadian Drinking Water Quality (GCDWQ) are provided on the back page of this newsletter. Figure 11 below indicates the GCDWQ limits that are most common to groundwater analyses. It should be noted that of the information provided in Figure 11, coliforms and Nitrate + Nitrite (as N) (3N) represent the greatest risk to human health and there is a maximum acceptable concentration (MAC) for each of these constituents. There is also a MAC of 1.5 mg/L for fluoride; the risk associated with fluoride is more long-term. The limits for other constituents are considered to be 'aesthetic' objectives (AOs) and do not generally represent a health hazard, though the presence of elevated sodium concentrations may be a risk for people on low-sodium diets.

The greatest risk to public health from groundwater is micro-organisms. The organisms most often are introduced into the water well via the water well casing from ground surface. This can happen when the casing does not stick up above ground, when the water well is not properly constructed or when the appropriate action is not taken to keep sources of micro-organisms away from the wellhead. The casing should stick up at least 20 cm above the ground or the highest known surface-water level (whichever is greater); the annulus between the casing and the drill hole wall must be sealed with an impermeable material; and the water well casing must be equipped with an acceptable cap. Regulations state that when a water well is used to provide water for human consumption, the water well must be located at least ten metres from a watertight septic tank and 15 metres from a sub-surface weeping tile field. Also, there is to be no storage of animal wastes, chemicals or of fuels within 50 metres of a water well; in the case of confined feedlot operations (CFOs), the water well is to be located more than 100 metres from any waste storage site.

Fecal coliforms are an indication that the groundwater from a water well has been contaminated and the groundwater should not be consumed without first contacting public health.

It is not uncommon to have bacteria in water wells. Bacteria occur naturally in groundwater and a water well provides a more favorable environment for bacteria growth than does the aquifer in which the water well is completed. The most common bacteria found in water wells are iron-related, sulfate-reducing and slime-forming bacteria. These bacteria do not typically pose a health risk, even when the bacteria are present in sufficient quantities to create offensive tastes and odours. The cause of the majority of odour problems associated with groundwater is due to the presence of sulfate-reducing bacteria in the water well and/or household pressure system. Sulfate-reducing bacteria produce hydrogen sulfide (H₂S) as part of their natural life-cycle and if present in sufficient quantities, can cause the groundwater to have a dark grey colour. Bacterial populations can be controlled by regular chlorination of the water well. For additional information on water well chlorination, contact a local water well driller, Prairie Farm Rehabilitation Administration (PFRA), or the local health unit.

Nitrate + nitrite (as N) in groundwater is an indication that the groundwater is being contaminated. If the contamination source includes fecal coliforms, the elevated 3N is a flag that the groundwater is unsuitable for consumption until a public health official indicates that the groundwater is safe to drink. If the 3N exceeds ten mg/L, there is a possibility that children under the age of six years can be at risk if they consume the groundwater.

Water Use	Concern	Parameter	MAC	AO	Comments
Potable water	Health risk	Coliforms	<1 CFU		Indication of groundwater contamination
Potable water	Health risk	Nitrate + Nitrite as N	10 mg/L		Indication of groundwater contamination
Potable water	Health risk	Fluoride	1.5 mg/L		Possible long-term health effects
Potable water	Health risk	Sodium		200 mg/L	Concern to people on low sodium diets
Domestic use	Nuisance	Iron		0.3 mg/L	Staining
Domestic use	Nuisance	Manganese		0.05 mg/L	Staining
Potable water	Nuisance	Odour			Improper maintenance
Potable water	Nuisance	Turbidity	1 NTU		Improper maintenance

MAC - Maximum acceptable concentration; AO - Aesthetic objective

Figure 11. Safe Drinking Water

The MAC for fluoride concentration is more of a long-term risk. Elevated fluoride is more common in groundwater with specific amounts of sodium. The elevated fluoride can occur in groundwater when the sodium ions are between 200 and 600 mg/L and when fluoride is available in the aquifer from which the groundwater is obtained. There are two methods to ensure that the groundwater does not exceed the MAC for fluoride. The first is to test the fluoride concentration of the groundwater before completing a water well; the second method is to treat the groundwater, using reverse osmosis or distillation, to reduce the fluoride concentration.

The MAC for sodium is set for aesthetic purposes only, but drinking groundwater with an elevated sodium concentration may negatively impact someone's health if they are on a low-sodium diet. The AO for sodium as determined by the GCDWQ is set at 200 mg/L.

The concentrations of iron, manganese and odour do not pose health risks, but they do become barriers to using groundwater for normal domestic uses. The groundwater needs to be treated to reduce the iron and manganese concentrations to acceptable levels. In most instances, the odour in groundwater is a maintenance problem.

The MAC of one mg/L for turbidity is mainly for water supplies that must be chlorinated. Turbidity reduces the effectiveness of the chlorine. However, if the groundwater from a water well has not been turbid in the past, turbid groundwater can indicate a failure of the water well casing and an indication that groundwater is entering the water well from a shallow depth. Because the water well has lost its integrity, there is a chance that the groundwater is unsafe to drink and should be tested by a public health official before the groundwater is consumed.

The quality of most groundwater is satisfactory for livestock and poultry. It is most often excess salinity that would make the groundwaters unsatisfactory for these uses. The TDS content of the groundwaters is a guide to the use of the groundwater for livestock and poultry. Groundwaters with TDS values of less than 1,000 mg/L should be excellent, and a TDS content of less than 3,000 mg/L should be satisfactory for all classes of livestock and poultry. Groundwaters with a TDS content of up to 5,000 mg/L is considered to be satisfactory for livestock but are unsatisfactory for poultry.

Upper Bedrock

Generally, groundwater from water wells completed in bedrock aquifers are sodium-bicarbonate-type or sodium-sulfate-type waters. The table (Figure 11) indicates the limits in the GCDWQ, for the common chemical constituents of groundwater, which have been established to date. It should be noted that, with the exception of 3N, coliforms and fluoride, the limits are considered to be 'aesthetic' objectives (AO) and do not represent a health hazard.

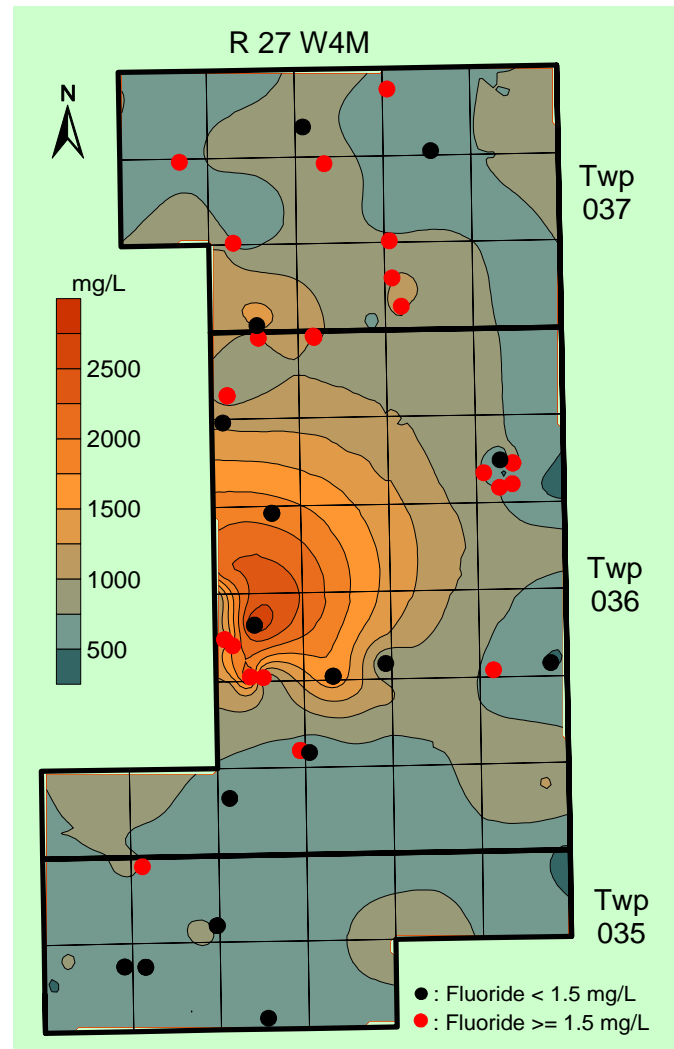


Figure 12. TDS in Upper Bedrock Aquifers

Total dissolved solids is a measure of the overall chemical make-up of the groundwater. Figure 12 shows that the TDS concentrations in groundwaters from the upper bedrock aquifers in the AOI are above 250 mg/L throughout the area, and in the central part of the area, TDS values are in the order of 1,500 to 2,500 mg/L.

Most groundwaters from the upper bedrock aquifer(s) are chemically soft. This means that the sodium concentration can be elevated and can pose a risk to people on low-sodium diets. There are 88 values for sodium in groundwater from bedrock water wells in the groundwater database for the AOI. Of these, 72 have a value that exceeds 200 mg/L; 68% of the groundwater associated with the 88 sodium values is considered chemically soft.

Also, chemically soft groundwater can have elevated concentrations of fluoride. There are 50 values for fluoride in groundwater from bedrock water wells in the groundwater database for the AOI; 22 values for fluoride are less than the MAC of 1.5 mg/L and 28 values exceed the MAC of 1.5 mg/L. The maximum value for fluoride is 4.6 mg/L. There does not appear to be a specific aquifer associated with the high-fluoride groundwater.

The database includes 75 values for 3N in bedrock aquifers in the AOI; 62 values are less than one mg/L, eight values are between one and ten mg/L and five values of 3N are above the MAC of ten mg/L.

Surficial Deposits

A spatial variation in the quality of groundwater from water wells completed in aquifers in the surficial deposits can be significant. Generally, the groundwater from the surficial deposits is chemically hard and high in dissolved iron. Also, groundwater from surficial deposits can have elevated concentrations of manganese, which has the same effect as dissolved iron, that of staining fixtures and staining clothing in a washing machine.

Risk of Groundwater Contamination

The adjacent map (Figure 13) shows the risk potential for groundwater contamination from surface activities. The risk of groundwater contamination is high when the near-surface materials are porous and permeable and low when the materials are less porous and less permeable. The sources of data for the risk analysis include (a) a determination of when sand and gravel is or is not present within one metre of the ground surface, and (b) the surficial geology and/or the soil map. The presence or absence of sand and gravel within one metre of the land surface is based on a geological surface prepared from the data supplied on the water well drilling reports. The information available on the surficial geology and/or the soil map is categorized based on relative permeability. The information from these sources is combined to form the risk assessment map. The map shows that in less than 5% of the AOI, the risk of groundwater contamination is classified as high.

Conclusions

All of the 168 water wells in the groundwater database that have sufficient information to determine a completion depth are completed in the Paskapoo Formation; completion depths for water wells completed in the Paskapoo Formation range from 8 to 152 metres BGL, as shown in Figure 14. It is recommended that if the NGC well is to be fractured to enhance the production of gas, a minimum vertical distance of 50 metres be left between the bottom of the deepest water well within 500 metres of the NGC well and the top fracture in the NGC well.

Based on the information in the groundwater database, there are no domestic water wells completed in the Horseshoe Canyon Formation and it is unlikely that the development of CBM wells in the Horseshoe Canyon Formation will have a negative effect on water wells completed in overlying formations.

It is also recommended that in drilling the NGC wells, fresh water be used in the drilling of the well and in the preparation of the drilling mud. If, during the drilling of a NGC well, circulation is lost into an aquifer being utilized by a nearby domestic water well, it is recommended that the owner(s) of any nearby water wells completed in the

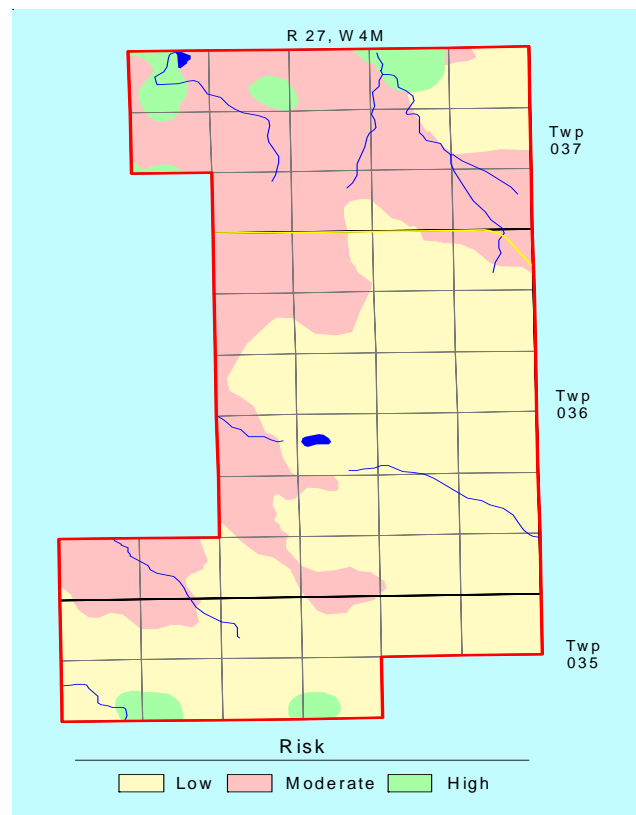


Figure 13. Risk of Groundwater Contamination from Surface Sources

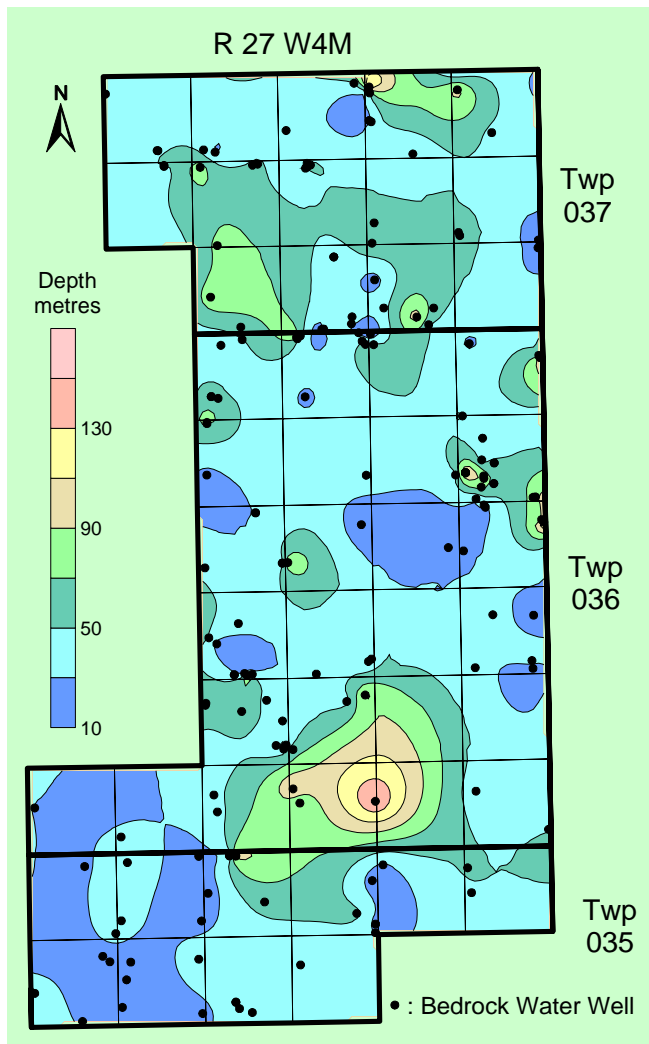


Figure 14. Depth of Water Wells

same aquifer in which the circulation was lost be notified so that the water well can be monitored for any change in groundwater quality.

To allow for mitigation of any problems that may occur as a result of drilling NGC wells, it is recommended that background data be collected for the water wells within 500 metres of the proposed NGC well site. The distance of 500 metres is recommended as a guideline only and the collection of background hydrogeological data may be required at greater distances. It should be noted that there are water wells in the AOI that are completed in areas of higher permeability and it may be necessary to collect background data from a larger radius than 500 metres.

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
inches	25.400 000	millimetres
miles	1.609 344	kilometres
kilometre	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)
ipgm	6.546 300	cubic metres/day (m ³ /day)
cubic metres/day (m ³ /day)	0.152 759	ipgm
Pressure		
psi	6.894 757	kpa
kpa	0.145 038	psi
Miscellaneous		
Celsius	$F^{\circ} = 9/5 (C^{\circ} + 32)$	Fahrenheit
Fahrenheit	$C^{\circ} = (F^{\circ} - 32) * 5/9$	Celsius
degrees	0.017 453	radians

Trouble Shooting Water Well Problems

Symptom #1 - Reduced Water Well Yield

Possible causes:	What to check for:	How to correct:
Pump and/or water system	Low pump production in spite of normal water level in well.	Have a drilling contractor or plumber check the pump and water system.
Aquifer depletion - rate of withdrawal exceeds rate of recharge - times of drought can temporarily deplete shallow groundwater zones	Compare current non-pumping (static) water level with the level at the time of water well construction.	Reduce groundwater use. Drill a deeper well or one that is completed in another aquifer.
Biofilm buildup in water well casing, screen or pump intake.	Slime buildup on household plumbing fixtures and livestock waterers.	Shock chlorinate the water well and water distribution system as required - usually once or twice a year. See Module 6 "Shock Chlorination - Water Well Maintenance."
Neighboring water well interference.	Check for significant drop in water wells in nearby water wells.	Identify other nearby water wells located in the same aquifer. Reduce pumping rates as required.
Mineral scale (incrustation) buildup on perforated water well casing or pump screen.	Scale formation on plumbing fixtures and livestock waterers.	Water well should be cleaned by a drilling contractor by scouring, surfing and/or acid treatment.
Sediment plugging on outside of perforated casing or screen.	Sediment in groundwater, followed by sudden decline in water well yield.	Have a drilling contractor redevelop the water well.
Collapse of water well casing or borehole due to age of water well.	Compare current depth of water well with original records. A collapsed water well will show a shallower depth than the original water well.	Recondition the water well. If repair is not economical, plug the water well and redrill. See Module 9 "Plugging Abandoned Water Wells" for more information on plugging a water well.

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

Symptom #2 - Change in Groundwater Quality

Possible causes:	What to check for:	How to correct:
Corrosion of water well casing, liner or screen, causing holes. Holes can allow groundwater of undesirable quality to enter the water well.	Change in groundwater quality, often coupled with sudden appearance of sediment in groundwater.	Consult with a drilling contractor about possible repair.
Failure of the annulus or casing seal.	Changes in groundwater quality and possible appearance of sediment.	Consult with a drilling contractor about possible repair.
Iron bacteria or sulfate-reducing bacteria (biofouling).	Change in groundwater quality such as color, odor (e.g., rotten egg) or taste. Check inside toilet tank for slime buildup.	Shock chlorinate the water well. For more information on shock chlorination, see Module 6 "Shock Chlorination - Well Maintenance".
Contamination from man-made sources.	Changes in groundwater quality as indicated by odor or taste. Compare results from regular groundwater analyses for changes.	Identify and remove contamination source. Have groundwater analyzed through local health unit to ensure it is safe to drink.

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

Trouble Shooting Water Well Problems

Symptom #3 - Sediment in Groundwater

Possible causes:	What to check for:	How to correct:
Improper water well design or construction.	Sediment appears in groundwater shortly after water well completion.	Have a drilling contractor repair the construction problem.
Insufficient water well development after construction.	Sediment appears shortly after water well completion. Water well production may improve with pumping.	A drilling contractor should redevelop the water well.
Continous overpumping of water well.	Sediment appears in groundwater shortly after water well completion.	Compare current discharge rate of water well with the driller's recommended rate. If the current flow rate is higher, install a flow restrictor on pump.
Corrosion of water well casing, liner or screen causing holes.	Sudden appearance of sediment in groundwater when there was no previous problem. Often coupled with a change in groundwater quality.	Consult a drilling contractor. Depending on the water well construction, repair or replace water well.
Failure of the annulus or casing seal.	Sudden appearance of sediment, coupled with a change in water quality.	Consult a drilling contractor. It may be possible to re-establish the seal. Test groundwater quality regularly and investigate when quality changes occur.

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

Symptom #4 - Dissolved Gas in the Groundwater

Possible causes:	What to check for:	How to correct:
Dissolved gases in groundwater include: - carbon dioxide - methane - nitrogen	Spurting household water taps Milky color to the water which lasts only a few seconds Cautions: 1. Carbon dioxide is an asphyxiant 2. Methane can be flammable and explosive 3. Nitrogen is an asphyxiant	For low concentrations of gas: <ul style="list-style-type: none"> • Install an air volume release valve on the pressure tank, if the tank does not have an air bladder. Also ensure the tank is properly vented outside of building. • Spray groundwater from the water well into a sealed storage tank that is properly vented to the outside. For higher concentrations of gas: <ul style="list-style-type: none"> • Determine the depth that the gas is entering the water well. • If possible, lower the pump intake to below where the gas is entering. A drilling contractor could install a plastic gas-sleeve over the pump intake so the gas will be forced out of the groundwater as it enters the intake. The gas will accumulate at the top of the water well, so properly vent the water well head so the gas is directed to the outside.
Malfunctioning pump or overpumping the water well.	Refer to troubleshooting guide for your particular pumping system. Compare the rate at which you are pumping the water well with the rate recommended by the driller.	Have a drilling contractor or plumber check the pump and pressure system equipment for malfunction. Make sure that any new plumbing equipment is sized correctly to meet the production capability of the water well. Reduce pumping rate from water well, if necessary.

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Guidelines for Canadian Drinking Water Quality

Parameter	MAC	Parameter	AO
Total Coliforms (CFU/100 mL)	0	pH	6.5-8.5
Fecal Coliforms (CFU/100 mL)	0	Sodium	200
Escherichia coli (CFU/100 mL)	0	Iron	0.3
Fluoride	1.5	Manganese	0.05
Nitrate - N	10	Chloride	250
Nitrite - N	1	Sulphate (SO4)	500
Nitrate and Nitrite - N	10	Total dissolved solids	500
Mercury	0.001	Colour	15
Antimony	0.006	Turbidity	5
Arsenic	0.025	Aluminum	0.1
Barium	1	Copper	1
Boron	5	Zinc	5
Cadmium	0.005	Ethylbenzene	0.0024
Chromium	0.05	Toluene	0.024
Lead	0.01	Total Xylenes	0.3
Selenium	0.01		
Uranium	0.02		
Turbidity	1		
Benzene	0.005		

Note:

MAC - Maximum acceptable concentration
 AO - Aesthetic objective

Concentrations in mg/L except as noted

Wellhead Protection

- Annulus around casing is sealed
- Casing extends above ground level at least 20 cm
- No water well pits
- Approved water well seal or cap
- Reclaim unused water wells in accordance with regulation
- No storage or discharge of liquids within 30 metres of a water well
- Regularly check chemical and microbiological quality of groundwater and investigate any changes