

(3) Subsection (2)(b) applies only to a hazardous recyclable facility whose only function is the storage of hazardous recyclables, and does not apply to a site that is located in or is part of a manufacturing, processing or other operation.

Recycle docket

19 The recycle docket referred to in section 169 of the Act must

- (a) meet the requirements for the shipping document for dangerous goods specified in the Federal Regulations, and
- (b) have an attachment showing
 - (i) the name of the consignor of the hazardous recyclable in the shipment,
 - (ii) the location from which the hazardous recyclable in the shipment originated,
 - (iii) the amount of hazardous recyclable in the shipment, and
 - (iv) the signature of an authorized representative for the consignor of the hazardous recyclable in the shipment.

AR 192/96 s19;251/2001;162/2005

Information

20 The person responsible for a hazardous recyclable facility shall

- (a) keep the following information for at least 2 years from the last day of the year in which the information was produced:
 - (i) copies of all recycle dockets for hazardous recyclables received at the facility;
 - (ii) a record of releases of substances at the facility;
 - (iii) calibration and maintenance records of monitoring equipment;
 - (iv) the results of all physical inventories of hazardous recyclables at the facility;
 - (v) any other information prescribed in a notice in writing by the Director;
- (b) make the information available to the Director on the Director's request in writing.

Importation

21 No person shall import hazardous recyclables into Alberta without first obtaining written authorization from the Minister.

Part 3

Non-hazardous Waste

Application

22 This Part applies to the management of waste, other than hazardous waste.

Prohibition

23(1) No person shall deposit waste for disposal in any place other than a waste management facility authorized in accordance with the Act and this Regulation.

(2) Subsection (1) does not apply to

- (a) the disposal of agricultural waste by a farmer on his own land where the waste is produced on his farm,
- (b) the depositing of earth, or
- (c) inert waste used for reclamation.

AR 192/96 s23;162/2005

General

24(1) The person responsible for a Class II or Class III landfill shall ensure that the landfill is sited, designed, constructed, operated and reclaimed so as to meet as a minimum

- (a) the requirements specified in this Regulation, and
- (b) the standards and requirements set out in the *Code of Practice for Landfills*.

(2) The person responsible for a Class I or Class II compost facility shall ensure that the compost facility is sited, designed, constructed, operated and reclaimed so as to meet as a minimum

- (a) the requirements specified in this Regulation, and
- (b) the standards and requirements set out in the Code of Practice for Compost Facilities.

(3) Subsection (1) does not apply to a waste management facility that is operating at the time of publication of the Code of Practice for Landfills until such time as the Director provides written notice

to the person responsible for the waste management facility that the Code of Practice or part of the Code of Practice is to apply.

(4) Subsection (2) does not apply to a waste management facility that is operating at the time of publication of the Code of Practice for Compost Facilities until such time as the Director provides written notice to the person responsible for the waste management facility that the Code of Practice or part of the Code of Practice is to apply.

(5) Where the waste management facility is not required to comply with subsection (1) or (2) because of subsections (3) and (4), the person responsible for the waste management facility must comply with the conditions specified in the approval and permit issued under the *Waste Management Regulation* (Alta. Reg. 250/85) before its repeal or the permit issued by the Provincial Board of Health which is deemed a permit under section 14 of that Regulation.

(6) A person responsible who receives a notice in writing from the Director under subsection (3) or (4) shall comply with the notice in accordance with the terms specified in the notice.

(7) The notice referred to in subsections (3) and (4) must specify that all or part of the Code of Practice is to apply and if only part, which part, and specify the date on which all or part of the Code of Practice is to apply.

Certified operators

25(1) The person responsible for a Class II or Class III landfill or Class I or Class II compost facility shall ensure that the facility is supervised by a certified operator during its hours of operation.

(2) A certified operator may have one or more assistants who may supervise the facility in his temporary absence.

(3) The person responsible for a Class II or Class III landfill or Class I or Class II compost facility shall notify the Director in writing of the names of all certified operators and their assistants and any change in any of the certified operators or their assistants within 30 days of the change.

(4) Subsections (1), (2) and (3) do not apply until September 1, 2001.

Burning

26 No person shall burn or permit burning at a waste management facility unless

- (a) the burning is conducted in accordance with the *Substance Release Regulation* (AR 124/93),
 - (b) the burning is done in an area that is
 - (i) constructed with a fire break consisting of barren mineral soil,
 - (ii) located so that is separated from disposal operations, storage compounds and buildings, and
 - (iii) supervised at the time of burning,
- and
- (c) the person responsible for the waste management facility has notified
 - (i) the local authorities,
 - (ii) all adjoining property owners,
 - (iii) the Director, and
 - (iv) the local fire department
- at least 7 days prior to the date of the burning, informing them of the proposed burning and the date on which the proposed burning is to take place.

AR 192/96 s26;162/2005

Part 4 Security

Security required

27(1) Where an approval or a registration is required in respect of

- (a) a waste management facility, excluding an on-site facility, or
- (b) a hazardous recyclable facility,

the Director shall require the applicant for the approval or registration to provide security before operation or reclamation of the facility commences.

(2) Subsection (1) does not apply where the applicant for the approval or registration is the Crown or a local authority.

Amount of security

28(1) Security shall be in an amount determined by the Director to be sufficient to ensure completion of conservation and reclamation as required by the Act and the Regulations under the Act based on

- (a) the estimated costs of conservation and reclamation submitted by the applicant, approval holder or registration holder,
- (b) the nature, complexity and extent of the facility's operations,
- (c) the probable difficulty of conservation and reclamation, giving consideration to such factors as topography, soils, geology, hydrology and revegetation, and
- (d) any other factors the Director considers to be relevant.

(2) Within 30 days of any changes to the most recent conservation and reclamation plan submitted under the *Approvals Procedure Regulation* (Alta. Reg. 113/93), the approval holder or registration holder shall recalculate the applicable cost estimates and submit adjusted cost estimates to the Director.

Adjustment of security

29(1) The Director may increase or decrease the amount of security that is to be provided where

- (a) the cost of future conservation and reclamation changes,
- (b) the extent of the operation of the facility is increased or reduced,
- (c) the land or any portion of it is conserved and reclaimed,
- (d) the conservation and reclamation plan in the approval or registration is changed,
- (e) the approval holder or registration holder is conducting on the site of the facility more than one activity for which security is required, or
- (f) any other circumstances exist that may increase or decrease the estimated cost of conservation and reclamation.

(2) The Director may specify times or set a schedule for re-evaluating and adjusting the security provided.

(3) The Director shall notify an approval holder or registration holder of any proposed adjustment to the amount of the security.

Form of security

30 Security must be in one or more of the following forms as required by the Director:

- (a) cash;
- (b) cheques and other similar negotiable instruments payable to the Minister of Finance;
- (c) Government guaranteed bonds, debentures, term deposits, certificates of deposit, trust certificates or investment certificates assigned to the Minister of Finance;
- (d) irrevocable letters of credit, irrevocable letters of guarantee, performance bonds or surety bonds in a form acceptable to the Director;
- (e) any other form that is acceptable to the Director.

AR 192/96 s30;27/2002;68/2008;31/2012

Return of security

31(1) Where a reclamation or remediation certificate is issued in respect of all or part of a facility, the Minister may return or direct the return of all or part of the security provided, as the case may be.

(2) Notwithstanding subsection (1), if conservation and reclamation has been partially completed as required under the Act and the Regulations, the Minister may, on application by the approval holder or registration holder, return or direct the return of a part of the security, as determined by the Minister.

(3) Where the Director decreases the amount of security under section 29 the Minister shall return or direct the return of part of the security provided.

(4) The Minister shall return or direct the return of all security provided where an application for an approval or registration is submitted but no approval or registration is issued.

Retention of security

32 In a case to which section 15 of the *Conservation and Reclamation Regulation* (Alta. Reg. 115/93) applies, the Minister may, notwithstanding that a reclamation certificate has been issued, retain all or part of the security until the expiration of the applicable period referred to in that section.

Forfeiture of security

33(1) The Minister may order that all or part of the security provided by the approval holder or registration holder be forfeited if

- (a) the approval holder or registration holder fails to commence and complete conservation and reclamation in a timely fashion,
- (b) the approval holder fails to meet conservation and reclamation standards specified in an approval,
- (c) the registration holder fails to meet conservation and reclamation standards specified in the applicable Code of Practice,
- (d) the approval holder or registration holder fails to renew existing security before its expiry date,
- (e) the approval holder or registration holder fails to adjust the amount of security for inflation or to account for changes in the conservation and reclamation plan,
- (f) the approval holder or registration holder has not complied with an environmental protection order or enforcement order issued by the Director, or
- (g) a receiver, receiver-manager or trustee has been appointed in respect of the operations of the approval holder or registration holder,

and as a result, conservation and reclamation of the facility as required by the Act and the Regulations would, in the Minister's opinion, be prevented or interfered with.

(2) Where the Minister orders security to be forfeited under subsection (1), the Minister shall

- (a) give written notice of the decision to the approval holder and registration holder, and
- (b) direct the Minister of Finance to transfer the security from the Environmental Protection Security Fund to the Environmental Protection and Enhancement Fund.

(3) On the request of the Minister the Minister of Finance shall pay to the Minister from the Environmental Protection and Enhancement Fund as much of the security transferred under subsection (2) as the Minister considers is necessary to carry out the conservation and reclamation in accordance with the Act, the

Regulations and the approval, and the Minister shall use the security for that purpose.

(4) Subsection (3) applies despite the fact that the approval holder or registration holder may not have actually received the notice referred to in subsection (2)(a).

(5) Where the amount of the forfeited security exceeds the amount required for conservation and reclamation, the Minister of Finance shall on the direction of the Minister pay the excess amount to the approval holder or registration holder.

(6) Where the amount of the forfeited security is insufficient to pay for the cost of conservation and reclamation, the approval holder or registration holder remains liable for the balance.

AR 192/96 s33;27/2002;68/2008;31/2012

Part 5 Miscellaneous

Expanded definition of waste

34 A motor vehicle that is not registered and is inoperative is waste for the purposes of the sections referred to in section 168(k) of the Act.

AR 192/96 s34;251/2001

Form of order

35(1) An enforcement order issued under section 211 of the Act must be in Form 1 in Schedule 3.

(2) An environmental protection order issued under section 183 of the Act must be in Form 2 in Schedule 3.

AR 192/96 s35;251/2001

Review of EPO

36(1) A committee appointed under section 186(3) of the Act must consist of at least 3 members.

(2) Where a request for review under section 186(1) of the Act is made to a local authority, the following applies:

- (a) the committee shall give written notice to the inspector, investigator or Director who issued the environmental protection order that a request for review has been made;
- (b) the committee may request from the inspector, investigator or Director any information that it considers necessary;

- (c) no action may be taken under the Act with respect to the enforcement of the order during the time that the decision of the committee on the review is pending;
 - (d) the committee may conduct any investigation that it considers necessary to properly review the order and shall complete its review within 30 days after receipt of the request for the review or within any further extended period under subsection (3);
 - (e) the committee shall issue a written decision on the review and shall give a copy of the decision to the inspector, investigator or Director who issued the order and to the person to whom the order was directed, all within 45 days after receipt of the request for the review or within any extended period under subsection (3).
- (3) Where the committee considers that extenuating circumstances exist that make it impractical for the committee to complete its duties within the period of time imposed under subsection (2)(d) or (e) it may extend that period of time.
- (4) Where the decision of the committee confirms or varies the environmental protection order, the decision shall prescribe the time within which the order must be complied with, which shall not be more than 60 days after the date the person to whom the order was directed receives a copy of the decision.

AR 192/96 s36;251/2001

Part 6

General

37 Repealed AR 230/2005 s2.

Standards for compost facilities

- 38** All compost facilities shall be constructed and operated so that
- (a) the generation of odours is minimized,
 - (b) run-on and run-off water is controlled so that surface water and groundwater are not contaminated, and
 - (c) animals and vectors of disease are controlled.

AR 192/96 s38;162/2005

Records

39(1) The Director may, by notice in writing to the person responsible for a waste management facility, including but not

limited to a hazardous waste management facility or a hazardous recycling facility, require that person to keep records in the form and manner and containing the information specified by the Director in the notice.

(2) The person shall keep information in a record referred to in subsection (1) for at least 5 years after the information was entered in the record.

(3) The person shall provide the records referred to in subsection (1) to the Director on demand.

Plans and reports

40 The Director may, by notice in writing directed to the person responsible for a waste management facility, including but not limited to a hazardous waste management facility or a hazardous recycling facility, require that person to submit plans and reports respecting the construction, operation or reclamation of the facility.

Waste collection containers

41(1) The Minister may by notice in writing given to a person require that person to provide waste collection containers in the numbers, at the locations and within the time specified in the notice.

(2) A person who receives a notice under subsection (1) shall comply with it in accordance with its terms.

Offences

42 A person who contravenes sections 3.1, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 23, 24, 26, 37, 39, 40 or 41 is guilty of an offence and is liable

- (a) in the case of an individual, to a fine of not more than \$50 000, or
- (b) in the case of a corporation, to a fine of not more than \$500 000.

AR 192/96 s42;162/2005

Due diligence

43 No person shall be convicted of an offence referred to in section 42 if that person establishes on a balance of probabilities that he took all reasonable steps to prevent its commission.

AR 192/96 s43;87/2007

Transition

44 A person who on August 31, 1996 was registered under section 13.1 of the *Waste Control Regulation* (Alta. Reg. 129/93) is deemed to have complied with section 12 of this Regulation with respect to PCBs stored before September 1, 1996.

Repeal

45 The following Regulations are repealed:

- (a) the *Waste Control Regulation* (Alta. Reg. 129/93);
- (b) the *Waste Management Regulation* (Alta. Reg. 250/85).

Coming into force

46 This Regulation comes into force on September 1, 1996.

Schedule 1**Properties of hazardous waste**

1 Waste is hazardous and a recyclable is a hazardous recyclable waste if, when tested according to a test method set out in the Alberta User Guide for Waste Managers, 1996, published by the Department, as amended from time to time, or a test method authorized in writing by the Director,

- (a) it has a flash point of less than or equal to 60.5°C,
- (b) it ignites and propagates combustion in a test sample,
- (c) it contributes oxygen for combustion at a rate that is equal to or greater than that provided by ammonium persulphate, potassium perchlorate or potassium bromate,
- (d) it is toxic because it
 - (i) has a rat oral toxicity LD₅₀ not greater than 200 mg/kg, if a solid, or 500 mg/kg, if a liquid,
 - (ii) has a dermal toxicity LD₅₀ not greater than 1000 mg/kg, or
 - (iii) has an inhalation toxicity LC₅₀ not greater than 10,000 mg/m³ at normal atmospheric pressure,
- (e) it has a pH value less than 2.0 or greater than 12.5,

- (f) it contains polychlorinated biphenyls at a concentration equal to or greater than 50 mg/kg, or
- (g) it is a toxic leachate because it is in a dispersible form and
 - (i) it contains at a concentration of 100 mg/L or higher of any substance listed in Table 1 of the Schedule to the Alberta User Guide for Waste Managers, published by the Department, as amended from time to time,
 - (ii) its leachate contains any substance listed in Table 2 of the Schedule to the Alberta User Guide for Waste Managers, published by the Department, as amended from time to time in excess of the concentrations listed in that Table, or
 - (iii) it contains any of the following substances in a concentration greater than 0.001 mg/L:
 - hexachloro-dibenzo-p-dioxins
 - pentachloro-dibenzo-p-dioxins
 - tetrachloro-dibenzo-p-dioxins
 - hexachloro-dibenzofurans
 - pentachloro-dibenzofurans
 - tetrachloro-dibenzofurans.

Hazardous waste**2** The following waste is hazardous waste:

- (a) waste types listed in Table 3 of the Schedule to the Alberta User Guide for Waste Managers, published by the Department, as amended from time to time;
- (b) commercial products or off-specification products listed in Part A of Table 4 of the Schedule to the Alberta User Guide for Waste Managers, published by the Department, as amended from time to time;
- (c) a container, other than an empty container, that has an internal volume greater than 5 litres and contains a substance listed in Part A of Table 4 of the Schedule to the Alberta User Guide for Waste Managers, published by the Department, as amended from time to time;
- (d) a number of containers, other than empty containers, that have an aggregate internal volume greater than 5 litres and contain a substance listed in Part A of Table 4 of the Schedule to the Alberta User Guide for Waste Managers,

published by the Department, as amended from time to time;

- (e) commercial products or off-specification products listed in Part B of Table 4 of the Schedule to the Alberta User Guide for Waste Managers, published by the Department, as amended from time to time;
- (f) an unrinsed empty container that has an internal volume greater than 5 litres and contained a substance listed in Part B of Table 4 of the Schedule to the Alberta User Guide for Waste Managers, published by the Department, as amended from time to time; or
- (g) a number of unrinsed empty containers that have an aggregate internal volume greater than 5 litres and contained a substance listed in Part B of Table 4 of the Schedule to the Alberta User Guide for Waste Managers, published by the Department, as amended from time to time.

Hazardous recyclables

3 Substances or mixtures of substances specified in section 2 of this Schedule as being hazardous waste are, if they are intended to be recycled, hazardous recyclables.

AR 192/96 Sched.1;162/2005

Schedule 2

Not hazardous waste

1 The following are not hazardous waste for the purposes of the Act and this Regulation:

- (a) household waste in the possession of the householder or while unsegregated in a municipal waste management system;
- (b) agricultural waste;
- (c) domestic sewage;
- (d) waste regulated under the *Nuclear Safety and Control Act* (Canada);
- (e) wastes resulting from emergency spill clean-ups, if the Director or an investigator has authorized the handling of the clean-up debris;

- (f) biomedical waste;
- (g) waste described in Schedule 1, other than those substances listed in Table 4, Part B of the Schedule to the Alberta Users Guide for Waste Managers published by the Department, as amended from time to time, that is produced in an amount less than 5 kilograms per month if a solid or 5 litres per month if a liquid and the total quantity accumulated does not exceed 5 kilograms or 5 litres at any one time;
- (h) waste resulting from the treatment of hazardous waste where the treatment employs a method, technique or process that represents acceptable industry practice.

Not hazardous recyclables

2 The wastes specified in section 1 of this Schedule as not being hazardous waste are also not hazardous recyclables.

AR 192/96 Sched.2;162/2005

Schedule 3**Form 1****Enforcement Order****(Environmental Protection and
Enhancement Act, section 211)**

To _____ (name)
of _____ (address)

Take notice that:

I have reason to believe that you have contravened section (indicate appropriate section number 178, 179, 180 or 182) of the *Environmental Protection and Enhancement Act*.

Pursuant to section 211 of the *Environmental Protection and Enhancement Act*, you are hereby ordered

- (a) to pick up and remove all waste unlawfully disposed of within ____ days, and in particular to take the following action:

(list particulars if necessary)

- (b) to refrain from any further or continuing unlawful disposal of waste.

Contravention of this order may result in one or more of the following actions being taken against you:

- you might be prosecuted under the Act in respect of the contravention;
- an application might be made to the Court of Queen's Bench for an order that you comply with the enforcement order;
- the enforcement order might be carried out by the Director and the costs are recoverable from you.

Dated this _____ day of _____, 20__.

Director/Investigator

Form 2

Environmental Protection Order

(Environmental Protection and Enhancement Act, Section 183)

To _____ (name)
of _____ (address)

Take notice that:

The property located at _____ (address or legal description) is considered to be unsightly by reason of the existence of waste on it.

You are hereby ordered, pursuant to section 183 of the *Environmental Protection and Enhancement Act*, to clean up the unsightly property by doing the following: _____
on or before _____

Contravention of this order may result in one or more of the following actions being taken against you:

- you might be prosecuted under the Act in respect of the contravention;
- an application might be made to the Court of Queen's Bench for an order that you comply with the environmental protection order;
- the environmental protection order might be carried out by the local authority or the Director and the costs are recoverable from you.

This environmental protection order may be reviewed by a committee appointed by the (name of local authority or Minister of

Municipal Affairs) if a written request for review is made within 21 days of the date of receipt of this order to (name and address of local authority or Minister of Municipal Affairs).

Dated this _____ day of _____, 20__.

Director/Investigator

AR 192/96 Sched. 3;251/2001;35/2007;68/2008

Schedule 4

COLUMN A	COLUMN B
The construction, operation or reclamation of a small incinerator as set out in clause (b) of Schedule 2, Division 1 of the <i>Activities Designation Regulation</i> (AR 276/2003).	Code of Practice for Small Incinerators, 2005, published by the Department.
The construction, operation or reclamation of a fixed facility for the land treatment of soil containing hydrocarbons as set out in clause (f) of Schedule 2, Division 1 of the <i>Activities Designation Regulation</i> (AR 276/2003).	Code of Practice for Land Treatment of Soil Containing Hydrocarbons, 2005, published by the Department.
The construction, operation or reclamation of a facility for energy recovery by the production of alternate fuel or the burning of waste as fuel, as set out in clause (d) of Schedule 2, Division 1 of the <i>Activities Designation Regulation</i> (AR 276/2003).	Code of Practice for Energy Recovery, 2005, published by the Department.

AR 192/96 Sched.4;162/2005

Alberta Landfill and Composting Facility
Operator Certification Guideline

Alberta ■

FORWORD

This document replaces the “Alberta Landfill and Composting Facility Operator Certification Guidelines (July 2010)”, published by Environmental Policy Branch, Alberta Environment (ISBN 978-0-7785-8985-3), and is effective September 1, 2012.

The Alberta Landfill and Composting Facility Operator Certification Program involves industry associations as certifying partners. The certifying partners provide training programs, administer exams, and manage certificates. The Northern Lights Chapter of the Solid Waste Association of North America (SWANA-NLC) and the Compost Council of Canada (CCC) are the certifying partners representing the landfill industry and composting industry, respectively. Both organizations have training programs in place, and have membership subscriptions throughout Alberta and Canada.

The Solid Waste Certification Advisory Committee (SWCAC), chaired by Alberta Environment and Sustainable Resource Development, governs the program by making recommendations on program requirements, exam bank updates, auditing certifying partner programs, and other matters that are integral to the certification program.

Updates to the program include the requirement for a Certified Operator Personnel Plan, and specialized training.

Alberta Environment and Sustainable Resource Development acknowledges, with gratitude, the guidance and direction provided by the 2012 members of the SWCAC in updating this guidance document. The members willingly participated in the process by volunteering their time to attend meetings and review documents.

Solid Waste Certification Advisory Committee Members (2012):

Marcedes Braumberger	-	Aquatera Utilities Inc.
Corey Colbran	-	City of Calgary
Janice Isberg	-	EWMCE – Education Manager
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Sheri Praski	-	Solid Waste Association of North America (SWANA)
Terry Rowley	-	City of Red Deer/ SWANA
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Victor Skoreiko	-	Waste Management – West Edmonton Landfill
Rob Smith	-	Athabasca Regional Waste Management Services Commission
Reid Williams	-	BFI Inc.
Allan Yee	-	City of Edmonton/Composting Council of Canada (CCC)

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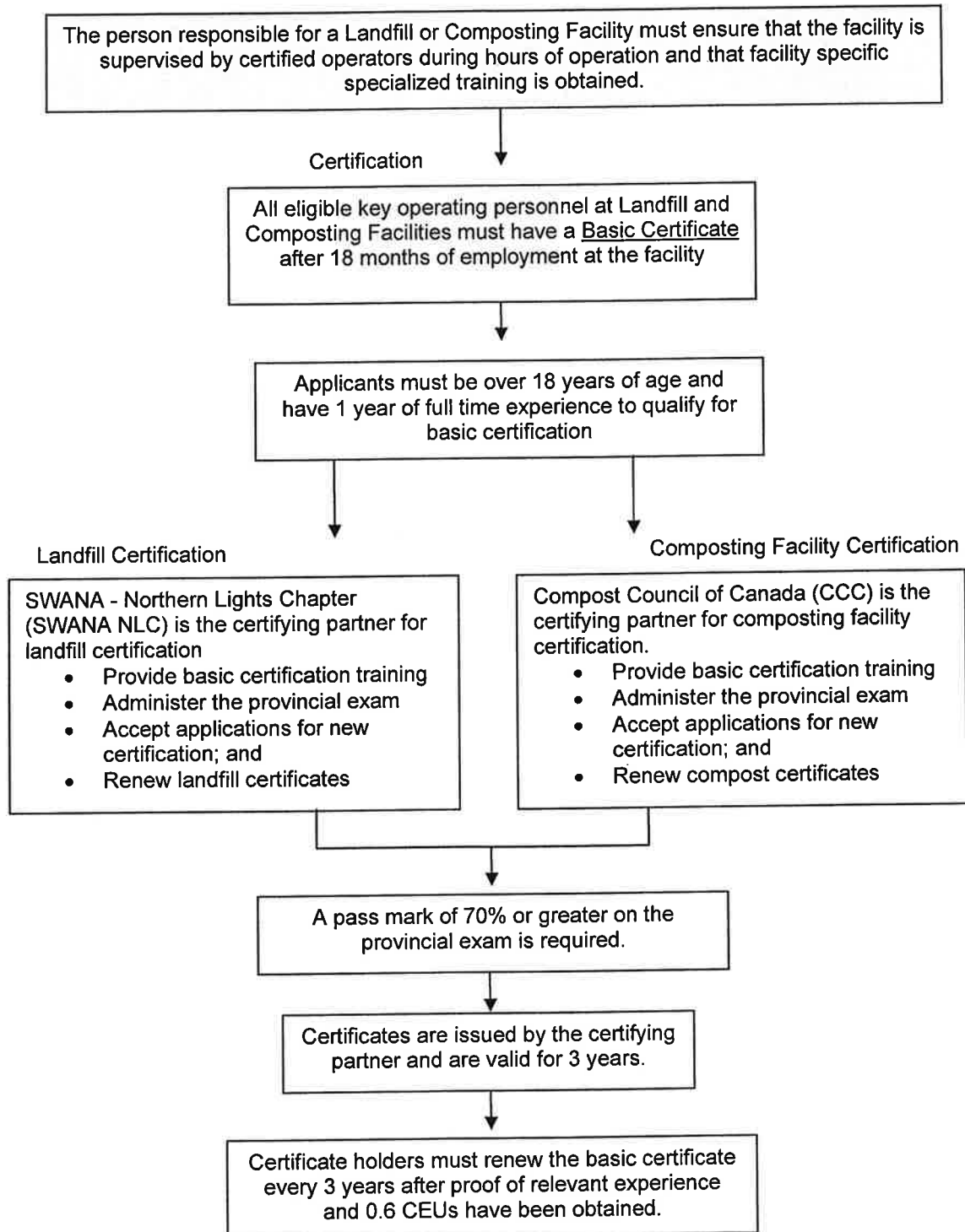
Revised Edition (July 2012)

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LANDFILL AND COMPOSTING FACILITY OPERATOR CERTIFICATION PROGRAM SYNOPSIS



DEFINITIONS

- (a) 'Act' means the *Alberta Environmental Enhancement and Protection Act*, R.S.A. 2000 c. E-12, as amended.
- (b) 'Certified Operator' means, in respect to a landfill or composting facility, a person who holds a certificate recognized by the Director;
- (c) 'Certified Operator Personnel Plan' means a document that identifies
 - a) all key operating personnel,
 - b) timelines showing when operators were certified,
 - c) timelines showing when new key operating personnel are scheduled to be certified,
 - d) distance supervision requirements,
 - e) and, which certified operators have obtained the specialized training required for the site;
- (d) 'Class I compost facility' means a waste management facility where waste, not including hazardous waste, is decomposed through a controlled bio-oxidation process, including a thermophilic phase, that results in a stable humus-like material, but does not include:
 - a) a residential composter,
 - b) a compost facility that receives only sludge as defined in the *Wastewater and Storm Drainage Regulation* (AR 119/93),
 - c) a Class II compost facility, or
 - d) a manure storage facility as defined in the *Agricultural Operation Practices Act*;
- (e) 'Class II compost facility' means a waste management facility where only vegetative matter or manure is decomposed through a controlled bio-oxidation process, including a thermophilic phase, that results in a stable humus-like material, but does not include:
 - a) a residential composter, or
 - b) a manure storage facility as defined in the *Agricultural Operation Practices Act*;
- (f) 'Class II landfill' means a landfill for the disposal of waste, not including hazardous waste;
- (g) 'Class III landfill' means a landfill for the disposal of inert waste;
- (h) 'Continuing Education Unit (CEU)' - means 10 contact hours of participation in an organized, relevant continuing education experience as approved by the Solid Waste Certification Advisory Committee.
- (i) 'Conditional Restricted Certificates (CR)' means a program implementation (grandfather) certificate issued prior to September 1, 2001. The certificate is designated with 'CR' preceding the certificate number.
- (j) 'Experience' means full-time employment spent working at a landfill or composting facility.

- (k) 'Key operating personnel' mean all staff that are directly responsible, or directly supervise, the daily operations of a landfill or composting facility. This does not include employees or contractors that are exclusively employed for equipment operation.
- (l) 'Operations' means the active daily on-site processes or activities that ensure the landfill is operated in accordance with appropriate municipal, provincial and federal regulations and policies.
- (m) 'Specialized training' means learning opportunities that provide certified operators with knowledge to effectively manage specialized waste management technology or materials. Courses must be approved by the Solid Waste Certification Advisory Committee to qualify as "specialized training".
- (n) 'Year' is defined as one calendar year or 12 consecutive months.

1. PROGRAM HISTORY

1.1. Regulatory Requirement for Certified Operators

Certified operators have been a requirement for Alberta landfill and composting facilities since 1996. The Waste Control Regulation (AR 192/1996), Part 3, Section 25, Subsections 1 to 4 state that Class II and III landfills, and Class I and II compost facilities shall be supervised by a certified operator during its hours of operation. The implementation date was September 1, 2001.

A solid waste certification program was developed by the Municipal Program Development Branch in 1997, where approximately 20 stakeholders representing the solid waste industry reviewed and provided input to the program.

1.2. Solid Waste Certification Advisory Committee

The first Solid Waste Certification Advisory Committee (Advisory Committee) was formed in 1999 with 12 members representing waste management facility operators, academia, municipal governments, Alberta Environment staff, and consulting engineers practicing in the area of waste management. The role of the Advisory Committee is to provide review and recommendations for the certification program.

Members of the Advisory Committee are appointed on three year terms and two new members are introduced each year as appointments expire.

1.3. Certifying Partners

In 2010 partnerships were formed between Alberta Environment and Sustainable Resource Development and Northern Lights Chapter of the Solid Waste Association of North America (SWANA-NLC) and the Compost Council of Canada (CCC) to administer the landfill and composting facility certification program, respectively. These associations will offer the basic certificate examination, and will be required to have their certification programs reviewed and approved by Alberta Environment.

1.4. Goal of Program

Landfill and Composting Facility Operators will increase their knowledge to operate and manage waste management facilities so that:

- Environmental quality will be protected;
- Public health and safety will be protected;
- Regulatory compliance will be enhanced;
- Landfill and composting facilities will be operated effectively;
- Waste reduction and resource conservation objectives are met; and,
- Sites are managed to follow the waste management hierarchy of reduce, reuse, recycle, and recover.

2. SOLID WASTE CERTIFICATION ADVISORY COMMITTEE

2.1. Advisory Committee Members

Members of the Solid Waste Certification Advisory Committee provide review and recommendations concerning the Certification Program.

The Advisory Committee consists of the following representatives:

- one representative from Environmental Policy Division of Alberta Environment and Sustainable Resource Development;
- one representative from each certifying partner;
- at least one municipal government employee in a managerial position (not elected) responsible for municipal waste management facilities;
- at least one faculty member of a post secondary institution where that person conducts training related to municipal solid waste facility operations;
- operating personnel with representation from both landfill and composting facilities; and
- one regional representative from Alberta Environment and Sustainable Resource Development.

The Advisory Committee is chaired by Alberta Environment and Sustainable Resource Development. Members serve 3 year terms which are staggered so that at least two of the positions will expire each year. Advisory Committee members have the option to renew their term once.

2.2. Duties of the Solid Waste Certification Advisory Committee

The Advisory Committee meets a minimum of three times per year, to make recommendations on the following items:

- certification program requirements;
- question bank review and update;
- evaluation of specific training/education with respect to the program;
- audit partner programs to ensure adherence to the program requirements; and
- other matters that may be requested.

Written requests for improvements to the program may be directed to the Advisory Committee chair.

3. LANDFILL AND COMPOSTING FACILITY OPERATOR CERTIFICATION PROGRAM

3.1. Certified Operator Defined

The Waste Control Regulation currently defines a “certified operator” as “a person who holds a valid certificate of qualification issued in accordance with the Act and this Regulation”.

A review of the definition of a certified operator is underway as part of the Waste Control Regulation Review. The intent is to change the definition so a certified operator will be a person who holds a certificate recognized by the Director, and no longer needs to have a certificate of qualification issued by Alberta Environment and Sustainable Resource Development.

The proposed definition is:

‘Certified Operator’ means a person who holds a certificate recognized by the Director.

3.2. Recognized Certificates

The following certificates are recognized by the Director:

Landfills:

1. “Alberta Environment Certificate of Qualification” issued under the Municipal Waste Facility Operator Certification Guidelines for a landfill facility.
2. “Alberta Landfill Operator Basic Certificate” issued by SWANA-NLC.

Composting Facilities:

1. “Alberta Environment Certificate of Qualification” issued under the Municipal Waste Facility Operator Certification Guidelines for a compost facility.
2. “Alberta Composting Facility Operator Basic Certificate” issued by the Compost Council of Canada.

3.3. Key Operating Personnel

Key operating personnel are individuals that are designated as the on-site supervisors who are responsible for operations at the facility. This does not include employees or contractors that are exclusively employed for equipment operation. The Advisory Committee recommends that all eligible key operating personnel employed at landfill or composting facility operations shall apply for basic certification after eighteen months of employment at the facility.

Key personnel for landfills are, but not limited to, the following positions:

- o Foreman¹

¹ Job titles are provided as examples. Determination of key personnel is based on the job description of the individual.

- Site supervisor
- Site operator
- Operations Manager
- Lead Hand
- Lead Operator
- Senior Operator
- Regional Landfill Manager

Key personnel for composting facilities are, but not limited to, the following positions:

- Foreman
- Site supervisor
- Site operator
- Manager
- Compost Technician

Employees at landfills and composting facilities that are not considered key operating personnel may be certified if they meet the program requirements. It is the recommendation of the SWCAC that any employee working at landfills and composting facilities be certified.

3.4. Role of the Person Responsible for the Waste Management Facility

The need for a certified operator program is established by the Waste Control Regulation, Section 25, and additional details are outlined in the Standards for Landfills in Alberta and the Standards for Composting Facilities in Alberta. A copy of the certified operator requirements is provided in Appendix A.

All operating landfills and composting facilities regulated by Alberta Environment and Sustainable Resource Development must be supervised by certified operators during hours of operation. This includes any Class II and Class III landfill that accepts only industrial waste. Composting facilities that are regulated through the Natural Resources Conservation Board do not need to have operators certified through this program.

The person responsible shall ensure that all key operational personnel eligible for certification have basic certification, and that at least one certified operator has the appropriate specialized training for the facility. More information about specialized training is in Section 3.5.

The person responsible for the waste management facility must have a **Certified Operator Personnel Plan** identifying all key operating personnel, timelines showing when they were certified, and which certified operators have obtained the specialized training required for the site. The names of new key operating personnel that still require experience prior to qualifying for certification must also be added to the plan, as well as reasonable timelines for obtaining their Basic Certification. This plan must be available on site and available during site inspections. For facilities that have only one key operating person, Section 3.6 provides details on how to meet the supervision requirement during temporary absences.

It is the legal responsibility of the person responsible of each facility to be aware of the requirements for certified operators and to ensure that the requirements are met. It is

important that facility owners or managers develop the Certified Operator Personnel Plan so that substitute or replacement personnel are available as necessary.

3.5. Specialized Training

Operators at landfills and composting facilities require additional knowledge to operate some facilities compared to others. For example, an operator working at a landfill with a leachate collection system will require additional information about leachate management compared to working at a landfill without one. Because basic certification does not provide detailed information about every technology or materials a waste facility operator may encounter, "specialized training" is being developed through the guidance of the Advisory Committee.

Specialized training will be Advisory Committee approved courses that provide certified operators with more in depth knowledge of technology, materials, or processes they may encounter as waste operators. The Registration or Approval issued by Alberta Environment and Sustainable Resource Development will be used to flag any specialized training is required for certified operators of the site. The person responsible shall ensure that at least one certified operator has the appropriate specialized training for the facility. A person responsible can meet the specialized training requirement by hiring qualified professionals that have completed the specialized training relevant for the facility.

Upon successful completion of the course, the certifying partner will send a sticker to the certified operator as proof of obtaining the required training. This sticker is to be added to the operator's certificate. Once completed, specialized training does not expire so long as the operator's certificate remains active.

This new part of the certification program will be introduced in stages by Alberta Environment and Sustainable Resource Development to ensure operators have a reasonable opportunity to complete the required specialized training courses. Courses are under development and must be approved by the SWCAC to qualify as "specialized training". Certified operators will be informed when specialized training courses become available.

(a) Specialized Training for Landfill Operators

SWCAC is evaluating the following subjects for specialized training courses:

- Leachate management collection systems
- Industrial waste and contaminated soils
- Landfill gas
- Household hazardous waste management
- Bioreactor landfills
- Construction and demolition waste

(b) Specialized Training for Composting Facility Operators

The Advisory Committee is evaluating the following subjects for specialized training courses:

- Active aeration systems
- Biosolids and Industrial wastes
- Industrial, commercial, and institutional organics
- Mortalities

3.6. Distant Supervision

Distant supervision is the ability of the certified operator to review and direct operations of a landfill or composting facility through communication with assistant operators that are on site. This may be necessary during a period of time where the certified operator is temporarily or permanently absent.

Temporary absence can occur due to vacation, illness, maternal or paternal leave etc, and the operator is expected to return to regular duties after the period of absence. The person responsible shall review the nature of the temporary absence and determine the necessary back fill requirements.

Permanent absence is period of time where the certified operator is absent due to circumstances that have released the certified operator from responsibilities at the waste management facility, e.g. re-assigned to other duties within the organization, or laid off. Permanent absence means the certified operator is not expected to return to regular duties. The person responsible for the facility shall provide an alternative certified operator for the facility if the certified operator is permanently absent, and update the Certified Operator Personnel Plan as required.

(a) Distant Supervision Guidelines

Distant supervision by offsite certified operator(s) will be allowed by Alberta Environment and Sustainable Resource Development under the following conditions:

Arrangements for distant supervision staffing shall be developed and written in the Certified Operator Personnel Plan. The section on distant supervision shall include a list of current certified operators and assistants names. If contractors are used, copies of any agreements with the contractors shall be included.

The certified operator(s) shall have valid basic certificates and have the required specialized training.

An employee of the landfill or composting facility is designated as the assistant to the certified operator and is onsite during hours of operation.

The certified operator shall visit the facility not less than one time per month. Such visits shall be documented in the facility's operating record.

Where infrastructure exists, the designated operator assistant shall be able to communicate with the certified operator from the facility via telephone or some other means of real-time communication.

The certified operator will regularly review the operations log with the operator assistant, and provide feedback and direction on issues encountered and short term operating plans.

The certified operator will be made aware of any complaints received by the facility, and the steps taken to address the complaint.

3.7. Certificate Types

All certificates will be valid as long as the holder uses reasonable care, judgement, and knowledge in the performance of operational duties.

No certificate will be valid if obtained or renewed through fraud, deceit, or the submission of inaccurate qualification data.

(a) Basic Certification

A Basic Certificate is issued when an operator meets the appropriate experience requirements of the Certification Program and achieves a mark of 70% or better on the provincial exam. Basic Certificates are valid for a maximum of three years.

Operators that take and pass the exam in the months of January to June will be issued a certificate with a June 30th expiry date. Operators that take and pass the exam in the months of July to December will be issued a certificate with a December 30th expiry date.

(i) Qualifications for Basic Certification

Effective January 1, 2010, an applicant for a basic certificate must:

- be at least 18 years of age, and
- have at least 1 year of full time operational experience at a landfill or composting facility.

The full-time experience requirement must be current to be within the last 3 years from the date of application.

(ii) Application for Basic Certification

Application forms for basic certification can be obtained directly through SWANA-NLC or CCC. Completed application forms should be forwarded directly to the certifying partners.

For Landfill certification:

SWANA Northern Lights Chapter
PO Box 3317
Sherwood Park, AB
T8H 2T2

Tel: 780.496.5614
Fax: 1.866.698.8203
Email: office@swananorthernlights.org
<http://www.swananorthernlights.org>

For Composting Facility Certification:

Compost Council of Canada
16, Northumberland St.
Toronto, ON
M6H 1P7

Tel: 1-877-571-GROW (4769)
Email: info@compost.org
<http://www.compost.org>

(b) Provincial Certificates (issued prior to January 1, 2010)

Certificates of Qualification were issued by Alberta Environment between September 1999 and December 2009 to operators that met the program requirements and successfully passed a provincial certification exam. These certificates were issued based on classifications of landfills and composting facilities defined in the Activities Designation Regulation.

As of January 1, 2010, all certificates issued by Alberta Environment will be considered Basic Certificates.

(c) Conditional Certificate

Application for Conditional Certificates must be made to Alberta Environment and Sustainable Resource Development. Conditional certificates are issued to facilities that do not have operators that met the requirements for certification. The Conditional Certificates are temporary and are non renewable. Operators who have valid conditional certificates should comply with the timelines outlined in the conditional certificate to obtain basic certification.

Please contact Natasha Page, Waste Reduction Specialist, Alberta Environment and Sustainable Resource Development at (780) 427-5830 or natasha.page@gov.ab.ca for conditional certificate application requirements.

(d) Conditional Restricted Certificates (R)

Conditional Restricted Certificates were issued during the implementation stage of the certificate program. The certificate is restricted to the facility being operated and is designated with the letters 'CR' preceding the certificate number. If kept current through renewal every three years, a Conditional Restricted certificate will remain valid until the operator is no longer employed at the specified facility, or until the renewal is allowed to lapse. Once allowed to lapse, a Conditional Restricted Certificate will become invalid.

Conditional Restricted Certificates were renewable until December 31st, 2011 and will remain valid until the expiry date or until the operator is no longer employed at the specified facility. Upon expiry, operators must apply for basic certification.

(e) Manager Level Certificates

The SWCAC recommends that manager level certificates be introduced to the program at a later date. Key operating personnel are expected to be in supervisory roles and are required to obtain the basic certification. A manager level certificate covers competences above and beyond what is required for operators and is beyond the scope of the current program.

3.8. Certification Exam

Alberta Environment and Sustainable Resource Development, through the Advisory Committee, maintains and updates the question bank from which the exams are prepared. Certifying partners will administer the provincial exam and all marks will be recorded and submitted to Alberta Environment and Sustainable Resource Development for record keeping.

Each exam consists of 100 multiple choice questions drawn from the question bank. The question bank for composting and landfill facilities is developed from competency profiles and occupational analyses. The analyses were developed jointly by Alberta Environment, Northern Alberta Institute of Technology, Olds College and a number of operators and stakeholders in Alberta. Exam questions make up the following critical tasks for the respective categories:

(a) Landfill Facilities Critical Tasks

- Site Management
- Environmental Monitoring to Meet Regulatory Requirements
- Waste Handling
- Waste Screening
- General Site Maintenance and Operations
- Scale Operation
- Equipment Operation
- Site Administration
- Safety
- Public Relations
- Transfer Stations

(b) Composting Facilities Critical Tasks

- Feedstock Management
- Health and Safety
- Site Operations Management
- Regulatory Requirements
- Composting Science
- Process Control
- Process monitoring and control
- Composting Technology and Equipment
- Communications
- Role of Composting in Waste Management
- Compost Markets

To obtain basic certification the examinee must obtain a mark of 70% or better.

(c) Rewrites of Certifications Exams

There is no waiting period for operators that wish to rewrite the basic certification exam. However, it is recommended that after several unsuccessful attempts, the operator should enroll in a training program before rewriting.

3.9. Certificate Renewal

Certificates will be renewed every three years to ensure that the operator continues to meet program requirements in a manner satisfactory to Alberta Environment and Sustainable Resource Development. Renewal forms will be sent to operators within six months prior to the renewal date. Operators must be able to demonstrate the renewal requirements are met. Verification of the operational duties by a supervisor or designate is required.

(a) Renewal Requirements

(i) Experience

The operator must show relevant full-time experience in landfill or composting facility operations for at least 1 year out of the 3 years of the renewal period.

(ii) Continuing Education Units (CEUs)

Since September 1, 2011 a total of 0.6 CEUs (6 hours of contact time) are required for certificate renewal. The applicant must provide evidence of relevant CEU hours at the time of renewal application. It is the responsibility of the applicant to keep records of the CEU taken.

A list of approved CEUs is posted on the AEW Certification website. <http://environment.alberta.ca/02955.html>. The list consists of courses, conference, and workshops that may be one time offerings or are available on a regular basis. The

training courses listed may or may not be currently available. Please contact the training provider directly for more information on specific courses.

If an operator has attended CEU training that is not on the approved list, the operator may request the Advisory Committee to review the course for relevancy. More information about nominating courses for CEUs can be found in the CEU policy document.

(b) Inactive Certificates

Certificates can become inactive in three ways. If an operator becomes inactive in landfilling or composting operations for more than two years out of a three year renewal period, the certificate will then become inactive and the operator will need to apply to reactive the certificate. Operators may also be deemed inactive if their job duties are changed for more than two years of the three year renewal period to work experience that is not approved by the Certificate Advisory Committee. A certificate will become inactive if the operator fails to renew prior to the expiry date.

(c) Reactivation

An inactive certificate may be reactivated upon application within three years of the date it became inactive.

After a certificate has been inactive for more than three years, a minimum of six months of full-time relevant experience is required prior to renewal application submission. The six months of full time experience must be current to within a year.

(d) Revocation

Alberta Environment and Sustainable Resource Development may cancel or suspend a certificate if:

- the person to whom the certificate was issued has contravened the Environmental Protection and Enhancement Act or Regulations under the Act;
- it is found that the person has practised fraud or deception;
- reasonable care, judgement or the application of the operator's knowledge or ability was not used in the performance of operation duties;
- the individual is incompetent or unable to perform prescribed duties properly;
- for any other reason the individual is no longer qualified to operate a landfill or composting facility.

(e) Appeals

In the event that an individual believes that these guidelines have been misinterpreted, applied inequitably or special circumstances have not been considered, then the following appeal process may be used:

1. Written appeal to the Solid Waste Certification Advisory Committee c/o Natasha Page, Waste Reduction Specialist, Environment and Sustainable Resource Development (natasha.page@gov.ab.ca) ; or
2. Verbal presentation to the Solid Waste Certification Advisory Committee.

4. LABOUR MOBILITY

4.1. North West Partnership Trade Agreement (NWPTA) and Agreement in International Trade (AIT – Chapter 7)

The North West Partnership Trade Agreement and Agreement in International Trade are policies that state any qualified worker in an occupation in one province or territory must be granted access to similar employment opportunities in any other Canadian jurisdiction.

Alberta is currently the only province in Canada that requires certified operators at landfills and composting facilities. The Alberta program is open to any operator that meets the requirements for basic certification, including operators not residing in Alberta.

4.2. Certificate Equivalence

Any person who holds an equivalent operator certificate from any province, or equivalent certifying authority, may apply to the certifying partners to obtain an Alberta basic certificate. The applicant will then be required to write the Alberta Regulations portion of the certification exam and obtain a minimum of 70%.

At this time, the Advisory Committee does not acknowledge any other solid waste operator certificates as equivalent to those issued under the Landfill and Composting Facility Operator Certification Program. Certifying bodies claiming the equivalence of their program must provide a written submission to the Advisory Committee with supporting documentation to show what competencies have been met through their program. If the Advisory Committee deems the competencies obtained are equivalent to those under the Alberta certification program, equivalency will be granted.

APPENDIX A: Landfill and Composting Facility Standards

Landfill Standards:

4.1 Operator Certification

- (a) The person responsible for a landfill shall ensure that during active landfill life and until final landfill closure all key operating personnel hold a valid basic landfill operator certificate after 18 months of employment at the facility.
- (b) To qualify for basic certification, the operator must:
 - (i) be at least 18 years of age; and
 - (ii) have one year of full time operational experience at a landfill which is current to within the last 3 years from the date of application.
- (c) The following landfill operator certificates are recognized by the Director:
 - (i) Alberta Environment Certificate of Qualification issued under the Municipal Waste Facility Operator Certification Guideline; and
 - (ii) Alberta Basic Landfill Operator Certificate issued by the Solid Waste Association of North America-Northern Lights Chapter.
- (d) The person responsible for the facility shall ensure that the facility has operators with the required certification endorsements as per the *Alberta Landfill and Composting Facility Operator Certification Guidelines*, published by Alberta Environment.
- (e) The person responsible for the landfill shall notify the Director in writing of the names of all the key operating personnel, the required facility endorsements, and any change in any of the key operating personnel or facility endorsements within 30 days of the change.

Composting Facility Standards²:

4.1 Certified Operator

- (a) The person responsible for a composting facility shall ensure that during operations all key operating personnel hold a valid basic compost operator certificate after 18 months of employment at the facility.
- (b) To qualify for basic certification, the operator must:
 - (i) be at least 18 years of age; and
 - (ii) have one year of full time operational experience at a composting facility which is current to within the last 3 years from the date of application.
- (c) The following composting facility operator certificates are recognized by the Director:
 - Alberta Environment Certificate of Qualification issued under the Municipal Waste Facility Operator Certification Guideline; and

² To be updated in the Composting Facility Standards (2007)

- (d) Alberta Basic Composting Facility Operator Certificate issued by the Compost Council of Canada.
- (e) The person responsible for the facility shall ensure that the facility has operators with the required certification endorsements as per the *Alberta Landfill and Composting Facility Operator Certification Guidelines*, published by Alberta Environment.
- (f) The person responsible for the composting facility shall notify the Director in writing of the names of all the key operating personnel, the required facility endorsements, and any change in any of the key operating personnel or facility endorsements within 30 days of the change.

Parkland County

Part of the North Saskatchewan and Athabasca River Basins
Parts of Tp 050 to 054, R 25, W4M to R 08, W5M
Regional Groundwater Assessment

Prepared for



In conjunction with



Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada

Prairie Farm Rehabilitation
Administration

Administration du rétablissement
agricole des Prairies

Canada 

Prepared by
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1-800-661-7972
Our File No.: **97-202**

August 1998
(Revised November 1999)

PERMIT TO PRACTICE

HYDROGEOLOGICAL CONSULTANTS LTD.

Signature _____

Date _____

PERMIT NUMBER: P 385

The Association of Professional Engineers,
Geologists and Geophysicists of Alberta

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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 creates a solid base for increased economic activity. **This report, even though it is preliminary in nature, is the first step in fulfilling a commitment by Parkland County toward the management of the groundwater resource, which is a key component of the well-being of the County, and is a guide for future groundwater-related projects**

1.1 About This Report

This report provides an overview of (a) the groundwater resources of Parkland 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 this report. The files include the geo-referenced electronic groundwater database, maps showing distribution of various hydrogeological parameters, the groundwater query, and ArcView files. Likewise, all of the illustrations and maps from the present report, plus additional maps, figures and cross-sections, are available on the CD-ROM. For convenience, poster-size maps and cross-sections have been prepared as a visual summary of the results presented in this report. Copies of these poster-size drawings have been forwarded with this report, and are included in Appendix D.

Appendix A features page-size copies of the figures within the report plus additional maps and illustrations. An index of the page-size maps and figures is given at the beginning of Appendix A.

Appendix B provides a complete list of maps and figures included on the CD-ROM.

Appendix C includes the following:

- 1) a procedure for conducting aquifer tests with water wells;
- 2) a table of contents for the Water Well Regulation under the Environmental Protection and Enhancement Act; and
- 3) additional information.

The Water Well 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.

1.2 The Project

It must be noted that the present project is a regional study and as such the results are to be used only as a guide. Detailed local studies are required to verify hydrogeological conditions at given locations.

The present project is made up of five parts as follows:

- Module 1 - Data Collection and Synthesis
- Module 2 - Hydrogeological Maps
- Module 3 - Covering Report
- Module 4 - Groundwater Query
- Module 5 - Training Session

This report represents Modules 2 and 3.

1.3 Purpose

This project is a regional groundwater assessment of Parkland 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 includes:

- identification of the aquifers¹ within the surficial deposits² and the upper bedrock;
- spatial definition of the main aquifers;
- quantity and quality of the groundwater associated with each aquifer;
- hydraulic relationship between aquifers; and
- identification of the first sand and gravel deposits below ground level.

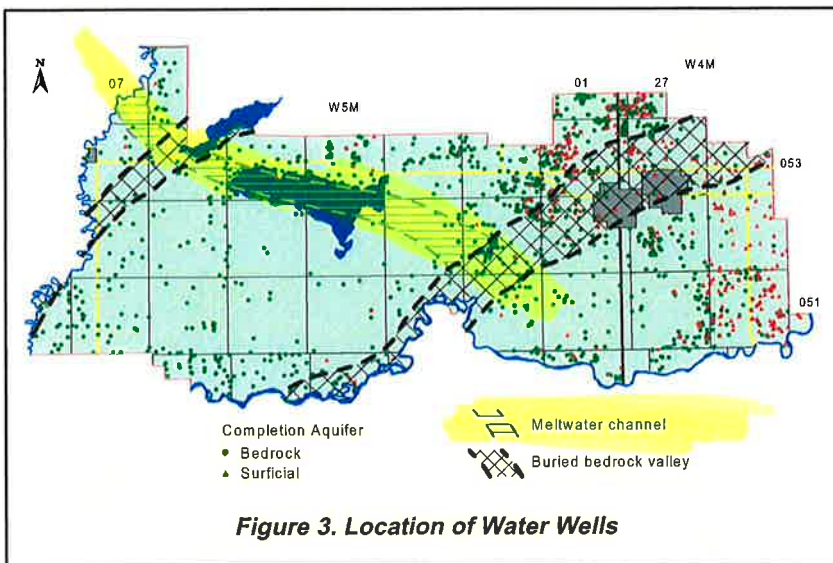
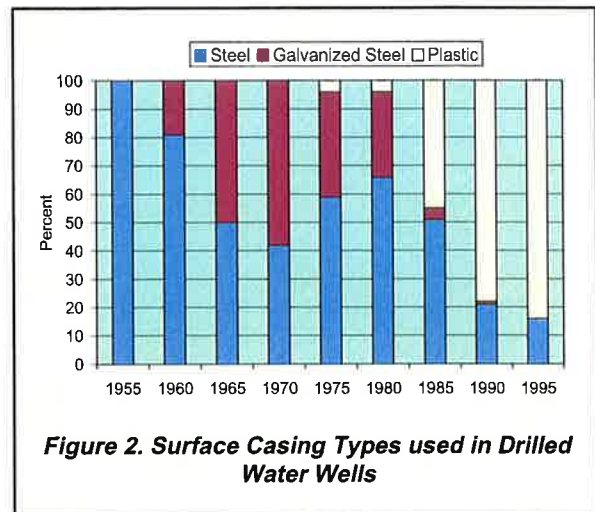
Under the present program, the groundwater-related data for Parkland County have been assembled. Where practical, the data have been digitized. These data are then being used in the regional groundwater assessment for the County.

¹ See glossary

² See glossary

Data for casing diameters are available for 2,231 water wells, with 72 indicated as having a diameter of more than 400 mm and 2,159 having a diameter of less than 180 mm. The casing diameters of greater than 400 mm are mainly bored water wells and those with a surface casing diameter of less than 180 mm are drilled water wells.

There are five different materials that have been used for surface casing over the last 40 years in water wells completed in the County. The three most common materials are galvanized steel, steel and plastic. Steel casing was in use in the 1950s and is still used in 16% of the water wells being drilled in the County. Galvanized steel surface casing was used in 19% of the new water wells in the early 1960s. By the early 1970s, galvanized steel casing was being used in 58% of the water wells. From 1975 onward, there was a general decrease in the percentage of water wells using galvanized steel, with the last reported use in September 1993. Plastic casing was used for the first time in August 1978. The percentage of water wells with plastic casing has increased and in the mid-1990s, plastic casing was used in 84% of the water wells drilled in the County.



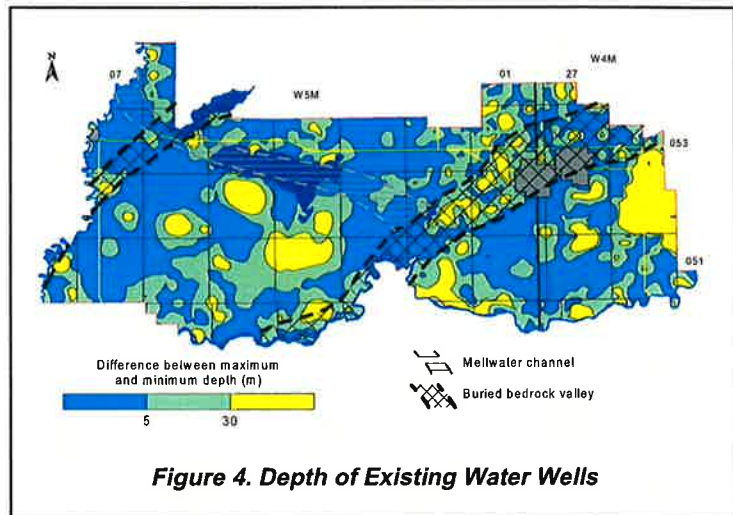
There are 2,024 water well records with sufficient information to identify the aquifer in which the water wells are completed. The water wells that were not drilled deep enough to encounter the bedrock plus water wells that have the bottom of their completion interval above the bedrock surface are water wells completed in surficial aquifers. The number of water wells completed in aquifers in the surficial deposits is 20%, a total of 407 water wells. Ninety-five percent of the surficial water

wells occur in the eastern three ranges of the County.

The remaining 1,617 water wells have the top of their completion interval deeper than the depth to the bedrock surface. From the above map, it can be seen that water wells completed in bedrock aquifers occur over most of the County.

Water wells not used for domestic needs must be licensed. At the end of 1996, 153 groundwater diversions were licensed in the County. The total maximum authorized diversion from the water wells associated with these licences is 11,760 cubic metres per day (m^3/day); 8.7 percent of the authorized groundwater diversion is allotted for agricultural use. The largest licensed groundwater diversion within the County is for the Town of Stony Plain, having a diversion of 5,882 m^3/day for their dewatering program. The user with the second largest authorized diversion is Alberta Transportation at a location adjacent to the North Saskatchewan River.

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 surface was prepared representing the minimum depth for water wells and a second 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, the impression is that only one aquifer is being used. Over approximately 30% of the County, the difference between the maximum and minimum depth is more than 30 metres. In the vicinity of linear bedrock lows, the greatest differences between minimum and maximum depth occur. Generally this occurs because aquifers are developed in both the surficial deposits and the bedrock deposits.

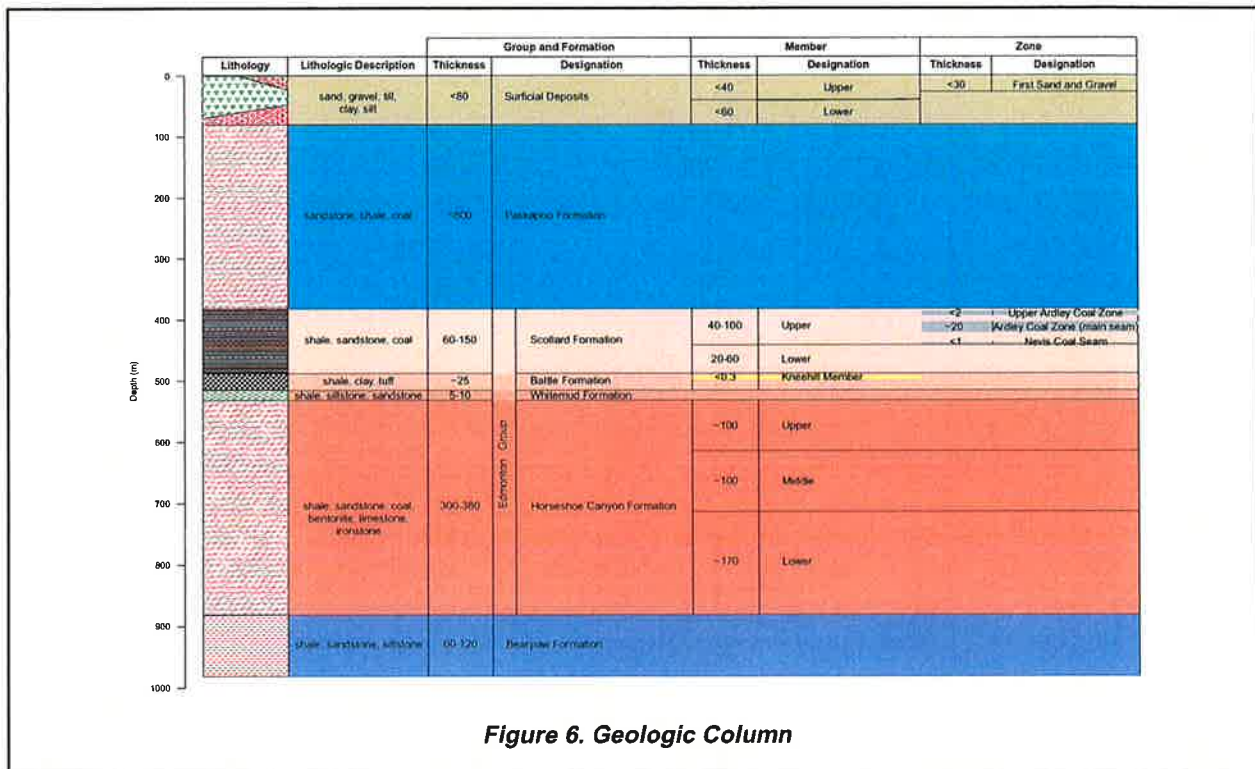
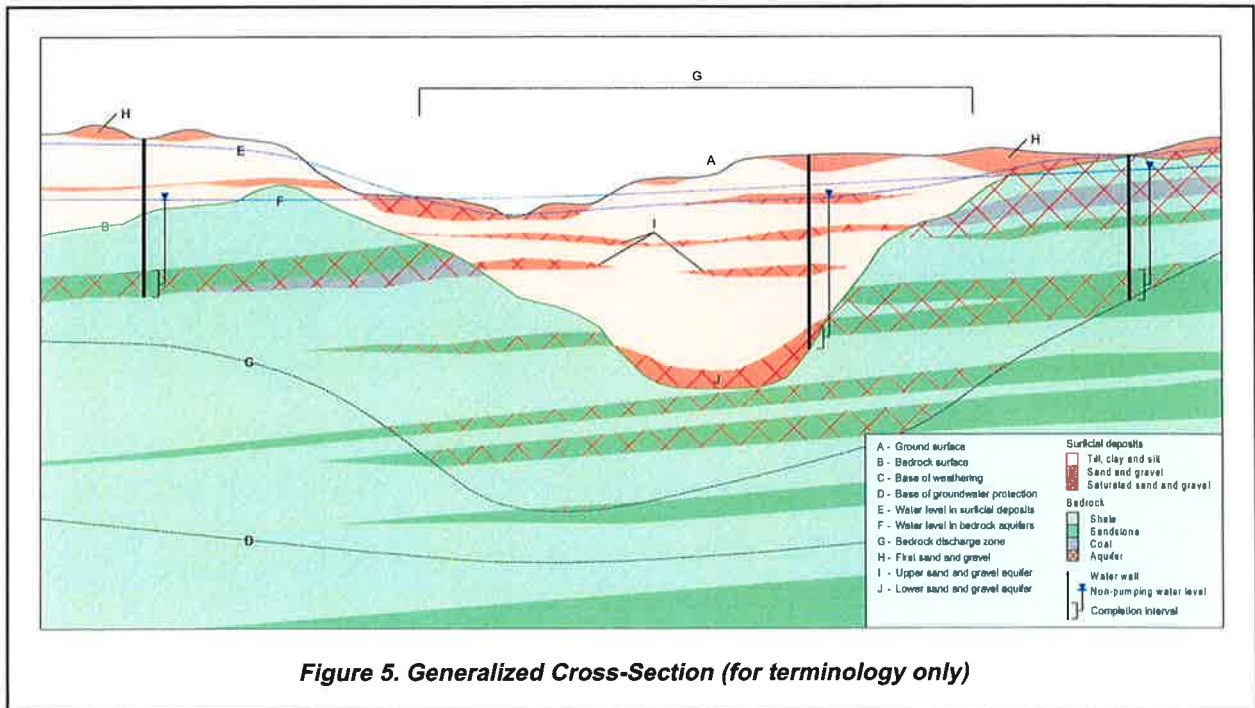


The total dissolved solids (TDS) concentration in the groundwaters from the upper bedrock in the County are generally less than 1,000 milligrams per litre (mg/L). Groundwaters from the surficial deposits can be expected to be chemically hard with a high dissolved iron content. Groundwaters from the bedrock aquifers frequently are chemically soft with concentrations of dissolved iron generally less than 0.5 mg/L . The chemically soft groundwater can be high in sodium concentration. Approximately 15% of the chemical analyses indicate a fluoride concentration above 1.5 mg/L .

Proper management of the groundwater resource requires water-level data. These data are often collected from observation water wells. At the present time, data are available from three **Alberta Environmental Protection (AEP)**-operated observation water wells within Parkland County. Additional data can be obtained from some of the licensed groundwater diversions. In the past, these data have been difficult to obtain from AEP, in part because of the failure of the licensee to provide the data.

However, even with the available sources of data, the number of water-level data points relative to the size of the County is too few to provide a reliable groundwater budget. 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.

3 TERMS



4 METHODOLOGY

4.1 Data Collection and Synthesis

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

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

The main disadvantage to the database is the absence of quality control. Very little can be done to overcome this lack of quality control in the data collection, other than to assess the usefulness of control points relative to other data during the interpretation. Another disadvantage to the database is the lack of adequate spatial information.

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

The present project uses the 10TM coordinate system. This means that a record for the NW ¼ of section 02, township 053, range 01, W5M, would have a horizontal coordinate with an Easting of 63,316 metres and a Northing of 5,931,510 metres, the centre of the quarter section. Once the horizontal coordinates are determined, a ground elevation is obtained from the 1:20,000 Digital Elevation Model (DEM) from the Resource Data Division of AEP.

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

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

- 1) depth to bedrock;
- 2) total thickness of sand and gravel;
- 3) thickness of first sand and gravel when present within one metre of ground surface;
- 4) total thickness of saturated sand and gravel; and
- 5) depth to the top and bottom of completion intervals.

Also, where sufficient information is available, values for apparent transmissivity³ and apparent yield⁴ are calculated, based on the aquifer test summary data supplied on the water well drilling reports. The apparent transmissivity results are used to estimate a value for hydraulic conductivity⁵. The conductivity values are obtained by dividing the apparent transmissivity by the completion interval. To obtain a value for regional transmissivity of the aquifer, the hydraulic conductivity is multiplied by the effective thickness of the aquifer based on nearby e-log information. Where valid detailed aquifer test results exist, the interpreted data provide values for aquifer transmissivity and effective transmissivity.

The Alberta Energy and Utilities Board (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 geological units;
- 3) type and intervals for various down-hole geophysical logs; and
- 4) drill stem test (DST) summaries.

Unfortunately, the EUB database contains very little information from above the base of groundwater protection. Because the main interest for a groundwater study comes from data above the base of groundwater protection, the data from the EUB database have limited use.

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

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

4.2 Spatial Distribution of Aquifers

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

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

The identification of aquifers becomes a two-step process: first, mapping the tops and bottoms of individual geological units; and second, identifying the porous and permeable parts of each geological unit in which the aquifer is present.

After obtaining values for the elevation of the top and bottom of individual geological units at specific locations, the spatial distribution of the individual surfaces can be determined. Digitally, establishment of the distribution of a surface requires the preparation of a grid. The inconsistent quality of the data

³ For definitions of Transmissivity, see glossary

⁴ For definitions of Yield, see glossary

⁵ See glossary

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 Kriging⁶ 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.

The porous and permeable parts of the individual geological units have been mainly determined from geophysical logs.

4.3 Hydrogeological Parameters

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

After the water wells are assigned to a specific aquifer, the parameters from the water well records are assigned to the individual aquifers. The parameters include non-pumping (static) water level (NPWL), transmissivity and projected water well yield. The total dissolved solids, chloride and sulfate concentrations from the chemical analysis of the groundwater are also assigned to applicable aquifers.

Once the values for the various parameters of the individual aquifers are established, the spatial distribution of 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, which is used in contouring the distribution of individual parameters.

4.3.1 Risk Criteria

The main source of groundwater contamination involves activities on or near the land surface. The risk is high when the near-surface materials are porous and permeable and low when the materials are less porous and less permeable. The two 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 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 map is categorized based on relative permeability. The information from these two sources is combined to form the risk assessment map. The criteria used in the classification of risk are given in the table above.

Surface Permeability	Sand or Gravel Present Top Within One Metre Of Ground Surface	Groundwater Contamination Risk
Low	No	Low
Moderate	No	Moderate
High	No	High
Low	Yes	High
Moderate	Yes	High
High	Yes	Very High

Table 1. Risk of Groundwater Contamination Criteria

⁶ See glossary

4.4 Maps and Cross-Sections

Once grids for geological surfaces have been prepared, various grids need to be combined to establish the extent and thickness of individual geological units. For example, the relationship between an upper bedrock unit and the bedrock surface must be determined. This process provides both the aquifer outline and the aquifer thickness. The aquifer thickness is used to determine the aquifer transmissivity by multiplying the hydraulic conductivity by the thickness.

Grids must also be combined to allow the calculation of projected long-term yields for individual water wells. The grids related to the elevation of the non-pumping water level and the elevation of the top of the aquifer are combined to determine the available drawdown⁷. The available drawdown data and the transmissivity values are used to calculate values for projected long-term yields for individual water wells, completed in a specific aquifer, wherever the aquifer is present.

Once the appropriate grids are available, the maps are prepared by contouring the grids. The areal extent of individual parameters is outlined by masks to delineate individual aquifers. 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 geological units are then transferred from the digitally prepared surfaces to the cross-section.

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. These cross-sections are presented in this report and in Appendix A, are included on the CD-ROM, and are in Appendix D in a page-size format.

4.5 Software

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

- Microsoft Professional Office 97
- Surfer 6.04
- ArcView 3.0a
- AutoCAD 14.01
- CorelDRAW! 8.0
- Acrobat 3.0

⁷ See glossary

5 AQUIFERS

5.1 Background

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

5.1.1 Surficial Aquifers

Surficial deposits in the County are mainly less than 20 metres thick, except in areas of linear bedrock lows where the thickness of surficial deposits can exceed 100 metres. The Buried Beverly Valley is one of the main linear bedrock lows. This linear low is present in the central part of the County and trends southwest to northeast. In the southwest part of the area, the North Saskatchewan River and the Buried Beverly Valley occupy the same linear bedrock low. Cross-section A-A' passes through the Buried Beverly Valley and shows the surficial deposits being up to 100 metres thick within the Valley.

The main aquifers in the surficial materials are sand and gravel deposits. In order for a sand and gravel deposit to be an aquifer, it must be saturated; if not saturated, a sand and gravel deposit is not an aquifer. The top of the surficial aquifers has been determined from the NPWL in water wells that are less than 15 metres deep. The base of the surficial deposits is the bedrock surface.

For a water well with a small-diameter casing to be effective in surficial deposits and to provide sand-free groundwater, the water well must be completed with a water well screen. Some water wells completed in the surficial deposits are completed in low-permeability aquifers and have a large-diameter casing. The large-diameter water wells may have been hand dug or bored and because they are completed in very

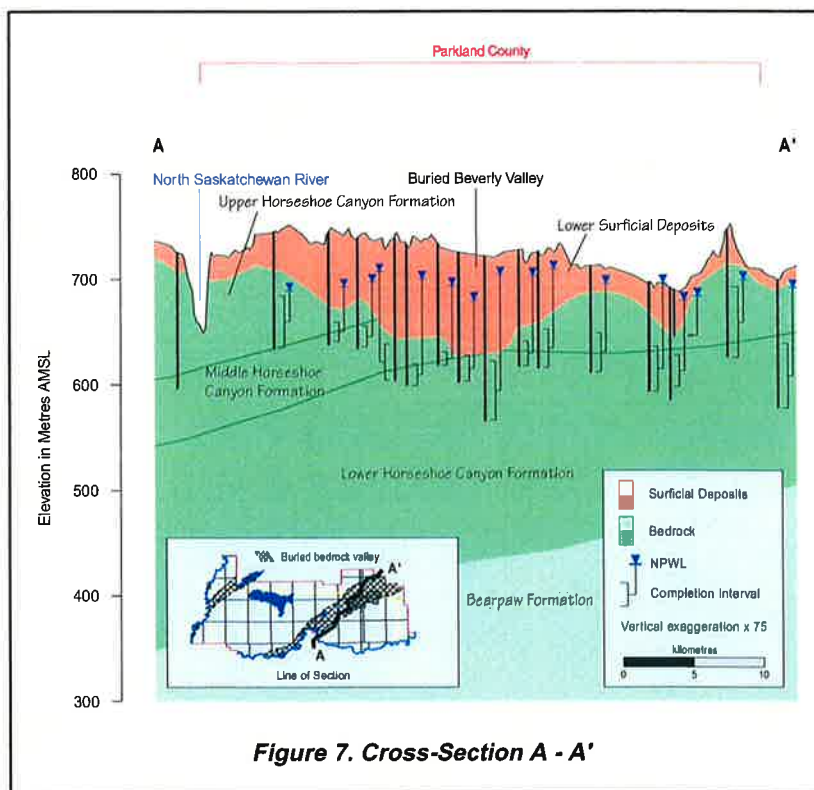


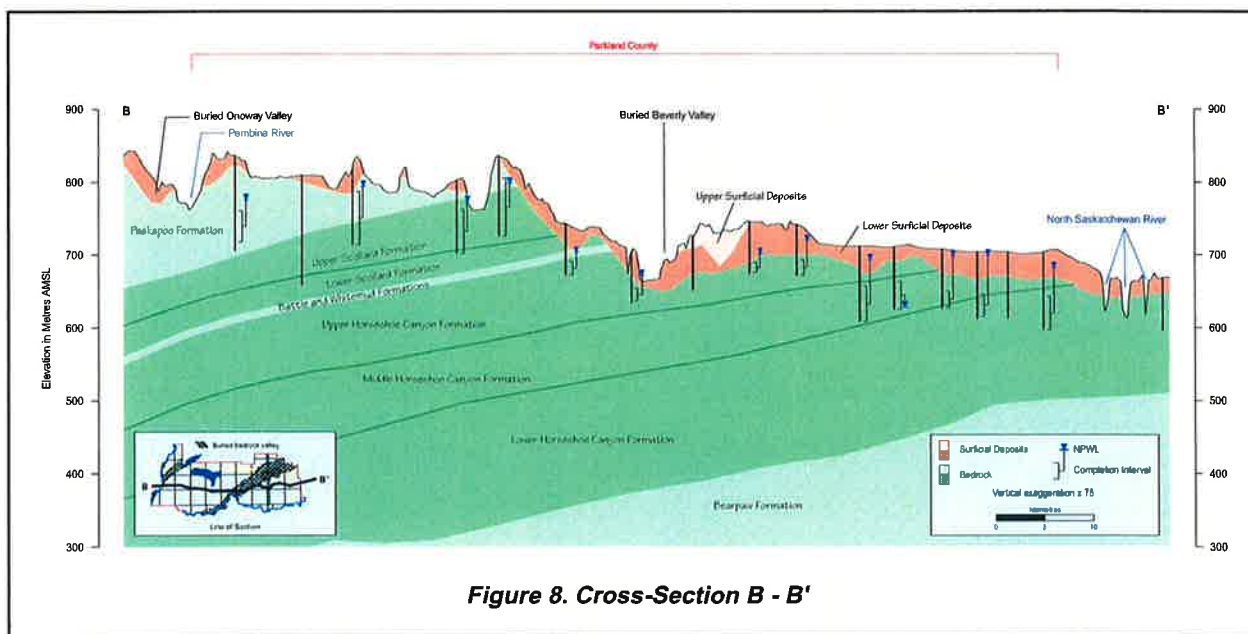
Figure 7. Cross-Section A - A'

low permeability aquifers, most of these water wells would not benefit from water well screens. The groundwater from an aquifer in the surficial deposits usually has a chemical hardness of at least a few hundred mg/L and a dissolved iron concentration such that the groundwater must be treated before being used for domestic needs. Within the County, 12% of the water wells completed in the surficial deposits have a casing diameter of greater than 180 millimetres or no reported diameter for the surface casing, and are assumed to be dug or bored water wells.

5.1.2 Bedrock Aquifers

The upper bedrock includes rocks that are less than 200 metres below the bedrock surface. Some of this bedrock contains porous and saturated rocks that have a structure that is permeable enough to be an aquifer. Water wells completed in bedrock aquifers usually do not require water well screens and the groundwater is usually chemically soft. The data for 1,617 water wells indicate 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. Of these 1,617 water wells in the database, 1,555 have values for surface casing diameter. Of the 1,555 water wells, 99% have casing diameters of less than 180 millimetres and fewer than 6% of these water wells have been completed with water well screens.

The upper bedrock includes parts of the Paskapoo, Scollard, and Horseshoe Canyon formations. The Bearpaw Formation underlies the Lower Horseshoe Canyon Formation and is a regional aquitard⁸. The Bearpaw Formation is not considered part of the upper bedrock in the Parkland area, although in some areas it is less than 200 metres below the bedrock surface. The present-day Pembina River has eroded into the Paskapoo Formation in the western part of the County.



⁸ See glossary

5.2 Aquifers in Surficial Deposits

The surficial deposits are the sediments above the bedrock surface. This includes pre-glacial materials, which were deposited before glaciation, and materials deposited directly or indirectly by glaciation. The lower surficial deposits include pre-glacial fluvial⁹ and lacustrine¹⁰ deposits. The lacustrine deposits include clay, silt, fine-grained sand and coal. The upper surficial deposits include the more traditional glacial deposits of till and meltwater deposits.

5.2.1 Geological Characteristics of Surficial Deposits

While the surficial deposits are treated as one hydrogeological unit, they can consist of three hydraulic parts. The first is the sand and gravel deposits of the lower surficial deposits, the second is the saturated sand and gravel deposits of the upper surficial deposits and third is the sand and gravel close to ground level, of which some can be unsaturated. The sand and gravel deposits close to the ground surface are significant since they provide a pathway for liquid contaminants to move downward into the groundwater. Because of the significance of the shallow sand and gravel deposits, they have been mapped where they are present within one metre of the ground surface and are referred to as the “first sand and gravel”.

Over the majority of the County, the surficial deposits are less than 20 metres thick. The exceptions are mainly in association with the linear bedrock lows where the deposits can have a thickness of up to 100 metres. The main linear bedrock low in the County has been designated as the Buried Beverly Valley, as shown on the adjacent map. This Valley trends from southwest to northeast from the North Saskatchewan River and underlies most of the towns of Stony Plain and Spruce Grove. The Buried Beverly Valley is approximately 6 to 9 kilometres wide, with local bedrock relief being less than 60 metres. Sand and gravel deposits can be expected in association with this bedrock low, but the thickness of the sand and gravel deposits is expected to be mainly less than 30 metres. The Town of Stony Plain, Forest Green Subdivision has an extensive dewatering system that was established in 1976 (Hydrogeological Consultants Ltd., 1976). Three dewatering wells were completed in the sand and gravel aquifer associated with the Buried Beverly Valley.

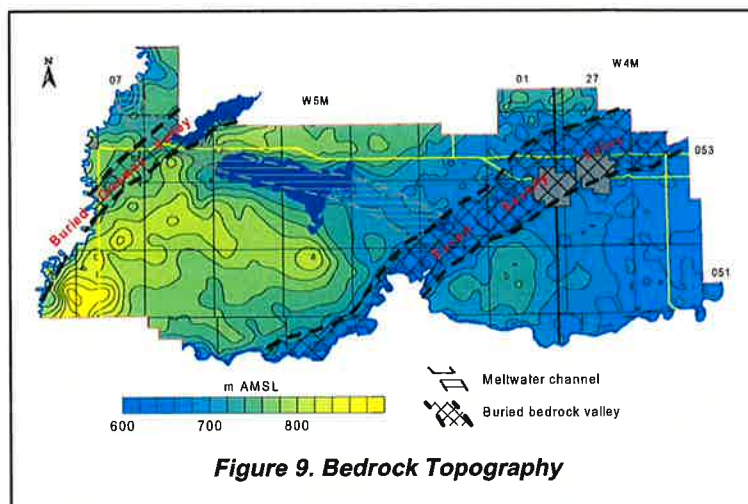


Figure 9. Bedrock Topography

A second linear bedrock low, the Buried Onoway Valley, trends from southwest to northeast and is present in the northwest part of the County, southeast of the Town of Entwistle. The Buried Onoway Valley is approximately 4 kilometres wide, with local relief being less than 40 metres. Sand and gravel deposits associated with the linear bedrock low can be expected to be less than 30 metres thick.

⁹ See glossary

¹⁰ See glossary

In addition to the Buried Beverly and Onoway valleys, there is a low in the bedrock surface in the southeastern part of the County. The edges of this broad bedrock low are poorly defined but the bedrock low does have a regional northwest-southeast trend and is present from the Town of Spruce Grove to the North Saskatchewan River near Devon. Sand and gravel deposits with a thickness of less than 30 metres can be expected to be present in association with this bedrock low. The Devonian Botanical Gardens uses a water well completed in the sand and gravel deposits associated with this bedrock low (Hydrogeological Consultants Ltd., 1987).

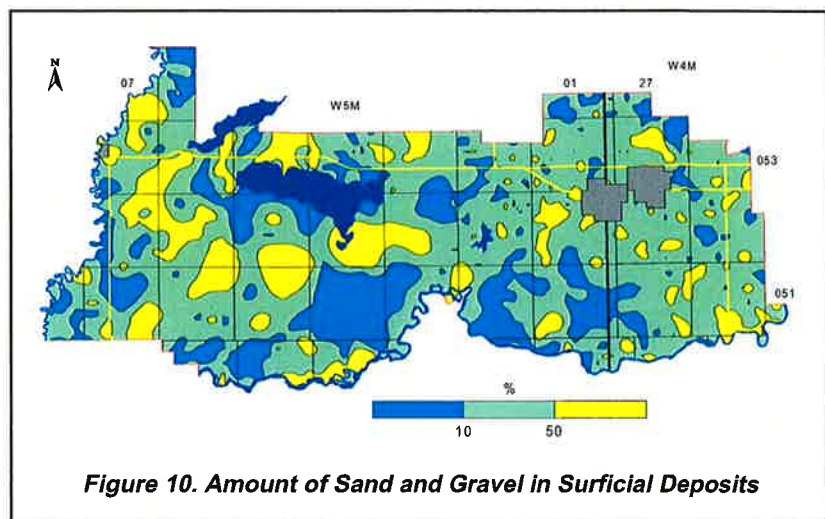
There is also a minor linear bedrock low that is believed to be associated with a meltwater channel. This meltwater channel is noted on the bedrock topography map and is between the Buried Onoway Valley and the Buried Beverly Valley, passing below Lake Wabamun.

The lower surficial deposits are composed mostly of fluvial and lacustrine deposits. The total thickness of the lower surficial deposits is mainly less than 20 metres in the western part of the County, but ranges mostly between 20 and 80 metres in the eastern part of the County. The lowest part of the lower surficial deposits includes pre-glacial sand and gravel deposits. These deposits would generally be expected to directly overlie the bedrock surface in the Buried Beverly and Onoway valleys. The lowest sand and gravel deposits are of fluvial origin and are usually no more than a few metres thick.

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 occur as isolated pockets. The thickness of the upper surficial deposits can exceed 100 metres. The greatest thickness of upper surficial deposits occurs in the areas of the buried bedrock valleys; there are several areas in the County where these deposits are not present.

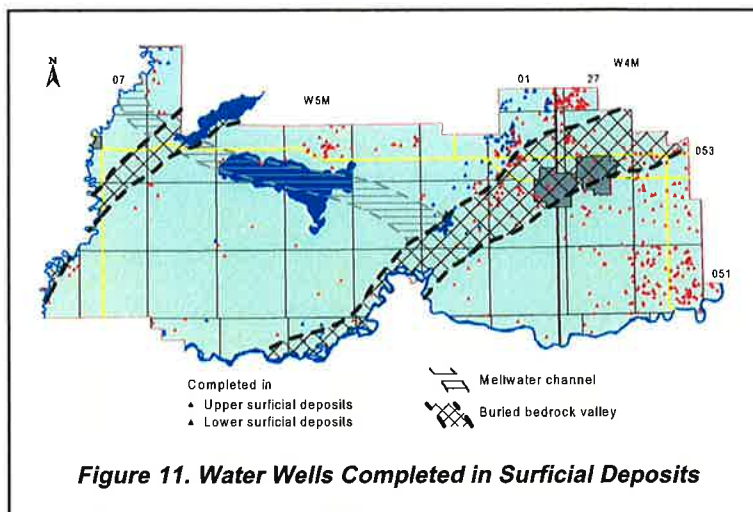
Sand and gravel deposits can occur throughout the entire unconsolidated section. The total thickness of sand and gravel deposits is generally less than 10 metres in the western part of the County but can be more than 30 metres in the eastern part of the County. The greatest thickness of sand and gravel deposits occurs in the areas of the buried bedrock lows and meltwater channels. 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 30% of the western part of the County, the sand and gravel deposits are more than 50% of the total thickness of the surficial deposits. The areas where the sand and gravel percentages are more than 50% in the eastern half of the County are associated with the Buried Beverly Valley and the bedrock low in the southeastern part of the County.



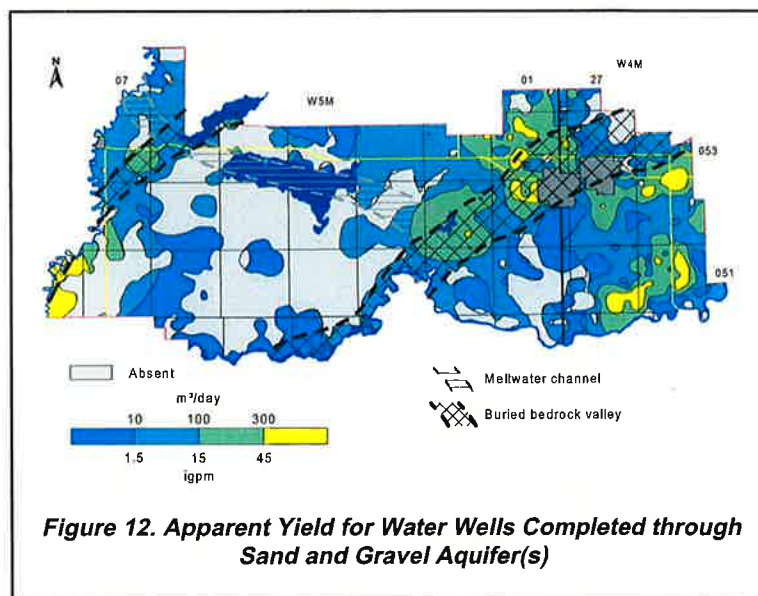
5.2.2 Sand and Gravel Aquifer(s)

One significant source of groundwater in the County includes aquifers in the surficial deposits. The actual aquifer developed will usually be dictated by whichever aquifer is present. From the present hydrogeological analysis, 648 water wells are completed in aquifers in the lower surficial deposits and 196 are completed in aquifers in the upper surficial deposits. This number of water wells is slightly more than double the number of water wells determined to be completed in aquifers in the surficial deposits, based on lithology given on the water well drilling reports.



The majority of the water wells completed in the upper surficial deposits are located in or near the Buried Beverly Valley as shown in Figure 11. The majority of the water wells completed in the lower surficial deposits are located in the area of the Buried Beverly and Onoway valleys or the bedrock low southeast of the Town of Spruce Grove, between the Town and the North Saskatchewan River.

The adjacent map shows water well yields that are expected in the County, based on the aquifers that have been developed by existing water wells. These data show that water wells with yields of less than 100 m³/day from sand and gravel aquifer(s) can be expected in most areas of the County. The most notable areas where yields of more than 100 m³/day are expected are in the eastern half of the County. Over approximately 50% of the County, the sand and gravel deposits are not present or if present, are not saturated.



The Town of Stony Plain, Forest Green Subdivision groundwater dewatering system was established in 1976. The three dewatering wells are completed in a sand and gravel aquifer in the lower surficial deposits associated with the Buried Beverly Valley. These dewatering wells have diverted an average of 2,300 m³/day for the last 20 years, with no adverse effect on the water level in the aquifer. Since dewatering began in 1976, the water level has declined less than 2 metres in the observation water well completed in the same aquifer and less than 10 metres from the nearest dewatering well (Hydrogeological Consultants Ltd., 1998). The water level in the observation water well

completed in the upper bedrock aquifer was measured from 1977 to 1989. The water-level fluctuations in both observation water wells were similar from a graphical perspective. However, the water-level fluctuations in the bedrock observation water well were of a lesser magnitude, declining less than 0.5 metres between 1977 and 1989 (Hydrogeological Consultants Ltd., 1991).

5.2.2.1 Chemical Quality of Groundwater from Surficial Deposits

The chemical analysis results of groundwaters from the surficial deposits have not been differentiated based on aquifers in the upper or lower surficial deposits. The main reason for not separating the chemical analysis results is that there appears to be no major chemical difference between groundwater from the upper and lower sand and gravel aquifers. The groundwaters from these aquifers are generally chemically hard and high in dissolved iron.

The Piper tri-linear diagram shows that the majority of the groundwaters are calcium-magnesium-bicarbonate-type or sodium-bicarbonate-type waters; however, some groundwaters from the surficial deposits are sodium-sulfate-type waters.

Eighty-five percent of the groundwaters from the surficial aquifers have a chemical hardness of more than 50 mg/L. The TDS concentrations in the groundwaters from the surficial deposits range from less than 200 to over 1,500 mg/L. Groundwaters from the surficial deposits with a TDS of less than 500 mg/L occur in approximately 20% of the County. Sulfate concentrations of greater than 400 mg/L occur in areas where TDS values in the groundwaters from the surficial deposits exceed 1,200 mg/L.

There are very few groundwaters from the surficial deposits with appreciable concentrations of the chloride ion and in most of the County the chloride ion concentration is less than 50 mg/L.

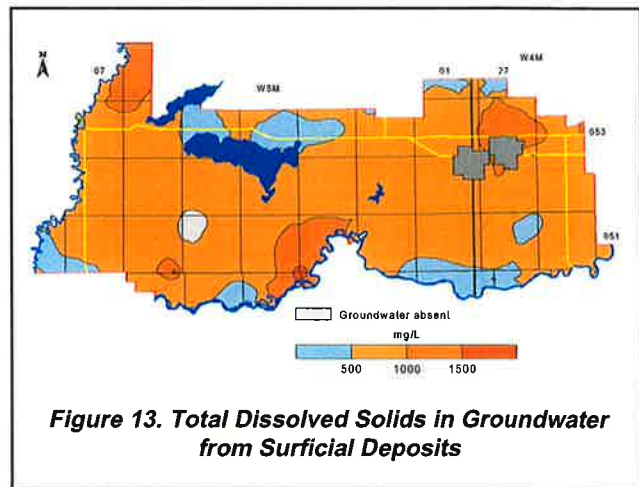
5.2.3 Upper Sand and Gravel Aquifer

The Upper Sand and Gravel Aquifer includes saturated sand and gravel deposits in the upper surficial deposits. These aquifers typically occur above an elevation of 660 metres AMSL. The saturated sand and gravel deposits are not continuous and are expected over approximately 60% of the County.

5.2.3.1 Aquifer Thickness

The thickness of the Upper Sand and Gravel Aquifer is in part a function of the elevation of the non-pumping water level associated with the upper surficial deposits and in part a result of the depth to the bedrock surface. Since the non-pumping water level tends to be a subdued replica of the bedrock surface, the thickness of the Upper Sand and Gravel Aquifer tends to be directly proportional to the thickness of the surficial deposits.

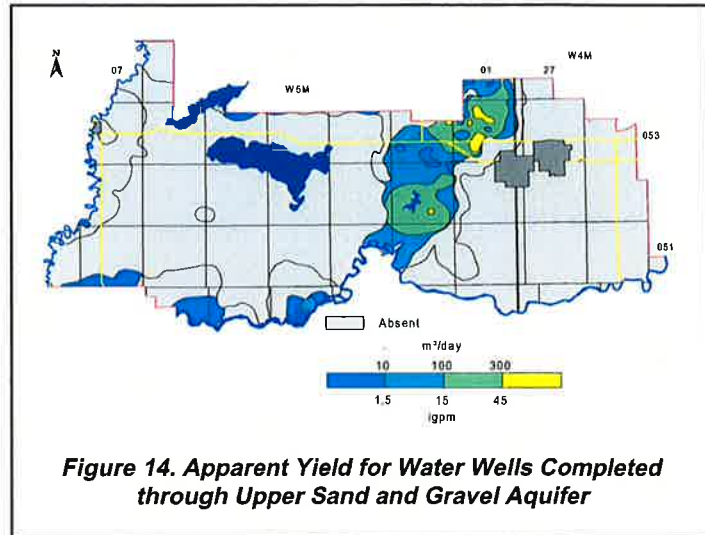
While the sand and gravel deposits in the upper surficial deposits are not continuous, the Upper Sand and Gravel Aquifer includes all of the aquifers present in the upper surficial deposits. The Upper Sand



and Gravel Aquifer is more than 10 metres thick in the Buried Beverly Valley, but over the majority of the County, is less than 10 metres thick or absent.

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 water wells with high yields; however, because the sand and gravel deposits occur mainly as hydraulically discontinuous pockets, the long-term yield of the water wells is limited. The apparent yields for water wells completed in this Aquifer are expected to be mainly less than 100 m³/day. Where the Upper Sand and Gravel Aquifer is absent and where the yields are low, the development of water wells for the domestic needs of single families may not be possible.

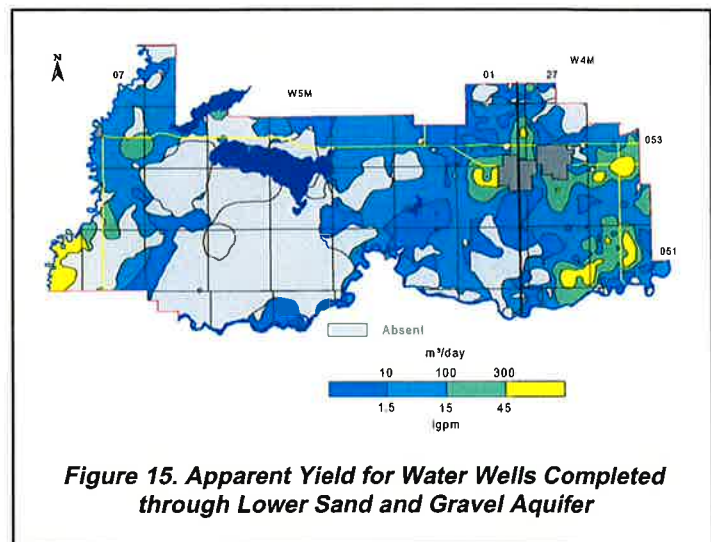


5.2.4 Lower Sand and Gravel Aquifer

The Lower Sand and Gravel Aquifer is a saturated sand and gravel deposit that occurs at or near the base of the surficial deposits in the deepest part of the pre-glacial linear bedrock lows. Coal fragments are frequently associated with the Lower Sand and Gravel Aquifer in the eastern part of the County. During water well development, the presence of the coal deposits can create a problem by plugging the water well screen. The Lower Sand and Gravel Aquifer is present in most of the County, with a thickness of more than 10 metres in 50% of the area east of range 02, W5M.

5.2.4.1 Apparent Yield

Water wells completed in the Lower Sand and Gravel Aquifer may have yields in excess of 300 m³/day. The highest yields are expected in the Buried Beverly Valley. In this area, the projected long-term yields from individual water wells could be more than 500 m³/day. The yields for water wells completed in the Lower Sand and Gravel Aquifer are expected to be less than 100 m³/day in the majority of the County.

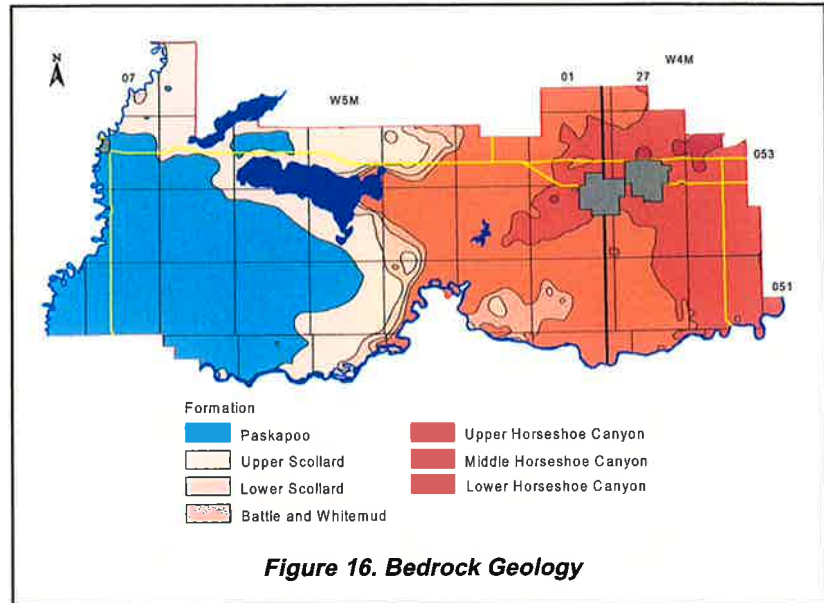


An extended aquifer test conducted with a water test hole completed in the Lower Sand and Gravel Aquifer for the Devonian Botanical Gardens (Hydrogeological Consultants Ltd., 1987) indicated a long-term yield of nearly 200 m³/day.

5.3 Bedrock

5.3.1 Geological Characteristics

The upper bedrock in the County is the Paskapoo Formation and the Edmonton Group. The Paskapoo Formation consists of cycles of thick, tabular sandstones, siltstone and mudstone layers (Glass, D. J. [editor], 1990). The Edmonton Group consists of fresh and brackish-water deposits of fine-grained sandstone and silty shale, thick coal seams, and numerous bentonite beds (Carrigy, 1971). The maximum thickness of the Paskapoo Formation can be up to 800 metres, but in the County, the thickness is from 0 to 250 metres. The thickness of the Edmonton Group varies from 300 to 500 metres and is underlain by the Bearpaw Formation. The Edmonton Group in the County includes the Scollard, Battle, Whitemud and Horseshoe Canyon formations.



The Paskapoo Formation is the upper bedrock and subcrops in the southwestern part of the County.

The Scollard Formation underlies the Paskapoo Formation and subcrops mainly in the east-central part of the County. The Scollard Formation has a maximum thickness of 120 metres within the County and includes the Upper and Lower Scollard formations. The Upper Scollard consists mainly of sandstone, siltstone, shale and coal seams or zones. Two prominent coal zones within the Upper Scollard are the Ardley Coal (up to 20 metres thick) and the Nevis Coal (up to 3.5 metres thick). The bottom of the Nevis Coal Seam is the border between the Upper and Lower Scollard formations. The Lower Scollard Formation has a maximum thickness of 40 metres and is composed mainly of shale and sandstone.

Beneath the Scollard Formation are two formations having a maximum thickness of 30 metres; the two are the Battle and Whitemud formations. The Battle and Whitemud formations are also present only in the southwestern part of the County. 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 considered to be significant geologic markers, and were used to prepare the structural maps and hydrostratigraphy classifications. Because of the ubiquitous nature of the bentonite in the Battle and Whitemud formations, there is very little significant permeability within these two formations.

The Horseshoe Canyon Formation is the lower part of the Edmonton Group and is the upper bedrock in the remainder of the County. The Horseshoe Canyon Formation has a maximum thickness of 350

metres and within the County includes the Upper, Middle and Lower Horseshoe Canyon formations. The Upper Horseshoe Canyon, which can be up to 100 metres thick, is the upper bedrock in the east-central part of the County immediately east of the area where the Scollard Formation subcrops. The Middle Horseshoe Canyon, which is up to 80 metres thick, is the upper bedrock in the northeastern part of the County. The Lower Horseshoe Canyon, which is up to 180 metres thick, is the upper bedrock in a few areas of the northeastern part of the County.

The Horseshoe Canyon Formation consists of deltaic¹¹ and fluvial sandstone, siltstone and shale with interbedded coal seams, bentonite and thin nodular beds of 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.

The Bearpaw Formation underlies the Horseshoe Canyon Formation and is in the order of 80 metres thick within the County. The Bearpaw Formation includes transgressive, shallow marine (shoreface) and open marine facies¹² deposits. In Parkland County, the Bearpaw Formation is composed mainly of shale and as such is a regional aquitard.

5.3.2 Aquifers

Of the 3,107 water wells in the database, 1,617 were defined as being completed in bedrock aquifer(s). This designation is based on the top of the completion interval being below the bedrock surface. The completion depth is available for the majority of water wells. In order to make use of additional information within the groundwater database, it was statistically determined that water wells typically have completion intervals equivalent to one quarter of their completed depth. This relationship was used

Bedrock Aquifer	No. of Water Wells
Paskapoo	290
Upper Scollard	216
Lower Scollard	30
Upper Horseshoe Canyon	640
Middle Horseshoe Canyon	485
Lower Horseshoe Canyon	79
Bearpaw	9

Table 2. Completion Aquifer

to increase the number of water wells identified as completed in bedrock aquifer(s) to 2,598 from 1,617. With the use of geological surfaces that were determined from the interpretation of geophysical logs, it has been possible to assign the water wells completed in bedrock aquifer(s) to specific aquifers based on their completion intervals. The bedrock water wells are mainly completed in the Upper and Middle Horseshoe Canyon Aquifers as shown in the adjacent table; 849 bedrock water wells are completed in more than one aquifer. The discussions related to specific aquifers, later in this report, do not include the Bearpaw Aquifer. However, maps associated with the Bearpaw Aquifer are included on the CD-ROM.

¹¹ See glossary

¹² See glossary

There are 1,340 records for bedrock water wells that have apparent yield values. In Parkland County, water well yields can be expected to be mainly less than 100 m³/day. The adjacent map shows that water well yields are generally higher in the southwestern and northeastern parts of the County. In these areas, projected long-term yields are greater than 100 m³/day. These higher yields may be a result of increased permeability that has resulted from the weathering process.

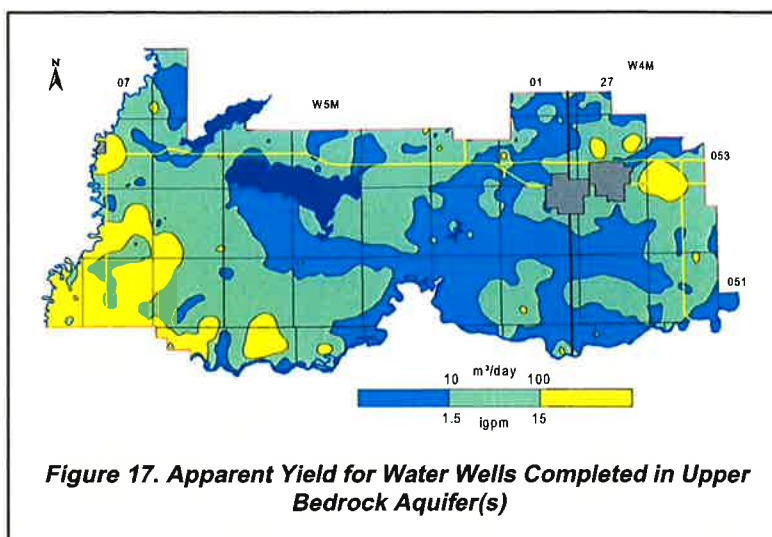


Figure 17. Apparent Yield for Water Wells Completed in Upper Bedrock Aquifer(s)

Of the 1,340 records that have apparent yields, there are 869 bedrock water wells with apparent yields. With the exception of the Lower Horseshoe Canyon Aquifer, more than 50% of the bedrock water wells have apparent yields that range from 10 to 100 m³/day, as shown in the adjacent table.

Aquifer	No. of Water Wells with Apparent Yields	Percentage of Water Wells with Apparent Yield		
		<10 m ³ /day	10 to 100 m ³ /day	>100 m ³ /day
Paskapoo	87	8%	66%	26%
Upper Scollard	65	23%	58%	19%
Lower Scollard	9	12%	66%	22%
Upper Horseshoe Canyon	366	23%	62%	15%
Middle Horseshoe Canyon	306	25%	58%	17%
Lower Horseshoe Canyon	36	36%	36%	28%
Bearpaw	0	#N/A	#N/A	#N/A

Table 3. Apparent Yields of Bedrock Aquifer(s)

5.3.3 Chemical Quality of Groundwater

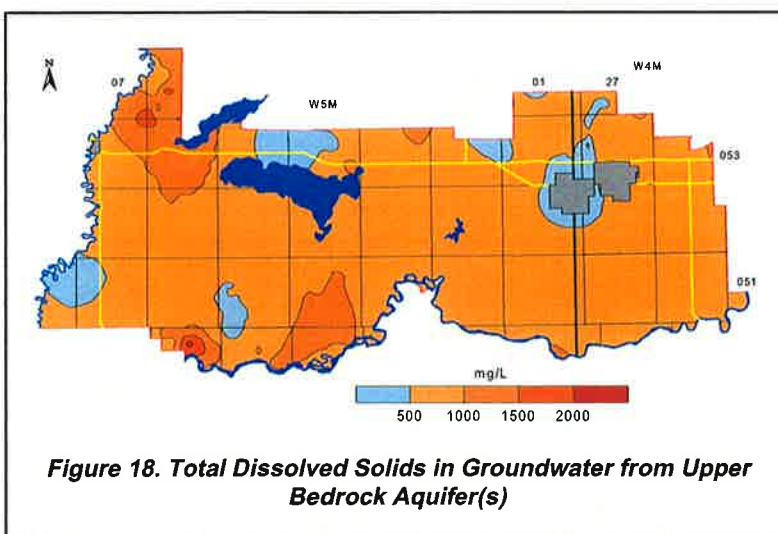


Figure 18. Total Dissolved Solids in Groundwater from Upper Bedrock Aquifer(s)

The TDS concentrations in the groundwaters from the upper bedrock aquifer(s) range from less than 500 to more than 1,500 mg/L. In more than 90% of the area, TDS values are less than 1,000 mg/L.

A relationship between TDS and sulfate concentrations shows that when TDS values in the upper bedrock aquifer(s) exceed 1,300 mg/L, the sulfate concentration exceeds 400 mg/L.

The Piper tri-linear diagrams show that all chemical types of

groundwater occur in the bedrock aquifer(s). However, the majority of the groundwaters are sodium-bicarbonate or calcium-magnesium-bicarbonate types.

In 80% of the County, the fluoride ion concentration in the groundwater from the upper bedrock aquifer(s) is less than 1.5 mg/L.

5.3.4 Paskapoo Aquifer

The Paskapoo Aquifer is any part of the Paskapoo Formation that is porous and permeable. The Paskapoo Aquifer is present under the extreme western one third of the County. Within the County, the thickness of the Paskapoo Formation is generally less than 100 metres; in the remaining two thirds of the County, the Paskapoo Formation has been eroded. In general terms, the permeability of the Paskapoo Aquifer is very low. Higher local permeability can be expected when the depth of burial is less than 100 metres and the weathering process has occurred.

5.3.4.1 Depth to Top

The depth to the top of the Paskapoo Formation is mainly less than 20 metres below ground level.

5.3.4.2 Apparent Yield

The projected long-term yield for individual water wells completed through the Paskapoo Aquifer is mainly 10 to 100 m³/day. The areas where water wells with higher yields are expected within the Paskapoo Aquifer are mainly in the southwestern part of the County.

An extended aquifer test conducted with a water test hole completed in the Paskapoo Aquifer for Pembina River Provincial Park (Hydrogeological Consultants Ltd., 1988) indicated a long-term yield of more than 70 m³/day.

5.3.4.3 Quality

The TDS concentrations for groundwater from the Paskapoo Aquifer are mainly between 500 and 1,000 mg/L. There are two areas where the TDS are less than 500 mg/L and one small area where TDS are expected to be more than 1,000 mg/L. The sulfate concentrations are less than 250 mg/L in over 90% of the County where the Paskapoo subcrops.

The chloride concentration from the Paskapoo Aquifer can be expected to be mainly less than 10 mg/L.

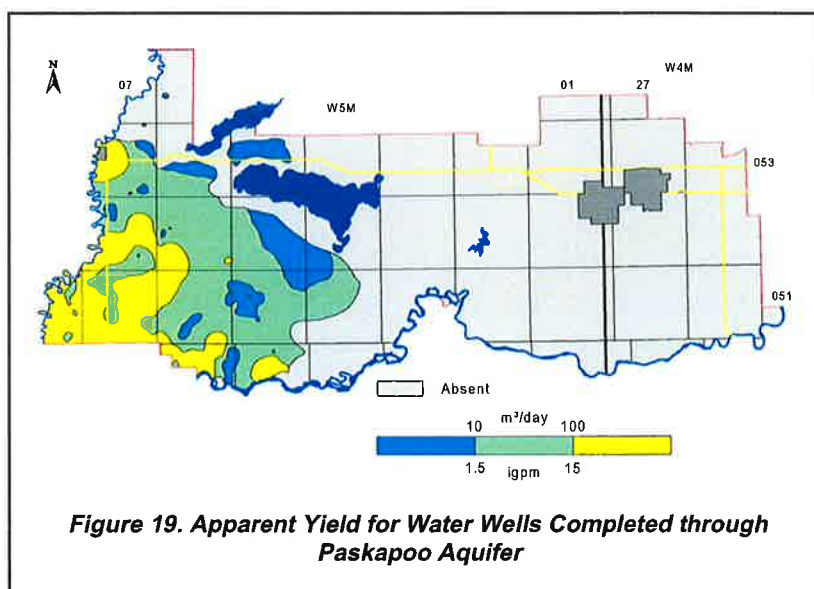


Figure 19. Apparent Yield for Water Wells Completed through Paskapoo Aquifer

5.3.5 Upper Scollard Aquifer

The Upper Scollard Aquifer is any part of the Upper Scollard Formation that is porous and permeable. The Upper Scollard subcrops in the western-central part of the County. The thickness of the Upper Scollard Formation is generally less than 60 metres. The Upper Scollard Formation has been eroded in more than two thirds of the County. In general terms, the permeability of the Upper Scollard Aquifer is very low. Higher local permeability can be expected when the depth of burial is less than 100 metres and the weathering process has occurred.

5.3.5.1 Depth to Top

The depth to the top of the Upper Scollard Formation is mainly less than 20 metres below ground level where the Formation subcrops. The greatest depth is in areas where the Paskapoo Formation is present.

5.3.5.2 Apparent Yield

Fifty percent of the projected long-term yields for individual water wells completed through the Upper Scollard Aquifer are between 10 and 100 m³/day. Water well yields are highest in township 050, range 05, W5M. One of the more extensive hydrogeological studies of the Upper Scollard Formation was by Alberta Environmental Protection (AEP, 1980). The AEP study was in connection with the mining of the Ardley Coal Seam at the Whitewood Mine north of Wabamun Lake.

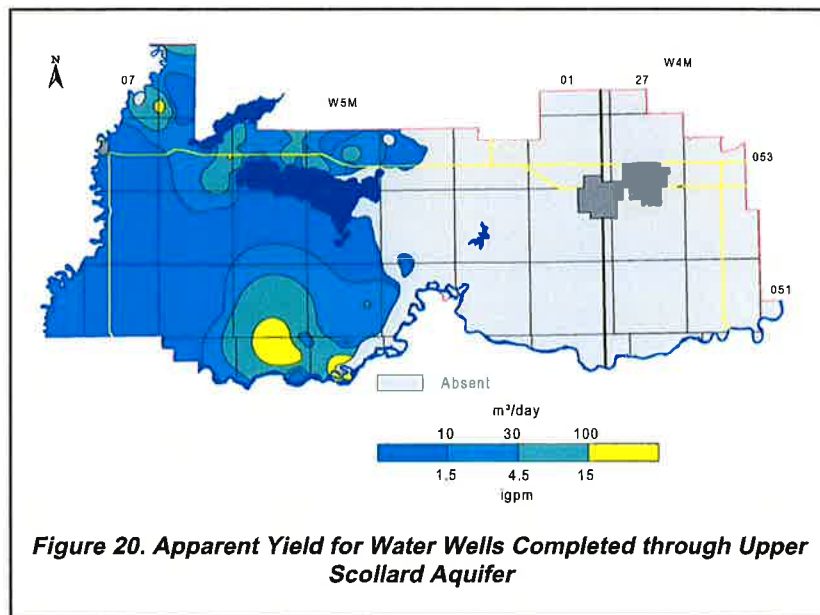


Figure 20. Apparent Yield for Water Wells Completed through Upper Scollard Aquifer

5.3.5.3 Quality

The TDS concentrations for groundwater from the Upper Scollard Aquifer are mainly less than 1,500 mg/L, with 50% of the values being less than 1,000 mg/L. The sulfate concentrations are generally less than 500 mg/L. The higher concentrations are expected in the northwestern part of the County.

The chloride concentration of the groundwater from the Upper Scollard Aquifer can be expected to be less than 100 mg/L, except in the southwestern part of the County.

5.3.6 Lower Scollard Aquifer

The Lower Scollard Aquifer is any part of the Lower Scollard Formation that is porous and permeable. The Scollard Formation subcrops along a narrow north-south trending band through the central part of the County. The thickness of the Lower Scollard Formation is generally less than 30 metres and is absent in the northeastern two thirds of the County. In general terms, the permeability of the Lower Scollard Aquifer is very low. Higher local permeability can be expected when the depth of burial is less than 100 metres and the weathering process has occurred.

5.3.6.1 Depth to Top

The depth to the top of the Lower Scollard Aquifer is mainly less than 100 metres below ground level, increasing toward the southwestern edge of the County.

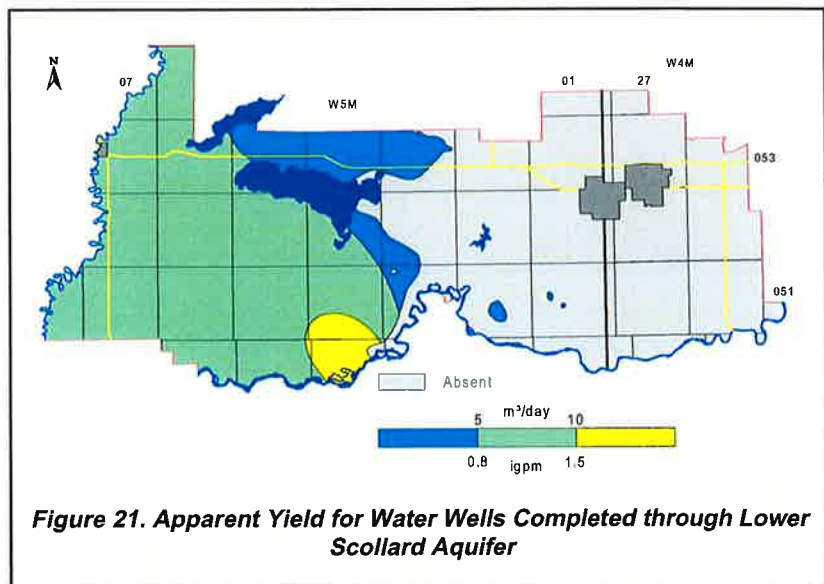
5.3.6.2 Apparent Yield

The projected long-term yields for individual water wells completed through the Lower Scollard Aquifer are mainly 5 to 10 m³/day.

5.3.6.3 Quality

The TDS concentrations for groundwater from the Lower Scollard Aquifer are mainly less than 1,500 mg/L. The sulfate concentrations are generally less than 500 mg/L.

The chloride concentration of the groundwater from the Lower Scollard Aquifer can be expected to be less than 10 mg/L except in the western part of the County.



5.3.7 Upper Horseshoe Canyon Aquifer

The Upper Horseshoe Canyon Aquifer is the porous and permeable parts of the Upper Horseshoe Canyon Formation. The Formation subcrops under the majority of the eastern half of the County. The thickness of the Upper Horseshoe Canyon Aquifer increases to the west and can reach more than 100 metres in the western part of the County. In general terms, the permeability of the Upper Horseshoe Canyon Aquifer is very low. Higher local permeability can be expected when the depth of burial is less than 100 metres and weathering processes have occurred.

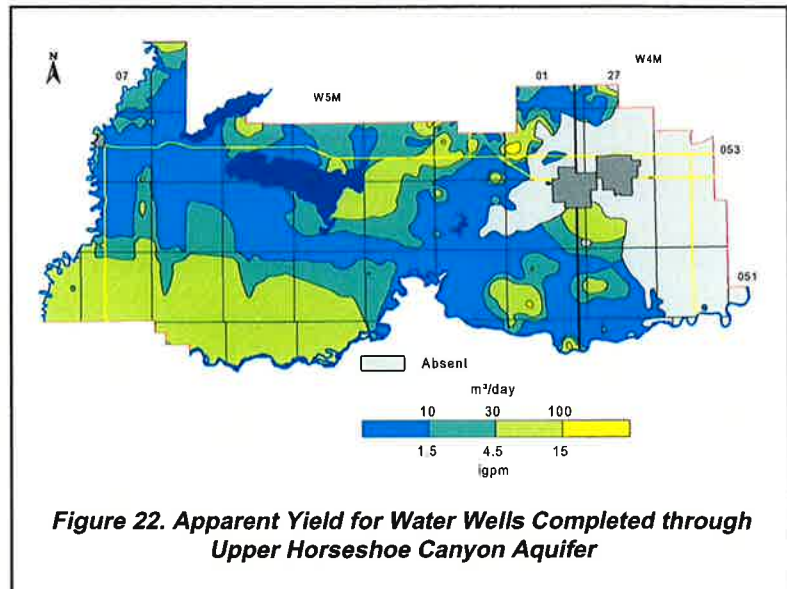
5.3.7.1 Depth to Top

The depth to the top of the Upper Horseshoe Canyon Formation is variable, ranging from less than 20 to more than 300 metres. The largest area where the top of the Upper Horseshoe Canyon Formation is more than 150 metres below ground level is in the western part of the County, where the Upper Horseshoe Canyon Formation underlies the Paskapoo Formation.

5.3.7.2 Apparent Yield

The projected long-term yields for water wells completed through the Upper Horseshoe Canyon Aquifer are mainly 10 to 100 m³/day. The lower yields presented west of range 03, W5M within the County could be a result of the gridding procedure used to process a very limited number of data points.

An extensive aquifer test conducted with a water test hole completed in the Upper Horseshoe Canyon Aquifer and drilled in NW 02-053-03 W5M on the northeast side of Wabamun Lake (Hydrogeological Consultants Ltd., 1976) indicated a long-term yield of 70 m³/day.



5.3.7.3 Quality

The Piper tri-linear diagrams show that sodium-bicarbonate and calcium-magnesium-bicarbonate are the dominant types of groundwater that occur in the Upper Horseshoe Canyon Aquifer. The TDS concentrations in groundwater from the Upper Horseshoe Canyon Aquifer range mainly from 500 to 1,000 mg/L. The sulfate concentrations in groundwater from the Aquifer are mainly less than 250 mg/L.

Chloride concentrations in the groundwater from the Upper Horseshoe Canyon Aquifer are mainly less than 100 mg/L. The exception occurs in a small area along the southern extent of the County. In this area, chloride concentrations range from 100 to 250 mg/L.

5.3.8 Middle Horseshoe Canyon Aquifer

The Middle Horseshoe Canyon Aquifer is the porous and permeable parts of the Middle Horseshoe Canyon Formation which subcrops under a small area in the eastern part of the County. The thickness of the Middle Horseshoe Canyon Aquifer increases to the southwest and can reach more than 60 metres in the western part of the County. In general terms, the permeability of the Middle Horseshoe Canyon Aquifer is very low. Higher local permeability can be expected when the depth of burial is less than 100 metres and weathering processes have occurred.

5.3.8.1 Depth to Top

The depth to the top of the Middle Horseshoe Canyon Formation is variable, ranging from less than 50 to more than 400 metres. The largest area where the top of the Middle Horseshoe Canyon Formation is more than 200 metres below ground level is west of Wabamun Lake, where the Middle Horseshoe Canyon underlies the Upper Horseshoe Canyon Formation.

5.3.8.2 Apparent Yield

The projected long-term yields for water wells completed through the Middle Horseshoe Canyon Aquifer range from 10 to more than 30 m³/day where the Formation is the upper bedrock. However, there are little or no data for the western half of the County due to the large depth to the top of the Formation.

5.3.8.3 Quality

The Piper tri-linear diagrams show that groundwaters in the Middle Horseshoe Canyon Aquifer are mainly a sodium-bicarbonate-type. The TDS concentrations in groundwater from the Middle Horseshoe Canyon Aquifer are mainly less than 1,000 mg/L. The higher TDS values are in the northeastern part of the County where the Middle Horseshoe Canyon is present as the upper bedrock. When TDS values exceed 1,200 mg/L, the sulfate concentrations exceed 400 mg/L.

Chloride concentrations in the groundwater from the Middle Horseshoe Canyon Aquifer are mainly less than 10 mg/L.

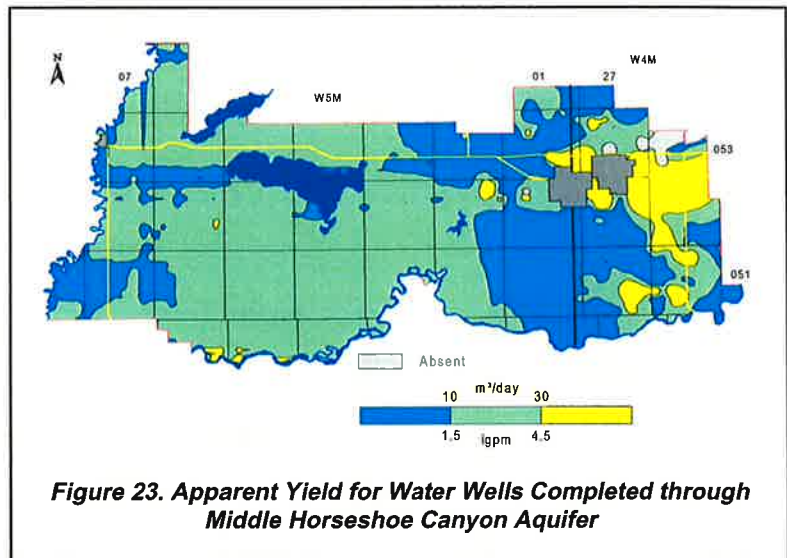


Figure 23. Apparent Yield for Water Wells Completed through Middle Horseshoe Canyon Aquifer

5.3.9 Lower Horseshoe Canyon Aquifer

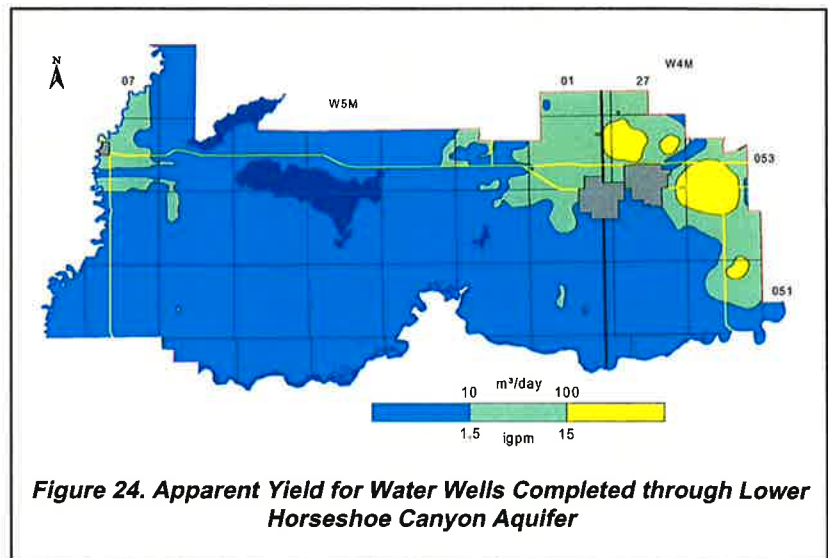
The Lower Horseshoe Canyon Aquifer is the porous and permeable parts of the Lower Horseshoe Canyon Formation which subcrops in the extreme northeastern part of the County. The thickness of the Lower Horseshoe Canyon Aquifer is generally 170 metres.

5.3.9.1 Depth to Top

The depth to the top of the Lower Horseshoe Canyon Formation ranges from less than 50 metres in the northeastern part of the County where the Formation subcrops, to more than 500 metres in the southwestern part of the County where the Paskapoo Formation is present.

5.3.9.2 Apparent Yield

The projected long-term yields for individual water wells completed in the Lower Horseshoe Canyon Aquifer are mainly less than 10 m³/day. The adjacent map indicates that apparent yields of 10 to more than 100 m³/day are expected mainly in the northeastern part of the County; however, there are little or no data for the Aquifer for the majority of the County due to the large depth to the top of the Formation.



5.3.9.3 Quality

Groundwaters from the Lower Horseshoe Canyon Aquifer are mainly sodium-bicarbonate or sodium-sulfate-type waters. TDS concentrations are expected to be in the order of 500 to 1,000 mg/L where the Aquifer is present, although there is a paucity of data for the majority of the County. When TDS values exceed 1,200 mg/L, the sulfate concentrations exceed 400 mg/L.

Chloride concentrations in the groundwater from the Lower Horseshoe Canyon Aquifer are mainly less than 100 mg/L. However, the chloride ion concentration can be expected to increase to the southwest as the depth of burial increases.

6 GROUNDWATER BUDGET

6.1 Hydrographs

There are three observation water wells in the County where water levels are being measured and recorded with time. These observation water wells are part of the AEP groundwater-monitoring network. Two of the observation water wells (AEP Obs WW No. 325 and AEP Obs WW No. 327) are located approximately 10 kilometres northwest of the Town of Stony Plain, and the third (AEP Obs WW No. 377) is located in Enstwistle.

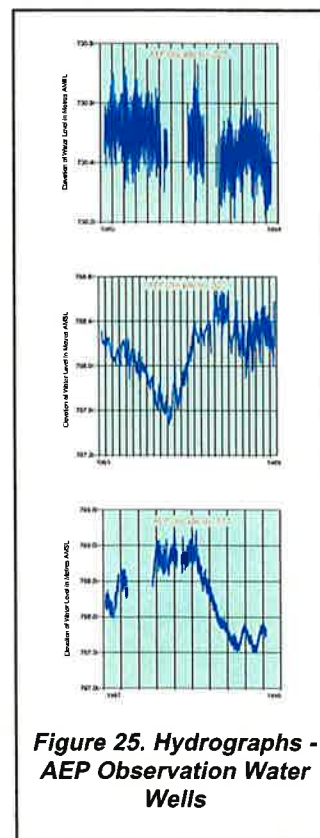
AEP Obs WW No. 325 is completed in the Lower Sand and Gravel Aquifer, just above the bedrock surface. The water level, which was measured from 1980 to 1994, shows a water-level decline of slightly more than 0.10 metres. The water level in the observation water well fluctuates up to 0.16 metres per day, with there being a general 0.10-metre change over a few months. While there has been a general decline over the 15 years of monitoring, there was a rise in water levels from 1990 to 1992.

AEP Obs WW No. 327 is at the same site as AEP Obs WW No. 325, but is completed immediately below the bedrock surface. The water level in AEP Obs WW No. 327 is reported in the AEP Obs WW database to have been 724 metres AMSL in 1961. However, the AEP data show the elevation of the water level in the hydrograph being 45 metres higher. It is assumed that the reference for the hydrograph is in error but that the relative fluctuations are correct.

The present data indicate that AEP Obs WW No. 327 is completed in a sandstone layer near the base of the Upper Horseshoe Canyon Formation. The water-level decline from 1961 to 1971 is believed to be a result of interference from a municipal water supply well. In the mid-1970s, a regional water line was installed and the towns of Stony Plain and Spruce Grove obtained their water supply from the water line. Therefore, the rise in the water level in the observation water well was most likely a result of a switch from a groundwater supply to a water supply from the pipeline. In the 1980s, the water level in the observation water well was above the level measured at the start of monitoring in the early 1960s.

AEP Obs WW No. 377 is completed at a depth of 25.6 metres below ground level in the uppermost part of the bedrock, which is the Paskapoo Formation. The water-level monitoring began in 1987 and data are available to early 1996. Although there are breaks in the water-level record, the water level rose from 1987 to 1990. Throughout 1990 and 1991 the water-level change was less than 0.5 metres. In 1992, 1993 and the first half of 1994, the water level declined 1.5 metres. Between 1994 and 1995, there was no net decline in the water level, although an annual fluctuation is evident. On 26 Feb 92, the Village of Entwistle was authorized to divert up to 226 m³/day from a water supply well in 02-20-053-07 W5M, no more than a few hundred metres from AEP Obs WW No. 377.

The limited amount of data indicates that in the area of the observation water wells there is no depletion of the groundwater resource.



**Figure 25. Hydrographs -
AEP Observation Water
Wells**

6.2 Groundwater Flow

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

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

Aquifer Designation	Transmissivity (m ² /day)	Gradient (m/m)	Width (km)	Main Direction of Flow	Quantity (m ³ /day)
Surficial Deposits	14.4	0.003	30	Southeast	1296
Buried Beverly Valley	12.6	0.0045	8	Northeast	454
Paskapoo	25.2	0.005	40	Northwest/Southeast	5040
Upper Scollard	8.4	0.002	60	Northwest/Southeast	1008
Upper Horseshoe Canyon	5.6	0.002	60	Northwest/Southeast	672
Middle Horseshoe Canyon	3.8	0.003	60	Northwest/Southeast	684
Lower Horseshoe Canyon	1	0.003	60	Northwest/Southeast	180

The recharge to these aquifers would be mainly restricted to Parkland County. This means that there would not be a significant inflow of groundwater into the County from the surrounding areas.

6.2.1 Quantity of Groundwater

An estimate of the volume of groundwater stored in the sand and gravel aquifers in the surficial deposits is 0.7 to 4.0 cubic kilometres. This volume is based on an areal extent of 2,700 square kilometres and a saturated sand and gravel thickness of five metres. The variation in the total volume is based on the value of porosity that is used for the sand and gravel. One estimate of porosity is 5%, which gives the low value of the total volume. The high estimate is based on a porosity of 30% (Ozoray, Dubord and Cowen, 1990).

The adjacent water-level map has been prepared by considering water wells completed in aquifers in the surficial deposits. The map shows the highest level of groundwater in surficial deposits, and this level was used for the calculation of saturated surficial deposits and for calculations of recharge/discharge areas.

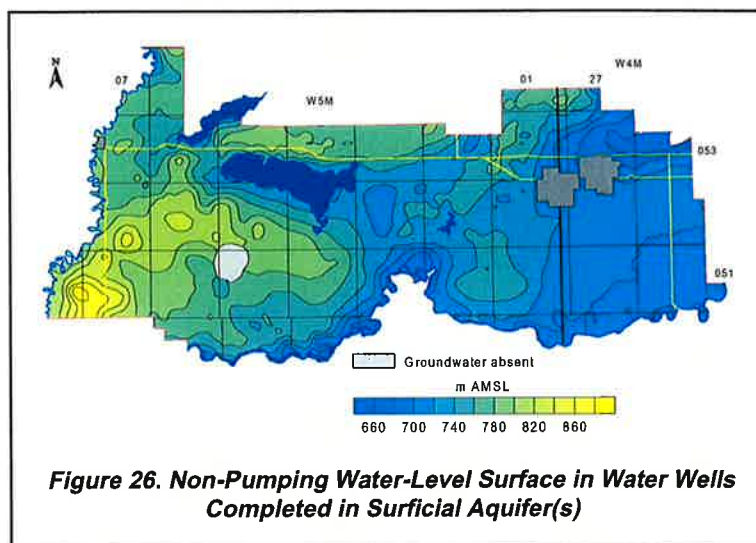


Figure 26. Non-Pumping Water-Level Surface in Water Wells Completed in Surficial Aquifer(s)

6.2.2 Recharge/Discharge

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

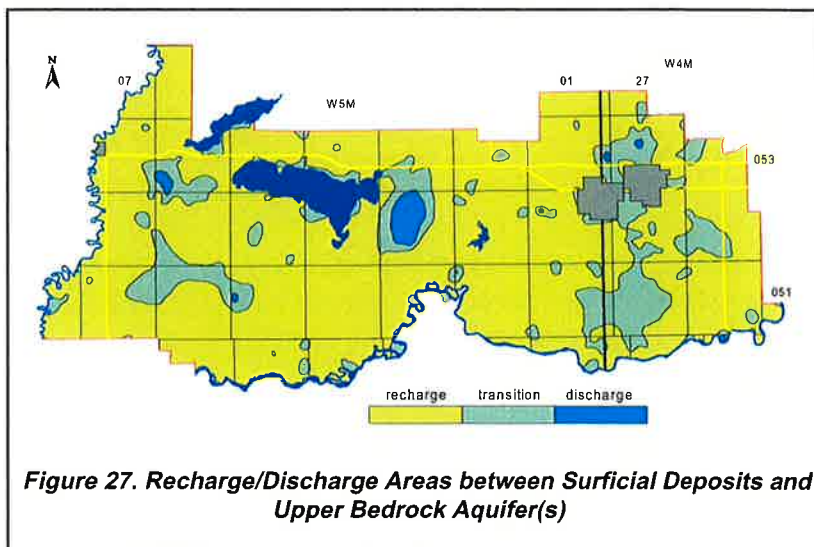
When the hydraulic gradient is from the bedrock aquifers to the surficial deposits, the condition is a discharge area, relative to the bedrock aquifers.

6.2.2.1 Surficial Deposits/Bedrock Aquifers

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

The adjacent map shows that in more than 85% of the County there is a downward hydraulic gradient between the surficial deposits and the upper bedrock aquifer(s). Areas where there is an upward hydraulic gradient, discharge from the bedrock, are very few. One of the main areas of discharge from the bedrock is in Tp 052, R 03, W5M, east of Wabamun Lake. The remaining parts of the County are areas where there is a transition condition. One of the main areas of transitional flow trends north-south and is on the east side of the Fifth Meridian, passing beneath the towns of Stony Plain and Spruce Grove.

The other main areas of transitional flow occur in range 06, W5M. The extensive areas of transition conditions may be a result of the topographic relief and/or the limited amount of data for both aquifer conditions generally and specifically for the surficial deposits.



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

Previous work associated with the Town of Stony Plain has shown that with the diversion of 2,500 m³/day (Hydrogeological Consultants Ltd., 1998) there has been no appreciable lowering of the water level in the Lower Sand and Gravel Aquifer after 20 years of diversion. Based on the regional results, the estimated flow through the Lower Sand and Gravel Aquifer associated with the Buried Beverly Valley is 454 m³/day. The lower value based on the regional data may be a result of the data being mainly from domestic water wells and from the method of calculating apparent transmissivity. In order to support a flow of 2,500 m³/day through the Aquifer and all other conditions remaining constant, the transmissivity of the aquifer would need to be 70 m²/day. This value of transmissivity is less than the 800 m²/day determined from the aquifer tests with the original dewatering wells (Hydrogeological Consultants Ltd., 1976).

Based on the water-level map for the surficial deposits, the area that could be expected to contribute recharge to the Lower Sand and Gravel Aquifer associated with the Buried Beverly Valley near Stony Plain would be approximately one township, 92 square kilometres. With an average annual precipitation of 533 mm in the area, slightly less than 2% of the precipitation would be needed to maintain a flow of 2,500 m³/day through the Aquifer.

6.3 Bedrock Aquifers

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

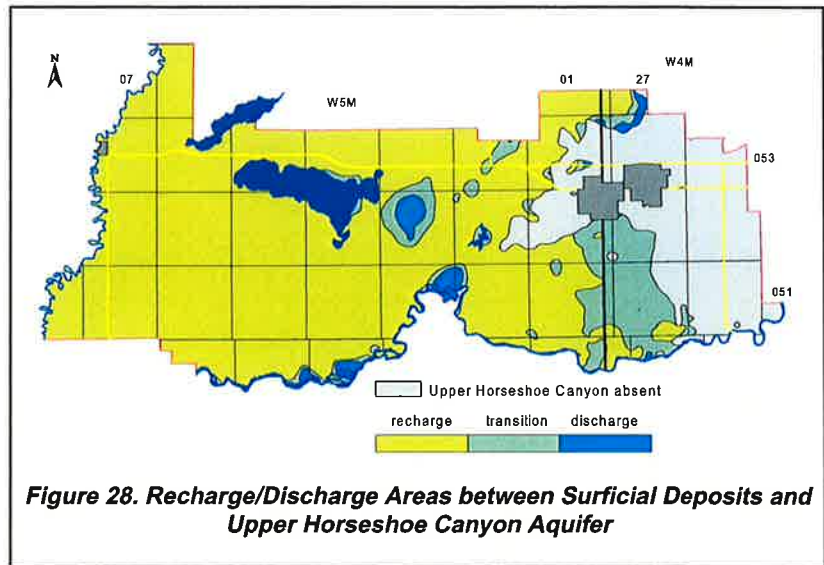
The hydraulic relationship between the surficial deposits and the Paskapoo Aquifer indicates that in 80% of the County where the Paskapoo is present, there is a downward hydraulic gradient. The main discharge occurs at the edge of the Paskapoo Formation south and west of Wabamun Lake. There is also an extensive transition flow area that extends northwest from the North Saskatchewan River in townships 050 and 051, ranges 05 and 06, W5M. Because both the Pembina and North Saskatchewan rivers are deeply incised into the bedrock, there would be little or no groundwater flow into the County in the Paskapoo Formation.

The hydraulic relationship between the surficial deposits and the Upper and Lower Scollard Aquifer indicates that in 95% of the County where the Aquifer is present, there is a downward hydraulic gradient. Discharge or transition areas are present mainly along the eastern edges of the Scollard Formation.

The recharge/discharge configuration for each of the Upper, Middle and Lower Horseshoe Canyon formations and the surficial deposits shows that, generally, discharge from the bedrock occurs over an area of less than 10% of the County. The discharge from the Lower Horseshoe Canyon Aquifer is mainly along the North Saskatchewan River in the south-central part of the County. Discharge from the Middle Horseshoe Canyon Aquifer is minimal but the areas of transitional flow are associated

with the Buried Beverly Valley and an area southeast of the towns of Stony Plain and Spruce Grove. One of the main transitional zones for the Upper Horseshoe Canyon Aquifer is along the eastern edge of the Formation south of the towns of Stony Plain and Spruce Grove.

The recharge/discharge maps generally support the idea that there is flow through the aquifers from west to east, with there being discharge from the individual units only when there cannot be any more flow through the aquifers because they have been eroded.



7 POTENTIAL FOR GROUNDWATER CONTAMINATION

The most common sources of contaminants that can impact groundwater originate on or near the ground surface. The contaminant sources can include leachate from landfills, effluent from leaking lagoons or from septic fields, and petroleum products from storage tanks or pipeline breaks. The agricultural activities that generate contaminants include spreading of fertilizers, pesticides, herbicides and manure. The spreading of highway salt can also degrade groundwater quality.

When activities occur that do or can produce a liquid which could contaminate groundwater, it is prudent (from a hydrogeological point of view) to locate the activities where the risk of groundwater contamination is minimal. Alternatively, if the activities must be located in an area where groundwater can be more easily contaminated, the necessary action must be taken to minimize the risk of groundwater contamination.

The potential for groundwater contamination is based on the concept that the easier it is for a liquid contaminant to move downward, the easier it is for the groundwater to become contaminated. In areas where there is groundwater discharge, liquid contaminants cannot enter the groundwater flow systems to be distributed throughout the area. When there are groundwater recharge areas, low-permeability materials impede the movement of liquid contaminants downward. Therefore, if the soils develop on a low-permeability parent material of till or clay, the downward migration of a contaminant is slower relative to a high-permeability parent material such as sand and gravel of fluvial origin. Once a liquid contaminant enters the subsurface, the possibility for groundwater contamination increases if it coincides with a higher permeability material within one metre of the land surface.

To determine the nature of the materials on the land surface, the surficial geology map prepared by the Alberta Research Council (Shetsen, 1990) has been reclassified based on the relative permeability. The classification of materials is as follows:

1. high permeability - sand and gravel;
2. moderate permeability - silt, sand with clay, gravel with clay, and bedrock; and
3. low permeability - clay and till.

To identify the areas where sand and gravel can be expected within one metre of the ground surface, all groundwater database records with lithologies were reviewed. From a total of 2,563 records in the area of the County with lithology descriptions, 608 have sand and gravel within one metre of ground surface. In the remaining 1,955 records, the first sand and gravel is deeper or not present. This information was gridded to prepare a distribution of where the first sand and gravel deposit could be expected within one metre of ground level.

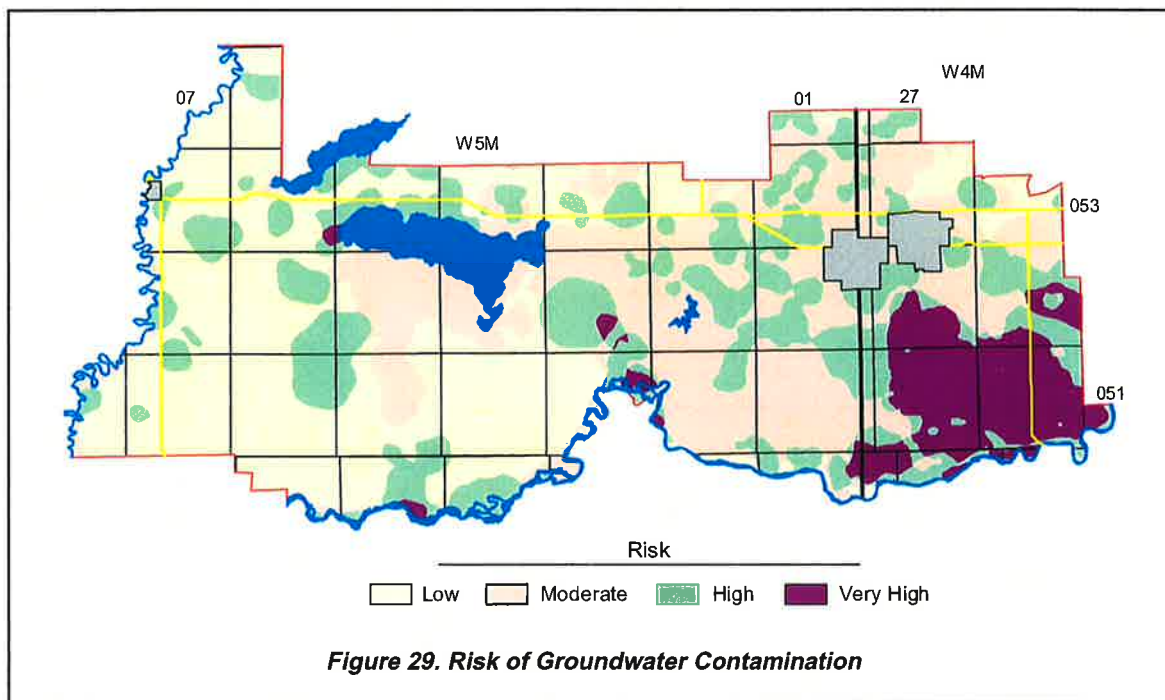
7.1.1 Risk of Groundwater Contamination Map

The information from the reclassification of the surficial geology map is the basis for preparing the initial risk map. The depth to the first sand and gravel is then used to modify the initial map and to prepare the final map. The criteria used for preparing the final Risk of Groundwater Contamination map are outlined in the adjacent table.

Surface Permeability	Sand or Gravel Present Top Within One Metre Of Ground Surface	Groundwater Contamination Risk
Low	No	Low
Moderate	No	Moderate
High	No	High
Low	Yes	High
Moderate	Yes	High
High	Yes	Very High

Table 4. Risk of Groundwater Contamination Criteria

The Risk of Groundwater Contamination map shows that, in 30% of the County, there is a high or very high risk of the groundwater being contaminated. These areas would be considered the least desirable ones for a development that has a product or by-product that could cause groundwater contamination. However, because the map has been prepared as part of a regional study, the designations are a guide only; detailed hydrogeological studies must be completed at any proposed development site to ensure the groundwater is protected from possible contamination. At all locations, good environmental practices should be exercised in order to ensure that groundwater contamination would not affect groundwater quality.



8 RECOMMENDATIONS

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

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

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

The results of the present study indicate that the only readily identifiable aquifers in the surficial deposits are the sand and gravel deposits associated with the lows in the bedrock surface. The most noteworthy bedrock lows include the Buried Beverly and Onoway valleys, linear bedrock lows, and a broad bedrock low in the southeastern part of the County. While details for each of the bedrock lows are generally available, specific details for each are lacking. This is particularly true for the area in the southeastern part of the County where the bedrock surface is poorly defined.

In areas where the lower 10 metres of the Upper Horseshoe Canyon Formation is the upper bedrock or is close to the bedrock surface, water well yields can be expected to be generally low. This condition occurs in an arc shaped area that is south, west and north of Stony Plain. In this area, there is a need to determine if the deeper Lower Horseshoe Canyon Formation is suitable as a source of groundwater for domestic needs. Water test holes may need to be drilled to depths of 250 metres to determine the aquifers present, to determine the hydraulic parameters and to obtain groundwater samples for analysis.

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

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

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

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

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

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

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

Groundwater is a renewable resource and it must be managed.