Environment Act Proposal (EAP) Form for the Argyle (Baldur) Existing Sewage Lagoon

Report

April 29, 2013

APEGM
Certificate of Authorization
Dillon Consulting Limited (MB)
No. 1789 Date: 2013-04-29

PROVINCE OF MANITOBA
R. MENON
4592
2013-04-29
REGISTERED ENGINEER

Environment Act Proposal Form (EAPF) for the Argyle (Baldur) Existing Sewage Lagoon

Manitoba Conservation

13-7248

Dick Menon, P. Eng. - Project Manager

Submitted by

Dillon Consulting Limited

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Environment Act Proposal Form

Manitoba Conservation

This form prescribes the nature and sequence of the information required to file a proposal for a development pursuant to subsections 10(3), 11(7), and 12(3) of *The Environment Act*.

Name of the development: Existing Sewage Lagoon		
Legal name of the proponent of the development: R.M of Argyle (LUD of Baldur)		
Location of the dev Street address: LUD Baldur City or Town:	Municipality: R.M of Argyle (LUD of Baldur Legal description: 2-843	
Name of proponent contact person for purposes of the environmental assessment: Dick Menon, on behalf of the Proponent		
Mailing address: Dillon Consulting Ltd., Suite 200-895 Waverley Street, Winnipeg, MB		
Postal code: R3T 5P4	Telephone: (204) 453-2301	Fax: (204) 452-4412
Date: February 28, 2013	Signature of the proponent, or corporate principal of the corporate proponent: B Bramwell Printed name: Barbara Bramwell (CAO, RM of Argyle)	

1) NOTE: APPLICATION FEE - Refer to Schedule "A" on reverse side.

2) NOTE: The proponent should reproduce the underlined portions of each section as noted below, adding the required information following each section as it applies to the development. A response to all the sections is required.

DESCRIPTION OF THE DEVELOPMENT:

i) Certificate of Title showing the owner(s) and legal description of the land upon which the development will be constructed; or (in the case of highways, rail lines, electrical transmission lines, or pipelines) a map or maps at a scale no less than 1:50,000 showing the location of the proposed development;

ii) Name of the owner of mineral rights beneath the land, if not the same as that of the surface owner;

iii) Description of the existing land use on the site and on land adjoining it, as well as changes that will be made thereto for the purposes of the development;

iv) Land use designation for the site and adjoining land as identified in a development plan adopted pursuant to *The Planning Act* or *The City of Winnipeg Act*, and the zoning designation as identified in a Zoning By-Law, if applicable;

v) A description of all previous studies and activities relating to feasibility, exploration, or project siting and prior authorization received from other government agencies;

vi) A description of the proposed development (including site plans), and the method of operation and hours of operation;

vii) An identification of any storage of gasoline or associated products (e.g. diesel fuel, used oil, heating oil, AV gas, solvents, isopropanol, methanol, acetone, etc.);

viii) A description of the potential impacts of the development on the environment, including, but not necessarily limited to:
- type, quantity and concentration of pollutants to be released into the air, water or on land;
- impact on wildlife;
- impact on fisheries;
- impact on surface water and groundwater;
- forestry related impacts;
- impact on heritage resources;
- socio-economic implications resulting from the environmental impacts.

ix) A description of the proposed environmental management practices to be employed to prevent or mitigate adverse implications from the impacts identified in viii) which will have regard to, where applicable: containment, handling, monitoring, storage, treatment, and final disposal of pollutants; conservation and protection of natural or heritage resources; environmental restoration and rehabilitation of the site upon decommissioning; and protection of environmental health.

SCHEDULE:

The proposed date of commencement of construction, commencement of operation, including staging of the development and termination of operation, if known.

FUNDING:

Name and address of any Government Agency (Federal, Provincial or otherwise) from which a grant or loan of capital funds have been requested, where applicable.

NOTE: *The Environment Act* requires that subject to the Confidential Information clause, Section 47, a proposal shall be filed in the public registry.

Proprietary information provided in this form should be clearly noted. A separate summary of the proposal excluding the proprietary information should accompany the proposal for the public registry file.

27 copies of any bound report or blueprints supporting the Proposal are required.

The completed Proposal form should be sent together with a covering letter to:

Director, Environmental Approvals
Manitoba Conservation
Suite 160, 123 Main Street
Winnipeg, Manitoba R3C 1A5

(In reply, please refer to)
Our File: 13-7248

DILLON
CONSULTING

1558 Willson Place
Winnipeg
Manitoba
Canada
R3T 0Y4
Telephone
(204) 453-2301
Fax
(204) 452-4412

April 29, 2013

Manitoba Conservation & Water Stewardship
169-123 Main Street
Winnipeg, Manitoba R3C 1A5

Attention: Ms. Tracey Braun
Director, Environmental Approvals

Environment Act Proposal Form (EAP) for the
Rural Municipality of Argyle (LUD of Baldur) Existing Sewage Lagoon

Dear Ms. Braun:

Dillon Consulting Limited is pleased to submit an Environment Act Proposal (EAP) for the existing Baldur Sewage lagoon, on behalf of the R.M. of Argyle, Manitoba. The EAP has been prepared in accordance with the designation of the Project as a Class II development under Manitoba Regulation 11.1 of the *Environment Act*. The RM of Argyle, as the Proponent, retained Dillon to complete the EAP.

As required, an application fee of $5,000 is attached to this submission, payable to the Minister of Finance.

If you require any further information, please contact the undersigned at (204) 453-2353, or by email at dmenon@dillon.ca .

Yours sincerely,

DILLON CONSULTING LIMITED

Dick Menon, P. Eng.
Project Manager

Enclosures:

- *Environment Act Proposal Form*
- *Environment Act Proposal Report*

Dillon Consulting
Limited

TABLE OF CONTENTS

Page No.

LIST OF TABLES

LIST OF APPENDICES

1.0 DESCRIPTION OF DEVELOPMENT

1.1 Land Ownership Title

The existing sewage lagoon for the LUD of Baldur is located approximately 1 km east from the center of the Town of Baldur. It is located in the Southeast quarter of Section Thirteen in the Fifth Township and Fourteenth Range, West (SE ¼ 13-5-14WPM) (Appendix A).

1.2 Name of Owner

The parcel of land that makes up the site is currently owned by the Rural Municipality (R.M.) of Argyle, under the title/deed number 86911.

1.3 Mineral Rights on Land

The mines and mineral rights of the land on which the existing sewage lagoon is located are held by the R.M. of Argyle.

1.4 Description of Existing Land Use

The existing land has been used for disposal of municipal wastewater and sewage since 1966. No other type of land use has existed on this parcel of land. A license to operate the lagoon was issued by the Provincial Sanitary Control Commission, in 1966 (P 125, Appendix B).

1.5 Summary from Previous Studies

In March 2006, Stantec Consulting Ltd. (Stantec) prepared a report entitled "*Baldur Sewer and Water Infrastructure Assessment*" for the R.M. of Argyle and the Manitoba Water Services Board. The report also included a geotechnical investigation and seepage analysis which was conducted by ENG-TECH Consulting Ltd. (ENG-TECH). The report provided a summary of the current condition of the water and sewer infrastructure and proposed recommendations for upgrades to the existing infrastructure based on the assessment findings. A copy of the infrastructure assessment summary and geotechnical reports is attached in Appendix C and D, respectively.

The "Baldur Sewer and Water Infrastructure Assessment" report indicated that there appeared to be some seepage from the lagoon at the time of the site visit. However, the soil tests indicated that the lagoon was constructed in high to medium plastic clay and the hydraulic conductivity results were within the provincial standards for a clay lined lagoon.

The Municipality conducted further investigation and found that the appearance of seepage was caused due to overloading of the lift station from the creek during spring floods. The RM took measures to fix the problem and there has not been any seepage around since then. This was confirmed during Dillon visit in Sept 2012.

2.0 EXISTING LAGOON

2.1 Description

The LUD of Baldur sewage lagoon is a two (2) cell, facultative lagoon. The primary and secondary lagoon cells occupy 0.79 hectare and 1.32 hectare, respectively.

Liquid wastewater and sewage from the Town of Baldur are collected from the residences via a piped sewer system. There are approximately 10 truckloads of wastewater/sewage that is dumped into the east lift station each year, from holding tanks. Although the lagoon has capacity to accept septage, none are received at the lift station.

2.2 Existing Capacity

The dimensions of the existing sewage lagoon primary and secondary cells are 91.4 m by 91.4 m (300 ft x 300 ft) and 93.0 m by 152.4 m (305 ft x 500 ft), respectively. Both lagoon cells cover a total land area of 2.11 hectare and have a combined total storage volume of approximately 31,027 m^3 as stated in the 2006 Stantec report.

Table 1: Lagoon Cells – Existing Capacity

Cell	Dimensions (m x m)	Operating Depth (m)	Volume (m^3)
Primary	91.4 x 91.4	1.52	12,267
Secondary	93.0 x 152.4	1.52	18,760
		Total	31,027

The hydraulic capacity of the existing sewage lagoon is approximately 24,893.5 m^3 for a 240 day retention period.

2.3 Description of Buffer Areas

A buffer area of 3.0 m to 15.2 m (10 ft. to 50 ft.) is located around the perimeter of the primary and secondary lagoon cells, with the exception of the area between lagoon cells and Oak Creek which boarders Elizabeth Street (Highway 23). Both lagoon cells are located within the entire buffer area, 217.9 m by 298.7 m (715 ft. by 980 ft.), 10.9 acres of land. The buffer area of the sewage lagoon has been established by a barbed wire fence.

2.4 Population and Potential for Growth

2.4.1 Population

The population of the LUD of Baldur, according to the 2006 census is 345 people. The population has not changed over the past seven (7) years.

2.4.2 Potential for Growth

It is deemed that the LUD of Baldur is not going to grow that much over the next twenty (20) years. Therefore, there are no requirements for future expansion of the existing lagoon cells.

2.5 Wastewater Quality and Quantity

2.5.1 Wastewater Quality

Trucked wastewater typically has a more concentrated wastewater quality compared to piped wastewater. A breakdown of the typical composition of untreated domestic wastewater, i.e. typical concentration for each contaminant found in medium strength (trucked) wastewater, is listed in the table below (Metcalf and Eddy, 2003).

Table 2: Breakdown of Typical Composition of Untreated Domestic Wastewater

Contaminant	Typical Concentration
Total Suspended Solids, TSS (mg/L)	210
5-day Biological Oxygen Demand, BOD_5 (mg/L)	190
Total Organic Carbon, TOC (mg/L)	140
Chemical Organic Demand, COD (mg/L)	430
Total Nitrogen as N (mg/L)	40
Total Phosphorus, TP (mg/L)	7
Oil and Grease, O&G (mg/L)	90
Total Coliform, TC (MPN/100 mL)	$10^6 – 10^8$
Fecal Coliform, FC (MPN/100 mL)	$10^3 – 10^5$
Volatile Organic Compounds, VOC (mg/L)	100 – 400

Source: Metcalf and Eddy, 4th ed.

2.5.2 Wastewater Quantity

Monthly wastewater generation rates for the period between January 2010 and September 2012 are shown in table format below.

Table 3: Monthly Wastewater Generation Rates

Month	Wastewater Generation Rates (m^3)		
	2010	2011	2012
January	2,255	1,742	1,541
February	1,732	1,663	1,452
March	1,975	1,897	1,567
April	1,651	1,776	1,413

Month	Wastewater Generation Rates (m^3)		
	2010	**2011**	**2012**
May	1,806	1,619	1,644
June	1,532	1,618	1,649
July	1,876	1,739	1,862
August	1,778	1,735	1,828
September	815	1,636	1,709
October	1,693	1,480	-
November	1,675	1,592	-
December	1,743	1,620	-
Total	**20,530**	**20,117**	**14,664**
Minimum	815	1,480	1,413
Maximum	2,255	1,897	1,862
Average	1,711	1,676	1,629

Based on the above wastewater generation rates, the existing lagoon has sufficient hydraulic retention capacity based on the original design of the system.

2.6 Effluent Quality and Discharge Route

2.6.1 Effluent Quality

Based on the water quality data for the wastewater samples collected in 2010, the wastewater effluent quality is meeting the requirements of effluent for discharge. On average, the Biological Oxygen Demand (BOD), fecal coliforms (FC) and total coliforms (TC) were between 3 and 15 mg/L, 3 and 15 MPN/100 ml, and 3 and 23 MPN/100 ml, respectively.

2.6.2 Discharge Route

Discharge from the secondary lagoon flows via a discharge pipe, south, into Oak Creek. The Oak Creek is located in the Souris River east watershed. The Creek meanders east about 5 miles, before turning north and eventually flowing north west, along the RM of Argyle boundary, and joins the Souris River, a few miles west of the confluence with the Assiniboine River (Central Assiniboine watershed). A map showing the effluent discharge route along Oak Creek is appended (Appendix E).

3.0 SITE INFORMATION

3.1 Site Condition

The berms of the lagoon cells consist of a mixture of highly plastic clay and medium plastic clay with clay till underlying the base of the lagoon area (Geotechnical Investigation, Stantec, 2005-06).
Manitoba Conservation requires clay material used for constructing cell berms to have a maximum permissible hydraulic conductivity rate (k_{20}) of 1 x 10^{-7} cm/sec for newly constructed lagoons. Based on

the geotechnical investigation and samples collected during the drilling program, the upper clay berms of the lagoon cells do meet this requirement (Geotechnical Investigation, Stantec, 2005-06).

3.2 Topography

The sewage lagoon is situated on a parcel of land that is relatively flat and consisting of farm land bordered on the west and south by a small creek. A topographic survey of the lagoon was completed as a part of the 2005-06 infrastructure assessment completed by Stantec.

3.3 Site Investigations

The observations and information provided in the 2006 Baldur Sewer and Water Infrastructure report were based on site investigations completed in the summer of 2005.

Dillon staff visited the lagoon site on Sept 25, 2012. During the visit, the following observations were made:

- The Oak Creek, which is at a considerably lower elevation than the lagoons, was dry, i.e. had no flow downstream of the lagoons.
- There were no appearances of any seepage from the lagoons. The creek, downstream of the lagoon was dry, with no appearance of any seepage. Pictures taken from the visit are located in Appendix E.
- There is a weir on the Oak Creek, west of the lagoons, which has created an impoundment in the Town area (lagoon is located east of Baldur)
- The RM operators have begun a program to trim and remove the excess growth from around the dykes.

Photographs taken during the site visits are appended (Appendix F).

4.0 SUMMARY OF DEVELOPMENT

There have been no recent future developments noted for the existing sewage lagoon.

5.0 ENVIRONMENTAL IMPACTS

Potential environmental impacts are the result of pollutants found in the treated sewage and wastewater once it is released into the receiving environment. These potential environment impacts, if any, are further explained in the subsections below.

To date, there have been no negative environmental impacts noted from the sewage lagoon operation.

5.1 Odour

With the site being 300 m from a residential housing and school area, there is a potential for unpleasant odours emanating from the sewage lagoon, in the spring, when the ice comes off and the lagoon conversion process begins. However, based on conversations with the community, there have not been any known occurrences of odours being an issue. During the Sept 2012 visit, there was no foul odour sensed.

5.2 Land and Land Use

The land on which the existing sewage lagoon is situated has been utilized for municipal waste use since the sewage lagoon was built in 1966 and the upgrades completed in 1988-89.

5.3 Buffers

Buffers around the sewage lagoon have been established and provided by a fence around the entire lagoon area.

5.4 Surface Water

The impact on Oak Creek due to the discharge of treated wastewater effluent entering into this fish bearing water body, is likely very minimal. Higher nutrient levels (BOD, FC and TC) are likely the only environmental impacts associated with the wastewater entering the water body. However, it should be noted that the effluent quality meets Manitoba's requirements for discharge to the environment.

5.5 Groundwater

The geotechnical investigation indicated that there will be minimal concern for contamination to the potable groundwater water supply as modeling illustrated that the clay till underlying the base of the lagoon cells provides adequate barrier between the lagoon effluent and groundwater aquifer. Therefore, there are no environmental impacts noted to the aquifer located under the clay till of the sewage lagoon cells or to the other local aquifers within the area at this time (Geotechnical Investigation, Stantec, 2005-06).

5.6 Species

The lagoon effluent meets all regulatory requirements for Municipal lagoon effluents. Therefore, the impact on any species in the watershed is very minimal.

5.7 Fish

Oak Creek is considered by the Department of Fisheries and Oceans (DFO) as a Type A habitat with intermitted or perennial flow, complex and present with indicator fish species. The indicator fish species that have been found in Oak Creek include the following:

- *Culaea inconstans* (Brook Stickleback);
- *Semotilus atromaculatus* (Creek Chub);
- *Pimephales promelas* (Fathead Minnow);
- *Margariscus margarita* (Pearl Dace); and,
- *Catostomus commersoni* (White Sucker).

This type of fish habitat is highly sensitive and is generally at higher risk from in-work waters compared to lower sensitive habitats.

5.8 Heritage Resources

The lagoon has been in operation for 47 years. There are no records available from the construction, with respect to Heritage Resources.

5.9 Socio-Economic

The lagoon has been in operation for 47 years. There are no potential negative impacts to social and economic aspects of the area, from the operation of the lagoons.

6.0 MANAGEMENT PROTOCOLS

6.1 Discharge Procedure

The secondary lagoon cell is discharge once per year into Oak Creek, usually in the fall, sometime before freeze-up. At that time, the wastewater held in the primary lagoon cell is transferred to the secondary cell.

6.2 Timing

The village has not had any significant growth since the construction of the lagoons. Therefore the disposal of treated effluent from the secondary cell occurs only once a year, usually in October prior to freeze-up.

6.3 Record Keeping and Inspection

The following records are kept for the operation and maintenance of the wastewater facility:

- Quantity (in gallons) of wastewater collected and disposed of in the sewage lagoon;
- Flow rate entering and exiting the lift station;
- Laboratory results from samples collected and analyzed as a part of the annual sampling requirements; and,
- Dates and description of operation and maintenance completed for the facility.

Routine inspection of the sewage lagoon is a part of the weekly, monthly and annual inspection regime for the facility. The routine inspection includes physical inspection of the site, noting any concerns and/or issues with the flow of wastewater from the lift station to the primary lagoon cell and into the secondary lagoon cell, in particular during the transfer and discharge of the primary and secondary cells.

7.0 OTHER PERTINENT ISSUES

Over the past 47 years, there have been some minor problems at the sewage lagoon, relating to operation and maintenance aspects of the overall system. The table below lists the observed problems and issues with the existing sewage lagoon since 2005.

Table 4: Observations with the Existing Lagoon Since 2005

<table>
<tr><th>Problem/Issue Observed</th><th>Date Noted</th><th>Changes Made to Fix Problem</th><th>Date Fixed</th></tr>
<tr><td rowspan="3">Infiltration into Lift Station and Emergency Pipe during Heavy Rainfalls</td><td rowspan="3">July 2005</td><td>Pipe entrance point into Cell #1</td><td rowspan="3">Spring 2007</td></tr>
<tr><td>Valve was installed on the emergency pipe</td></tr>
<tr><td>Discharge point of Cell #2 moved to southwest corner</td></tr>
<tr><td>Leak of wastewater from Primary Cell</td><td>Dec 2006</td><td>Clay was added to the berms</td><td>Spring 2007</td></tr>
<tr><td>Vegetation Overgrowth on Lagoon Berms</td><td>July 2005</td><td>Shaved, trimmed and removed cattails from inside slope.</td><td>Fall 2011</td></tr>
</table>

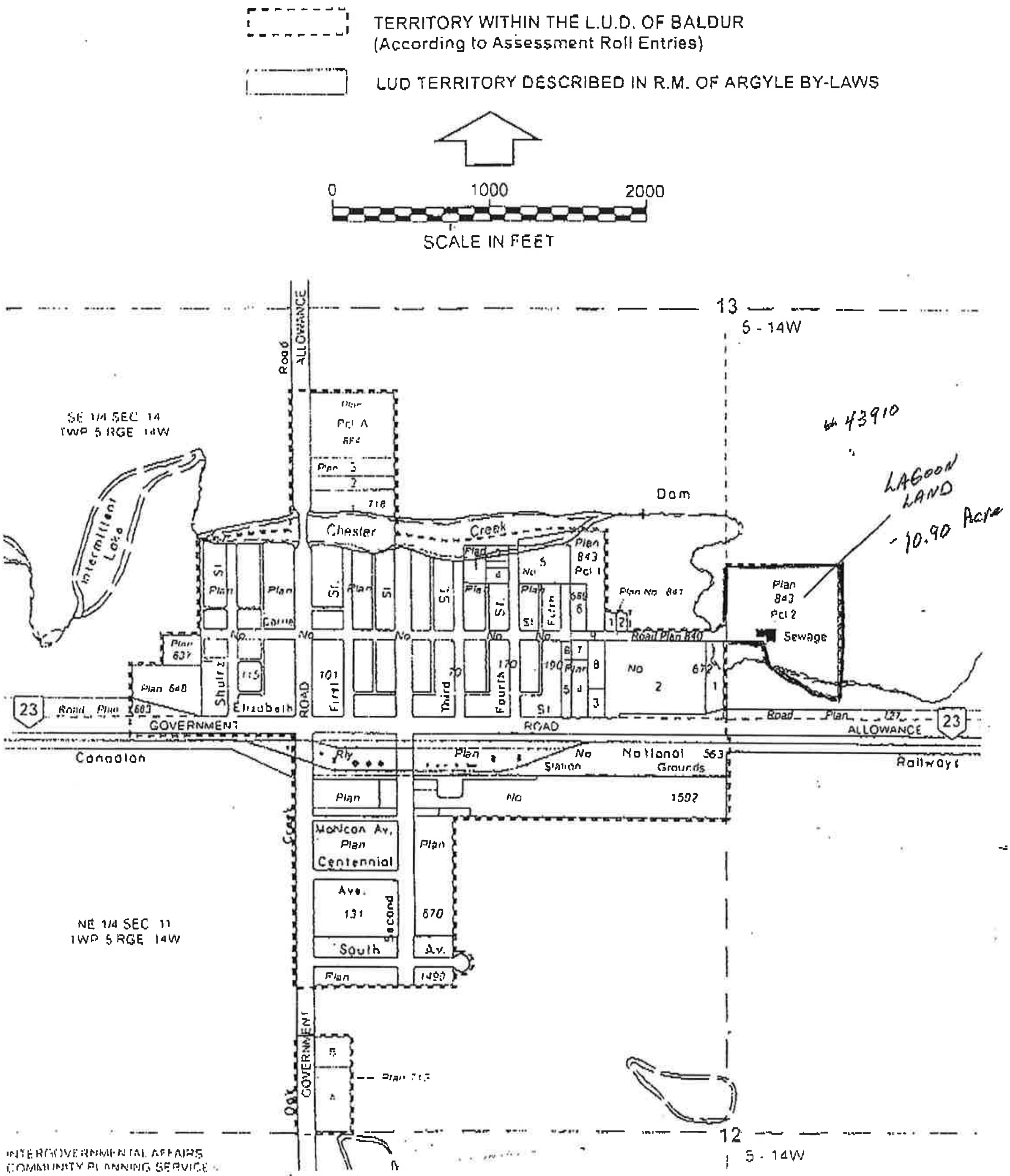
It was noted in conversations with the R.M. of Argyle (LUD of Baldur) personnel that there has been no wastewater overloading since the above improvements and changes to the existing sewage lagoon have been completed. The water quality results of the wastewater effluent exiting the secondary lagoon cell shows that the effluent is meeting the required discharge criteria for discharge into the environment. TM personnel indicate that they will undertake to remove excess growth from the inside slopes on a periodic basis.

Appendix A

CERTIFICATE OF TITLE FOR THE LOCATION OF THE EXISTING SEWAGE LAGOON

LOCAL URBAN DISTRICT (L.U.D.) OF BALDUR

IN THE R.M. ARGYLE



RM OF ARGYLE

2013 PRELIMINARY ASSESSMENT ROLL FOR REAL PROPERTY

Ward	Community	Run Date
	BALDUR	Oct 01, 2012

Roll Number	Owner Name And Mailing Address	Civic Address / Legal Description	Title Or Deed	Frontage Or Area	School Division	DU	Class Portion % Liability	Land Current Assmt / Portioned Assmt	Buildings Current Assmt / Portioned Assmt	Total Current Assmt / Portioned Assmt
43400.000	LOCKHART WILLIAM ALLAN 1/2 R BOX 111 BALDUR MB R0K 0B0 LOCKHART JAMES ALEXANDER JT R BOX 56 GLENORA MB R0K 0Y0	327 OAK CREEK RD N A--884 EXCEPTING - NLY 150 FEET ORG SW-13-05-14-W EXN150F	1896254	3.16AC	Prairie Spirit	0	Farm Property 26.00 Taxable	5,500 1,430	14,800 3,850	20,300 5,280
43500.000	GOSSELIN WILLIAM BLAIR JT R GOSSELIN LAVONA LEA JT R BOX 16 BALDUR MB R0K 0B0	343 OAK CREEK RD N A--884 NLY 150 FEET OF PARCEL A PLAN 884 MLTO IN SW 1/4 13-5-14 WPM ORG SW-13-05-14-W	1948981	1.84AC	Prairie Spirit	0	Other Property 65.00 Taxable	4,300 2,800	2,600 1,690	6,900 4,490
43600.000	FOUBERT JAMES MICHAEL JT R FOUBERT ARLENE GAIL JT R BOX 227 BALDUR MB R0K 0B0	601 CARRIE AVE E 1--841 ORG SW-13-05-14-W	1729371	60.00FT	Prairie Spirit	1	Residential 1 45.00 Taxable	2,000 900	44,500 20,030	46,500 20,930
43700.000	FOUBERT JAMES MICHAEL JT R FOUBERT ARLENE GAIL JT R BOX 227 BALDUR MB R0K 0B0	605 CARRIE AVE E 2--841 ORG SW-13-05-14-W	2291987	65.00FT	Prairie Spirit	0	Residential 1 45.00 Taxable	2,000 900		2,000 900
43800.000	HISCOCK GARRY AUSTIN D JT R HISCOCK TRACEY LYNN JT R BOX 266 BALDUR MB R0K 0B0	224 CARRIE AVE W 1--637 ALL THAT PORTION OUTLINED IN RED ON PLAN 637 MLTO IN SE 1/4 15-5-14 WPM ORG SE-14-05-14-W	1584998	210.00FT	Prairie Spirit	1	Residential 1 45.00 Taxable	3,500 1,580	42,100 18,950	45,600 20,530
43900.000	JOHNSON CARL SIGURJON JT R JOHNSON COREEN MAITLAND JT R BOX 215 BALDUR MB R0K 0B0	231 ELIZABETH AVE W --648 THAT PORTION OF SE 1/4 14-5-14 WPM SHOWN COLOURED PINK ON PLAN 648 MLTO EXCEPTING - PUBLIC ROAD PLAN 683 MLTO ORG SE-14-05-14-W	1706856	407.90FT	Prairie Spirit	1	Residential 1 45.00 Taxable	5,300 2,390	55,400 24,930	60,700 27,320
43910.000	R M OF ARGYLE LAGOON R BOX 40 BALDUR MB R0K 0B0	2--843 ORG SE-13-05-14-W ORG SW-13-05-14-W	86911	10.90AC	Prairie Spirit	0	Other Property 65.00 Exempt	7,300 4,750		7,300 4,750
43920.000	R M OF ARGYLE CAMPGROUND R BOX 40 BALDUR MB R0K 0B0	1--843 ORG SE-13-05-14-W ORG SW-13-05-14-W	86912	2.96AC	Prairie Spirit	0	Institutional Property 65.00 Exempt	5,200 3,380		5,200 3,380
							Other Property 65.00 Exempt	200 130	900 590	1,100 720

Appendix B

PSCC LICENSE FOR FACILITY

Black Acco Press Binder

P125

1966

PROVINCIAL SANITARY CONTROL COMMISSION LICENCE

The Provincial Sanitary Control Commission

Pursuant and subject to the provisions of "The Pollution of Waters Prevention Act" and subject to the conditions and restrictions hereinafter contained.

Hereby grants to the Rural Municipality of Argyle a licence to discharge the effluent from the sewage lagoon at the Unincorporated Village of Baldur into Oak Creek.

1) This Licence is subject to the following conditions and restrictions, namely:-

   (a) that the effluent shall receive treatment by lagooning in accordance with the recognized standards for the operation of sewage lagoons, and

   (b) that the effluent so deposited shall not create a nuisance either in Oak Creek or adjacent drainage courses, and

   (c) that the discharge shall be regulated as follows:-

      i) No discharge shall be made between November 1st, of any year and March 31st of the following year without the express permission of the Water Control and Conservation Branch of the Department of Agriculture and Conservation of the Province of Manitoba, and

      ii) No discharge shall be made between March 1st, and May 15th, of any year without permission from the Provincial Sanitary Control Commission.

2) This Licence is issued subject also to the following additional conditions and restrictions, namely:-

   (a) that the Rural Municipality of Argyle, its successors and assigns, from time to time shall comply with any order or regulation made from time to time by the Provincial Sanitary Control Commission under the provisions of "The Pollution of Waters Prevention Act", whether made before or after the issuing of this licence, and

   (b) that the restrictions and provisions herein set out in paragraph (1) hereof shall be subject to the additions thereto and the amendments or revisions thereof from time to time hereafter made by the Provincial Sanitary Control Commission for any reason which to the said Commission may seem meet, and

assigned to Eng. Ops. Aug. 20/13

(c) that whenever the Rural Municipality of Argyle, its successors and assigns, fails to comply with the said conditions or any of them as they may be added to, amended or revised from time to time as herein provided or whenever the Rural Municipality of Argyle, its successors and assigns, fails to comply with any order or regulation made by the Provincial Sanitary Control Commission, this licence shall be suspended and shall be subject to revocation and cancellation by the Provincial Sanitary Control Commission, and

(d) that the issuance of this licence shall not alter, prejudice or affect the right of any person as defined in "The Pollution of Waters Prevention Act" to recover from the Rural Municipality of Argyle, its successors and assigns, any loss or damage suffered or sustained by reason of the deposit of wastes under this licence, and

(e) that this licence be subject to suspension or revocation and cancellation at any time by the Provincial Sanitary Control Commission for any reason which to the said Commission may seem meet.

DATED at the CITY OF WINNIPEG, IN MANITOBA, the 4th DAY of January 196[illegible].

THE PROVINCIAL SANITARY CONTROL COMMISSION

R. Day

Chairman

Appendix C

SEWAGE LAGOON ASSESSMENT SUMMARY REPORT
AUGUST 2006
STANTEC

1 Truck A- 1/5 /

10 per year

9.0 Assessment of Existing Wastewater Lagoon

9.1 INTRODUCTION

Baldur currently has a two celled wastewater lagoon with a .79 hectare primary cell and 1.32 hectare secondary cell. At the time of the site visit on August 3, 2005, the primary cell (west cell) was overflowing into Oak Creek at a low spot in the southwest corner. The discharge pipe from the secondary cell was open and was discharging into the creek. There is only a rough trail to the lagoon and sewage trucks cannot access it. A topographic survey of the lagoon was undertaken using total station survey equipment.

The lagoon required cutting of vegetation and requires regrading to eliminate low dyke areas. There is residential housing and a school within 300 m of the lagoon dykes. The lagoon is enclosed with a barbed wire fence but no gate.

ENG-TECH Consulting Ltd. undertook a geotechnical investigation and a seepage analysis of the existing lagoon.

We were advised that the 300 m CMP overflow pipe between the east lift station and Oak Creek has caused high extraneous flows to be directed to the lagoon when the creek is high, backing up into the lift station.

The east lift station pumping times and rainfall were assessed for August and September of 2005. There was no evident increase in pumping rate during rainfalls. Therefore, we have assumed an average infiltration into the sewage system and have set an infiltration rate of 30% of generated domestic wastewater flow. No TV inspections have been done of the gravity sewer system. The RM advises that there are approximately 10 truck loads of holding tank sewage dumped into the east lift station each year and no septage. However, the design allows for 1 septage truck per day as part of the design loading, with a maximum of ten truck loads of septage or sewage per year. Reject water from the new WTP will be directed into Oak Creek.

9.2 WASTEWATER LAGOON DESIGN HYDRAULIC LOADING

The design wastewater criteria have been set as follows:

2024 design population	354
Total school population	155
Total hospital and hotel population; allow	30
Per capita water demand	250 lpcpd
Infiltration allowance	30%
Combined per capita & infiltration loading	325 lpcpd
Annual truck loads of sewage & septage	10
School, hospital and hotel per capita loading	70 lpcpd
Maximum septage dumping per day (non-winter only)	1 truck

9.0 Assessment of Existing Wastewater Lagoon

9.1 INTRODUCTION

Baldur currently has a two celled wastewater lagoon with a .79 hectare primary cell and 1.32 hectare secondary cell. At the time of the site visit on August 3, 2005, the primary cell (west cell) was overflowing into Oak Creek at a low spot in the southwest corner. The discharge pipe from the secondary cell was open and was discharging into the creek. There is only a rough trail to the lagoon and sewage trucks cannot access it. A topographic survey of the lagoon was undertaken using total station survey equipment.

The lagoon required cutting of vegetation and requires regrading to eliminate low dyke areas. There is residential housing and a school within 300 m of the lagoon dykes. The lagoon is enclosed with a barbed wire fence but no gate.

ENG-TECH Consulting Ltd. undertook a geotechnical investigation and a seepage analysis of the existing lagoon.

We were advised that the 300 m CMP overflow pipe between the east lift station and Oak Creek has caused high extraneous flows to be directed to the lagoon when the creek is high, backing up into the lift station.

The east lift station pumping times and rainfall were assessed for August and September of 2005. There was no evident increase in pumping rate during rainfalls. Therefore, we have assumed an average infiltration into the sewage system and have set an infiltration rate of 30% of generated domestic wastewater flow. No TV inspections have been done of the gravity sewer system. The RM advises that there are approximately 10 truck loads of holding tank sewage dumped into the east lift station each year and no septage. However, the design allows for 1 septage truck per day as part of the design loading, with a maximum of ten truck loads of septage or sewage per year. Reject water from the new WTP will be directed into Oak Creek.

9.2 WASTEWATER LAGOON DESIGN HYDRAULIC LOADING

The design wastewater criteria have been set as follows:

2024 design population	354
Total school population	155
Total hospital and hotel population; allow	30
Per capita water demand	250 lpcpd
Infiltration allowance	30%
Combined per capita & infiltration loading	325 lpcpd
Annual truck loads of sewage & septage	10
School, hospital and hotel per capita loading	70 lpcpd
Maximum septage dumping per day (non-winter only)	1 truck

Therefore, the 20 year estimated key loading quantities are as follows (to the nearest $1,000):

9.2.1 Annual Hydraulic Loading

Residential; 354 people @ 325 lpcpd x 365 =		41,990 m^3
School;155 people @ 70 =		2060
Hospital, hotel; 30 people @ 70 lpcpd @ x 365 =		770
Trucked RM holding tank sewage; 10 loads @ 4550 ℓ =		50
	Total	45,000 m^3

9.2.2 Maximum Daily Hydraulic Loading

Residential; 354 people @ 325 lpcpd =		115,050 ℓ
Trucked; 2 loads @ 4,550 ℓ (1 truck load only of septage)		9,100
School; 155 people @ 70 lpcpd =		10,850
Hospital, hotel; 30 people @ 70 lpcpd =		2,100
	Total	137,000 ℓ

9.2.3 Winter Average Daily Hydraulic Loading

Residential; 354 people @ 250 lpcpd =		88,500 ℓ
School; 10,850 ℓ x 5/7 =		7,750
Hospital, hotel =		2,100
Infiltration; 10% of 88,500 =		8,850
	Total	107,000 ℓ

9.3 LAGOON DESIGN MAXIMUM DAILY ORGANIC LOADING

The residential and school sewage organic loading calculations are hydraulically based and have been set at 250 mg/ℓ BOD_5. The infiltration / extraneous flow organic loading has been set at 25 mg/ℓ BOD_5..

Therefore, the design maximum daily organic loading is:

Residential; 88,500 ℓ @ 250 m/ℓ =	22.1 kg/day BOD_5
Infiltration; 88,500 ℓ x 30% @ 25 m/ℓ =	.7 kg/day BOD_5
Trucked Sewage; 1 truck @ 4,550 ℓ @ 250 m/ℓ =	1.1 kg/day BOD_5
Trucked Septage; 1 truck @ 4,550 ℓ @ 7000 m/ℓ =	31.9 kg/day BOD_5
School; 10,850 ℓ @ 250 =	2.7 kg/day BOD_5
Hospital, hotel; 2,100 ℓ @ 250 =	.5 kg/day BOD_5
	59.0 kg/day BOD_5

9.4 PRIMARY CELL SIZE

The maximum allowable primary cell organic loading is 56 kg/day/hectare. Therefore, the minimum primary cell size is 59 ÷ 56 = 1.05 hectare at full supply level (1.5 m of liquid in the cell).

One half of the primary cell hydraulic operating volume can be used for winter hydraulic storage. This allowable storage is equal to approximately 7,060 m^3.

9.5 REQUIRED LAGOON WINTER STORAGE

We propose 230 day winter storage with an allowable discharge period of June 16 to October 31 of any year. This discharge period would satisfy concerns with respect to ammonia on fish spawning.

The required winter storage would be 230 days x 107,000 ℓ = 24,610 m^3. Treated effluent would only be discharged after testing and confirmation that it meets License requirements.

NO SMELL

9.6 SECONDARY CELL STORAGE

The required storage in the secondary cell would be 24,610 – 7,060 = 17,550 m^3. This relates to a secondary cell size of 1.30 hectares at full supply level.

9.7 EXISTING WASTEWATER LAGOON SIZE

The full supply surface area comparison of the design lagoon to the existing lagoon is as follows:

Cell	Existing	Existing Required	(PREFERRED OPTION) Design Required with Septage	Design Required without Septage
Primary	0.79 hectare	0.47 hectare	1.05 hectare	0.51 hectare
Secondary	1.32 hectare	1.46 hectare	1.30 hectare	1.57 hectare
TOTAL	2.11 hectare	1.93 hectare	2.35 hectare	2.08 hectare

The above analysis shows that the existing primary cell is organically undersized for the design loading and cannot take trucked septage. The existing lagoon is also hydraulically overloaded for the design loading, even with the removal of the extraneous flow from the east lift station overflow pipe and direction of the proposed upgraded WTP reject water to Oak Creek.

The existing hydraulic and organic loading on the existing lagoon is at maximum capacity if the east lift station overflow pipe water from Oak Creek is eliminated. The difference in a new lagoon with allowing septage is that a much larger primary cell is required and the combined cell size is larger.

AFTER REMOVAL OF WASTE WATER PLANT ?

[redacted]

9.8 WASTEWATER LAGOON PHYSICAL DESIGN CRITERIA

CAN HANDLE
NO SMELL.
NO DAMAGE

The design criteria for a wastewater lagoon are:

- 4/1 inside slopes
- 3/1 outside slopes
- top to bottom elevation = 2.5 m
- maximum liquid operating depth = 1.5 m
- minimum distance from habitation = 300 m
- minimum berm width = 3 m
- minimum freeboard = .9 m
- minimum liquid depth = .3 m
- domestic wastes only including one truck load per day of septage. Maximum 10 truck loads per year of sewage/septage.
- seed 3.6 m of inside slopes, top and outside slopes
- gate valves on inlet, interconnecting and discharge pipes

9.9 TREATED EFFLUENT QUALITY FOR DISCHARGE

The lagoon as proposed in the Environmental Licence Application will be designed to provide the following treated effluent parameters:

BOD^5	< 30 mg/ℓ
Total Suspended Solids	< 30 mg/ℓ
Fecal Coliform	< 200 per 100 ml
Total Coliform	< 1500 per 100 ml
SAR	≤ 6

9.10 CONCLUSIONS AND RECOMMENDATIONS

Although the existing lagoon can probably handle existing loading, it shows signs of seepage ($160,000 to repair with a cut-off wall) and is too close to the community.

We therefore recommend that a new site be found and that a new two celled lagoon be constructed, at an estimated cost of $440,000 including contingency and engineering, but not including land, forcemain or road to the lagoon, which are site specific. We understand land may be available to the north or east of the exiting lagoon site.

The lagoon would be capable of accepting one truck load of septage per day and a total of truck loads per year of septage or sewage. The lagoon would have a 1.05 hectare primary cell and 1.30 hectare secondary cell.

10.3.4 Pump Capacity

Stantec undertook a draw down test at the lift station to determine the pump capacity. The draw down test indicated that the pump capacity is approximately 17.4 l/s. This compares to an estimated maximum hour flow of approximately 9 l/s. Therefore, the pump has adequate capacity provided there is not infiltration from Oak Creek through the existing overflow pipe.

The existing overflow pipe should be plugged and immediately replaced with a new overflow pipe with a gate valve. When Oak Creek reaches the level of the new overflow pipe, the valve would be closed. This is a short-term solution. A duplex pump system should be installed (no overflow required) or the lift station should be replaced.

10.3.5 Electrical

The panel is supplied with a 3 phase, 220 Volt power supply. This operates the pump motor, which could be sized up to 10 HP. The panel includes a 230 Volt, 1 phase power transformer that operates the auxiliary electrical systems.

The panel accepts control inputs from 3 floats. The floats provide high-level alarm, start/stop, and low level alarm signals. The floats were noted as being new.

The panel is likely original but is in fair condition. Some of the pump components such as the starter have been recently replaced and are in good condition. The panel gasket seal was intact but subsequent electrical work has left improperly sealed penetrations. The panel itself is heavily rusted on the bottom, but the internal electrical components do not show significant signs of corrosion. The interior components were operating as intended. No arching or wiring problems were observed. The alarm beacon is operational although the electrical operational scheme does not conform to current practices.

The panel is small and would require replacement only if additional equipment was incorporated.

10.4 RECOMMENDATIONS

The lift stations both require large investments to upgrade them to an acceptable condition. In our opinion, this investment is not justified and both lift stations should be replaced.

Appendix D

GEOTECHNICAL INVESTIGATION, OCT 2005
ENG-TECH CONSULTING LIMITED

ENG-TECH
CONSULTING LIMITED

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October 21, 2005

File No. 05-076-05

OCT 24

Stantec Consulting Ltd.
905 Waverley Street
Winnipeg, Manitoba
R3T 5P4

ATTENTION: Mr. Tim Stratton, P. Eng.

RE: Geotechnical Investigation, Baldur Lagoon - Baldur, Manitoba

Dear Mr. Stratton,

ENG-TECH Consulting Limited (ENG-TECH) has completed the requested geotechnical investigation and recommendations for up-grading the existing lagoon liners at the above location. The purpose of the investigation is to determine the underlain soils and groundwater conditions at the site followed by a seepage assessment as part of a feasibility study. In addition, comments on any unusual soil conditions and construction concerns are provided.

SCOPE of WORK

ENG-TECH completed the following scope of work:

- A test hole drilling and sampling program consisting of drilling a total of seven (7) test holes. The test holes were each drilled to a depth of 9.1 m below grade, with the exception of one test hole which was drilled to auger refusal at 2.3 m below grade. Test holes were drilled using 125 mm diameter solid stem continuous flight augers. Soil samples were collected off the auger flights and by Shelby tubes, at select depths and retained for testing. The soil stratigraphy was recorded at the time of drilling and all soil samples were retained for testing in ENG-TECH's Winnipeg laboratory.

- A vertical and horizontal survey of the each test hole location. The grade elevation of each test hole was referenced to the concrete pump station located southwest of the existing lagoons and was obtained using an engineer's level. The horizontal location was obtained by means of a hand held GPS (global positioning system) unit.

- A laboratory testing program consisting of moisture content analysis completed on all samples collected, two (2) Atterberg Limits, two (2) Particle Size Analyses, and a hydraulic conductivity test using a flexible wall permeameter.

- An engineering report outlining the geotechnical investigation. The report includes: a general site plan (including the test hole locations), test hole summary logs, laboratory test results, seepage modelling results and recommendations, and recommendations related to up-grading the lagoon liners. In addition, comments on unusual soil conditions and potential construction concerns are provided.

BACKGROUND

The existing lagoon is located within the northeast section of the town of Baldur, and is situated on relatively flat farm land bordered to the east and south by a small creek. The materials used to construct the lagoon berms consisted of a mixture of highly plastic organic clay fill and medium plastic silty clay. At the time of the investigation the elevation of the berms varied throughout the site and at some locations the lagoon effluent level was observed at or slightly above the top of the lagoon berms.

LOCAL GEOLOGY, GROUNDWATER CONDITIONS, and GROUNDWATER SUPPLY

Review of local geological maps and water well logs at 13-5-14W show that the typical subsurface stratigraphy in the area of Baldur Manitoba typically consists of weather surficial clays underlain by clay till followed by alternating hard and soft shale. Geological maps indicate that the bedrock interface is typically encountered approximately 30 m below grade, and consists of shale from the Odanah Member.

During drilling, perched groundwater was encountered above the underlying clay till between 0.6 and 2.7 m below existing grade. This perched groundwater does not constitute a useable potable water supply, and is separated from the underlying aquifer typically used for a potable water supply located approximately 80 m below grade. As such, the potential for environmental impact on the underlying aquifer is unlikely due to the thickness of the overlying clay till and shale deposits.

TEST HOLE DRILLING, SOIL SAMPLING, and LABORATORY TESTING

ENG-TECH supervised the drilling of seven (7) test holes (TH1 to TH7) at the site on August 2, 2005 with the test hole locations shown in Figure 1. The test holes were drilled using an S61 Nodwell track drill rig equipped with 125 mm diameter solid stem augers owned and operated by Paddock Drilling Ltd. The test holes were each advanced to a depth of 9.1 m below existing grade, with the exception of TH3 of which was drilled to auger refusal on a suspected boulder at 2.3 m below existing grade. Upon completion of drilling the depth of groundwater was measured and recorded from each test hole and then backfilled with bentonite pellets at test holes located along the top of the lagoon berms. Where as the remaining test holes located outside the lagoon footprint were backfilled with a mixture of auger cuttings and bentonite pellets. A vertical and horizontal survey was completed for each test hole, where the vertical grade elevation was obtained with reference to the existing concrete pump station located southwest of the site using an engineer's level, and further verified using a topographic contour survey plan provided by Stantec Consulting Ltd. The horizontal elevation was obtained by a hand held GPS unit.

Grab soil samples were collected off the auger flights and by Shelby tubes as required. The soil stratigraphy was visually classified at the time of drilling using the modified Unified Soil Classification System (USCS). Pocket Penetrometer and Torvane tests were completed at various depth intervals to evaluate the consistency of the cohesive soils. Shelby tube soil samples were also collected at various test hole locations for possible hydraulic conductivity testing.

In ENG-TECH's Winnipeg laboratory moisture contents were completed on all samples collected. In addition, two (2) Atterberg Limits and two (2) Particle Size Analyses were completed on samples collected from TH2 and TH5 at depths of 1.2 m and 2.0 m, respectively. In addition, a hydraulic conductivity test was completed to determine the hydraulic conductivity value of the existing berm material. A sample from TH2 at 1.2 m below the top of the berm was tested to determine the hydraulic conductivity value in accordance with ASTM D5084-00, Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials using a Flexible Wall Permeameter. The final hydraulic conductivity value (k_{20}) of 2.6×10^{-8} cm/sec and was obtained from the sample. The hydraulic conductivity test data is outlined in Table 1, and a graphical representation of the hydraulic conductivity versus elapsed time is shown in Figure 3.

The moisture contents and Atterberg Limits are summarized on the test hole logs, where the Particle Size Analysis reports are appended to the report.

STRATIGRAPHY

Overall, the stratigraphy of the lagoon berms (TH1, TH2, TH5, and TH6) consisted of a mixture of highly plastic organic clay fill and medium plastic silty clay. The upper stratigraphy consisted of a thin layer of topsoil underlain by black, highly plastic organic clay fill extending to a depth between 2.0 and 2.6 m below grade (between elev. 24.6 to 25.0 m). The organic clay fill was moist, very stiff, and contained in excess of 35% silt content. Underlying the organic clay was medium plastic silty clay extending between 3.0 and 4.4 m below grade (between elev. 23.0 to 24.0 m) to the underlying native clay till. The silty clay was dark grey, moist, stiff to firm, containing in excess of 35% silt content with trace sand & gravel sizes, with the exception of test hole TH7 where medium plastic clayey silt was encountered and was light brown and soft. The native clay till was highly plastic, brown between 4.6 to 5.8 m below grade and dark grey below, stiff, contained some silt with trace sand & gravel sizes.

The soil stratigraphy at test holes TH3, TH4 and TH7 were drilled outside the berms and consisted between 0.1 to 0.5 m of topsoil underlain by medium plastic sandy clay at TH3 and TH4, where medium plastic clayey silt was encountered at TH7. The sandy clay at TH3 and TH4 was dark brown, moist, firm, contained in excess of 35% sand sizes, with silt. The clayey silt at TH7 was light brown, very soft, moist, and contained in excess of 35% soil content. Underlying the sandy clay and clayey silt (elev. between 24.0 and 24.1 m) was native clay till.

In general, seepage was observed in all test holes ranging in depths between 0.6 m to 2.7 m below grade (between elev. 24.1 and 25.9 m). More detailed descriptions of the stratigraphy are shown on the test hole summary logs attached.

SEEPAGE ANALYSIS

The objective of the seepage analyses was to model the existing seepage conditions from the lagoon to the surrounding area as part of a feasibility study into the possibility and effectiveness of up-grading the existing lagoon. In addition, recommendations for up-grading the existing lagoon were to be modelled.

The seepage assessment was completed using Seep/W, a 2-dimensional commercial computer program that is based on the finite element method for seepage in porous media. In order to simplify the analysis, and to account for natural site variability in the soil conditions, the following assumptions and modelling techniques were undertaken:

- A review of the field investigation, test hole logs, test results, and topographic survey was competed in order to select a portion of the lagoon to be modelled. A cross-section passing through the north and south berms of the western cell was selected, as shown in Figure 1.

- Seepage through the sides of the western cell of the lagoon was modeled in 2-dimensions using a rectangular cross-section to represent the cell. The cross-section through the western cell was selected due to the underlying soil conditions which were considered to be the most permeable throughout the entire lagoon based on the site investigation.

- Seepage through the base and berm of the entire lagoon area (both eastern and western cells) was modelled in 2-dimensions using an axisymmetric cross-section to represent the lagoon. The axisymmetric cross-section was derived by setting the length of the cross-section equal to the radius of a circle that would result in a perimeter equal to the exterior perimeter of the lagoon, excluding the common berm separating the two cells. A final axisymmetric length of 112 m was used to represent the entire lagoon.

- Steady state seepage conditions were assumed for all modeling cases.

- The elevations used in modeling the geometry of the lagoon were based on information obtained from the topographic survey provided by Stantec Consulting Ltd.

- A constant water surface level (Total Head Elev. = 26.9 m) in the lagoon was assumed and maintained for all modeling cases. This elevation corresponds to the top elevation of the south berm where overtopping of the lagoon berm was observed during the field investigation.

- The depth of the lagoon was not measurable and was obtained from Stantec Consulting Ltd. A recommended depth of 1.5 m was used in the seepage assessment, corresponding to a lagoon base elevation of 25.4 m.

- The stratigraphy was modeled using the information obtained from the test holes and represents a worst case scenario when considering the hydraulic conductivities. When a question regarding which hydraulic conductivity value was to be modeled, the higher value (most conservative) was used. The dimensions of the cell were obtained from a topographic survey provided by Stantec Consulting Ltd.

- The stratigraphy of the cross-sections was simplified by using direct connections between soil deposits based on the results of ENG-TECH's field investigation. The stratigraphy of the modeled cross-sections is not considered to be an exact representation of the actual stratigraphy at the lagoon. The stratigraphy as shown in Figure 2 is based on the interpretation of the test hole data.

- The hydraulic conductivity values used were based on laboratory test results completed by ENG-TECH and on typical values for the soils encountered at the site.

- The ratio of the vertical to horizontal hydraulic conductivities (Ky/Kx) was assumed equal to 1. This assumption is reasonable because the organic clay, clayey silt, and clay till layers at the site were relatively uniform in their deposition, with no significant preferential fractures or flow paths observed.

- The natural groundwater level was modeled at the elevations observed at the time of drilling. A groundwater elevation of 25.0 m was modeled at the north boundary of the model, with a groundwater elevation 24.2 m modeled at the south boundary of the model.

- The 2-dimensional models are limited as they only allow flow in 2-dimensions, through the bottom of the cross-section and the end of the cross-sections. To model 3-dimensional flows from the lagoon using 2-dimensional axisymmetric analyses, the unit flow per radian was multiplied by the number of radians required to match the perimeter of the lagoon (2π).

The assumptions and modelling techniques listed above were used in order to model the approximate soil and seepage conditions of the lagoon. These assumptions have allowed a 3-dimensional problem to be analysed using 2-dimensional modelling. The axisymmetric geometric modelling of the cells is not realistic in that it assumes the rise or conversely the dip in the underlying soil layers uniformly circles the lagoon. Conversely, rectangular geometric modelling of the cells is not entirely representative of the true site conditions in that it restricts water movement to 2 dimensions. By comparing the axisymmetric and rectangular results, the sensitivity of seepage from the lagoon due to the non-uniformity of the underlying soils and 3-dimensional particle movement of water can be assessed.

The rectangular and axisymmetric cross-sections used in the analyses are shown in Figure 2. The locations where the rate of seepage was determined, also called flux sections, are also shown on each cross-section in Figure 2.

The hydraulic conductivities used in the analysis are outlined below:

Material Description	Saturated Vertical Hydraulic Conductivity (Ky) as tested (cm/sec)	Saturated Vertical Hydraulic Conductivity (Ky) used in modelling (cm/sec)	Hydraulic Conductivity Ratio (Ky/Kx)
Organic Clay (OH)	2.6×10^{-8}	2.6×10^{-8}	1.0
Clayey Silt (MH)	*	Variable – See Table 2	1.0
Silty Clay (CI)	*	Variable – See Table 2	1.0
Clay Till (CH)	*	1.0×10^{-7}	1.0

* These values were obtained from hydraulic conductivity tests on soils of similar gradation.

The seepage analyses were completed using a total of 16 different trials as summarized in Table 2. The hydraulic conductivity values for the organic clay and clay till layers were assumed constant at the values outlined in the table above, while the sensitivity of seepage through the sides of the lagoon (berms) to changes in the hydraulic conductivity of the clayey silt/silty clay layer was assessed or hydraulic conductivities of 1.0×10^{-9} cm/sec, 5.0×10^{-9} cm/sec, 7.5×10^{-9} cm/sec, and 1.0×10^{-8} cm/sec.

During the modelling, the rectangular model and the axisymmetric model yielded comparable results for all of the model variations, although the calculated seepage volumes through the berms of the lagoon using the axisymmetric model were slightly greater then the rectangular model. Axisymmetric analyses indicate that only minor seepage occurs from the lagoon, with approximately 135 L/day seeping from the entire lagoon for a clayey silt/silty clay hydraulic conductivity of 1.0×10^{-8} cm/sec. Further review of the axisymmetric model indicated that prior to installing a clay cut-off trench, most of the seepage from the lagoon occurs through the silty clay and clayey silt layers underlying the berms. Specifically, 65.0%, 89.5%, 92.5%, and 94.1% of the seepage from the lagoon exited through the silty clay/clayey silt layers for silty clay/clayey silt hydraulic conductivities of 1.0×10^{-9} cm/sec, 5.0×10^{-9} cm/sec, 7.5×10^{-9} cm/sec, and 1.0×10^{-8} cm/sec, respectively.

The quantity of seepage(s) is only indicative of water seeping from the lagoon, and does not indicate any quantities of contaminant transfer from the lagoon. Contaminant transfer would be affected by filtration from the soils, the dispersion of the contaminants within the lagoon, and such transport mechanisms as: Advection, Diffusion, Dispersion, Sorption, and Decay. The worst case scenario would be to assume the water seeping from the lagoon was uniformly contaminated by miscible contaminants which flow at the same rate as water and not impacted by any of the above transport mechanisms. An immiscible contaminant will have a different seepage rate than water, and that of a particulate contaminant will be different as well. An immiscible contaminant and a particulate contaminant may be entirely filtered by the sands, silts and clays as the water seeps from the lagoon.

DISCUSSION & RECOMMENDATIONS

Testing of the organic clay constituting the berm materials indicated that the upper portion of the berms still achieve the maximum permissible hydraulic conductivity of 1×10^{-7} cm/s required by Manitoba Conservation for newly constructed lagoons. In addition, modelling indicates that the clay till underlying the base of the lagoon provides an adequate barrier between the lagoon effluent and the potable groundwater source, and there is minimal concern for contamination of the potable water supply. Consequently, the field investigation and laboratory test results indicate that the lagoon base and berms are underlain by either a silty clay or clayey silt layer, situated immediately above the clay till. The hydraulic conductivities of the silty clay and clayey silt layers are expected to exceed the maximum permissible hydraulic conductivity of 1×10^{-7} cm/sec, as evidenced by their plasticity, Particle Size Analysis, and moisture content results.

In addition to the above, overtopping of the lagoon was evident at the time of drilling indicating that the operational level is exceeding the capacity of the lagoon. In order to prevent further overtopping of the lagoon, either a preset operational level should be established and maintained below the existing top of berm elevations, or the lagoon capacity should be increased as required.

ENG-TECH recommends that the berms of the lagoon be up-graded with a clay cut-off trench to reduce the potential for seepage through the silty clay and clayey silt layers such that the up-graded lagoon conforms to Manitoba Conservation specifications (i.e. the berm materials extending to 1 m below the base of the lagoon have a maximum hydraulic conductivity of 1.0×10^{-7} cm/sec over a minimum berm width of 1 m). Up-grading of the base of the lagoon is not anticipated due to the highly plastic nature and layer thickness of the underlying clay till soils. Due to budget constraints, the clay till could not be tested for hydraulic conductivity, however the till is expected to be capable of achieving a hydraulic conductivity of 1.0×10^{-7} cm/sec.

Outlined below are two potential lagoon up-grade options which could be used to reduce potential seepage from the silty clay/clayey silt layers. Selection of which option to implement will depend on an economic assessment of the construction costs and approval by Manitoba Conservation. Alternatively, a third option may be the decommissioning of the existing lagoon and construction of a new lagoon.

Lagoon Up-grade Option 1 (preferred option) - Clay Cut Off Trench

The silty clay and clayey silt layers underlying the berms and the base of the lagoon could be up- graded to meet the hydraulic conductivity criterion with the installation of a 1.2 m wide clay cut off trench. The clay cut off could consist of either the same organic clay used in construction of the existing berms or could consist of inorganic highly plastic clay, and should have a hydraulic conductivity (K_{20}) of less than 1×10^{-7} cm/sec.

Typically a clay cut-off is installed through the centre of the lagoon berm and extends from above the top of the berm into the underlying clay till, and is the preferred up-grade option. The cut-off is insulated from the effects of frost and desiccation by the surrounding berm materials, and consequently there is a reduction in the potential for the formation of fissures or preferential flow paths due to environmental effects. The clay cut-off should extend from the top of the berm to a keyed depth of 0.5 m into the underlying clay till to ensure a proper seal between the clay cut-off and clay till, and should extend around the entire perimeter of the lagoon. The resulting depth of the clay cut-off is expected to vary between 1.2 and 4.0 m below grade.

The installation of a clay cut-off offers the added benefit of sampling the underlying clay till to confirm the suitability of the underlying till as an in-situ lagoon liner, thereby identifying whether or not an up-grade to the lagoon liner is required.

Axisymmetric seepage analyses show that with the installation of a clay cut off trench having the same hydraulic conductivity properties as the existing organic clay berm, seepage through the sides of the lagoon would be reduced by between 41% and 52 % for silty clay/clayey silt hydraulic conductivities ranging between 5.0 x 10^{-9} cm/sec and 1.0 x 10^{-8} cm/sec. Consequently, the downward seepage of the effluent through the clay till would increase slightly, resulting in minimal change of the total volume seepage through both the sides and the base of the lagoon, with an overall seepage reduction of between 7.5 and 17.6 % for silty clay/clayey silt hydraulic conductivities ranging between 5.0 x 10^{-9} cm/sec and 1.0 x 10^{-8} cm/sec. Overall, analyses of the up-graded berms indicate the maximum seepage through the sides of the lagoon is not expected to exceed 50 L/day, whereas the total seepage from the entire lagoon is not expected to exceed 115.0 L/day.

Lagoon Up-grade Option 2- Liner Installation

Alternatively, a geomembrane or clay liner could be installed along the inside of the berms in order to reduce seepage from the lagoon, and could extend into the underlying clay till. There is no need to place a liner along the base of the lagoon since the clay till underlying the base is expected to achieve a maximum hydraulic conductivity (K_{20}) of 1 x 10^{-7} cm/sec. This option is generally considered secondary to the clay cut-off option outlined above due to the exposure of the liner to the surrounding environment and the potential for damage to the liner. Alternatively the liner could be placed in a trench, keyed into the clay till with continuous welds.

Construction Considerations

Although sloughing was not observed during drilling, a perched groundwater table overlying the clay till was observed and could present difficulties during excavation of a trench, as such dewatering equipment will likely be required during excavation. In addition, a clay cut-off trench should be excavated and completely backfilled on a daily basis in order to reduce the potential for sloughing of the trench walls, and to prevent overnight seepage into the open excavation.

Although the minimum width of the clay cut off trench will be 1.2 m, for construction purposes the trench may have to be slightly wider in order to facilitate soil placement and to ensure adequate compaction. Shoring of the side walls of the trench may also have to be conducted in some areas along the lagoon for both constructability and worker safety. Entrance into the trench without shoring should not be permitted and would be in violation of Provincial Laws and Regulations. The use of a remote controlled sheeps foot roller or a compactor attached to a hoe should be considered to facilitate compaction.

The degree of compaction on clay soils in order to achieve a hydraulic conductivity value less than 1.0 x 10^{-7} cm/sec will depend on the Atterberg Limits and Particle Size distribution of the material being used. Generally, for highly plastic clays the use of 95% of MDD at optimum moisture content will suffice. Lower density values while satisfying the maximum hydraulic conductivity value may be possible, but will depend on other factors such as, clay borrow source, pre testing of clay samples and site inspections during construction. For lower plastic clays the required degree of compaction is normally higher to reduce the size of the voids in the soil being used for the cut off trench.

CLOSURE

The findings and conclusions presented in this report were based on the scope of work outlined for the purpose of the investigation. The findings and conclusions presented herein were prepared in accordance with acceptable professional engineering principles and practices. If you have any questions, please contact the undersigned.

Sincerely,
ENG-TECH Consulting Limited

Clark Hryhoruk, M.Sc., P.Eng.
Principal, Geotechnical Engineer

C.D. HRYHORUK
Oct 21/05
REGISTERED PROFESSIONAL ENGINEER

CDH/kwj

Attachments:

- Figure 1 – Test Hole Locations
- Figure 2 – Rectangular & Axisymmetric Cross-Sections
- Figure 3 – Hydraulic Conductivity Versus elapsed Time (TH2 - S2)
- Table 1 – Hydraulic Conductivity Test Data
- Table 2 – Estimated Seepage Rates
- Test Hole Summary Log (7)
- Particle Size Analysis Report 5-76-5-1 & 2

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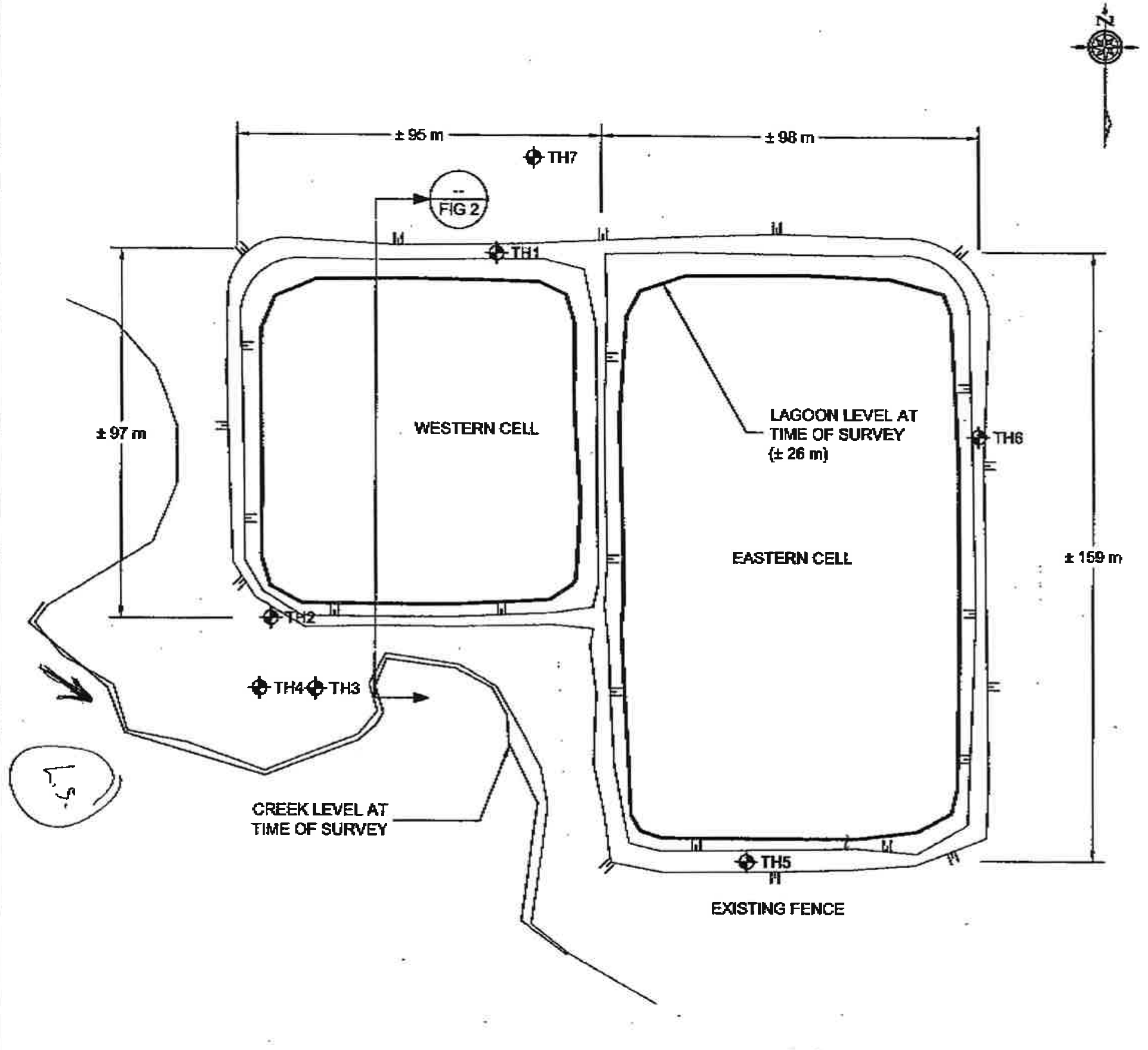

NOTES:

- TEST HOLE LOCATIONS OVERLAYED ON TOPOGRAPHIC SURVEY AS PROVIDED BY STANTEC CONSULTING LTD.

No.	DD/MM/YYYY	DESCRIPTION	BY
No.	DD/MM/YYYY		BY

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#6 - 854 Marion Street
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APEGM Certificate of Authorization ENG-TECH Consulting Limited No. 3179 Expiry: April 30, 2006

CLIENT: STANTEC CONSULTING LTD.

PROJECT: GEOTECHNICAL INVESTIGATION
BALDUR LAGOON
BALDUR, MANITOBA

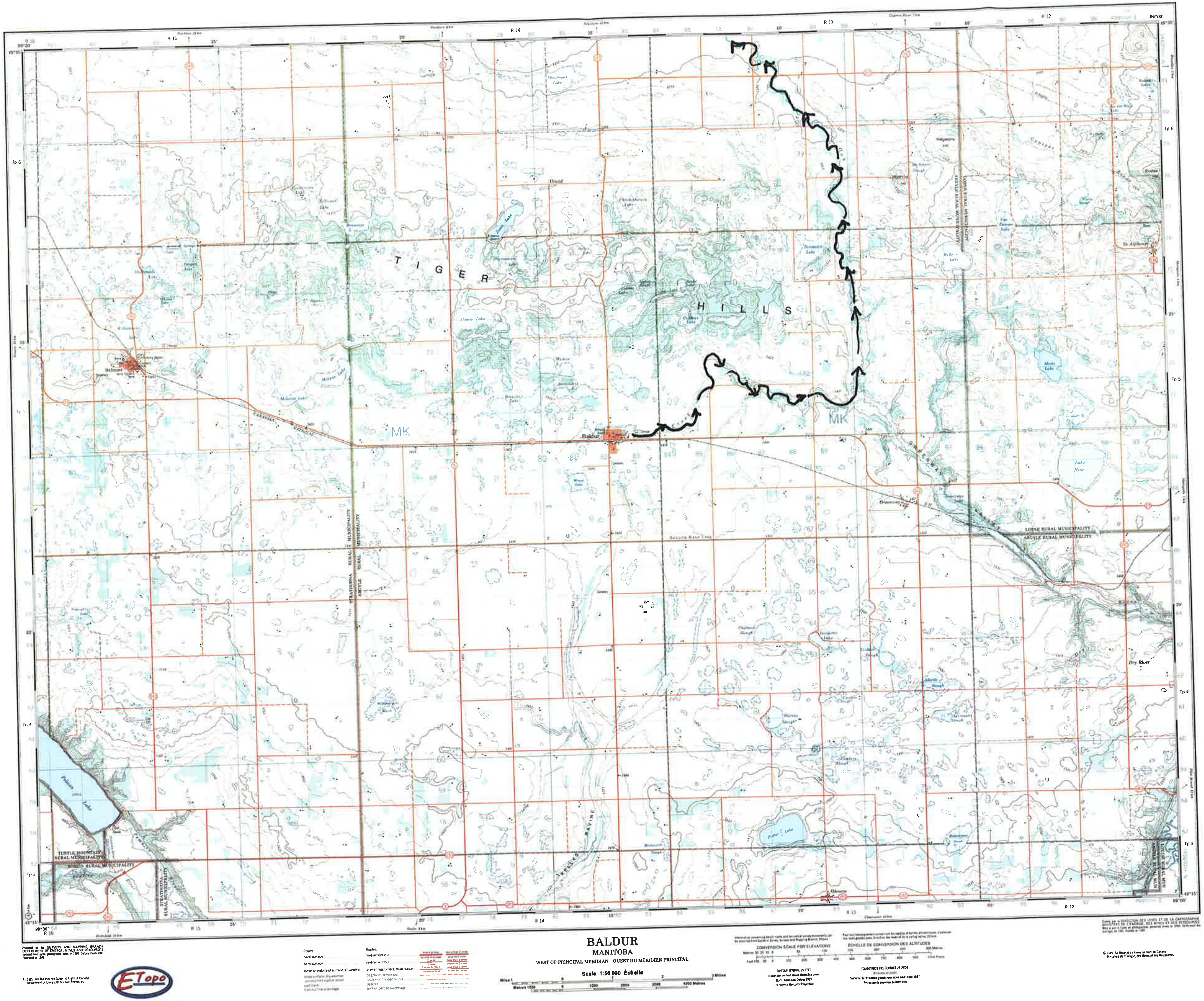
DWG DESCRIPTION: TEST HOLE LOCATIONS

SCALE: NOT TO SCALE

DRAWN BY:	DATE:
KWJ	OCTOBER 2005
FILE No.: 05-076-05	CLIENT DWG/FIG. No.:
ENG-TECH DWG/FIG. No.: 1	REV.: 0

Appendix E

BALDUR LAGOON DISCHARGE ROUTE – OAK CREEK



Baldur Lagoon Discharge route (Oak Creek)

Appendix F

BALDUR LAGOON – PHOTOGRAPHS TAKEN FROM SITE VISIT SEPT 2012

RM of Argyle (Baldur Lagoon): Sept 2012

Perimeter Fencing seen on left; Lift Station in the background

Lift Station

Oak Creek Upstream of Lagoon, behind Baldur Weir

Oak Creek Downstream of Lagoon: No flow indicative of no seepage

Clearing of excess growth at Baldur lagoon (2011)